Construction & Operations Plan

Ocean Wind Offshore Wind Farm

Volume II

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Submitted by:

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An Ørsted & PSEG project

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Certain information included in this Construction and Operations Plan (COP) qualifies as trade secrets and/or commercial or financial information that is privileged and confidential, and which is exempt from public disclosure under the Federal Freedom of Information Act (5 United States Code [U.S.C.] § 552(b)(4)) (as reflected in the Bureau of Ocean Energy Management's [BOEM's] regulations at 30 Code of Federal Regulations [CFR] §§ 585.113 and 585.620). This privileged and confidential information is also exempt from public disclosure under the New Jersey Open Records Act (pursuant to New Jersey Statutes Annotated [N.J.S.A.] 47:1A).

Ocean Wind LLC has marked each Appendix in this COP which contains privileged and confidential material with the legend "Contains Confidential Information", and requests that BOEM (and each federal and state agency to which a copy of this COP is provided) withhold these designated materials from public disclosure.

Construction and Operations Plan - Overall Outline

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μg/L	micrograms per liter
A	Ampere
AC	alternating current
ACS	American Community Survey
AIS	Automatic Identification System
AMAPPS	Atlantic Marine Assessment Program for Protected Species
ANL	Argonne National Laboratory
APE	Area of Potential Effect
APM	Applicant Proposed Measures
AQRV	appropriate air quality related value
ARSR	air route surveillance radar
ASAC	Air Station Atlantic City
ASMFC	Atlantic States Marine Fisheries Commission
ASR	airport surveillance radar
ATON	aids to navigation
AWOIS	Automated Wreck and Obstruction Information System
BERR	Department for Business Enterprise & Regulatory Reform
BLS	Bureau of Labor Statistics
BMP	best management practices
BOEM	Bureau of Ocean Energy Management
BRI	Biodiversity Research Institute
Caltrans	California Department of Transportation
CBRA	Coastal Barrier Resources Act
CBRS	Coastal Barrier Resources System
CEAs	Classification Exception Areas
CFR	Code of Federal Regulations
cm	centimeter
CMECS	Coastal and Marine Ecological Classification Standard
CO	carbon monoxide
CO2	carbon dioxide
COA	Corresponding Onshore Area
CODAR	coastal ocean dynamics applications radar
COP	Construction and Operations Plan
CPT	cone penetration test
CPUE	catch per unit of effort
CTD	conductivity, temperature, and depth
DASR	digital airport surveillance radar
dB	decibels
DC	direct current
DHI	Danish Hydraulic Institute
DHS	Department of Homeland Security
DO	dissolved oxygen
DoD	Department of Defense
DoN	Department of the Navy
DPS	distinct population segment

Eagle Act	Bald and Golden Eagle Protection Act
EBS	Ecological Baseline Studies
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
eGRID	Emissions & Generated Resource Integrated Database
EMF	electromagnetic fields
ESA	Endangered Species Act
ESRI	Environmental Systems Research Institute
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FIRMs	flood insurance rates maps
FLiDAR	floating light detection and ranging
FMP	fishery management plan
FR	Federal Register
ft	feet
FW2	estuarine freshwaters
GIS	Geographical Information System
GMWD	Global Maritime Wrecks Database
HAPC	habitat areas of particular concern
HDD	horizontal directional drilling
HRG	high resolution geophysical
HRG&G	high-resolution geophysical and geotechnical
HUC	hydrologic unit code
HVDC	high-voltage direct current
Hz	hertz
IBA	important bird area
ICPC	International Cable Protection Committee
IHA	incidental harassment authorization
in	inch
IPaC	information for planning and conservation
IPF	impact-producing factors
KCSs	known contaminated sites
kHz	kilohertz
km	kilometers
LA	limited access
LAGC	limited access general category
LSRP	licensed site remediation professional
LULC	land use/land cover
m	meter
m/s	meter per second
MAFMC	Mid-Atlantic Fishery Management Council
MDAT	Marine-life Data and Analysis Team
MEC	munitions and explosives of concern
mg/L	milligrams per liter
µg/L	micrograms per liter
µg/m3	micrograms per cubic meter
mG	milliGauss

MGEL	Marine Geospatial Ecology Lab
$mL/m^2/s$	milliliters per square meter per second
MLLW	mean lower low water
mm	millimeter
µm	micrometer
µT	microtesla
MMP	materials management plan
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MMSC	Marine Mammal Stranding Center
MOU	Memorandum of Understanding
MPA	marine protected area
mph	miles per hour
MSA	Magnuson-Stevens Fishery Conservation and Management Act
msl	mean sea level
MW	megawatt
N.J.A.C	New Jersey Administrative Code
N.J.S.A.	New Jersey Statutes Annotated
NAAQS	National Ambient Air Quality Standards
NARW	North Atlantic right whale
NEFMC	New England Fishery Management Council
NEFSC	Northeast Fisheries Science Center
NEPA	National Environmental Policy Act
NERRS	National Estuarine Research Reserve System
NETR	National Environmental Title Research
NHPA	National Historic Preservation Act
NJAAQS	New Jersey Ambient Air Quality Standards
NJDEP	New Jersey Department of Environmental Protection
NJDFW	New Jersey Division of Fish and Wildlife
NJDLWD	New Jersey Department of Labor and Workforce Development
NJDOT	New Jersey Department of Transportation
NJGIN	New Jersey Geographic Information System
NJHPO	New Jersey Historic Preservation Office
NJMM	New Jersey Maritime Museum
nm	nautical miles
NMFS	National Marine Fisheries Service
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPL	National Priorities List
NPP	net primary productivity
NRHP	National Register of Historic Places
NSRA	Navigation Safety Risk Assessment
NT	non-trout
NTU	nephelometric turbidity unit
NVIC	navigation and inspection circular
NWI	National Wetlands Inventory

O_3	ozone
ºC	degrees Celsius
Ocean Wind	Ocean Wind LLC
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OCW01	Ocean Wind Offshore Wind Farm
OPAREA	Operating Area
Orsted	Orsted Wind Power North America LLC
OSRP	Oil Spill Response Plan
PAM	passive acoustic monitoring
Pb	lead
PDE	Project design envelope
PL	pinelands water
PM	particulate matter
PMA	Pineland Management Area
ppm	parts per million
Project	Ocean Wind Offshore Wind Farm (OCW01)
PSMMP	protected species mitigation and monitoring plan
PSO	protected species observer
PSU	practical salinity unit
PTS	permanent threshold shift
QMA	qualified marine archaeologist
ROW	right-of-way
RMS	root mean square
RSZ	rotor-swept zone
SAR	Stock Assessment Report
SAV	submerged aquatic vegetation
SE1	brackish
SEFSC	Southeast Fisheries Science Center
SEL	sound exposure levels
SEL_{cum}	cumulative sound exposure levels
SHPO	State Historical Preservation Office
SO_2	sulfur dioxide
SPCC	spill prevention, control, and countermeasures
SPL	sound pressure level
SRHP	State Register of Historic Places
SSS	sea surface salinity
SST	sea surface temperature
SWPPP	stormwater pollution prevention plan
SWQS	surface water quality standards
TDS	total dissolved solids
TJB	transition joint bays
TSS	total suspended solids
TTS	temporary threshold shift
UME	unusual mortality event
USACE	United States Army Corps of Engineers
USAF	United States Air Force

USCG	United States Coast Guard
USDA	United States Department of Agriculture
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USTs	underground storage tanks
UXO	unexploded ordinances
VIA	visual impact assessment
VMS	vessel monitoring systems
VOCs	volatile organic compounds
VTR	vessel trip report
WEAs	Wind Energy Areas
WMA	Watershed Management Area
WRP	Wildlife Restoration Partnerships
WTG	wind turbine generator
YOY	young of the year

Ocean Wind LLC (Ocean Wind), an affiliate of Orsted Wind Power North America LLC (Orsted) is developing the Ocean Wind Offshore Wind Farm Project (OCW01, Offshore Wind Farm, or Project) pursuant to the Bureau of Ocean Energy Management (BOEM) requirements for the commercial lease of submerged lands for renewable energy development on the outer continental shelf (Lease Area OCS-A 0498). A complete description of the Project is provided in Volume I of this Construction and Operations Plan (COP) and should be read in conjunction with this Volume. This Volume (Volume II) includes a summary of potential impact producing factors and applicant proposed measures to avoid, minimize, and mitigate impacts in Section 1. Section 2 includes a description of the affected environment and assessment of potential impacts.

1. Potential Impact Producing Factors, Applicant Proposed Impact Minimization Measures, and Summary of Project Impacts

1.1 Potential Impact Producing Factors and Applicant Proposed Impact Minimization Measures

This section includes a summary of impact producing factors (IPFs) related to construction, operation and maintenance, and decommissioning activities **(Table 1.1-1)** as well as the Applicant Proposed Measures (APMs) to avoid, minimize, or mitigate impacts, and monitoring, by resource area (**Table 1.1-2)**. In Section 2 below, the environment that may be affected by the proposed Project activities is described as well as an analysis of potential impacts, associated with these IPFs. This analysis was used to develop proposed impact minimization measures (APMs presented in **Table 1.1-2**).

Table 1.1-1. Potential impact producing factors.

Resource	Impact Producing Factors									
	1 Physical seabed/land disturbance	2 Sediment suspension	3 Discharge/releases and withdrawals	4 Air emissions	5 Habitat conversion	6 Noise	7 Electromagnetic fields (EMF)	8 Traffic	9 Visible structures/lighting	10 Land use, economic change
Geological Resources	●	●								
Water Quality	●	●	●							
Air Quality				●				●		
Terrestrial and Coastal Habitats	●	●	●		●					
Terrestrial and Coastal Fauna	●	●			●	●	●	●		
Birds	●				●	●		●	●	
Bats					●	●		●	●	

Resource	Impact Producing Factors									
	1 Physical seabed/land disturbance	2 Sediment suspension	3 Discharge/releases and withdrawals	4 Air emissions	5 Habitat conversion	6 Noise	7 Electromagnetic fields (EMF)	8 Traffic	9 Visible structures/lighting	10 Land use, economic change
Benthic Resources	●	●	●		●	●	●	●		
Fish and Essential Fish Habitat (EFH)	●	●	●		●	●	●	●		
Marine Mammals	●					●		●		
Sea Turtles	●					●		●		
Demographics, Employment, and Economics						●		●		●
Environmental Justice				●		●		●	●	●
Recreation and Tourism	●	●			●	●	●	●	●	●
Commercial and For-Hire Recreational Fishing	●	●			●	●		●	●	●
Land Use and Coastal Infrastructure	●		●			●		●	●	●
Navigation and Vessel Traffic								●	●	●
Other Marine Uses								●	●	
Cultural, Historical, and Archeological Resources	●								●	

The proposed APMs presented in **Table 1.1-2** were developed based on BOEM's best management practices (BMPs; Appendix S) and APM numbers were assigned to allow for easy reference to specific measures.

Table 1.1-2. Applicant proposed measures (APMs) to avoid, minimize, or mitigate impacts, and monitoring (Bold items are beyond the requirements of or more specific than BOEM BMPs).

APM Number*	Applicant Proposed Measure**	Geological Resources	Water Quality	Air Quality	Terrestrial & Coastal Habitats	Terrest. & Coastal Fauna	Birds	Bats	Benthic Resources	Fish & EFH	Marine Mammals	Sea Turtles	Demog. Employ. & Econ.	Environmental Justice	Rec. & Tourism	Comm. & For-Hire Rec. Fishing	Land Use & Coastal Infrastructure	Nav. & Vessel Traffic	Other Marine Uses	Cultural Resources
General																				
Project Siting																				
GEN-01	**Site onshore export cable corridors and landfall within existing rights-of-way or previously disturbed/developed lands to the extent practicable.**	●	●	●	●	●	●	●					●	●	●		●			●
GEN-02	Site onshore, cable landfall and offshore facilities to avoid known locations of sensitive habitat (such as known nesting beaches) or species during sensitive periods (such as nesting season); important marine habitat (such as **high density, high value fishing grounds as determined by fishing revenues estimate [BOEM Geographical Information System (GIS) Data** - see Section 2.3.4]**)**; and sensitive benthic habitat; to the extent practicable. Avoid hard-bottom habitats and seagrass communities, where practicable, and restore any damage to these communities.	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
GEN-03	Avoid areas that would require extensive seabed or onshore alterations to the extent practicable.	●	●	●	●	●	●	●	●	●	●	●				●	●			●
GEN-04	Bury **onshore** and offshore cables below the surface or seabed to the extent practicable and inspect offshore cable burial depth periodically during project operation, as described in the Project Description, to ensure that adequate coverage is maintained to avoid interference with fishing gear/activity.	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
GEN-05	**Use existing port and onshore operations and maintenance (office, warehouse, and workshop) facilities to the extent practicable** and minimize impacts to seagrass by restricting vessel traffic to established traffic routes where these resources are present.		●	●	●	●	●	●	●	●		●	●	●	●	●	●	●		●
GEN-06	Develop and implement a site-specific monitoring program to ensure that environmental conditions are monitored during construction, operation, and decommissioning phases, designed to ensure environmental conditions are monitored and reasonable actions are taken to avoid and/or minimize seabed disturbance and sediment dispersion, consistent with permit conditions. The monitoring plan will be developed during the permitting process, in consultation with resource agencies.	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

APM Number*	Applicant Proposed Measure**	Geological Resources	Water Quality	Air Quality	Terrestrial & Coastal Habitats	Terrest. & Coastal Fauna	Birds	Bats	Benthic Resources	Fish & EFH	Marine Mammals	Sea Turtles	Demog. Employ. & Econ.	Environmental Justice	Rec. & Tourism	Comm. & For-Hire Rec. Fishing	Land Use & Coastal Infrastructure	Nav. & Vessel Traffic	Other Marine Uses	Cultural Resources
	Design																			
GEN-07	**Implement aircraft detection lighting system (ADLS)[1] on wind turbine generators (WTGs).** Comply with Federal Aviation Administration (FAA), BOEM, and U.S. Coast Guard (USCG) lighting, marking and signage requirements to aid navigation per USCG navigation and inspection circular (NVIC) 02-07 (USCG 2007) and comply with any other applicable USCG requirements while minimizing the impacts through appropriate application including directional aviation lights that minimize visibility from shore**. Information will be provided to allow above water obstructions and underwater cables to be marked in sea charts, aeronautical charts, and nautical handbooks.**		●				●	●			●	●	●	●	●	●	●	●	●	●
	Construction																			
GEN-08	To the extent practicable, use appropriate installation technology designed to minimize disturbance to the seabed and sensitive habitat (such as beaches and dunes, wetlands and associated buffers, streams, hard-bottom habitats, seagrass beds, and the near-shore zone); avoid anchoring on sensitive habitat; and implement turbidity reduction measures to minimize impacts to sensitive habitat from construction activities.	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●
GEN-9	During pile-driving activities, **use ramp up procedures as agreed with National Marine Fisheries Service (NMFS) for activities covered by Incidental Take Authorizations,** allowing mobile resources to leave the area before full-intensity pile-driving begins.						●			●	●	●				●				
GEN-10	Prepare waste management plans and hazardous materials plans as appropriate for the Project.		●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
GEN-11	Establish and implement erosion and sedimentation control measures in a **Stormwater Pollution Prevention Plan (SWPPP**, authorized by the State), and Spill Prevention, Control, and Countermeasures (SPCC) Plan to minimize impacts to water quality (signed/sealed by a New Jersey Professional Engineer and prepared in accordance with applicable regulations such as NJDEP Site Remediation Reform Act, Linear Construction Technical Guidance, and Spill Compensation and	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	

[1] ADLS would be used to provide continuous 360-degree radar surveillance of the airspace around the Project from the sea level to above aircraft flight altitudes, automatically issuing signals to activate obstruction lighting when aircraft are detected at a defined outer perimeter.

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	Control Act). Development and implementation of an Oil Spill Response Plan (OSRP, part of the SPCC plan) and SPCC plans for vessels.																			
GEN-12	**Where HDD trenchless technology methods are used, develop, and implement an Inadvertent Return Plan that includes measures to prevent inadvertent returns of drilling fluid to the extent practicable and measures to be taken in the event of an inadvertent return.**	●	●		●	●	●		●	●	●	●		●		●	●		●	
	Restoration																			
GEN-13	**Restore disturbance areas in the Onshore Project Area to pre-existing contours** (maintaining natural surface drainage patterns) and allow vegetation to become reestablished once construction activities are completed, to the extent practicable.	●	●	●	●	●	●	●		●				●			●			
	Communication																			
GEN-14	Develop and implement a communication plan to inform the **USCG, Department of Defense (DOD) headquarters,** harbor masters, **public, local businesses**, commercial and recreational fishers, **among others** of construction and maintenance activities and vessel movements**, as coordinated by the Marine Coordination Center and Marine Affairs**.		●				●		●				●	●	●	●	●	●	●	
GEN-15	**Develop and implement an Onshore Maintenance of Traffic Plan to minimize vehicular traffic impacts during construction. Ocean Wind would designate and utilize onshore construction vehicle traffic routes, construction parking areas, and carpool/bus plans to minimize potential impacts.**			●		●	●						●	●	●		●			
GEN-16	Prior to the start of operations, Ocean Wind will hold training to establish responsibilities of each involved party, define the chains of command, discuss communication procedures, provide an overview of monitoring procedures, and review operational procedures. This training will include all relevant personnel, crew members and protected species observers (PSO). New personnel must be trained as they join the work in progress. Vessel operators, crew members and protected species observers shall be required to undergo training on applicable vessel guidelines and the standard operating conditions. Ocean Wind will make a copy of the standard operating conditions available to each project-related vessel operator.	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

APM Number*	Applicant Proposed Measure**	Geological Resources	Water Quality	Air Quality	Terrestrial & Coastal Habitats	Terrest. & Coastal Fauna	Birds	Bats	Benthic Resources	Fish & EFH	Marine Mammals	Sea Turtles	Demog. Employ. & Econ.	Environmental Justice	Rec. & Tourism	Comm. & For-Hire Rec. Fishing	Land Use & Coastal Infrastructure	Nav. & Vessel Traffic	Other Marine Uses	Cultural Resources
GEN-17	**Implement Project and site-specific safety plans (Safety Management System, Appendix B).**		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
GEN-18	**No permanent exclusion zones during operation**												●		●	●	●	●	●	
Geological Resources																				
GEO-01	Reduce scouring action by ocean currents around foundations and to seabed topography by taking reasonable measures and employing periodic routine inspections to ensure structural integrity.	●	●						●	●	●	●	●	●		●	●		●	●
GEO-02	Take reasonable actions (use BMPs) to minimize seabed disturbance and sediment dispersion during cable installation and construction of project facilities.	●	●			●			●	●	●	●				●			●	●
GEO-03	Conduct periodic and routine inspections to determine if non-routine maintenance is required.	●	●				●	●	●	●	●	●	●	●		●	●	●	●	●
GEO-04	**In contaminated onshore areas, comply with State regulations requiring the hiring of a Licensed Site Remediation Professional (LSRP) to oversee the linear construction project and adherence to a Materials Management Plan (MMP). The MMP prepared for construction can also be followed as a best management practice when maintenance requires intrusive activities.**	●	●		●	●	●		●	●	●	●	●	●	●	●	●			
Water Quality																				
WQ-01	Implement turbidity reduction measures to minimize impacts to hard-bottom habitats, including seagrass communities, from construction activities, to the extent practicable.		●						●	●	●	●				●				
WQ-02	**All vessels will be certified by the Project to conform to vessel operations and maintenance protocols designed to minimize the risk of fuel spills and leaks.**		●				●		●	●	●	●				●		●	●	
Air Quality																				
AQ-01	**Use low sulfur fuels to the extent practicable** (15 parts per million [ppm] per 40 Code of Federal Regulations [CFR] §80.510(c) as applicable).			●										●						
AQ-02	**Select engines designed to reduce air pollution to the extent practicable (such as U.S. Environmental Protection Agency [USEPA] Tier 3 or 4 certified).**			●										●						
AQ-03	**Limit engine idling time.**			●										●						

APM Number*	Applicant Proposed Measure**	Geological Resources	Water Quality	Air Quality	Terrestrial & Coastal Habitats	Terrest. & Coastal Fauna	Birds	Bats	Benthic Resources	Fish & EFH	Marine Mammals	Sea Turtles	Demog. Employ. & Econ.	Environmental Justice	Rec. & Tourism	Comm. & For-Hire Rec. Fishing	Land Use & Coastal Infrastructure	Nav. & Vessel Traffic	Other Marine Uses	Cultural Resources
AQ-04	**Comply with international standards regarding air emissions from marine vessels.**			●										●						
AQ-05	**Implement dust control plan.**	●	●	●																
	Terrestrial and Coastal Habitats and Fauna																			
TCHF-01	Coordinate with the New Jersey Department of Environmental Protection (NJDEP) and United States Fish and Wildlife Service (USFWS) to identify unique or protected habitat or known habitat for threatened or endangered and candidate species and avoid these areas to the extent practicable.				●	●	●	●	●	●	●	●								
TCHF-02	**Conduct maintenance and repair activities in a manner to avoid or minimize impacts to sensitive species and habitat such as beaches, dunes, and the near-shore zone.**		●		●	●	●	●	●	●	●	●	●		●					
TCHF-03	Wetland mitigation options are being coordinated with state and federal agencies and may include a mix of banking and onsite restoration, depending on agency preference and availability.		●		●	●														
	Birds																			
BIRD-01	Evaluate avian use **by conducting pre-construction surveys for raptor nests, wading bird colonies, seabird nests, and shorebird nests during nesting periods.** (Focus being listed species or species identified of special concern by the Federal or State government.)						●													
BIRD-02	**An avian post-construction monitoring framework will be developed and coordinated with NJDEP and USFWS and implemented as required.**						●													
BIRD-03	**Cut trees and vegetation, when possible, during the winter months when most migratory birds are not present at the site.**				●	●	●	●												
BIRD-04	Use lighting technology that minimizes impacts on avian and bat species to the extent practicable.						●	●												
BIRD-06	**WTG air gaps (minimum blade tip elevation to the sea surface) to minimize collision risk to marine birds which fly close to ocean surface.**						●													
BIRD-07	**Ocean Wind has sited Wind Farm Area facilities in the eastern portion of the original Lease Area, outside the migratory pathway, to reduce exposure to birds.**						●	●												

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Bats																				
BAT-01	**Onshore, the Project will avoid potential impacts by conducting tree clearing during the winter months, to the extent practicable.**					●	●	●												
BAT-02	**If tree clearing is required in areas with trees suitable for bat roosting during the period when northern long-eared bats may be present, develop avoidance and minimization measures in coordination with USFWS and NJDEP and conduct pre-construction habitat surveys.**							●												
BAT-03	**A bat post-construction monitoring framework will be developed and coordinated with NJDEP and USFWS and implemented as required.**							●												
Benthic Resources																				
BENTH-01	Ocean Wind is conducting appropriate pre-siting surveys to identify and characterize potentially sensitive seabed habitats and topographic features.	●	●		●	●			●	●		●				●			●	●
BENTH-02	Use standard underwater cables which have electrical shielding to control the intensity of electromagnetic fields (EMF). EMF will be further refined as part of the design or cable burial risk assessment.								●	●	●	●				●			●	
BENTH-03	**Conduct a submerged aquatic vegetation (SAV) survey of the proposed inshore export cable route.**				●	●			●	●		●								
Fish and EFH																				
FISH-01	Evaluate geotechnical and geophysical survey results to identify sensitive habitats (e.g., shellfish and SAV beds) and avoid these areas during construction, to the extent practicable.				●				●	●		●	●		●	●	●		●	
FISH-02	Ocean Wind will coordinate with NJDEP, NMFS and USACE regarding time of year restrictions for winter flounder and river herring, as well as summer flounder habitat areas of particular concern (HAPC).				●				●	●					●	●				
Marine Mammals and Sea Turtles																				
MMST-01	Vessels related to project planning, construction, and operation shall travel at speeds in accordance with National Oceanic and Atmospheric Administration (NOAA) requirements or the agreed to adaptive management plan per the Project PSMMMP when assemblages of cetaceans are observe. Vessels will also maintain a reasonable distance from whales, small cetaceans, and sea turtles, as determined										●	●								

APM Number*	Applicant Proposed Measure**	Geological Resources	Water Quality	Air Quality	Terrestrial & Coastal Habitats	Terrest. & Coastal Fauna	Birds	Bats	Benthic Resources	Fish & EFH	Marine Mammals	Sea Turtles	Demog. Employ. & Econ.	Environmental Justice	Rec. & Tourism	Comm. & For-Hire Rec. Fishing	Land Use & Coastal Infrastructure	Nav. & Vessel Traffic	Other Marine Uses	Cultural Resources
	through site-specific consultations (**specifics to be added based on consultation**).																			
MMST-02	Project-related vessels will be required to adhere to NMFS Regional Viewing Guidelines for vessel strike avoidance measures during construction and operation to minimize the risk of vessel collision with marine mammals and sea turtles. Operators shall be required to undergo training on applicable vessel guidelines.										●	●								
MMST-03	Vessel operators will monitor NMFS North Atlantic right whale (NARW) reporting systems (e.g., the Early Warning System, Sighting Advisory System) for the presence of NARW during planning, construction, and operations within or adjacent to Seasonal Management Areas and/or Dynamic Management Areas.										●									
MMST-04	Ocean Wind will post a qualified observer as agreed to during the NMFS incidental take authorization process, on site during construction activities to avoid and minimize impacts to marine species and habitats in the Project Area.										●	●				●				
MMST-05	Obtain necessary permits to address potential impacts on marine mammals from underwater noise, and establish appropriate and practicable mitigation and monitoring measures in coordination with regulatory agencies.										●	●								
MMST-06	**Develop and implement a PSMMP.**										●	●								
	Socioeconomics and Environmental Justice																			
SOC-01	**Comply with NJDEP noise regulations (New Jersey Administrative Code [N.J.A.C.] 7:29), which limit noise from industrial facilities received at residential property lines to 50 decibels during nighttime (10:00 p.m. to 7:00 a.m.) and 65 decibels during daytime as well as specific octave band noise limits, and comply with any local noise regulations, to the extent practicable, to minimize impacts on nearby communities.**												●	●	●		●			
	Cultural, Historical, and Archaeological Resources																			
CUL-01	**Develop and implement an Unanticipated Discovery Plan.**																			●
CUL-02	**Use the results of geotechnical and geophysical surveys to identify potential cultural resources. Any cultural resources found will be avoided to the extent practicable. Where avoidance is not**																			●

APM Number*	Applicant Proposed Measure**	Geological Resources	Water Quality	Air Quality	Terrestrial & Coastal Habitats	Terrest. & Coastal Fauna	Birds	Bats	Benthic Resources	Fish & EFH	Marine Mammals	Sea Turtles	Demog. Employ. & Econ.	Environmental Justice	Rec. & Tourism	Comm. & For-Hire Rec. Fishing	Land Use & Coastal Infrastructure	Nav. & Vessel Traffic	Other Marine Uses	Cultural Resources
	practicable, coordinate with relevant agencies and affected tribes to determine minimization and mitigation as necessary.																			
CUL-03	**Conduct background research and consult with the State Historic Preservation Office (SHPO) to determine the need for cultural resource surveys onshore. Any cultural resources found will be avoided to the extent practicable. Where avoidance is not practicable, coordinate with SHPO and affected tribes to determine minimization and mitigation as necessary.**																			●
CUL-04	**The Project has been designed to minimize visual impacts to historic and cultural properties to the extent feasible. The Project's layout was adjusted to align turbines at the eastern portion of the lease area, so that closest turbines are at least 15 miles from shore. Visibility of the turbine array from all identified properties within the Preliminary Area of Potential Effect would be minimized and mitigated further by measures adopted in this table including ADLS and markings (GEN-07), and as in Appendix F-4.**																			●
CUL-05	**Mitigation in the form of documentation, planning, or educational materials will be coordinated with stakeholders, as in Appendix F-4.**																			●
CUL-06	**Develop an anchoring plan for vessels prior to construction to identify avoidance/no anchorage areas**																			●
Recreation and Tourism																				
REC-01	**Develop a construction schedule to minimize activities in the onshore export cable route during the peak summer recreation and tourism season, where practicable.**												●		●	●		●	●	
REC-02	**Coordinate with local municipalities to minimize impacts to popular events in the area during construction, to the extent practicable.**												●		●	●		●	●	
Commercial and For-Hire Recreational Fishing																				
CFHFISH-01	Work cooperatively with commercial/recreational fishing entities and interests to ensure that the construction and operation of the Project will minimize potential conflicts with commercial and recreational fishing interests. Review planned activities with potentially affected fishing organizations and port authorities to prevent unreasonable fishing gear conflicts.												●		●	●		●	●	

APM Number*	Applicant Proposed Measure**	Geological Resources	Water Quality	Air Quality	Terrestrial & Coastal Habitats	Terrest. & Coastal Fauna	Birds	Bats	Benthic Resources	Fish & EFH	Marine Mammals	Sea Turtles	Demog. Employ. & Econ.	Environmental Justice	Rec. & Tourism	Comm. & For-Hire Rec. Fishing	Land Use & Coastal Infrastructure	Nav. & Vessel Traffic	Other Marine Uses	Cultural Resources
CFHFISH-02	**Develop and implement a Fisheries Communication and Outreach Plan. (Appendix O) The plan includes the appointment of a dedicated fisheries liaison as well as fisheries representatives who will serve as conduits for providing information to, and gathering feedback from, the fishing industry, as well as Project-specific details on fisheries engagements.**		●										●		●	●	●	●	●	
CFHFISH-03	**Implement Orsted's corporate policy and procedure to compensate commercial/recreational fishing entities for gear loss as a result of Project activities.**												●		●	●	●		●	
Land Use and Coastal Infrastructure																				
LU-01	**Develop crossing and proximity agreements with utility owners prior to utility crossings.** (Crossing agreements in U.S. waters are supported by the International Cable Protection Committee (ICPC), which provides a framework for establishing cable crossing agreements.)		●						●								●	●	●	
Navigation and Vessel Traffic																				
NAV-01	**Ocean Wind has engaged and will continue to engage with FAA and DOD with regards to potential effects to aviation and radar.**														●		●	●	●	
NAV-02	Site facilities to avoid unreasonable interference with major ports and USCG-designated Traffic Separation Schemes.												●		●		●	●	●	
NAV-03	**Select structures within the proposed Wind Farm Area will be equipped with strategically located Automatic Identification System (AIS) transponders.**														●			●	●	
NAV-04	**WTGs will be arranged in equally spaced rows on a northwest to southeast orientation to aid the safe navigation of vessels operating within the Wind Farm Area.**															●		●	●	
Other Marine Uses																				
OUSE-01	**Evaluate geotechnical and geophysical survey results to identify existing conditions, existing infrastructure, and other marine uses. Areas of other marine uses will be avoided to the extent practicable, and Ocean Wind will coordinate with other users where avoidance is not practicable.**	●															●	●	●	●
Visual																				
VIS-01	Address key design elements, including visual uniformity, use of tubular towers, and proportion and color of turbines.												●	●	●		●			●

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APM Number*	Applicant Proposed Measure**	Geological Resources	Water Quality	Air Quality	Terrestrial & Coastal Habitats	Terrest. & Coastal Fauna	Birds	Bats	Benthic Resources	Fish & EFH	Marine Mammals	Sea Turtles	Demog. Employ. & Econ.	Environmental Justice	Rec. & Tourism	Comm. & For-Hire Rec. Fishing	Land Use & Coastal Infrastructure	Nav. & Vessel Traffic	Other Marine Uses	Cultural Resources
VIS-02	Ocean Wind has used appropriate viewshed mapping, photographic and virtual simulations, computer simulation, and field inventory techniques to determine the visibility of the proposed project. Simulations illustrate sensitive and scenic viewpoints.												●	●	●		●			●
VIS-03	Seek public input in evaluating the visual site design elements of proposed wind energy facilities.												●	●	●		●			●
VIS-04	**Security lighting for onshore facilities will be downshielded to mitigate light pollution.**																●			
VIS-05	Where substation components may be visible and highly contrasting with their surroundings, the Project would provide supplemental plantings and other landscape elements to screen the substation from public view.												●	●	●		●			●
VIS-06	Consideration will be given to visually adapt the buildings and other substation components into their physical context. The forms, lines, colors, and textures of these components will be influenced by their immediate surroundings and selected to minimize visual contrast and potential visual impact. Non-reflective paint will be used on all Project components.												●	●	●		●			●

* APM numbers were assigned to allow easy reference to specific measures. Each APM number includes an abbreviation of general (GEN) or the most pertinent resource area (e.g., NAV for Navigation) along with a number.
** **Bold** items are beyond the requirements of or more specific than the BOEM BMPs.

1.2 Summary of Project Impacts

A summary of the primary potential Project impacts discussed in the COP is contained in Volume I, **Table ES-1**.

2. Existing Conditions, Potential Impacts, and Mitigation

In this section, Ocean Wind discusses the potential impacts of the proposed Project on physical, biological, socioeconomic, and cultural resources. For each resource, Ocean Wind first describes the affected environment, which is the existing condition and baseline against which project impacts are measured. An analysis of the potential Project-specific impacts to each resource follows.

2.1 Physical Resources

2.1.1 Geological Resources

Ocean Wind's investigations of geological resources consists of desktop studies, site surveys, geological model development for mapping, and assessments of site constraints and hazards. A desktop study of the existing geological resources and hazards was used to inform the development of phased Project-specific site investigations (i.e., geophysical and geotechnical) survey campaign in accordance with BOEM *Guidelines for Providing Geophysical, Geotechnical, and Geohazard Information Pursuant to 30 CFR Part 585* and the *Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR Part 585*. This phased approach allows for each subsequent survey to be informed by the prior survey. The overall Ocean Wind phased survey schedule is summarized in **Table 2.1-1.**

Table 2.1-1. Overview of completed geophysical and geotechnical surveys.

Survey name	Survey period	Description of scope
Completed High Resolution Geophysical Surveys		
GP1A Site	2017 Q2-Q3	Reconnaissance survey covering the Wind Farm Area with grid spacing 900 m by 900 m
GP1A BL England	2019 Q2	Reconnaissance survey covering parts of the BL England export cable corridor. 3 main lines and cross lines evaluated.
GP1A Oyster Creek	2019 Q2	Reconnaissance survey covering parts of the Oyster Creek export cable corridor. 3 main lines and cross lines evaluated.
GP WTG East	2018 Q2 – 2019 Q2	Detailed survey covering the eastern WTG corridors. Corridors surveyed with 30 m main line spacing and 500 m cross line spacing.
GP WTG West	2019 Q2-Q3	Detailed survey covering the western WTG corridors. Corridors surveyed with 30 m main line spacing and 500 m cross line spacing. Infill corridors complete in the eastern part of the Wind Farm Areas. Further, parts of the Oyster Creek export cable corridor were surveyed
GP IAC	2019 Q4 -2020 Q2	Detailed survey covering the inter array cable corridors placed outsider the WTG corridors.
GP BL England Offshore	2019 Q3-Q4	Detailed survey covering the offshore part of the BL England export cable corridor

Survey name	Survey period	Description of scope
GP BL England Nearshore	2019 Q2-Q3	Detailed survey covering the nearshore part of the BL England export cable corridor
GP BL England Shallow Water	2020 Q1	Detailed survey covering the shallow part of the BL England export cable corridor
GP Oyster Creek Offshore	2019 Q3 – 2020 Q1	Detailed survey covering the offshore part of the Oyster Creek export cable corridor
GP Oyster Creek Nearshore	2019 Q3	Detailed survey covering the nearshore part of the Oyster Creek export cable corridor
GP Oyster Creek Shallow Water	2019 Q3 – 2020 Q1	Detailed survey covering the shallow part of the Oyster Creek export cable corridor
GP2a Engineering OC and BLE Nearshore	Q2 2021	Detailed nearshore survey of Oyster Creek and BL England
GP2a Engineering OC/BLE/IAC Offshore	Q2 2021	Detailed offshore survey of Oyster Creek and BL England cable corridors and array cables
Dredging permit survey (Single Beam IBSP)	Q4 2021	Detailed survey in Barnegat Bay
Dredging permit survey (Single Beam Prior Channel)	Q2 2022	Detailed survey in Barnegat Bay
Completed Geotechnical Surveys		
Geotechnical Survey 1A (GT1A)	2017 Q4 - 2018 Q2	38 seabed cone penetration tests (CPTs), 8 sampling borings and 8 co-located downhole CPT borings.
Geotechnical Survey 2 for Offshore Substations (GT2 OSS)	2019 Q4	3 sampling boreholes with 3 co-located downhole CPT borings
Geotechnical Survey for BL England Export Cable Corridor (GT BLE)	2019 Q3 – 2020 Q4	On the BL England export cable corridor: 1 sampling borehole, 44 seabed CPTs, 43 vibracores (VCs) and 18 in-situ thermal tests (TRTs), 1 Archaeological Core (AC).
Geotechnical Survey for Oyster Creek Export Cable Corridor (GT OC)	2019 Q3 - 2020 Q4	6 sampling boreholes, 143 seabed CPTs, 139 VCs and 73 TRTs, 1 AC
Geotechnical Survey 2 for Wind Turbine Generators (GT2 WTG)	2020 Q1 - 2020 Q3	92 seabed CPTs,10 seabed Seismic SCPTs (excluding re-test locations), 99 downhole CPT borings, 7 shallow samples, and 7 PS logging tests profiles.
Geotechnical Survey for Inter Array Cables (GT2 IAC)	2020 Q2 - 2020 Q3	41 seabed CPTs, 40 VCs, 14 ACs

The survey data are used during Project development to identify hazards that could impact Project routing and siting as well as design. The Marine Site Investigation Report (MSIR), including the Geophysical Survey and the Geotechnical Survey results, reflects the data collection. Additional geophysical surveys will be conducted to survey for UXO. These surveys are being coordinated with BOEM.

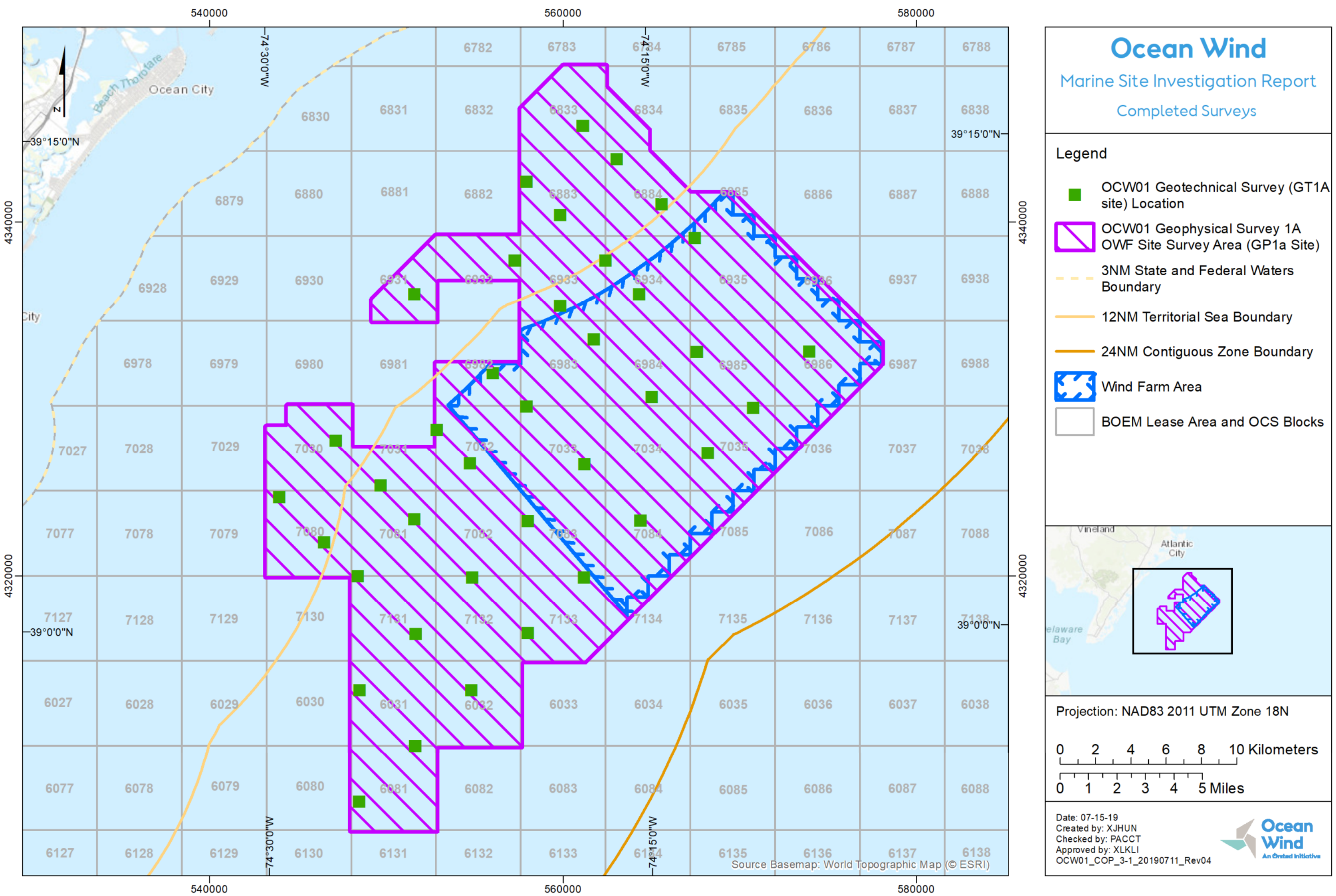
2.1.1.1 Affected Environment

Readily available geological maps and geophysical and geotechnical data were reviewed during the desktop study to characterize the potential conditions and geohazards (i.e., seismic faults, sediment transport, and shallow gas) in the Project Area.

Ocean Wind has conducted a reconnaissance level High Resolution Geophysical (HRG) Survey of the entire Lease Area. The purpose of these surveys is to gain a general understanding of the seabed and subsurface geological conditions as well to address the geophysical and geotechnical risks. Survey results are found in Volume III, Appendix D, as part of the Marine Site Investigation Report. Survey locations in the Wind Farm Area can be found in **Figure 2.1.1-1**, with additional survey location details for the Wind Farm Area, as well as survey locations for the cable route corridors, provided in Appendix D.

The surveys provided information regarding the geological conditions for both the seabed and the subsurface geology. The information includes descriptions of seabed sediments, seabed features, geohazards and geotechnical properties in support of 30 CFR 585.626(a) and Hazard reporting detailed in 30 CFR 585.627 (a) 1. Using the readily available data and the reconnaissance level site specific survey data, Ocean Wind has developed a preliminary ground model that describes existing geological conditions including seismic horizons per sediment province zone. A ground model for the Project has been developed integrating geotechnical and geophysical data, which demonstrates the extent of the seismic horizon and geological units. The ground model defines the geological conditions in line with the report, “Data Gathering Process: Geotechnical Departures for Offshore Wind Energy” BOEM Publication No.: 2018-054.

For the offshore export cable, seabed conditions, hazards, and sub-surface geological conditions are assessed based on the desktop study and existing bathymetric data (Appendix D).



Note: figure does not represent the proposed lease split.

Figure 2.1.1-1. Ocean Wind existing geophysical and geotechnical survey locations.

2.1.1.1.1 Offshore Project Area

Bathymetry

The general offshore area is characterized by typical continental shelf margins with very gradual increases in depth. Based on the geophysical survey, water depth in the Lease Area vary from -49 ft (-15 meters [m]) mean lower low water (MLLW) in the northern part to -125 ft (-38 m) MLLW in the southern part. From the coastline to the Lease Area there is a shallow slope with an average gradient of less than 1°.

Seabed morphology is generally a very gentle varying seabed. The sand ridges raise smoothly 32.8 – 49.2 ft (10 to 15 m) above the surrounding seabed. The ridges have rather irregular shapes and are oriented sub-parallel to the coastline. The Great Egg Valley is flat without topographic highs. There are areas where features of mega-ripples having a height around 1.6 ft (0.5 m) are found with varying slope gradients.

Along the export cable route options, in Federal water outside the 3 nm maritime limit, the water depths vary from –32.8 ft (15 m) depth MLLW to close to 98.4 ft (30 m) depth MLLW. In the back bays, water depths are predominantly shallow except in existing channels. Based on National Oceanic and Atmospheric Administration (NOAA) nautical charts, depths within Barnegat Bay (offshore export cable corridor to Oyster Creek) range from 1.0 to 9.8 ft (0.3 to 3.0 m), with a majority of the open water area within the study corridor ranging from 1.0 to 5.9 ft (0.3 to 1.8 m) MLLW. The deeper areas are found along the demarcated intercoastal waterway which ranges in depth from 6.9 to 9.8 ft (2.1 to 3.0 m) MLLW. The channels leading to Barnegat Inlet, including Oyster Creek Channel and Double Creek Channel, have the greatest depths, ranging from 7.9 to 20.0 ft (2.4 to 6.1 m) MLLW.

Great Egg Harbor Bay (within the BL England study area) is shallow with depths ranging from 1.0 to 3.0 ft (0.3 to 0.9 m) MLLW. The deepest areas, ranging from 3.3 to 41.0 ft (1.0 to 12.5 m) MLLW, are found at Great Egg Harbor Inlet and channels leading to the southern portions of the study corridor and up Great Egg Harbor River.

Geology and Seabed

The Lease Area can be divided into three sub-areas (Shoal Massif, Great Egg Valley, and Ridge and Swale areas) based on specific physiographic characteristics **(Figure 2.1.1.2)**. The Project is limited to the Shoal-Massif and Great Egg Valley areas. In general, the Great Egg Valley area is deeper than the surrounding morphology, at a similar distance from the shoreline. The deepest seabed, however, is found in the Ridge and Swale area. Presently, the New Jersey continental shelf is mainly affected by storm-dominated open-marine processes (Milliman, *et al*. 1990) and the site lies south of a region of repeated Pleistocene glaciations that are marked by terminal moraines. Generally, preservation of sedimentary units on the New Jersey shelf is limited.

Predominant features on the continental shelf include paleoshorelines, shoals, filled channels, and valleys, and shoal retreat massifs. The three physiographic zones found in the Project Area include 1) shelf ridges (ridge and swale topography), 2) the Great Egg Shelf Valley, and 3) Hudson Sediment Lobes (**Figure 2.1.1-2**). The primary stratigraphic units in the upper 300 ft consist of Holocene recent marine sands, Holocene transgressive deposits, Pleistocene deposits, and pre-quaternary deposits.

Within the Lease Area the seabed sediment consists predominantly of medium to coarse grained sand with areas of gravelly sand and gravel deposits (Fugro 2017, Alpine 2017a). Along the export cable route options, the seafloor consists predominantly of sand with various amounts of gravel and patches of fine-grained sediments. Close to shore, surficial sediments mixing fine-grained estuarine deposits and overwash of tidal-delta sands are found as well as fine-grained estuarine clays and silts deposited by multiple rivers. Locally, gravel is observed to be present in the upper 9.8 ft (3 m). In the Back Bays, sediment types primarily consist of sand and fine grain sediments.

The ground model being developed includes shelf sediment of Holocene to Pleistocene age, buried channels and transgressive sequences. Seven sedimentary sequences are identified down to 300 ft (91.4 m). The model demonstrates the dynamic depositional environment and the erosive nature of the sedimentation. Even though the Wind Farm Area is positioned south of the region of repeated Pleistocene glaciations, the effects of glaciation and related eustatic sea level changes have affected the sedimentation with comprehensive reworking of sediments. Additional information is found in Appendix D.

As noted in Section 2.3.7, several sand and gravel borrow areas designated and maintained by BOEM, as well as sand and gravel borrow areas designated by U.S. Army Corps of Engineers (USACE) in partnership with NJDEP, are mapped in the vicinity of the Wind Farm Area and the offshore export cable corridors to interconnection points at BL England and Oyster Creek (BOEM 2018c). The Project has been designed to avoid these sand and gravel borrow areas as practicable.

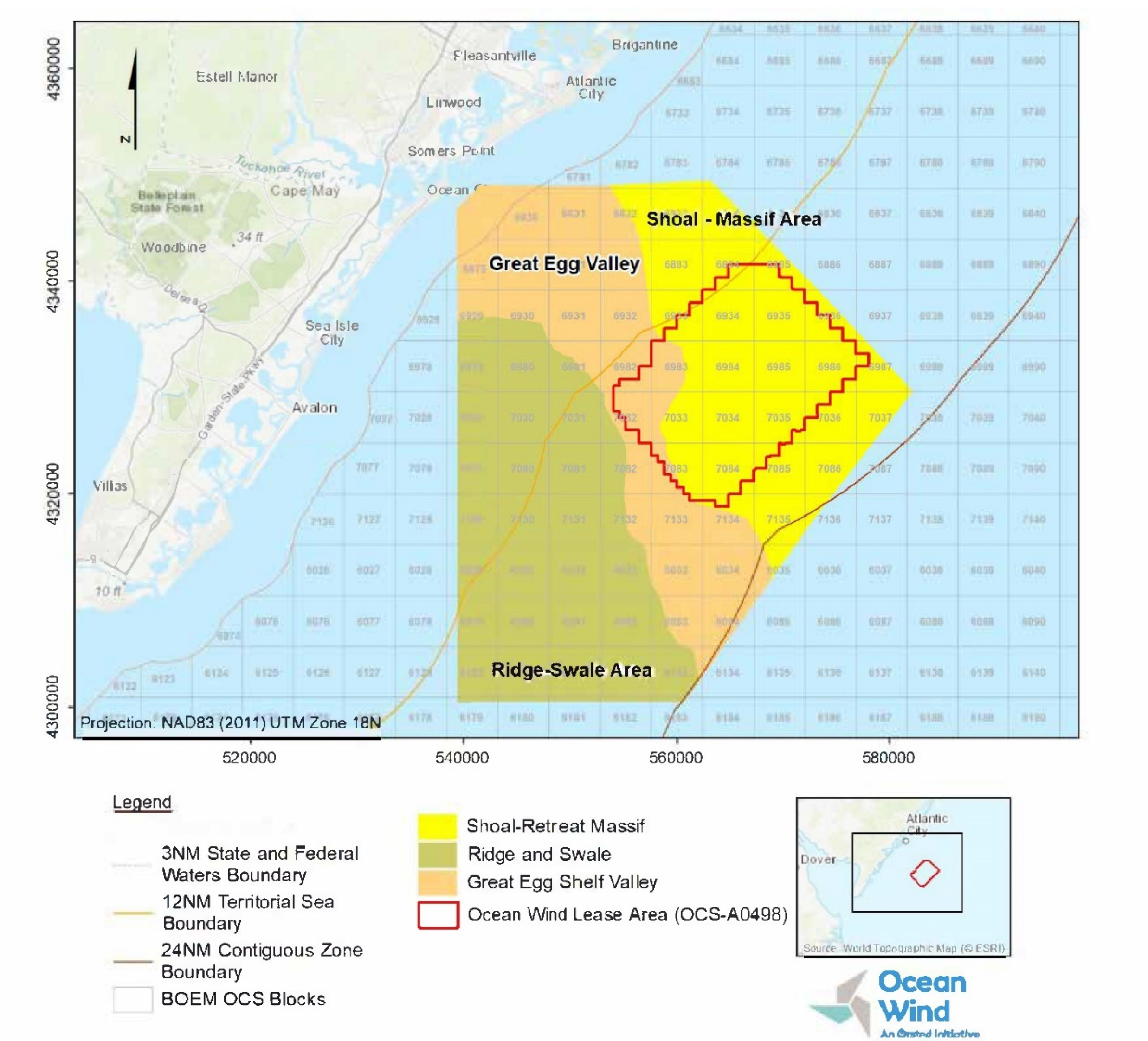


Figure 2.1.1-2. Physiographic zones within the Lease Area.

Geologic Hazards

As part of the ground model development, potential shallow hazards have been identified and assessed using HRG and geotechnical survey results and desktop study, and are summarized in Appendix D. The potential hazards are listed according to the COP regulations and BOEM's Guidelines for Providing Geophysical, Geotechnical and Geohazard Information Pursuant to 30 CFR Part 585, 2015.

In addition to the findings, the potential seismic hazard for the Lease Area has been assessed. The assessment is based on records of seismicity in the area, knowledge of the structural setting in the subsurface, and seismic hazard maps published by the United States Geological Survey (USGS) in 2014. There are three fault lines within the northern portion of New Jersey: the Flemington fault, Hopewell fault, and Ramapo fault. Since 2014, there have been 12 earthquakes that have occurred within New Jersey or for which the seismic activity has reached New Jersey (Earthquake Track 2018). Within 160 kilometers from the site, only minor earthquakes (≤ magnitude 4: non-damaging but felt) have been recorded since 1783. Fault rupture is not considered a hazard to the installations as no active or potentially active faults have been identified within or near the Project site area.

2.1.1.1.2 Onshore Project Area

The study areas are within the Outer Lowland Province of the Atlantic Coastal Plain, which is characterized by broad plains and gently sloping hills. The Outer Lowland Province is characterized by coastal estuaries, swamplands, and near sea level relief (US Geological Survey 2017). Based on the Digital Elevation Model and Light Detection and Ranging (LiDAR) data, the Oyster Creek and BL England study areas range in elevation between sea level and approximately 60 ft (18.5 meters) above mean sea level (msl).

NJDEP provides surficial geology and bedrock data collected by USGS for the State of New Jersey in GIS format. The dataset provides the locations, boundaries, and names of geologic formations throughout New Jersey. Bedrock below Oyster Creek includes the Wildwood Member (Tkw) of the Kirkwood Formation, and bedrock below BL England includes the Cohansey formation (Tch) in the upper 197 - 263 ft (60 to 80 meters) (Fugro 2018).

The bedrock units are overlain by surficial sediments and coastal plain deposits. Surficial thickness is less than 10 ft in several areas within the onshore cable corridors (NJDEP and USGS 2018). Thick coastal plain deposits underlie the subsurface materials in the region. These deposits may be comprised of sand, gravel, silt, and clay lithologies associated with the Cape May, Pennsauken, Bridgeton, Beacon Hill, Cohansey, and Kirkwood formations (Waldner and Hall 1991; Duncan *et al.* 2000; Nordford *et al.* 2009). Buried channels marking glacial meltwater pathways in the late Pleistocene may incise these deposits and include a similar range of fill materials. Channel orientations are predominantly in the onshore-offshore direction.

A desktop study by Fugro (2018) reviewed geotechnical boring data from New Jersey Department of Transportation (NJDOT) for the Ocean Drive Bridge (Highway 652) that crosses Great Egg Harbor Inlet near the BL England interconnection point; data from a newer bridge closer to the generating station was not available. The upper coarse and fine-grained units were interpreted by Fugro to be Cape May Formation sands, silts, and clays while the dense lower unit was interpreted to be the Tertiary Cohansey Formation sands and gravels.

The United States Department of Agriculture (USDA) provides soil maps and descriptions within the study corridors. The existing soil survey data include site specific data for soil type, slope, areas susceptible to landslide, erosion potential, rock outcrops, rocky soils, liquefaction potential, sheer strength, and other soil properties related to engineering. Surface soils within the study corridors consist primarily of sands and silts (USDA 1978).

NJDEP maps regions of New Jersey where there are areas of historic fill that cover greater than 5 acres in its "Historic Fill for New Jersey as of January 2016" GIS dataset (NJDEP and NJ Geological and Water Survey 2016). NJDEP identified historic fill within the Oyster Creek and BL England interconnection points. As is typical within developed areas, there are potential areas of soil contamination (NJDEP and NJ Geological and Water Survey 2016).

Sites of potential environmental concern including contaminated sites; sites with active, inactive, or completed remediation; and sites such as current and historical automobile service stations and dry cleaning facilities; are located near or within the Onshore Project Area for Oyster Creek and BL England. NJDEP provides data and records containing the locations and details of regulated Underground Storage Tanks (USTs) (NJDEP 2018c), permitted well locations (NJDEP 2018d), landfills including permitted and suspected illegal and pre-regulatory sites, which can be manmade hazards for the installation of subsurface utilities. These records are available as spreadsheets providing addresses, descriptions, and in some cases coordinates. **Table 2.1.1-1** provides a high-level summary of publicly available database listings including those listed above.

Table 2.1.1-1. Summary of soil quality data.

Data Set	Provider	Description	Additional Information
Superfund Site Locations	USEPA	USEPA provides data and records containing the location and details of Superfund sites listed on the National Priorities List (NPL). The NPL is the list of national priorities among the known releases or threatened releases of hazardous substances, pollutants, or contaminants throughout the United States and its territories. The NPL is intended primarily to guide USEPA in determining which sites warrant further investigation. (USEPA 2018b).	No Superfund sites are within the Oyster Creek or BL England study areas.
Known Contaminated Sites (KCSs) List	NJDEP	NJDEP provides location coordinates, remedial status, and contaminant information for KCSs. The KCSs list is an inventory that includes all sites in New Jersey where known contamination exists. The KCSs inventory is provided as both a GIS shapefile and a list. The remedial status for each site is designated as active, pending, or closed under NJDEP's Site Remediation Program (NJDEP 2018b).	KCSs within Lacey Township (Oyster Creek) include gasoline service stations, existing or removed USTs, Oyster Creek Generating Station, and the Jersey Central Power & Light Forked River Generating Station. KCSs within Upper Township (BL England) include gasoline service stations, existing or removed USTs, and BL England Generating Station.
New Jersey Gasoline Service Stations	NJDEP	NJDEP provides the locations of many automobile filling stations regulated by the agency via the New Jersey Gasoline Service Station spatial dataset. This dataset is	Gasoline service stations were identified within the proposed Oyster Creek and BL England study areas.

Data Set	Provider	Description	Additional Information
		currently incomplete (NJDEP and NJOGIS 2017).	
Aerial Photographs	NETR, NJDEP	NJDEP and National Environmental Title Research (NETR) provide historical aerial photographs of the State of New Jersey, including the study areas. Aerial photographs can be used to locate features of environmental concern including but not limited to gasoline filling stations, tank farms, rail yards, and industrial facilities. Aerial photographs also assist in confirming the historic presence of features identified in other databases (NETR n.d.) (NJDEP n.d.-c).	Aerial photographs between 1931 and 2015 were viewed. The area in the vicinity of BL England was minimally developed prior to construction of the generating station. The area in the vicinity of Oyster Creek was moderately developed prior to construction of the generating station.
Topographic Maps	USGS/ ESRI	USGS and Environmental Systems Research Institute (ESRI) provide historical topographic maps for the United States. These maps can provide an overview regarding previous land uses, including those of environmental concern such as tank farms, mines, landfills (USGS and ESRI n.d.).	A 1972 topographic map identifies a power plant in the location of Oyster Creek generating station. A 1989 map identified gravel pits to the south of Oyster Creek. A 1966 topographic map identified a power plant in the location of BL England.
Ground Water Classification Exception Areas (CEAs)	NJDEP	NJDEP provides the boundaries, status, and contaminant information for Ground Water CEAs. CEAs are institutional controls established through the approval of a groundwater pollution remedy. The dataset is in GIS format (NJDEP 2018a).	CEAs were not identified within the proposed Oyster Creek onshore boundary. CEAs were identified in the vicinities of BL England generating station and gasoline stations in the proposed BL England onshore boundary.
Dry Cleaning Facilities in New Jersey	NJDEP	NJDEP provides the locations of regulated dry-cleaning facilities in the State of New Jersey in their online GeoWeb application. The application provides the locations, names, and addresses of the facilities (NJDEP n.d.-c).	Dry cleaning facilities were identified within the proposed Oyster Creek onshore boundary. No dry-cleaning facilities were identified within the BL England study area.
Deed Notice Extent in New Jersey	NJDEP	NJDEP provides information and boundaries of deed notice areas assigned to KCSs and other sites in the Site Remediation Program. The data is provided in the GeoWeb online application, and provides site locations, and information regarding contaminants at those sites (NJDEP n.d.-c).	A deed notice was assigned to BL England generating station. Deed notices were not identified within the proposed Oyster Creek study area.

2.1.1.2 Potential Project Impacts on Geologic Resources

The following section describes the potential impacts on geological resources from the construction, operation and maintenance, and decommissioning phases of the Project for the onshore and offshore components. Impact producing factors that may impact geological resources are listed below and discussed in the following sections:

- Physical seabed/land disturbance
- Sediment suspension

2.1.1.2.1 Construction and Installation

Offshore Project Area

Wind Farm Area

This section outlines the potential high-level impacts from the Project on geological resources during construction within the Wind Farm Area and offshore export cable corridors. Activities that could cause direct impacts include construction of foundations, dredging, cable installation, and anchoring of vessels. Temporary Project impacts (e.g., cable burial, boulder removal, and sand wave clearing) would affect 4 percent of the Wind Farm Area, and permanent impacts (i.e., foundations and scour and cable protection) would affect 0.2 percent of the Wind Farm Area.

Foundation Installation and Scour Protection

Prior to offshore substation foundation installation, seabed preparation may be required. Preparations may include seabed levelling, removal of obstructions, and debris removal as identified in site-specific surveys.

Seabed preparations for the installation of monopile or piled jacket foundations may include limited removal of surface features (i.e., sand waves), boulders and obstructions or debris. Removal of obstructions and debris from the seabed surface would result in limited sediment displacement and re-suspension. Seabed levelling will include the excavation or dredging of soft seabed material. Disposal of drilling spoils adjacent to pile installations may result in rock and sediment from depth being deposited on the seabed.

For the WTGs, monopile foundations will be used. Anticipated impacts of surficial and sub-surface geological resources are detailed in Section 6 of Volume I. Direct impacts to geological resources are localized and would not change the geology of the region. As described in Volume I, Section 6.1.2, scour protection, if required, will surround each monopile foundation.

For the offshore substations, monopile or piled jacket foundations may be used. Foundation parameters and scour protection impact areas are provided in Section 6 of Volume I. Direct impacts to geological resources for foundation preparation, if needed, would be localized.

Seabed preparation activities, foundation installation, and placement of scour protection would result in the resuspension and sedimentation of finer grain sediments. As discussed in the Water Resources section (2.1.2.1), the medium to coarse grained sediments near the Wind Farm Area are likely to settle to the bottom of the water column quickly, and sand re-deposition would be minimal and near the trench centerline. Sediment disturbance would be localized and short in duration, limited to the construction time period.

Vessel Anchoring

Impacts to geological resources from vessels include spudding, anchoring, and sweeping from anchor chains. The extent of impacts will vary based on the number and type of vessels. Due to the medium to coarse grain sediment type in the Wind Farm Area, resuspension of sediments will be localized and temporary.

Array Cables

Installation of the array cables will have localized temporary impacts on surficial geological resources due to sediment disturbance for seabed preparation and cable burial. Impacts are expected to be small as existing sediments are medium to coarse grain and will settle quickly to the bottom. Impacts will be along the array cables and immediately next to the cable installation area. Additional activities that may impact surficial sediments along the array cable are from the use of pre-lay grapnel run to clear the area for cable installation and the placement of additional cable protection (e.g., cable mattresses) in areas where cable burial cannot be achieved. Localized changes to seabed topography would occur in areas where additional cable protection is needed. However, this would not change the hydrodynamics or natural sediment movement in the area.

Offshore Export Cables

Installation of offshore export cables would be conducted using jet plow/hydro plow, or mechanical plow. Impacts to geological resources are limited to the cable corridor and are associated with resuspension of sediments, direct removal of sediments via dredging (if needed), pre-lay grapnel run, and placement of additional cable protection (e.g., concrete mattresses).

For the offshore export cable corridors within and near the Wind Farm Area, existing sediments are comprised of medium and coarse grain sediments. As discussed in the Water Resources section (2.1.2.2.1), in these areas suspended sediment would settle on the seabed within minutes and potentially extend laterally up to 525 ft (160 m). Closer to shore, where there are finer sediments, suspended sediments would extend above the trench and take longer to settle to the seabed. These impacts for finer sediments are anticipated to be localized adjacent to the trench and temporary in nature.

In areas where required burial depth cannot be achieved due to sand waves or shallow bedrock, dredging and/or additional cable protection may be required. Dredging impacts would include a localized change in seabed topography and removal of sediments. Sediment resuspension and deposition would be localized and short-term due to existing sediment types. The placement of additional cable protection would also result in a localized change in surface sediment. However, due to local hydrodynamics, sediment would settle and fill in interstitial areas and cover the additional protection material. Impacts may take several years to over a decade to revert to original seabed elevations (BOEM n.d.). These activities would not permanently impact or change hydrodynamics or sediment movement in the area.

Vessel Anchoring

As described above, impacts to geological resources from vessels include spudding, anchoring, and sweeping from anchor chains. These impacts will be localized and temporary.

Landfall

As noted in Section 6 of Volume I, cable landfall would be by open cut or trenchless technology methods. For the open cut method, there are a number of options available, e.g., post cable installation burial, pre-trenching, or the pre-installation of a cable duct prior to the arrival of the cable installation vessel. For the excavation work, a variety of equipment can be used depending on the water depth and local circumstances.

Where trenchless technology methods are used, an Inadvertent Release Plan will be developed and used during construction. During HDD, a sediment mix including drilling mud (i.e., bentonite) is used. During drilling, reaming, or pulling events, some drilling mud may be released from the end of the bore hole. Therefore, each HDD will have an exit pit to receive the drilling mud. Bentonite is heavier than water, so it will remain in the exit pit and then be removed through a vacuum or suction dredge.

HDD conduits will be drilled for landfall. An HDD entry pit would be required for each cable duct. HDD entrance pit dimensions are detailed in Section 6 of Volume I. Exit pits are typically smaller than entrance pits. Overlying surfaces disturbed during the process would be restored to pre-disturbance conditions upon completion of work to minimize impacts. No long-term impacts to surface geological resources are expected associated with HDD. HDD will result in long-term minor changes to subsurface geology along the drill path. If there is an inadvertent release, containment and clean up procedures would be followed.

Onshore Project Area

Potential impacts associated with the construction of the transition joint bays (TJBs), onshore export cable route, and onshore substation are discussed below as construction techniques are similar for these Project components and will occur in developed areas where previously disturbed soils lacking in soil horizons predominate. During construction, soils will be excavated at the landfall (e.g., HDD pits or open cut) and installation of TJBs, along the cable route, and at the onshore substation site for foundations. The existing geological resources will be disturbed and removed from excavation areas. Following construction, soils will be back filled, where applicable, and surface grades returned to previous conditions.

Soil disturbing activities in these areas will not result in long-term impacts to physical soil properties. However, disturbance to upland soils within developed areas of New Jersey is likely to result in contact with contaminated soils, and if not managed, could result in the spread of contamination, resulting in impacts to clean soils and other resources or receptors. Project construction will require compliance with the NJDEP's Technical Requirements for Site Remediation (N.J.A.C. 7:26C and 7:26E). Construction will follow the NJDEP Site Remediation Program's Linear Construction Technical Guidance (January 2012). Administrative Requirements for the Remediation of Contaminated Sites mandates that a LSRP be hired to oversee the management of contamination, including contaminated soil, during the project. Impacts from excavation, backfilling, grading, handling, transport, and disposal of contaminated soil are mitigated by the LSRP preparing a MMP for the contractors to adhere to during construction.

As part of the MMP, the LSRP will gather information on the potential for contaminated areas along the construction corridor and may perform sampling if pre-existing data is lacking. This information will inform the MMP and will facilitate avoidance of unanticipated encounters with contaminated soil during construction, reducing the potential for impacts to human health and the environment.

Disturbances to upland soils within the construction corridor and at onshore substations will be localized to the work areas and short-term. Impacts will be mitigated via adherence to the MMP during construction.

2.1.1.2.2 Operations and Maintenance

Offshore Project Area

Once the Project is constructed and operational, temporary disturbance to geological resources will occur as a result of vessels anchoring during scheduled and unscheduled maintenance.

As detailed in Section 6 of Volume I, cable maintenance and protection would include inspection and maintenance of the seabed, scour protection (if required), and cable burial depth and annual maintenance. Scour protection replenishment impacts to the seabed would be similar in nature to impacts during construction, but on a smaller geographic scale.

Sediment disturbance and resettlement may occur during reburial activities. Cable length and width repair requirements, repair pit dimensions, and required jetting as discussed in the Project Description (Volume I) would impact the seabed in the work areas. During scour protection replenishment, temporary impacts to the seabed would occur in areas requiring additional scour protection. Once completed, scour protection replenishment will prevent scour as intended, however the addition of a rock berm over cables would alter the seabed from a rippled, low relief surface to a higher relief, armored surface in the placement areas.

Onshore Project Area

Soil disturbance during operation and maintenance is not anticipated. However, in the case of emergency repairs activities, impacts will be similar to construction and installation.

2.1.1.2.3 Decommissioning

At the end of the operational lifetime of the Project, it is anticipated that all structures above the seabed level or aboveground will be removed based on permit conditions. The decommissioning sequence will generally be the reverse of the construction sequence, will involve similar types and number of vessels, and similar equipment, therefore, the impacts to geological resources from seabed disturbance, ground disturbance, and resuspension of sediments will be similar to construction.

2.1.1.2.4 Summary of Potential Project Impacts on Geologic Resources

The IPFs affecting geological resources include physical seabed/land disturbance and sediment suspension.

Permanent impacts would result from placement of facilities/structures or scour protection on the seabed or soils. Specifically, offshore, the facility foundations, scour protection and limited cable protection are expected to result in long-term or permanent changes to the seabed, including added hard bottom habitat. Onshore, the substation facilities, TJBs, and link boxes are expected to result in permanent impacts to soils. Temporary impacts would result from sediment and soil removal or displacement and re-suspension. Impacts to geological resources would be minimized with the application of APMs.

2.1.1.3 Avoidance, Minimization, and Mitigation Measures

The proposed measures for avoiding, minimizing, reducing, eliminating, and monitoring environmental impacts are presented in **Table 1.1-2**.

2.1.2 Water Quality

The following section describes the existing meteorology and physical oceanography (metocean) and water quality in the Project Area.

2.1.2.1 Affected Environment

Attributes of metocean and water quality for the Wind Farm Area, offshore export cable corridors, and Onshore Project Area are provided below.

Metocean conditions consist of the combined wind, wave, current, and climate found in a given location. In temperate regions, metocean conditions are often highly seasonal and driven through atmospheric and ocean circulation patterns. Metocean data are often used for planning purposes to determine extreme events within a region, such as: historical storm severity, wind speed, wind direction, wave heights, storm surge, current direction, current velocity, water temperature, and water salinity.

Water quality consists of the physical, chemical, and biological characteristics of water. Waters within the Project Area consist of temperate ocean, coastal, brackish, and fresh water. Water quality data are used to assess the health of ecosystems and safety of human contact within the Atlantic Ocean, New Jersey coastline, and inland coastal waterways. Water quality can be impacted by introduction of pollutants through natural or anthropogenic sources which can lead to degradation of water bodies. Water quality data include water temperature, salinity, chlorophyll a concentration, dissolved oxygen concentration, and turbidity.

2.1.2.1.1 Wind Farm Area

Wind and Waves

Prevailing winds at the middle latitudes over North America occurs mostly west to east ("westerlies"). Westerlies within the Lease Area vary in strength, pattern, and directionality. Winds during the summer are typically from the southwest and flow parallel to the shore and winds in the winter months are typically from the northwest and flow perpendicular to the shore. Spring and fall are more variable, with wind currents from either the southwest or northeast (Schofield *et al.* 2008).

The Metocean Data Portal, maintained by the Danish Hydrological Institute (DHI), provides wind data for the entire U.S. East coast that has been generated through numerical models (DHI 2018). Data for a position located within the Lease Area were generated using the location found at 39.221195, -74.322056 (Latitude, Longitude). In the Lease Area, 2017 wind speeds reached 63.8 miles per hour (28.5 m/s) (**Figures 2.1.2-1** and **2.1.2-2**). The wind direction with the highest frequency generally occurred to the north and west direction (**Figure 2.1.2-2**).

Ocean Wind has been collecting wind and wave data from two stations located in the Lease Area, Stations F220 and F230 (**Figure 2.1.2-4**). **Table 2.1.2-1** provides the wave height data for the two stations during the monitoring period from June 23, 2018 through December 9, 2019.

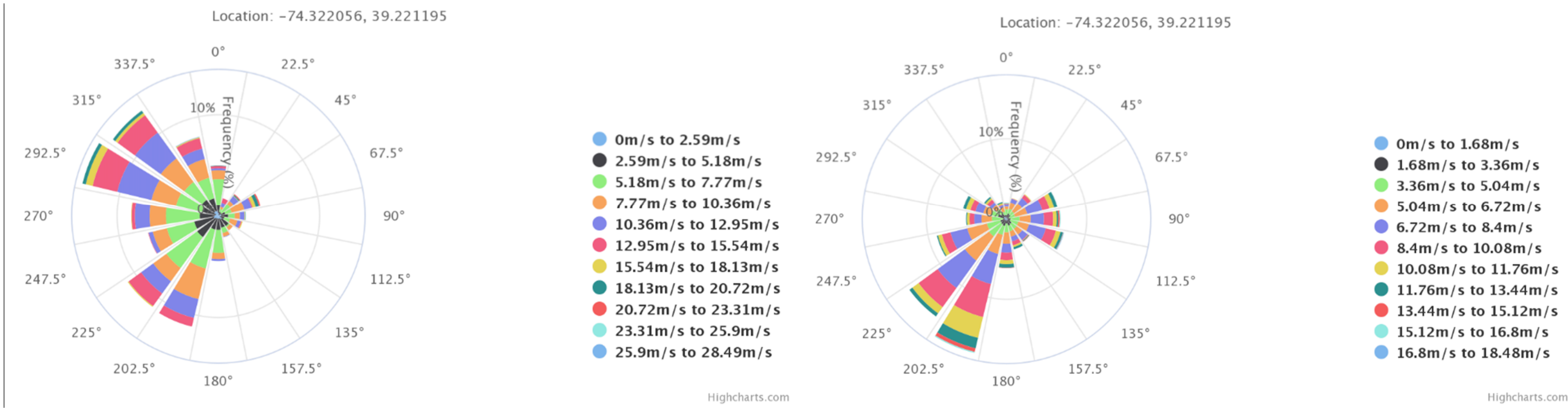


Figure 2.1.2-1. Wind rose graph for the Lease Area January through March 2017 and April through June 2017 (DHI 2018).

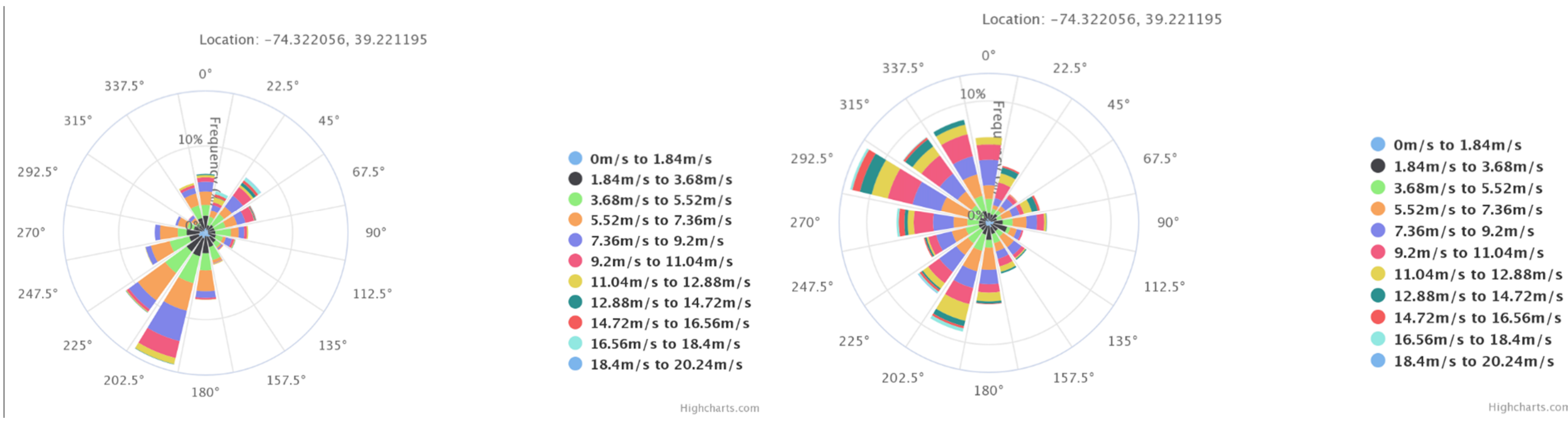


Figure 2.1.2-2. Wind rose graph for the Lease Area July through September 2017 and October through December 2017 (DHI 2018).

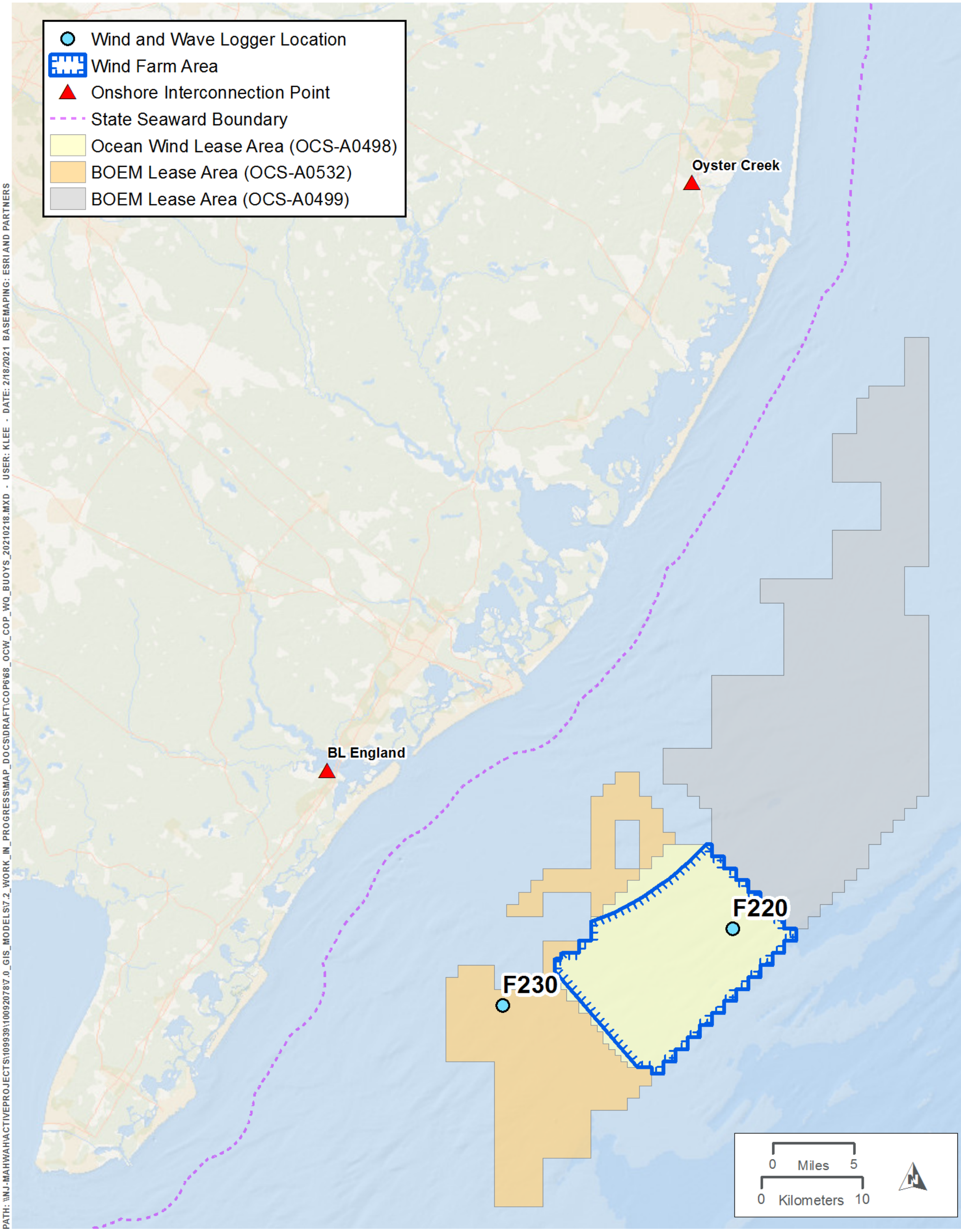
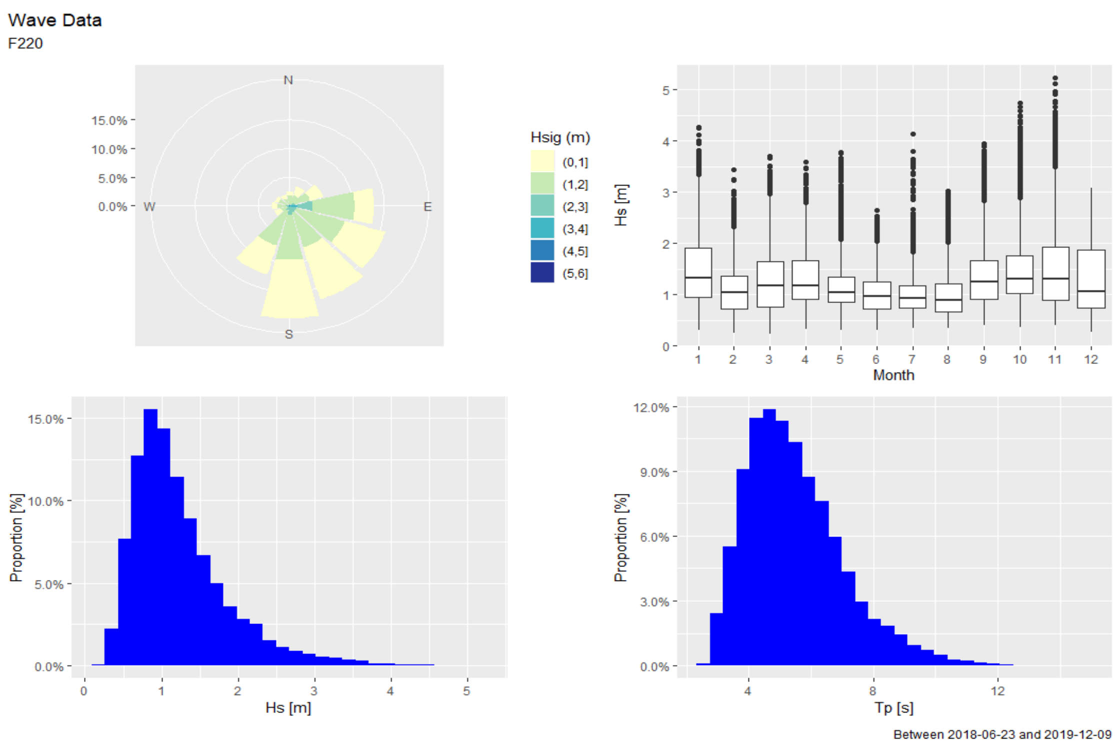


Figure 2.1.2-3. Ocean Wind Stations F220 and F230 location in the Lease Area.

Table 2.1.2-1. Wave data measured at Ocean Wind Stations F220 and F230 from June 23, 2018 to December 9, 2019.

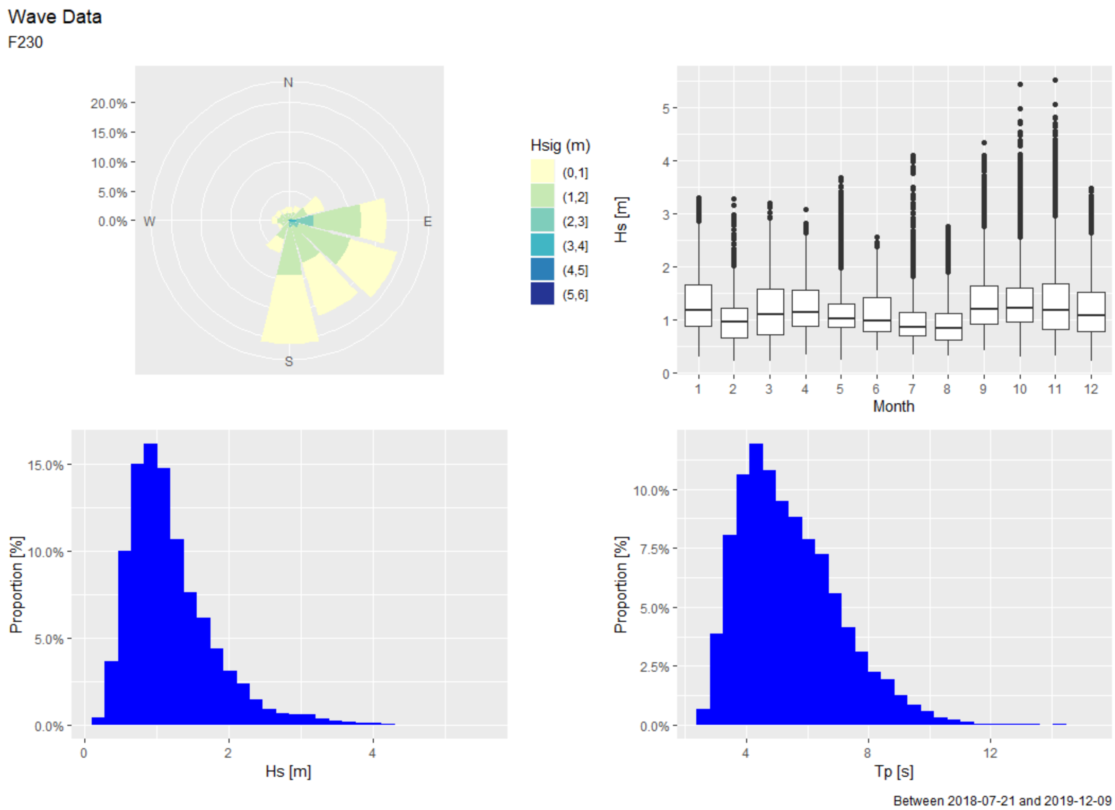
Station ID	Average Height ft/(m)	Maximum Height ft/(m)	Minimum Height ft/(m)	Dominant Wave Periods (s)	Average Wave Periods (s)
F220	2.6 (0.8)	11.4 (3.5)	0.5 (0.2)	10.1	4.3
F230	2.3 (0.8)	11.6 (3.6)	0.5 (0.1)	9.7	4.3

The majority of waves originate from the southeast with significant wave height typically less than 6.6 ft (2 m) and significant wave period of less than 6 seconds for both the F220 and F230 Stations. Both sites appear to have similar distributions across all recorded parameters during each calendar quarter and do not appear to be significantly different from each other. Both units have similar trends over time and over the period of record (**Figure 2.1.2-4** and **Figure 2.1.2-5**).



Note: Top left: significant wave height by mean direction; top right: descriptive statistics for monthly wave height; bottom left: frequency histogram of wave height over the monitoring period; and bottom right: frequency histogram of wave period over the monitoring period.

Figure 2.1.2-4. Wave data measured at Ocean Wind Station F220 from June 23, 2018 through December 9, 2019.



Note: Top left: depicts significant wave height by mean direction; top right: descriptive statistics for monthly wave height; bottom left: frequency histogram of wave height over the monitoring period; and bottom right: frequency histogram of wave period over the monitoring period.

Figure 2.1.2-5. Wave data measured at Ocean Wind Station F230 from June 23, 2018 through December 9, 2019.

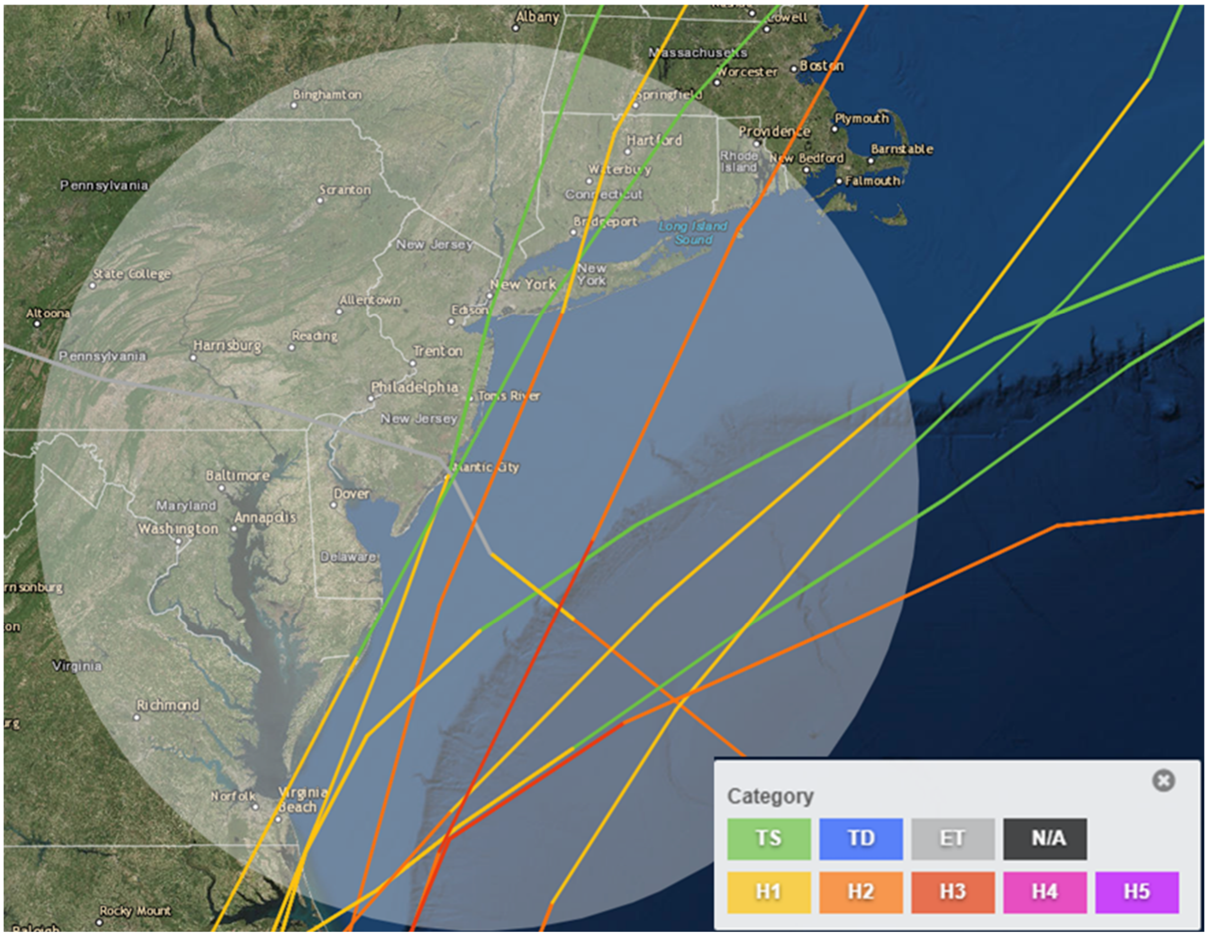
Hurricanes

Extratropical storms, including northeasters, are common in the Lease Area from October to April. These storms bring high winds and heavy precipitation, which can lead to severe flooding and storm surges. Storm surge is produced by water being pushed toward the shore by the force of the winds moving cyclonically around the storm. When an advancing storm surge is combined with the normal high tides, water levels can reach dangerous levels and cause extensive damage. Hurricanes that travel along the coastline of the eastern U.S. have the potential to impact the Lease Area with high winds and severe flooding. Most hurricane events within the Atlantic generally occur from mid-August to late October, with the majority of all events occurring in September (Donnelly *et al.* 2004). On average, hurricanes occur every 3 to 4 years within 90 to 170 miles of the New Jersey Coast (NJDEP 2010a).

Figure 2.1.2-6 identifies the hurricane tracks within the Lease Area and surrounding areas since 1979 (NOAA 2018c). The category for each storm is designated by a color for each track in **Figure 2.1.2-6**. At least two tropical storms passed through the Lease Area since 1979. **Table 2.1.2-2** identifies the storms and their storm categories that have occurred throughout the Lease Area and cable corridor.

Hurricane Sandy occurred in 2012 and caused the highest storm surges and greatest inundation on land in New Jersey. The storm surge and large waves from the Atlantic Ocean meeting up with rising waters from back bays such as Barnegat Bay and Little Egg Harbor caused barrier Islands to be completely inundated (Blake

2013). In Atlantic City and Cape May, tide gauges measured storm surges of 5.8 ft and 5.2 ft, respectively (Blake 2013). Atlantic City International Airport (KACY) recorded maximum sustained wind speeds of 44.3 knots (51 mph) and a peak wind speed of 55.6 knots (64 mph) on the coast (NOAA 2012). Marine observations at the Cape May National Ocean Service (CMAN4) recorded sustained wind speeds at 52 knots and an estimated inundation of 3.5 ft (Blake 2013).



Note: Green indicates a tropical storm, blue a tropical depression, gray an extratropical storm, and hurricane categories one through five are denoted as H1 to H5 (NOAA 2018c).

Figure 2.1.2-6. Hurricane tracks within the Lease Area since 1979 (NOAA 2018c).

Table 2.1.2-2. Storms that have occurred within 200 nautical miles (nm) of the Lease Area since 1979 (NOAA 2018c).

Storm Name	Date	Storm Category in Search Area (200 NM of Lease Area)
Gloria	1985	Category 1 and Category 2 Hurricane
Bob	1991	Category 2 and Category 3 Hurricane
Emily	1993	Category 2 and Category 3 Hurricane
Charley	1998	Tropical Storm and Category 1 Hurricane
Floyd	1999	Tropical Storm and Category 1 Hurricane

Storm Name	Date	Storm Category in Search Area (200 NM of Lease Area)
Earl	2010	Tropical Storm and Category 1 Hurricane
Irene	2011	Tropical Storm and Category 1 Hurricane
Sandy	2012	Extratropical Cyclone, Hurricane Category 1, and Category 2 Hurricane
Arthur	2014	Category 1 Hurricane

Ocean Currents

To measure the current, Ocean Wind deployed two meteorological monitoring buoys attached to the seabed, which housed an Acoustic Doppler Current Profilers to measure water current speed (velocity) and direction. Additional information is provided in Appendix Y. The offshore export cable corridors experience semi-diurnal tides driven by the moon and sun. Currents in the Lease Area are predominantly south-easterly resulting in a net direction of flow offshore towards the Continental Shelf (**Figure 2.1.2-7**). Current data was derived from Coastal Ocean Dynamics Applications Radar/Coastal Radar (CODAR) stations located in Sandy Hook, Loveladies, Wildwood, and Tuckerton, New Jersey. Bottom current speed and direction modeled by the University of Massachusetts-Dartmouth School for Marine Science and Technology, Woods Hole Oceanographic Institution (WHOI) were available as climatological long-term averages from 1978 to 2013. Bottom currents in the Lease Area appear to flow in a southerly direction (**Figure 2.1.2-8;** WHOI 2016).

The current speed and current direction data were downloaded from the DHI Metocean Data Portal for the Lease Area for the 2017 year (**Figures 2.1.2-9** to **2.1.2-16**; DHI 2018)**.** Current speeds and directions were divided into three-month intervals. The highest current speeds were approximately 1.4 ft/s (0.42 m/s) for January through March, 1.3 ft/s (0.40 m/s) April through June, 1.2 ft/s (0.37 m/s) July through September, and 1.1 ft/s (0.35 m/)s for October through December.

The apparent disagreement between the CODAR-derived surface currents (**Figure 2.1.2-7**) direction and the modeled bottom current direction (**Figure 2.1.2-8**) is likely because CODAR is a remote sensing technology that only measures the very top-most surface water direction which will primarily be wind driven. Because the prevailing wind direction is from the west, it is not surprising that the CODAR-derived current direction is co-linear with the wind direction. Currents within the water column are generally more influenced by local bathymetry and regional density gradients than wind and thus can differ from CODAR measurements. Moreover, the current pattern shown in **Figure 2.1.2-8** is typical for coastal water in the northeast with a predominant southerly direction offshore and perpendicular to shore currents in the inshore areas (due to upwelling).

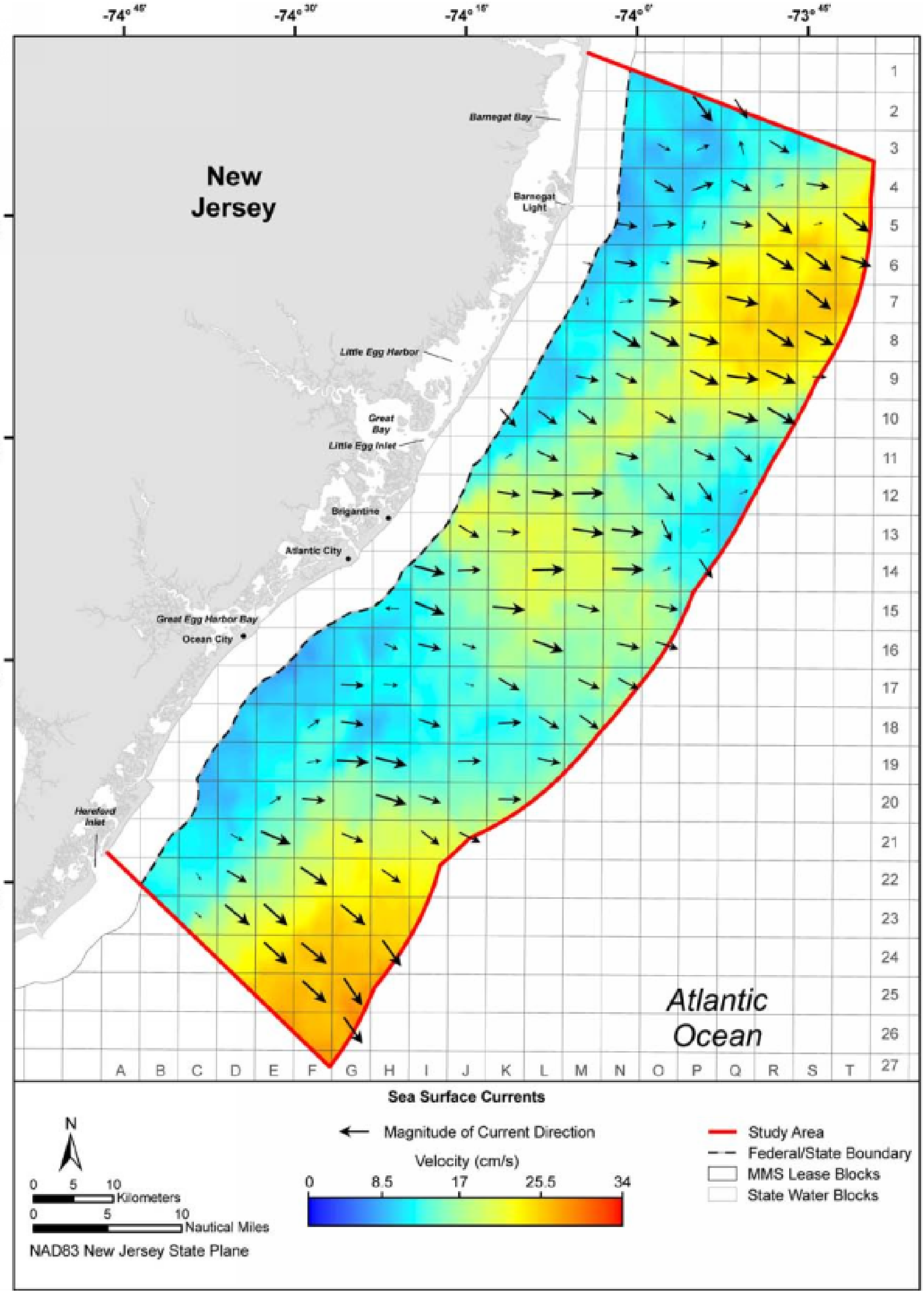


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Figure 2.1.2-7. Mean annual surface currents in the vicinity of the Lease Area measured by CODAR over the year of 2004 (NJDEP 2010a).

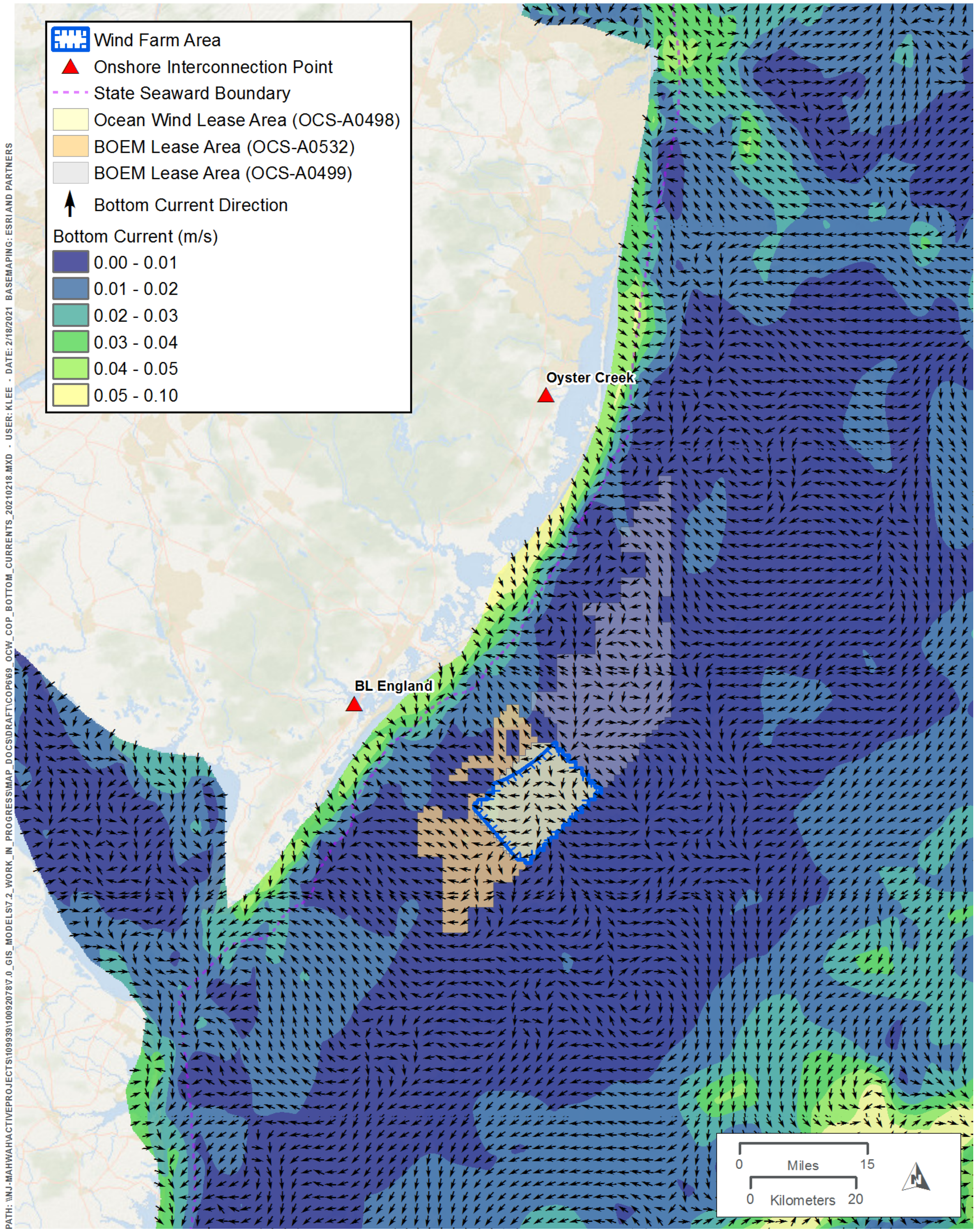

Figure 2.1.2-8. Modelled climatological annual average bottom current direction and speed offshore of New Jersey from 1978 to 2013 (WHOI 2016).

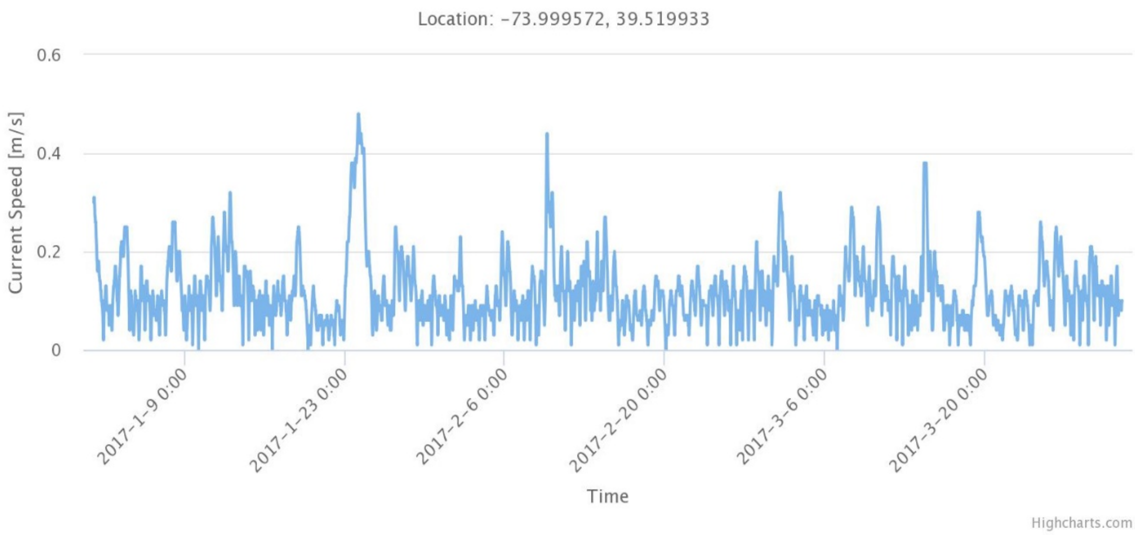

Figure 2.1.2-9. Current speeds for the Lease Area January through March 2017 (DHI 2018).

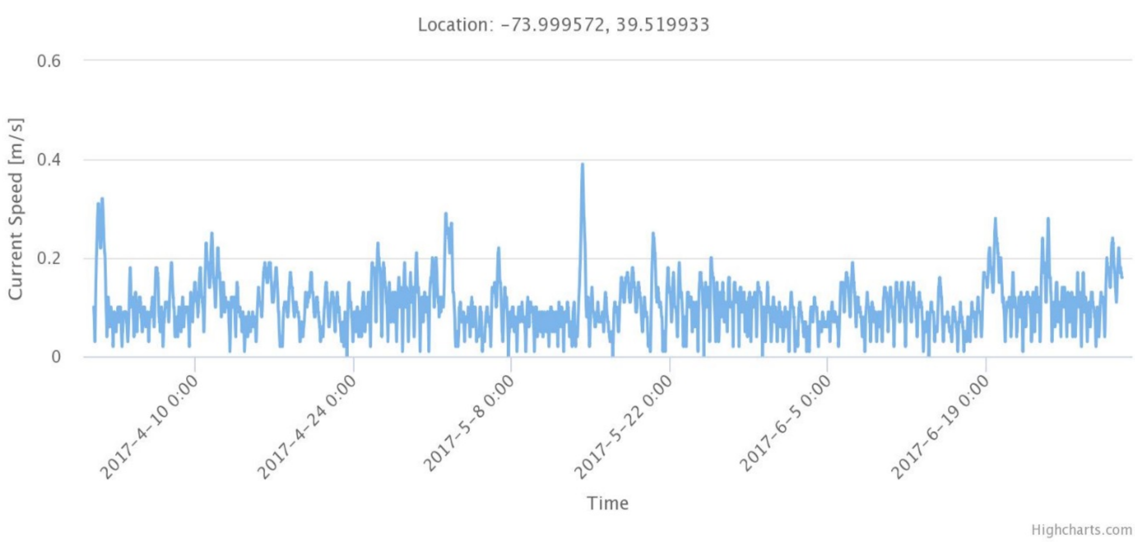

Figure 2.1.2-10. Current speeds for the Lease Area April through June 2017 (DHI 2018).

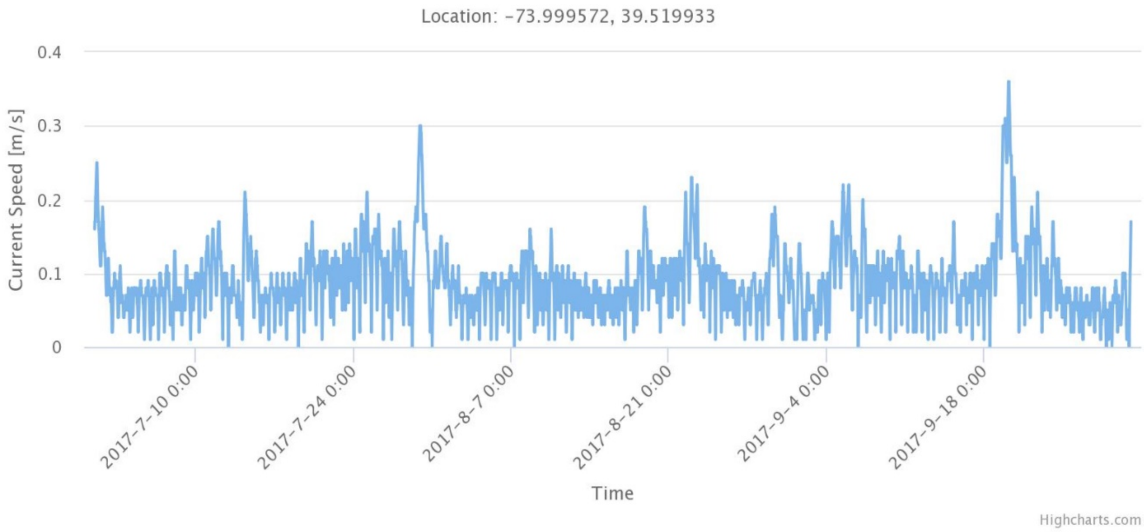

Figure 2.1.2-11. Current speeds for the Lease Area July through September 2017 (DHI 2018).

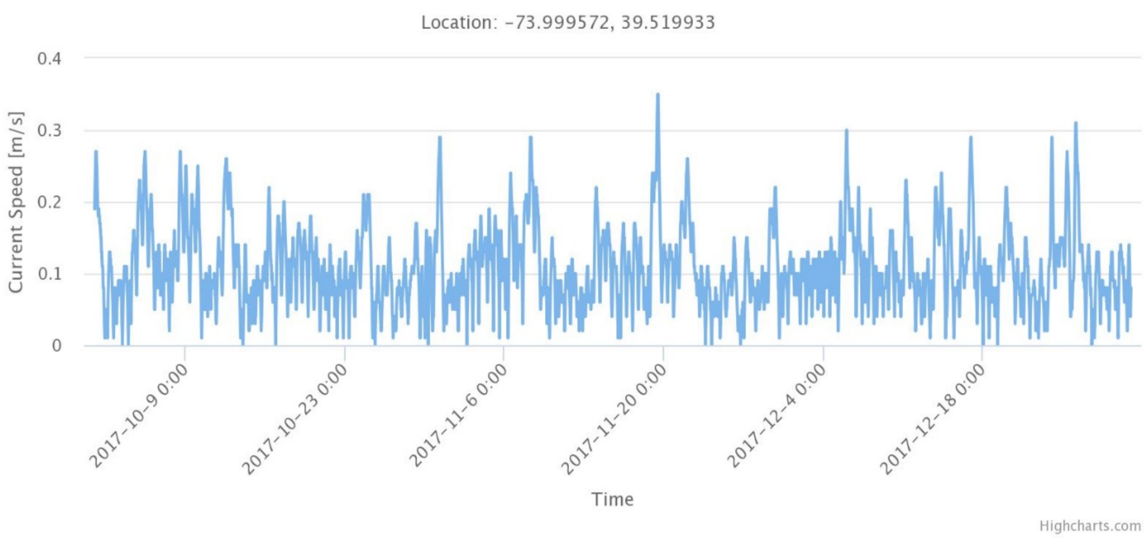

Figure 2.1.2-12. Current speeds for the Lease Area October through December 2017 (DHI 2018).

Figure 2.1.2-13. Current direction for the Lease Area January through March 2017 (DHI 2018).

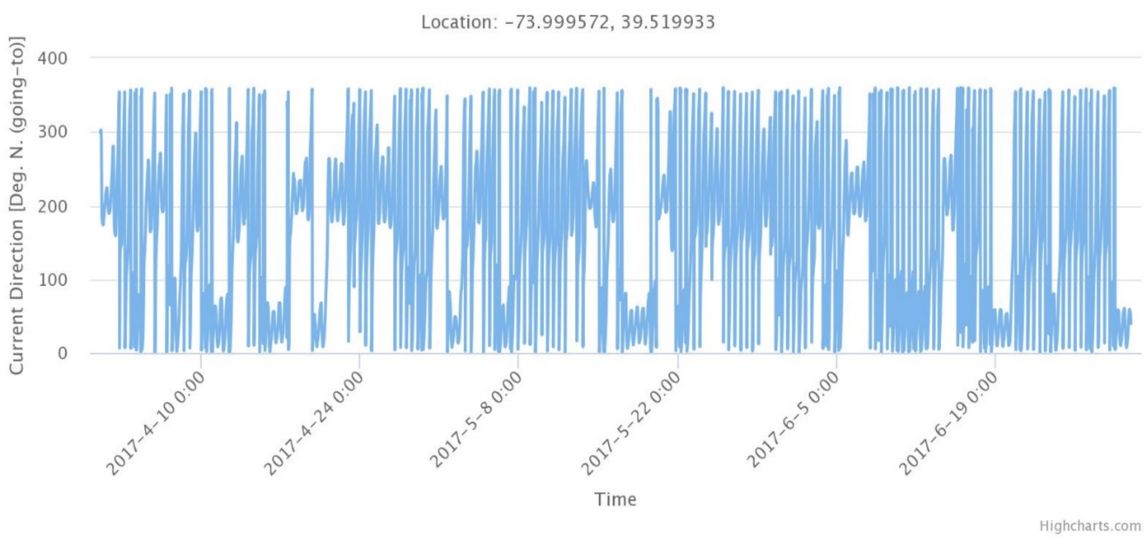

Figure 2.1.2-14. Current direction for the Lease Area April through June 2017 (DHI 2018).

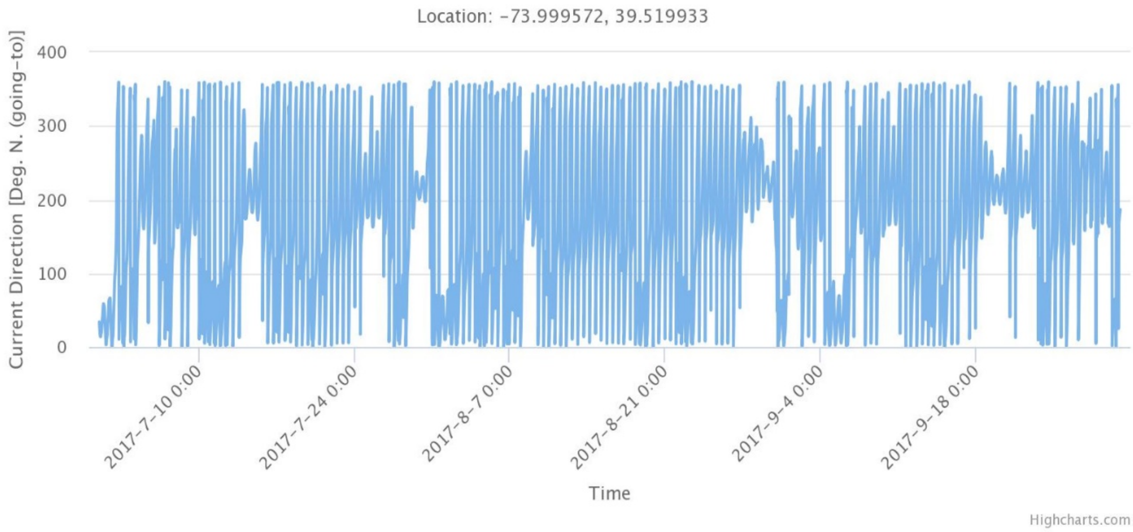

Figure 2.1.2-15. Current direction for the Lease Area July through September 2017 (DHI 2018).

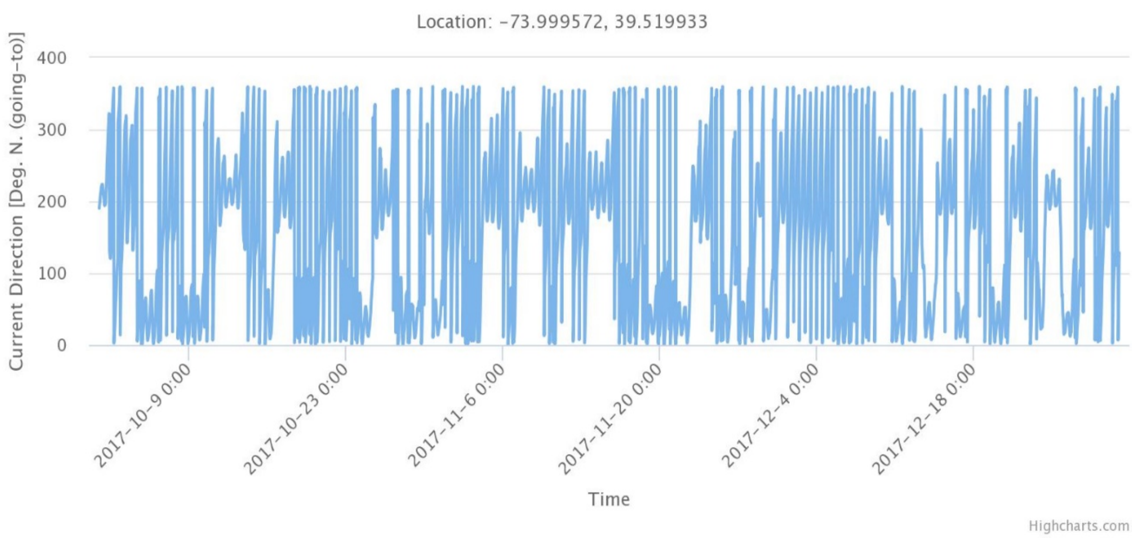

Figure 2.1.2-16. Current direction for the Lease Area October through December 2017 (DHI 2018).

Salinity

BOEM and NOAA funded a comprehensive multi-scale benthic assessment conducted by NOAA Northeast Fisheries Science Center (NEFSC), in collaboration with Woods Hole Oceanographic Institution and the University of Massachusetts-Dartmouth School for Marine Science and Technology, of the eight Atlantic outer continental shelf (OCS) Wind Energy Areas (WEAs), which includes the Ocean Wind Lease Area (Guida *et al.* 2017). Surveys were conducted to characterize benthic communities within the WEAs as well as collect environmental data and habitat definition. Median salinity measured in the Lease Area for the period of 2003-2016 was 32.2 practical salinity units (PSU), with a full range spanning 29.4 to 34.4 PSU (n=4,205). This range is within the euhaline range (30-40 PSU), which is the typical salinity range for seawater (Venice salinity classification system: Anon 1958).

Climate, Thermocline, and Water Quality

Refer to Climate, Thermocline, and Water Quality in Section 2.1.2.1.2.

2.1.2.1.2 Offshore Export Cable Corridors

Wind and Waves

In addition to the wind data presented in Section 2.1.2.1.1, NOAA's National Data Buoy Center offers wave data in proximity to the offshore export cable corridors. Data are collected from the New York Harbor buoy station every half hour and parameters recorded include: wave height, dominant wave period, average period, mean wave direction, water temperature, significant wave height, swell height, swell period, swell direction, wind wave height, wind wave period, wind wave direction, wave steepness, and average wave period. Real time data can be downloaded in tabular form for the previous 45 days. Additionally, the station offers historical data and climatic summaries (verified quality controlled) for the current month, previous months, and previous years. Data are collected by these data buoys; the historical data provides a robust summary of the existing conditions temporally and spatially along the New Jersey coastline and the Offshore Project Area.

Data were readily available for wind speeds and wind directions from the New York Harbor buoy (Buoy No. 44065) for the years 2014-2018. The New York Harbor buoy is approximately 78 miles northeast of the Lease Area. Data for 2018 were taken up to the month of August. The maximum wind speed recorded from 2014-2018 was 47.4 mph (21.2 m/s) in 2018, with average wind speeds between 11.2-15.7 mph (5-7 m/s) across these five years (**Table 2.1.2-3**). The average wind direction is from the southwest and south during this period. For the seasons across 2017, the maximum wind speed was recorded at 26.8 mph (21 m/s) in the spring, with average wind speeds between 11.2-15.7 mph (5-7 m/s) (**Table 2.1.2-4**). The average wind direction occurs mostly from the south and southwest.

Table 2.1.2-3. Wind speed and wind direction for New York Harbor from January 2014 - August 2018.

Year	Average Windspeed mph/(m/s)	Maximum Windspeed mph/(m/s)	Average Wind Direction (° from True North)	No. of Observations
2014	15.9 (7.1)	40.9 (18.3)	326.5 (Northwest)	5,251
2015	14.1 (6.3)	14.6 (18.6)	202.2 (Southwest)	8,746
2016	14.5 (6.5)	45.0 (20.1)	199.8 (Southwest)	8,740
2017	14.5 (6.5)5.1	47.0 (21.0)	197.9 (Southwest)	8,702
2018	11.4 (5.1)	47.4 (21.2)	185.0 (South)	24,280

Table 2.1.2-4. Wind speed and wind direction for New York Harbor across seasons for 2017.

Season	Average Windspeed mph/(m/s)	Maximum Windspeed mph/(m/s)	Average Wind Direction (° from True North)	No. of Observations
Winter	16.8 (7.5)	44.3 (19.8)	223.9 (Southwest)	2,151
Spring	14.5 (6.5)	47.0 (21.0)	187.0 (South)	2,172
Summer	11.4 (5.1)	30.4 (13.6)	183.5 (South)	2,198
Fall	15.2 (6.8)	39.1 (17.5)	197.8 (Southwest)	2,181

The Barnegat, NJ, buoy was used to determine the wave height likely found within the estuary of the offshore export cable corridor (Buoy Number 44091). **Table 2.1.2-5** presents the wave height data for Barnegat Bay.

Table 2.1.2-5. Wave data for 2014-2017 in Barnegat Bay.

Year	Average Height ft/(m)	Maximum Height ft/(m)	Minimum Height ft/(m)	Dominant Wave Periods (s)	Average Wave Periods (s)
2014	3.9 (1.2)	13.1 (4.0)	1.3 (0.4)	7.2	4.5
2015	4.3 (1.3)	18.0 (5.5)	1.0 (0.3)	7.7	5.1
2016	4.3 (1.3)	27.2 (8.3)	0.7 (0.2)	7.7	5.2
2017	4.3 (1.3)	22.3 (6.8)	1.3 (0.4)	7.9	5.3

Climate

Recent air temperature and sea surface temperature (SST) data can be downloaded from the NOAA buoys found throughout the Offshore Project Area. Data for the years 2014 and up to August 2018 were downloaded from Atlantic City (Buoy No. ACYN4). The data are summarized in **Table 2.1.2-6** for the years 2014 through August 2018. **Table 2.1.2-7** provides the average air temperature and average SST for the 2017 seasons.

Table 2.1.2-6. Average air temperature and SST °F (°C) for the Offshore Export Cable Corridor for January 2014 - August 2018 - Atlantic City Buoy (Buoy No. ACYN4).

Year	Average Air Temperature °F/(°C)	No. of Observations	Average SST °F/(°C)	No. of Observations
Atlantic City				
2014	53.8 (12.1)	86,432	54.3 (12.4)	82,289
2015	55.4 (13.0)	86,357	55.8 (13.2)	86,202
2016	55.6 (13.1)	81,252	56.8 (13.8)	86,075
2017	55.9 (13.3)	85,557	56.7 (13.7)	86,326
2018	52.9 (11.6)	63,856	52.3 (11.3)	64,676

Table 2.1.2-7. Average air temperature and SST °F (°C) of the Offshore Export Cable Corridor for 2017 Seasons - Atlantic City Buoy (Buoy No. ACYN4).

Season	Average Air Temperature °F/(°C)	No. of Observations	Average SST °F/(°C)	No. of Observations
Atlantic City				
Winter (Dec-Feb)	39.7 (4.3)	21,214	42.3 (5.74)	21,462
Spring (Mar-May)	50.5 (10.3)	21,843	49.9 (9.93)	21,972
Summer (June-Aug)	71.8 (22.1)	21,537	69.7 (21.0)	21,737
Fall (Sep-Nov)	61.6 (16.4)	20,963	65.0 (18.4)	21,155

The NJDEP conducted ecological baseline studies between 2008 and 2009, within the Lease Area (NJDEP 2010a). This study can be used to determine the existing conditions within the Offshore Project Area. It includes a description of the offshore climate including air and SST, wind patterns, and tides using data from the National Aeronautics and Space Administration, NOAA, the Office of the New Jersey State Climatologist, and peer reviewed papers. The Lease Area and offshore export cable corridors are characterized by mild seasons and storms throughout the year with precipitation in the form of rain and snow being most common (NJDEP 2010a).

Available air temperature and precipitation data was collected in the southern and coastal areas of New Jersey from 1985 through 2009. The annual, seasonal, and monthly means were determined. The mean seasonal temperature is depicted in **Figure 2.1.2-17** and mean annual precipitation is depicted in **Figure 2.1.2-18**. The mean season air temperature during the winter ranges between approximately 32-43°F (0-6°C) and 54-64°F (12-18°C) during the spring. The mean season air temperature during the summer ranges between approximately 68-75°F (20-24°C) and 54°F (12°C) during the fall (**Figure 2.1.2-17**). The mean seasonal precipitation for the Offshore Project Area ranges between approximately 0-0.030 milliliters per square meter per second ($mL/m^2/s$) for the winter and 0-0.025 $mL/m^2/s$ for the spring. The mean seasonal precipitation is approximately 0.075-1 $mL/m^2/s$ for the summer and 0.05 $mL/m^2/s$ for the fall within the Offshore Project Area (Lease Area and offshore export cable corridors) (**Figure 2.1.2-18**).

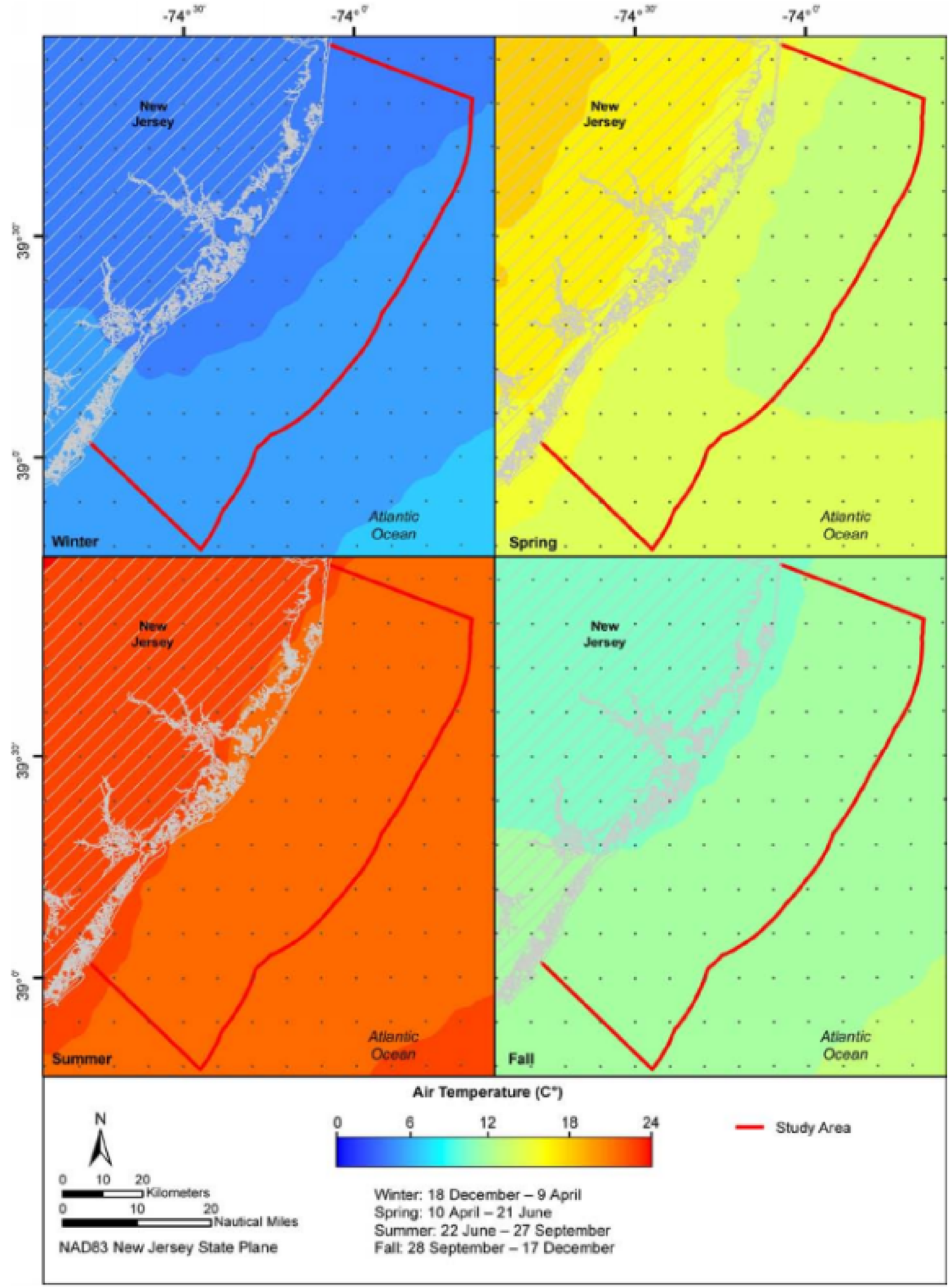

Figure 2.1.2-17. Mean season air temperature (°C) in NJDEP offshore study area (NJDEP 2010a).

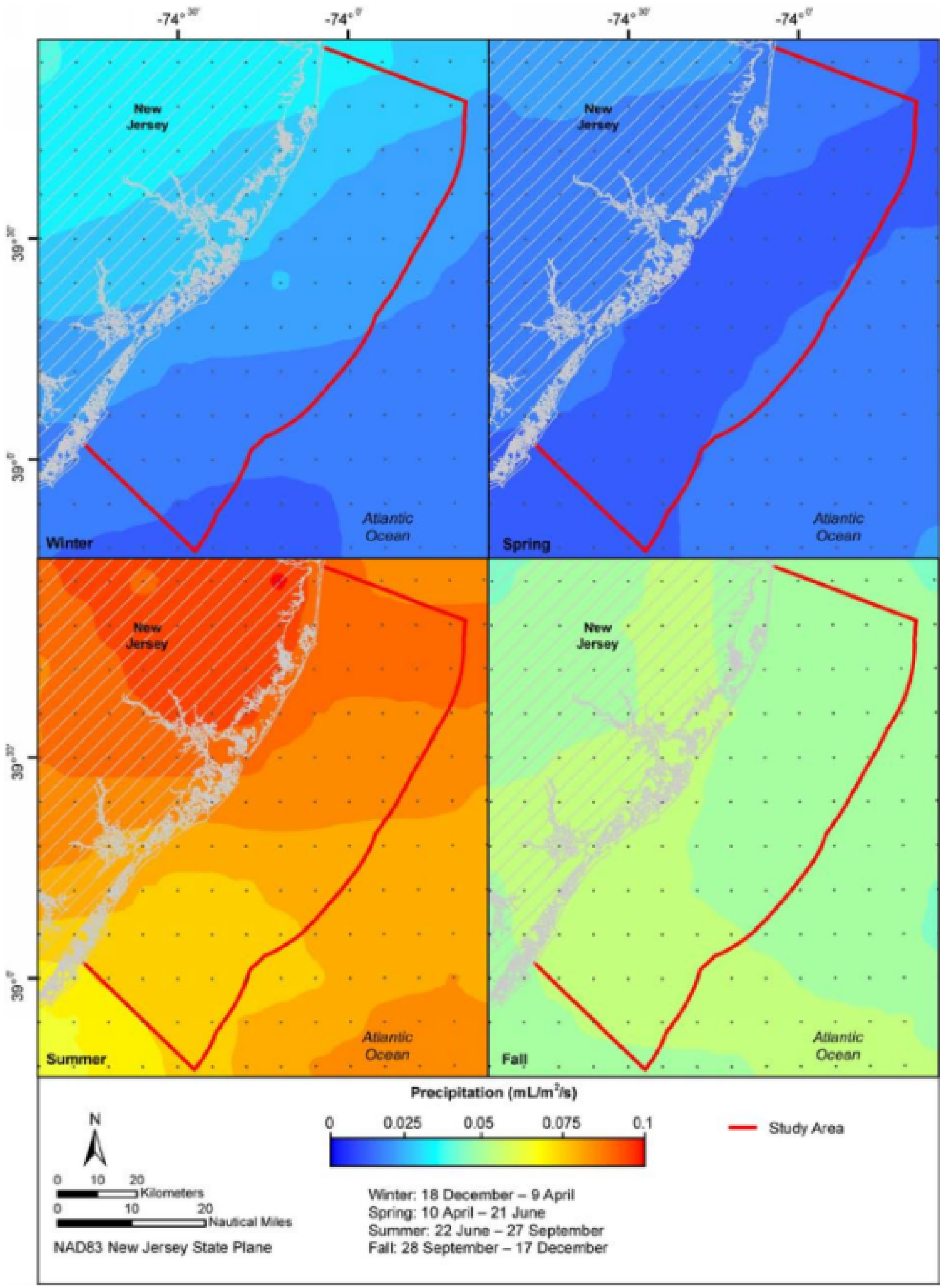

Figure 2.1.2-18. Mean seasonal precipitation (mL/m²/s) in NJDEP offshore study area (NJDEP 2010a).

Water Temperature

Boat-based surveys were conducted to collect various water quality parameters within the Lease Area and surrounding Atlantic Ocean. Conductivity, temperature, and depth (CTD) profiles were conducted at the beginning of the survey day, at noon, and end of the survey day as well as the end of each trackline whenever possible (NJDEP 2010a). Survey tracklines from 2008 and 2009 are shown in **Figure 2.1.2-19**. The minimum SST value collected was 36°F (2°C) during winter and the maximum SST value collected was 79°F (26°C) during summer.

Figure 2.1.2-20 shows the water temperature within the water column in the New Jersey WEA over the period of 2003 to 2016 (Guida *et al*. 2017). Seasonal fluctuation spanned as much as 68°F (20°C) at the surface and 59°F (15°C) at the bottom, with thermal stratification beginning in April and increasing into August. Actual surface and bottom temperatures varied substantially from year to year, particularly during the fall. Surface to bottom temperature gradients were warmer and the surface and cooler at the bottom, with a stratified condition in spring and summer and isothermal condition following the fall turnover during winter.

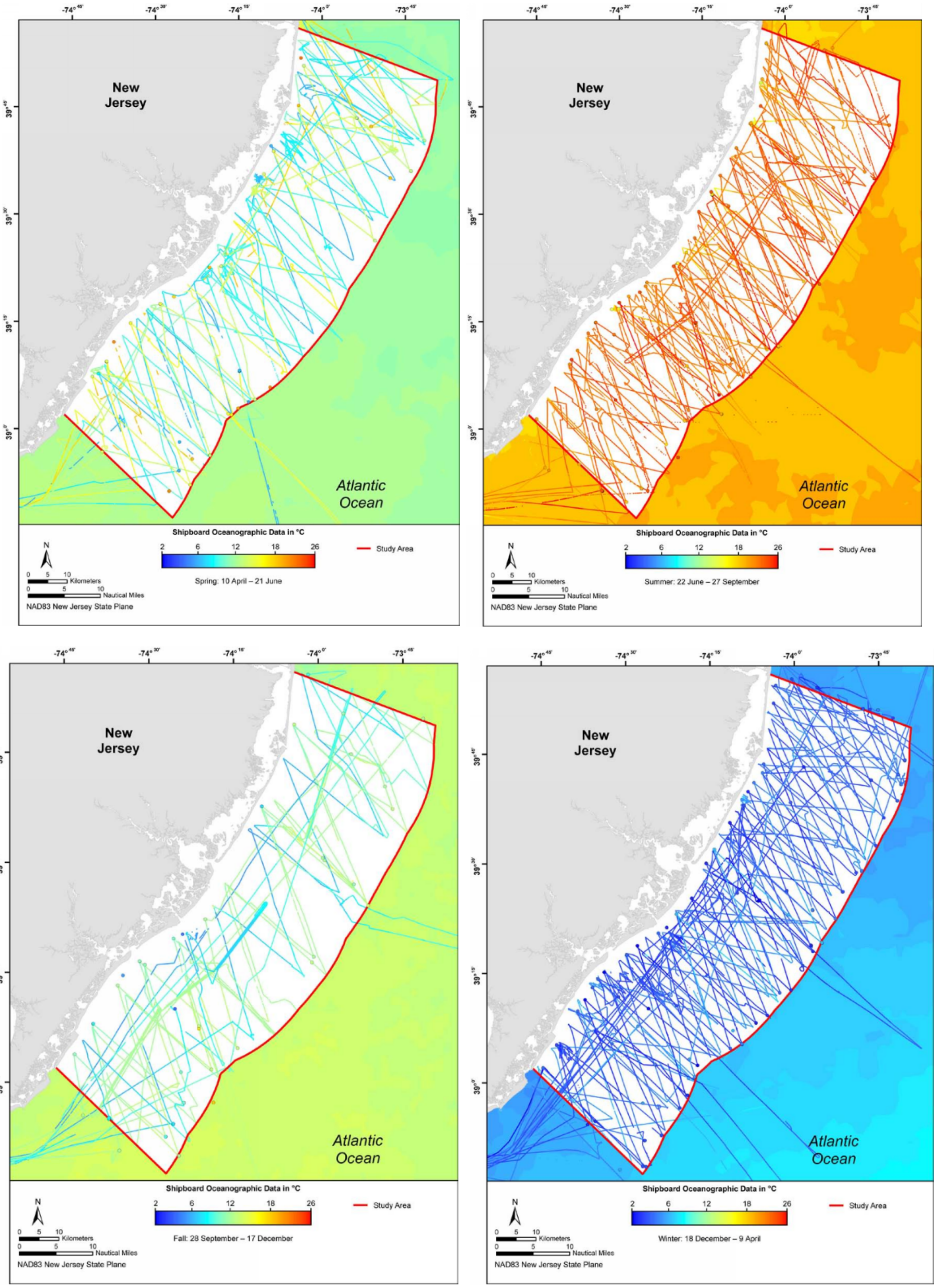

Figure 2.1.2-19. SSTs for the winter, spring, summer, and fall seasons in the study area collected via the Surface Mapping System and the CTD casts on board the R/V Hugh R. Sharp (2008 and 2009) (NJDEP 2010a).

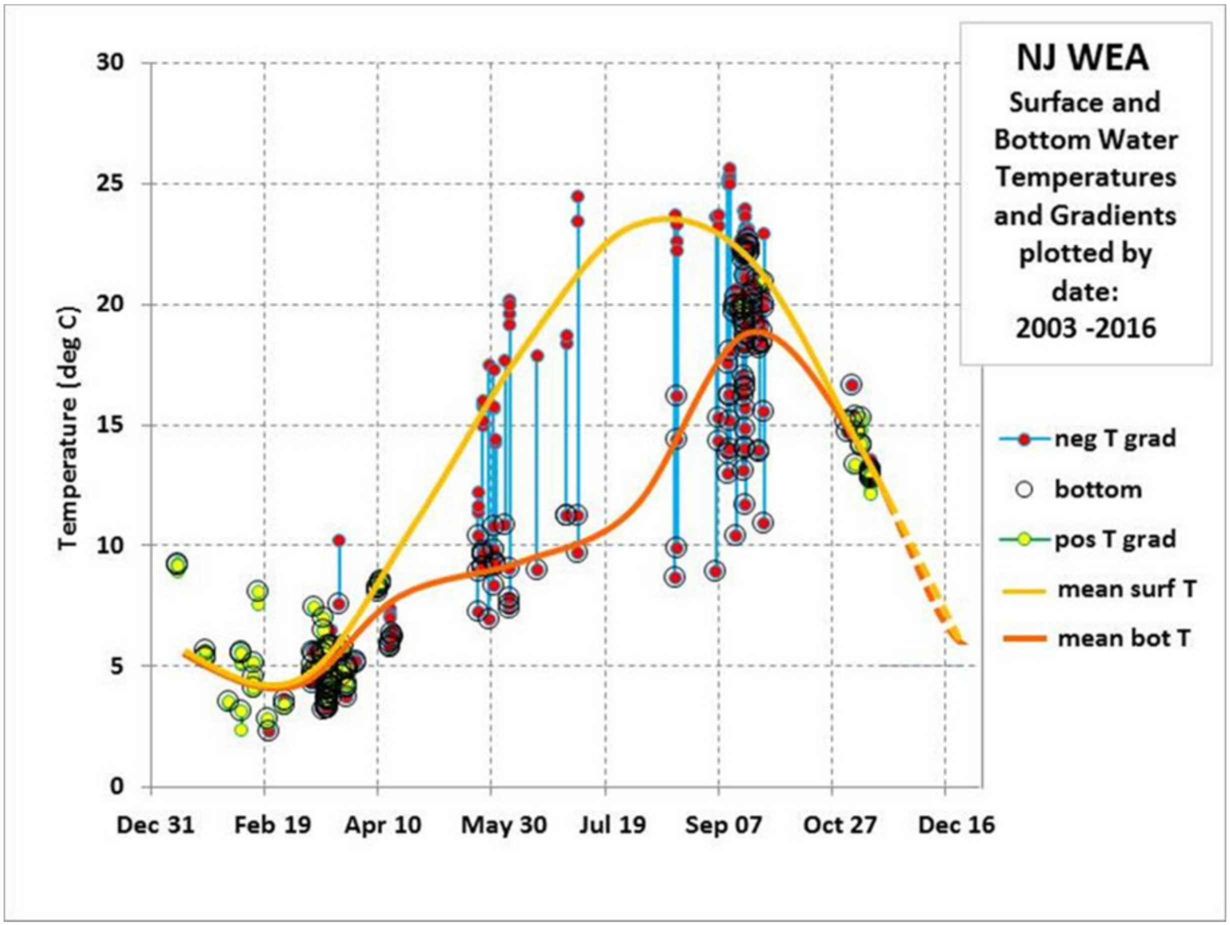

Figure 2.1.2-20. Water temperatures from CTD casts made between 2003 and 2016 in the New Jersey WEA (Guida *et al.* 2017).

Salinity

In general, the average salinity increases in the offshore direction off New Jersey. The salinity signature of the offshore export cable corridor is characterized by high seasonal variability due to the seasonal river discharge and wind variations. The NJDEP conducted ecological baseline studies between 2008 and 2009, within the Lease Area (NJDEP 2010a). Boat-based surveys were conducted to collect various water quality parameters within the Lease Area and surrounding Atlantic Ocean. Sea surface salinity (SSS) profiles were conducted at the beginning of the survey day, at noon, and end of the survey day as well as the end of each trackline whenever possible (NJDEP 2010a). Mean seasonal SSS from 2008, 2009, and previous studies are shown in **Figure 2.1.2-21**. The mean seasonal SSS for winter is approximately 30-31.6 PSU and between 29-31.6 PSU for spring. This range for spring is caused by the Hudson River outflow during the spring freshet, where the freshwater is close to the coast. The SSS for summer ranges between approximately 30.25 - 31.5 PSU for the summer and 31.5-31.75 PSU for the fall.

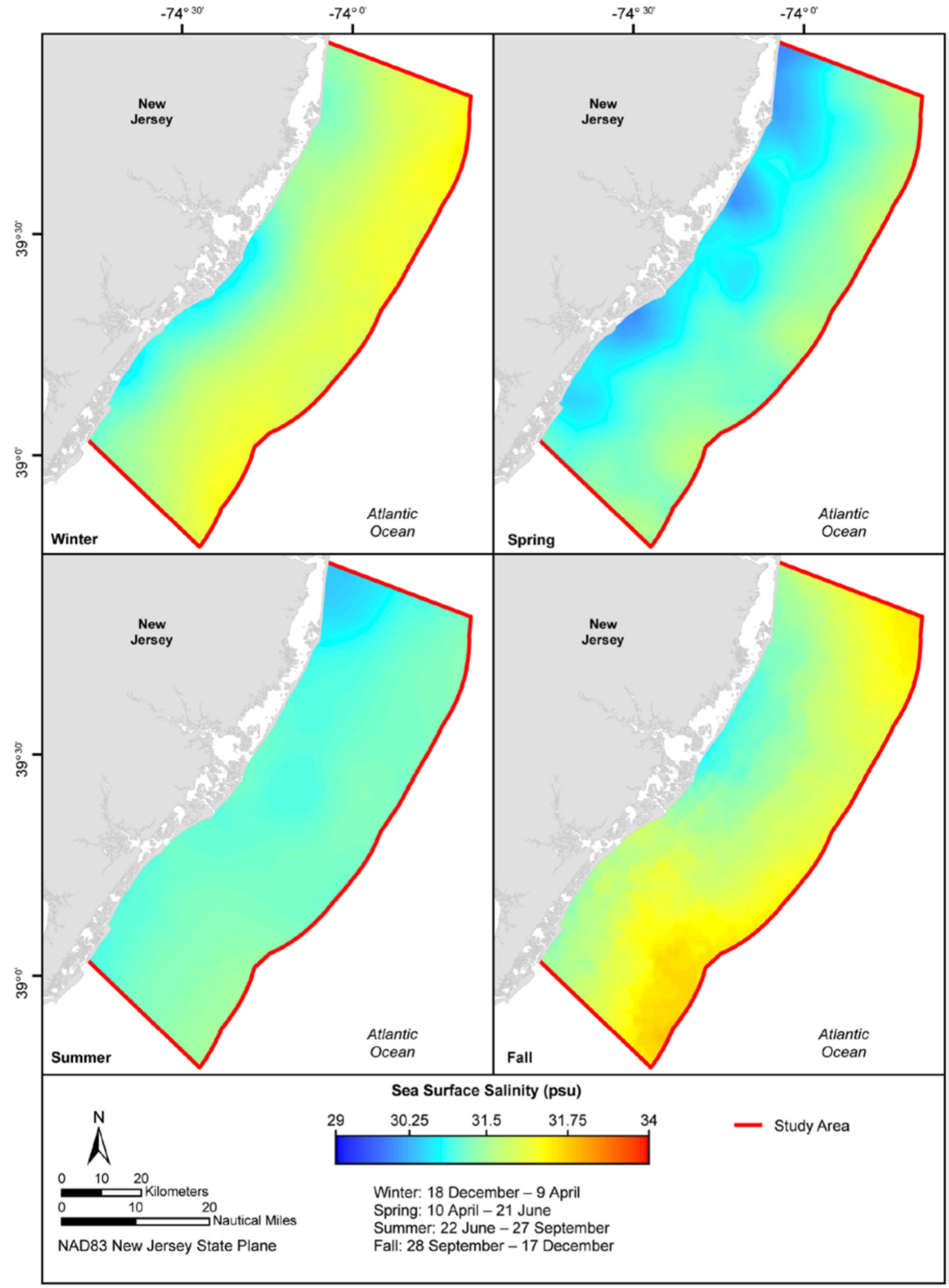

Figure 2.1.2-21. Mean seasonal SST in the study area (1927 to 1989).

Thermocline

CTD profiles were conducted at the beginning of the survey day, at noon, and end of the survey day as well as the end of each trackline whenever possible (NJDEP 2010a). Based on these profiles, the thermocline for the Lease Area and offshore export cable corridor can be established. The formation of the thermocline is established in the upper 164 ft (50 m) of the water column. **Figure 2.1.2-22** shows a well-established stratified thermocline that is characteristic of the summer season of the Lease Area and **Figure 2.1.2-23** shows a well-mixed water column indicative of the winter season.

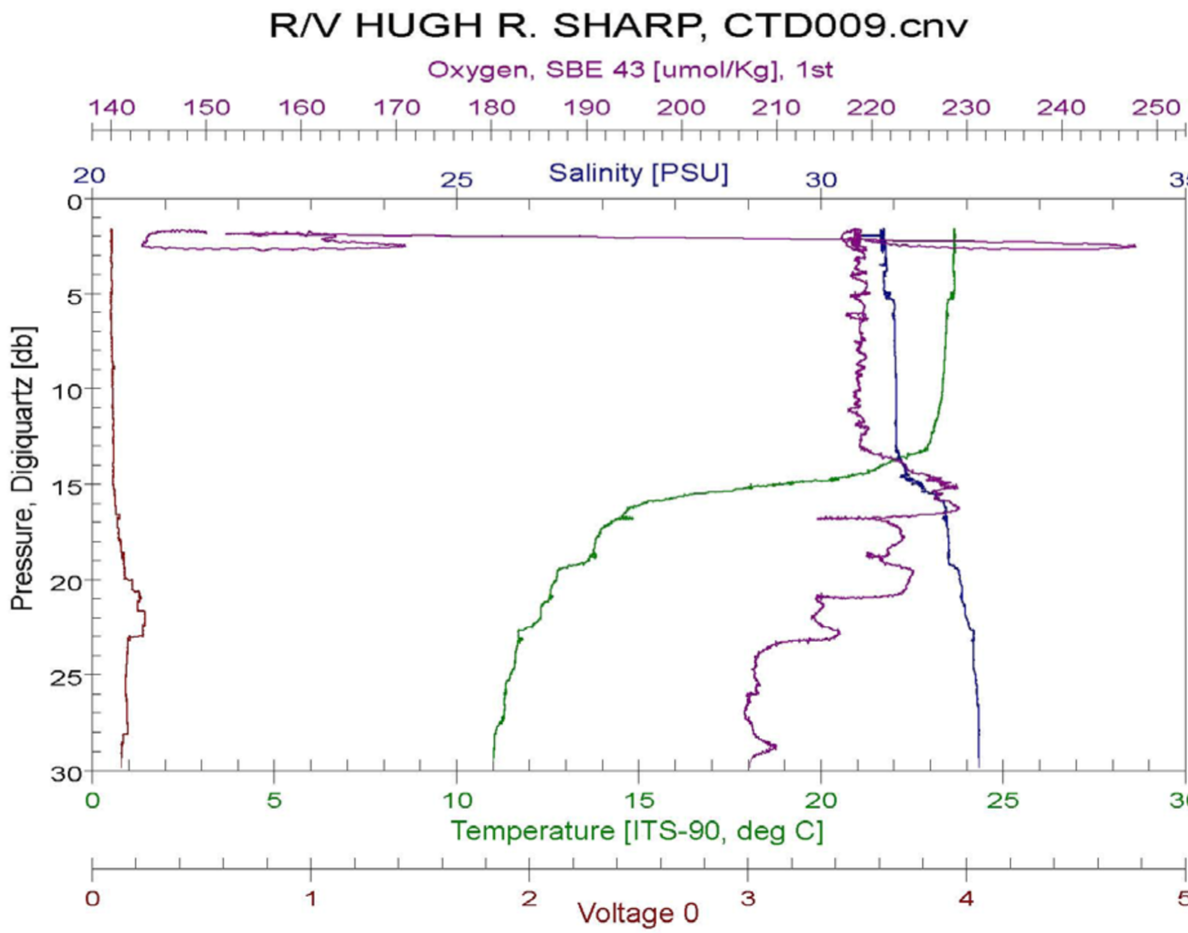

Figure 2.1.2-22. The measurements of water temperature (°C), salinity (PSU), dissolved oxygen (mg/L), and conductivity (voltage) displayed as a profile of the water column (as a function of depth, pressure digiquartz [db]) August 2, 2009, at 39°07.47 N, 74°07.65 W (NJDEP 2010a).

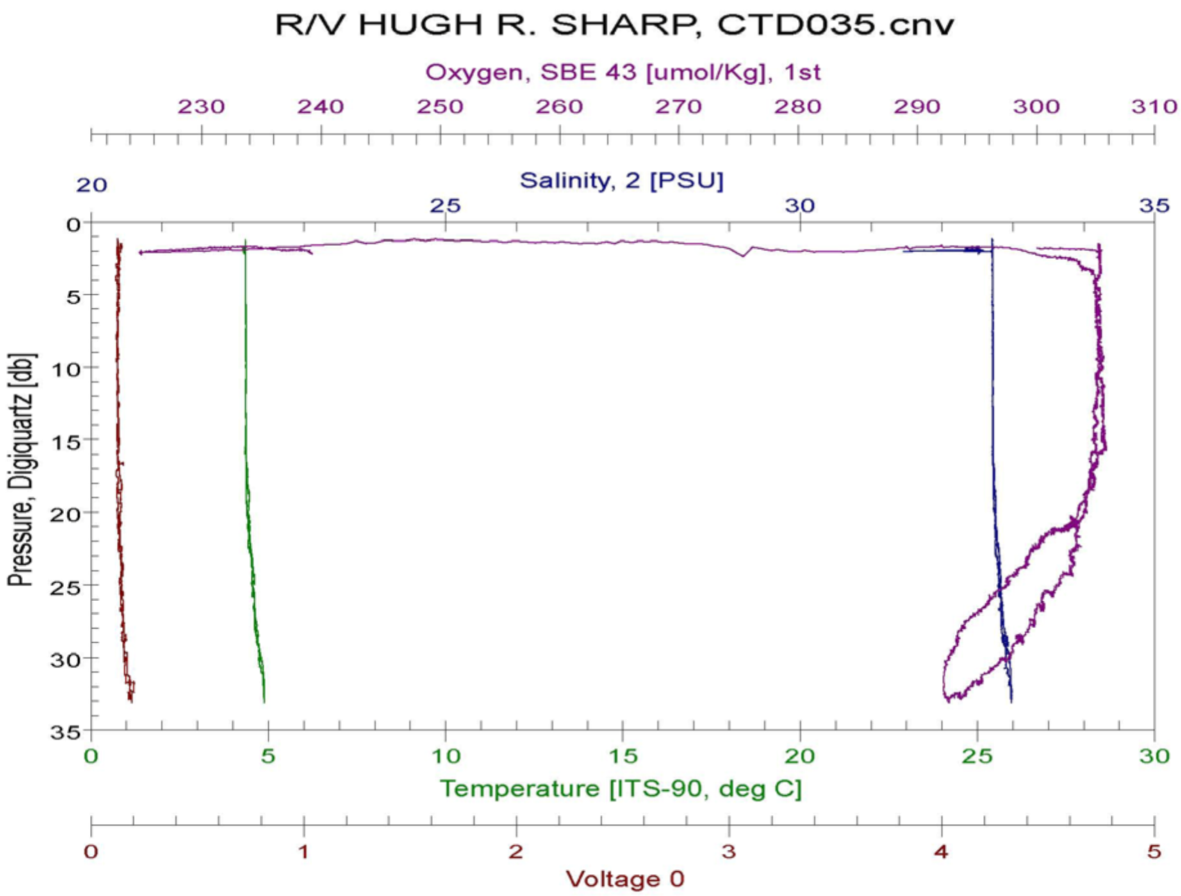

Figure 2.1.2-23. The measurements of water temperature (°C), salinity (PSU), dissolved oxygen (mg/L), and conductivity (voltage) displayed as a profile of the water column (as a function of depth, pressure digiquartz [db]) February 15, 2009 at 39°09.13 N, 074°04.80 W (NJDEP 2010a).

Chlorophyll a

Nutrient concentrations, as approximated by phytoplankton concentration as chlorophyll a, were measured via remote sensing techniques (**Figure 2.1.2-24**). In the coastal areas of the Project Area, chlorophyll a values are higher compared to the offshore areas due to input of nutrients from anthropogenic sources. The most recent phytoplankton blooms occur during the fall and winter seasons when stratification decreases due to frequent storms and seasonal overturn. In the Project Area, the winter bloom generally extends to a mean depth of 135 ft (41 meters) or 24 nm offshore (NJDEP 2010a). Phytoplankton blooms are also common during the summer months when winds blow surface waters away from the coast and the deeper, cooler, nutrient-rich waters well up from the depths, a phenomenon known as upwelling. When upwelling occurs, these nutrients combined with sunlight lead to phytoplankton blooms along the Jersey Shore.

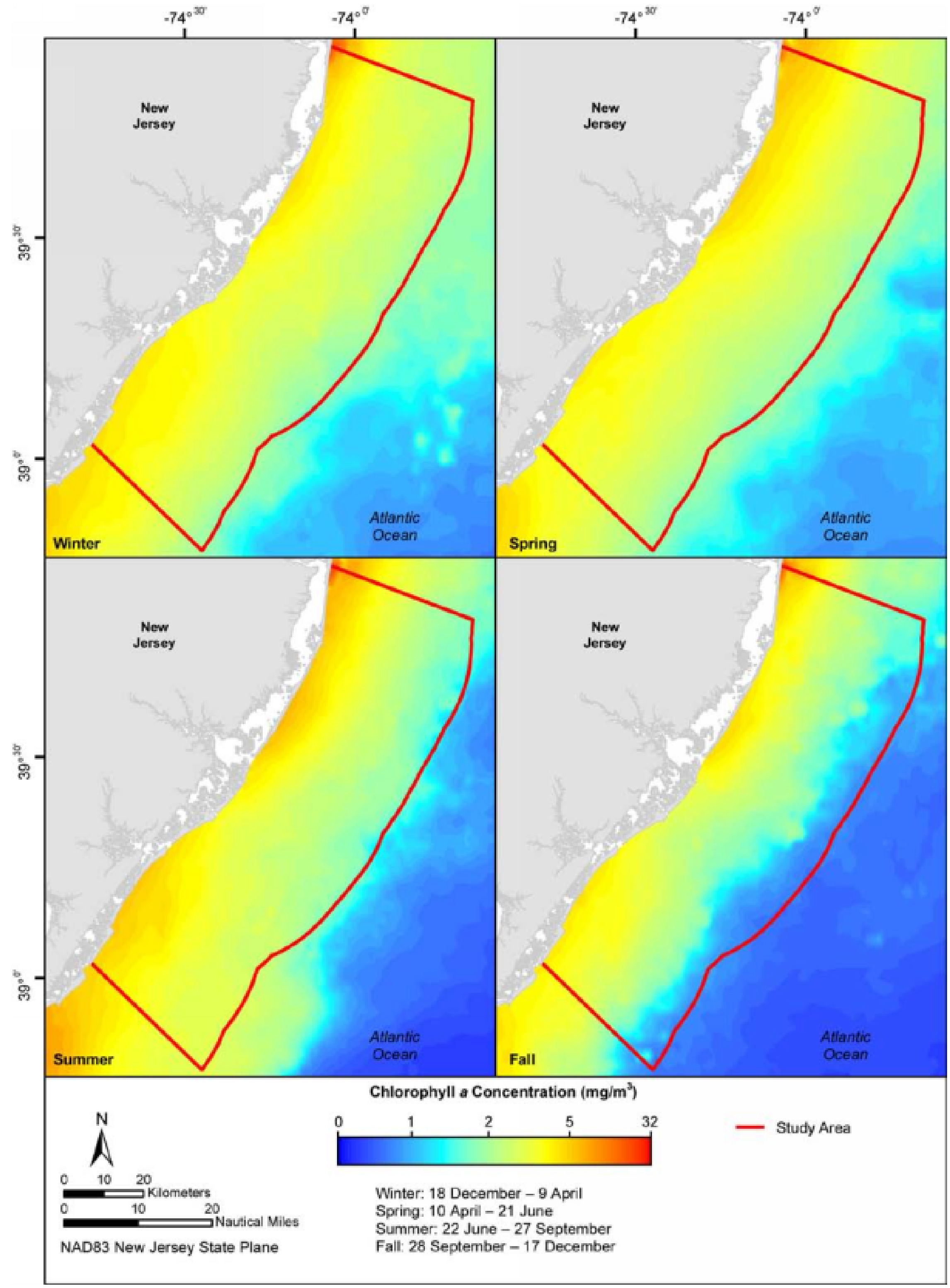

Figure 2.1.2-24. Mean seasonal surface Chlorophyll-a concentration found in NJDEP study area from January 1, 2007, through December 31, 2009 (NJDEP 2010a).

Water Quality

NJDEP conducts annual coastal water quality monitoring as required by the Clean Water Act. These data are utilized for New Jersey's Integrated Report to identify impaired waters. The monitoring program includes 250 locations and 1,000 samples collected per year for dissolved oxygen (DO), nutrients, and chlorophyll. **Table 2.1.2-8** provides the results from the annual coastal water quality monitoring from 1989-2009 at the locations collected in the New Jersey Atlantic Ocean waters, which represent locations within the offshore export cable corridor.

Table 2.1.2-8. Results from annual coastal water quality samples taken near the Offshore Export Cable Corridor (1989-2009).

Water Quality Parameter (No. of Samples)	Unit	Mean	Maximum	Count of Samples
Raritan Bay				
Ammonia	µg/L	188	712	11
Nitrate	µg/L	314	3155	115
Total Nitrogen	µg/L	852	3287	114
Total Phosphorus	µg/L	93	204	48
Chlorophyll a	µg/L	14	112	61
Dissolved Oxygen (DO)	mg/L	8.7	14.4	113
Sandy Hook Bay				
Ammonia	µg/L	97	560	160
Nitrate	µg/L	209	2008	169
Total Nitrogen	µg/L	681	2025	168
Total Phosphorus	µg/L	81	168	84
Chlorophyll a	µg/L	14	89	102
Dissolved Oxygen	mg/L	8.5	13.5	167
Navesink River				
Ammonia	µg/L	84	660	214
Nitrate	µg/L	129	1325	213
Total Nitrogen	µg/L	697	2046	210
Total Phosphorus	µg/L	127	465	120
Chlorophyll a	µg/L	14	74	138
Dissolved Oxygen	mg/L	7.6	12.2	211
Shrewsbury River				
Ammonia	µg/L	74	368	235
Nitrate	µg/L	157	1991	240
Total Nitrogen	µg/L	641	2053	237
Total Phosphorus	µg/L	96	346	146
Chlorophyll a	µg/L	17	77	161
Dissolved Oxygen	mg/L	7.5	12.6	238

Water Quality Parameter (No. of Samples)	Unit	Mean	Maximum	Count of Samples
Shark River				
Ammonia	µg/L	71	434	328
Nitrate	µg/L	67	626	333
Total Nitrogen	µg/Lh	351	2634	330
Total Phosphorus	µg/L	39	341	206
Chlorophyll a	µg/L	2	17	245
Dissolved Oxygen	mg/L	6.3	11.2	334
Great Egg Harbor Bay				
Ammonia	µg/L	61	385	188
Nitrate	µg/L	48	2288	194
Total Nitrogen	µg/L	344	2471	192
Total Phosphorus	µg/L	41	96	95
Chlorophyll a	µg/L	2	19	124
Dissolved Oxygen	mg/L	7	9	190
Little Egg Harbor				
Ammonia	µg/L	--	--	--
Nitrate	µg/L	21	369	409
Total Nitrogen	µg/L	413	1981	434
Total Phosphorus	µg/L	44	140	271
Chlorophyll a	µg/L	4	27	311
Dissolved Oxygen	mg/L	8	10.9	448
Great Bay				
Ammonia	µg/L	50	535	407
Nitrate	µg/L	37	396	409
Total Nitrogen	µg/L	375	1815	402
Total Phosphorus	µg/L	46	304	217
Chlorophyll a	µg/L	3	27	311
Dissolved Oxygen	mg/L	7.5	11.3	404
Atlantic Ocean				
Ammonia	µg/L	27	504	1188
Nitrate	µg/L	38	259	1218
Total Nitrogen	µg/L	314	8457	1201
Total Phosphorus	µg/L	39	286	803
Chlorophyll a	µg/L	3	50	1021
Dissolved Oxygen	mg/L	7.7	15.1	1188

Water Quality Parameter (No. of Samples)	Unit	Mean	Maximum	Count of Samples
Manahawkin Bay				
Ammonia	µg/L	26	131	146
Nitrate	µg/L	20	214	148
Total Nitrogen	µg/L	544	1896	148
Total Phosphorus	µg/L	50	144	94
Chlorophyll a	µg/L	6	260	108
Dissolved Oxygen	mg/L	7.8	9	152

Note: µg/L = micrograms per liter; mg/L = milligrams per liter

Source: Connell 2010.

Water Quality - Estuaries

The NJDEP conducts annual assessments of the State's waterways for water quality parameters and biological indicators. These measurements include DO, temperature, pH, turbidity, and Enterococci bacteria taken throughout the year (approximate 5-10 times per year). Approximately 440 sites in New Jersey within or near the Barnegat Bay are included in the assessment. Sampling in 2013 season included DO, total suspended solids (TSS) and clarity, and chlorophyll a. **Table 2.1.2-9** summarizes the results of the Barnegat Bay Interim Assessment Report for DO, turbidity, clarity, and chlorophyll a (NJDEP 2014b).

Out of the 440 sites, there were five within Barnegat Bay that were non-attaining for turbidity and two for non-attaining DO. For Manahawkin Bay and Upper Little Egg Harbor areas of measurement, 50 percent of the 18 stations were below the > 5 mg/L DO target. For samples taken from 15 stations in Lower Little Egg Harbor, 44 percent were below the > 5 mg/L DO target (NJDEP 2014b). Manahawkin Bay, Upper Little Egg Harbor, and Lower Little Egg Harbor Bay water quality were designated as fully supporting recreation and shellfish, but not supporting wildlife due to increased turbidity and low DO levels. At Toms Estuary, recreation, aquatic life, shellfish, and fish consumption designated uses were all considered not supporting due to Enterococci bacteria, DO, total coliform, and metal contamination in fish.

Table 2.1.2-9. Summary of water quality data from Barnegat Bay Interim Assessment Report (NJDEP 2014b).

Assessment Unit	Number of Stations				
	DO Concentration (mg/L)	DO Saturation (%)	TSS Concentration (mg/L)	% Light Through Water	Chlorophyll a Concentration (µg/L)
Point Pleasant Canal and Bay Head Harbor	2	1	2	0	2
Metedeconk Estuary	5	0	2	0	2
Metedeconk and lower tributaries - Bay	20	4	16	4	16
Toms Estuary	16	1	5	1	5
Central West	15	3	11	0	11
Central East	9	2	7	0	7
Central Bottom	5	1	3	1	3

Assessment Unit	Number of Stations				
	DO Concentration (mg/L)	DO Saturation (%)	TSS Concentration (mg/L)	% Light Through Water	Chlorophyll a Concentration (µg/L)
Manahawkin Bay and Upper Little Egg Harbor	18	3	12	3	12
Lower Little Egg Harbor Bay	15	3	12	3	12

Table 2.1.2-10 provides the water quality results from Barnegat Bay from the Connell 2010 study. **Table 2.1.2-11** provides water quality results from Great Bay for the year 2017 (National Estuarine Research Reserve System [NERRS] 2018).

Table 2.1.2-10. Water quality results from Barnegat Bay (Connell 2010).

Water Quality Paramenter	Unit	Mean	Maximum	Count
Ammonia	µg/L	28	247	1163
Nitrate	µg/L	38	550	1173
Total Nitrogen	µg/L	442	1820	1152
Total Phosphorus	µg/L	33	187	662
Chlorophyll a	µg/L	5	24	726
Dissolved Oxygen (DO)	mg/L	7.7	10	1146

Note: µg/L = micrograms per liter; mg/L = milligrams per liter

Table 2.1.2-11. Water quality results from Great Bay for the year 2017 (NERRS 2018).

Water Quality Paramenter	Unit	Mean	Maximum	Count
Ammonium	mg/L	0.019	0.265	167
Orthophosphate	mg/L	0.041	0.053	167
Nitrate + Nitrite	mg/L	0.015	0.195	167
Chlorophyll a	µg/L	4.4	11.03	167

Note: µg/L = micrograms per liter; mg/L = milligrams per liter

Chlorophyll a

Based on data provided in the Mid-Atlantic Ocean Data Portal (MARCO n.d.), there are several ocean acidification monitoring sites in the area, where carbon dioxide (CO_2), total alkalinity, dissolved inorganic carbon, and other parameters are monitored to measure ocean, coastal, and estuarine acidification (MARCO n.d.). In 2012 and 2013, the fronts probability, which measures upper ocean processes that influence the spatial distribution of biological productivity by controlling the accumulation of marine debris, was low across all seasons (winter, spring, summer, and fall) within the Project Area (MARCO n.d.). The 2011-2013 seasonal 'max' values of ocean net primary productivity (NPP) indicate that NPP was highest during the summer (June, July, August) and fall (September, October, November), and lowest in the winter (January, February, December) (MARCO n.d.).

2.1.2.1.3 Onshore Project Area

Climate

The Onshore Project Area is characterized by mild seasons and storms that bring precipitation (rain and snow) to the region; the mild seasons are influenced by sea winds that reduce both the range and mean temperature while providing humidity (NJDEP 2010a). Air temperature data collected from the Office of the New Jersey State Climatologist, Rutgers University, which averaged the annual, seasonal, and monthly means in southern and coastal areas of New Jersey, between 1985 through 2009, indicate that the annual mean air temperature was 53.2°F (11.8°C) (NJDEP 2010a). The mean seasonal temperature between the years of 1985 and 2010 ranged from 38.6°F (3.6°C) in winter to 70.9°F (21.6°C) in summer with the lowest average temperatures in January and the highest averages in July (NJDEP 2010a).

In the vicinity of the Onshore Project Area, precipitation commonly occurs in the form of rain, as thunderstorms (short-term storms) and cyclonic storms (relatively longer-term storms) in the warmer months of July, August, and September (NJDEP 2010a). Precipitation data collected from the Office of the New Jersey State Climatologist, Rutgers University, averaged the annual, seasonal, and monthly means in southern and coastal areas of New Jersey, between 1985 through 2009. The mean annual precipitation (between the years of 1985 and 2010) for the combined southern and coastal regions of New Jersey is 43.3 inches (109.9 centimeters [cm]) (NJDEP 2010a). The mean seasonal precipitation ranged from 10.3 inches (26.3 cm) in spring to 17.7 inches (45.0 cm) in winter with the lowest average precipitation in February and highest averages in August (NJDEP 2010a).

Weather systems in the middle latitude westerlies over North America move predominantly from west to east. These systems produce winds in the Project Area, which exhibit variability in strength, pattern, and directionality throughout the year. Winds during the summer are typically from the southwest and flow parallel to shore, while the winds dominant in the winter months come from the northwest and flow perpendicular to the coast (NJDEP 2010a). Onshore breezes, mesoscale wind pattern events that form perpendicular to the coast, directly influence local temperatures, and can greatly influence coastal climate and spread inland (NJDEP 2010a). Annual average wind speeds at 295 ft (90 m) height on the Atlantic Ocean coastline of the Project Area range between 23 ft (7 m) per second to 27.9 ft (8.5 m) per second (WINDExchange n.d.).

The Project Area experiences semi-diurnal (twice daily) tides with an average period of 12 hours 25 minutes and a maximum amplitude of about 3.9 to 5.9 inches (10 to 15 cm) per second; these semi-diurnal tides are oriented in the cross-shelf direction with a small, weaker diurnal component oriented in the along-shelf direction (NJDEP 2010a).

Extratropical storms, including northeasters, are common in the vicinity of the Project Area from late fall to mid-spring (October to April), bringing high winds and heavy precipitation that can cause significant damage including severe flooding and shoreline erosion (NJDEP 2010a). Thunderstorms are possible but are less common near the coast, and there is potential for tornadoes (NJDEP 2010a). Tropical cyclones, non-frontal, low pressure, rotating storm systems originating over tropical waters, including tropical depressions, tropical storms, and all hurricane categories have impacted the vicinity of the Project (NJDEP 2010a).

Surface Waters

Readily available data was reviewed to identify streams and rivers and waterways within the Project Area. As onshore export cable routes and substation locations are finalized, Ocean Wind will conduct site specific stream crossing surveys and coordinate with NJDEP and USACE.

The BL England study area lies within five watersheds: Absecon Creek (hydrologic unit code [HUC] 11 No. 02040302020), Patcong Creek/Great Egg Harbor Bay (HUC 11 No. 02040302060), Tuckahoe River (HUC 11

No. 02040302070), Reeds Bay/ Absecon Bay and Tributaries (HUC 11 No. 02040302010), and Absecon Creek (HUC 11 No. 02040302020). All of the watersheds are located within the Great Egg Harbor Watershed Management Area (WMA) (WMA 15). The major watercourses draining these watersheds into the bays include Patcong Creek, and the Great Egg Harbor, Middle, and Tuckahoe Rivers in the southern portion of the Project Area. The NJDEP Surface Water Quality Standards (SWQS) were established for protection and enhancement of surface water resources, such as use designations and water quality-based effluent limitations. The watercourses within this area are predominantly categorized as FW2-NT/SE1, meaning that they are non-trout (NT) estuarine freshwaters (FW2) or brackish (SE1). In all FW2 waters, the designated uses include maintenance, migration, and propagation of natural and established biota, primary contact recreation, industrial and agricultural water supply, and public potable water supply after conventional filtration treatment. In SE1 waters, the designated uses include shellfish harvesting in accordance with N.J.A.C. 7:12; maintenance, migration, and propagation of natural and established biota; and primary contact recreation.

Most of the watercourses to the west of the Great Egg Harbor River, which the onshore export cable route would cross, have a Category 1 (C1 waters) antidegredation designation, meaning that they are exceptional resource waters with special protections and are subject to 300-foot disturbance buffers. In October 1992, a total of 129 miles of the Great Egg Harbor River and its tributaries were designated as a National Scenic and Recreational River through the National Park Service Wild and Scenic River System. The northern portion of the Project Area is largely drained by Mill Branch and the creeks and tributaries along the bays. Mill Branch has a SWQS of pinelands water (PL) along its western reaches and FW2-NT/SE1 south of the Garden State Parkway. Pinelands water (PL) is the general surface water classification applied to waters within Pinelands Protection and Preservation Areas and includes the following designated uses: cranberry bog water supply and other agricultural uses; maintenance, migration, and propagation of the natural and established biota indigenous to this unique ecological system; public potable water supply after conventional filtration treatment; and primary contact recreation. The creeks surrounding the bays north of Great Egg inlet are also classified as FW2-NT/SE1 waters (**Figure 2.1.2-25**).

The Oyster Creek Project Area lies within three watersheds: Oyster Creek/South Branch Forked River (Hydrologic Unit Code (HUC) 11 No. 02040301110, Barnegat Bay Central and Tributaries (HUC11 No. 02040301100, and Waretown Creek / Barnegat Bay South (HUC 11 No. 02040301120). All of the watersheds are located within the Barnegat Bay WMA (WMA 13). Oyster Creek and the South Branch of the Forked River are the major river systems within this Project Area. Based on NJDEP's SWQS, these watercourses are classified as non-trout saline and estuarine freshwaters or brackish (FW2-NT/SE1) (**Figure 2.1.2-26**).

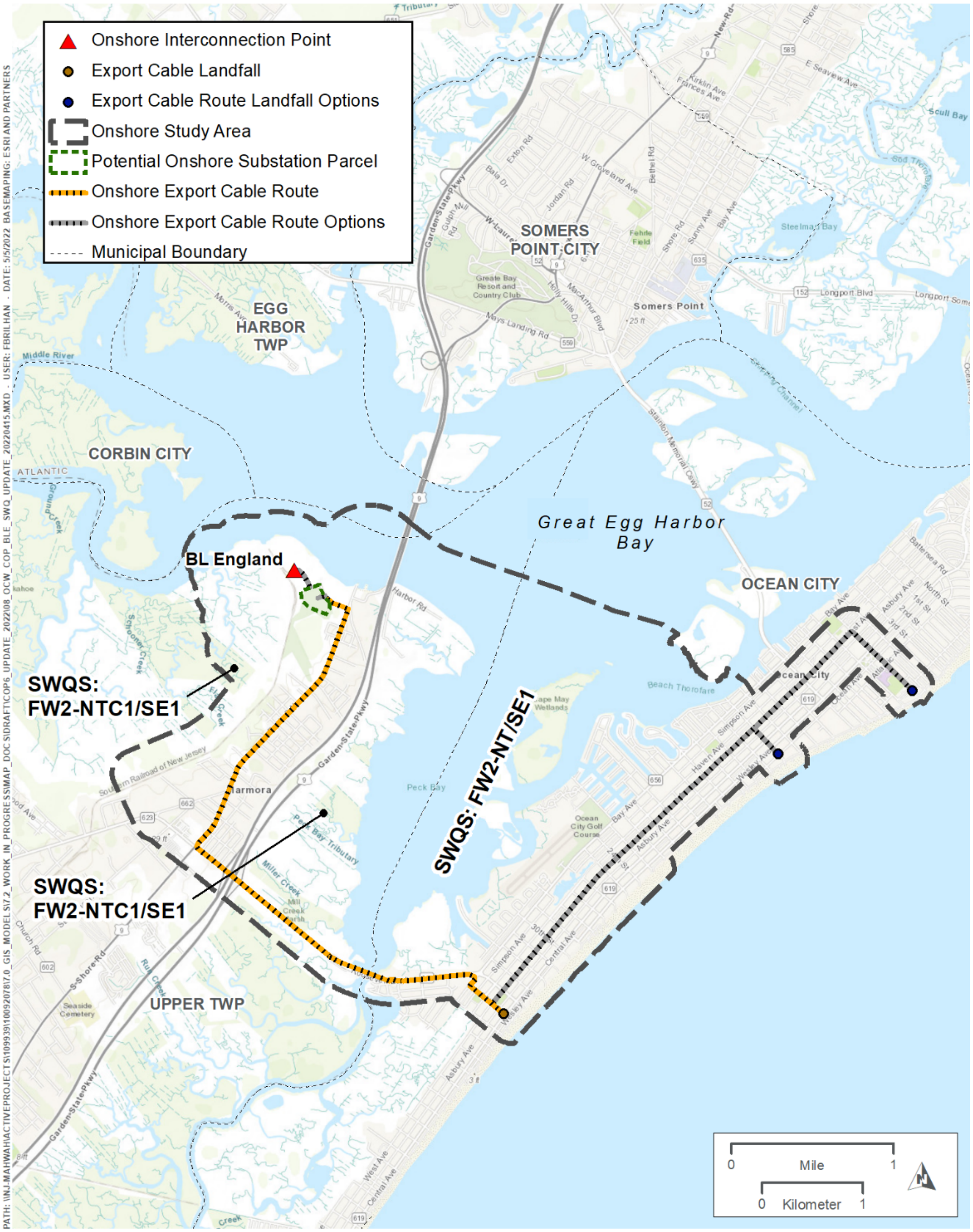

Figure 2.1.2-25. NJ SWQS for the BL England study area.

Classifications for NJ SWQS Found at N.J.A.C. 7:9B:
FW1 - Freshwaters that are Outstanding National Resource Waters of the State
FW2 - General classification that applies to fresh waters that are not designated as FW1 or Pinelands Waters
NT - Nontrout waters
SE1 - General surface water classification for saline waters of estuaries
C1 - Category One waters
PL - Pineland Waters

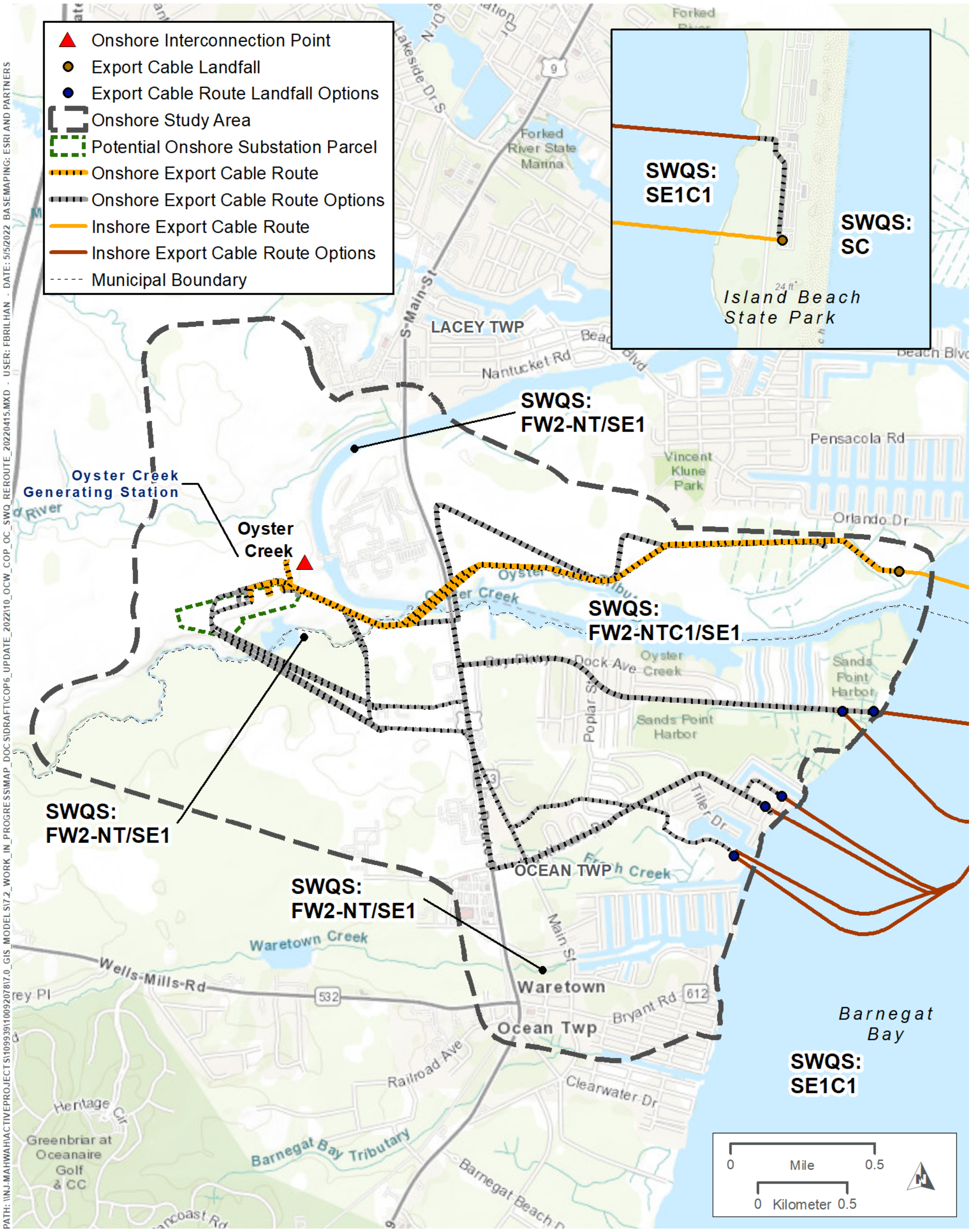

Figure 2.1.2-26. NJ SWQS for the Oyster Creek study area.

Classifications for NJ SWQS Found at N.J.A.C. 7:9B:
FW1 - Freshwaters that are Outstanding National Resource Waters of the State
FW2 - General classification that applies to fresh waters that are not designated as FW1 or Pinelands Waters
NT - Nontrout waters
SE1 - General surface water classification for saline waters of estuaries
C1 - Category One Waters
PL - Pineland Waters

Groundwater

The onshore facilities of the Project Area are located within a sole source aquifer known as the New Jersey Coastal Plain Aquifer. A sole source aquifer is an aquifer that supplies at least 50 percent of the drinking water for its service area and is the only reasonable drinking water source for that area (USEPA 2015). The New Jersey Coastal Plain Aquifer System meets these requirements and is recognized by the USEPA as a sole source aquifer for the southern half of New Jersey (USEPA 2015, NJDEP 1999). Several aquifers compose this larger aquifer system. They are the Kirkwood-Cohansey aquifer system, the Atlantic City 800-foot sand, the Wenonah-Mount Laurel aquifer, the Englishtown aquifer, and the Potomac-Raritan-Magothy aquifer system (USGS 1985). The high production yields and storage capacities of the aquifer system as a whole are directly due to the unconsolidated deposits that form the geology of the Coastal Plain Province. In general, these deposits are highly permeable beds of sand and gravel that allow for the storage of groundwater. Deposits of silt and clay form mostly confining layers in between the more permeable deposits, which restrict the vertical migration of water. Aquifer recharge occurs directly by the vertical leakage of water through confining beds from precipitation or by seepage from surface water (USGS 1985).

The New Jersey Ambient Ground Water Quality Monitoring Network program utilizes 150 wells throughout northern and southern New Jersey to evaluate shallow groundwater quality. The chemical and physical characteristic measured in each well-water sample include pH, specific conductivity, DO, temperature, alkalinity, major ions, trace elements, nutrients, gross-alpha particle activity, volatile organic compounds (VOCs), total dissolved solids (TDS), and pesticides. In southern New Jersey, shallow groundwater has a more acidic pH and lower TDS levels, reflecting the coastal plain origin (New Jersey Geological and Water Survey 2016). In the urbanized areas of southern New Jersey, lower DO levels are detected due to large proportions of impervious surface area. Specific conductivity increases in southern New Jersey have been attributed to application of road salt during the winter. Urban areas in New Jersey have high concentrations of nutrients, such as nitrate and nitrite, in groundwater due to possible leakage from septic and sewer systems. Pesticides, VOCs, trace elements, and major ion concentrations were all higher in the urban areas of Southern New Jersey compared to undeveloped areas.

The USGS New Jersey Groundwater Network monitors groundwater at several locations throughout New Jersey. **Table 2.1.2-12** has the location of the groundwater wells within the vicinity of the Onshore study areas for Oyster Creek and BL England and the depth to water table reading. The depths to the water table range from 39.9 ft to 102.8 ft.

Table 2.1.2-12. USGS groundwater monitoring locations.

Station Number	Station Name	Station Location (Lat/Long)	Well Depth (ft)	Depth to Water Table (ft below land surface)
392017074300201 - 010834	Margate Firehouse 1 Obs	39°20'17", 74°30'02"	997.4	39.9 (recorded on 7/18/2018)
391827074371001 - 010578	Jobs Point Obs	39°18'26", 74°37'09"	680	72.1 (recorded on 7/16/2018)
392754074270101 - 010180	Oceanville 1 Obs	39°27'54", 74°27'01"	570	68.2 (recorded on 7/20/2018)
392232074234401 - 010704	Egg Harbor Hs Deep	39°23'43", 74°37'33"	611	102.8 (recorded on 9/27/2018)

Station Number	Station Name	Station Location (Lat/Long)	Well Depth (ft)	Depth to Water Table (ft below land surface)
393232074263901 - 010703	Faa Pomona Obs	39°26'39", 74°32'32"	575	91.5 (recorded on 9/13/2018)
392153074250101 - 010037	Galen Hall Obs	39°21'52", 74°24'58"	842	69.0 (recorded on 12/11/2018)
392125074260401 - 010648	Com-1	9°21'25", 74°26'03"	835	75.5 (recorded on 12/20/2018)

2.1.2.2 Potential Project Impacts on Water Quality

The potential for impacts on water quality can be introduced during construction, operation, and maintenance of facilities, and during decommissioning activities, and include foundation placement and pile driving, placement of scour protection, installation of cables, vessel anchors, jack-up spud barges, dredging, and vessel or construction equipment spills. Impact producing factors include the following:

- Physical seabed/land disturbance
- Sediment suspension
- Discharge/releases and withdrawals

2.1.2.2.1 Construction

Offshore Project Area

Wind Turbines and Offshore Substations

Construction of WTGs will use jack-up vessels or vessels with dynamic positioning and accompanying barges for foundation installation. Impacts to the seabed would occur locally at each of the proposed WTGs.

The potential impacts to water quality, such as resuspension of sediments during pile driving activities, would be localized. In addition, seabed preparation activities (e.g., removal of debris or seabed levelling) may be required. Temporary, localized sediment suspension would also occur during the placement of scour protection materials, if required, around each WTG. Methods of installation may include side stone dumping, fall pipe, or crane placement. Placement of scour protection may temporarily increase suspended sediments due to resuspension of bottom sediments; however, impacts are anticipated to be short-term and temporary due to the predominately sandy composition of upper sediments in the Project Area.

Potential contamination may occur from unforeseen spills or accidents, and any such occurrence will be reported and addressed in accordance with the local authority. These potential impacts will be minimized by implementing an approved oil spill response plan, by following proper storage and disposal protocols on land, and by requiring vessel operators used for construction to have a vessel-specific spill response plan for use in the event of an accidental release, per the APMs in **Table 1.1-2**.

Array Cables and Offshore Export Cables

The array cables and offshore export cables will be installed via jet plow, mechanical plow, and/or mechanical trenching. Site preparation activities will take place prior to placement and burial of cable in the offshore export cable corridor. Similar to installation of WTG foundations, these activities potentially include a pre-lay grapnel run, sandwave clearance, and boulder removal. Local ocean currents and the volume of sediment disturbed would influence the mobility of sediments during plowing and cable laying activities. Temporary increases in turbidity and sediment resuspension may result from site preparation activities and would not cause any long-term impacts to water quality.

Sediment dispersion modelling conducted for three other offshore wind projects (the Vineyard Wind Project in Massachusetts, the Block Island Wind Farm in Rhode Island and the Virginia Offshore Wind Technology Advancement Project of Virginia), and two underwater cable projects (the Seacoast Reliability Project in Little Bay, New Hampshire and the Silver Run Electric Project in the Delaware River estuary), were reviewed and evaluated, as general sediment conditions and hydrodynamics are similar to the Project Area. The sediments within each project area were predominantly sands and current velocities were within similar ranges indicating that the results of each modeling effort would be expected to be representative of the Project site. The conditions at each project site are compared in **Table 2.1.2-13**.

Previous Hydrodynamic and Sediment Transport Modeling Examples

As shown in **Table 2.1.2-13**, known sediment characteristics and hydrodynamic conditions at other East Coast wind and submarine cable projects demonstrate a consistent pattern of existing and expected sediment resuspension conditions. As summarized below, previous modeling results have demonstrated that sediment grain size and hydrodynamic currents are predictable drivers in the resuspension and settling of sediments associated with jet trenching technologies. Some variations in existing conditions from offshore lease areas and offshore export cable routes to near shore and inshore export cable route areas may be expected and are summarized below.

Offshore Lease Areas and Offshore Export Cable Routes

Vineyard Wind LLC used a HYDROMAP hydrodynamic model domain, which extended from approximately Provincetown, Massachusetts, at the northern tip of Cape Cod to Sandy Hook, New Jersey. The model results indicated that most of the suspended sediment mass settles out quickly and is not transported for long by currents (Vineyard Wind 2018). TSS concentrations higher than 10 mg/L persisted at a given point for less than 6 or 12 hours and the plume is confined to the bottom 9.8 ft (3 m) of the water column. Deposition greater than 0.008 in (0.2 millimeter [mm]) that may occur from project activities was confined within 656 ft (200 m) to 919 ft (280 m) of the trench centerline during model simulations. Therefore, water quality impacts from array cable installation would be short-term and localized (Vineyard Wind 2018).

For the Block Island Wind Farm, Tetra Tech (2012), modeling indicated that in areas characterized by mostly coarse sand (particle diameter > 130 μm), sediment suspended during jet plow operations settled quickly to the seabed, and major plumes would not form in the water column. As with the Vineyard Wind project, while suspended sediment concentrations would be elevated within a few meters of the jet plow, beyond this nearfield zone, concentrations would not exceed 100 mg/L. Concentrations greater than 10 mg/L would occur in an area within 160 ft (50 m) of the jet plow trenching for a duration of approximately 10 minutes. Sediment deposition was estimated to exceed 0.4 in (10 mm) only immediately adjacent to the trench. Sediment re-deposition would not be greater than 0.04 in (1 mm) at distances greater than 130 ft (40 m) from the trench (Tetra Tech 2012).

Table 2.1.2-13. Comparison of sediment characteristics and hydrodynamics at other East Coast wind projects.

Project/Study	Region	Burial Method Analyzed	Sediment Characteristics	Hydrodynamics	Notes
Ocean Wind	Offshore Lease Area	Jet plow, mechanical plow, and/or mechanical trenching where sand waves are encountered or when crossing Federal and State navigation channels	Medium to coarse grain sand. Mean sediment sizes for each sample ranged from 135 micrometer (µm) to 2,298 µm (Alpine 2017a).	Current velocities of 0.35-0.42 m/s	Semi-diurnal tides with currents predominantly south-easterly resulting in a net direction of flow offshore towards the Continental Shelf
	Offshore Export Cable Corridor	Jet plow, mechanical plow, and/or mechanical trenching where sand waves are encountered or when crossing Federal and State navigation channels	Medium to coarse grained sediments with patches of gravel. Mean sediment sizes for each sample ranged from 135 µm to 2,298 µm (Alpine 2017a).	Current velocities of 0.35-0.42 m/s	Semi-diurnal tides with currents predominantly south-easterly resulting in a net direction of flow offshore towards the Continental Shelf
	Nearshore Export Cable Corridor	Jet plow, mechanical plow, and/or mechanical trenching where sand waves are encountered or when crossing Federal and State navigation channels	Close to shore, surficial sediments mixing fine-grained estuarine deposits and overwash of tidal-delta sands. Mean sediment sizes for each sample ranged from 135 µm to 2,298 µm (Alpine 2017a).	Current velocities of 0.35-0.42 m/s	Semi-diurnal tides with currents predominantly south-easterly resulting in a net direction of flow offshore towards the Continental Shelf
	Inshore Export Cable Route	Jet trenching techology	In the Back Bays, sediment types primarily consist of sand and fine grain sediments (Fugro 2017, Alpine 2017a). Based on USGS (2014) sediments in Barnegat Bay are generally sand and silty sand with some silt and sandy silt sediments in near shore areas extending up the Toms River inlet.	Strong tidal currents occur closer to the inlets at maximum velocities greater than 1 m/s. Current velocities vary in central Barnegat Bay due to State and Federal navigation channels and Oyster Creek to less than 0.5 m/s in shallow areas. Wind influences hydrodynamics and water column mixing.	Barnegat Bay is a shallow estuary with mean depth of 1.6 m and a semi-diurnal mean tidal range of 0.2–1 m. Ocean/ estuary exchange occurs through three inlets/outlets: the Little Egg and Barnegat Inlets, and the Manasquan (Kennish 2001).

Project/Study	Region	Burial Method Analyzed	Sediment Characteristics	Hydrodynamics	Notes
Vineyard Wind (2018)	Offshore Export Cable Corridor	Jet plow with mechanical dredging (as needed) in sand wave areas	Primarily coarse sands (>130µm)	Average current velocities of 0.3 m/s in vicinity of wind area.	Sediments in the project area were comprised of primarily coarse sands (>130 µm) which made up approximately 60-90% of sediments sampled. The grain size distribution input used in the transport modeling effort selected the sediment sample with the greatest proportion of finer sediments as a conservative measure. The model input was composed of 62.14% coarse sand, 8.98 % fine sand (75-130 µm), and 9.63% each of coarse silt (36-74 µm), fine silt (8-35 µm), and clay (0-7 µm). Semi-diurnal tides with depth.
	Wind Development Area	Jet plow with mechanical dredging (as needed) in sand wave areas	Primarily coarse sands (>130µm)	Averaged current velocities of 0.3 m/s in vicinity of wind area.	Sediments in the project area were comprised of primarily coarse sands (>130 µm) which made up approximately 60-90% of sediments sampled. The grain size distribution input used in the transport modeling effort selected the sediment sample with the greatest proportion of finer sediments as a conservative measure. The model input was composed of 62.14% coarse sand, 8.98 % fine sand (75-130 µm), and 9.63% each of coarse silt (36-74 µm), fine silt (8-35 µm), and clay (0-7 µm). Semi-diurnal tides with depth.

Project/Study	Region	Burial Method Analyzed	Sediment Characteristics	Hydrodynamics	Notes
Block Island Wind Farm (Tetra Tech 2012, BOEM 2017) - Observing Cable Laying and Particle Settlement During the Construction of the Block Island Wind Farm	Offshore Export Cable Route in Federal and State waters off Block Island, RI	Jet plow and horizontal directional drilling (HDD)	Study area was generally characterized by coarse sands (>130 μm) and gravels.	Semi-diurnal tides with current velocities of 0.1-0.3 m/s.	Some spots along cable route included clays and silts
Virginia Offshore Wind Technology Advancement Project (BOEM 2015)	Offshore Lease Area on the Outer Continental Shelf (approx. 24 nautical miles east of Virginia Beach, Virginia) with export cable route into near shore Federal and State waters	Jet plow	On average 14% sediments were finer than 200 μm and 86% were larger than 200 μm indicating that sediments were dominated by coarse sands.	Current velocities ranged from 0.15-0.4 m/s.	
Seacoast Reliability Project (Normandeau 2015)	Inshore	Jet plow and diver hand jetting	Varied based on the east to west crossing. Ranged from 80% clays (< 4 μm) to 81% fine sands (< 250 μm).	Maximum current velocity of 0.5 m/s (1 knot) except at shallow shoals.	Grain-size distributions from 12 locations sampled along the cable route. Semi-diurnal tides.
Silver Run Electric Project (ESS Group 2017)	Inshore	Vertical injector and jet plow	Median grain size of 77 μm (very fine sand) with individual cores ranging from 33 μm (silt) to 301 μm (medium sand).	Semi-diurnal tides with a mean tide range of 1.6 m at Reedy Point. Currents also influenced by wind and freshwater inputs as secondary drivers to the tides with maximum velocities of 2.0 to 2.6 m/s (4-5 knots) in the channel with lower speeds in shallow areas.	Predominately organic clays and inorganic silts (68% of the samples) with poorly graded sands and silty sands comprising the remaining samples. 21% of the samples contained high proportions (>70 %) of sand.

In its Environmental Assessment for the Virginia Offshore Wind Technology Advancement Project, BOEM (2015) noted that sediment transport modeling estimated that suspended sediment (particle diameter <200 μm) during burial of the subsea cable would extend about 6.6 ft (2 m) above the trench and extend laterally up to 328 ft to 525 ft (100 to 160 m). Sediment would settle on the seabed within 6 to 7 minutes, and re-deposition of sediment would not be greater than 0.04 in (1 mm) within 328 ft (100 m) of the trench (BOEM 2015).

As the wind farm areas of Vineyard Wind, Block Island and Virginia Offshore Wind are similar in sediment and hydrodynamics to Ocean Wind's Lease Area, sediments resuspended during trenching would settle quickly to the seabed within the trench, potential plumes would be limited to right above the seabed and not within the water column and concentrations greater than 10 mg/l would be short in duration up to 6 hours and limited to within approximately 50 to 200 m of the center of the trench in these offshore areas.

Inshore Export Cable Routes

Two computer models were used in the analysis for the Seacoast Reliability Project (Normandeau 2015): BELLAMY, a hydrodynamic model used for predicting the currents in Little Bay, and SSFATE (Suspended Sediment FATE), a sediment dispersion model used for predicting the transport of sediment resuspended by the jet plowing and diver operations. During jet plowing, suspended sediment concentrations within the plume (defined by the 10 mg/L excess SS) were predicted to encompass an area averaged over time of 36.6 acres ranging from a low of 14.6 acres at 1 hour duration to a high of 55.3 acres at 10 hours. These total areas dropped dramatically for the higher concentrations, averaging 4.8 acres at 100 mg/L, 0.7 acres at 1,000 mg/L and 0.05 acres at 5,000 mg/L indicating that the extent of the plume is limited for higher concentrations. In the shallows, suspended sediments from the jet plow activity were predicted to reach nearly to the water surface. In the channel, excess suspended sediments were predicted to be restricted to the lower half of the water column (Normandeau 2015).

The size of the suspended sediment plumes for the west and east diver burial sections of the Seacoast Reliability Project were also examined. It was assumed that no silt curtains were used during this activity (if they had been modeled, the amount of excess suspended sediment would be reduced 10-fold outside the silt curtained area). Typically, at 10 mg/L, the instantaneous total area enclosed by the contour was 20.7 acres for the west section and 4.7 acres for the east section. However, these total enclosed areas dropped dramatically for the higher concentrations near the diver burial activities. The area at 1,000 mg/L was only about 0.6 acre for the west section and 0.1 acre for the east section, indicating that the extent of the plume is again relatively limited (Normandeau 2015).

Modeling was conducted to predict the dispersal of sediment suspended during jet plowing and vertical injector embedment of a submarine electric cable in the Delaware River. The analysis included a prediction of suspended sediment concentrations in the water column and eventual deposition thickness on the riverbed. To complete the analysis, an Advanced Circulation Model (ADCIRC) nested within the boundaries of the NOAA Delaware Bay Operational Forecast System (DBOFS) model was coupled with a sediment dispersion Particle Tracking Model (PTM). The PTM used the currents from the hydrodynamic model to predict sediment transport, taking into account the variable embedment depth, the jetting sled and vertical injector embedment speeds anticipated by the installer, and the distribution of sediment grain sizes along the planned cable route. Results from the modeling study predicted that increases in suspended sediment concentrations greater than 200 mg/L would be limited to distances less than 695 meters from the installed cable for short periods of time (less than 2 hours after each pass with the jetting sled or vertical injector). Increases in suspended sediment in the water column were predicted to have a short duration, with concentrations predicted to return to pre-installation conditions within 24 hours after the completion of jetting operations (ESS Group 2017).

Jet plow and diver activities in near shore areas such as Barnegat Bay for the Ocean Wind Project are similar to the modelling results shown in the shallow water areas of Little Bay, New Hampshire (Seacoast Reliability Project) where the mostly fine sediment (silts and clays) were projected to persist for two days at very low levels of 10 mg/L above background (Normandeau 2015). These impacts to water quality for finer sediments are anticipated to be localized adjacent to the trench and temporary in nature. Therefore, given the known hydrodynamic conditions within the area of the Project and the expected best management practices associated with jet plowing technologies, no long-term impacts to water quality are anticipated following cable installation activities.

The different burial techniques were evaluated for the offshore cables and inter-array cables in relation to the sediment type (Department for Business Enterprise & Regulatory Reform [BERR] 2008). **Table 2.1.2-14** describes the typical burial technique for varying sediment types. Upon further advancement of the project design, the proper technique will be utilized for cable burial within the Offshore Project Area.

Table 2.1.2-14. Typical Offshore cable burial technique by seabed sediment types.

Potential Burial Technique	Sediment Type
Mechanical Plow	Sands, silts, gravel, weak clays, and stiff clays
Jet Plow	Sands, silts, and weak clays
Mechanical Trenching	Sands

Source: BERR 2008.

Dredging may occur along the proposed cable route in locations where sand waves (naturally mobile slopes on the seabed) are encountered or when crossing Federal and State navigation channels. Because the predominant sediment type is fine sand or coarser, duration of exposure to the plume would likely be relatively short term. In a study done on dredge plume dynamics of New York/New Jersey Harbor (USACE 2015), it was noted that concentrations decrease exponentially with time and distance in the down-current direction (within 15 minutes of release concentrations were noted to be less than 50 mg/L). BOEM (2018b) noted for the Vineyard Wind offshore wind project:

> *Modeling showed sediment concentrations greater than 10 mg/L from dredging could extend up to 10 miles (16 kilometers) from the route centerline and spread through the entire water column. These plumes typically settled within 3 hours but could persist in small areas (15 acres [60,703 m^2] or less) for up to 6 to 12 hours (Epsilon 2018c). Dredged material disposal could cause concentrations greater than 1,000 mg/L for a duration of less than 2 hours and a distance of approximately 3 miles (5 kilometers).*

As BOEM (2018b) notes, while turbidity will likely be high in the areas affected by dredging, the sediment would not affect water quality after it settles. The period of sediment suspension would be very short-term and localized, and Ocean Wind would minimize dredging to the extent possible.

Onshore Project Area

Cable Landfall

Cable landfall is the transition from submarine offshore export cable to onshore export cable. Offshore cables would be connected to onshore export cables at TJBs located onshore. The offshore export cable would be installed up to the TJB using open cut installation or trenchless technology (as described in Vol I Section 6.2.2.1). Landfall for BL England includes beaches that are included in the USACE beach nourishment program, and therefore trenchless technology options are preferred in order to achieve burial depths based on coordination with USACE. To minimize the impacts from disturbance to ground and surface water quality, erosion and sedimentation controls would be implemented, per the APMs in **Table 1.1-2**. One aspect of the HDD or other trenchless methods that can cause adverse impacts to surface water quality is the inadvertent return of drilling lubricant, which can potentially enter surface waters. This fluid has the potential to increase turbidity, as well as impact plants, fish, and their eggs (TetraTech 2016b). BMPs, such as monitoring of the drilling mud volumes, pressures, and pump rates and returns, would be followed to determine if drill mud loss occurs in amounts that signal a possible inadvertent return. An Inadvertent Return Plan would be developed and implemented as described in **Table 1.1-2**. Any fluids used during the onshore HDD work will be minimized by containment and reused as necessary. Following BMPs, the direct impacts from cable landfall are anticipated to be minimal and not cause any long-term adverse impacts to surface and ground water quality.

Onshore Export Cable Route

The onshore export cable will be installed via typical civil and electrical construction methods, such as trenching, cut and cover, and trenchless technology methods. Prior to construction, Ocean Wind will evaluate the depth to the water table and tidal influence along the onshore export cable corridor to determine if groundwater will have to be managed. Dewatering activities will be temporary and water drawdown will be minimal to prevent any permanent impacts to groundwater quality. Further, erosion and sedimentation controls would be implemented to minimize impacts to ground and surface water quality. By following BMPs for trenchless technology methods and erosion and sediment control, per the APMs in **Table 1.1-2**, Project construction activities for the onshore export cables are not anticipated to negatively impact water quality long-term.

Potential contamination may occur from unforeseen spills or accidents, and any such occurrence will be reported and addressed in accordance with the local authority. These potential impacts would be minimized by implementing an approved oil spill response plan, by following proper storage and disposal protocols, and by limiting the amount of hazardous or regulated materials to be used onsite to minimize the risk of a spill, per the APMs in **Table 1.1-2**.

Onshore Substations

During construction, there will be a temporary onshore construction compound at each substation and at each landfall. Site preparation may include clearing and grading, installation of a gravel layer, and installation of an access road. Construction of each onshore substation would require a permanent site, including area for the substation equipment and buildings, energy storage, and stormwater management and landscaping. A Stormwater Pollution Prevention Plan, including erosion and sedimentation control measures, will minimize potential impacts to water quality during onshore substation construction operations. Following APMs, construction activities for the onshore substations are not anticipated to negatively impact water quality once sediment and erosion controls are in place prior to construction activities.

Onshore Grid Connection

Additional buried cable would be required to connect each onshore substation to the existing grid. This section of cable would have similar impacts to water quality as discussed above for onshore export cable installation. Erosion and sedimentation control measures would be utilized to minimize potential impacts to water quality.

2.1.2.2.2 Operations and Maintenance

Offshore Project Area

Foundation maintenance activities are planned for the offshore wind turbines and offshore substations. Each subsea foundation would be periodically cleaned of organic build-up and inspected for damage or corrosion. Vessels will be used to transport crew and materials for each type of maintenance. Similar to construction impacts, during operations and maintenance, potential contamination may occur from unforeseen spills or accidents that could result in liquid wastes that are discharged to coastal and marine waters from vessels or facilities (WTGs or offshore substations), such as sewage, solid waste or chemicals, solvents, oils, and greases from equipment. Any such occurrence will be reported and addressed in accordance with the local authority. These potential impacts will be minimized by implementing an approved oil spill response plan (Appendix A), by following proper storage and disposal protocols on land, and by requiring vessel operators used for maintenance to have a vessel-specific spill response plans in the event of an accidental release, per the APMs.

The presence of WTGs and offshore substation structures has the potential to result in localized changes to hydrodynamics and sediment transport. When the tidal currents move past a structure, the velocities on either side of the structure will increase due to the restriction in flow. Hydrodynamic model results for calendar year 2017 were validated against data collected at six acoustic Doppler current profilers (ADCPs) (DHI 2018). Modeled depth-averaged current speeds for the Lease Area were 0.1 m/s, with a maximum flow in late January 2017 of approximately 0.5 m/s (**Figures 2.1.2-9 through 2.1.2-12**). At these current speeds, flow divergence around individual monopiles will be turbulent, with a turbulent wake created downstream. Turbulent mixing will be increased locally within the flow divergence and in the wake, which will enhance local dispersion and dissipation of flow energy. However, because the monopiles are spaced between 0.8 and 1 mile apart, there is less than 1 percent areal blockage and the net effect over the spatial scale of the Project will be negligible.

The localized increased current velocities around the structure have the potential to cause scour. The predominance in the Lease Area of medium to coarse sand, gravelly sand, and gravel deposits indicates that the seabed resuspension is subject to energetic events such as episodic large storms. These coarser particles drop out of suspension more rapidly than finer sediments which are transferred out of the area, limiting the potential of resuspending sediments. The potential for scour and resuspension of sediments will be further limited by the installation of scour protection, if required, around foundations as described in Volume 1, Section 6 of the COP.

A modeling study conducted at a wind farm in the North Sea determined that, as the currents move past a foundation structure, a turbulent wake is generated; this turbulence can contribute to the localized mixing of the seasonally stratified water column (Carpenter *et al*. 2016). This same study also determined that the existing wind farm installation is unlikely to result in regional changes to stratification. As discussed in Section 2.1.2.1.2, a thermocline is seasonally present (spring and summer) in the Lease Area within the upper 164 feet of the water column. The thermocline begins to establish in the spring and intensifies through the summer months. The presence of WTGs and offshore substations has the potential to result in seasonal localized changes in stratification in these areas (Carpenter *et al*. 2016). Inspection and maintenance of the seabed, scour protection, and cable burial depth will be required. Any resuspension of bottom sediments will be temporary in nature and will not adversely impact water quality long-term.

Onshore Project Area

Potential impacts to groundwater and surface water quality is not anticipated during operations and maintenance except in the case of a failure and an emergency repair. In the event of an emergency repair or failure, ground disturbing activities and potential for spills as described above for construction will occur.

Operations and maintenance plans regarding spill prevention have been developed to prevent any potential impacts to groundwater and surface water quality from accidental releases (Appendix A). Appropriate APMs will be implemented to minimize erosion and sedimentation occur following ground disturbing operations and maintenance activities. These include erosion and sedimentation control, such as silt curtains or turbidity booms to prevent erosion to surface waters. Operations and maintenance activities for the onshore facilities are not anticipated to negatively impact water quality.

2.1.2.2.3 Decommissioning

At the end of the operational lifetime of the Project, it is anticipated that all structures above the seabed level or aboveground will be removed based on permit conditions. Similar types of equipment and vessels will be used as during construction. Impacts will be similar to those for construction.

2.1.2.2.4 Summary of Potential Project Impacts on Water Quality

The IPFs affecting water quality include physical seabed/land disturbance, sediment suspension, and discharge/releases and withdrawals.

No long-term impacts to water quality are anticipated. Impacts to water quality are expected to be localized, temporary, and short-term with the application of APMs. Seabed disturbance for offshore construction and operations and maintenance activities will result in temporary increases of suspended sediment. Regulated discharges will be in conformance with required Federal, State, and local approvals. Potential contamination may occur from unforeseen spills or accidents, and any such occurrence will be reported and addressed in accordance with the local authority. Spills and inadvertent releases would be minimized with application of the APMs.

2.1.2.3 Avoidance, Minimization, and Mitigation Measures

The proposed measures for avoiding, minimizing, reducing, eliminating, and monitoring environmental impacts are presented in **Table 1.1-2**.

2.1.3 Air Quality

This section describes the current status of air quality in the vicinity of the Project and the potential Project impacts to air quality for the offshore portions of the Project. The distance that marine vessels and helicopters travel from the center of the array to the port of call is an important parameter in air emissions estimates. The ports of call have not yet been finalized. The air emissions presented in the COP are therefore a conservative estimate based on selecting ports that result in the most emissions.

2.1.3.1 Affected Environment

The Project may affect air quality in the New Jersey region and nearby coastal waters during construction, operations and maintenance, and decommissioning activities. Onshore emissions will occur in the onshore export cable corridors and at points of interconnection, potentially including BL England and Oyster Creek, in the counties of Ocean, Atlantic, and Cape May in New Jersey. Offshore emissions will be located within the OCS, including State offshore waters. Offshore emissions will occur in the Lease Area and the offshore export cable corridors.

Federal and State air regulations protect human health and the environment through ensuring that the impacts of background, existing sources and proposed sources are in compliance with ambient air quality standards. National Ambient Air Quality Standards[2] (NAAQS) have been promulgated for six air pollutants, known as criteria air pollutants. The six criteria air pollutants are carbon monoxide (CO), lead (Pb), nitrogen dioxide

[2] Clean Air Act. Retrieved from: https://www.epa.gov/criteria-air-pollutants/naaqs-table.

(NO_2), ozone (O_3), particulate matter (PM) (including PM_{10} [particles with a diameter smaller than 10 micrometers] and $PM_{2.5}$ [particles with a diameter smaller than 2.5 micrometers]), and sulfur dioxide (SO_2). NAAQS are expressed as primary standards, which are intended to protect human health, and secondary standards, which are intended to protect public welfare. Public welfare considerations include protection against damage to animals, crops, and buildings. NAAQS have varying averaging times and forms that define a NAAQS exceedance for each pollutant and standard.

As required under 40 CFR Part 55, Ocean Wind submitted to USEPA a Notice of Intent (NOI) on September 13, 2021, and an initial OCS air permit application on March 29, 2022. After receipt of the NOI, EPA designated New Jersey the COA for the Project and conducted a consistency review of regulations in New Jersey. EPA published a Final Rule to incorporate New Jersey air pollution control requirements applicable to OCS Sources as of October 6, 2021, into 40 CFR Part 55, Appendix A (87 FR 11962, March 3, 2022). The New Jersey regulations (as of February 23, 2022) are incorporated into 40 CFR Part 55 by reference and are listed in Appendix A of Part 55.

Individual states may establish State-specific ambient air quality standards. The State of New Jersey has promulgated primary and secondary ambient air quality standards (NJAAQS)[3] which are generally the same but not identical to the NAAQS. In this document, the more stringent of either the NAAQS or the NJAAQS is used to compare with potential Project impacts. **Table 2.1.3-1** displays both the NAAQS and the NJAAQS side-by-side.

Table 2.1.3-1. National Ambient Air Quality Standards (NAAQS) and New Jersey Ambient Air Quality Standards (NJAAQS). When there is a difference between the NAAQS and the NJAAQS, the more stringent of the standards is in bold text.

Pollutant	Averaging Period	National Ambient Air Quality Standards [1]		New Jersey Ambient Air Quality Standards [2]	
		Primary	Secondary	Primary	Secondary
		μg/m³	μg/m³	μg/m³	μg/m³
Carbon Monoxide (CO)	8-hour [3]	10,000	None	10,000	**10,000**
	1-hour [3]	40,000	None	40,000	**40,000**
Lead (Pb)	Rolling 3-month average [4]	0.15	0.15	0.15	0.15
Nitrogen Dioxide (NO_2)	Annual [4]	100	100	100	100
	1-hour [5]	**188**	None	None	None
Ozone (O_3)	8-hour [6]	**137**	**137**	None	None
	1-hour [3]	None	None	**235**	**160**
Particulate Matter (PM_{10})	24-hour [7]	**150**	**150**	None	None
Particulate Matter ($PM_{2.5}$)	Annual [8]	**12**	**15**	None	None
	24-hour [9]	**35**	**35**	None	None
Sulfur Dioxide (SO_2)	Annual [4,10]	80	None	80	**60**
	24-hour [3,10]	365	None	365	**260**
	3-hour [3]	None	1300	None	1300
	1-hour [11]	**196**	None	None	None

[3] N.J.A.C. 7:27-13. Retrieved from: https://www.state.nj.us/dep/aqm/rules27.html.

Pollutant	Averaging Period	National Ambient Air Quality Standards [1]		New Jersey Ambient Air Quality Standards [2]	
		Primary	Secondary	Primary	Secondary
		µg/m³	µg/m³	µg/m³	µg/m³
Suspended Particulate Matter	24-hour [3]	None	None	**260**	**150**
	Annual [12]	None	None	**75**	**60**

[1] Source of National Ambient Air Quality Standards: USEPA (2018a). Retrieved from: https://www.epa.gov/criteria-air-pollutants/naaqs-table.
[2] Source of New Jersey Ambient Air Quality Standards: New Jersey (2008). Retrieved from: https://www.state.nj.us/dep/aqm/rules27.html, Subchapter 13.
[3] Not to be exceeded more than once per year
[4] Not to be exceeded
[5] 98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
[6] Annual 4th-highest daily maximum 8-hour concentration, averaged over 3 years
[7] Not to be exceeded more than once per year on average over 3 years
[8] Annual mean, averaged over 3 years
[9] 98th percentile, averaged over 3 years
[10] USEPA revoked the annual and 24-hour SO_2 NAAQS in 2010. However, they remain in effect until one year after the area's initial attainment designation, unless designated as nonattainment. New Jersey maintains both a 24-hour and annual SO_2 standard.
[11] 99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
[12] Not to be exceeded (Geometric mean)

The Wind Farm Area is located approximately 13 nm southeast of Atlantic City and is roughly parallel to the coastline, extending approximately 60 miles along Ocean County, Atlantic County, and Cape May County, all in New Jersey. The Wind Farm Area extends approximately 15 miles from west to east.

All areas of the United States are classified by the USEPA as *attainment*, *nonattainment*, or *unclassified* for the criteria air pollutants. An area in attainment is in compliance with all NAAQS. An area in nonattainment is not in compliance with one or more NAAQS. An unclassified area cannot be classified as attainment or nonattainment based on available information but is treated as an area in attainment. If an area was in nonattainment at any point in the last twenty years but is currently in attainment or is unclassified, then the area is termed a *maintenance* area.

The official record of the attainment status of all areas in the United States is published in 40 C.F.R. Part 81: Designation of Areas for Air Quality Planning Purposes and can also be found in the USEPA's Green Book[4]. For all coastal areas along the Atlantic Ocean, the attainment status boundary extends 3 nm, to the seaward boundary[5].

General Conformity regulations require that projects which are considered Federal actions and result in direct and indirect emissions in a nonattainment or maintenance area be compared to *de minimis* thresholds for the nonattainment or maintenance area(s) in which project emissions occur. Due to anti-backsliding provisions of the Clean Air Act, the Project must consider the potential applicability of all previously designated nonattainment or maintenance areas, regardless of whether or not the standard for which it was designated nonattainment or maintenance has since been revoked. The Project is projected to result in direct and indirect emissions in the following nonattainment or maintenance areas:

- Philadelphia-Wilmington-Atlantic City, PA-NJ-MD-DE (8-hr 1997 ozone standard; 8-hr 2008 ozone standard; 8-hr 2015 ozone standard)
- Norfolk-Virginia Beach-Newport News (Hampton Roads), VA (8-hr 1997 ozone standard; 1-hr 1979 ozone standard)

[4] https://www.epa.gov/green-book
[5] U.S. EPA. (2017, June 28). General Conformity Training Module 3.1: Applicability Analyses. Retrieved from https://www.epa.gov/general-conformity/general-conformity-training-module-31-applicability-analyses.

- New York-N. New Jersey-Long Island, NY-NJ-CT (1-hr 1979 ozone standard)
- Philadelphia-Wilmington-Trenton, PA-NJ-DE-MD (1-hr 1979 ozone standard)
- Sussex County, DE (1-hr 1979 ozone standard)
- Atlantic City, NJ (1-hr 1979 ozone standard; 1971 carbon monoxide standard)
- Philadelphia-Camden Co, PA-NJ (1971 carbon monoxide standard)
- Penns Grove, NJ (1971 carbon monoxide standard).

Direct and indirect Project emissions are projected to result from the construction of two onshore substations. The BL England study area is in Cape May and Atlantic Counties; and the Oyster Creek study area is in Ocean County; all three counties are part of the Philadelphia-Wilmington-Atlantic City, PA-NJ-MD-DE nonattainment area for the three 8-hour ozone standards. Oyster Creek is also located in the New York-N. New Jersey-Long Island, NY-NJ-CT nonattainment area for the revoked 1979 1-hour ozone standard. BL England is located in the Atlantic City nonattainment area for the revoked 1979 1-hour ozone standard.

Direct and indirect Project emissions are projected to result from marine vessels as they travel to and from ports to the Project area. Marine vessel transit routes are expected to be located within nonattainment or maintenance areas for the 1-hour 1979 ozone standard, 8-hour 1997 ozone standard, 8-hour 2008 ozone standard, 2015 ozone standard, and the 1971 carbon monoxide standard. See Appendix N for figures displaying vessel transit routes and nonattainment and maintenance areas.

The Project is not projected to result in direct or indirect emissions within nonattainment or maintenance areas for four of the six criteria pollutants: Pb, NO_2, PM (including $PM_{2.5}$ and PM_{10}) and SO_2.

Atlantic, Cape May, and Ocean Counties are all located within the Philadelphia-Wilmington-Atlantic City, PA-NJ-MD-DE nonattainment area that is currently classified as marginal nonattainment with the current version of the ozone standard, the 2015 8-hour standard of 0.07 parts per million (ppm), which came into effect as of December 28, 2015. Initial attainment designations for the 2015 standard became effective January 16, 2018. Previously, the Philadelphia-Wilmington-Atlantic City, PA-NJ-MD-DE nonattainment area was classified as moderate nonattainment for ozone under the 1997 8-hour standard of 0.08 ppm. This standard was replaced, effective in 2008, with an 8-hour standard of 0.075 ppm. The 1997 8-hour standard was officially revoked on April 6, 2015. Under the 2008 8-hour ozone standard, the Philadelphia-Wilmington-Atlantic City, PA-NJ-MD-DE nonattainment area was designated marginal nonattainment, similar to its designations under the stricter 2015 standard.

Although the Philadelphia-Wilmington-Atlantic City, PA-NJ-MD-DE nonattainment area is classified as nonattainment, ozone pollution has steadily been decreasing in this area since 1997, when it was classified as moderate nonattainment. Attainment designations for all nonattainment or maintenance areas where Project emissions may occur are summarized in **Table 2.1.3-2**. Pb, NO_2, PM (including $PM_{2.5}$ and PM_{10}) and SO_2 are not included in the table since the Project is not projected to result in emissions in a nonattainment or maintenance area for these pollutants.

Table 2.1.3-2. Attainment status for areas where Project emissions may occur.

<table>
<tr><th rowspan="2"></th><th colspan="4">Ozone</th><th>Carbon Monoxide</th></tr>
<tr><th>2015 8-Hr Std</th><th>2008 8-Hr Std</th><th>1997 8-Hr Std</th><th>1979 1-Hr Std</th><th>1971 Std</th></tr>
<tr><td>Status of NAAQS</td><td>Current</td><td>Replaced by 2015 std</td><td>Revoked</td><td>Revoked</td><td>Current</td></tr>
<tr><td>Philadelphia-Wilmington-Atlantic City</td><td>Marginal NA</td><td>Marginal NA</td><td>Moderate NA</td><td>--</td><td>--</td></tr>
<tr><td>Philadelphia-Wilmington-Trenton</td><td>--</td><td>--</td><td>--</td><td>Severe NA</td><td>--</td></tr>
<tr><td>Norfolk-Virginia Beach-Newport News (Hampton Roads)</td><td>--</td><td>--</td><td>Maintenance</td><td>Maintenance</td><td>--</td></tr>
<tr><td>New York-N. New Jersey-Long Island</td><td>Project Emissions will not Occur in this Designated Area</td><td>Project Emissions will not Occur in this Designated Area</td><td>Project Emissions will not Occur in this Designated Area</td><td>Severe NA</td><td>--</td></tr>
<tr><td>Sussex County</td><td>--</td><td>--</td><td>--</td><td>Marginal NA</td><td>--</td></tr>
<tr><td>Atlantic City</td><td>--</td><td>--</td><td>--</td><td>Moderate NA</td><td>Maintenance</td></tr>
<tr><td>Philadelphia-Camden County</td><td colspan="4" rowspan="2">These areas were designated for carbon monoxide standard.</td><td>Maintenance</td></tr>
<tr><td>Penns Grove</td><td>Maintenance</td></tr>
</table>

-- = No nonattainment or maintenance designation for this designated area for this standard
NA = Nonattainment

Projects subject to General Conformity are required to provide the Federal land manager charged with direct responsibility of designated Class I areas within 62 miles (100 km) of the Project copies of the draft General Conformity demonstration. The location of Class I areas nearest to the Project are shown in **Figure 2.1.3-1**. The Brigantine Wilderness Area is the only Class I area within 62 miles (100 km) of the Project. It is located approximately 25 miles from the centroid of the Project. The Federal land manager identifies appropriate air quality related values (AQRVs) for the Class I area and evaluates the impact of the Project on AQRVs. AQRVs identified for Brigantine Wilderness include aquatic resources, fauna/wildlife, soils, vegetation, and visibility. At the request of the Federal Land Manager for the Brigantine Wilderness Area, the Project is conducting visibility analyses (both plume blight and haze) and a sulfur and nitrogen deposition analysis in accordance with the Federal Land Managers' Air Quality Related Values Work Group (2010).

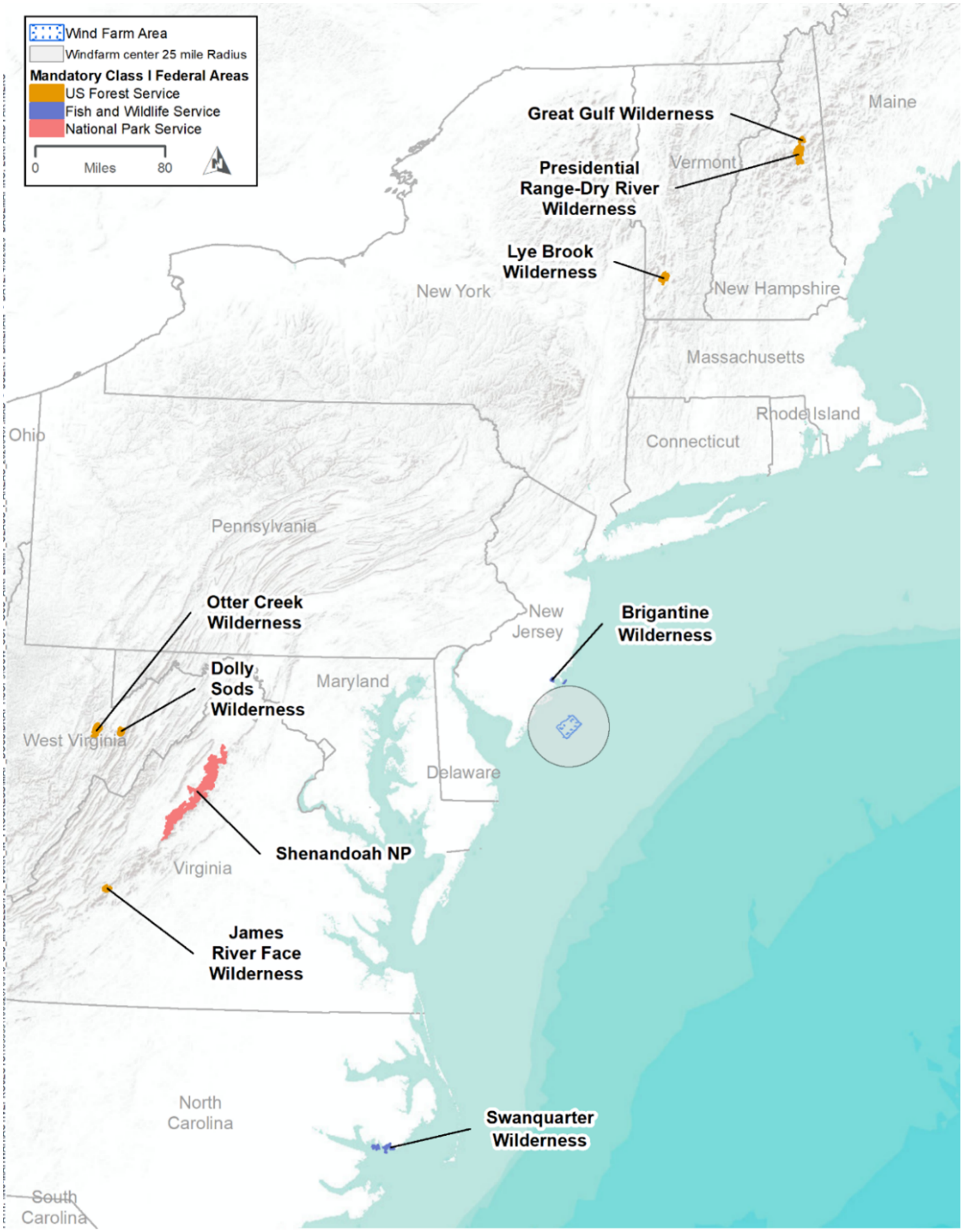

Figure 2.1.3-1. Class I areas nearest to the Project.

2.1.3.2 Potential Project Impacts on Air Quality

2.1.3.2.1 Overview

While the proposed WTGs will not generate air emissions during operation, the Project will emit air pollutants during construction, operation, and decommissioning phases. Impact producing factors are air emissions resulting from Project-related traffic during these project phases. As explained in this section, the air emissions from these phases of the Project will be offset by the Project's displacement of fossil fuel-generated electricity on the regional power grid (PJM Interconnection L.L.C.) for 35 years, the lifespan of the Project.

This section describes the potential impacts of the Project on air quality in the area surrounding the proposed Project. In order to define the scope of potential impacts due to air emissions, this section first focuses on the air regulatory framework applicable to the Project. The section then details how potential air emissions from construction and operation of the Project were estimated, as well as emissions offset from the regional power grid by the Project. Finally, this section discusses the potential impacts of Project air emissions and how Ocean Wind intends to avoid, minimize, and mitigate the potential impacts of the Project on ambient air quality.

Regulatory Framework

Under 30 CFR 585.659, all projects not located in the Gulf of Mexico must follow the appropriate regulations promulgated by the USEPA under 40 CFR part 55. This part regulates air emissions from OCS sources, which are defined in 40 CFR 55.2 as any equipment, activity, or facility which:

(1) Emits or has the potential to emit any air pollutant;
(2) Is regulated or authorized under the Outer Continental Shelf Lands Act (OCSLA) (43 U.S.C. § 1331 *et seq.*); and
(3) Is located on the OCS or in or on waters above the OCS.

This definition shall include vessels only when they are:

A. Permanently or temporarily attached to the seabed and erected thereon and used for the purpose of exploring, developing or producing resources therefrom, within the meaning of section 4(a)(1) of OCSLA (43 U.S.C. § 1331*et seq.*); or
B. Physically attached to an OCS facility, in which case only the stationary source aspects of the vessels will be regulated.

40 CFR 55.2 also defines *potential emissions* of OCS sources as:

> *the maximum emissions of a pollutant from an OCS source operating at its design capacity. Any physical or operational limitation on the capacity of a source to emit a pollutant, including air pollution control equipment and restrictions on hours of operation or on the type or amount of material combusted, stored, or processed, shall be treated as a limit on the design capacity of the source if the limitation is federally enforceable. Pursuant to section 328 of the Clean Air Act (Act), emissions from vessels servicing or associated with an OCS source shall be considered direct emissions from such a source while at the source, and while enroute to or from the source when within 25 miles of the source, and shall be included in the "potential to emit" for an OCS source. This definition does not alter or affect the use of this term for any other purposes under §§ 55.13 or 55.14 of this part, except that vessel emissions must be included in the "potential to emit" as used in §§ 55.13 and 55.14 of this part.*

Therefore, air emissions from OCS sources subject to 40 CFR part 55 include emissions from OCS sources, vessels located at the OCS source, and vessels while en route to or from the OCS source while within 25 miles of the source (measured from source's center). Combined, these emissions are considered the source's potential emissions with respect to OCS air permitting.

40 CFR part 55 differentiates between OCS sources located within 25 miles of a state's seaward boundary and OCS sources located farther than 25 miles of a state's seaward boundary. The Project's OCS-regulated air emissions (emissions within a 25-mile radius of the Project's centroid) will be primarily located within 25 miles of New Jersey's seaward boundary with a small portion of the emissions located farther than 25 miles from New Jersey's seaward boundary. Under 40 CFR part 55, OCS sources located within 25 miles of a state's seaward boundary must comply with the Federal, State, and local requirements of the COA.

As noted in Section 2.1.3.1, the Project is potentially subject to USEPA's General Conformity regulations as promulgated in 40 CFR Part 93 Subpart B and 40 CFR Part 51 Subpart W. General Conformity regulations are intended to ensure that Federal actions do not interfere with states' plans to attain and maintain the NAAQS in areas that are or have been in nonattainment for one or more pollutants. As discussed in Section 2.1.3.1, a portion of the Project's projected direct and indirect emissions may occur in areas that are, or have been previously, designated as nonattainment or maintenance; therefore, it must be determined whether the Project is subject to General Conformity requirements. Emissions that are subject to New Source Review will be excluded from the General Conformity analysis; therefore, emissions that will be regulated by the OCS air permit will be excluded from the General Conformity analysis. **Figure 2.1.3-2** illustrates the components of the Project that are subject to the OCS Air Permit regulations. Emissions estimates presented in Appendix N break down total Project emissions into those subject to the OCS air permit, those potentially subject to General Conformity, and emissions not subject to either an OCS air permit or to General Conformity.

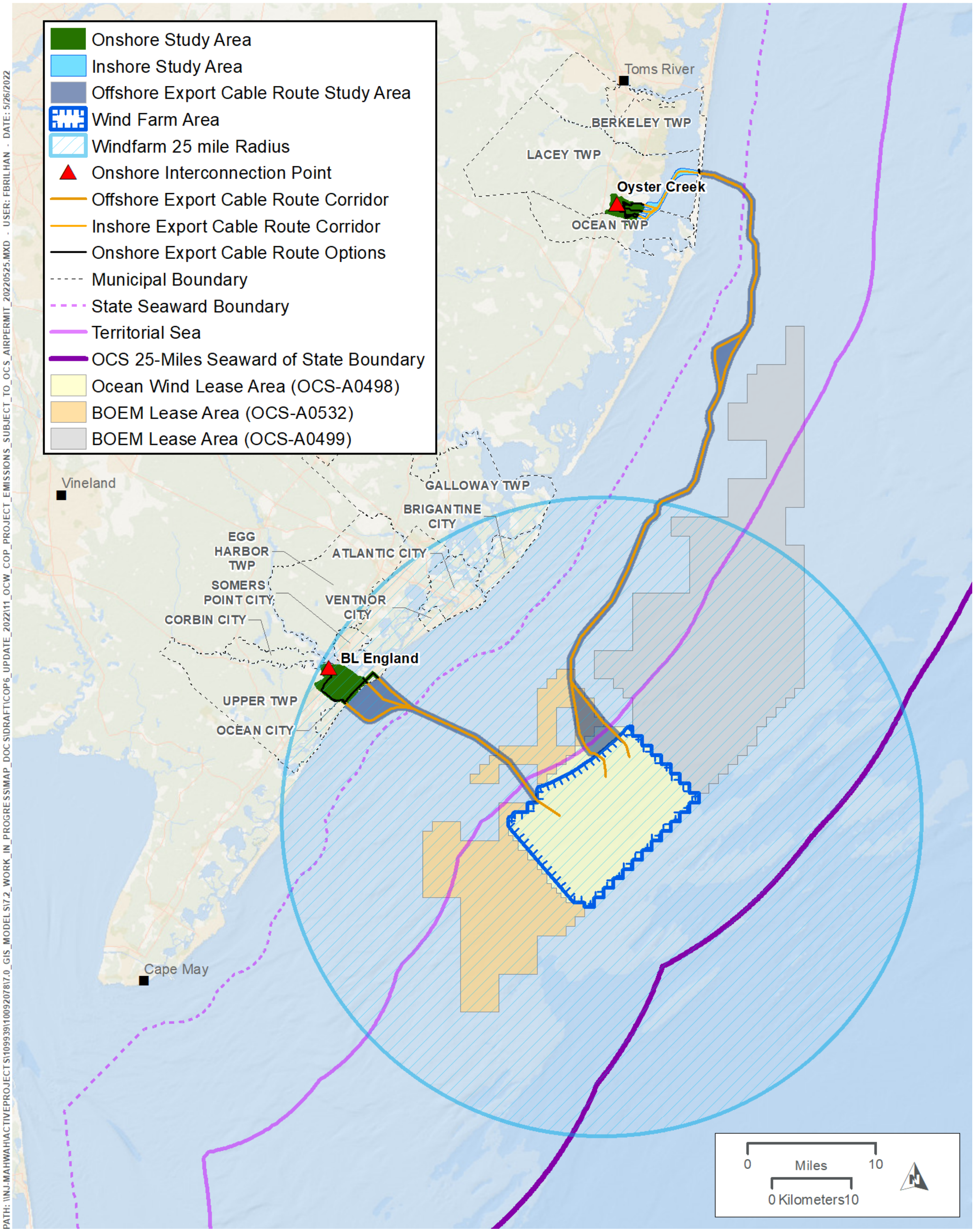

Figure 2.1.3-2. Project emissions subject to OCS Air Permit.

Emission Estimation Methodology

The potential air emissions were estimated based on the Project Design Envelope (PDE) approach outlined in BOEM's Draft Guidance published January 12, 2018[6]. Therefore, the emissions presented in this document are considered the upper bound of Project emissions, also known as a 'maximum-case'. The air emission estimates are based on indicative vessel trips that are different from but within the PDE (less than the PDE) included in Volume I.

Parameters of the Project used to estimate air emissions include the following:

- 99 WTGs (This analysis was conducted for up to 99 turbines. The PDE was subsequently reduced to 98 turbines; because the PDE was reduced (not increased), the air emissions analysis was not changed)
- 3 onshore substations/interconnection points (The PDE was subsequently reduced to 2; because the PDE was reduced (not increased), the air emissions analysis was not changed)
- 3 offshore substations
- 3 offshore export cable corridors (The PDE was subsequently reduced to 2; because the PDE was reduced (not increased), the air emissions analysis was not changed)
- WTG foundation construction methodology is monopile
- Operational life of 35 years
- Nominal capacity of array is approximately 1,100 megawatts (MW)

Because Project planning is under development, some aspects of the Project pertinent to estimating air emissions are under consideration. Where this occurred, a reasonable maximum-case assumption was made, in line with the PDE approach. The major assumptions include:

- Atlantic City Port used by marine vessels during construction of offshore substations and during operations and by all crew transfer vessels
- Paulsboro Port or Europe (directly) used by marine vessels during construction of WTG and offshore substation foundations
- Hope Creek Port or Norfolk, VA used by marine vessels during construction of WTGs
- Port Elizabeth, Charleston Port, or a European port used by marine vessels during construction of offshore export cables and interconnection cables
- Woodbine Municipal Airport in Atlantic City used by helicopters during construction and operations phases
- Construction phase is two years; it is assumed all onshore construction occurs in Year 1 and all offshore construction occurs in Year 2
- Capacity factor of array is 42.13 percent

Sources of Emissions

Air emissions from all three phases of the Project are generated primarily by fuel combustion in diesel engines. There are five primary categories of air emission sources:

- Commercial marine vessels
- Helicopters
- Generators (backup power/emergency generators)
- Onshore nonroad engines (construction equipment)
- Onshore mobile engines

[6] https://www.boem.gov/Draft-Design-Envelope-Guidance/

OCS Emissions

BOEM developed a tool to estimate emissions from offshore wind energy facilities, called Wind Tool. BOEM developed Wind Tool to establish an efficient, consistent approach to estimate emissions associated with offshore wind energy facilities. The intended audience is for BOEM's National Environmental Protection Act (NEPA) document authors, as well as possibly project applicants (Chang *et al.* 2017). In addition to calculating emissions associated with constructing, operating, and decommissioning an offshore wind facility, Wind Tool quantifies the fossil fuel combustion emissions that the wind facility will displace from the grid.

Diesel Marine Vessels

To estimate emissions for the Project, default values for emission factors and average vessel speed from Wind Tool were used for all vessel types. Project-specific information was limited to the number of each vessel type used in each phase, the distance the vessels travel (distance from port to centroid of array), the number of trips each vessel will take, and the number of days each vessel will be used. Additionally, specifications for installation marine vessels for WTG and offshore substation foundations, WTG construction, and offshore substation construction were obtained from representative vessel specification sheets.

Helicopters

The Project will use the Woodbine Municipal Airport, approximately 15 miles southwest of Atlantic City, or Atlantic City Airport[7], as the support airport during construction and during operations and maintenance; therefore, the distance from airport to Project Area used in construction and in operation and maintenance emission estimates is 30 statute miles. Project-specific information specified the number of trips each helicopter will take throughout the Project phases.

Emergency Engines

Temporary diesel engines may need to be brought to the WTGs during commissioning for a period of up to two weeks, after which time they will be removed from the WTG. The number of emergency engines used in the operations phase, as well as the rated capacity and number of hours used per year for testing purposes, was based on similar projects and scaled appropriately to account for the Project's size.

Avoided Emissions

The avoided emission estimates were calculated using Wind Tool which utilizes emission factors from the USEPA's Emissions & Generated Resource Integrated Database (eGRID) and the Argonne National Laboratory (ANL). In both sets of emission factors, emissions are corresponded to the point of electricity generation; eGRID uses eGRID subregions and ANL uses North American Electrical Reliability Corporation regions. Wind Tool utilizes a user-supplied zip code of the location where the Project will be connected to the shore-based grid. Because the Project may connect to the shore-based grid at locations that are in more than one zip code, the zip code 08401 was selected as the closest zip code to the Project. Because Wind Tool relies upon eGRID and ANL emission factors, it does not account for future changes to the resource mix of the grid. Wind Tool multiplies the avoided emissions estimated for the first year of operation, based on the most recent eGRID and ANL emission factors, by the expected life of the Project to estimate the lifetime avoided emissions of the Project.

2.1.3.2.2 Construction

Emissions subject to the OCS air permit that may occur in the construction phase are displayed in the following section. Project related air emissions on the OCS over the two-year construction period will have minor

[7] Woodbine Municipal Airport is further from the Wind Farm Area than the Atlantic City Airport, so Woodbine Municipal Airport was used in the air emissions analysis as a conservative assumption.

localized impacts to air quality. These impacts will be temporary during construction; estimates of regulated air pollutants are presented below. Emission summaries are presented as total and annual emissions in tons per year. **Table 2.1.3-3** displays total Project emissions that may occur as a result of the construction phase, both onshore and offshore. **Table 2.1.3-4** displays the estimated offshore construction emissions of the Project in the OCS permit area, and the comparison of the total OCS permit area emissions to the total emission inventories of the potentially impacted counties. This is a conservative analysis because it is likely that not all emissions generated offshore would reach land and because emissions that do reach land will disperse over many counties.

2.1.3.2.3 Operations and Maintenance

Table 2.1.3-5 displays total Project emissions that may occur as a result of the operations phase both onshore and offshore. All emissions in the tables below are presented in tons. **Table 2.1.3-5** displays the estimated offshore O&M emissions of the Project in the OCS permit area, and the comparison of the total OCS permit area emissions to the total emission inventories of the potentially impacted counties. This is a conservative analysis because it is likely that not all emissions generated offshore would reach land and because emissions that do reach land will disperse over many counties. Detailed emissions estimates are located in Appendix N.

Table 2.1.3-3. Construction phase emissions (tons).

Emission Source	Year	CO_2	CH_4 [1]	N_2O [1]	CO_2e	Black Carbon [1]	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	Lead [1]	VOC
Onshore Equipment	1	3,539	--	--	3,539	--	2.5	5.1	0.3	0.3	0.02	--	0.4
Marine Vessels	2	651,668	4.1	32.0	661,313	267.6	2,148	11,142	363.6	347.5	113.6	0.04	290.3
Helicopters	2	178.7	0.01	0.01	180.5	0.002	0.3	0.5	0.0	0.0	0.06	--	0.2
Offshore Emergency Engines	2	927.4	--	--	927.4	--	5.4	25.0	1.8	1.8	1.7	--	2.0
Subtotal – Year 1	1	3,539	--	--	3,539	--	2.5	5.1	0.3	0.3	0.02	--	0.4
Subtotal – Year 2	2	652,774	4.1	32.0	662,421	267.6	2,154	11,168	365.3	349.3	115.3	0.04	292.6
Total Construction Phase Emissions		656,313	4.1	32.0	665,960	267.6	2,156	11,173	365.6	349.5	115.3	0.04	293.0

Table 2.1.3-4. Estimated construction emissions (tons) in OCS Permit Area

Period	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC	CO_2e
OCS Permit Area Year 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OCS Permit Area Year 2	1,342	7,486	244.3	232.8	94.5	216.6	424,114
Total	**1,342**	**7,486**	**244.3**	**232.8**	**94.5**	**216.6**	**424,114**
Atlantic County, New Jersey 2017 Inventory	29,820.4	4,492.6	1,828.1	839	267	15,084.2	1,598,849.4
Percentage of Atlantic County, New Jersey 2017 Inventory	4.5	166.6	13.4	27.7	35.4	1.4	26.5

Period	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	CO_2e
Cape May County, New Jersey 2017 Inventory	18,830.5	2,883.3	958.9	475.2	63.5	9,015.3	833,591.8
Percentage of Cape May County, New Jersey 2017 Inventory	7.1	259.6	25.5	49.0	148.8	2.4	50.9
Ocean County, New Jersey 2017 Inventory	63,398.4	7,737.8	3,237.8	2,064.3	187.1	20,865.9	3,702,977.4
Percentage of Ocean County, New Jersey 2017 Inventory	2.1	96.7	7.5	11.3	50.5	1.0	11.5

Table 2.1.3-5. Operations phase emissions (tons).

Emission Source	CO_2	CH_4 [1]	N_2O [2]	CO_2e	Black Carbon [1]	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	Lead [1]	VOC
Marine Vessels	10,280	0.06	0.5	10,428	3.7	36.5	145.86	4.9	4.8	0.1	0.001	2.2
Helicopter	1,036	0.03	0.03	1,047	0.01	1.5	3.0	0.09	0.08	0.3	--	1.3
Onshore Equipment	12.1	--	--	12.1	--	0.06	0.004	0.001	0.0003	0.0001		0.001
Offshore Emergency Engines	424.9	--	--	424.9	--	2.3	10.4	0.6	0.6	0.5		0.7
Annual Subtotal	11,753	0.09	0.5	11,912	3.7	40.3	159.3	5.6	5.4	0.9	0.001	4.1
35-Year Lifetime Total	411,347	3.3	18.4	416,907	128.9	1,411	5,576	196.0	190.6	31.1	0.03	143.6

[1] Methane (CH_4), N_2O, Black Carbon and Lead emissions were not estimated for offshore emergency engines or onshore equipment because the emissions from these units were estimated using AP-42 Vol. I, Section 3.3 (emergency engines) and EPA's MOVES2014b (onshore equipment), which do not have emission factors for these pollutants. When Ocean Wind submits an NOI, it will contain all pollutants required to be quantified under 40 CFR Part 55.

Table 2.1.3-6. Estimated operations emissions (tons) in OCS Permit Area.

Period	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	CO_2e
OCS Permit Area Annual	**40.0**	**158.8**	**5.6**	**5.4**	**0.8**	**3.9**	**11,744**
Atlantic County, New Jersey 2017 Inventory	29,820.4	4,492.6	1,828.1	839	267	15,084.2	1,598,849.4
Percentage of Atlantic County, New Jersey 2017 Inventory	0.1	3.5	0.3	0.6	0.3	0.0	0.7
Cape May County, New Jersey 2017 Inventory	18,830.5	2,883.3	958.9	475.2	63.5	9,015.3	833,591.8
Percentage of Cape May County, New Jersey 2017 Inventory	0.2	5.5	0.6	1.1	1.3	0.0	1.4
Ocean County, New Jersey 2017 Inventory	63,398.4	7,737.8	3,237.8	2,064.3	187.1	20,865.9	3,702,977.4
Percentage of Ocean County, New Jersey 2017 Inventory	0.1	2.1	0.2	0.3	0.4	0.0	0.3

The Project will have a net benefit on ambient air quality in New Jersey and in the region. Even though short term impacts include emission of air pollution during the construction phase, and a small amount of pollution during the operational phase, the proposed Project would provide renewable electricity, providing more than half a million New Jersey homes with clean, reliable, and stable-priced power. The Project would thereby result in a net reduction of regional air pollution. **Table 2.1.3-7** below shows estimated avoided emissions on an annual basis and over the 35-year lifespan of the Project.

Table 2.1.3-7. Avoided annual emissions (tons).

	CO_2	CH_4	N_2O	Black Carbon	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	Lead	VOC
Annual	2,989,161	243.0	35.2	5.4	648.9	2,362	151.6	114.2	5,705	0.1	71.6
Lifetime	104,620,660	8,506	1,231	187.5	22,710	82,695	5,307	3,997	199,704	3.5	2,506

2.1.3.2.4 Decommissioning

Emissions from decommissioning were not assessed as the Project anticipates pursuing a separate OCS Air Permit for those activities since it is assumed marine vessels and construction technology will change substantially in the next 35 years.

2.1.3.2.5 Summary of Potential Project Impacts on Air Quality Resources

The IPFs affecting air quality include air emissions and traffic.

The Project itself is an air quality impact avoidance measure since it would result in a net reduction of regional air pollution over the life of the Project through displacement of fossil fuel-generated power plants. Other potential impacts are short-term. Short term impacts include emission of air pollutants during construction, operations and maintenance, and decommissioning phases. There are four primary categories of air emission sources: marine vessels, helicopters, generators (backup power/emergency generators), and nonroad engines (construction equipment). Short-term impacts to air quality would result from fugitive dust and emissions from Project equipment and vessels associated with construction-related activities and on a smaller scale with operations-related activities.

2.1.3.3 Avoidance, Minimization, and Mitigation Measures

The proposed measures for avoiding, minimizing, reducing, eliminating, and monitoring environmental impacts for the Project are presented in **Table 1.1-2**. The Project itself is an air quality impact avoidance measure since it is resulting in a net reduction of regional air pollution over the life of the Project.

2.2 Biological Resources

This section describes the biological resources in the Project Area and the potential Project impacts for onshore and offshore portions of the Project. Resources evaluated include terrestrial and coastal habitat and fauna, birds, bats, benthic resources, fish, marine mammals, and sea turtles.

2.2.1 Terrestrial and Coastal Habitats

This section describes existing conditions, impacts and mitigation associated with terrestrial and coastal habitats associated with the Project's onshore and offshore facilities (note: birds and bats are discussed in Sections 2.2.3 and 2.2.4).

2.2.1.1 Affected Environment

2.2.1.1.1 Vegetation

The NJDEP's Landscape Project data is based on documented wildlife locations and habitat types depicted in the 2012 land use and land cover data. The dataset combines documented wildlife locations along with aerials and land use and land cover data to delineate protected species habitat in the State. Species polygons based on their ranking or listing status are provided in spatial format and depict the location and extent of species habitats. Each habitat is given a rank of from 1 to 5 that reflects the critical nature of the habitat (**Figure 2.2.1-1**). Areas with Ranks 3, 4, or 5 are considered most critical since they represent habitat areas utilized by species on the State Threatened, State Endangered, and Federal Threatened and Endangered Species lists (NJDFW 2017b).

Based on NJDEP's Landscape Project, and land use and land cover data **(**see **Figure 2.3.5-1**), vegetation communities within the BL England study area are limited to fringe areas of the barrier island as the majority of the barrier island is developed. The vegetated dune community is found along the Atlantic Ocean. Communities on the beach and landside along the backbays are dominated by saline low marshes with common reed dominated wetland present along the Atlantic City Expressway, which bisects the BL England study area from the mainland to Atlantic City. An extensive area of saline low marsh fringed with forested wetlands is also present within the large riverine complex associated with the Great Egg Harbor Bay, Middle and Tuckahoe Rivers (see below for additional details on wetlands and watercourses). In addition, segments of the onshore export cable corridor are dominated by mixed forested communities interspersed with urban development. Urban development dominates the northwestern portion of the BL England study area. Mixed forest communities upland and wetland communities are also present in this area. The communities present are characteristic of those found throughout the pineland and coastal areas of the State (NJDFW 2017b).

According to the Environmental Resource Inventory for Atlantic County (1973), the forested areas of the BL England study area consist of lowland forest and upland forest. Lowland forests are characterized by Atlantic white-cedar (*Chamaecyparis thyoides*), and other broadleaf species. Along the edges of the lowlands are occasional gray birch (*Betula populifolia*), willow oak (*Quercus phellos*), sweet gum (*Liquidambar styraciflua*), and several other water tolerant lowland species. Lowland forest communities include cedar swamps, hardwood swamps, and pine lowlands. Upland forests are characterized by pines, especially the pitch pine (*Pinus rigida*) and shortleaf pine (*P. echinata*). As compared to the lowlands, the canopy is more varied in composition. Pitch pine is the most abundant and its associations include shortleaf pine and oaks. Communities within the upland association include pine-black oak (*Q. velutina*), pine-black oak-scrub oak (*Q. berberidifolia*), and oak-pine.

Ocean City encompasses several islands within Great Egg Harbor Bay and the barrier beach to the south of Great Egg Harbor Inlet. A Conservation Plan Element for Ocean City was developed in 2009. The document identifies several coastal communities including constructed dunes planted with native species, upland beaches, and wetlands. Terrestrial plant species identified within the communities present in the BL England study area are presented in **Table 2.2.1-1**.

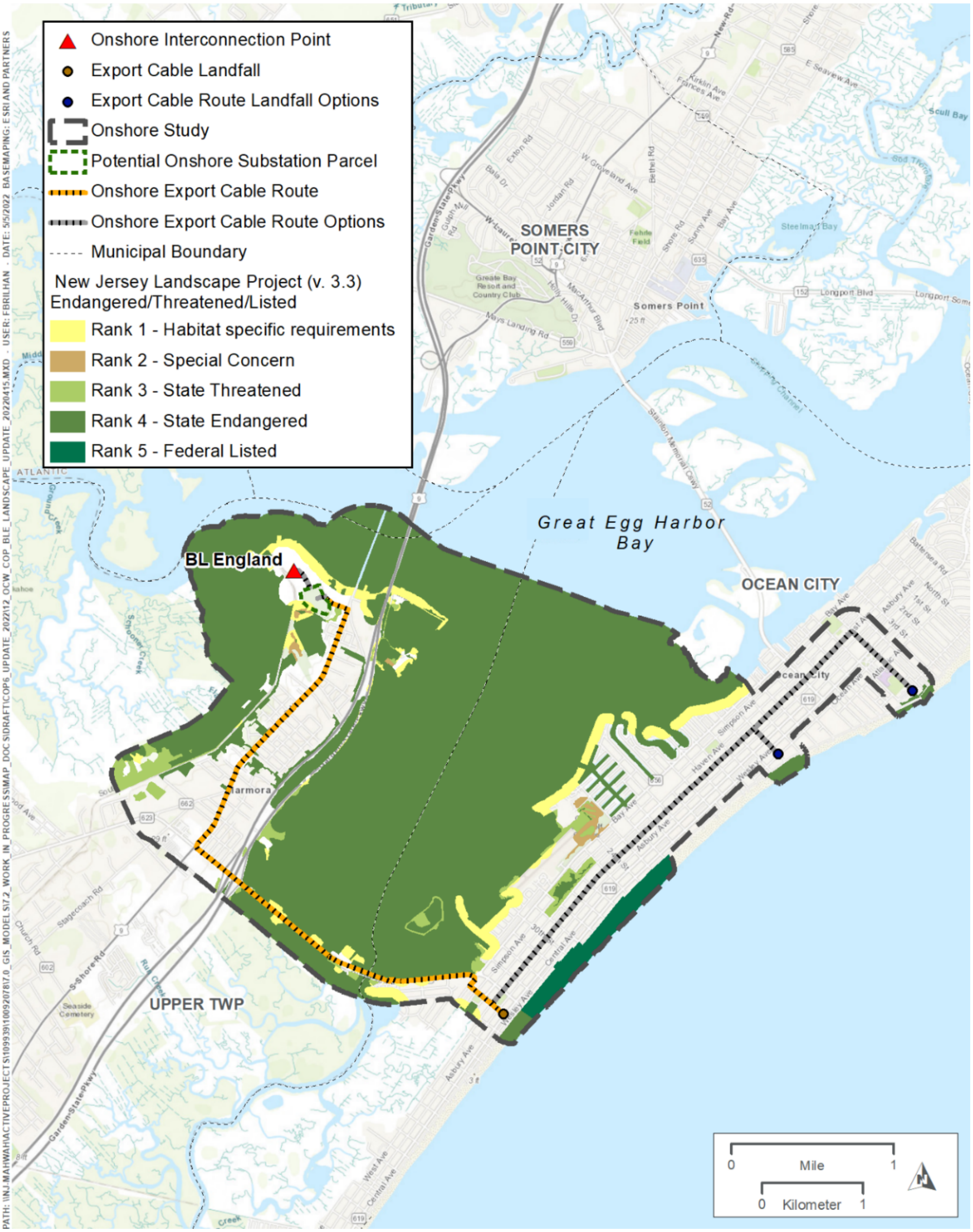

Figure 2.2.1-1. NJDEP Landscape Project data for the BL England study area.

Table 2.2.1-1. Common vegetation present in the BL England study area.

Common Name	Scientific Name	Common Name	Scientific Name
Atlantic white cedar[1]	*Chamaecyparis thyoides*	poison ivy[4,7]	*Toxicodendron radicans*
bayberry[4,6,7]	*Myrica pensylvanica*	post oak[2]	*Quercus stellata*
beach grass[5]	*Ammophila breviligulata*	Queen Anne's lace[6]	*Daucus carota*
black cherry[6]	*Prunus serotina*	rugosa rose[7]	*Rosa rugosa*
black gum[1]	*Nyssa sylvatica*	saltmeadow cordgrass[4]	*Spartina patens*
black oak[2]	*Quercus velutina*	saltwort[5]	*Salsola kali*
blackjack oak[2]	*Quercus. marilandica*	sandbur[5]	*Cenchrus spp*
broomsedge bluestem[6]	*Andropogon virginicus*	scrub oak	*Quercus berberidifolia*
camphorweed[7]	*Heterotheca subaxillaris*	seaside goldenrod[5,7]	*Solidago sempervirens*
chickweed[6]	*Stellaria spp.*	seaside spurge[5]	*Euphorbia polygonifolia*
coastal panicgrass[7]	*Panicum amarum*	shortleaf Pine[2]	*Pinus echinata*
common cocklebur[5]	*Xanthium strumarium*	smooth cordgrass[3,4]	*Spartina alterniflora*
common reed[4]	*Phragmites australis*	staghorn sumac[7]	*Rhus typhina*
common wormwood[5]	*Artemisia vulgaris*	spike grass[4]	*Distichlis spicata*
dandelion[6]	*Taraxacum officinale*	swamp magnolia[1]	*Magnolia virginiana*
eastern red cedar[4,6]	*Juniperus virginiana*	sweet gum[1]	*Liquidambar styraciflua*
glasswort[3]	*Salicornia virginica*	switch grass[4,6]	*Panicum virgatum*
gray birch[1]	*Betula populifolia*	trident maple[1]	*Acer buergerianum*
groundsel tree[4]	*Baccharis halimifolia*	Virginia creeper[7]	*Parthenocissus quinquefolia*
Jesuit's bark[4]	*Iva frutescens*	wild onion[6]	*Allium vineale*
marsh orach[3]	*Atriplex patula*	willow oak	*Quercus phellos*
mullein[6]	*Verbascum thapsus*	winged sumac[7]	*Rhus copallinum*
pitch pine[1,2]	Pinus rigida	yucca[7]	*Yucca* spp

[1]Atlantic White Cedar Swamp Community (Atlantic County 1973).
[2]Mixed Forest Community (Atlantic County 1973).
[3]Low Marsh Community (Somers Point City 1993, Ocean City 2009).
[4]High Marsh Community (Somers Point City 1993).
[5]Upland Beach Community (Somers Point City 1993, Ocean City 2009)
[6]Old Field (Somers Point City 1993).
[7]Beach Dune Community (Ocean City 2009)

The Oyster Creek study area encompasses several protected areas of barrier beaches and bay islands with undisturbed ecological communities. According to the Ocean County Comprehensive Master Plan (2018), the barrier beaches of Ocean County include significant undisturbed areas containing vegetation originally common to this type of barrier beach habitat such as low and high marsh, scrub-shrub wetlands, and vegetated dunes. These undisturbed areas are protected from development and include Island Beach State Park, the Holgate Unit of the Forsythe National Wildlife Refuge, and Barnegat Light State Park (**Figure 2.2.1-2**). The saline low marsh areas are generally dominated by cordgrass species (*Spartina* spp.) that are salt tolerant and adapted to daily tidal inundation. Areas further from the shoreline and higher in elevation are dominated by species more tolerant of dry conditions with lower salinity and shrubs (Barnegat Bay Partnership 2018).

Based on the available data, the barrier island within Island Beach State Park is dominated by several community types including barren beach, vegetated dunes, scrub/shrub wetlands, *Phragmites*-dominated wetlands, and saline low marsh communities. Habitat areas to the south of the park are limited by development on the barrier island but also include barren beaches and vegetated dune communities. Habitat communities on the mainland are dominated by *Phragmites*-dominated coastal wetlands and saline low marsh communities along the bay, and upland coniferous forests and forested wetlands (see below for additional details on wetlands) including Atlantic white cedar swamps in the western portions of the study area (NJDFW 2017b).

Atlantic white cedar swamps are prevalent in the western portion of the Oyster Creek study area along the riverine areas. This community is typically dominated by Atlantic white cedar surrounded by hummocks of sphagnum mosses (*Sphagnum* spp.) with wildflowers, grasses, sedges, rushes, and other species also present (Pinelands Reserve Alliance 2018). Coniferous and mixed forest communities are also present within the study area. In the Pinelands, these communities are typically dominated by oaks and pines (Pinelands Reserve Alliance 2018). Species found in the Oyster Creek study area are listed in **Table 2.2.1-2.**

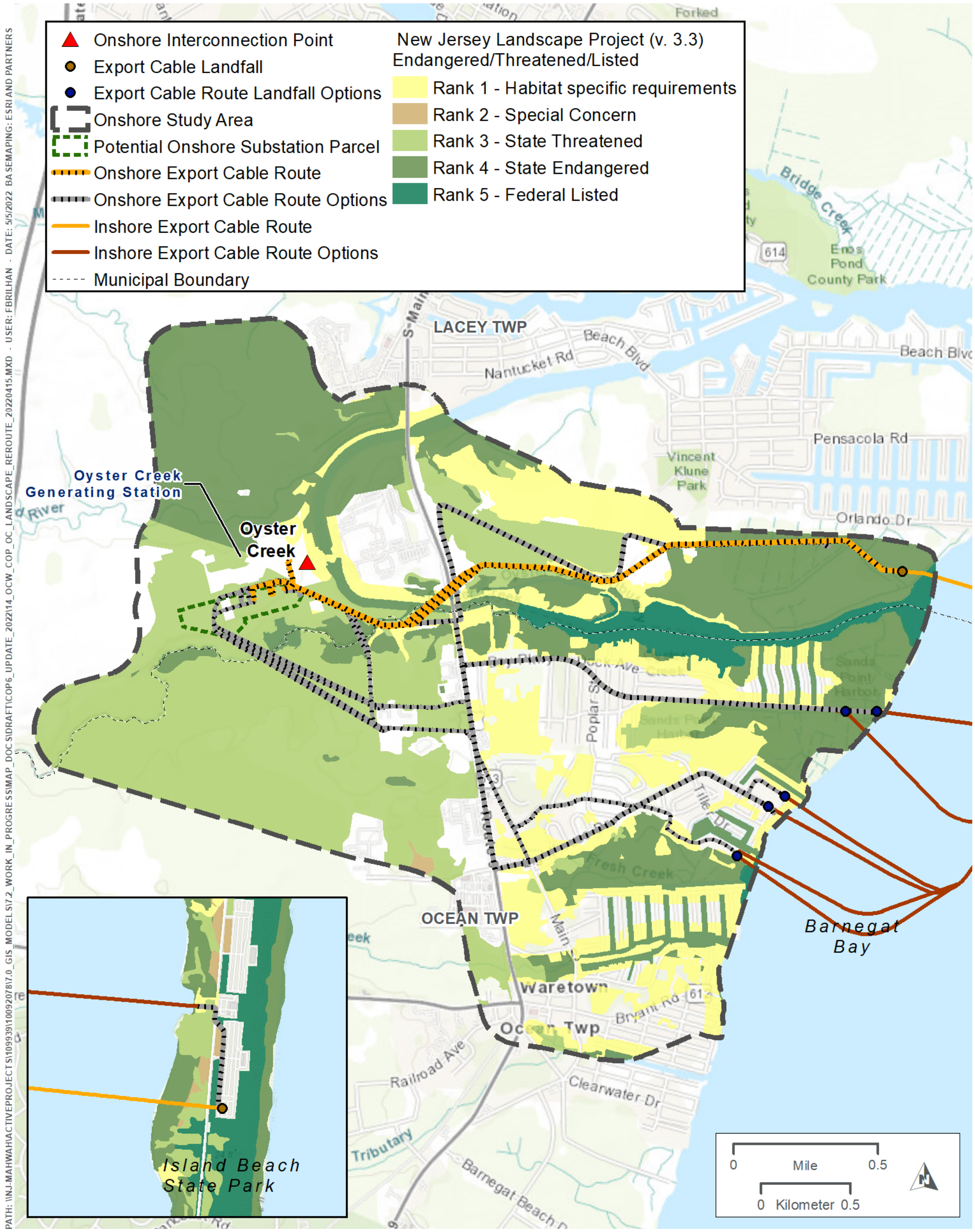

Figure 2.2.1-2. NJDEP Landscape Project data for the Oyster Creek study area.

Table 2.2.1-2. Common vegetation present in the Oyster Creek study area.

Common Name	Scientific Name	Common Name	Scientific Name
Atlantic white cedar[1]	*Chamaecyparis thyoides*	pine barrens heather[2]	*Hudsonia ericoides*
bayberry[5]	*Myrica pensylvanica*	pitch pine[2,5]	*Pinus rigida*
blackjack oak[2]	*Quercus. marilandica*	pitcher plants[1]	*Sarracenia spp*
blue huckleberry[2]	*Gaylussacia frondosa*	prickly pear[5]	*Opuntia compressa*
blueberry[2]	*Vaccinium vacillans*	saltmeadow cordgrass[3,4]	*Spartina patens*
bracken[5]	*Pteridium aquilinum*	saltmeadow rush[3,4]	*Juncus gerardii*
calico aster[5]	*Symphyotrichum lateriflorum (L.)*	scarlet oak[2]	*Quercus coccinea*
common reed[3,4]	*Phragmites australis*	scrub oak[2,5]	*Quercus ilicifolia*
dwarf huckleberry[2]	*Gaylussacia dumosa*	shortleaf Pine[2]	*Pinus echinata*
eastern red cedar[5]	*Juniperus virginiana*	smooth cordgrass[3]	*Spartina alterniflora*
fragrant goldenrod[5]	*Solidago odora*	Sphagnum mosses	*Sphagnum* spp.
glasswort[3]	*Salicornia virginica*	spike grass[4]	*Distichlis spicata*
golden false heather[5]	*Hudsonia ericoides*	stiff aster[5]	*Ionactis linariifolius*
grass-leaved goldenrod[5]	*Euthamia graminifolia*	sundews[1]	*Drosera spp*
gray birch[1]	*Betula populifolia*	swamp azalea[1]	*Rhododendron viscosum*
groundsel tree[4]	*Baccharis halimifolia*	swamp magnolia[1]	*Magnolia virginiana*
hawkweed[5]	*Hieracium sp*	sweet-fern[2]	*Comptonia peregrina*
highbush blueberry[1]	*Vaccinium corymbosum*	switch grass[5]	*Panicum virgatum*
Jesuit's bark[4]	*Iva frutescens*	Virginia pine[2]	*Pinus virginiana*
low blueberry[2]	*Vaccinium angustifolium*	white oak[2]	*Quercus alba*
mountain laurel[2]	*Kalmia latifolia*	white panicled aster[5]	*Aster simplex*
orchids[1]	*Orchidaceae*	willow[2]	*Quercus phellos*

[1]Atlantic White Cedar Swamp Community (Pinelands Preservation Alliance 2018).
[2]Mixed Forest Community (Pinelands Preservation Alliance 2018, Radis and Sutton 1991; as summarized in AmerGen 2005).
[3]Low Marsh Community (Barnegat Bay Partnership 2018, USFWS 1994).
[4]High Marsh Community (Barnegat Bay Partnership 2018, USFWS 1994).
[5]Old Field Community (USFWS 1994)

In 2005, AmerGen published an Environmental Report for the Oyster Creek Generating Station site. The site is situated in the northwestern portion of the Oyster Creek study area along Oyster Creek to the south of the Forked River. It is bisected by Route 9 and extends to Barnegat Bay. The portion of the site to the west of Route 9 contains the power facility and its related infrastructure, while the portion to the east of Route 9 is the former Finninger Farm. The former Finninger Farm tract is largely undeveloped and is comprised of approximately 650 acres of old field, abandoned orchards, forests, and wetlands. At the time of the study, the old fields were undergoing succession and vegetation ranged from native grasses to pines and small oaks, typical of coastal New Jersey. A large portion of the site near the mouth of Oyster Creek along Barnegat Bay consists of wetlands dominated by common reed (Radis and Sutton; as described in AmerGen 2005).

Herpetological Associates conducted surveys of the former Finninger Farm as part of a proposal to expand the Edwin B. Forsyth National Wildlife Refuge (USFWS 1994). This was one of eight sites surveyed adjacent to Barnegat Bay. The findings of the surveys documented tidal wetlands, oak/pine pine/oak uplands, and large areas of open fields, which were once part of the farm. This study noted that the tidal area is crossed by canals, contains mounds of dredge spoil, and the predominant vegetation consists of dense growths of common reed, with areas often densely overgrown with coastal shrubs. There was very little cordgrass remaining in this area. Wooded uplands were composed mainly of pitch pine and mixed oaks. The understory was a fairly uniform growth of shrubs. The old fields contained scattered pines and oaks with open sandy areas devoid of most vegetation. Ground cover consisted of such species as grasses and wildflowers. A small Atlantic white cedar swamp was located along the river at the northwest of the site. A large diked area on the western portion of the tract appeared to be a retention basin (USFWS 1994).

2.2.1.1.2 Wetlands

Readily available data was reviewed to identify wetlands within the Project Area. Wetland surveys have been completed for terrestrial portions of the Project (Appendix AC), with the exception of Oyster Creek alternatives west of Route 9 and alternatives associated with Lighthouse Drive, Nautilus Drive and Marina landfalls. Wetland surveys for the Oyster Creek onshore alternatives and landfall locations are being conducted during summer 2022. **Figure 2.2.1-3** shows the surveyed wetland areas in the Oyster Creek study area as compared to the areas not yet surveyed. BL England wetland surveys are complete. An updated Appendix AC will be provided once additional surveys are complete. Ocean Wind has also provided wetland survey information to, and coordinated with, NJDEP and USACE during Project permitting.

NJDEP and National Wetlands Inventory (NWI) wetland data were reviewed in the BL England study area. Estuarine wetlands are dominated by large contiguous swaths of tidal saline low marsh communities fringed by *Phragmites*. Tidal wetlands within the BL England study area are limited to areas adjacent to Roosevelt Boulevard and the Great Egg Harbor shoreline at the BL England generating station property. Freshwater wetlands are dominated by forested wetland communities. A large expanse of freshwater forested/shrub wetland is also identified within the Tuckahoe Wildlife Management Area found along the northwestern boundary of the BL England study area. NWI data is consistent with NJDEP data that shows estuarine and marine wetlands present along the backbays, major watercourses, and their tributaries. The NWI also identifies a large freshwater lake within the Tuckahoe Wildlife Management Area and several smaller freshwater lakes and ponds throughout the study area (**Figure 2.2.1-4**).

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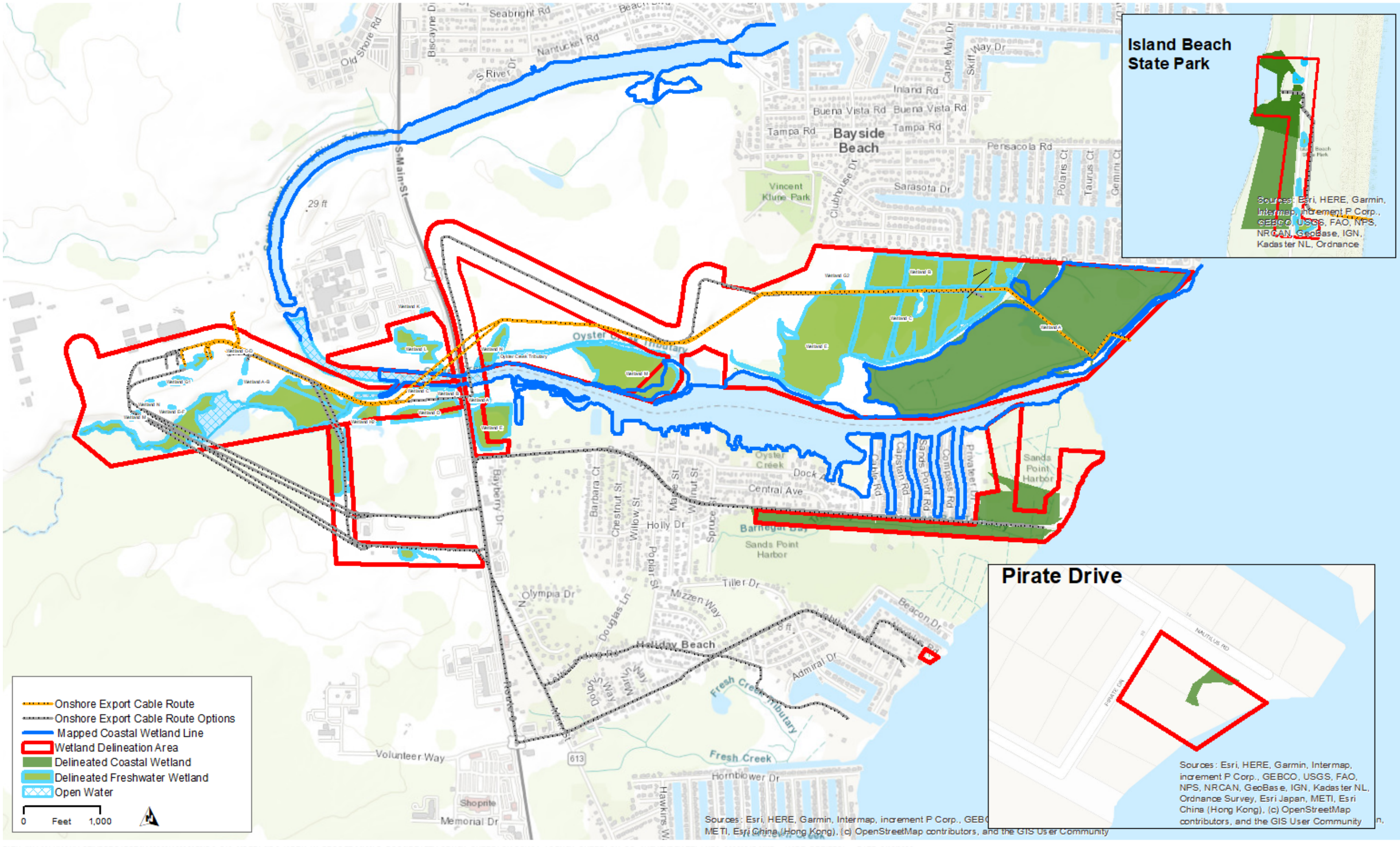

Figure 2.2.1-3. Surveyed wetland areas in the Oyster Creek study area.

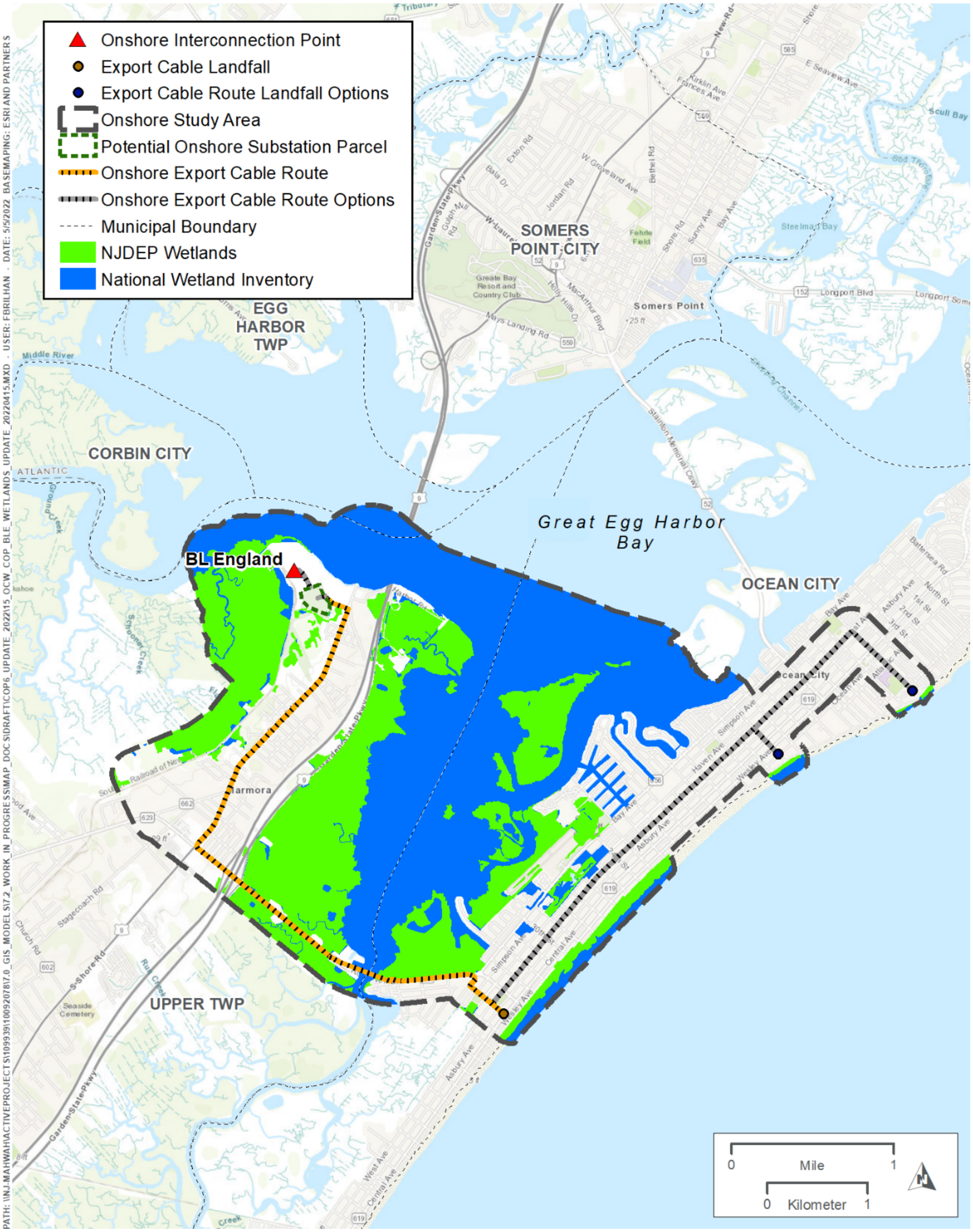

Figure 2.2.1-4. BL England study area NWI and NJDEP wetland data.

Based on the NJDEP and NWI wetland data, estuarine and freshwater wetlands are found within the Oyster Creek study area (**Figure 2.2.1-5**). According to NJDEP data, wetlands are concentrated along the Forked River, Oyster Creek, and their tributaries. Freshwater wetlands are dominated by forested wetlands with large areas of Atlantic white cedar wetlands, which are diminishing across the State and are protected from disturbance by the NJDEP. Tidal wetlands within the Oyster Creek study area are limited to areas adjacent to Barnegat Bay and the mouth of Oyster Creek and Forked River. A large area of low saline marsh dominates the area at the mouth of Forked River. Low saline marsh *Phragmites*-dominated coastal wetlands and scrub shrub wetlands dominate the area at the mouth of Oyster Creek.

2.2.1.1.3 Surface Waters

Readily available data was reviewed to identify streams, rivers, and waterways within the Project Area. Wetland surveys have been completed for terrestrial portions of the Project, with the exception of Oyster Creek alternatives west of Route 9 and alternatives associated with Nautilus Drive and Marina landfalls, which include site specific stream crossing surveys (Appendix AC). Ocean Wind has provided this survey information to, and coordinated with, NJDEP and USACE during Project permitting. Surface waters are described in Section 2.1.2. **Figures 2.2.1-6** and **2.2.1-7** show locations of streams in the BL England and Oyster Creek study areas.

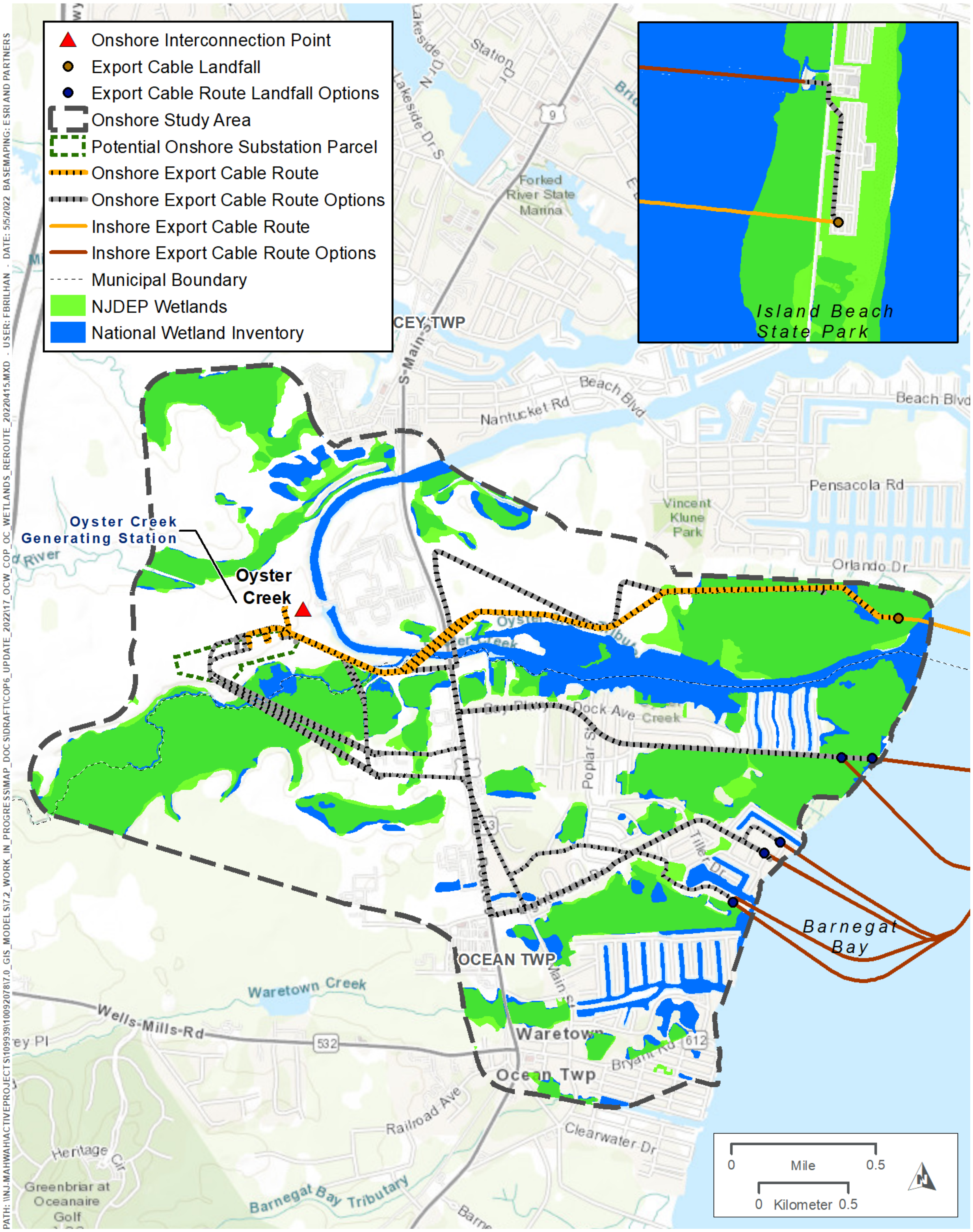

Figure 2.2.1-5. Oyster Creek study area NWI and NJDEP wetland data.

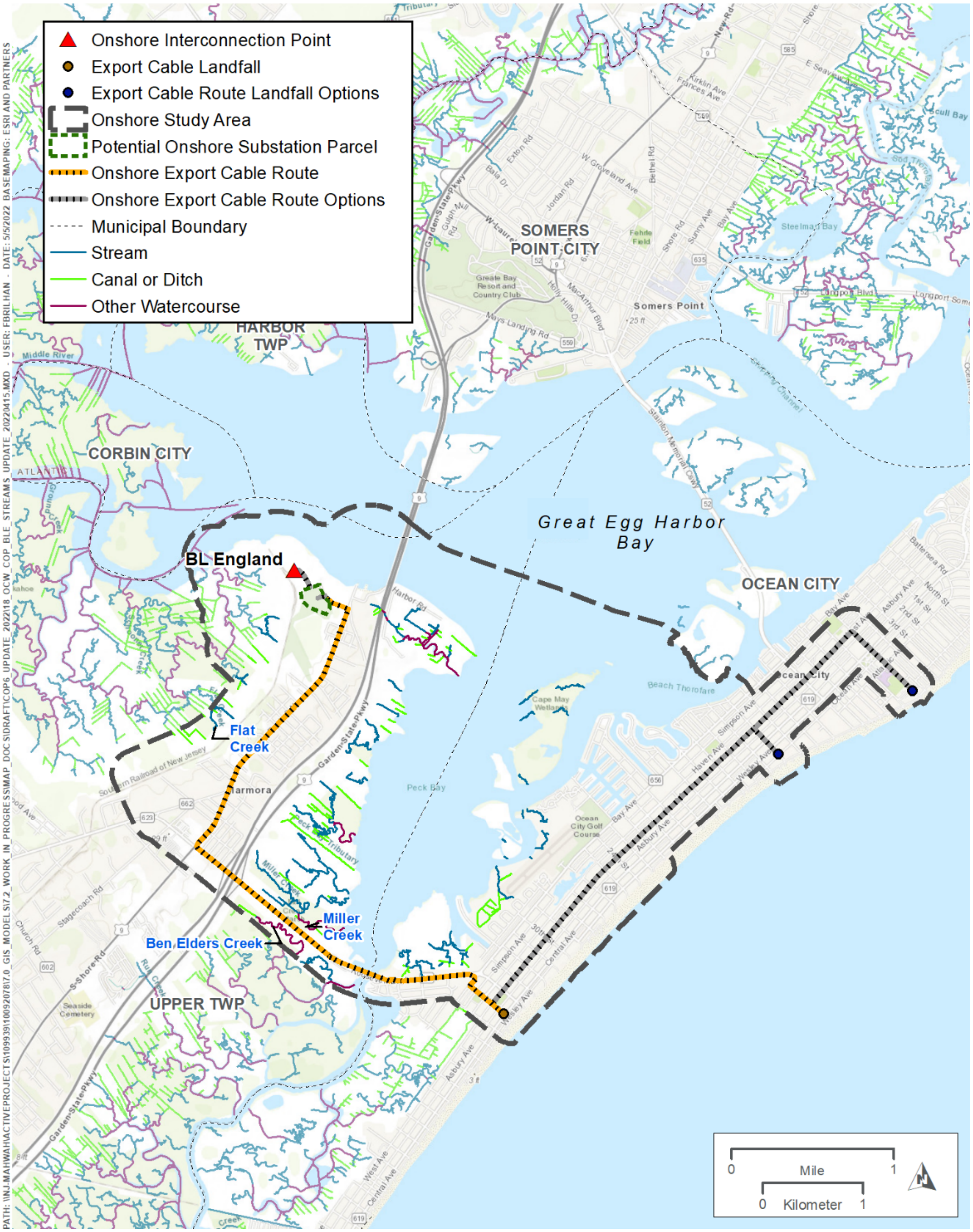

Figure 2.2.1-6. Streams in the BL England study area.

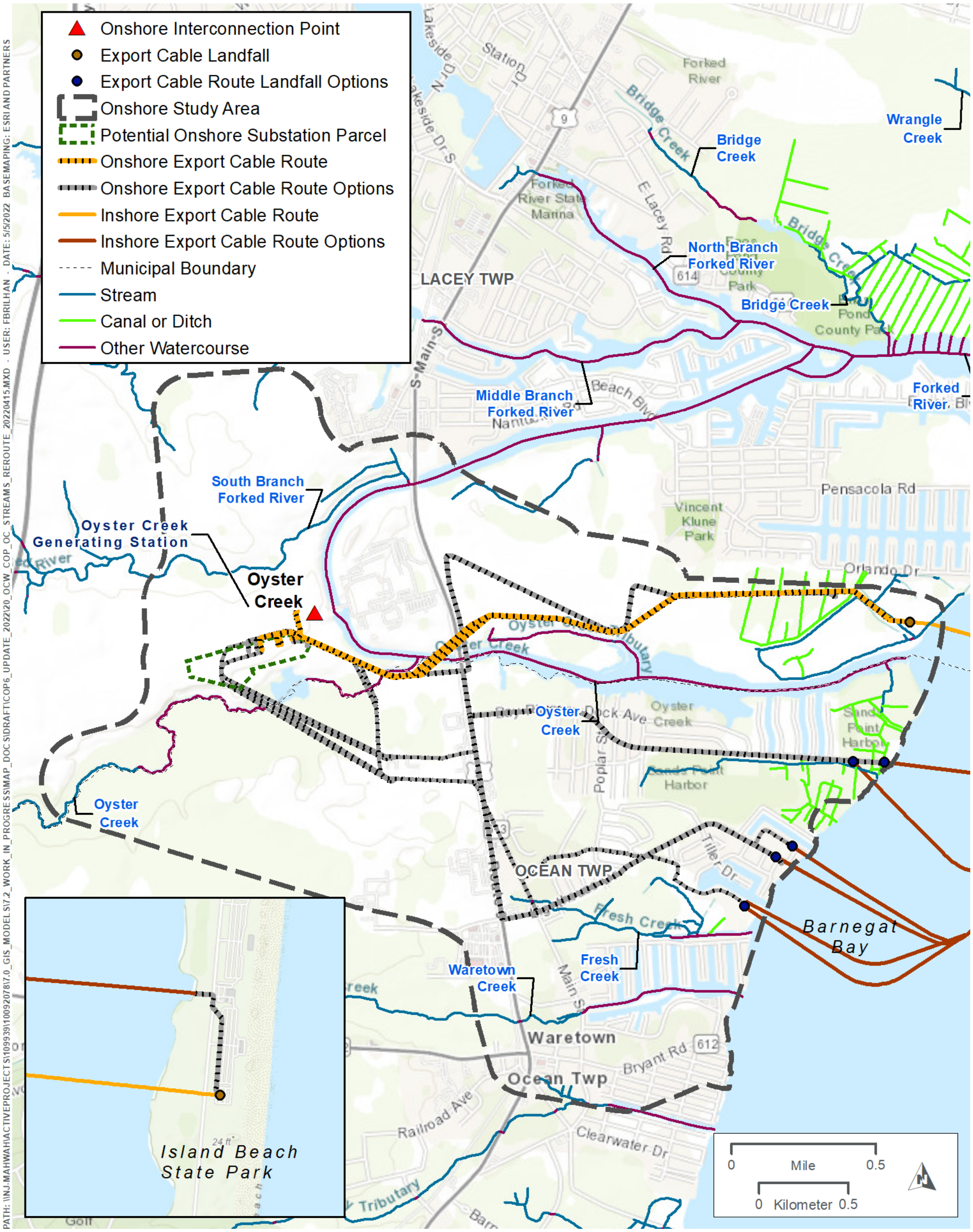

Figure 2.2.1-7. Streams in the Oyster Creek study area.

2.2.1.1.4 Floodplains

The effective Federal Emergency Management Agency (FEMA) maps for much of the northern portion of the BL England study area are dated from the 1980s. While these maps have been amended following Hurricane Sandy, no preliminary maps have been issued outlining new flood elevations. To the northeast of Atlantic City and in the vicinity of the Atlantic City International Airport, effective Flood Insurance Rate Map (FIRMS) were updated in 2018. The southwestern portion of the study areas west of the Great Egg Harbor River have updated effective maps from 2003 prior to Hurricane Sandy. The effective FIRMs were updated in 2017 only for the southeastern portion of the study area (FEMA 2018). Based on the effective maps available, the barrier beaches, bays and lagoons, as well as major watercourses and their tributaries are within the Zone A (100-year floodplain), Zone AE (100-year floodplain with base flood elevations), and Zone X (500-year floodplain). Zone VE (coastal zone subject to wave action) extends along the seaward and landward portions of the barrier island, and along the shorelines of Great Egg Harbor Bay.

For the BL England study area, the FEMA 1 percent annual Flood Elevations are: Zone VE (high velocity zone along the shoreline portion of the site) and Zone AE (wetlands, golf course, and wooded areas of the site). Much of the developed portion of the generating station is not within the regulated Flood Hazard Area; portions of the site lie within the Zone B/X500B (outside 500-year floodplain) where the annual chance of flooding is 0.2 percent or less (AECOM 2018).

The effective FEMA maps for the Oyster Creek study area are dated from 2006 prior to Hurricane Sandy. Following Sandy, preliminary FIRMs were developed in 2014 and early 2015 for this area. According to the preliminary maps, all of the areas around major watercourses and tributaries, as well as the lagoons along Barnegat Bay fall within the 100 and 500 year floodplains and are mapped as Zone A, Zone AE, and Zone X. Zone VE occurs along the ocean side of the barrier island, along the shorelines of Barnegat Bay and along major river corridors such as that of the North Branch Forked River (FEMA 2018).

2.2.1.1.5 Beaches and Dunes

There are many beaches along the New Jersey coastline. BOEM’s 2012 environmental impact statement for the lease issuance and site assessment activities off the mid-Atlantic states (BOEM 2012b) reports the following numbers of coastal beaches in the counties being considered: 69 in Cape May County, 48 in Atlantic County, and 84 in Ocean County.

Beach and dune communities are found within each onshore study area. These features are generally located along the barrier beach system along the Atlantic shoreline. Dune communities are protected under New Jersey’s Coastal Zone Management Program as they provide special protection from coastal storms. Additionally, many beach and dune communities are protected from development if they are located within State parks or wildlife refuges. In general, these communities are either barren or consist of dune grasses that protect the dune and assist in sand accretion.

2.2.1.1.6 Other Sensitive or Unique Habitats

The following managed and projected areas are found within the Project study areas. These areas provide habitat for a variety of terrestrial and coastal flora and fauna, including threatened or endangered and candidate species and sensitive biological communities. They also provide recreational opportunities for visitors and residents:

- New Jersey Pinelands Management Area;
- Marine Protected Areas (discussed in Section 2.2.6 Finfish and Essential Fish Habitat);
- Coastal Barrier Resources System;
- Coastal Area Facility Review Act Coastal Planning Areas;

- Natural Heritage Priority Sites;
- State Parks (discussed in Section 2.3.3 Recreation and Tourism);
- Refuges (discussed in Section 2.3.3 Recreation and Tourism);
- Preserves (discussed in Section 2.3.3 Recreation and Tourism); and
- Special Management Areas (discussed in Section 2.3.3 Recreation and Tourism).

Appendix Q contains Ocean Wind's Coastal Zone Consistency review for the Project.

New Jersey Pinelands Management Areas

The New Jersey Pinelands Commission is an independent State agency whose mission is to "preserve, protect, and enhance the natural and cultural resources of the Pinelands National Reserve, and to encourage compatible economic and other human activities consistent with that purpose." (State of New Jersey Pinelands Commission 2018). To accomplish its mission, the Commission implements a comprehensive plan that guides land use, development, and natural resource protection programs in the 938,000-acre Pinelands Area of southern New Jersey (State of New Jersey Pinelands Commission 2018). The Pinelands Comprehensive Management Plan establishes nine land use management areas with goals, objectives, development intensities, and permitted uses for each.

There are three Pinelands management areas mapped within the Oyster Creek and BL England study areas including the following categories:

- Rural Development Area;
- Regional Growth Area; and
- Forest Area.

Coastal Barrier Resources System

The Coastal Barrier Resources Act (CBRA) protects coastal areas that serve as barriers against wind and tidal forces caused by coastal storms, and serve as habitat for aquatic species. The CBRA designated relatively undeveloped coastal barriers along the Atlantic and Gulf coasts as part of the John H. Chafee Coastal Barrier Resources System (CBRS) (**Figure 2.2.1-8**; BOEM and NOAA 2018). The CBRA encourages the conservation of hurricane prone, biologically rich coastal barriers by restricting Federal expenditures that encourage development (BOEM and NOAA 2018). Two CBRS are mapped within the Oyster Creek and Offshore study area: Island Beach Unit NJ-05P and Brigantine Unit NJ-07P (**Figure 2.2.1-8**). No CBRS are found within the BL England study area.

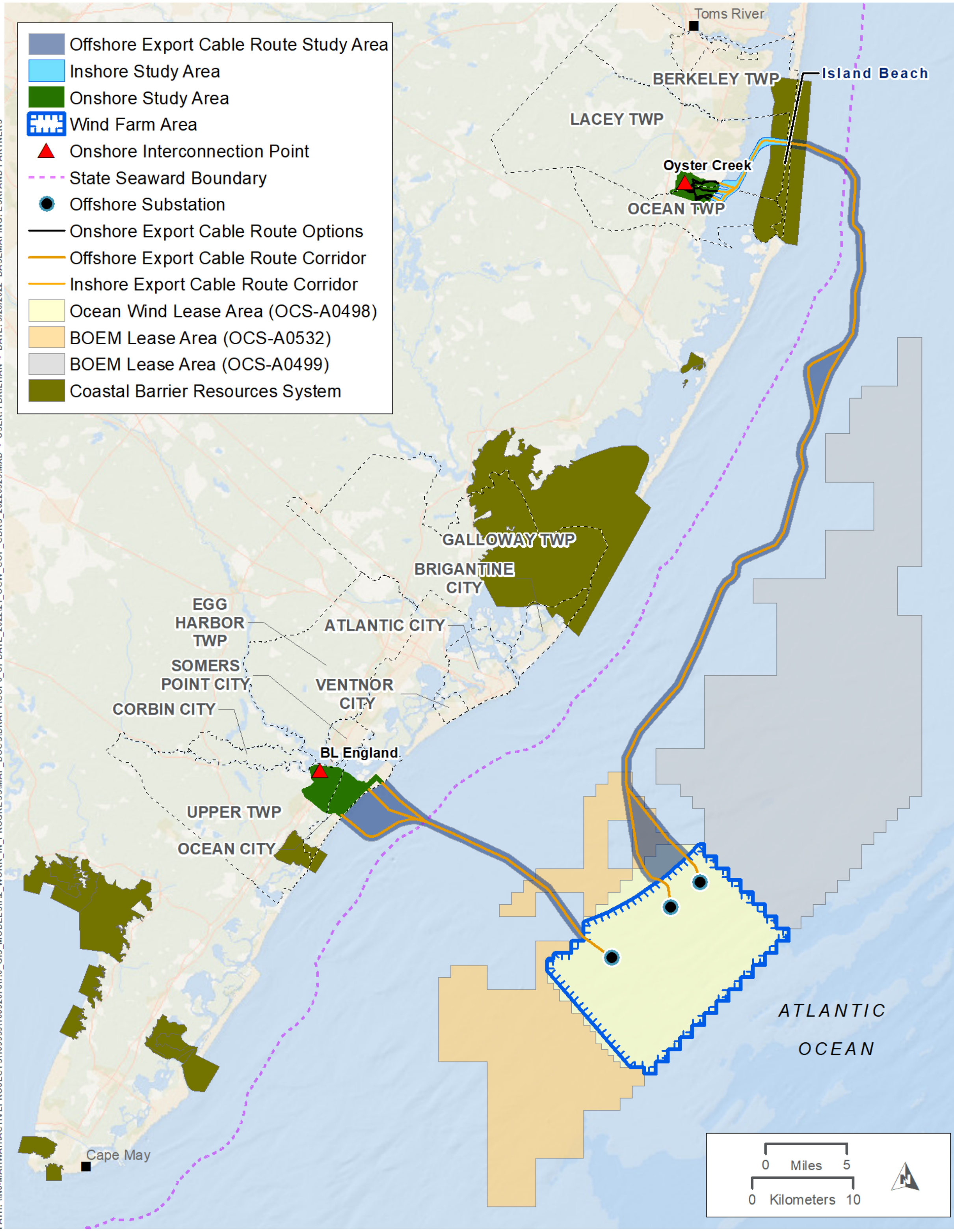

Figure 2.2.1-8. Protected areas - Coastal Barrier Resources System (CBRS).

Natural Heritage Priority Sites

Natural Heritage Priority Sites identify critically important areas to conserve New Jersey's biological diversity, with particular emphasis on rare plant species and ecological communities. These sites are designated based on analysis of information in the New Jersey Natural Heritage Database; however, they do not cover the entire known habitat for endangered and threatened species in New Jersey (NJDEP and ONLM 2007).

Several Natural Heritage Priority Sites have been designated within the study areas. These sites are outlined in **Table 2.2.1-3**.

Table 2.2.1-3. Summary of Natural Heritage Priority Sites within the study areas.

Site Name	Study Area	Description
Forked River Mountain Macrosite	Oyster Creek	Consists of several small dwarf pine plains (<150 acres) communities, up to 1,000+ acres of transitional pine plains, and several small occurrences of hydric pine plains. Most of the plains are in the vicinity of Forked River Mountain. The site contains a globally imperiled pine plains natural community.
Pits and Pond		Consists of two borrow pits and mowed pipeline right-of-way (ROW) through pitch pine lowland forest. The site contains four globally rare plant species, two of which are State endangered, and one of which is also Federally threatened.
Forked River Pond		Small pond located within the ecotone between Atlantic white cedar swamp and salt marsh. Two State listed endangered plant species and several plant species of special concern.
Middle Branch Forked River		Open wetlands adjacent to pine barren stream through Atlantic white cedar swamp. Several globally rare and State listed plant species.
Island Beach Macrosite		Large expansive beaches, dunes and wetlands on and adjacent to Island Beach State Park and on the northern tip of Long Beach Island. The site contains populations of several globally rare and State rare endangered and threatened animals, plants, and natural communities.
Longport	BL England	Tidal salt marsh land near the mouth of Great Egg Harbor Inlet with some sand beach habitat along southern portion of the Island. Contains a globally rare State endangered bird species and several other State imperiled bird species. It is among the top 20 migratory bird concentration sites in the nation.
Bill Henry Pond		A large (5-acre) coastal plain intermittent pond surrounded by undeveloped pine-oak forest. Good quality globally rare natural community and several globally rare or State significant plant species.

The Natural Heritage Program along with USFWS also lists threatened and endangered plant species as occurring within the study areas. These species are outlined in **Table 2.2.1-4** below.

Table 2.2.1-4. Summary of threatened and endangered plant species within the Study Areas.

Species Common	Species Scientific	Status	Study Area	
			Oyster Creek	BL England
Plants				
American chaffseed	*Schwalbea Americana*	FE		X
Knieskern's beaked-rush	*Rhynchospora knieskernii*	FT, SE	X	X
Seabeach amaranth	*Amaranthus pumilus*	FT, SE	X	X
Sensitive joint-vetch	*Aeschynomene virginica*	FT		X
Swamp pink	*Helonias bullata*	FT, SE	X	X

Status: FT - Federally Threatened, FE - Federally Endangered, SE - State Endangered, ST - State Threatened

2.2.1.2 Potential Project Impacts on Terrestrial and Coastal Habitats

The following section describes the potential impacts on terrestrial and coastal habitats from the Project during construction, operation and maintenance, and decommissioning for the onshore components of the project, including the cable landfall, TJBs, onshore export cables, and onshore substations at BL England and Oyster Creek. Potential impact producing factors that may affect terrestrial and coastal habitats include:

- Physical seabed/land disturbance
- Habitat conversion
- Discharges/releases and withdrawals
- Sediment suspension

Coastal habitats extend from mean high water to 3 miles offshore, and sediment suspension is addressed in Sections 2.2.5.2 Benthic Resources and 2.2.6.2 Finfish and EFH.

2.2.1.2.1 Construction

Onshore coastal and terrestrial habitats may experience temporary or permanent impacts from construction activities, including clearing and grading, trenchless cable installation, open trench excavation, onshore substation construction, and equipment and construction staging. The sections below detail these potential impacts as well as the avoidance and mitigation measures that Ocean Wind will adopt to minimize these potential impacts.

Offshore Export Cable Landfall

Cable landfall is the transition from submarine cable to onshore cable, which would require connections at TJBs at the BL England and Oyster Creek landfall sites. Cable installation at the landfall sites would be made using open cut (i.e., "trenching") and/or trenchless technologies such as HDD or direct pipe and would have temporary short-term impacts on onshore coastal and terrestrial habitats. Impacts related to soil disturbance are summarized above in Section 2.1.1.2.1.

For Oyster Creek, potential landfalls include existing road ROW, previously disturbed areas, and wetlands. BL England potential landfalls include road ROW, industrial areas, and previously disturbed areas. Workspace for TJBs, open trench installation, and potential areas of impact from trenchless installation operations are detailed in Section 6 of Volume I.

Preparation of the ROW and landfall workspace would require clearing of vegetation which would result in temporary and permanent upland and wetland habitat alteration. Within wetlands, the primary impacts would be excavation, rutting, compaction, mixing of topsoil and subsoil, and the potential alteration of habitat due to clearing at HDD entry pit locations. Long term temporary changes from wooded to herbaceous wetlands could occur if clearing is required in wooded wetlands. Loss of wetland habitat could occur if permanent placement of fill is required in wetlands. Following installation of export cables within wetlands, surface grades would be restored to previous conditions in areas of temporary impact and soils would be decompacted as needed to avoid long term impacts to soils and hydrology.

Based on NJDEP's wetland mapping and indicative cable route options as described in Volume I of this COP, approximately 0.53 and 20.04 acres of temporary wetland impacts could potentially occur as a result of cable burial at BL England and Oyster Creek, respectively. Of these totals, 0.35 acres of *Phragmites*-dominated coastal wetlands and 0.18 acres of saline low marsh may be temporarily impacted at BL England. At Oyster Creek, approximately 2.54 acres of impacts may occur to saline high marsh (**Table 2.2.1-5**).

In order to calculate the maximum wetland impacts, in accordance with the PDE, Ocean Wind first calculated wetland impacts, by NJDEP wetland type, for each indicative route using the 50-ft wide corridor and the workspace. Then, Ocean Wind selected the indicative route which had the highest wetland impact, for each wetland type. For example, the Farm Property was the only route with impacts to Mixed Scrub/Shrub Wetlands (Deciduous) so for that wetland type, Ocean Wind used the impacts associated with the Farm Property Route for inclusion in **Table 2.2.1-5**. The Nautilus route would result in the highest impact to Mixed Wooded Wetlands (Deciduous), so Ocean Wind used the impacts associated with the Nautilus route for inclusion in **Table 2.2.1-5**. The same process was used for Table 2.2.1-6 using NWI wetland types.

Finally, Ocean Wind added additional workspace to those wetland types where required. Additional workspace for Oyster Creek was added for the Farm property landfall workspace, the workspace at IBSP surrounding the maintenance area, and between the parking lot and the road. Additional workspace for landfall at Bay Parkway, Lighthouse Drive, Nautilus Drive, and for potential HDD areas west of Route 9 were reviewed and wetland overlap added as applicable. Impacts were considered long term and permanent for forested wetland types. For BL England there were no differences between the routes. No additional workspace was included as landfall and associated laydown will not result in impacts to wetlands.

Based on NWI's wetland mapping and indicative cable route options as described in Volume I of this COP, approximately 1.21 and 12.93 acres of temporary wetland impacts could potentially occur as a result of cable burial at BL England and Oyster Creek, respectively (**Table 2.2.1-6**). In terms of long-term impacts or permanent habitat alteration of wetlands, neither NJDEP or NWI wetlands are anticipated to be affected permanently at BL England. Approximately 1.02 acres of NJDEP wetlands and 4.81 acres of NWI wetlands may experience long-term or permanent affects at Oyster Creek.

These wetland communities are assumed to be areas that lie below mean high water. Following construction, these areas would be restored to pre-existing conditions, and herbaceous vegetation would become reestablished. The permanent ROW around the TJBs would be maintained in an herbaceous state during the operational life of the project. An access cover would be placed over TJBs to allow future access for maintenance. If the TJBs are located within a vegetated area, habitat will be permanently lost in the area of the permanent access cover. Recovery timeframes for wetlands would vary depending on the habitat type in the wetland and the nature of the impacts. Herbaceous wetlands are expected to recover within one to three growing seasons and shrub/scrub wetlands within three to five growing seasons. Wooded wetlands within temporary workspace are expected to take more than five years to recover to pre-construction conditions and wooded wetlands within the permanent easement would be permanently converted to herbaceous or shrub/scrub wetlands. Work within wetlands and wetland restoration would be done in accordance with applicable NJDEP permit requirements.

Habitat assessments have been conducted in conjunction with wetland delineation surveys where necessary to minimize impacts to sensitive habitats and potential threatened and endangered vegetation species. An assessment of the ecological communities was conducted by mapping and classifying the dominant wetlands and deepwater habitat types as defined by Cowardin et al. (1979) within the wetland review areas (WRA). The upland communities within the WRAs were mapped based on the observed dominant plant species and size of trees where applicable. Additionally, incidental wildlife species observations were documented. Habitat assessments have been completed to facilitate avoiding sensitive areas, including wetlands. The wetland delineation reports, including functional assessments, are included in Appendix AC.

Table 2.2.1-5. Summary of wetland impacts along indicative onshore export cable routes by NJDEP wetland community type within the study areas.

Onshore Export Cable Route	NJDEP Wetland Community Type	Acres of Temporary Impact	Impact Breakdown by Route and Workspace	Duration	Acres of Long Term or Permanent Habitat Alteration
BL England	*Phragmites* dominate coastal wetlands	0.35	All routes the same	Short term 1-3 years	N/A
	Saline marsh (low marsh)	0.18	All routes the same	Short term 1-3 years	N/A
Oyster Creek	Deciduous scrub/shrub wetlands	1.53	Farm Property Reroute 0.65 Farm Property Workspace 0.77 IBSP Clearing Easement 0.12	Short term 3-5 years	N/A
	Deciduous wooded wetlands	0.96	Farm Property Reroute 0.96	Long term More than 5 years	0.96
	Herbaceous wetlands	0.08	Farm Property 0.08	Short term 1-3 years	N/A
	Mixed scrub/shrub wetlands (coniferous dom.)	0.81	Farm Property Reroute 0.81	Short term 3-5 years	N/A
	Mixed scrub/shrub wetlands (deciduous dom.)	1.55	Farm Property 1.01 IBSP Clearing Easement 0.54	Short term 3-5 years	N/A
	Mixed wooded wetlands (coniferous dom.)	0.87	Nautilus Drive Alternative 0.65 Bay Parkway South Alternative 0.22	Long term More than 5 years	0.87

Onshore Export Cable Route	NJDEP Wetland Community Type	Acres of Temporary Impact	Impact Breakdown by Route and Workspace	Duration	Acres of Long Term or Permanent Habitat Alteration
	Saline marsh (high marsh)	2.54	Bay Parkway 0.03 Farm Property workspace 2.50	Short term 1-3 years	N/A
	Saline marsh (low marsh)	2.72	Bay Parkway 0.03 Bay Parkway South workspace 2.69	Short term 1-3 years	N/A
	Phragmites dominate coastal wetlands	4.37	Farm Property Workspace 4.37	Short term 1-3 years	N/A
	Vegetated Dune Communities	0.53	IBSP Clearing Easement 0.53	Short term 3-5 years	N/A
	Atlantic White Cedar Wetlands	2.39	Nautilus Drive route 0.78 Bay Parkway South HDD workspace west of Route 9: 1.62	Long term More than 5 years	2.39
	Coniferous Scrub/Shrub Wetlands	0.40	Nautilus Drive Alternative 0.40	Short term 3-5 years	N/A
	Coniferous Wooded Wetlands	0.42	Marina Alternative 0.42	Long term More than 5 years	0.42
	Disturbed Tidal Wetlands	0.05	Marina Alternative workspace 0.05	Short term 1-3 years	N/A
	Managed Wetland in Built-up Maintained Recreation Area	0.48	Marina Alternative 0.48	Short term 1-3 years	N/A
	Mixed Wooded Wetlands (Deciduous)	0.34	Bay Parkway South Alternative 0.31 Bay Parkway South workspace 0.02	Long term More than 5 years	0.34

Note: Wetland surveys have been completed for terrestrial portions of the Project with the exception of Oyster Creek alternatives west of Route 9 and alternatives associated with Nautilus Drive amd Marina landfalls. Permanent and temporary impacts will be updated once the survey reporting is complete and will be coordinated with the State and Federal agencies during permitting.

Table 2.2.1-6. Summary of wetland impacts along indicative onshore export cable routes by NWI wetland community type within the study areas.

Onshore Export Cable Route	NWI Wetland Community Type	Acres of Temporary Impact	Impact Breakdown by Route and Workspace	Duration	Acres of Long Term or Permanent Habitat Alteration
BL England	Estuarine and Marine Deepwater	0.72	5 Street Alternative 0.72	Short term 1-3 years	N/A
	Estuarine and Marine Wetland	0.49	5 Street Alternative 0.49	Short term 1-3 years	N/A
Oyster Creek	Estuarine and Marine Deepwater	0.29	Farm Property 0.22 Farm property workspace 0.06	Short term 1-3 years	N/A
	Estuarine and Marine Wetland	7.35	IBSP clearing 0.25 Bay Parkway 0.18 Holtec Property workspace 6.92	Short term 1-3 years	N/A
	Freshwater Forested/Shrub Wetland	4.81	IBSP clearing 0.95 Holtec Property 3.14 Bay Parkway South 1.43	Long Term 3 to greater than 5 years	4.81
	Riverine	0.05	Lighthouse 0.05	Short term 1-3 years	N/A
	Freshwater Emergent Wetland	0.29	Marina Alternative 0.29	Short term 1-3 years	Freshwater Emergent Wetland
	Freshwater Pond	0.14	Nautilus Drive Alternative	Short term 1-3 years	Freshwater Pond

Note: Wetland surveys have been completed for terrestrial portions of the Project with the exception of Oyster Creek alternatives west of Route 9 and alternatives associated with Nautilus Drive and Marina landfalls. Permanent and temporary impacts will be updated once the survey reporting is complete and will be coordinated with the State and Federal agencies during permitting.

Construction laydown areas will be located in previously disturbed areas where possible. Within wetlands, the primary impacts would be excavation, rutting, compaction, mixing of topsoil and subsoil, and the potential alteration of habitat due to clearing at HDD entry pit locations. Loss of wetland habitat could occur if permanent placement of fill is required in wetlands. NJDEP-regulated adjacent transition areas may also be affected by clearing and soil disturbance. An Inadvertent Return Plan will be developed and used during trenchless cable installation as indicated in **Table 1.1-2**.

Water quality within wetlands and streams could be affected by stream bed disturbance, sedimentation from nearby exposed soils, or inadvertent spills of fuel or chemicals. Ocean Wind would use erosion and sedimentation controls and BMPs and will develop and implement a SWPPP to avoid and minimize water quality impacts during onshore construction. Additionally, during onshore construction, dewatering may be required. BMPs would be used during discharge of water, such as energy dissipation devices and erosion and sediment controls. Dewatering activities would be temporary, short-term, and water drawdown would be minimal. Discharges and releases will be managed using the Oil Spill Response Plan. For additional discussion regarding potential Project impacts to water quality, see Section 2.1.2.2.

Onshore Export Cable

Onshore export cables would carry electricity from the TJBs at landfall to the substations and would be collocated with existing ROWs to the extent practicable. The onshore export cables would be installed primarily via typical trenching and open cut methods. Cables would be installed in sections, and sections would be joined within joint bays (i.e., manholes). Manholes would be similar in function to the TJBs described above for landfall, but smaller. They would be required along the onshore export cable route, would be buried, and the overlying surface would be restored following installation and jointing. Trenchless technology options may be used along portions of the onshore export cable routes to avoid impacts to wetlands, surface water crossings, or other sensitive and unique habitats.

Impacts associated with installation of the onshore export cables would be similar to those described above for cable landfall, however, they would affect a longer route than landfall construction activities. Cable installation would require permanent ROW and temporary workspace along onshore export cables. Although preparation activities for installation, including clearing, will result in a greater area of soil disturbance, any specific area will only be affected for a short period, and will be restored when installation is complete in that area. Soil disturbance would have the same short-term, temporary impacts as described above. Additionally, reestablishment of vegetation would be similar to that described for landfall. Habitat along the onshore export cables would be similar to habitat found at landfall sites; therefore, impacts would be similar to those described for landfall. Impacts to wetlands, NJDEP-regulated adjacent transition areas, and streams are described under landfall. Habitat assessments have been conducted where necessary to minimize impacts to sensitive habitats and potential threatened and endangered vegetation species. Community types include deciduous wooded and scrub/shrub wetlands, herbaceous wetlands, and mixed scrub/shrub wetlands dominated by both deciduous and coniferous species (**Table 2.2.1.5**).

Limited sections of the onshore export cable corridors would be located in or along roadways that intersect FEMA-mapped 100-year or 500-year floodplains. Impacts within floodplains will be temporary and short-term during construction.

Overall impacts associated with construction of the onshore export cable will result in short-term localized temporary impacts to coastal and terrestrial habitats as the routes were sited within existing ROW to the extent practicable. For Oyster Creek, there is one route option that is sited within berms and previously disturbed areas in wetlands. This route option would follow existing cleared trails where practicable and may require some clearing of woody vegetation resulting in potential long-term impacts to wetlands and would be restored and mitigated as required.

Onshore Substations

Construction of the onshore substations would result in temporary and permanent impacts to habitat from construction of the permanent substation facilities and use of temporary construction workspace. Construction of the onshore substation would require a permanent site, including area for the substation equipment and buildings, equipment yards, energy storage, stormwater management, a parking area, access road, and landscaping. During construction, additional areas will be required for temporary workspace.

Construction at the onshore substation will begin with installation of fencing around the construction workspace and a security gate, site preparation, and site access. Site preparation will include installation of erosion and sediment controls, clearing and grading, installation of a gravel layer, and excavation for foundation installation. Site access will require the installation of an access road. Foundations will be installed, and equipment would be delivered and installed on pre-installed foundations. Buswork and ductwork for electrical connections would be installed. Cables and control equipment would be installed, and electrical connections would be completed. Additional information regarding onshore substations can be found in Section 6 of Volume I.

Impacts to habitat are generally similar to those described above for landfall. The existing habitat at the proposed onshore substation sites at BL England and Oyster Creek is already developed and fragmented. Any remnant habitat within the permanent substation site will be converted to developed land with landscaping for the duration of the project's operational lifetime. Landscaped areas will provide some habitat for species acclimated to human activity. The substation sites have been selected within already disturbed and developed areas to minimize impacts to habitat. Permanent and temporary workspace for substation construction will be sited to avoid streams, floodplains, and wetlands to the extent practicable. Depending on the site selected, it may be necessary to locate an access road within these resources. Habitat assessments have been conducted where necessary to minimize impacts to sensitive habitats and potential threatened and endangered vegetation species.

2.2.1.2.2 Operations and Maintenance

During regular operations and maintenance activities, additional impacts to coastal and terrestrial resources is not anticipated. If cable inspection and repair operations are needed, additional impacts may be associated with clearing and excavating and may result in additional land disturbance. These impacts would be localized and temporary.

2.2.1.2.3 Decommissioning

During decommissioning activities, impacts to coastal and terrestrial habitats would be expected to be similar to construction operations discussed above. Impacted areas would be restored.

2.2.1.2.4 Summary of Potential Project Impacts on Terrestrial and Coastal Habitats Resources

The IPFs affecting terrestrial and coastal habitats include physical seabed/land disturbance, discharge/releases and withdrawals, and habitat conversion.

The onshore substation facilities will result in permanent impacts to previously disturbed habitat, and where tree clearing is required, habitat will be converted to non-forested. Other impacts to terrestrial and coastal habitats are expected to be localized, temporary and short-term with the application of APMs. Onshore coastal and terrestrial habitats may experience temporary disturbance from construction and installation activities, including clearing and grading, trenchless cable installation, open trench excavation, onshore substation construction, equipment and construction staging and potential contamination from spills.

2.2.1.3 Avoidance, Minimization, and Mitigation Measures

The proposed measures for avoiding, minimizing, reducing, eliminating, and monitoring environmental impacts for the Project are presented in **Table 1.1-2**.

2.2.2 Terrestrial and Coastal Fauna

This section addresses impacts to terrestrial and coastal wildlife species that are located at the Project's onshore facilities. Terrestrial and coastal habitats are discussed in Section 2.2.1. Birds and bats are discussed in Sections 2.2.3 and 2.2.4, respectively.

2.2.2.1 Affected Environment

New Jersey hosts a diversity of wildlife habitats. Species distribution across the State is reflective of this diversity. The species that are mentioned in this section are known to commonly occur in the Onshore study areas.

The wildlife found within the BL England study area are summarized in **Table 2.2.2-1** and are typical of coastal areas of New Jersey (Atlantic County 1973 and Ocean City 2009).

Table 2.2.2-1. Species potentially present in the BL England study area.

Name	Scientific Name	Common Name	Scientific Name
black snake[3]	*Pantherophis obsoletus*	meadow vole[1,2,3]	*Microtus pennsylvanicus*
bobcat[2]	*Felis refus*	mink[1]	*Neovison vison*
bog lemming[1]	*Synaptomys cooperi*	moles[2]	*Scalopus aquaticus*
bog turtle[1]	*Glyptemys muhlenbergii*	muskrat[3]	*Ondatra zibethicus*
box turtle[3]	*Terrapene carolina carolina*	northern scarlet snake[2]	*Cemophora coccinea copei*
brown bat[2]	*Myotis lucifugus*	Norway rat[2,3]	*Rattus norvegicus*
chipmunk[2,3]	*Tamias striatus*	opossum[2,3]	*Didelphis virginiana*
corn snake[2]	*Pantherophis guttatus*	Pine Barrens tree frog[2]	*Hyla andersonii*
cottontail rabbit[1,2,3]	*Sylvilagus floridanus*	porcupine[2]	*Erethizon dorsatum*
deer mouse[2]	*Peromyscus maniculatus*	raccoon[1,2,3]	*Procyon lotor*
diamondback terrapin[3]	*Malaclemys terrapin*	red fox[1,2,3]	*Vulpes vulpes*
eastern spiny softshell[1]	*Apalone Spinifera*	red squirrel[2]	*Tamiasciurus hudsonicus*
eastern tiger salamander[1]	*Ambystoma tigrinum*	rice rat[1]	*Oryzomys palustris*
flying squirrel[2]	*Glaucomys volans*	river otter[3]	*Lontra canadensis*
Fowler's toad[3]	*Anaxyrus fowleri*	shrew[2]	*Blarina brevicauda*
garter snake[2]	*Thamnophis sirtalis*	skunk[2]	*Mephitis mephitis*
gray tree frog[2]	*Hyla chrysoscelis*	spring peeper[3]	*Pseudacris crucifer*
gray fox[2]	*Urocyon cinereoargenteus*	timber rattlesnake[2]	*Crotalus horridus*
gray squirrel[2,3]	*Sciurus carolinensis*	weasel[1,2]	*Mustela frenata*
ground skink [2]	*Scincella lateralis*	white-footed mouse[2]	*Peromyscus leucopus*
house mouse[2,3]	*Mus musculus*	whitetail deer[1,2,3]	*Odocoileus virginianus*
meadow mouse[2]	*Microtus pennsylvanicus*		

[1]Wildlife documented within cedar and hardwood swamp communities (Atlantic County 1973).
[2]Wildlife documented within lowland and upland forest communities (Atlantic County 1973).
[3]Wildlife documented in Ocean City (Ocean City 2009).

The vegetation communities in the Oyster Creek study area described in Section 2.2.1 provide a wide range of habitats available for many terrestrial species. Several localized wildlife surveys and resource inventories have been completed in the Oyster Creek study area, as described above. The surveys identify characteristic species that can be found in similar habitats in the Oyster Creek study area. Wildlife expected to be present along the onshore export cable corridor or at the onshore substation construction in the Oyster Creek study area include species known to inhabit forested wetland, forested lowland and upland habitats and pinelands, while wildlife expected to be present along the cable landfall sites in the Oyster Creek study area include species known to inhabit coastal wetland, barrier beaches, and bay island habitats (**Table 2.2.2-2**).

Table 2.2.2-2. Species potentially present in the Oyster Creek study area.

Common Name	Scientific Name	Common Name	Scientific Name
American bittern	American bittern	northern diamondback terrapin	*Malaclemys terrapin*
eastern chipmunk	*Tamias striatus*	northern harrier	*Circus hudsonius*
eastern cottontail	*Sylvilagus floridanus*	northern pine snake*	*Pituophis melanoleucus*
eastern hognose snake	*Heterodon platirhinos*	osprey	*Pandion haliaetus*
eastern meadowlarks	*Sturnella magna*	pine siskins	*Spinus pinus*
eastern mole	*Scalopus aquaticus*	raccoon	*Procyon lotor*
finches	*Fringillidae*	red bat	*Lasiurus borealis*
grasshopper sparrow	*Ammodramus savannarum*	red fox	*Vulpes vulpes*
gray fox	*Urocyon cinereoargenteus*	red squirrel	*Sciurus vulgaris*
gray squirrel	*Sciurus carolinensis*	red-backed salamander	*Plethodon cinereus*
horned larks	*Eremophila alpestris*	savannah sparrows	*Passerculus sandwichensis*
kinglets	*Regulus* spp.	Virginia opossum	*Didelphis virginiana*
little blue heron	*Egretta caerulea*	white-tailed deer	*Odocoileus virginianus*
masked shrew	*Sorex cinereus*	woodchuck	*Marmota monax*
northern black racer	*Coluber constrictor*		

Source: Radis and Sutton 1991, as summarized in AmerGen 2005

2.2.2.1.1 Threatened or Endangered Species and Candidate Species

Under the Endangered Species Act (ESA) and the New Jersey Endangered and Nongame Species Program, species and their habitats potentially impacted by construction and operation of the proposed Project would require further evaluation to determine presence of habitat and individuals in the Project Area and its immediate vicinity. These evaluations would be required to support Federal and State permit requirements. Ocean Wind will conduct site-specific endangered species habitat surveys to determine the location and extent of these resources so they can be avoided or mitigated during construction, operations, maintenance and decommissioning. Readily available data was reviewed to identify threatened or endangered species within the Project Area. As onshore export cable routes and substation locations are finalized, Ocean Wind has conducted site specific habitat assessment surveys and has been coordinating with NJDEP, USFWS, USACE and NOAA.

In coordination with the USFWS and the NJDEP Division of Fish and Wildlife, Ocean Wind commissioned species-surveys within portions of the proposed project areas that may contain habitat suitable for listed species. Based on coordination with USFWS in March of 2021, surveys were conducted for Swamp Pink and Knieskern's Beaked-rush within the forested wetland and ditch areas at the Holtec Property of Lacey Township on the Oyster Creek Route. These surveys were conducted by a Professional Wetland Scientist with rare plant survey experience. No individuals of either species were observed during these surveys.

In addition to these surveys, a bog turtle Phase 1 Habitat Assessment Survey was conducted on the BL England proposed onshore substation parcel. The survey was conducted by a USFWS-approved Certified Bog Turtle Surveyor and a Professional Wetland Scientist. Bog turtle habitat was not identified on this parcel.

As part of the South Jersey Regional Rail Study (Gannett Fleming 2002), field surveys were conducted along a corridor beginning from Mays Landing to Atlantic City to determine the absence or presence of habitat suitable for rare, threatened, and/or endangered species based on USFWS and NJDEP Natural Heritage Program's county lists. It was determined that the following Federally protected species have suitable habitat: swamp pink (*Helonias bullata*), Knieskern's beaked-rush (*Rhynchospora knieskernii*), American chaffseed (*Schwalbea Americana*), sensitive joint-vetch (*Aeschynomene virginica*), and bog turtle (*Clemys muhlenbergii*). It was determined that the following State protected species have suitable habitat: red milkweed (*Asclepias rubra*), wood turtle (*Clemmys insculpta*), rare skipper (*Problema bulenta*), and northern pine snake.

The coastal habitats on the barrier island/peninsula include a Natural Heritage Priority Site (i.e., Island Beach Macrosite) and support populations of State-listed endangered and species of concern plant species. Seaside sandplant (*Honckenya peploides var. robusta*), sea-beach knotweed (*Polygonum glaucum*), seabeach sedge (*Carex silicea*), and sickle-leaf golden-aster (*Pityopsis falcate*) are known to be present at Island Beach State Park.

Additional threatened and endangered species information is provided by the USFWS information for planning and conservation (IPaC) and the New Jersey Natural Heritage Program Landscape Project database. These databases generate lists of Federally and State protected species potentially occurring within a particular area. Species identified using these tools within the Onshore study areas are outlined in **Table 2.2.2-3**. In addition to those listed species in the table below, special concern species of birds, reptiles, amphibians, mammals, and invertebrates are also monitored by the NJDEP. Special concern species that could potentially occur in these areas include but are not limited to spotted turtle (*Clemmys guttata*) and the eastern box turtle (*Terrapene carolina carolina).* Additionally, the monarch butterfly (*Donaus plexippus plexippus)* has been listed as a candidate species by the USFWS and has the potential to occur within the study area.

Table 2.2.2-3. Federal and State endangered and threatened species with potential to occur within the study areas.

Species Common	Species Scientific	Status	Study Area	
			Oyster Creek	BL England
Mammals				
Bobcat	*Lynx rufus*	SE	X	
Northern long-eared bat	*Myotis septentrionalis*	FT	X	X
Reptiles				
Bog turtle	*Clemys muhlenbergii*	FT, SE		X
Corn snake	*Pantherophis guttatus*	SE		X
Northern pine snake	*Pituophis melanoleucus melanoleucus*	ST	X	X
Timber rattlesnake	*Crotalus horridus horridus*	SE	X	
Wood turtle	*Glyptemus insculpta*	ST		X
Amphibians				
Pine barrens treefrog	*Hyla andersonii*	ST	X	X
Cope's gray treefrog (southern gray treefrog)	*Hyla chrysoscelis*	SE	X	X

Status: FT - Federally Threatened, FE - Federally Endangered, SE - State Endangered, ST - State Threatened

2.2.2.2 *Potential Project Impacts on Terrestrial and Coastal Fauna*

The following section describes the potential impacts on terrestrial and onshore coastal fauna, other than birds and bats, from the construction, operation and maintenance, and decommissioning phases for the onshore components of the Project, including the cable landfall, onshore export cables, onshore substations at BL England and Oyster Creek, and the onshore grid connections. These facilities are described in Volume I. Factors that may impact terrestrial and onshore coastal fauna include:

- Physical seabed/land disturbance
- Habitat conversion
- Noise
- Traffic
- Sediment suspension
- EMF

While coastal habitats extend from mean high water to 3 miles offshore, these habitats overlap with marine habitat and effects of sediment suspension and EMF are therefore discussed in Section 2.2.5 Benthic Resources and Section 2.2.6, Finfish and EFH.

2.2.2.2.1 Construction

Short-term and long-term impacts on wildlife are expected to occur as a result of habitat impacts and increased noise and traffic from construction. Impacts would vary depending on the specific habitat requirements and mobility of the species. Potential short-term impacts include displacement of individuals from construction areas and adjacent habitats. During construction, the project will adhere to special permit conditions that may include work restriction windows, which will reduce the likelihood of direct impacts to terrestrial and coastal fauna, including potential threatened and endangered species.

Impacts to fauna are related to impacts on habitat, which are described in Section 2.2.1.2. These habitats provide forage, cover, and breeding/nesting habitat for a variety of wildlife species. Developed land (industrial/commercial and residential) typically provides limited habitat for wildlife as compared to more natural settings. As described above, Ocean Wind would site onshore facilities and construction workspace in previously disturbed habitat (i.e., existing ROWs, developed lands) to the extent practicable. In areas with sensitive or unique habitats, trenchless technology may be used, thereby reducing impacts to more sensitive species reliant on specialized habitats.

Offshore Export Cable Landfall

As described above in Section 2.2.1.2, for Oyster Creek, potential landfalls include existing road ROW, previously disturbed areas, and wetlands. BL England potential landfalls include previously disturbed road ROW, industrial areas and previously disturbed areas. With the exception of wetlands, these habitats are already previously disturbed and fragmented, providing limited habitat for wildlife. Trenchless technology options will be used at natural and sensitive landfall locations to the extent practicable.

As discussed, it is expected that the direct loss of habitat for most faunal species would be minimal and that the extent of available intact adjacent habitat would be suitable for faunal species. Mobile organisms (e.g., medium and larger fauna) are expected to avoid disturbed habitat; however, the operation of construction equipment may have direct impacts on sessile or slow-moving organisms, especially within coastal habitats. Sessile organisms, such as barnacles, would be unable to move away from construction activities or areas with loss of habitat, in general. Therefore, adverse direct impacts to these sessile organisms are possible. However, because the disturbed area would be small and localized, and the habitat altered would represent only a small portion of the available habitat, population-level impacts to sessile organisms are unlikely. Habitat assessments have been completed to facilitate avoiding sensitive habitat areas (sensitive habitats are described in Section 2.2.1.1) and potential work restriction windows will be implemented to reduce impacts to terrestrial and coastal fauna during sensitive periods (such as migration), including potential threatened and endangered species.

Noise would be generated from activities such as operation of heavy equipment for clearing, grading, excavation, and trenchless cable installation. Construction activities also would generate vehicular traffic in the area, but would typically be consistent with current levels of traffic. It is possible that noise and traffic would be notable at times within the immediate construction areas. Mobile organisms would either be acclimated to these activities due to the relatively urban setting, or would be frightened by increased human activity and noise generation, resulting in movement away from disturbed habitat and avoidance of potential impacts. Smaller fauna and sessile organisms around construction areas may be unable to avoid noise generation; however, disturbances at these sites would be short-term, localized, and temporary.

Onshore Export Cable

Onshore export cables would carry electricity from the TJBs at landfall to the substations and would be collocated with existing rights-of-way to the extent practicable. Potential onshore export cable routes include existing road ROW, industrial areas, previously disturbed areas and wetlands. Wildlife using ROW, industrial, and previously disturbed areas are expected to be acclimated to disturbance and human activity common in developed areas. The onshore export cables would be installed primarily via typical trenching and open cut methods. Trenchless technology methods may be used along portions of the onshore export cable routes to avoid impacts to wetlands, surface water crossings, or other sensitive and unique habitats.

Habitat and wildlife use along the onshore export cables would be similar to habitat found at landfall sites; therefore, impacts would be similar to those described for landfall. Any specific area disturbed during installation will only be affected for a short period, and will be restored when installation is complete in that area. As described above for landfall, mobile wildlife is expected to move away from areas of construction noise traffic and direct impact during periods of active construction. Sessile organisms would be unable to move away from construction activities and loss of habitat would likely occur. Therefore, direct adverse impacts are possible, but the area of habitat impact would be small compared to the surrounding unaffected similar habitat; while individuals could be affected, population level impacts are not likely. Habitat assessments have been completed to facilitate avoiding sensitive areas, and potential work restriction windows will be implemented to reduce impacts to terrestrial and coastal fauna, including potential threatened and endangered species.

Overall impacts associated with construction of the onshore export cable will result in short-term localized impacts to coastal and terrestrial fauna as the routes were sited within existing ROW to the extent practicable.

Onshore Substations

The proposed onshore substation sites at BL England and Oyster Creek consist of habitat that is already developed and fragmented. These habitat types are not known to be used by any threatened or endangered or candidate species. Although construction activities at the onshore substations are expected to result in permanent habitat loss, the affected habitat is common to the region and wildlife would have availability and access to similar habitats in the vicinity of BL England and Oyster Creek. Additionally, the location of the onshore substations in previously developed and fragmented habitat of low quality avoids potential impacts to more high quality wildlife habitat, including habitat for threatened or endangered or candidate species (such as the high quality habitat areas depicted in **Figures 2.2.1-1** and **2.2.1-2**).

Noise would be generated from activities such as operation of heavy equipment for clearing, grading, excavation, and construction of structures. Construction activities also would generate vehicular traffic in the area, but would typically be consistent with current levels of traffic and would likely go unnoticed. It is possible that noise and traffic would be notable at times within the immediate construction areas. Mobile organisms would likely be frightened by increased human activity and noise generation, resulting in movement away from the active construction at the substation and temporary displacement. Smaller fauna and sessile organisms around construction areas may be unable to avoid noise generation; however, disturbances at these sites would be localized and temporary, resulting in minimal impacts to these organisms. Noise and vehicular traffic impacts during construction activities would be temporary.

2.2.2.2.2 Operations and Maintenance

Operations and maintenance of onshore facilities of the Project are expected to result in noise, vehicular traffic, and habitat disturbance impacts on terrestrial and coastal fauna. During operational activities, noise would be generated at the onshore substation and vehicular traffic would occur. Noise and traffic are expected to be consistent with existing levels. It is expected that wildlife would become acclimated to these activities or would relocate to habitat away from the noise and traffic. During maintenance activities, noise, vehicular traffic, and habitat disturbance would occur in association with maintenance and repair of onshore facilities (similar to those described for construction); however, these disturbances would be limited to specific areas and would occur over shorter periods of time in comparison to the construction phase of the Project. Potential impacts from EMF will be localized to the onshore export cable corridor. However, the cable will be buried at a depth sufficient to minimize effects to the extent practicable.

2.2.2.2.3 Decommissioning

During decommissioning activities, impacts to coastal and terrestrial fauna would be expected to be similar to construction impacts discussed above.

2.2.2.2.4 Summary of Potential Project Impacts on Terrestrial and Coastal Fauna Resources

The IPFs affecting terrestrial and coastal fauna include physical seabed/land disturbance, habitat conversion, noise, traffic, sediment suspension, and EMF.

While the onshore substation facilities will result in permanent impacts to previously disturbed habitat, it is expected that the direct loss of habitat for most faunal species would be minimal because the direct loss of habitat is small compared to available adjacent habitat. Other impacts to terrestrial and coastal fauna are expected to be localized and temporary with the application of APMs. For example, short-term impacts on wildlife are expected to occur as a result of temporary habitat disturbance and increased noise and traffic from construction. Construction noise and traffic associated with the Project would typically be temporary and consistent with current levels of traffic. Operations and maintenance noise and traffic disturbances would be limited to specific areas and would occur over shorter periods of time than during construction.

2.2.2.3 Avoidance, Minimization, and Mitigation Measures

The proposed measures for avoiding, minimizing, reducing, eliminating, and monitoring environmental impacts for the Project are presented in **Table 1.1-2**.

2.2.3 Birds

2.2.3.1 Affected Environment

This section provides an overview of the avian community that has the potential to be exposed to the proposed onshore and offshore Project activities, with separate sections on Federally listed species. 'Exposure' is defined as the extent of overlap between a species' seasonal or annual distribution and the Project footprint. For species where site-specific data was available, a semi-quantitative exposure assessment was conducted (details provided in Appendix H). Appendix H provides a detailed and thorough assessment of the birds that may be exposed to the project. Below, a summary of Appendix H is provided for the offshore and onshore components of the project. **Table 2.2.3-1** lists birds identified through the USFWS IPaC database and other sources that are listed in New Jersey and/or Federally, any of which have the potential to pass through the area of both study areas (BL England and Oyster Creek). For species listed under the ESA and the Bald and Golden Eagle Protection Act, exposure was assessed individually.

Table 2.2.3-1. State and Federal Listed birds that have the potential to pass through the BL England and Oyster Creek study areas.

Common Name	Scientific Name	NJ Status*	Federal Status*
American Oystercatcher	*Haematopus palliates*	SC - Breeding + Non-breeding	BCC
Lesser Yellowlegs	*Tringa flavipes*	-	BCC - Non-breeding
Whimbrel	*Numenius phaeopus*	SC - Non-breeding	BCC - Non-breeding
Willet	*Tringa semipalmata*	-	BCC
Hudsonian Godwit	*Limosa haemastica*	-	BCC - Non-breeding
Marbled Godwit	*Limosa fedoa*	-	BCC - Non-breeding
Short-billed Dowitcher	*Limnodromus griseus*	-	BCC - Non-breeding
Piping Plover	*Charadrius melodus*	E - Breeding + Non-breeding	T
Purple Sandpiper	*Calidris maritima*	-	BCC - Non-breeding
Semipalmated Sandpiper	*Calidris pusilla*	SC - Non-breeding	BCC - Non-breeding
Spotted Sandpiper	*Actitis macularius*	SC - Breeding	-
Buff-breasted Sandpiper	*Calidris subruficollis*	-	BCC - Non-breeding
Upland Sandpiper	*Batramia longicauda*	E - Breeding + Non-breeding	BCC
Solitary Sandpiper	*Tringa solitaria*	-	BCC - Non-breeding
Sanderling	*Calidris alba*	SC - Non-breeding	-
Red Knot	*Calidris canutus rufa*	E - Non-breeding	T - Non-breeding
Bald Eagle	*Haliaeetus leucocephalus*	E - Breeding, T - Non-breeding	BCC
Peregrine Falcon	*Falco peregrinus*	E - Breeding, SC - Non-breeding	BCC
American Kestrel	*Falco sparverius*	T - Breeding + Non-breeding	-
Northern Goshawk	*Accipiter gentilis*	E - Breeding, SC - Non-breeding	-
Northern Harrier	*Circus cyaneus*	E - Breeding, SC - Non-breeding	-
Red-shouldered Hawk	*Buteo lineatus*	E - Breeding, SC - Non-breeding	-
Broad-winged Hawk	*Buteo platypterus*	SC - Breeding	-
Cooper's Hawk	*Accipiter cooperii*	SC - Breeding	-
Sharp-shinned Hawk	*Accipiter striatus*	SC - Breeding + Non-breeding	-
Osprey	*Pandion haliaetus*	T - Breeding	-
Snowy Owl	*Bubo scandiacus*	-	BCC
Short-eared Owl	*Asio flammeus*	E - Breeding, SC - Non-breeding	BCC - Non-breeding
Barred Owl	*Strix varia*	T - Breeding + Non-breeding	-

Common Name	Scientific Name	NJ Status*	Federal Status*
Long-eared Owl	*Asio otus*	T - Breeding + Non-breeding	-
Barn Owl	*Tyto alba*	SC - Breeding + Non-breeding	-
Black Rail	*Laterallus jamaicensis*	E - Breeding, T - Non-breeding	BCC
Eastern Black Rail	*Laterallus jamaicensis*	-	PT - Proposed Threatened
King Rail	*Rallus elegans*	-	BCC
American Bittern	*Botaurus lentiginosos*	E - Breeding, SC - Non-breeding	BCC
Least Bittern	*Ixobrychus exilis*	SC - Breeding + Non-breeding	BCC
Cattle Egret	*Bubulcus ibis*	T - Breeding, SC - Non-breeding	-
Snowy Egret	*Egretta thula*	SC - Breeding	BCC
Black-crowned Night-heron	*Nycticorax nycticorax*	T - Breeding, SC - Non-breeding	-
Yellow-crowned Night-Heron	*Nyctanassa violacea*	T - Breeding + Non-breeding	-
Great Blue Heron	*Ardea herodias*	SC - Breeding	-
Tricolored Heron	*Egretta tricolor*	SC - Breeding + Non-breeding	-
Little Blue Heron	*Egretta caerulea*	SC - Breeding + Non-breeding	-
Glossy Ibis	*Plegadis falcinellus*	SC - Breeding	-
Pied-billed Grebe	*Podilymbus podiceps*	E - Breeding, SC - Non-breeding	BCC
Horned Grebe	*Pidiceps auritus*	-	BCC - Non-breeding
Black-billed Cuckoo	*Coccyzus erythropthalmus*	SC - Breeding	BCC
Blue-headed Vireo	*Vireo solitarius*	SC - Breeding	-
Bobolink	*Dolichonyx oryzivorus*	T - Breeding, SC - Non-breeding	BCC
Brown Thrasher	*Toxostoma rufum*	SC - Breeding	-
Canada Warbler	*Cardellina canadensis*	SC - Breeding	BCC
Cerulean Warbler	*Dendroica cerulea*	SC - Breeding + Non-breeding	BCC
Prairie Warbler	*Dendroica discolor*	-	BCC
Blackburnian Warbler	*Dendroica fusca*	SC - Breeding	-
Black-throated Blue Warbler	*Dendroica caerulescens*	SC - Breeding	-
Black-throated Green Warbler	*Dendroica virens*	SC - Breeding	-
Prothonotary Warbler	*Protonotaria citrea*	-	BCC
Hooded Warbler	*Wilsonia citrina*	SC - Breeding	-
Nashville Warbler	*Oreothlypis ruficapilla*	SC - Breeding	-

Common Name	Scientific Name	NJ Status*	Federal Status*
Northern Parula	*Parula americana*	SC - Breeding	-
Worm-eating Warbler	*Helmitheros vermivorum*	SC - Breeding	BCC
Yellow-breasted Chat	*Icteria virens*	SC - Breeding	-
Kentucky Warbler	*Oporornis formosus*	SC - Breeding + Non-breeding	BCC
Golden-winged Warbler	*Vermivora chrysoptera*	E - Breeding, SC - Non-breeding	BCC
Blue-winged Warbler	*Vermivora cyanoptera*	-	BCC
Saltmarsh Sparrow	*Ammodramus caudacutus*	SC - Breeding	BCC
Seaside Sparrow	*Ammodramus maritimus*	-	BCC
Ipswich Sparrow	*Passerculus sandwichensis princeps*	SC - Non-breeding	-
Nelson's Sparrow	*Ammodramus nelsoni*	-	BCC
Grasshopper Sparrow	*Ammodramus savannarum*	T - Breeding, SC - Non-breeding	-
Savannah Sparrow	*Passerculus sandwichensis*	T - Breeding	-
Henslow's Sparrow	*Ammodramus henslowii*	E - Breeding + Non-breeding	BCC
Vesper Sparrow	*Pooecetes gramineus*	E - Breeding, SC - Non-breeding	-
Winter Wren	*Troglodytes hiemalis*	SC - Breeding	-
Sedge Wren	*Cistothorus platensis*	E - Breeding + Non-breeding	BCC
Cliff Swallow	*Petrochelidon pyrrhonota*	SC - Breeding	-
Eastern Meadowlark	*Stunella magna*	SC - Breeding + Non-breeding	-
Evening Grosbeak	*Coccothraustes vespertinus*	-	BCC
Red-headed Woodpecker	*Melanerpes erythrochephalus*	T - Breeding + Non-breeding	BCC
Rusty Blackbird	*Euphagus carolinus*	-	BCC - Non-breeding
Wood Thrush	*Hylocichla mustelina*	SC - Breeding	BCC
Gray-cheeked Thrush	*Catharus minimus*	SC - Non-breeding	-
Veery	*Catharus fuscescens*	SC - Breeding	-
Least Flycatcher	*Empidonax minimus*	SC - Breeding	-
Loggerhead Shrike	*Lanius ludovicianus*	E - Non-breeding	BCC
Horned Lark	*Eremophila alpestris*	T - Breeding, SC - Non-breeding	-
Eastern Whip-poor-will	*Antrostomus vociferus*	SC - Breeding	BCC
Common Nighthawk	*Chordeiles minor*	SC - Breeding + Non-breeding	-

Common Name	Scientific Name	NJ Status*	Federal Status*
Black Skimmer	*Rynchops niger*	E - Breeding + Non-breeding	BCC
Common Tern	*Sterna hirundo*	SC - Breeding	-
Gull-billed Tern	*Gelochelidon nilotica*	SC - Breeding + Non-breeding	BCC
Least Tern	*Sterna antillarum*	E - Breeding + Non-breeding	BCC
Roseate Tern	*Sterna dougallii*	E - Breeding + Non-breeding	E
Caspian Tern	*Hydroprogne caspia*	SC - Breeding	-
Red-throated Loon	*Gavia stellate*	-	BCC - Non-breeding

Source: NJDEP 2012 and USFWS IPaC database (USFWS 2018b).

*** E = Endangered, T = Threatened, SC = Special Concern, BCC = Birds of Conservation Concern**

2.2.3.1.1 Offshore Project Area

The summary below is focused upon the Wind Farm Area, but is also inclusive of the birds that may fly over, or forage in the vicinity of, the offshore export cable corridor.

A broad group of avian species may pass through the Wind Farm Area, including terrestrial migrants (such as raptors and songbirds), coastal birds (such as shorebirds, waterfowl, and waders), and marine birds (such as seabirds and seaducks). There is high diversity of marine birds that may use the Wind Farm Area because it is located in the Mid-Atlantic Bight, which overlaps with the ranges of both northern and southern species and falls within the Atlantic Flyway (a major migratory pathway for birds in the eastern U.S. and Canada).

Migrant terrestrial species may follow the coastline on their annual trips or choose more direct flight routes over expanses of open water. Many marine birds also make annual migrations up and down the eastern seaboard (e.g., gannets, loons, and seaducks), taking them directly through the mid-Atlantic region in spring and fall. This results in a complex ecosystem where the community composition shifts regularly, and temporal and geographic patterns are highly variable. The mid-Atlantic supports large populations of birds in summer, some of which breed in the area, such as coastal gulls and terns. Other summer residents, such as shearwaters and storm-petrels, visit from the Southern Hemisphere (where they breed during the austral summer). In the fall, many of the summer residents leave the area and migrate south to warmer climes, and are replaced by species that breed further north and winter in the mid-Atlantic. Below, a detailed assessment of exposure is presented for each major taxonomic group.

Three species listed under the ESA are present in the region: regional populations of the Piping Plover (*Charadrius m. melodus*), the Roseate Tern (*Sterna d. dougallii*), and a subspecies of the Red Knot (*Calidris canutus rufa*). Piping Plovers nest along New Jersey beaches, and will also migrate (spring and fall) through the area in transit to and from northern breeding sites. Red Knots also fly through the region during migration in transit to northern breeding sites; a critical staging area for the birds is Delaware Bay. Roseate terns fly through the mid-Atlantic on their way to breeding sites in New York and New England. Federally listed species are assessed individually below.

Non-marine Migratory Birds

Shorebirds

Shorebirds are coastal breeders and foragers and generally avoid straying out over deep waters during breeding. Of the shorebirds, only Red Phalarope (*Phalaropus fulicarius*) and Red-necked Phalarope (*P. lobatus*) are generally considered marine species (Rubega *et al.* 2000, Tracy *et al.* 2002). Overall, exposure of shorebirds to the offshore component of the Project will be limited to migration, and, with the exception of phalaropes, the offshore marine environment does not provide habitat for shorebirds. Two shorebird species Federally protected under the ESA are addressed in detail below.

Piping Plover - Piping Plovers nest on beaches and wetlands along the Atlantic coast of North America, the Great Lakes, and in the Midwestern plains (Elliott-Smith and Haig 2004) and winter in the coastal southeastern United States and Caribbean (Elliott-Smith and Haig 2004, USFWS, BOEM 2014). Due to a number of threats, the Atlantic subspecies (*C. m. melodus*) is listed as threatened under the ESA. Piping Plovers are present in New Jersey during spring and fall migratory periods, and during the breeding season (USFWS 2018a). They breed above the high tide line along the coast, primarily on sand beaches (USFWS 2018a). Non-migratory movements in May-August appear to be exclusively coastal (Burger *et al.* 2011). Piping Plovers, like other shorebirds, either make nonstop long-distance migratory flights (Normandeau Associates Inc. 2011), or offshore migratory “hops” between coastal areas (Loring *et al.* 2017). As such, at least some individuals of this species likely traverse the New Jersey WEA, and thus potentially the Wind Farm Area, during migration (BOEM

2012b). Migration occurs primarily during nocturnal periods, with the average takeoff time appearing to be around 5-6 pm (Loring *et al.* 2017). A recent nanotag study tracked migrating Piping Plovers captured in Massachusetts and Rhode Island. The study estimated that two of the tracked birds (*n*= 102) would be exposed to the northern portion of the New Jersey Wind Energy Area and zero birds would be exposed to the southern portion of the New Jersey Wind Energy Area where the Wind Farm Area is located (Loring *et al*. 2017).

Red Knot - The Red Knot exhibits one of the longest migrations in the world (Baker *et al.* 2013). The *rufa* subspecies is listed as threatened under the ESA, because the Atlantic flyway population decreased by approximately 70 percent from 1981 to 2012 (Burger *et al.* 2011, Baker *et al.* 2013). Red Knots breed in the High Arctic, and winter in the southeastern U.S., Caribbean, and South America (Baker *et al.* 2013). These populations share several key migration stopover areas along the U.S. east coast, particularly in Delaware Bay and coastal islands of Virginia (Burger *et al.* 2011). The Red Knot is present in New Jersey only during migratory periods (BOEM 2014). The fall migration period is July-October. Migration routes appear to be highly diverse, with some individuals flying out over the open ocean from the northeastern U.S. directly to stopover/wintering sites in the Caribbean and South America, while others make the ocean "jump" from farther south, or follow the U.S. Atlantic coast for the duration (Baker *et al.* 2013, BOEM 2014). A small proportion of the short-distance migrant population, may pass through the New Jersey WEA, and potentially the Wind Farm Area, during migration (Loring *et al.* 2018).

Ocean Wind conducted a study to track short-distance migrant Red Knots captured at sites in coastal New Jersey in 2021 using satellite telemetry (Biodiversity Research Institute [BRI] and Wildlife Restoration Partnerships [WRP] 2022); this report is contained in Appendix E.

Wading birds

Most long-legged wading birds breed and migrate in coastal and inland areas. Like the smaller shorebirds, wading birds are coastal breeders and foragers and generally avoid straying out over deep waters (Hafner *et al.* 2000), but may traverse the Wind Farm Area during spring and fall migration periods. The IPaC database did not indicate any wading birds in the Wind Farm Area or adjacent waters, and the NJDEP Ecological Baseline Studies (EBS) surveys detected few heron and egrets offshore (Appendix H).

Raptors

Except for falcons, most raptors do not fly in the offshore marine environment due to their wing morphology, which requires thermal column formation to support their gliding flight (Kerlinger 1985). Falcons are encountered offshore because they can make large water crossings (Kerlinger 1985). Merlins (*Falco columbarius*) and Peregrine Falcons (*F. peregrinus*) are commonly observed offshore (Cochran 1985, DeSorbo *et al.* 2018), fly offshore during migration (DeSorbo *et al.* 2015), and have been observed on offshore oil platforms (McGrady *et al.* 2006, Johnson *et al.* 2011a). Thus, falcons may pass through the Wind Farm Area during migration. Ospreys (*Pandion haliaetus*) fly over open water crossings (Kerlinger 1985); however, satellite telemetry data from Ospreys in New England and the mid-Atlantic suggest these birds generally follow coastal or inland migration routes. Bald Eagles (*Haliaeetus leucocephalus*) are protected under the Bald and Golden Eagle Protection Act (Eagle Act) and are discussed in greater detail below.

Eagles - The Bald Eagle is broadly distributed across North America and is present in New Jersey. They generally nest and perch in association with water, but often remain within roughly 1,640 ft (500 m) of the shoreline (Buehler 2000). The Golden Eagle (*Aquila chrysaetos*) commonly winters in the southern Appalachians and is regularly observed in the mid-Atlantic U.S., spanning coastal plain habitat in Virginia, Delaware, North Carolina, South Carolina, and other southeastern states. In a study evaluating the space use of Bald Eagles captured in Chesapeake Bay, the coast of New Jersey was associated with moderate levels of use (Mojica *et al.* 2016), and they were rarely observed in offshore surveys (all observations <3.7 miles (6 km) from shore (Williams *et al.* 2015). The general morphology of both Bald Eagles and Golden Eagles dissuades regular use of offshore habitats (Kerlinger 1985), and they are unlikely to fly through the Wind Farm Area.

Songbirds

Songbirds almost exclusively use terrestrial, freshwater, and coastal habitats and do not use the offshore marine system except during migration. Songbirds regularly cross large bodies of water (Bruderer and Lietchi 1999, Gauthreaux and Belser 1999), and there is some evidence that species migrate over the northern Atlantic (Adams *et al.* 2015). Some birds may briefly fly over the water while others, like the Blackpoll Warbler (*Setophaga striata*), can migrate over vast expanses of ocean (Faaborg *et al.* 2010, DeLuca *et al.* 2015). Evidence for a variety of species suggests that overwater migration in the Atlantic is much more common in fall (than in spring), when the frequency of overwater flights increases perhaps due to consistent tailwinds from the northwest (e.g., see Morris *et al*. 1994, Hatch *et al*. 2013, Adams *et al*. 2015, DeLuca *et al*. 2015). Overall, the exposure of songbirds to the Wind Farm Area will be limited to migration.

Coastal Waterbirds

Coastal waterbirds (including waterfowl) use terrestrial or coastal wetland habitats and rarely use the marine offshore environment. The species in this group are generally restricted to freshwater or use saltmarshes, beaches, and other strictly coastal habitats and are unlikely to pass through the Wind Farm Area. Seaducks are discussed below in the marine bird section.

Marine birds

Marine bird distributions are generally more pelagic and widespread than coastal birds. A total of 83 marine bird species are known to regularly occur off the eastern seaboard of the U.S. (Nisbet *et al.* 2013). Many of these marine bird species use the Wind Farm Area during multiple time periods, either seasonally or year-round, including loons, petrels and shearwaters, gannets, gulls and terns, and auks. Below each major taxonomic group is discussed separately, and the Roseate Tern, listed under the ESA, is discussed individually.

Loons

Common Loons (*Gavia immer*) and Red-throated Loons (*G. stellata*) use the Atlantic OCS in winter. Analysis of satellite-tracked Red-throated Loons, captured and tagged in the mid-Atlantic area, found their winter distributions to be largely inshore of the mid-Atlantic WEAs, although they did overlap with the Wind Farm Area during spring migration (Gray *et al.* 2016). The NJDEP EBS surveys and Marine-life Data and Analysis Team (MDAT) models show higher use of the Wind Farm Area by loons in the spring than other seasons.

Seaducks

The seaducks use the Atlantic OCS heavily in winter. Most seaducks forage on mussels and/or other benthic invertebrates, and generally winter in shallower inshore waters or out over large offshore shoals, where they can access benthic prey. Surf Scoters tracked with satellite transmitters remained largely inshore of the Wind Farm Area (Spiegel *et al.* 2017). Exposure to the Wind Farm Area will be primarily limited to migration or travel between wintering sites.

Petrel Group

This group consists mostly of shearwaters and storm-petrels that breed in the southern hemisphere and visit the northern hemisphere during the austral winter (boreal summer) and may pass through the Wind Farm Area.

These species use the U.S. Atlantic OCS region heavily (Nisbet *et al.* 2013), but mostly concentrate offshore and in the Gulf of Maine (Winship *et al.* 2018).

Gannets, Cormorants, and Pelicans

The Northern Gannet (*Morus bassanus*) uses the US Atlantic OCS primarily during winter. They breed in southeastern Canada and winter along the mid-Atlantic region and in the Gulf of Mexico. They are opportunistic foragers, capable of long-distance oceanic movements, and may pass through the Wind Farm Area regularly during the non-breeding period (Stenhouse *et al.* 2017). The Double-crested Cormorant (*Phalacrocorax auritus*) is the most likely species of cormorant exposed to the Wind Farm Area, but regional MDAT abundance models show that cormorants are concentrated closer to shore and not commonly encountered well offshore. Brown Pelicans (*Pelecanus occidentalis*) are rare in the area (NJDEP 2010c), and unlikely to pass through the Wind Farm Area in any numbers.

Gulls, Skuas, and Jaegers

Nine species in this group were observed in the NJDEP surveys and could potentially pass through the Wind Farm Area. The regional MDAT abundance models show that these birds have wide distributions, ranging from near shore (gulls) to offshore (jaegers). The Herring Gull (*Larus argentatus*) and Great Black-backed Gull (*L. marinus*) are resident in the region year-round, and are found further offshore outside of the breeding season (Winship *et al.* 2018). The Parasitic Jaeger (*Stercorarius parasiticus*) is often observed closer to shore during migration than the others species (Wiley and Lee 1999) and Great Skuas (*S. skua*) may pass along the Atlantic OCS outside the breeding season.

Terns

Seven species of tern are present in New Jersey during the spring, summer, and fall. Of these, there are breeding records in New Jersey of Caspian Tern (*Hydroprogne caspia*), Common Tern (*Sterna hirundo*), Forster's Tern (*S. forsteri*), Gull-billed Tern (*Gelochelidon nilotica*), Least Tern (*Sternula antillarum*), and Royal Tern (*Thalasseus maximus*) (Conserve Wildlife Foundation of New Jersey 2018). Terns generally restrict themselves to coastal waters during breeding, although they may pass through the Wind Farm Area infrequently to forage and during migration. Roseate Terns (*Sterna dougallii*) are Federally and State listed, and are described in detail below.

Roseate Tern - The Roseate Tern breeds colonially on coastal islands in the northeast. The northwest Atlantic Ocean population has been Federally listed as Endangered under the ESA since 1987. This population breeds in the northeastern United States and Atlantic Canada, and winters in South America, primarily eastern Brazil. Over 90 percent of remaining individuals breed at just three colony locations in Massachusetts (Bird, Ram, and Penikese Islands in Buzzards Bay) and one colony in New York (Great Gull Island, near the entrance to Long Island Sound (Nisbet *et al.* 2014, Loring *et al.* 2017). There are no breeding colonies in New Jersey. Roseate Tern migration routes are poorly understood, but they appear to migrate primarily well offshore (Nisbet 1984, USFWS 2010, Burger *et al.* 2011, Mostello *et al.* 2014, Nisbet *et al.* 2014). A recent study used nanotags to track Roseate Terns tagged in Massachusetts. While the movement models are not representative of the entire breeding and posting period for many individuals, due to incomplete spatial coverage of the receiving stations and tag loss, none of the tracked birds (*n*=145) were estimated to pass through the northern or southern portions of the New Jersey Wind Energy Area (Loring *et al*. 2017). Overall, the regional MDAT models show that the birds are generally concentrated closer to shore during spring migration and have low exposure in New Jersey waters during the summer and fall. However, Roseate Terns may occur at the Wind Farm Area ephemerally during spring and fall migration (Burger *et al.* 2011, BOEM 2014).

Auks

The auk species present in New Jersey offshore waters are generally northern or Arctic-breeders that winter along the U.S. Atlantic OCS. The annual abundance and distribution of auks along the eastern seaboard in winter is erratic, however, depending upon broad climatic conditions and the availability of prey (Gaston & Jones 1998). In winters with prolonged harsh weather, which may prevent foraging for extended periods, these generally pelagic species often move inshore, or are driven considerably further south than usual. The MDAT abundance models show that auks are generally concentrated offshore and south of Nova Scotia (Winship *et al.* 2018), but some individuals may pass through the Wind Farm Area during winter.

2.2.3.1.2 Onshore Project Area

This section discusses the birds that may be exposed to construction and operation of the Project's onshore facilities in the BL England and Oyster Creek study areas. The study areas contain a diverse set of habitats including coastal wetlands, forested wetlands, forested uplands, forested lowlands, barrier beaches, and bay island habitats that providing breeding, migratory stopover, and wintering habitat for a variety of birds. The bird species discussed below are known to commonly occur in areas that will be potentially exposed to the construction of the onshore facilities. Since the Project will use trenchless technology methods to cross under barrier beaches, barrier beaches are not considered an area that will be affected by Project activities and is not assessed.

There are multiple proposed onshore export cable route options within the BL England study area. Appendix H includes detailed descriptions of the potential onshore export cable routes for the BL England study area and the birds that could be potentially exposed.

For proposed onshore export cable routes, the transmission lines will be co-located with existing developed areas (i.e., roads and existing transmission lines) that pass through residential and commercial areas wherever possible, thereby minimizing potential impacts to terrestrial wildlife habitat. Bird species likely occurring along the Onshore study areas (**Table 2.2.3-1**) are those associated with coastal wetland, forested wetland, forested lowland and upland habitats, while bird species likely occurring at the cable landfall sites are those associated with coastal wetland, beach, and bay island habitats. These variable coastal habitats within the BL England study area support a diversity of avian taxa. These habitats are critical to shorebirds, wading birds, seabirds, waterfowl, raptors, and passerines. Forested wetlands and lowlands within the BL England study area provide habitat for many species of passerines and several species wading birds, waterfowl, of raptors. The upland habitats provide habitat primarily for passerines and raptors.

Portions of the study areas include Pinelands National Reserve and Lester G. MacNamara (Tuckahoe) Wildlife Management Area lands. Coastal wetland sections of the BL England study area fall within state-priority Important Bird Areas (IBAs) while some upland sections fall within a continental-priority IBAs (Audubon 2018).

There are multiple proposed onshore export cable route options within the Oyster Creek study area. Appendix H includes detailed descriptions of the potential onshore export cable routes for the Oyster Creek study area and the birds that could be potentially exposed.

For all proposed onshore export cable routes, the transmission lines will be co-located with existing developed areas (i.e., roads and existing transmission lines) that pass through residential and commercial areas wherever possible, thereby minimizing potential impacts to terrestrial wildlife habitat. The Oyster Creek Route will terminate at the Oyster Creek Substation. Bird species likely occurring along the Onshore study areas (**Table 2.2.3-1**) are those associated with coastal wetland, forested wetland, forested lowland and upland habitats, while bird species likely occurring at the cable landfall sites are those associated with coastal wetland, beach, and bay island habitats. These variable coastal habitats within the Oyster Creek study area support a diversity of avian taxa. These habitats are critical to shorebirds, wading birds, seabirds, waterfowl, raptors, and passerines. Forested uplands within the Oyster Creek site provide habitat primarily for passerines and raptors. Forested wetlands within the Oyster Creek site provide habitat for many species of passerines and several species wading birds, waterfowl, of raptors. An area of old farmland within the study area also includes areas of open fields contained scattered pines and oaks, open sandy areas, and abandoned orchards, all habitats commonly utilized by passerines and raptors.

Portions of the study areas include Pinelands National Reserve land, Natural Heritage Priority Sites including Middle Branch Forked River (Lacey Township) and Island Beach Macrosite (Barnegat Light Borough), Island Beach State Park, Forsythe National Wildlife Refuge land, and Barnegat Light State Park. Coastal wetland sections of the Oyster Creek study area fall within state-priority IBAs while some upland sections fall within continental-priority IBA.

2.2.3.2 Potential Project Impacts on Birds

A desktop avian assessment to evaluate the potential impacts on terrestrial migrants (such as raptors and songbirds), coastal birds (such as shorebirds, waterfowl, and waders), and marine birds (such as seabirds and seaducks) from the proposed development of the Project was conducted. This section is a summary of the extensive assessment conducted in Appendix H, which provides a detailed analysis of the exposure, vulnerability, and risk to birds from each Project development phase and component.

The assessment follows the *Guidelines for Information Requirements for a Renewable Energy Construction and Operations Plan* (BOEM 2016a). Under ‘Attachment A: Best Management Practices’, BOEM states the following with regard to avian resources: “The lessee shall evaluate avian use in the Project Area and design the project to minimize or mitigate the potential for bird strikes and habitat loss.” This assessment was specifically developed to meet COP requirements, provide information for NEPA review, and support agency consultations.

For the purposes of this assessment, the offshore components of the Project are considered the Wind Farm Area and the offshore export cable corridor, and the onshore components of the Project are the onshore cable corridor and related support infrastructure (onshore substations and grid interconnections).

The assessment (Appendix H) used a weight-of-evidence approach that included an analysis of exposure of birds to each specific project hazard (i.e., impact producing factor), and behavioral vulnerability to the hazard. Offshore, for marine birds for which survey data was available, a semi-quantitative exposure assessment was conducted. For other marine birds and non-marine migratory birds, other data sources (e.g., individual tracking data), literature, and species accounts were used to assess exposure. Onshore, the habitat potentially disturbed by the Project was described, and the species likely to occupy the habitat were identified. For species listed under the ESA and the Eagle Act, exposure was assessed individually.

IPFs that may potentially affect birds include the following and are discussed in the following sections.

- Physical seabed/land disturbance
- Habitat conversion
- Noise
- Visible structures/lighting
- Traffic

As IPFs such as seabed disturbance, noise, and traffic are expected to be temporary and highly localized, the following sections will focus primarily on the potential impacts of collision with visible structures and displacement from the Project Area.

2.2.3.2.1 Construction

Offshore Project Area

Wind energy is recognized as a major contributor to reducing greenhouse gases and mitigating the effects of climate change (Allison *et al*. 2019). The purpose of this section is to discuss the potential effects of the proposed wind farm on birds to support NEPA review, but potential effects should be considered within the context of the benefits the wind farm is providing. Bird exposure and vulnerability for construction are similar to operation, and are therefore discussed in greater detail in Section 2.2.3.2.2. Spatially, bird exposure to the Wind Farm Area will be similar during both phases, but exposure to construction activities are considered to be temporary. Birds are expected to have the same basic behavioral vulnerability to construction activity as operation (i.e., displacement; and collision, especially if lit) when they interact with construction vessels or wind turbines being installed. During construction, there may be temporary disturbance of sediment during cable installation (see Section 2.1.2), but the disturbance will be confined to a relatively small area, and permanent loss of foraging habitat for seabirds is unlikely (see Appendix H for further discussion).

Onshore Project Area

For the onshore component of the Project, the primary IPF (i.e., hazard) is habitat conversion (modification) during construction, causing an indirect effect of reduced foraging and breeding habitat. Other potential hazards are temporary disturbance from construction and operation activities, causing displacement from breeding and foraging habitat; and, though unlikely, collisions with construction equipment.

Since the BL England and Oyster Creek study areas generally have the same habitat types and generally the same avian communities, potential impacts of the Project are discussed below for both areas simultaneously. Since there are hundreds of species of birds in New Jersey (NJDFW 2004), many of which may pass through the Onshore Project Area at some point during the life cycle (see Affected Environment) and could have similar responses to the IPFs, the assessment will consider potential impacts to birds as a whole, rather than by species group.

Coastal disturbance and associated impacts to birds will be limited per APMs (**Table 1.1-2**) and BMPs (Appendix S). These APMs include cutting trees and vegetation, when possible, during the winter months when most migratory birds are not present at the site.

Overall, impacts to bird habitat from onshore Project activities are limited because, whenever possible, facilities (including overhead transmission lines) will be co-located with existing developed areas (i.e., roads and existing transmission lines, existing developed areas) to limit disturbance. Where necessary, construction of onshore facilities may require clearing and some permanent removal of some trees. Clearing and grading during construction within temporary workspaces will result in temporary loss of forage and cover for birds within the area. However, the work will not affect habitat outside the construction area. Due to the short duration of the activities, and the action taken to reduce impacts (**Table 1.1-2**), population level impacts to birds from temporary habitat modification are unlikely.

Noise and vibration generated by construction equipment will likely temporarily displace some birds within nearby habitat. Due to their generally high mobility, birds are likely to leave the corridor as construction progresses. However, these birds are expected to return once construction activity is complete, and thus, population level impacts are unlikely.

2.2.3.2.2 Operations and Maintenance

Offshore Project Area

During operation, the primary potential impacts of offshore wind developments on birds are habitat loss due to displacement, and mortality due to collision (Drewitt and Langston 2006, Fox et al. 2006, Goodale and Milman 2016). The lighting associated with wind turbines and the offshore substation may result in attraction of birds and increased risk of collision (Fox and Petersen 2019). Other IPFs are not discussed in detail here as they are expected to have limited impacts on birds during Project operation. Since the potential impacts from the offshore export cable corridor are primarily the temporary disturbance of benthic feeding habitat during construction, impacts from the proposed submarine cables and offshore sub-stations are expected to be minimal, and therefore, are not discussed in detail. During operation, the risk of habitat loss and collision mortality will be species dependent.

Below, the potential impacts of the Project are discussed for each major species group (non-marine and marine birds), with additional information on Federally listed species. Since potential impacts during construction are temporary and unlikely to cause population level impacts (see Appendix H), the discussion below is focused on the potential impacts of operation. At the end of the section, mitigation and monitoring approaches are detailed.

Non-marine Migratory Birds

<u>Shorebirds</u>

Exposure of shorebirds to construction and operation is minimal, would be limited to migration, and few shorebirds were observed offshore in the NJDEP EBS surveys (the Wind Farm Area is 15 miles offshore at its closest point). Due to the limited exposure of these species, a vulnerability and risk assessment was not conducted for non-ESA shorebird species. Two shorebird species are Federally protected under the ESA and are addressed in detail below:

- *Piping Plover*: Due to their proximity to shore during breeding, Piping Plover exposure to the Project is limited to migration and there is no habitat for the species in the Wind Farm Area. The migratory flight height of Piping Plovers tagged with nanotags were generally above the rotor-swept zone (RSZ), defined in the study as 82 to 820 ft (25 to 250 m), with 15.2 percent of birds flying through the RSZ in Wind Energy Areas (Loring *et al*. 2017). Offshore radar studies have recorded shorebirds flying at 3,000 to 6,500 ft (1,000 to 2,000 m; Rachardson 1976, Williams and Williams 1990 *in* Loring *et al*. 2017), while nearshore radar studies have recorded lower flight heights of 330 ft (100 m). Flight heights can vary with weather; during times of poor visibility the birds may fly lower, within the RSZ (Dirksen *et al*. 2000 *in* Loring *et al*. 2017). Since the birds generally migrate at flight heights above the RSZ, potential exposure to collisions with turbines, construction equipment, or other structures is reduced. They also have good visual acuity and maneuverability in the air (Burger *et al.* 2011), and there is no evidence to suggest that they are particularly vulnerable to collisions. Given that the exposure of Piping Plovers will be limited to migration, they have low vulnerability to collision, and there is no evidence of vulnerability to displacement, individual level impacts are unlikely.
- *Red Knot*: Red Knot exposure to the Project is limited to migration. Flight heights during migration are thought to be well above the RSZ for long-distance migrants (Burger *et al.* 2012), but there is potential for exposure to collision for shorter-distance migrants that can traverse the WEA within 82 to 820 ft (25 to 250 m), particularly during the fall (Loring *et al.* 2018). Ocean Wind conducted a study to track short-distance migrant Red Knots captured at sites in coastal New Jersey in 2021 using satellite telemetry (BRI and WRP 2022; Appendix E). Of the 17 individuals with tags that provided data, five made migratory movements within the life of the tags, including four short-distance migrants and one long-

distance migrant. Tracks indicate that one of the short-distance migrants may have flown through the Lease Area. Overall, the majority of locations established by satellite tags were associated with relatively low flight height estimates (BRI and WRP 2022). Migration flights are generally undertaken at night, but in fine weather conditions with good visibility (Loring *et al.* 2018), perhaps lessening collision risk. Given that Red Knot exposure will be limited to migration and that these birds have minimal to low vulnerability to both collision and displacement (Appendix H), individual level impacts are unlikely.

Wading Birds

Exposure during Project operation is considered to be minimal because wading birds spend a majority of the year in freshwater aquatic systems and near-shore marine system, and the NJDEP EBS surveys had few observations of wading birds offshore. Due to the minimal exposure, a vulnerability and risk assessment was not conducted.

Raptors

Raptor exposure to the Wind Farm Area is expected to be limited to falcons. While falcons are documented to migrate offshore, individuals are more likely to fly close to coastal areas. Falcons may use turbines as perches which may increase temporal exposure during the short-duration migration period. Falcon mortalities have been documented at terrestrial wind farms, but not at European offshore wind developments, though monitoring for collision and mortality offshore is inherently more difficult. Falcons were also considered to have low collision risk at the Horns Rev 3 offshore wind farm in Denmark based on various visual and radar-based surveys at existing offshore wind farms (Jensen *et al.* 2014). Overall, the vulnerability to falcons is limited to collision with wind turbines. However, considerable uncertainty exists about what proportion of migrating falcons, particularly Peregrine Falcons, might be attracted to offshore wind energy projects for perching, roosting and foraging, and the extent to which individuals might avoid turbines or collide with them. Eagles are listed under the Eagle Act and are discussed in greater detail below.

- *Eagles*: Both Bald Eagles and Golden Eagles are Federally protected under the Eagle Act. For both species exposure is expected to be minimal because these birds are rarely observed far offshore and the general morphology of both Bald Eagles and Golden Eagles dissuades regular use of offshore habitats (Kerlinger 1985). Although there is little research on eagle interactions with offshore developments, eagles are expected to have a minimal vulnerability to collision and displacement. Therefore, the individual level impacts during construction and operation are unlikely.

Songbirds

Exposure of songbirds to operation is considered to be minimal to low because they do not use the offshore marine system as habitat, and there is little evidence of songbird use of the Wind Farm Area outside of the migratory periods. If exposed to offshore wind turbines, some songbirds may be vulnerable to collision. In some instances, songbirds may be able to avoid colliding with offshore wind turbines (Petersen *et al.* 2006), but are known to collide with illuminated terrestrial and marine structures (Fox *et al.* 2006). Songbirds typically migrate at heights of 295 - 1,968 ft (90 - 600 m) (NYSERDA 2010), but can fly lower during inclement weather or with headwinds. While the sample size is low (n = 333), flight heights recorded during the NJDEP EBS survey show that songbirds generally fly below 100 ft (30 m) during the day. At Nysted, Denmark, in 2,400 hours of monitoring with an infrared video camera, only one collision of an unidentified small bird was detected (Petersen *et al.* 2006). At the Thanet Offshore Wind Farm, thermal imaging did not detect any songbird collision (Skov *et al.* 2018). Overall, population-level impacts are unlikely because, while these birds have some vulnerability to collision, they have minimal to low exposure, which will be limited to migration.

Coastal Waterbirds

Exposure is considered to be minimal because coastal waterfowl spend a majority of the year in freshwater aquatic systems and near-shore marine systems. In addition, the NJDEP EBS surveys had few observations of waterbirds offshore. Due to the minimal exposure, a vulnerability and risk assessment was not conducted.

Marine Birds

Marine bird distributions are generally more pelagic and widespread than coastal birds. A total of 83 marine bird species are known to regularly occur off the eastern seaboard of the U.S. (Nisbet *et al.* 2013). Many of these marine bird species use the Wind Farm Area during multiple time periods, either seasonally or year-round, including loons, petrels and shearwaters, gannets, gulls and terns, and auks. Below each major taxonomic group is discussed separately, and the Roseate Tern, listed under the ESA, is discussed individually.

Loons

Exposure to operation is considered to be low to medium because loons may pass through the Wind Farm Area during spring and fall migration and Common Loons may use the area during the winter. Loons are consistently identified as being vulnerable to displacement, but not particularly vulnerable to collision (Garthe and Hüppop 2004, Furness *et al.* 2013, MMO 2018). Red-throated Loons have been documented to avoid offshore wind developments, which can lead to displacement (Dierschke *et al.* 2016), and Common Loons likely will have a similar avoidance response. Overall, population level impacts to loons from displacement is unlikely, because loons are generally concentrated closer to shore and there is foraging habitat available to the birds adjacent to the Wind Farm Area.

Seaducks

Exposure is considered to be minimal to low because the MDAT models and NJDEP EBS surveys indicate some use of the Wind Farm Area, the average counts of seaduck within the Wind Farm Area were generally lower than in the NJDEP EBS survey area, and the literature indicates that seaduck exposure will be primarily limited to migration or travel between wintering sites. Seaducks, particularly scoters, have been identified as being vulnerable to displacement (MMO 2018), although this has been shown to be temporary for some species. Sea ducks are generally not considered vulnerable to collision (Furness *et al.* 2013), flying primarily below 100 ft (30 m). Population level impacts to seaducks are unlikely because they have limited exposure to the Array.

Petrel Group

Overall, exposure is considered to be minimal to low because, while the petrel group is commonly observed throughout the region during the summer months, the bulk of these populations are concentrated offshore and in the Gulf of Maine. Shearwaters and storm-petrels rank at the bottom of displacement vulnerability assessments (Furness *et al.* 2013), and the flight height data from the NJDEP EBS surveys indicates the birds fly below 100 ft (30 m). Therefore, since exposure and vulnerable are minimal, population level impacts are unlikely.

Gannets, Cormorants, and Pelicans

Northern Gannet exposure is considered to be low to medium because individual tracking data indicates the Wind Farm Area is within a core use area for the birds during the winter, spring, and fall. Cormorants (primarily double-crested) have minimal exposure because few cormorants were observed offshore during the NJDEP

EBS surveys. Since pelicans are rare in the area, and New Jersey is at the northern extent of their range, few individuals are expected to be exposed to the Project.

The Northern Gannet is identified as being vulnerable to both displacement and collision: gannets are considered to be vulnerable to displacement from habitat because studies indicate that they strongly avoid offshore wind developments (Krijgsveld *et al.* 2011, Cook *et al.* 2012, Hartman *et al.* 2012, Vanermen *et al.* 2015, Dierschke *et al.* 2016, Garthe *et al.* 2017). When gannets enter a wind development, however, they may also be vulnerable to collision because they have the potential to fly within the RSZ (Furness *et al.* 2013, Garthe *et al.* 2014, Cleasby *et al.* 2015). Flight height data collected during the NJDEP EBS surveys indicate the Northern Gannets are flying below 100 ft (30 m) 75 percent of the time. Overall, population level impacts to species within this group is unlikely because pelicans and cormorants have minimal exposure; and any foraging habitat that gannets lose is unlikely to impact population trends because of the relatively small size of the Offshore Project Area in relation to available foraging habitat.

Gulls, Skuas, and Jaegers

There are 12 species of gulls, skuas, and jaegers that could be exposed to the Project, but only nine species in this group were observed in the NJDEP surveys. Overall, exposure of birds within this group is minimal to medium depending on the species and season (see Appendix H for details). Jaegers and gulls are considered to be vulnerable to collision, but not displacement (Furness *et al.* 2013). At European offshore wind developments, gulls have been documented to be attracted to wind turbines, which may be the result of increased boat traffic, new food resources, or new loafing habitat (i.e., perching areas; Fox *et al.* 2006, Vanermen *et al.* 2015), but interaction with offshore wind developments varies by season (Thaxter *et al.* 2015). Recent research suggests that some gull species may not exhibit macro-avoidance of the wind farm, but will preferentially fly between turbines, suggesting meso-avoidance that would reduce overall collision risk (Thaxter *et al.* 2018). While gulls are vulnerable to collision, population level impacts are unlikely for this group.

Terns

Overall, exposure is considered to be low to medium based upon the regional MDAT models and the NJDEP EBS surveys. Terns are considered to be vulnerable to collisions, but not generally to displacement (Garthe and Hüppop 2004, Furness *et al.* 2013). Tern flight heights recorded in the NJDEP EBS surveys indicate the birds are almost exclusively flying below 100 ft (30 m) a majority of the time. A recent nanotag study estimated that Common Terns primarily flew below 82 ft (25 m) and that the frequency of Common Terns flying offshore between 82-820 ft (25-250 m) ranged from 0.9-9.8 percent (Loring *et al*. 2017). Common Terns and Roseate Terns tended to avoid the airspace around a 660 kW turbine at the Massachusetts Maritime Academy when the turbine was rotating, and usually avoided the RSZ (Vlietstra 2007). Most observed tern mortalities in Europe have occurred at turbines <98 ft (30 m) from nests (Burger *et al.* 2011). While terns can collide with turbines, overall, the population level impacts are unlikely because the Project is far from breeding colonies and exposure will be low.

Roseate Tern: Since there are no local breeding colonies of Roseate Terns in New Jersey, exposure will be limited to migration. Roseate Terns have not been confirmed in the Wind Farm Area and an analysis of unknown tern observations (NJDEP EBS data) in the Wind Farm Area indicate few, if any, of the unknowns were likely to be Roseate Terns. The altitude at which Roseate Terns migrate offshore is still poorly understood, but is thought to be higher than foraging altitudes or nearshore flight altitudes (likely hundreds to thousands of meters; Perkins *et al.* 2004, MMS 2008). A recent nanotag study estimated that terns primarily flew below the RSZ (<82 ft [25 m]) and that Roseate Terns flying offshore only occasionally flew within the lower portion of the RSZ (Federal waters, 6.4 percent; Wind Energy Areas, 0 percent; Loring *et al*. 2017). As described above, terns are identified as having low vulnerability to collision and there is little evidence to indicate they are displaced from offshore wind farms. Therefore, due to exposure being limited to migration and low vulnerability, individual level impacts are unlikely.

<u>Auks</u>

Exposure is considered to be minimal to low because the MDAT models indicate auks are more concentrated offshore and in the Gulf of Maine, and few birds were observed during the NJDEP EBS surveys. Auks are considered to be vulnerable to displacement, but not collision. Due to a sensitivity to disturbance from boat traffic and a high habitat specialization, many auks rank high in displacement vulnerability assessments (Furness *et al.* 2013, Dierschke *et al.* 2016, Wade *et al.* 2016). Population level impacts are unlikely, however, because there is generally low use of the Wind Farm Area by auk populations.

Onshore Project Area

Generally, operation is not expected to pose any significant IPFs (i.e., hazards) to birds (BOEM 2018b) because activities will disturb little if any habitat, and the transmission lines will be primarily below ground. Overhead transmission lines are unlikely to be a significant IPF because they are short (< 0.5 miles [0.8 km]); located in existing highly disturbed industrial areas that are unlikely to provide important bird habitat; and best practices, such as implementing Avian Power Line Interaction Committee (APLIC) standard design guidance to the extent practicable, will be used to minimize potential impacts from collision and electrocution (see Appendix H for further discussion). Noise and vibration generated by maintenance equipment may temporarily disturb some birds within nearby habitat, but these birds are expected to return once the activity is complete.

2.2.3.2.3 Decommissioning

Offshore Project Area

The impacts from decommissioning are expected to be the same or less than construction activities.

Onshore Project Area

Decommissioning is expected to be equal to or less than impacts from construction, and the Project will use the best practices available at the time to minimize potential impacts.

2.2.3.2.4 Summary of Potential Project Impacts on Bird Resources

The IPFs affecting birds include physical seabed/land disturbance, habitat conversion, visible structures/lighting, and traffic. As IPFs such as seabed disturbance, noise, and vessel traffic are expected to be temporary and highly localized, the potential impacts primarily affecting birds are expected to be collision with visible structures and displacement from the Project area.

During construction, activities offshore will be short-term and are unlikely to impact bird populations. Onshore, potential temporary construction impacts include onshore habitat modification and disturbance, but these will be limited to small areas. During offshore operations, the potential long-term impacts are collision and habitat loss due to displacement, but population level impacts are unlikely (see detailed discussion above and in Appendix H). Long-term onshore habitat loss impacts are expected to be limited, because substations will be co-located in existing disturbed areas and cables will be buried.

2.2.3.3 Avoidance, Minimization, and Mitigation Measures

The proposed measures for avoiding, minimizing, reducing, eliminating, and monitoring environmental impacts for the Project are presented in **Table 1.1-2.** Ocean Wind's Avian and Bat Post-Construction Monitoring Framework (Appendix AB) describes the anticipated monitoring to be employed during Project operations.

2.2.4 Bats

2.2.4.1 Affected Environment

This bat assessment provides an overview of the bat community that has the potential to be exposed to the proposed onshore and offshore Project activities, with separate sections on Federally listed species. Appendix H provides a detailed, and more comprehensive assessment of the bat species that may be exposed to the Project. Below, a summary of Appendix H is provided for the offshore and onshore components of the Project.

2.2.4.1.1 Overview of bats in New Jersey

There are nine species of bats present in the State of New Jersey, of which six are year-round residents (**Table 2.2.4-1**) (Maslo and Leu 2013). These species can be broken down into two major groups based on their wintering strategy: cave-hibernating bats and migratory tree bats. Both groups of bats are nocturnal insectivores that use a variety of forested and open habitats for foraging during the summer (Barbour and Davis 1969). Cave-hibernating bats are generally not observed offshore (Dowling and O'Dell 2018) and, in the winter, migrate from summer habitat to hibernacula in the mid-Atlantic regional (Maslo and Leu 2013). Tree bats fly to southern parts of the U.S. in the winter and are observed offshore during migration (Hatch *et al.* 2013).

Table 2.2.4-1. Bat species present in New Jersey and their conservation status (Maslo and Leu 2013).

Common Name	Scientific Name	Type	State Status	Federal Status
Eastern small-footed bat	*Myotis leibii*	Cave-Hibernating Bat	-	-
Little brown bat	*Myotis lucifugus*	Cave-Hibernating Bat	-	-
Northern long-eared bat	*Myotis septentrionalis*	Cave-Hibernating Bat	-	T
Indiana bat*	*Myotis sodalis*	Cave-Hibernating Bat	E	E
Tri-colored bat	*Perimyotis subflavus*	Cave-Hibernating Bat	-	-
Big brown bat	*Eptesicus fuscus*	Cave-Hibernating Bat	-	-
Eastern red bat	*Lasiurus borealis*	Migratory Tree Bat	-	-
Hoary bat	*Lasiurus cinereus*	Migratory Tree Bat	-	-
Silver-haired bat	*Lasionycteris noctivigans*	Migratory Tree Bat	-	-

*Range does not indicate species present in the Project Area
"Type" refers to two major life history strategies among bats in eastern North America; cave-hibernating bats roost in large numbers in caves during the winter, while migratory tree bats do not aggregate in caves and are known to migrate considerable distances.
E=endangered; T=threatened.

Two Federally listed bats are present in New Jersey: Indiana bat and northern long-eared bat. The northern long-eared bat is found in Monmouth, Ocean, and Atlantic counties of New Jersey. Historical records and current records of Indiana bat only demonstrate its presence in Northern New Jersey to western central areas (Barbour and Davis 1969; USFWS New Jersey Field Office 2017). Thus, this assessment will focus solely on the potential exposure of northern long-eared bat to the Onshore and Offshore Project Areas.

Below, exposure of bats to the Onshore Project Area and the Offshore Project Area are assessed separately.

2.2.4.1.2 Offshore Project Area

While there is uncertainty on the specific movements of bats offshore, bats have been documented in the marine environment in the U.S. (Grady and Olson 2006, Cryan and Brown 2007, Johnson et al. 2011b, Hatch et al. 2013, Pelletier et al. 2013, Dowling and O'Dell 2018). Bats have been observed to temporarily roost on structures on nearshore islands such as lighthouses (Dowling *et al.* 2017) and there is historical evidence of bats, particularly the eastern red bat, migrating offshore in the Atlantic (Hatch *et al.* 2013). In a mid-Atlantic bat acoustic study conducted during the spring and fall of 2009 and 2010 (86 nights), the maximum distance that bats were detected from shore was 13.6 miles (21.9 km) and the mean distance was 5.2 miles (8.4 km) (Sjollema *et al.* 2014). In Maine, bats were detected on islands up to 25.8 miles (41.6 km) from the mainland (Peterson *et al.* 2014). In the mid-Atlantic acoustic study, eastern red bat comprised 78 percent (166 bat detections during 898 monitoring hours) of all bat detections offshore and bat activity decreased as wind increased (Sjollema *et al.* 2014). In addition, eastern red bats were detected in the mid-Atlantic up to 27.3 miles (44 km) offshore by high-definition video aerial surveys (Hatch *et al.* 2013).

Cave-hibernating bats

Cave-hibernating bats hibernate regionally in caves, mines, and other structures and feed primarily on insects in terrestrial and fresh-water habitats. These species generally exhibit lower activity in the offshore environment than the migratory tree bats (Sjollema *et al.* 2014), with movements primarily during the fall. In the mid-Atlantic, the maximum distance *Myotis* bats were detected off shore was 7.2 miles (11.5 km; (Sjollema *et al.* 2014). A recent nano-tracking study on Martha's Vineyard recorded little brown bat (*n* = 3) movements off the island in late August and early September with one individual flying from Martha's Vineyard to Cape Cod (Dowling *et al.* 2017). Big brown bats (*n* = 2) were also detected migrating from the island later in the year (October-November; Dowling *et al.* 2017)). These findings are supported by an acoustic study conducted on islands and buoys of the Gulf of Maine that indicated the greatest percentage of activity in July-October (Peterson *et al.* 2014). Given that the use of the coastline as a migratory pathway by cave-hibernating bats is likely limited to their fall migration period, that acoustic studies indicate lower use of the offshore environment by cave-hibernating bats, and that cave-hibernating bats do not regularly feed on insects over the ocean, exposure to the Wind Farm Area is unlikely for this group. Northern long-eared bats are discussed in greater depth below.

Northern long-eared bat

Northern long-eared bats are not expected to be exposed to the Wind Farm Area. While there is little information on the movements of northern long-eared bat over the ocean, a recent tracking study on Martha's Vineyard (n = 8; July-October 2016) did not record any offshore movements (Dowling *et al.* 2017). If northern long-eared bats were to migrate over water, movements would likely be in close proximity to the mainland (locations of maternity roosts in New Jersey are discussed in the onshore section).

Migratory tree bats

Tree bats migrate south to overwinter and have been documented in the offshore environment (Hatch *et al.* 2013). Eastern red bats have been detected migrating from Martha's Vineyard late in the fall and one bat tracked as far south as Maryland (Dowling *et al.* 2017). These results are supported by historical observations of eastern-red bats offshore and recent acoustic and survey results (Hatch *et al.* 2013, Peterson *et al.* 2014, Sjollema *et al.* 2014). While little local data is available, the NJDEP EBS surveys recorded several observations of bats flying over the ocean, with observations of migratory tree bats in the near-shore portion of the Wind Farm Area. Given that tree-bats were detected in the offshore environment, they may pass through the Project Area during the migration period.

2.2.4.1.3 Onshore Project Area

Bat species present in New Jersey are nocturnal insectivores. Preferred foraging habitats vary among species, however, and the type of foraging habitat a bat species selects may be linked to the flight capabilities, preferred diet, and echolocation capabilities of each species (Norberg and Rayner 1987). Small, maneuverable species like the Northern long-eared bat and the little brown bat can forage in cluttered conditions such as the forest understory or small forest gaps. Larger, faster-flying bats, such as the hoary bat, often forage above the forest canopy or in forest gaps (Taylor 2006). Some species, such as the little brown bat and the tri-colored bats, regularly forage over water sources. The big brown bat, eastern red bat, and hoary bat are also known to use waterways as foraging areas, as well as travel corridors (Barbour and Davis 1969).

Forested habitats, such as the area adjacent to the proposed onshore export cable routes at BL England and Oyster Creek, can provide roosting areas for both migratory and non-migratory species. Bat species are known to utilize forested areas (of varying types) during summer for roosting and foraging. Some of these species roost solely in the foliage of trees, while others select dead and dying trees where they roost in peeling bark or inside crevices. Some species may select forest interior sites, while others prefer edge habitats (Barbour and Davis 1969).

Caves and mines provide key habitat to for non-migratory bats. These locations serve as winter hibernacula, fall swarm locations (areas where mating takes place in the fall months), and summer roosting locations for some individuals. Hibernacula are documented in New Jersey, but the numbers of individuals at the sites have declined dramatically because of white-nose syndrome (NJ Division of Fish and Wildlife 2017).

Although there is no data for non-listed species in this area, BRI has completed field work in the area at Edwin B. Forsythe National Wildlife Refuge (about 6 miles south of Oyster Creek and about 30 miles north of BL England) where BRI biologists did capture northern long-eared, red, big brown and little brown bats in 2011. No telemetry was done so it is unknown if the captured bats used the refuge or surrounding areas for roosting. Since 2011, the fungal disease known as white-nose syndrome has substantially reduced Myotis bat populations in New Jersey (NJDFW 2017) and generally there are fewer bats along the coast of New Jersey.

Overall, while both cave-hibernating and migratory tree bats may occur in the area around both BL England and Oyster Creek, the onshore export cable corridors are not likely to provide suitable habitat because, to the extent practical, they are co-located with existing disturbed areas (e.g., roads, transmission lines).

Northern long-eared bat

The northern long-eared bat is an insectivorous bat that hibernates in caves, mines, and other locations (possibly talus slopes) in winter, and spends the remainder of the year in forested habitats. The species' range includes most of the eastern and mid-western United States and southern Canada. Due to impacts from the fungal disease white-nose syndrome, the species has declined by 90-100 percent in most locations where the disease has occurred, and declines are expected to continue as white-nose syndrome spreads throughout the remainder of the species' range (USFWS 2016). As a result, the northern long-eared bat was listed as Threatened under the ESA in 2015 with a 4(d) rule. In the areas of the country affected by white nose syndrome, the 4(d) rule prohibits incidental take that may occur from tree removal activities within 150 feet of a known occupied maternity roost during the pup season (June 1 through July 31) or within 0.25 miles of a hibernation site, year round (USFWS 2016). Northern-long eared bat maternity roosts have been detected in Atlantic County (BL England) and Ocean County (Oyster Creek; USFWS New Jersey Field Office 2017), indicating that they could be present in the study areas but the onshore export cable corridors are not likely to provide suitable foraging or roosting habitat due to existing levels of disturbance.

2.2.4.2 Potential Project Impacts on Bats

The potential impacts of the Project to bats were evaluated by considering the exposure of bats to project hazards (i.e., IPF). This section is a summary of the extensive assessment conducted in Appendix H, which provides a detailed analysis of the exposure, vulnerability, and risk to bats from each Project development phase and component.

Impact producing factors that may potentially affect bats include the following and are discussed in the following sections:

- Habitat conversion
- Noise
- Visible structures/lighting
- Traffic

2.2.4.2.1 Construction

Offshore Project Area

During construction, bats may be attracted to vessels installing wind turbines, sub-stations, or export cables, particularly if insects are drawn to the lights of the vessels. However, stationary objects are not generally considered a collision risk for bats (BOEM 2012b). Therefore, behavioral vulnerability to collision with construction equipment is limited, and population level impacts from construction to all bat species are considered unlikely.

Onshore Project Area

The primary potential effect of the onshore Project components to all bats, including northern long-eared bats, is habitat modification during construction. When the transmission lines are installed, permanent ROW and temporary workspace may be disturbed, including limited cutting of trees. However, the majority of the proposed routes are located in already disturbed areas (e.g., roadways, transmission lines), and the cutting of trees is not expected to cause any loss of important habitat for northern long-eared bats and other species. If tree clearing is required in areas with trees suitable for bat roosting during the period when northern long-eared bats may be present, Ocean Wind will develop avoidance and minimization measures in coordination with USFWS and NJDEP. Noise and vibration generated by construction equipment may temporarily disturb some bats within nearby habitat, but these bats are expected to return once the activity is complete. Overall, habitat loss would be limited, population level impacts for non-listed species are unlikely, and individual level impacts for the northern long-eared bat are unlikely. Therefore, individual and population level impacts are expected to be low.

2.2.4.2.2 Operations and Maintenance

Offshore Project Area

During operation, the potential impact to bats is mortality or injury from collision with wind turbines. At terrestrial wind farms in the U.S., bat mortality has been documented (Cryan and Barclay 2009, Hayes 2013, Smallwood 2013, Martin *et al.* 2017, Pettit and O'Keefe 2017), and affects predominantly migratory tree-roosting bats (Kunz *et al.* 2007). As described in Section 2.2.4.1, cave-hibernating bats, including northern long-eared bats, are generally not observed offshore (Sjollema *et al.* 2014, Dowling and O'Dell 2018), and exposure is expected to be minimal to low. Therefore, impacts to individuals and populations are unlikely. Migratory tree bats have the potential to pass through the Wind Farm Area, but overall a small number of bats are expected in the New Jersey Wind Energy Area given its distance from shore (BOEM 2012b). Therefore, population level impacts are unlikely.

Onshore Project Area

Generally, onshore operation is not expected to pose any significant hazards (BOEM 2018b) because any additional activities will disturb little, if any, habitat, and the transmission lines will be primarily below ground. Overhead transmission lines between the interconnection point and the onshore substation would not be expected to affect bats and bat habitat because bats generally do not collide with stationary objects and no loss of important bat habitat is expected because overhead lines would be constructed in existing highly disturbed industrial areas (see discussion of effects to birds, Section 2.2.3.2.2, Onshore Project Area). Noise and vibration generated by maintenance equipment may temporarily disturb some bats within nearby habitat, but these bats are expected to return once the activity is complete.

2.2.4.2.3 Decommissioning

Impacts from decommissioning are expected to be equal to or less than impacts from construction for both the Offshore Project Area and the Onshore Project Area. The Project will use best practices available at the time to minimize potential impacts.

2.2.4.2.4 Summary of Potential Project Impacts on Bats

The IPFs affecting bats include habitat conversion, visible structures/lighting, noise, and traffic.

Potential temporary construction impacts include short-term disturbance offshore and habitat modification onshore, which are expected to be localized and temporary with the application of APMs.

During operation, the long-term potential impacts offshore are collision with visible structures and, onshore, habitat loss due to habitat disturbance, but population level impacts are unlikely. Long-term or permanent habitat loss would occur if trees providing bat habitat are removed, but this is expected to be very limited if at all due to facilities co-located in existing disturbed areas.

2.2.4.3 Avoidance, Minimization, and Mitigation Measures

The proposed measures for avoiding, minimizing, reducing, eliminating, and monitoring environmental impacts for the Project are presented in **Table 1.1-2**. Ocean Wind's Avian and Bat Post-Construction Monitoring Framework (Appendix AB) describes the anticipated monitoring to be employed during Project operations.

2.2.5 Benthic Resources

2.2.5.1 Affected Environment

This section describes the existing benthic resources in the marine waters of the Offshore Project Area (Wind Farm Area and offshore export cable corridors) and the estuarine waters of the offshore export cable corridors. Potential impacts from the Ocean Wind Offshore Wind Farm Project are also presented. Benthic Resources include flora and fauna such as SAV and invertebrates. Data used to describe these resources came from various entities spanning decades of studies. Primary resources included Ocean Wind's floating light detection and ranging (FLiDAR) surveys of the Lease Area, the Mid-Atlantic Ocean Data Portal description of benthic habitat, Habitat Mapping and Assessment of Northeast Wind Energy Areas (Guida *et al.* 2017), an Assessment of Ecological Status of Benthic Communities in New Jersey Marine Coastal Waters (Ramey, Kennish, & Petrecca 2011), and NJDEP's Ocean/Wind Power Ecological Baseline Studies (NJDEP 2010b). Data consist of both grab samples and imagery that span spring, summer, and fall across multiple years. These data allow for the characterization of species community composition, abundance, and diversity in the Project Area.

Per the Guidelines for Providing Benthic Habitat Survey Information for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585, readily available public data will be augmented with data collected during the high-resolution geophysical and geotechnical (HRG&G) surveys for the Project. The survey data will be reviewed to confirm benthic habitat Coastal and Marine Ecological Classification Standard (CMECS). As part of the site investigations survey, Ocean Wind conducted a benthic habitat assessment using sediment grabs and sediment profile and plan view imaging; the benthic habitat assessment report is included in Appendix E.

2.2.5.1.1 Benthic Invertebrate Community

Offshore Project Area

The Mid-Atlantic Ocean Data Portal and the Nature Conservancy (Greene *et al.* 2010) have characterized species, habitats, and ecosystems of the Offshore Project Area. According to these sources, the benthic habitat within the Wind Farm Area is made up of substrate ranging from fine (0.005-0.010 in) (0.125-0.25 mm) to coarse (0.02-0.039 in) (0.5-1 mm) sands at depths of 82-148 ft (25-45 m). More information on substrate type can be found in Section 2.1.1 Geological Resources.

In 2017, Ocean Wind conducted benthic habitat surveys associated with two FLiDAR locations within the Lease Area. Samples were collected using a 0.1 m^2 Day grab sampler and groundtruthed with a camera. Sediments were characterized as sandy with shell fragments and tube worms and sand dollars as being the dominant fauna. The benthic community at each FLiDAR location is typical of sandy bottom habitats and included Annelida, Arthropoda, Mollusca and Echinodermata (Alpine 2017a). Based on seabed imagery and sampling, there was no evidence of sensitive benthic habitats, as defined by BOEM (2013), such as exposed hard bottoms, algal beds, or the presence of anthozoan species. Additionally, there is no critical habitat for fish mapped by the USFWS or National Marine Fisheries Service (NMFS).

Offshore benthic habitat of New Jersey has been studied by various entities. Byrnes and Hammer (2001) conducted a study to evaluate the feasibility of sand borrowing and documented a sandy benthic habitat dominated by polychaete worms and Atlantic nut clams. Boesch (1979) categorized offshore benthic habitat a few miles offshore of Atlantic City as inner shelf coarse substrate with dynamic, uniformly coarse sand containing a benthic community dependent on changes in subtle bottom topography, particularly ridges and swales. Communities were dominated by mollusks (*Tellina agilis*), crustaceans (*Tanaissus liljeborgi*), polychaetes, and sand dollars (*Echinarachnius parma*).

Geo-Marine, Inc. reviewed available data for benthic invertebrate (epifauna) taxa that occur along the New Jersey inner shelf (NJDEP 2010b), which includes the Offshore Project Area. Common macrofauna within the Offshore Project Area include species from several taxa including echinoderms (e.g., sea stars, sea urchins, and sand dollars), cnidarians (e.g., sea anemones and corals), mollusks (e.g., bivalves, cephalopods, and gastropods), bryozoans, sponges, amphipods, and crustaceans (NJDEP 2010b). The mid-shelf is dominated by sand dollars and surfclams from about 131 ft to 230 ft (40 to 70 m) with various other epifauna (e.g., rock crabs, hermit crabs, cancer crabs, horseshoe crabs[8], spider crabs, and lobsters) found throughout the shelf (NJDEP 2010b). Within the near-shore area, common crustaceans include hermit crabs (*Pagurus* spp.), Atlantic rock crab (*Cancer irrotatus*) and sevenspine bay shrimp (*Crangon septemspinosa*) (NJDEP 2010b). A summary is provided in **Table 2.2.5-1**.

Table 2.2.5-1. Summary of common benthic invertebrate species that inhabit the Offshore Project Area.

Common Name	Scientific Name
Echinoderms	
N/A	*Cidaris abyssicola*
Purple-spined sea urchin	*Arbacia punctulata*
Northern sea urchin	*Strongylocentrotus droebachiensis*
Common sand dollar	*Echinarachnius parma*
Five-slotted sand dollar	*Mellita quinquiesperforata*

[8] Horseshoe crabs spend winter 20 to 60 feet deep on the continental shelf (ASMFC 2013).

Common Name	Scientific Name
N/A	*Schizaster orbignyanus*
Sea potato	*Echinocardium cordatum*
Cnidarians	
Deeplet sea anemone	*Bolocera tuediae*
North American tube anemone	*Ceriantheopsis americanus*
Northern cerianthid	*Cerianthus borealis*
Lined sea anemone	*Edwardsiella lineata*
Plumose anemone	*Metridium senile*
Mollusks	
Atlantic surfclam	*Spisula solidissima*
Long-finned squid	*Loligo pealei*
Short-finned squid	*Illex illecebrosus*
Common octopus	*Octopus vulgaris*
Whelks	*Busycon* spp.
Northern moon snail	*Euspira heros*
Shark eye	*Nevirita duplicata*
Bryozoans	
N/A	*Bowerbankia imbricata*
N/A	*Bugula fulva*
N/A	*Nolella stipata*
Crustaceans	
Hermit crabs	*Pagurus* spp.
Atlantic rock crab	*Cancer irroratus*
Sevenspine bay shrimp	*Crangon septemspinosa*
American horseshoe crab	*Limulus polyphemus*
Lady crab	*Ovalipes ocellatus*
Spider crab	*Libinia emarginata*

Source: NJDEP 2010b

Within the Project Area, Guida *et al*. (2017) used the CMECS habitat classification system and identified the following benthic assemblages: small surface-burrowing fauna, small tube-building fauna, clam beds and sand dollar beds. Amphipods were present but not a core assemblage. Records of shellfish species of concern in the NJ WEA include sea scallop, surfclam and ocean quahog. Ocean quahog was not found in the Ocean Wind Lease Area. Sea scallops occurred in the Ocean Wind Lease Area and the adjacent OCS-A 0499, but were more commonly encountered in OCS-A 0499. In most cases they were trawled up only in small numbers and are not abundant within the Project Area. Since quantitative trawl captures were located at the mid-point of the trawl track, which may lie outside the WEA limits, it is not certain whether the sea scallops near the WEA boundary were actually caught inside or outside the WEA in some cases. Current sea scallop EFH does not intersect the NJ WEA (Guida *et al*. 2017).

The USEPA's National Coastal Assessment program is the most spatially and temporally comprehensive survey conducted on New Jersey benthic communities (Ramey, Kennish, and Petrecca 2011). The sampling program was designed to take into account episodic natural upwelling, offshore wastewater discharges, and State management zones. Samples were collected with a Van Veen grab from Sandy Hook to Cape May at 153 station along the Atlantic Coastline in August and September 2007 and 2009. In total over 110,000 individuals belonging to 273 species/taxa were identified. In a review of 19 studies on benthic soft-sediment fauna Ramey, Kennish, and Petrecca (2011) identified 540 benthic macrofaunal species/taxa in New Jersey Coastal Waters (Ramey, Kennish, and Petrecca 2011). Dominant taxonomic groups included polychaete and oligochaete worms (*Prionospio pygmaeus*, *Tharyx* sp. A, *Aricidea catherinae, Grania longiducta, Peosidrilus coeloprostatus*), amphipods (*Protohaustorius deichmannae*), and the bivalve *Nucula proxima*.

Horseshoe Crabs

The Delaware Bay supports the largest spawning population in the world of horseshoe crab. A 2013 stock assessment of the Delaware Bay indicated that the population remains stable from New Jersey south to Virginia (Atlantic States Marine Fisheries Commission [ASMFC] 2013). Little information is available on New Jersey horseshoe crab populations north of Delaware Bay. However, they would be considered a common species that could be encountered during construction, operations and maintenance, and decommissioning of the Project.

The Carl N Shuster, Jr. Horseshoe Crab Reserve is a NMFS-established sanctuary located in Federal waters off the New Jersey coast just south of Little Egg Harbor and extending to the southern edge of the Delaware Bay (**Figure 2.2.5-1**). The sanctuary was created to protect the large spawning population of horseshoe crabs in the Delaware Bay and maintain eggs available to migratory shorebirds. No commercial harvest of horseshoe crabs is permitted within the waters of the Carl N Shuster, Jr. Horseshoe Crab Reserve, but State and Federal regulations do not limit development activities within these waters. The horseshoe crab spawning season in the mid-Atlantic area usually occurs during May and June when large numbers of horseshoe crabs move onto sandy beaches to mate and lay eggs. Spawning habitat generally includes sandy beach areas within bays and coves that are protected from significant wave action. Male and female horseshoe crabs are coupled during mating and egg-laying. During the May and June horseshoe crab spawning season, migratory shorebirds, especially the red knot, are likely to be present on the beaches feeding on horseshoe crab eggs to replenish their body weight and continue the migration to their arctic breeding grounds. It is estimated that up to 11 species of shorebirds feed on American horseshoe crab eggs during their migrations along the eastern seaboard (NJDEP 2010b).

The NJDEP Ocean Trawl Surveys are bottom trawl surveys conducted from 1988 through 2019 seasonally within inshore (<30 ft depth), midshore (30-60 ft depth), and offshore (60-90 ft depth) waters from Sandy Hook, New Jersey to Cape Henlopen, Delaware (**Figure 2.2.5-1**). **Table 2.2.5-2** presents horseshoe crab collections by the different depth stratum areas and across all months of collection. Horseshoe crab collections appear to decrease with increasing water depth. The collections were highest in the inshore strata areas of less than 30 ft water depth during spring, summer, and fall. Winter had the lowest collections.

Table 2.2.5-2. Horseshoe crab collections by depth stratum area and month, 1988-2019.

Depth Stratum Area[1]	January	February[2]	April	June	August	October	December[2]	Total
15 (inshore)	2	1	350	337	699	170	-	1,559
16 (midshore)	6	-	49	4	104	182	-	345
17 (offshore)	2	-	14	1	-	26	-	43
18 (inshore)	5	-	953	880	1,642	478	-	3,958

Depth Stratum Area[1]	January	February[2]	April	June	August	October	December[2]	Total
19 (midshore)	14	-	243	237	394	382	1	1,271
20 (offshore)	4	1	72	4	17	80	-	178
23 (offshore)	113	2	252	7	14	233	1	622
TOTAL	146	4	1,933	1,470	2,870	1,551	2	7,976

1 – Depth stratum areas shown in following figure.
2 – Trawl survey only conducted in February 2017 and December 1989.

Estuarine Portion of the Offshore Export Cable Corridor

Benthic communities in back bays such as Barnegat Bay and Great Egg Harbor differ from that of the open ocean because these areas are protected from wave action and currents found in the open ocean. Reduced wave and current action influence substrate sediment type, which, along with other environmental factors such as water quality, dictate benthic communities. The Mid-Atlantic Ocean Data Portal and the Nature Conservancy (Greene *et al.* 2010) have characterized species, habitats, and ecosystems of the Estuarine Project Area, in particular the Barnegat Bay and Great Egg Harbor estuaries. According to these sources, the majority of the benthic habitat within Barnegat Bay is made up of very fine (0.002 - 0.005 in) (0.06 - 0.125 mm) and fine (0.005-0.010) (0.125 - 0.25 mm) sands at depths of less than 32.8 ft (10 m). The Absecon Bay inlet represents a transition zone between the protected back bays and the open ocean environment. The Absecon Bay Inlet is made up of mostly medium (0.01-0.02 in) (0.25 - 0.5 mm) and fine (0.005-0.010) (0.125 - 0.25 mm) sands at depths of less than 57 ft (17.4 meters). The Great Egg Harbor estuary is mapped as predominantly medium sand (0.01-0.02 in) (0.25 - 0.5 mm) at depths of less than 32.8 ft (10 meters). More information on substrate type can be found in Section 2.1.1 Geological Resources.

Taghon *et al.* (2017) studied the benthic community of Barnegat Bay using Van Veen grab samples that were analyzed to the lowest practical taxonomic unit (species in most cases). The benthic surveys were conducted in 2012, 2013 and 2014. During each survey, 97 stations were randomly selected in Barnegat Bay - Little Egg Harbor estuary. Taghon *et al.* (2017) found that benthic invertebrates were abundant, and the community was, in general, highly diverse. Spatial variability based on sediment size was observed. These data were then compared, where possible, to historical data collected from 1965 to 2010 and show few changes in abundance and species composition. A list of species collected can be found below in **Table 2.2.5-3**. Scott and Bruce (1999) conducted sampling in and around Great Egg Harbor Inlet as part of the assessment of offshore borrow pits and nearshore placement. Sampling was conducted on soft sandy bottoms and hard rocky intertidal areas. The most abundant taxa included common surf-zone clam (*Donax variabilis*), haustorid amphipod (*Amphiporeia virginiana*), mole crab (*Emerita talpoida*), and polychaete (*Scolelepis squamata*).

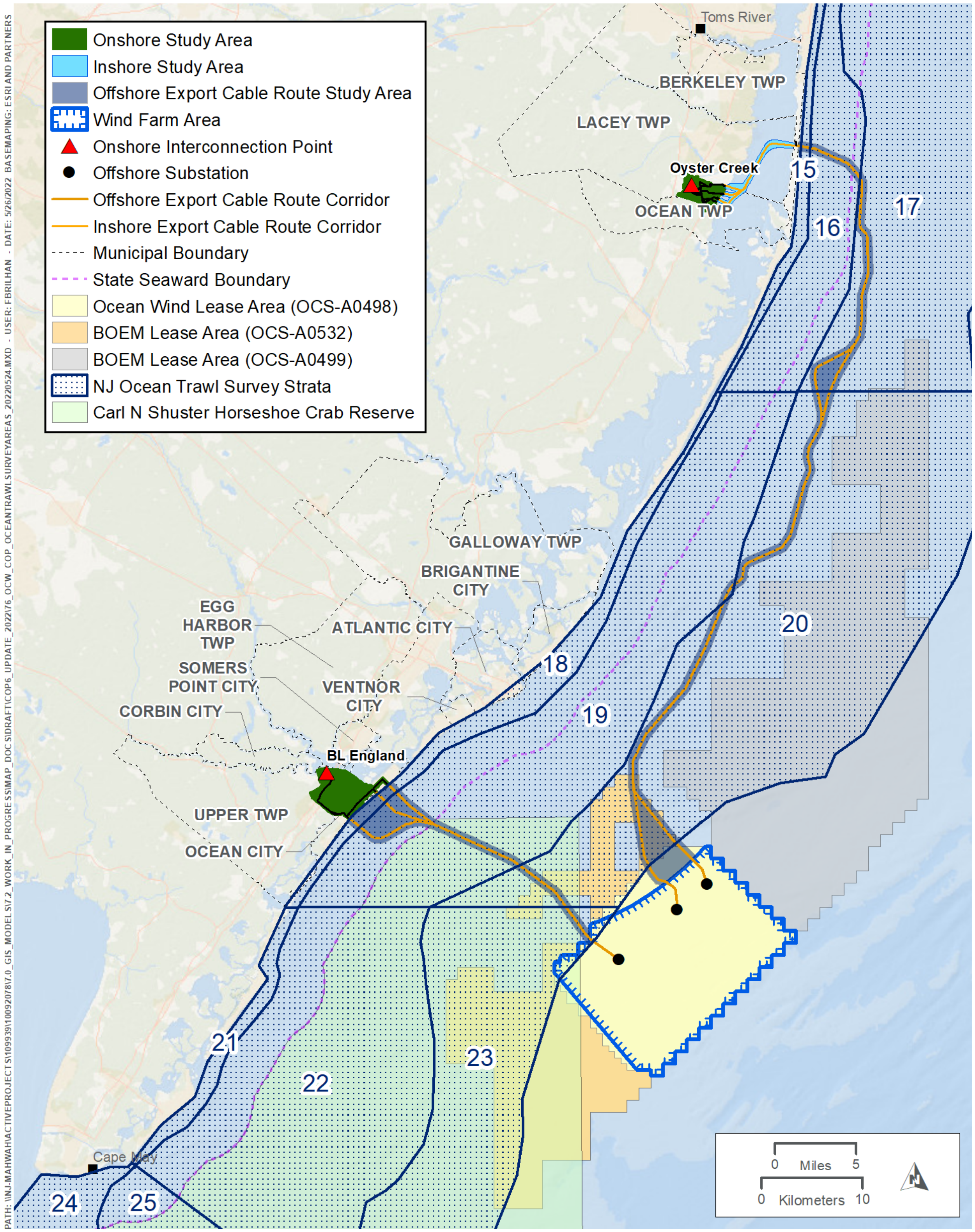

Figure 2.2.5-1. NJ ocean trawl survey areas and Carl N. Shuster, Jr. Horseshoe Crab Reserve.

Table 2.2.5-3. Benthic species identified in Barnegat Bay.

Species	Taxonomic Class
Acteocina canaliculata	Gastropoda
Ameritella agilis	Bivalvia
Ampelisca spp.	Malacostraca
Astyris lunata	Gastropoda
Bittiolum alternatum	Gastropoda
Clymenella torquata	Polychaeta
Cyathura polita	Malacostraca
Elasmopus levis	Malacostraca
Glycera americana	Polychaeta
Glycera dibranchiata	Polychaeta
Goniadidae	Polychaeta
Microdeutopus gryllotalpa	Malacostraca
Mulinia lateralis	Bivalvia
Pectinaria gouldii	Polychaeta
Sabaco elongatus	Polychaeta
Turbonilla interrupta	Gastropoda

Source: Taghon et. al., 2017

NJDEP conducts a shellfish inventory program which collects data on the distribution and abundance of shellfish species. This robust dataset includes data on New Jersey coastal bays from 1983. Shellfish abundance varies based on water quality, hydrodynamics and large storm events such as Hurricane Sandy. NJDEP has published shellfish distribution maps that describe shellfish density by species for hard clams, surfclams, mussels, and oysters. The maps have not been updated and in some cases date back to 1984. NJDEP Division of Land Use Regulation regulates these areas as shellfish habitat. The NJDEP updated the 1985/86 Barnegat Bay stock assessment by conducting a new survey in Barnegat Bay in 2012 to assess the impact of storm events (Hurricane Sandy) on the species distribution and abundance. The department mapped the hardclam (*Mercenaria mercenaria*) distribution as “moderate” in the portions of Barnegat Bay around Oyster Creek and Forked River. Overall, results indicated a significant decrease in hard clam abundance when compared to abundance of the 1985/86 survey. Hurricane Sandy was not found to have a significant effect on hard clam abundance (**Figure 2.2.5-2**). **Figure 2.2.5-3** depicts hard clams in Great Egg Harbor near BL England.

NJDEP also provides mapping for aquaculture leases in Barnegat Bay (**Figure 2.2.5-2**). The study area includes an aquaculture lease area on the west side of Barnegat Bay near the southernmost potential Oyster Creek landfall.

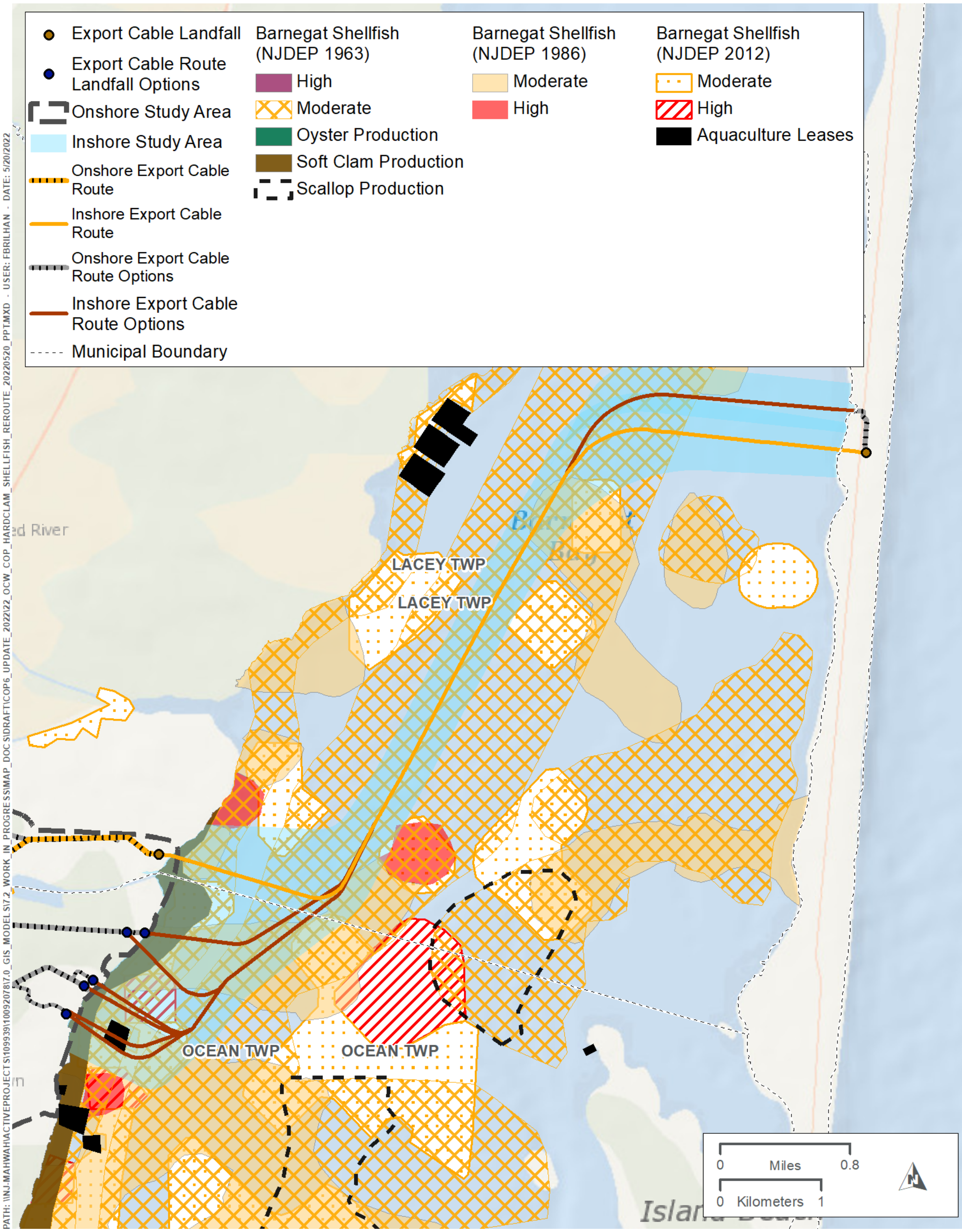

Figure 2.2.5-2. Mapping of hardclams by NJDEP in central Barnegat Bay around Oyster Creek.

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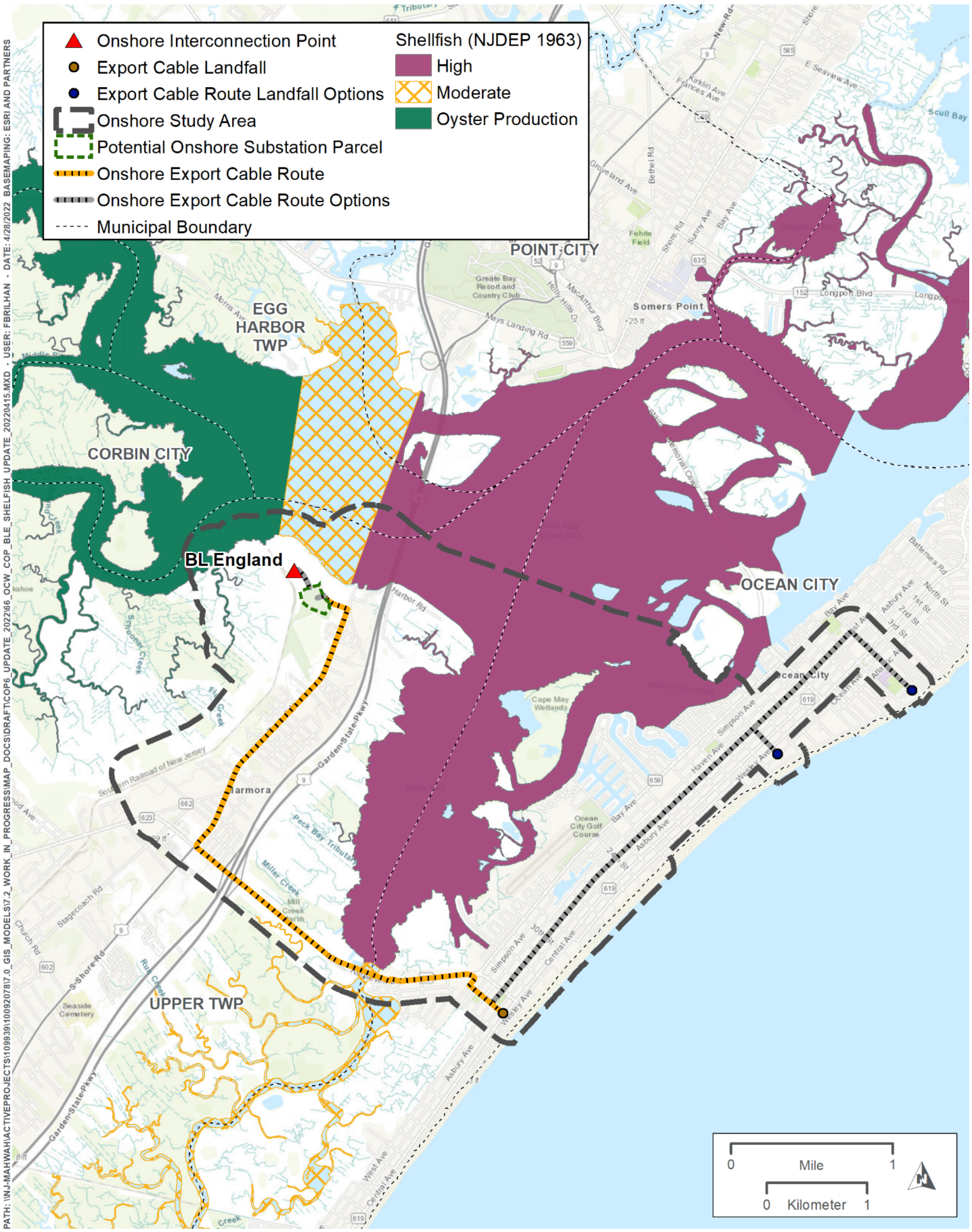

Figure 2.2.5-3. Mapping of hardclams by NJDEP in Great Egg Harbor Bay around BL England.

In 1984, the department also mapped shellfish and oyster beds in the Great Egg Harbor River. More recent surveys of Great Egg Harbor shellfish beds are not readily available. However, Psuty and Silveira (2009) describe the mixing of fluvial silts and coastal sands as creating soft bottom habitat, optimal for shellfish.

Versar (2008) conducted a comprehensive analysis of surfclam data collected by NJDEP over a 19-year period from 1988 to 2006. This data shows variable densities over the years, but tended to show higher densities closer to Manasquan Inlet and Barnegat Inlet. From a historical perspective, some areas between Manasquan Inlet and Barnegat Inlet showed densities that were relatively high (>5.7 bushels/100m^2).

A summary of typical shellfish found in Barnegat Bay and other coastal estuaries in New Jersey is provided in **Table 2.2.5-4.**

Table 2.2.5-4. Typical Barnegat Bay shellfish.

Common name	Scientific name
Bivalves	
Hard clam or northern quahog	*Mercenaria mercenaria*
Soft shell clam	*Mya arenaria*
Atlantic jackknife clam or razor clam	*Ensis directus*
Sout tagelus	*Tagelus plebeius*
Ark clam	*Arcidae* sp.
Atlantic surfclam	*Spisula solidissima*
Little surfclam or dwarf surfclam	*Mulinia lateralis*
Eastern oyster	*Crassostrea virginica*
Blue mussel	*Mytilus edulis*
Atlantic ribbed mussel	*Geukensia demissa*
Bay scallops	*Aequipecten irradians*
Crustaceans	
Blue Crab	*Callinectes sapidus*
Black-fingered mud crab	*Panoeius herbstii*
Green crab	*Carcinus maenas*
Rock crab	*Cancer irroratus*
Common spider crab	*Libinia emarginata*
Lady crab	*Ovalipes ocellatus*
Chinese mitten crab	*Eriocheir sinensis*
Marsh fiddler crab	*Uca pugnax*
Atlantic sand crab	*Emerita talpoida*
Ghost crab	*Ocypode quadrata*
Long-armed hermit crab	*Pagurus lonicarpus*
Daggerblade grass shrimp	*Palaemonetes pugio*
Sand shrimp	*Crangon septemspinosa*
American lobster	*Hormarus americanus*
Bay barnacle	*Balanus improvisus*
Mollusks	
Mud dog whelk / Eastern mud snail	*Llyassoma obsolete*
Northern moon snail	*Euspira heros*
Atlantic moon snail	*Polinices duplicatus*
Atlantic oyster drill	*Urosalpinx cinerea*

Common name	Scientific name
Atlantic slipper shell	*Credpidula fornicate*
Gastropods	
Knobbed whelk	*Busycon carica*
Channelled whelk	*Busycotypus canaliculatus*

Source: Barnegat Bay Shellfish 2013

2.2.5.1.2 Submerged Aquatic Vegetation

The offshore export cable is unlikely to cross any potential SAV as aquatic vegetation growth is limited by water depth (light penetration) and wave/current energy (Long Island Sound Study 2003). Therefore, this section will only describe SAV growth within estuarine waters of the offshore export cable corridor.

Estuarine Portions of the Offshore Export Cable Corridor

SAV serves several functions in estuarine ecosystems in New Jersey like that of Barnegat Bay (Oyster Creek area). SAV provides a substantial amount of primary production for the Barnegat Bay estuary, and serve as critically important spawning, nursery, and feeding habitat for benthic and finfish communities. SAV also serves to stabilize the benthic habitat by attenuating waves and currents and minimizing substrate erosion. In the coastal waters and back bays of New Jersey, SAV species diversity peaks in the late spring and is highly dependent on solar radiation and water temperature. Dominant vascular and algal species within Barnegat Bay include *Ulva lactuca, Gracilaria tikvahiae, Codium fragile, Zostera marina, Ceramium fastigiatum,* and *Agardhiella subulata* (Kennish *et al.* 2001).

SAV along the New Jersey coast has been studied by various public and private entities over the last 40 years. Barnegat Bay and the Oyster Creek area have been extensively studied; the coastal areas south of Little Egg Harbor (near the BL England Generating Station) have been less extensively studied. The NJDEP has mapped SAV habitat along the New Jersey coast from Sandy Hook to Cape May. The majority of this mapping took place from 1979 to 1987, with a 2011 update to Little Egg Harbor Bay (NJDEP 2018e; **Figure 2.2.5-4**). NJDEP stipulates that historical SAV areas must be considered current SAV habitat and are subject to NJDEP regulation.

Additional research has been conducted that can supplement NJDEP data and provide an updated map of SAV habitat particularly in Barnegat Bay. Bologna *et al.* (2000), Lathrop *et al.* (2004), and Lathrop and Haag (2011) extensively studied the locations of seagrasses in Barnegat Bay. The Bologna study was conducted in Little Egg Harbor assessing eel grass (*Zostera marina*) and widgeon grass (*Ruppia maritime*) distribution during 1999. The study compares past SAV distribution maps (Good *et al.* 1978, Macomber and Allen 1979, and McLain and McHale 1997) to current findings and indicates drastic declines in SAV coverage within Barnegat Bay and around Oyster Creek over a period of 25 years. Lathrop's findings agree with Bologna's as they note an approximately 60 percent decline in seagrass density from 2003 to 2009 based on the use of aerial imaging to assess seagrass habitat in Barnegat Bay. Boat based surveys were also conducted and incorporated into the dataset for the 2009 study. Habitat maps were created based on the two survey years, showing the changes in seagrass biomass between the two years. Lathrop (2001) incorporated several mapped studies of SAV in Barnegat Bay from the 1960s to 1990s to create a prediction model for the distribution of future seagrass habitat throughout the Bay. In 2009, Rutgers University conducted aerial mapping studies of the seagrasses in Barnegat Bay (Lathrop and Haag 2011; **Figure 2.2.5-4**).

In fall of 2019 Ocean Wind conducted aerial SAV mapping surveys in Barnegat Bay and Great Egg Harbor. The survey was conducted to incorporate methodologies from previous studies (Lathrop and Haag 2011) and existing agency guidelines (Colarusso and Verkade 2016) with the main goal to inform Project design and quantify potential areas of impacts. The survey was conducted via aerial photography in October 2019 over the proposed inshore export cable route in Barnegat Bay in the Oyster Creek study area along with Great Egg Harbor in the BL England study area. The areas of SAV documented in the Phase 1 Survey were used to inform the more intensive Phase 2 Survey effort.

A Phase 2 in-water drop camera SAV survey was conducted in October 2020 and included a field reconnaissance of Barnegat Bay[9] where seabottom disturbance is anticipated to occur. The Phase 2 SAV survey was conducted to identify the presence, extent, density, and species composition of SAV beds within the proposed export cable routes at potential landfall locations at Island Beach State Park, the Holtec property, Bay Parkway and Lighthouse Drive. The inshore reconnaissance area surveyed in 2020 included transects parallel to the shoreline as well as 164 ft (50) meters on either side of the indicative cable routes (Appendix E). Survey protocols were coordinated with NJDEP, BOEM and NMFS. SAV was documented in 41.7 percent of the survey locations. Of the three landfall areas surveyed on the western shoreline of the bay, the Holtec Property had the lowest percent cover of SAV, with SAV present at only a single survey station close to the shoreline. Based on review of the photographs collected during the field survey and the SAV samples collected, observed SAV consisted almost entirely of eelgrass (*Zostera marina*) with the exception of a single location at the Holtec Property which contained widgeon grass (*Ruppia maritima*). Results of the SAV aerial survey conducted in 2019 are shown on **Figure 2.2.5-4** and **Figure 2.2.5-5.** The results of the SAV aerial survey conducted in 2019 and in-water survey conducted in 2020 are provided in Appendix E.

In October 2021, an additional field survey was performed in Barnegat Bay to assess the presence or absence of SAV, general sediment characteristics, and water depth in the prior channel that extends west from the Island Beach State Park maintenance area. SAV was present at 13 of 33 sample stations; all of these stations were on the adjacent flats or on the channel edge. Of the 21 samples collected in the channel, SAV was absent in 20, with one station inconclusive due to soft sediments in the channel causing turbid conditions as the metal quadrat frame hit the sea floor at that station. The results of the Island Beach State Park Prior Channel Route Option SAV survey are included in Appendix E.

Figure 2.2.5-6 shows where the Phase 1 and Phase 2 SAV surveys have been completed in Barnegat Bay as well as areas to be surveyed during pre-construction activities. Additional field surveys will be performed in Barnegat Bay in summer 2022 near the potential Bay Parkway, Nautilus Drive, Lighthouse Drive and marina landfalls on the west side of Barnegat Bay as well as the prior channel area on the east side. Survey reports will be provided. The summer 2022 survey will involve in-water video collection to further refine the delineations of the SAV beds near the Project areas (2019 aerial imagery) (Tier 1 in the Colarusso and Verkade 2016 guidelines). The aim of this underwater imagery survey will be to document percent cover of SAV, species identification (likely all Zostera), and delineate the edges of the SAV beds in relation to the current Project design options. The results of this survey will inform the final Project design to avoid and minimize impacts to SAV (e.g., selecting the landfall route on the western side of the Bay, establishing designated anchoring/mooring locations for construction vessels).

In addition, within six months before cable installation begins, a focused pre-construction SAV survey will be conducted within the growing season to characterize the SAV condition (e.g., shoot density, etc.) within the established potential area of impact associated with the Project. This survey will be repeated immediately post construction and annually to document any impacts to SAV resulting from the Project and to monitor recovery.

[9] A Phase 2 SAV survey was not conducted in Great Egg Harbor as the inshore route option was no longer being considered.

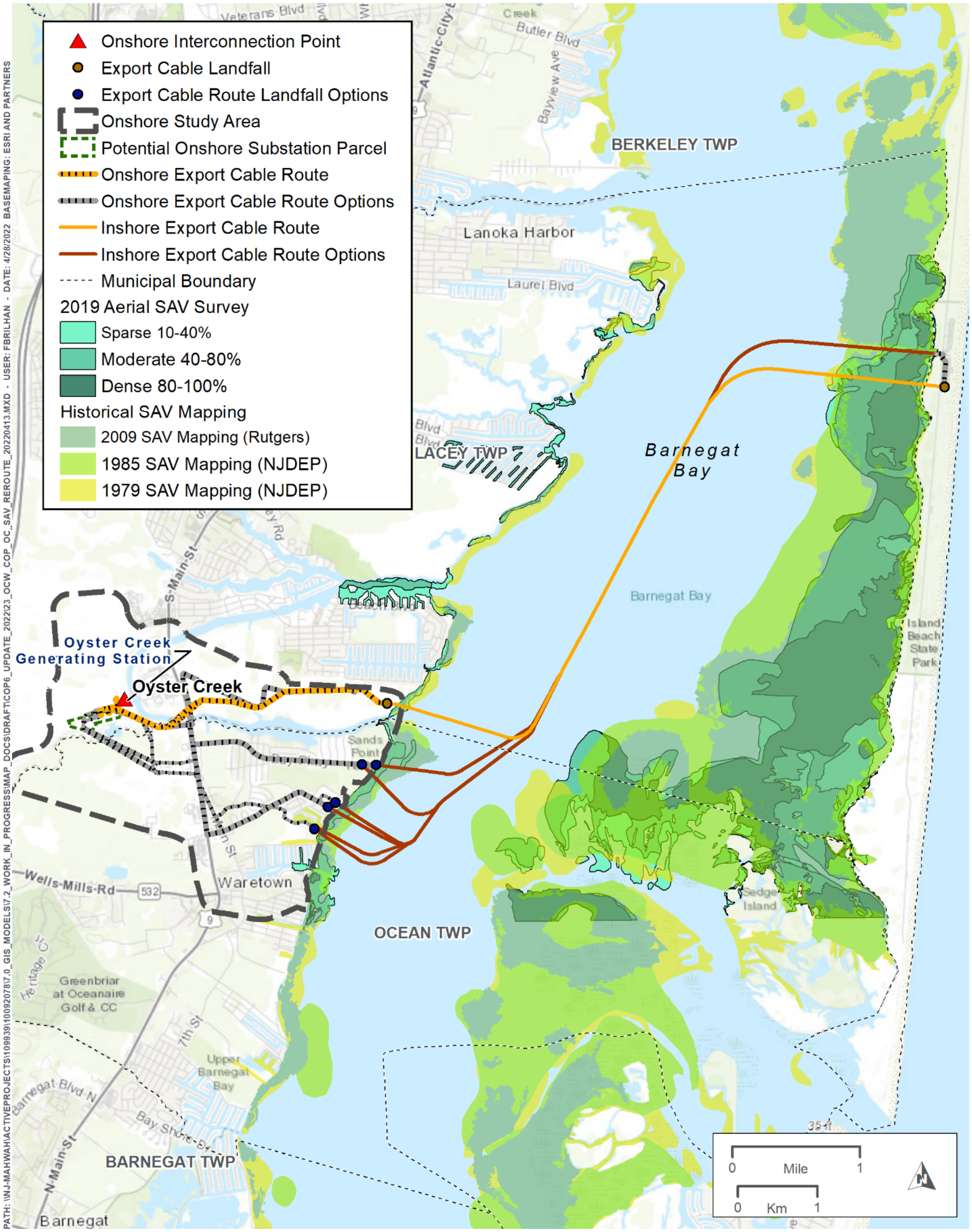

Figure 2.2.5-4. Aerial SAV mapping by Rutgers (Lathrop and Haag 2011), NJDEP (1979 and 1985), and Ocean Wind (2019) in Barnegat Bay around Oyster Creek.

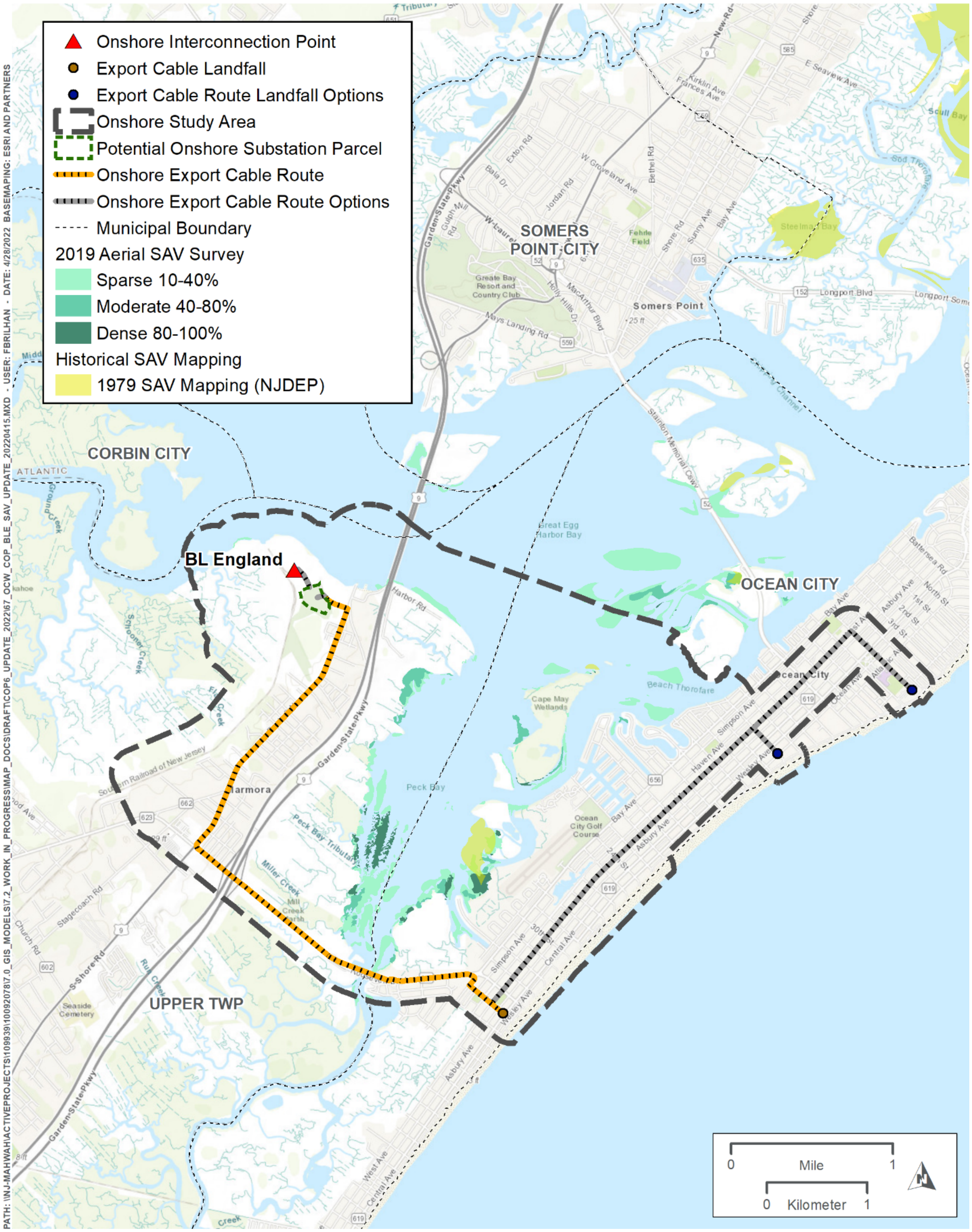

Figure 2.2.5-5. Aerial SAV mapping by NJDEP (1979 and 1985) and Ocean Wind (2019) in Great Egg Harbor around BL England.

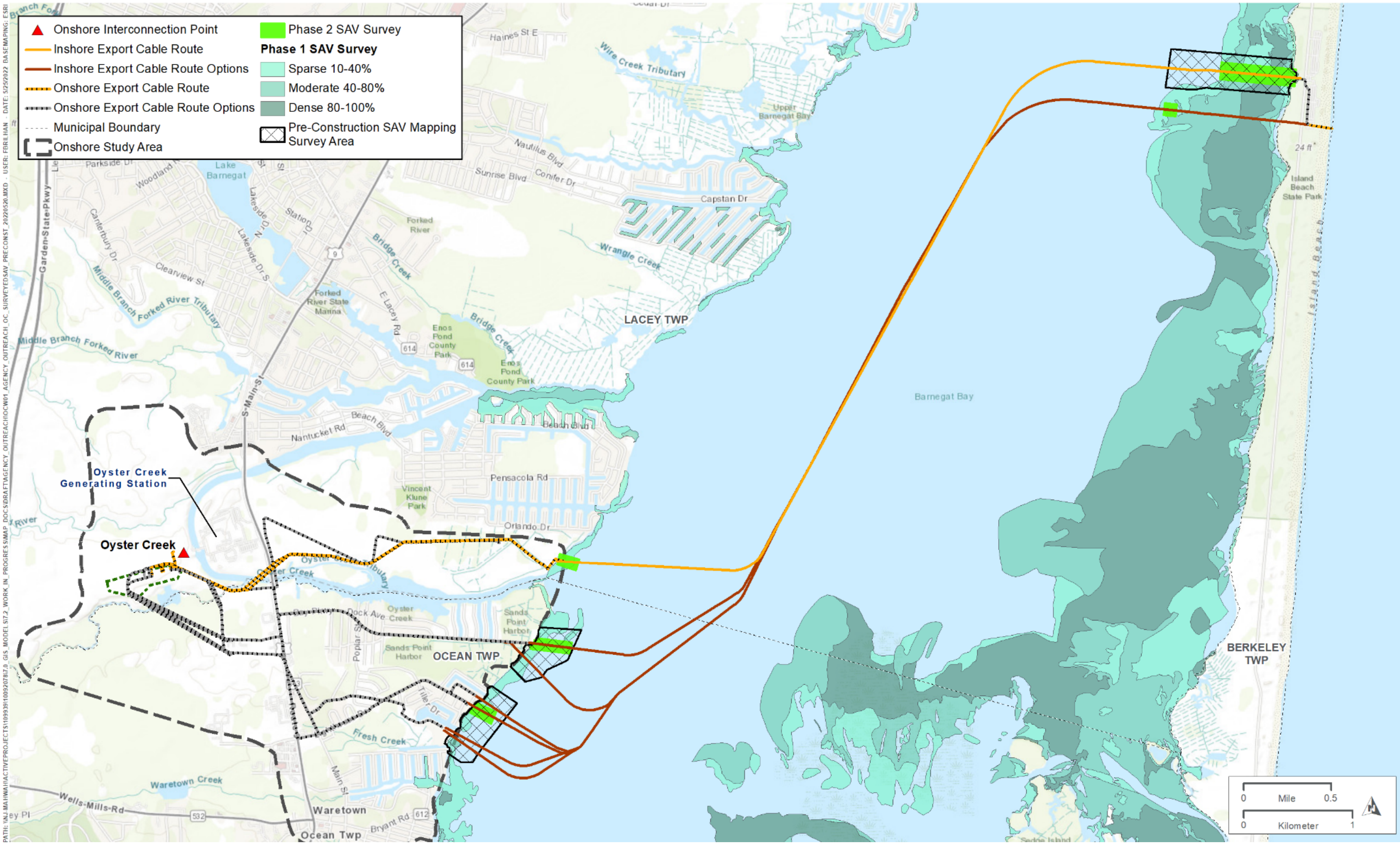

Figure 2.2.5-6. Phase 1 and 2 SAV surveyed areas in Barnegat Bay and pre-construction survey areas.

2.2.5.2 Potential Project Impacts on Benthic Resources

Activities that could cause impacts to benthic habitat include bottom disturbing activities such as pre-construction preparation of seabed (i.e., pre-lay grapnel surveys, in-situ UXO/MEC disposal[10]), pile driving for WTGs and offshore substations, placement of scour protection, installation of cables (array and export), anchoring and spudding, and dredging, if necessary. The majority of impacts would be direct impacts; however, they would be localized and temporary. Permanent conversion of benthic habitat will occur around WTGs for scour protection and in areas along the cable corridors where additional cable protection is required. IPFs that may affect benthic resources during construction, operations and maintenance, and decommissioning are as follows and discussed in the following sections:

- Physical seabed/land disturbance
- Sediment suspension
- Discharge/releases/withdrawals
- Habitat conversion
- Noise
- EMF
- Vessel traffic

Impacts to benthic resources during construction activities include direct impacts such as habitat conversion and burial and indirect such as temporary displacement. Direct impacts including burial of benthic organisms is expected in the disturbance footprint for foundations and cable placement, and would be localized. Loss of soft bottom, homogenous benthic habitat will be replaced by hard substrate and vertical structure. Indirect impacts causing displacement will also occur due to increased turbidity. Temporary Project impacts would affect 4 percent of the Wind Farm Area, and permanent impacts would affect 0.2 percent of the Wind Farm Area. Following construction, benthic resources are expected to recover quickly as the surrounding area will recolonize those areas impacted. Avoidance and mitigation measures will be implemented to minimize impacts to benthic resources wherever possible.

Impacts to invertebrate resources as a result of the operation and maintenance of this project would be related to habitat alteration, EMF, and maintenance and cable repair. Species assemblage will transition to a structure-oriented community in the areas around the foundations. Routine maintenance and repairs to the cable and turbines may impact invertebrates due to vessel traffic, anchoring, and other bottom disturbances. All impacts from habitat alteration will be localized to foundation locations. Potential impacts from EMF will be localized to the cable corridor. However, the cable will be buried at a depth sufficient to minimize effects to the extent practicable.

2.2.5.2.1 Construction

Wind Farm Area

Foundations and Scour Protection

The construction of the Project in the Wind Farm Area includes installation of foundations and scour protection (if required) for WTGs and the offshore substations. The direct footprint of impacts for WTGs, including WTG foundations and scour protection, as well as impacts for offshore substations, are detailed in Section 6 of Volume I and additionally below in **Table 2.2.5-5.**

Foundation preparation activities may be required depending on the seabed and the foundation type. Foundation preparation, if required, may include levelling and removal of surface or subsurface debris such as

[10] MEC - munitions and explosives of concern; UXO - unexploded ordnance.

boulders and sandwaves or in-situ UXO/MEC disposal. Excavation may be required where debris is buried or partially buried. Benthic sessile or slow-moving organisms, such as polychaete tube worms, sand dollars, and mollusks that are within the area of impact would experience direct impacts from burial or removal. Benthic habitat that is not directly buried by WTGs and offshore substations is expected to quickly recover as a result of recolonization from the surrounding unaffected area.

Low order (deflagration) or high order (detonation) in-situ disposal of UXO/MEC has the potential to affect benthic resources. UXO/MEC disposal has the potential to cause disturbances to the seafloor (sediment suspension and deposition) as well as noise. Impacts are expected to be short term and direct, with the potential to cause injury or mortality to benthic species within the direct vicinity of the disposal activities.

Indirect impacts may occur as a result of the settlement of suspended sediments associated with construction. Certain taxa are more susceptible to sediment plumes than others. Sessile and attached, or slow moving, invertebrates experience the highest impacts during resuspension and sedimentation (Gates and Jones 2012). According to Newcombe and MacDonald (1991), impacts from settlement of resuspended sediment plumes increase with the concentration of resuspension and the duration invertebrates are exposed to that plume. Sediments within the Wind Farm Area are medium to coarse grain sands so resuspension of sediments will be limited in duration. Displacement of mobile benthic organisms will also occur due to vibration during pile driving.

Scour protection may be required for WTGs and at the offshore substations, and is discussed further in Volume I, Section 6. Mobile benthic organisms such as crabs would likely be able to avoid direct construction impacts from seabed clearing and pile driving activities. Areas of scour protection will result in habitat conversion from sediment to structured rocky bottom. Although, there is a change in benthic community structure, interstitial spaces within the scour protection will be sedimented and a new benthic community will develop.

The Carl N. Shuster Horseshoe Crab Reserve is located on the western section of the Lease Area. A total of four WTGs in the Wind Farm Area are potentially located in the reserve. Potential impacts to horseshoe crabs may occur in the footprint of foundations, such as mortality during pile driving and placement of scour protection as well as potential conversion of habitat from sand bottom to structured habitat. Temporary displacement of horseshoe crabs would likely also occur during construction.

Table 2.2.5-5. Indicative benthic impacts for the Project.

Component	Temporary Benthic Disturbance (acres)	Permanent Benthic Disturbance (acres)	Total Benthic Disturbance within Carl N. Shuster Horseshoe Crab Reserve (acres)
WTG Foundations	-	2.3	0.1
WTG Scour Protection	-	58	2.4
Offshore Substation Foundations	-	0.1	-
Offshore Substation Scour Protection	-	3	-
Array Cables	2,220	77 (cable protection)	29
Substation Interconnector Cables	222	8 (cable protection)	-
Offshore Export Cables within Wind Farm Area	120	4 (cable protection)	0
TOTAL within Wind Farm Area	***2,562***	***150***	***32***

Component	Temporary Benthic Disturbance (acres)	Permanent Benthic Disturbance (acres)	Total Benthic Disturbance within Carl N. Shuster Horseshoe Crab Reserve (acres)
Offshore Export Cables outside Wind Farm Area	1,980	82 (cable protection)	113
TOTAL for Project	**4,542**	**232**	**145**

Note: These are indicative estimates based on the project design envelope. Potential temporary and permanent impacts will be updated based on final design and will be included in permit applications.

Vessels

During installation, vessels may require anchoring and/or spudding to facilitate construction activities. Anchoring will take place in areas of soft bottom and result in potential seabed disturbance from anchor placement, drag and chain sweep. Localized impacts on sessile and or slow-moving benthic resources will occur in these areas. Mobile benthic organisms will be temporarily displaced by the anchors. Certain construction vessels such as jack-up vessels or hotel vessels will require stabilization spuds. The spuds will cause some localized direct impacts where they meet the sediment. Vessels may also have a direct impact on benthic plankton entraining them while taking on ballast water, withdrawing water for engine cooling, hoteling, and operating on-board reverse osmosis systems (U.S. Department of Energy [USDOE] 2012). Impacts from increased vessel traffic and construction activities will be temporary and localized in nature.

Array Cables

Bottom disturbance will occur during array cable installation between turbines (array cables) and substation foundations (interconnection cables) (**Table 2.2.5-5)**. Initial disturbance will include potential seabed boulder clearance, in-situ UXO/MEC disposal, and/or sandwave clearance followed by cable installation. These disturbances will result in direct and indirect impacts from burial. Array cable installation will be completed via hydroplow wherever possible with alternative methods that include surface lay, trenching, jetting, plowing and pre-plowing, vertical injection, and control flow excavation as necessary. Planktonic larvae of benthic species could be entrained within the water intakes of the jet plow. Entrainment of organisms typically results in direct impacts due to temperature changes and mechanical and hydraulic injury from pump impellors and passage through piping (USDOE 2012). Direct mortality to slow moving and sessile organisms could result from fluidizing the sediments during cable burial. Indirect mortality could occur to sessile or slow-moving organisms during array cable installation as a result of sedimentation, however, based on existing sediment type and hydrodynamics, sediment suspension would occur within and laterally from the trench area would be short term (see Section 2.1.2.2.1). In areas where the cable cannot be buried to desired depth, additional cable protection will be placed. Placement of additional cable protection will result in localized impacts to sessile benthic organisms and habitat conversion from sediment to hard structure. Mobile benthic organisms such as crabs and horseshoe crabs will sense the vibration and noise from construction activities and are expected to avoid the area for the duration of the construction. Impacts related to in-situ UXO/MEC disposal are as discussed above under Foundations and Scour Protection. Following construction, the areas will be recolonized from surrounding habitat.

Offshore Export Cable Corridor

Dredging

Dredging may be required in shallow areas in Barnegat Bay to allow vessel access for the HDD marine construction spread west of Island Beach State Park (Berkeley Township), as well as near the landfall at Lacey or Ocean Township, or in the prior maintenance channel. Dredging may also occur along the proposed cable route in locations where sand waves (naturally mobile slopes on the seabed) are encountered or when crossing Federal and State navigation channels. The area of potential dredging is currently unknown due to the dynamic nature of sandwaves; however, the area of potential dredging would be expected to be within the benthic disturbance footprints discussed below and shown in **Table 2.2.5-6**. Direct impacts including injury and mortality to sessile or slow-moving benthic organisms such as polychaete tube worms, sand dollars, and molluscs would occur in the footprint of the dredging activity. Other more mobile invertebrates, such as crabs and horseshoe crabs, may be able to avoid the dredge bucket and move to areas outside of the dredging footprint. Sessile or slow-moving benthic invertebrates outside of the dredging footprint will experience indirect impacts due to resuspension and subsequent settling of sediment plumes. As discussed in sections above, those impacts increase with the concentration of plume and the duration in which the invertebrates are exposed to that plume (Newcombe and MacDonald 1991). However, because the predominant sediment type is fine sand or coarser, duration of exposure to the plume would likely be relatively short term. In a study done on dredge plume dynamics of New York/New Jersey Harbor (USACE 2015), it was noted that concentrations decrease exponentially with time and distance in the down-current direction (within 15 minutes of release concentrations were noted to be less than 50 mg/L) (See Section 2.1.2.2 for additional discussion).

As described above for the Wind Farm Area, during installation, vessels may require anchoring and/or spudding to facilitate construction activities, including dredging and HDD installation activities. Anchoring will take place in areas of soft bottom and result in potential seabed disturbance from anchor placement, drag and chain sweep. Localized impacts on sessile and or slow-moving benthic resources will occur in these areas, potentially including anchor drag and chain sweep in the aquaculture lease area near the marina landfall. Mobile benthic organisms will be temporarily displaced by the anchors. Impacts from increased vessel traffic and construction activities will be temporary and localized in nature.

Offshore Export Cables

Offshore export cables will be placed by the same methods listed above for array cables, depending on site conditions. Site preparation activities will take place prior to the placement and burial of the cable along the offshore export cable corridor, similar to those described for the array cables. These activities could result in direct impacts such as burial, displacement, and/or mortality of benthic organisms. Sessile or slow-moving species of shellfish, sand dollars, starfish, and tube worms would be directly impacted. Direct mortality to slow moving and sessile organisms could result from fluidizing the sediments during cable burial. Indirect mortality could occur to sessile or slow-moving organisms during array cable installation as a result of sedimentation, however, based on existing sediment type and hydrodynamics, sediment suspension would be short term (see Section 2.1.2.2.1). Mobile organisms such as certain polychaete species, amphipods, and crabs, and horseshoe crabs may be temporarily displaced by the habitat disturbance and noise and may be able to avoid these activities. Bottom disturbance will also take place once additional cable protection and placement activities begin including laying rock, concrete mattress, and seabed spacers and this disturbance will have localized impacts due to habitat conversion and sedimentation (**Table 2.2.5-6**).

Table 2.2.5-6 Maximum offshore export cable corridor benthic impacts to shellfish habitat and SAV by landfall.

Export Cable Route	Total Benthic Disturbance within Shellfish Habitat (acres)	Total Benthic Disturbance within SAV (acres)
Oyster Creek	121	20
BL England	1	0
TOTAL	122	20

Installation of the offshore export cables could result in the burial, displacement, and/or mortality of benthic organisms, including within the aquaculture lease area near the marina landfall. Impacts from this process will be short-term and benthic communities are expected to recover quickly as invertebrates from the surrounding area will recolonize the impacted area, potentially with new benthic communities including more sessile, attached and structure-oriented species, and thus increasing species diversity. Several studies have assessed the short- and long-term effects of submarine cables on the benthic and demersal ecosystems (Andrulewicz *et al.* 2003, Environmental Resources Management 2007, Kogan *et al.* 2006, Marra 1989, Sultzman *et al.* 2002). One of the most thorough studies examined the effects of 59 mi (95 km) of coaxial cable installed from Pillar Point Air Station to Pioneer Seamount off Half Moon Bay, California, eight years after the cable had been installed (Kogan *et al.* 2006). Quantitative comparisons of benthic communities and sea-floor features at nine different sampling station led these authors to conclude that there were few changes in the distribution or abundance of benthic fauna (epifauna and infauna) and that the cable had had minimal statistically-significant effect on the benthic community along the cable route. In some instances, the presence of the cable had created habitat diversity that increased the density of sea anemones (Actiniarians) and some fish along the cable's route.

Pre- and post-construction benthic sampling that was completed for a transmission cable project in the Hudson River off Manhattan revealed that the benthic community 9 months after cable installation showed no significant difference between areas sampled within the cable corridor and those sampled in excess of 100 ft on either side of the cable corridor. The sampling also showed no significant difference from the same sampling locations that had been sampled prior to the cable installation (HDR 2013).

Indirect impacts of cable installation include water withdrawals for jet plowing and sediment plume settlement impacts. In addition, entrainment of organisms typically results in high mortality due to temperature changes and mechanical and hydraulic injury from pump impellors and passage through piping (USDOE 2012).

Impacts at landfall locations will be minimized using trenchless technology methods, to the extent practicable. In addition, SAV surveys have been conducted so impacts at the landfall locations can be avoided. In Barnegat Bay and Great Egg Harbor Bay, where sediments are predominantly fine grain, potential temporary impacts due to resuspension of sediments may occur. Sabol *et al.* (2005) documented the impacts of dredging to SAV and found the distribution of eelgrass to be highly variable based on season and year. Indirect impacts due to increased turbidity were not discernible from the seasonal variation that was documented. A study by Wisehart *et al.* (2007) showed that eelgrass density and seedling recruitment 5 months following disturbance was also higher in dredged aquaculture beds than areas with long-line aquaculture beds. This suggests that potential impacts to SAV habitat are short-term and localized. BMPs will be used to minimize potential resuspension of sediments.

Shellfish beds are found throughout Barnegat Bay. The proposed indicative cable route avoids moderate to high density shellfish beds mapped by the NJDEP to the extent practicable, as well as crossing previously disturbed areas. Direct impacts will be minimized via routing and use of trenchless technology options.

Potential indirect impacts to shellfish beds include resuspension of sediments and potential burial. However, impacts will likely be minimal because cable routes will avoid highest densities of shellfish to the extent practicable and because shellfish such as the hardclam (*Mercenaria mercenaria*) have the ability to vertically migrate through sediment and survive burial events (Maurer *et al.* 1986). BMPs will be used to minimize potential resuspension of sediments.

BMPs will be implemented to minimize suspended sediment plumes during construction activities to mitigate any potential impacts on shellfish beds in Barnegat Bay, Great Egg Harbor, and the offshore export cable corridor, per the APMs.

2.2.5.2.2 Operations and Maintenance

Offshore Project Area

Foundation and Scour Protection

Vessel anchoring impacts, and scour protection maintenance, will be similar to those discussed for construction. The installation of the turbine foundation structures will introduce new hard substrate habitat for the life of the Project. Approximately 0.2 percent[11] of the sandy smooth bottom habitat within the Wind Farm Area will be converted to structure habitat. Benthic community composition around the turbine foundation will shift due to the conversion from a soft bottom sand habitat to a structure-based habitat around the rock placement and vertical foundation. The newly forming structure-based habitats will encourage recruitment of structure-oriented species and thus may increase biodiversity (Hiscock *et al.* 2002). Structure-oriented species that could colonize scour protection rocks and vertical foundations include barnacles, anemones, shellfish like crabs and lobsters, and sponges (Vattenfall 2005). Scour protection around the base of the piling will fill in with sand and silt due to the movement of sediments and changing hydrodynamics around these foundations. The base of these foundations will likely support benthic species typical of sandy, soft-bottom habitat such as polychaete tube worms, sand dollars, and molluscs. Routine maintenance and repairs to the WTGs may impact invertebrates due to vessel traffic, anchoring, and other bottom disturbances.

Cable Operation and Maintenance

Impacts to benthic habitat during maintenance and repairs are similar to those described above during construction. Cable operation during the life of the Project could result in impacts related to EMF. EMF occurs naturally in the ocean, with the primary source being the geomagnetic field of the earth. Shielding of cables eliminates electric fields; magnetic fields cannot be shielded. The flow of seawater through the Earth's magnetic field creates a weak electric field, which is called an induced electric field (Slater et al. 2010).

These fields are identified by the number of times the strength and direction of the field alternates each second, or hertz (Hz) (CSA Ocean Sciences Inc. and Exponent 2019). Direct current (DC) fields have a constant direction (i.e., no oscillations); thus, their frequency is 0 Hz. DC fields are closely linked to the Earth's magnetic field. While natural alternating current (AC) fields change direction many times per second, most natural AC fields in the marine environment occur at frequencies less than 10 Hz and are produced by marine organisms, including fish. The Earth's DC magnetic field causes a compass needle to align in a magnetic north-south direction. The strength of the Earth's DC magnetic field is approximately 516 milliGauss (mG, 51.6 microtesla [μT]) along the southern New England coast. As ocean currents and organisms move through this DC magnetic field, a weak DC electric field is produced. For example, the electric field generated by the movement of the ocean currents through the Earth's magnetic field is reported to be approximately 0.075 mV/m (0.000075 V/m) or less. The estimated ambient EMF level in the Project area is 505 mG (NOAA 2022).

[11] Installation of turbine foundations and scour and cable protection will result in up to 175 acres of conversion of the bottom habitat to structure habitat in the Wind Farm Area. The Wind Farm Area is 68,450 acres.

Species most likely to experience impacts from the cable EMF would be to benthic and demersal fish and invertebrates. Potential impacts to invertebrates from EMF have not been extensively studied and are dependent upon the sensory capabilities of the species that would be found near the cable, the life functions that the species' magnetic or electric sensory systems support, and the natural history characteristics of the species. Recent evidence indicated that the Dungeness crab (*Metacarcinus magister*), and American lobster (*Homarus americanus*) showed few behavioral responses that would indicate explicit avoidance or attraction to EMF in a laboratory setting (Pacific Northwest National Laboratory 2013).

In a BOEM-funded study, researchers from the University of Rhode Island evaluated the behavioral response of American lobsters and little skate (*Leucoraja erinacea*), contained in netted enclosures, to EMF from the Cross Sound Cable, a 330 MW capacity high-voltage direct current (HVDC) subsea cable, south of New Haven, CT (Hutchison *et al*. 2018). The study found that while behavioral responses did occur in both lobsters and skate when exposed to EMF, "neither of the species showed spatial restriction in their movements and at the power levels transmitted, the cable did not act as a barrier to movement." Researchers concluded that there appeared to be no "…significant effect that would be deemed an impact for lobsters". The researchers concluded "While the behavioral studies conducted in this project provided clear evidence of a behavioral response when receptive animals encountered the EMF, the evidence for a biological impact of a single HVDC cable under the conditions observed in this study would most likely be assessed as minor" (Hutchison *et al*. 2018).

BOEM also evaluated EMF from power cables by conducting in-situ studies of both powered and unpowered cables (Love *et al.* 2015, 2016). Results from three years of surveys included:

- "Researchers did not observe any significant differences in the fish communities living around energized and unenergized cables and natural habitats;
- They found no compelling evidence that the EMF produced by the energized power cables in this study were either attracting or repelling fish or macroinvertebrates;
- EMF strength dissipated relatively quickly with distance from the cable and approached background levels at about one meter from the cable; and
- Cable burial would not appear necessary strictly for biological reasons" (BOEM 2016b).

EMF produced by cables decreases rapidly with distance from the cable, as shown for the array cables in **Figure 2.2.5-7** for the offshore export cables in **Figure 2.2.5-8.** Shielding and burial of the cables will further minimize potential EMF impacts.

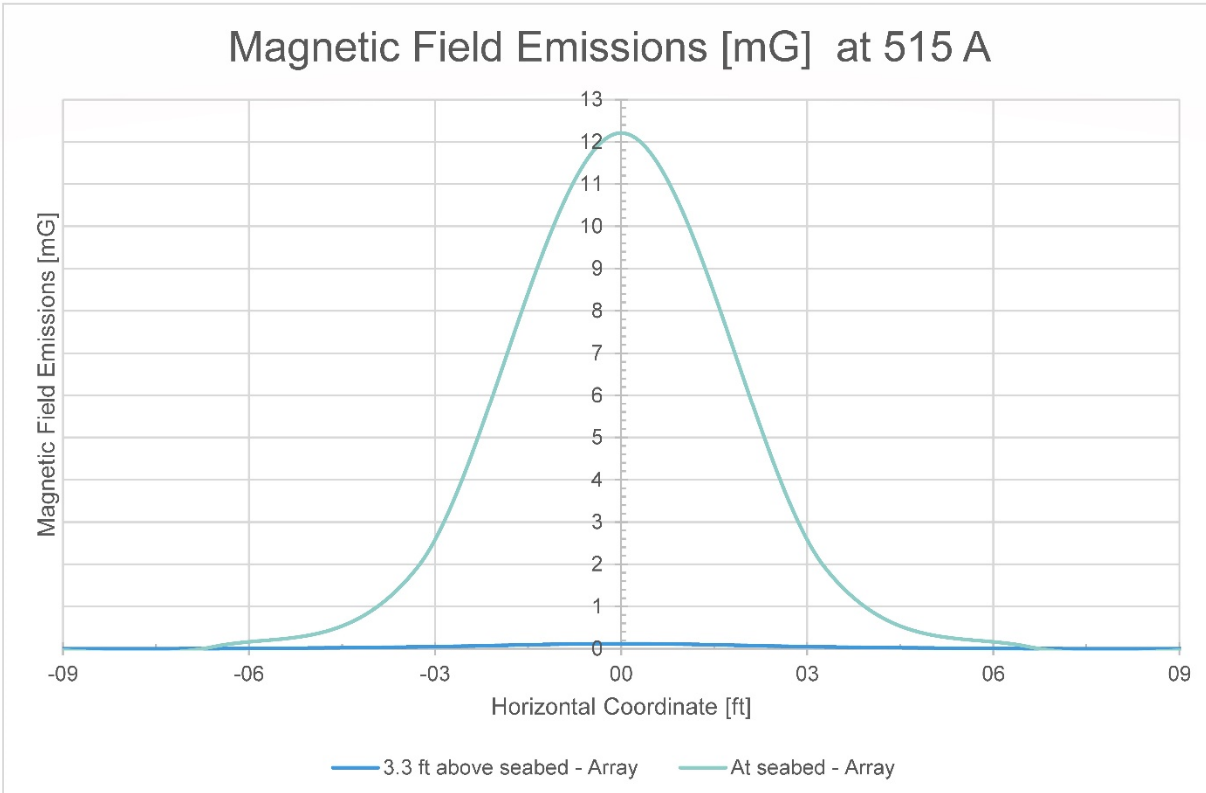

Figure 2.2.5-7. Magnetic field emissions of the Ocean Wind array cables (515 Ampere [A]) related to distance at the seabed and 1 m above the seabed.

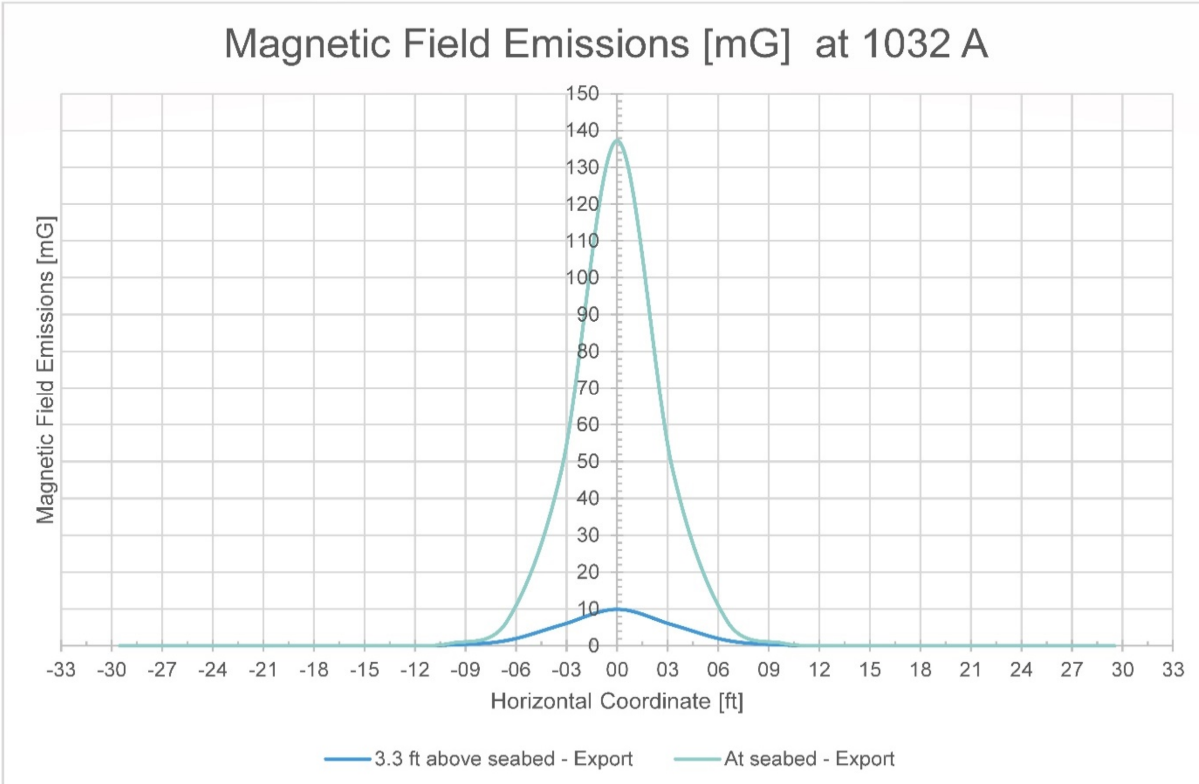

Figure 2.2.5-8. Magnetic field emissions of the Ocean Wind offshore export cables (1,032 A) related to distance at the seabed and 1 m above the seabed.

Routine maintenance and repairs to the cable may impact invertebrates due to vessel traffic, anchoring, and other bottom disturbances.

2.2.5.2.3 Decommissioning

Similar equipment and number of vessels would be used to remove Project infrastructure. Piles would be cut below the seabed using pile cutting devices. Removal of turbine foundations would mean loss of the unique hard substrate and vertical habitat that had established itself over the life of the Project. Potential impacts include injury or mortality to benthic species during removal of piles and turbine foundations, as well as from vessel anchoring during decommissioning activities. Similar to discussion of impacts during construction (Section 2.2.5.2.1), indirect impacts may occur as a result of the settlement of suspended sediments associated with decommissioning. Sessile and attached, or slow moving, invertebrates experience the highest impacts during resuspension and sedimentation (Gates and Jones 2012). Benthic habitat is expected to recover from decommissioning activities. Successional epifaunal and infaunal benthic species are anticipated to recolonize the disturbance areas from the surrounding sandy bottom habitat. Impacts are anticipated to be short-term and localized to the Wind Farm Area and not cause adverse impacts long-term to benthic species and habitat.

2.2.5.2.4 Summary of Potential Project Impacts on Benthic Resources

The IPFs affecting benthic resources include physical seabed/land disturbance, sediment suspension, discharge/ releases and withdrawals, habitat conversion, EMF, and traffic.

Long term conversion of sandy bottom to hard bottom benthic habitat will occur around WTGs from scour protection and in areas along the cable corridors where additional cable protection is required, resulting in introduction of hard bottom habitat. Temporary, short-term sediment disturbing activities include pre-construction preparation of seabed (i.e., pre-lay grapnel surveys, potential in-situ UXO/MEC disposal), pile driving for WTG and offshore substation foundations, installation of cables, anchoring and spudding, and leveling if necessary. These activities would primarily result in localized and temporary impacts, though they could result in mortality of sessile or slow moving benthic organisms. Potential impacts would be minimized by implementing APMs.

2.2.5.3 Avoidance, Minimization, and Mitigation Measures

The proposed measures for avoiding, minimizing, reducing, eliminating, and monitoring environmental impacts for the Project are presented in **Table 1.1-2**.

2.2.6 Finfish and Essential Fish Habitat

This section describes the existing finfish and EFH resources in the Project Area and potential Project impacts.

2.2.6.1 Affected Environment

The Project Area is defined as the Offshore Project Area (Wind Farm Area and offshore export cable corridors) and the Onshore Project Area. These areas of marine and estuarine waters have a very diverse fish and invertebrate assemblage that can be classified according to habitat requirements and location. This discussion is based on review of existing available literature that supports the characterization of the distribution, abundance and composition of finfish and marine communities. Finfish community assemblage and abundance is largely dependent on environmental characteristics including but not limited to factors such as depth, salinity, substrate, currents, season, and temperature. The community is made up of pelagic, demersal, and highly migratory species. Pelagic species spend the majority of their lives within the water column, migrating to different depths based on temperature and light penetration. Demersal species spend the majority of their lives at or near the bottom. Highly migratory species travel long distances and often cross domestic and international boundaries. Species include tuna, swordfish, billfish and sharks. Diadromous fish spend a portion of their life cycle in freshwater and a portion in saltwater. Diadromous and marine fish species are managed and protected by NOAA Fisheries and the New Jersey Division of Fish and Wildlife (NJDFW). **Table 2.2.6-1** below contains a summary of the major fish and invertebrate species found in the Project Areas, habitat association, and Federal and State-management status.

Table 2.2.6-1. Major fish and invertebrate species potentially encountered in the Project Area.

Common Name	Scientific Name	EFH[1]	Highly Migratory Species	Listing Status	Commercial/ Recreational Importance[2]	Habitat Association
alewife	*Alosa pseudoharengus*				X[1]	Pelagic
American conger	*Conger oceanicus*					Demersal/Structure Oriented
American lobster	*Homarus americanus*				X[1]	Benthic
American eel	*Anguilla rostrata*				X[1]	Demersal/Structure Oriented
American gizzard shad	*Dorosoma cepedianum*					Pelagic
Atlantic angel shark	*Squatina dumerili*	L,J,A	X			Pelagic
Atlantic butterfish	*Peprilus triacanthus*	L,J,A			X	Demersal/Pelagic
Atlantic cod	*Gadus morhua*	A			X[1]	Demersal/Structure Oriented
Atlantic croaker	*Micropogonias undulatus*					Demersal
Atlantic herring	*Clupea harengus*	L,J,A			X	Pelagic
Atlantic mackerel	*Scomber scombrus*	E,L,J			X	Pelagic
Atlantic menhaden	*Brevoortia tyrannus*				X	Pelagic
Atlantic needlefish	*Strongylura marina*					Pelagic
American shad	*Alosa sapidissima*				X[1]	Pelagic
Atlantic sharpnose shark	*Rhizopriondon terraenovae*	A	X			Pelagic
Atlantic silverside	*Menidia menidia*					Pelagic
Atlantic sturgeon	*Acipenser oxyrhynchus oxyrhynchus*			ESA Endangered		Demersal
basking shark	*Cetorhinus maximus*	A	X			Pelagic
bay anchovy	*Anchoa mitchilli*					Pelagic
black drum	*Pogonias cromis*				X[1]	Demersal
black sea bass	*Centropristis striata*	L,J,A			X[1]	Pelagic/Structure Oriented
blue crab	*Callinectes sapidus*				X	Benthic
blue shark	*Prionace glauca*	E,L,J,A	X			Pelagic
blueback herring	*Alosa aestivalis*				X[1]	Pelagic
bluefin tuna	*Thunnus thynnus*	J,A	X		X	Pelagic
bluefish	*Pomatomus saltatrix*	E,L,J,A			X[1]	Pelagic
bluntnose stingray	*Dasyatis say*					Demersal
broad-striped anchovy	*Anchoa hepsetus*					Pelagic
clearnose skate	*Raja eglanteria*					Demersal

Common Name	Scientific Name	EFH[1]	Highly Migratory Species	Listing Status	Commercial/ Recreational Importance[2]	Habitat Association
cobia	*Rachycentron canadum*	E,L,J,A			X[1]	Pelagic
common thresher shark	*Alopias vulpinus*	E,L,J,A	X			Pelagic
cownose ray	*Rhinoptera bonasus*					Demersal
crevalle jack	*Caranx hippos*					Pelagic/Structure Oriented
cunner	*Tautogolabrus adspersus*					Demersal/Pelagic
cusk	*Brosme brosme*			ESA Candidate Species		Demersal
dusky shark	*Carcharhinus obscurus*	E,L,J,A	X			Pelagic
hard clam	*Mercenaria mercenaria*				X[1]	Benthic
haddock	*Melanogrammus aeglefinus*				X[1]	Demersal
hickory shad	*Alosa mediocris*					Pelagic
hogchoker	*Trinectes maculatus*					Demersal
horseshoe crab	*Limulidae*					Benthic
inland silverside	*Menidia beryllina*					Pelagic
Jonah crab	*Cancer borealis*				X[1]	Benthic
king mackerel	*Scomberomorus cavalla*	E,L,J,A			X[1]	Pelagic
lined seahorse	*Hippocampus erectus*					Demersal/Structure Oriented
little sculpin	*Myoxocephalus aenaeus*					Demersal/Structure Oriented
little skate	*Raja erinacea*				X	Demersal
long finned squid	*Loligo pealeii*	J,A			X	Pelagic
lookdown	*Selene vomer*					Demersal/Pelagic
monkfish	*Lophius americanus*	E,L,J,A			X	Demersal
mummichog	*Fundulus heteroclitus*					Demersal/Pelagic
naked goby	*Gobiosoma bosc*					Demersal
northern kingfish	*Menticirrhus saxatilis*				X	Demersal
northern pipefish	*Syngnathus fuscus*					Demersal/Structure Oriented
northern puffer	*Sphoeroides maculatus*					Demersal
northern sand lance	*Ammodytes dubius*				X	Demersal
northern seahorse	*Hippocampus erectus*					Demersal
northern searobin	*Prionotus carolinus*				X	Demersal
northern stargazer	*Astroscopus guttatus*					Demersal

Common Name	Scientific Name	EFH[1]	Highly Migratory Species	Listing Status	Commercial/ Recreational Importance[2]	Habitat Association
ocean quahog	*Artica islandica*	J,A			X	Demersal
oyster toadfish	*Opsanus tau*					Demersal
pollock	*Pollachius virens*				X[1]	Demersal/Structure Oriented
red hake	*Urophycis chuss*	E,L,J,A				Demersal
redfish	*Sebastes fasciatus*				X[1]	Demersal
sand tiger shark	*Carcharias Taurus*	E,LJ	X			Pelagic
sandbar shark	*Carcharhinus plumbeus*	L,J,A	X			Pelagic
scalloped hammerhead shark	*Sphyrna lewini*		X			Pelagic
scup	*Stenotomus chrysops*	J,A			X	Demersal
sea scallop	*Placopecten magellanicus*	E,L,J,A			X	Benthic
sheepshead minnow	*Cyprinodon variegatus*					Pelagic
short finned squid	*Illex illecebrosus*					Pelagic
shortfin mako shark	*Isurus oxyrinchus*	L,J,A	X		X	Pelagic
shortnose sturgeon	*Acipenser brevirostrum*			ESA Endangered		Demersal
silver hake	*Merluccius bilinearis*				X	Demersal
skilletfish	*Gobiesox strumosus*					Demersal
skipjack tuna	*Katsuwonus pelamis*	J,A	X			Pelagic
smallmouth flounder	*Etropus microstomus*					Demersal
smoothhound shark	*Mustelus canis*	E,L,J,A				Demersal
southern rock crab	*Cancer irroratus*					Benthic
spanish mackerel	*Scomberomorus maculatus*	E,L,J,A				Pelagic
spiny dogfish	*Squalus acanthias*	J,A			X	Demersal
spot	*Leiostomus xanthurus*					Demersal
spotfin killifish	*Fundulus luciae*					Pelagic
spotted hake	*Urophycis regia*					Demersal
striped bass	*Morone saxatilis*				X	Pelagic/Structure Oriented
striped killifish	*Fundulus majalis*					Pelagic
striped searobin	*Prionotus evolans*					Demersal
summer flounder	*Paralichthys dentatus*	E,L,J,A			X[1]	Demersal
surfclam	*Spisula solidissima*	J,A				Benthic
swordfish	*Xiphias gladius*	J	X		X	Pelagic

Common Name	Scientific Name	EFH[1]	Highly Migratory Species	Listing Status	Commercial/ Recreational Importance[2]	Habitat Association
tautog	*Tautoga onitis*				X[1]	Demersal/Structure Oriented
three-spined stickleback	*Gasterosteus aculeatus*					Demersal
tiger shark	*Galeocerdo cuvieri*	J,A	X			Pelagic
weakfish	*Cynoscion regalis*				X[1]	Pelagic
white mullet	*Mugil curema*					Pelagic
white perch	*Morone americana*					Pelagic
white shark	*Carcharodon carcharias*	E,LJ,A	X			Pelagic
whiting	*Merluccius bilnearis*	E,L,J,A				Demersal
windowpane flounder	*Scophthalmus aquosus*	E,L,J,A				Demersal
winter flounder	*Pseudopleuronectes americanus*	E,L,J,A			X[1]	Demersal
winter skate	*Leucoraja ocellata*				X	Demersal
witch flounder	*Glyptocephalus cynoglossus*	E,L			X	Demersal
yellowfin tuna	*Thunnus albacares*	J	X			Pelagic
yellowtail flounder	*Limanda ferruginea*	E,L,J,A			X	Demersal

Note: [1] - EFH denotes life stage; E = Eggs, L = Larval, J = Juvenile, A = Adult

[2] - Commercial/Recreational State Managed Species

Sources: Vasslides and Able 2008, Guida *et al.* 2017, Able *et al.* 2013, 2014, and 2015, Geo-Marine, Inc. 2010, NOAA Fisheries 2018d, NJDEP 2018f, NJDEP 2018g

2.2.6.1.1 Finfish

Offshore Project Area

The Offshore Project Area (Wind Farm Area and offshore export cable corridors) is an open ocean/marine environment with unique characteristics influencing the fish community.

Relevant data for the Offshore Project Area includes studies that took place within the New Jersey WEA such as the Northeast Fisheries Science Center Seasonal Trawl Surveys conducted between 2003 and 2016 (Guida *et al.* 2017) as well as studies that were conducted in close proximity to the WEA for which fish and invertebrate collection data would be representative of the Project Area (Vasslides and Able 2008). These studies encompassed multiple seasons and were grouped into cold (winter/spring) and warm seasons (summer/fall). A summary of species collected in these studies by season is provided in **Table 2.2.6-2.**

Table 2.2.6-2. Taxa in seasonal trawl survey catches between 2003 and 2016 in cold (winter/spring) and warm (summer/fall) seasons.

Common Name	Scientific Name	Winter/Spring	Summer/Fall
Atlantic croaker	*Micropogonias undulatus*[1,2]		X
Atlantic herring	*Clupea harengus*[1]	X	X
Atlantic mackerel	*Scomber scombrus*[1]	X	X
Bay anchovy	*Anchoa mitchilli*[1,2]		X
Black sea bass	*Centropristis striatus*[2]		X
Bluefish	*Pomatomus saltatrix*[2]		X
Bullnose ray	*Myliobatis freminvillii*[1]		X
Butterfish	*Peprilus triacanthus*[1,2]		X
Clearnose skate	*Raja eglanteria*[1]		X
Fourspot flounder	*Paralichthys oblongus*[2]		X
Gulf stream flounder	*Citharichthys arctifrons*[2]		X
Horseshoe crab	*Limulidae*[1]	X	X
Little skate	*Leucoraja erinacea*[1]	X	
Longfin Squid	*Doryteuthis pealeii*[1]	X	
Northern puffer	*Sphoeroides maculatus* [2]		X
Northern sand lance	*Ammodytes dubius*[1]	X	X
Northern seahorse	*Hippocampus erectus*[2]		X
Northern searobin	*Prionotus carolinus*[1,2]	X	X
Red hake	*Urophycis chuss*[2]		X
Roughtail stingray	*Dasyatis centroura*[1]		X
Round herring	*Spratelloides gracilis*[1]		X
Scup	*Stenotomus chrysops*[1,2]		X
Sea scallop	*Placopecten magellanicus*[1]	X	X
Silver hake	*Merluccius bilinearis*[1,2]	X	X

Common Name	Scientific Name	Winter/Spring	Summer/Fall
Smallmouth flounder	*Etropus microstomus*[2]		X
Smooth dogfish	*Mustelus canis*[1]		X
Southern rock crab	*Cancer irroratus*[1]	X	X
Spiny dogfish	*Squalus acanthias*[1]	X	X
Spot	*Leiostomus xanthurus*[1]		X
Spotted hake	*Urophycis regia*[1,2]	X	X
Striped searobin	*Prionotus evolans*[2]		X
Summer flounder	*Paralichthys dentatus*[1]	X	X
Weakfish	*Cynoscion regalis*[1]		X
Windowpane flounder	*Scophthalmus aquosus*[1]	X	X
Winter Skate	*Leucoraja ocellata*[1]	X	X

[1] - Guida *et al.* 2017, [2] - Vasslides and Able 2008

BOEM conducted habitat assessments in the New Jersey WEAs between 2013 and 2016, which included temperature data, benthic sampling, sediment type, and habitat type. Beam trawls for benthic epifauna and 15 triplicate Van Veen grabs for benthic infauna were collected (Guida *et al.* 2017). There were no year-round dominant species among 113 taxa of megafauna during the 14 years of seasonal trawls. Warm seasons were dominated by Atlantic croaker (*Micropogonias undulates*), longfin squid (*Doryteuthis pealeii*), and scup (*Stenotomus chrysops*), whereas the cold season was dominated by Atlantic Herring (*Clupea harengus*), little skate (*Leucoraja erinacea*), and spiny dogfish (*Squalus acanthias*) (Guida *et al.* 2017).

No Atlantic cod were captured within the boundaries of the New Jersey WEA between 2003 and 2016 despite the New Jersey WEA being entirely within the current adult cod EFH zone (Guida *et al.* 2017). Black sea bass (*Centropristis striata*) young of the year (YOY) and sub-adult to adult were widespread, common, and abundant in the Lease Area. YOY were observed restricted to the OCS-A 0498 lease, despite more gravel-heavy sediments in the northern part of the New Jersey WEA which are typically more favorable substrate for juvenile black sea bass (Guida *et al.* 2017). YOY black sea bass are thought to have differing requirements with response to bottom habitat refuge requirements than adults and therefore this is a species where there is potential for bottom habitat disturbance (Guida *et al.* 2017).

Additional fish studies within the Offshore Project Area included Vasslides and Able (2008) and Wilber *et al.* (2003). These studies report species assemblage across coastal beaches and the surf zone along with the pelagic zone specific to shoreface sand ridges on the inner continental shelf. The Vasslides and Able (2008) study was located slightly north of the Lease Area and summarized otter trawl and beam trawl collections conducted across various habitat types of the southern New Jersey coast. Beam-trawl samples in mid- and late-summer 1991-1995 were conducted at eight stations along a transect line between Little Egg Inlet using a two-meter beam trawl. Otter trawl samples in mid-summer 1997-2006 were conducted from 2 to 7 miles off the coast of Little Egg Inlet in the vicinity of Beach Haven Ridge during four replicate tows in the inlet station. The study concluded that shoreface sand ridges are important habitats for fish species including families *Paralichthyidae* (large-tooth flounders), *Triglidae* (sea robins), *Gobiidae* (gobies), *Serranidae* (groupers/sea bass), *Engraulidae* (anchovies), *Stromateidae* (butterfish), and *Sciaenidae* (drums/croakers).

The USACE New York District (Burlas and Clarke 2001) conducted offshore otter trawl surveys along the coast of northern New Jersey from 1994 to 1999 near borrow areas located from 1.9 to 6.2 miles (3 to 10 km) offshore near the Manasquan Inlet. A total of 84 taxa representing 44 families were collected during the study. The most abundant taxa included carangids (jacks), clupeids (herring), gadids (cods), bothids (flounders), sciaenids (drums), and scombrids (mackerels). Species were highly variable depending on season. Blueback herring (*Alosa aestivalus*), skates (*Raja* spp.) and anchovies (*Anchoa* spp.) dominated spring collections. Butterfish (*Peprilus triacanthus*) and sea robins (*Priontus* spp.) dominated fall collections.

Seasonal nearshore bottom trawl surveys have been conducted since 2007 by the Virginia Institute of Marine Science as part of the Northeast Area Monitoring and Assessment Program (NEAMAP) to support single and multispecies stock assessments in the Mid-Atlantic (Bonzek *et al*. 2017). The bottom trawl survey takes place across 17 regions from Cape Hatteras, North Carolina to Rhode Island Sound near the Massachusetts state waters. Three of these regions cover the New Jersey nearshore waters from Monmouth to Cape May County. Surveys off the coast of New Jersey target water depths up to 60 feet within 10 miles from shore. Within these three regions, seasonal trends in species abundance and occurrence are noticeable. Similar to the aforementioned studies, NEAMAP results also showed distinct seasonal variation is species assemblage and abundance. During spring trawling surveys, the most abundant species included alewife (*Alosa pseudoharengus*), American shad (*Alosa sapidissima*), bay anchovy (*Anchoa mitchilli*), blueback herring, butterfish (*Peprilus triacanthus*), scup and silver hake (*Merluccius bilinearis*) along with clearnose (*Raja eglanteria*) and little skates (*Leucoraja erinacea*). During fall trawling surveys, these species were mostly absent from collections and a different assemblage was found to be most abundant and included bluefish (*Pomatomus saltatrix*), kingfish (*Menticirrhus saxatilis*), and weakfish (*Cynoscion regalis*).

NMFS has conducted annual bottom trawl surveys since 1999 during the winter (1999-2007), spring and fall (1999-2019) at depths that ranged from 50 to 190 ft. During the 2007 winter trawl survey, abundant species included spiny dogfish, yellowtail flounder (*Limanda ferruginea*), winter flounder (*Pseudopleuronectes americanus*), windowpane flounder (*Scophthalmus aquosus*), summer flounder (*Paralichthys dentatus*), Atlantic herring, and little skate (NMFS 2007). Spring (NMFS 2019) and fall species assemblages were similar to the NEAMAP surveys with the addition of abundant collections of longfin squid in the fall (NMFS 2018a).

The NJDEP has conducted the NJ Ocean Trawl Program annually for over 30 years to document the occurrence, distribution, and relative abundance of marine recreational and non-recreational fish species inhabiting the nearshore coastal waters of New Jersey. Seasonal trends were similar to those seen in Virginia Institute of Marine Science and NMFS surveys. Winter collections have been dominated by Atlantic herring, blueback herring, little skate, silver hake, and spiny dogfish. Spring collections were similar to winter with the addition of large numbers of bay anchovy. Summer collections were also dominated by bay anchovy, with additional high abundances of butterfish, longfin squid, northern searobin (*Prionotus carolinus*), scup, and striped anchovy (*Anchoa hepsetus*). Fall collections were dominated by bay anchovy but also had collections of longfin squid, scup, and butterfish (NJDEP 2019).

Estuarine Portion of the Offshore Export Cable Corridors

The estuarine waters of the offshore export cable corridors also contain a very diverse fish community that can tolerate unique habitat characteristics of inshore waters. These characteristics include but are not limited to shallow water depths, lower salinities, differing wave and current action, and different benthic habitat, including SAV beds.

Three studies directly related to the estuarine waters of the offshore export cable corridors are Able *et al.* (2013, 2014, and 2015), Zampella *et al.* (2006), and Valenti *et al.* (2017). In these studies, a variety of habitats for fish and crabs including marsh creeks, SAV beds, and open water in Barnegat Bay were sampled extensively with otter trawl collections, plankton nets, and gill nets. Sampling locations included Forked River and Oyster Creek whose results were compared to historical data from the late 1970s and early 1980s. Findings concluded that historical and recent data yielded similar results in terms of species diversity for cool water migrant species (those species with general northern sub-boreal cool water affinities that move into the Mid-Atlantic during fall and winter months), but a change in the occurrence of warm water migrants (those that have warm-temperate sub-tropical affinities with centers of distribution to the south, but that may migrate along shore to occupy Mid-Atlantic-Bight waters during the warm summer months). Resident and cool-water migrant species (e.g., silver hake) were less abundant and had been replaced by warm-water migrants such as northern kingfish and black drum (*Pogonias cromis*). A prime example of a warm water migrant that is now so abundant that it is harvested in commercial and recreational fisheries is Atlantic croaker (*Micropogonias undulatus*). Additionally, species such as bay anchovies (*Anchoa mitchilli*) and Atlantic silverside (*Menidia menidia*) exhibited a substantially higher abundance during summer and fall months. A summary of identified species is provided in **Table 2.2.6-3**.

Table 2.2.6-3. Species composition in Barnegat Bay sampling gear during 2012-2014 (X indicates present).

Species		Sampling Method		
Scientific Name	Common Name	Plankton Net	Otter Trawl	Gill Net
Alosa mediocris	Hickory shad		X	X
Alosa pseudoharengus	Alewife		X	
Alosa sp			X	
Ammodytes sp		X		
Anchoa hepsetus	Broad-striped anchovy	X	X	
Anchoa mitchilli	Bay anchovy	X	X	
Anchoa sp		X	X	
Anguilla rostrata	American eel	X	X	
Apeltes quadracus	Fourspine stickleback	X	X	
Archosargus probatocephalus	Southern sheeps head		X	
Astroscopus guttatus	Northern stargazer		X	
Bairdiella chrysoura	American silver perch	X	X	X
Blenniidae sp		X		
Brevoortia tyrannus	Atlantic menhaden	X	X	X
Caranx crysos	Blue runner		X	
Caranx hippos	Crevalle jack		X	
Carcharhinus plumbeus	Sandbar shark			X
Centropristis striata	Black sea bass	X	X	
Chaetodon ocellatus	Spotfin butterfly fish		X	
Chasmodes bosquianus	Striped blenny	X	X	
Chilomycterus schoepfi	Striped burrfish	X	X	
Clupea harengus	Atlantic herring	X	X	
Clupeidae sp		X	X	
Clupeiformes sp		X	X	

Species		Sampling Method		
Scientific Name	**Common Name**	**Plankton Net**	**Otter Trawl**	**Gill Net**
Conger oceanicus	American conger	X	X	
Ctenogobius boleosoma	Darter goby	X		
Cynoscion regalis	Weakfish	X	X	X
Cyprinodon variegatus	Sheepshead minnow		X	
Dactylopterus volitans	Flying gurnard		X	
Dasyatis say	Bluntnose stingray		X	X
Dorosoma cepedianum	American gizzard shad			X
Elops saurus	Ladyfish	X		
Enchelyopus cimbrius	Fourbeard rockling	X		
Engraulidae sp		X		
Engraulis eurystole	Silver anchovy	X		
Etropus microstomus	Smallmouth flounder	X	X	
Eucinostomus argenteus	Spotfin mojarra		X	
Fundulus heteroclitus	Mummichog	X	X	
Fundulus luciae	Spotfin killifish	X	X	
Fundulus majalis	Striped killifish	X	X	
Fundulus sp		X	X	
Gadus morhua	Atlantic cod	X	X	
Gasterosteus aculeatus	Three-spined stickleback		X	
Gobiesox strumosus	Skilletfish	X	X	
Gobiidae sp		X		
Gobionellus oceanicus	Highfin goby	X		
Gobiosoma bosc	Naked goby	X	X	
Gobiosoma ginsburgi	Seaboard goby	X	X	
Gobiosoma sp		X	X	
Hippocampus erectus	Lined seahorse	X	X	
Hyporhamphus meeki	American halfbeak	X		
Hypsoblennius hentz	Feather Blenny	X	X	
Ictalurus punctatus	Channel catfish		X	
Lagodon rhomboides	Pinfish	X	X	
Leiostomus xanthurus	Spot	X	X	X
Lepomis gibbosus	Pumpkinseed sunfish		X	
Lepomis macrochirus	Bluegill sunfish		X	
Lucania parva	Rainwater killifish	X	X	
Lutjanus griseus	Mangrove snapper		X	
Menidia beryllina	Inland silverside	X	X	
Menidia menidia	Atlantic silverside	X	X	

Species		Sampling Method		
Scientific Name	Common Name	Plankton Net	Otter Trawl	Gill Net
Menidia sp		X	X	
Menticirrhus saxatilis	Northern kingfish	X	X	X
Microgobius thalassinus	Green goby	X	X	
Micropogonias undulatus	Atlantic croaker	X	X	X
Morone americana	White perch		X	X
Morone saxatilis	Striped bass		X	X
Morone sp			X	
Mugil cephalus	Flathead grey mullet	X	X	
Mugil curema	White mullet	X	X	
Mugil sp				X
Mustelus canis	Smooth dogfish		X	X
Mycteroperca microlepis	Gag grouper		X	
Myliobatis freminvillii	Bullnose ray			X
Myoxocephalus aenaeus	Little sculpin	X		
Myrophis punctatus	Speckled worm eel	X		
Ophichthus cruentifer	Margined snake eel	X		
Opisthonema oglinum	Atlantic thread herring	X		X
Opsanus tau	Oyster toadfish	X	X	
Paralichthys dentatus	Summer flounder	X	X	X
Peprilus sp		X	X	
Peprilus triacanthus	American butterfish	X	X	
Perca flavescens	Yellow perch		X	
Pholis gunnellus	Rock gunnel	X		
Pleuronectes sp		X		
Pogonias cromis	Black drum	X	X	X
Pollachius virens	Pollock		X	
Pomatomus saltatrix	Bluefish	X	X	X
Prionotus carolinus	Northern searobin	X	X	
Prionotus evolans	Striped searobin	X		
Pseudopleuronectes americanus	Winter flounder	X	X	
Raja erinacea	Little skate		X	
Rhinoptera bonasus	Cownose ray			X
Sciaenidae sp		X	X	
Scophthalmus aquosus	Windowpane flounder	X	X	
Selene setapinnis	Atlantic moonfish		X	
Selene vomer	Lookdown		X	
Sphoeroides maculatus	Northern puffer	X	X	
Stenotomus chrysops	Scup		X	

Species		Sampling Method		
Scientific Name	Common Name	Plankton Net	Otter Trawl	Gill Net
Strongylura marina	Atlantic needlefish	X	X	X
Symphurus plagiusa	Blackcheek tonguefish	X	X	
Syngnathus fuscus	Northern pipefish	X	X	
Synodus foetens	Inshore lizardfish		X	
Tautoga onitis	Tautog	X	X	
Tautogolabrus adspersus	Cunner	X	X	
Trinectes maculatus	Hogchoker	X	X	X
Tylosurus acus	Pike fish	X		
Urophycis regia	Spotted Hake	X	X	

Source: Able et al. 2013, 2014, 2015

Fish communities have been extensively studied within estuarine waters, in particular within Barnegat Bay, Little Egg Harbor, and Great Egg Harbor. Akers (2015) focuses on species assemblages found within the Great Egg Harbor River near the BL England Generating Station that were surveyed in 2014 and 2015. Fisheries surveys were conducted using otter trawls; species and abundance data are presented, along with spatial analysis of the 32 net tows conducted in the Great Egg Harbor River and 8 tows in the upper Tuckahoe River. Data from a 1998-1999 study using electrofishing and seining, conducted by University of Maryland, is compared with the current study for species abundance among sample sites. At the three sampling locations closest to the BL England Generating Station at Great Egg Harbor, the dominant species collected included white perch (*Morone americana*), hogchoker (*Trinectes maculatus*), and brown bullhead (*Ameiurus nebulosus*).

The Wilber *et al.* (2003) study occurred off the coast of Monmouth and Ocean County. The surf zone fish community along 9.3 miles (15 km) of northern New Jersey was sampled every two weeks by beach seine in the late summer and early fall of 1995-1999 as part of monitoring of a beach nourishment. Fifty-seven species representing 30 families were collected during the study, where 90 percent of each sampling period's catch was composed of five taxa or less. These included Atlantic silverside (*Menidia menidia*), rough silverside (*Membras martinica*), bluefish (*Pomatomus saltatrix*), bay anchovies (*Anchoa mitchilli*), and striped anchovies (*Anchoa hepsetus*) (Wilber *et al.* 2003).

2.2.6.1.2 Essential Fish Habitat and Habitat Areas of Particular Concern

EFH includes all types of aquatic habitat that fish require to survive and reproduce. These habitats include wetlands, coral reefs, seagrasses, and rivers that fish use for spawning, breeding, foraging and growth. EFH data are available through the NOAA EFH Mapper (NOAA 2018f). This online tool provides information on the species and life stages managed by the New England Fishery Management Council (NEFMC) and Mid-Atlantic Fishery Management Council (MAFMC). The EFH Mapper has information on EFH species and life stages for the Project Areas including onshore and offshore. However, the EFH Mapper does not provide complete data, as all species managed by the regional councils have not been added to the database.

EFH and Habitat Areas of Particular Concern (HAPC) data are also documented within the Ocean/Wind Power Ecological Baseline Studies, Volume 1 (NJDEP 2010b). This report documents 43 managed species within the Wind Farm Area (**Table 2.2.6-1**) that have EFH designation by three fishery management councils and NMFS. EFH and HAPC areas were also used as resources to develop the Environmental Sensitivity Index map for the offshore wind study area. A GIS overlay procedure was used to identify development areas that may be more sensitive to disturbance. An EFH/HAPC sensitivity map was developed and provides coverage for the Oyster Creek and BL England study areas **(Table 2.2.6-1)**.

The sandbar shark has mapped HAPC located within the backbays and nearshore estuarine waters just north of Great Egg Harbor, outside of the Project area. The HAPC extends north into Great Bay, the inland bays to the southwest surrounding Atlantic City, and the offshore coastal waters extending to approximately the state-seaward boundary. Sandbar HAPC is also mapped within Delaware Bay (**Figure 2.2.6-1**). The BL England and Oyster Creek cable corridors avoid this HAPC. Additional detail regarding EFH is included in Appendix P.

NMFS has also designated HAPC for Summer flounder (*Paralichthys dentatus*) that exists in all native species of microalgae, seagrasses, and freshwater and tidal macrophytes in any size bed, as well as loose aggregations, within adult and juvenile summer flounder EFH. NMFS states that if native species of SAV are eliminated, then exotic species should be protected because of functional value, however, all efforts should be made to restore native SAV species (**Figure 2.2.6-1**). Additional detail regarding EFH is included in Appendix P.

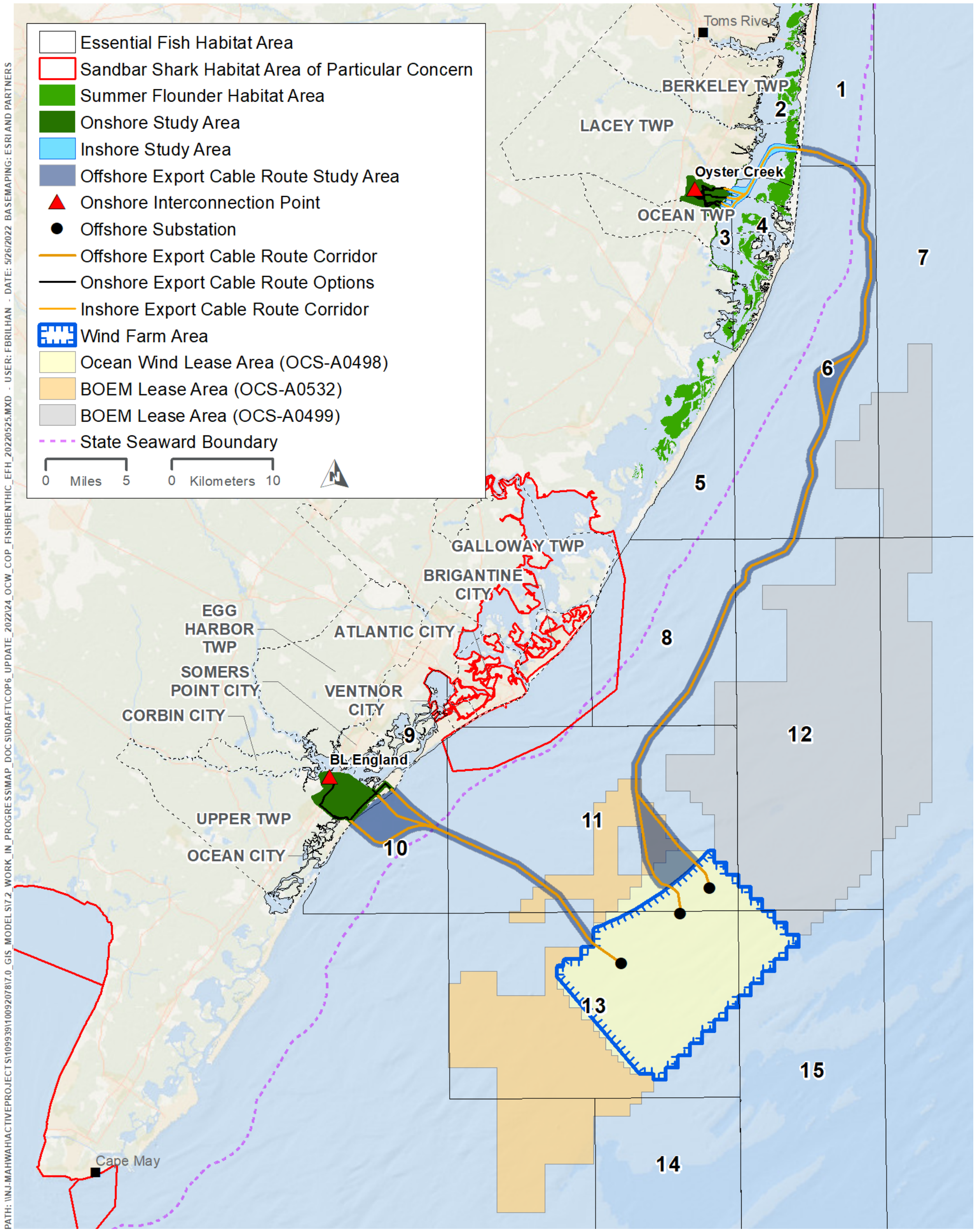

Figure 2.2.6-1. EFH/HAPC location map.

2.2.6.1.3 Threatened and Endangered Fish

Two Federally and State-listed endangered fish species may occur off the New Jersey coast: shortnose sturgeon (*Acipenser brevirostrum*) and the Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). A further description of these species is provided below. Additionally, species that are candidates for listing are also listed in **Table 2.2.6-4**.

Table 2.2.6-4. List of Mid-Atlantic threatened and endangered species.

Species (Scientific Name)	Endangered Species Act Status
Shortnose sturgeon (*Acipenser brevirostrum*)	New York Bight distinct population segment (DPS) - ESA Endangered
Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*)	New York Bight DPS - ESA Endangered
Oceanic whitetip shark (*Caracharinus longimanus*)	ESA Threatened
Giant manta ray (*Manta birostris*)	ESA Threatened
Alewife (*Alosa pseudoharengus*)	Candidate Species
Blueback herring (*Alosa aestevalis*)	Candidate Species
Cusk (*Brosme brosme*)	Candidate Species

Shortnose Sturgeon

Shortnose sturgeon is an anadromous fish species that migrates far upstream into freshwater rivers to spawn in the spring. Once they mature, males spawn every 1 to 2 years while females spawn every 3 to 5 years. Females can produce up to 200,000 eggs per year. The species spends relatively little time in marine waters, with the majority of their lives being spent in the estuarine waters. When they do enter ocean waters, they generally stay close to shore. Historically, the species was found in coastal rivers along the entire east coast of North America. Because of threats such as habitat degradation, water pollution, dredging, water withdrawals, fishery bycatch and habitat impediments (e.g., dams), the species is now listed as endangered throughout the entire population range. Within the Mid-Atlantic Region, shortnose sturgeon are found in the in the Delaware and Hudson River estuaries (NOAA Fisheries 2018d). Because of preference for estuarine and river habitat, the species is not expected to be found in the offshore Wind Farm Area and unlikely to be found in the estuaries of Barnegat Bay and Great Egg Harbor (offshore export cable corridors) as they are not listed by NOAA as one of the 42 ecosystems where they are known to occur (NMFS 2010).

Atlantic Sturgeon

Atlantic sturgeon is an anadromous fish species that lives in rivers and coastal waters along the entire east coast from Canada to Florida. The species hatches in freshwaters and migrates to the ocean as juveniles. Once reaching maturity, Atlantic sturgeon migrate back up rivers to spawn in the spring with males spawning almost every year and females every two to three years. Distribution and abundance vary by season as they are found in shallow coastal waters during the summer months and move to deeper waters in winter and early spring (Dunton *et al.* 2010).

Historically, the species was found in great abundance, but due to overfishing and habitat loss, populations have drastically declined. Other threats include vessel strikes, fishery bycatch, habitat degradation, poor water quality, and habitat impediments. Currently, four distinct population segments (DPS) are listed as Endangered, including the New York Bight DPS.

On April 6, 2012, NMFS divided U.S. populations of Atlantic sturgeon into five “species” or DPSs. However, based on genetic data and tracking and tagging data, sturgeon from any of these DPSs and Canada can occur anywhere in the geographic range of the subspecies. Eyler *et al*. (2009) reported that Atlantic sturgeon tagged off New Jersey have been recaptured in Long Island Sound, off Maryland, Delaware, New Hampshire, and

North Carolina. Consequently, the sturgeon that occur in the Project area may represent any of the five DPS of this species.

Atlantic sturgeon have been captured in several sampling programs off the New Jersey coast (Dunton *et al*. 2010, Erickson *et al*. 2011, Eyler *et al*. 2009, Stein *et al.* 2004). Dunton *et al.* (2010) analyzed data from surveys covering the northwest Atlantic Ocean from Cape Hatteras (North Carolina) to the Gulf of Maine conducted by five agencies. The catch per unit of effort (CPUE) for Atlantic sturgeon off New Jersey, from New York Harbor south to the entrance of Delaware Bay (Delaware), was second only to CPUE from the entrance of New York harbor to Montauk Point (New York). Supplemental information on Atlantic sturgeon is contained in Appendix I.

Oceanic Whitetip Shark

The oceanic whitetip shark can be found throughout the world's oceans in tropical and sub-tropical waters. The species is generally found on the OCS and around oceanic islands in water depths greater than 600 ft. They are most commonly found near the surface in waters above 68°F (20°C). The shark is considered a top predator and is opportunistic, feeding on bony fishes and cephalopods, such as squid, sportfish, seabirds, other sharks and rays, and marine mammals. The long-lived species can survive for up to 36 years, maturing between 6 and 9 years of age, depending on geographic location. Evidence suggests that this species is experiencing a decline in abundance across the world due to bycatch in pelagic longlines, purse seines and gillnets along with harvest for international trade (NOAA Fisheries 2019b). The species would be unlikely to be found in the Project Area as water depths are too shallow to accommodate the life history requirements. Therefore, this species is not discussed further.

Giant Manta Ray

The giant manta ray is the world's largest ray and can be found worldwide in tropical, subtropical, and temperate waters in the United States as far north as New Jersey during summer months. Giant manta rays are commonly found along the U.S. East Coast in waters between 66.2 and 71.6°F (19 and 22°C). The species is a filter feeder that feeds on zooplankton. Migration occurs throughout the East Coast waters following these zooplankton, along with tidal patterns, seasonal upwellings, seawater temperature, and possibly mating behavior. They are slow-growing, long-lived, and have the lowest fecundity of all elasmobranchs, typically giving birth to only one pup every two to three years. While the species has been documented to live up to 40 years, little is known about their growth and development. The species has seen its populations decline across the globe due to commercial fishing as both a targeted species and as bycatch. The rays are also valued for their gill rakers, which are traded internationally (NOAA Fisheries 2019a). The species would be unlikely to occur within the Project Area as water temperatures are likely at the lower range of its tolerance. Additionally, the rays frequently feed in waters at depths of 656 to 1,312 ft (200 to 400 meters) (NOAA Fisheries 2019a), depths much greater than waters found within the Project Area. Therefore, this species is not discussed further.

Alewife

Alewife is an anadromous fish species native to the Atlantic coast and its tributaries that migrate from the ocean to freshwater to spawn. The species may spend its entire life in fresh water. Alewife begin spawning when water temperatures reach 51°F and females produce 60,000 to 350,000 eggs that hatch within 3-6 days (USFWS 2018c). Juveniles remain in tidal freshwater nursery areas in spring and early summer and move downstream to more saline waters in the fall (ASMFC 2018). Alewife populations have seen declines throughout much of their range due to blocked access to spawning grounds and habitat degradation caused by dams and culverts (NOAA Fisheries 2018a). Alewife is a candidate species throughout its entire range under the ESA. In August 2017, a status review for alewife was initiated by NOAA Fisheries to determine if listing alewife under the ESA as endangered or threatened is necessary. However, on June 19, 2019 NOAA issued a determination that listing under the ESA was not warranted.

Blueback Herring

Blueback herring is an anadromous species native to the east coast of North America, with a range from the lower parts of Cape Breton Rivers in Nova Scotia, Canada, and south to the St. John's River in Florida. Spawning occurs in fast moving, shallow water in the main stem of river tributaries. Juveniles normally remain in the same watershed throughout the summer and fall and then migrate to sea once waters reach a lower temperature (ASMFC 2018). Blueback herring have experienced population declines due to habitat impediments such as dams; habitat degradation and loss; and commercial and recreational fishing (NOAA Fisheries 2018b). Blueback herring is a candidate species throughout its entire range under the ESA. In August 2017, a status review for blueback herring was initiated by NOAA Fisheries to determine if listing blueback herring under the ESA as endangered or threatened is necessary. However, on June 19, 2019 NOAA issued a determination that listing under the ESA was not warranted.

Cusk

Cusk is a deep, cooler water species found in rocky, hard bottom areas to a depth of approximately 328 ft (100 m). The general range of cusk is from the northwest Atlantic Ocean from New Jersey to the Strait of Belle Isle in Canada. They are occasionally found on mud bottoms but rarely on smooth, clean sand (Dultz 2013). Cusk spawn in spring and early summer, with females releasing up to 2 million eggs. The planktonic young remain in coastal, shallow water environments until they reach a length of about 2 inches (50 mm) and then become benthic. Cusk is a relatively slow-growing and late-maturing species, reaching a maximum age greater than 14 years. Because this species has nearly identical habitats with Atlantic cod, cusk becomes an accidental bycatch and subsequently consumed (Dultz 2013). Decreases in landings and size of fish caught likely indicate a decline in population. In March 2007, a status review for cusk was initiated by NOAA Fisheries to determine if listing cusk under the ESA as endangered or threatened is necessary (NOAA Fisheries 2018c). Cusk is currently still listed as a candidate species throughout its entire range under the ESA.

2.2.6.1.4 Plankton

Offshore Project Area

Phytoplankton are microscopic, single-celled organisms that use sunlight and chlorophyll to photosynthesize, serving as the base for the marine food chain. Phytoplankton distribution is patchy and dependent on water temperature, light, and nutrient concentration. It is denser in nearshore areas where there is input of nutrients such as dissolved nitrogen, phosphorus, and silica from land sources. In general, in continental shelf and slope waters, the concentration of chlorophyll a (the means of measuring phytoplankton concentration) decreases with distance from shore and with increasing water depth. Phytoplankton within the coastal waters are typically dominated by chromophytic algae with diatoms being the major phytoplankton taxa present (NJDEP 2010a).

Zooplankton form an essential link connecting fishes, birds, marine mammals, other large marine species and the primary producers (phytoplankton and marine bacteria) of the marine food web. They are aquatic animals ranging from the smallest protozoans to jellyfish. Zooplankton species are capable of moving sizable distances, performing vertical migrations in the water column. However, horizontal distribution is mostly governed by ocean currents and physical, chemical and biological conditions. The major zooplankton groups include chaetognaths, copepods, gelatinous zooplankton, ichthyoplankton, amphipods, cladocerans, euphausiids, heteropods, polychaetes, and pteropods. Zooplankton on the continental shelf is comprised mostly of the copepods *Pseudocalanus* sp. and *Centropages typicus*, and pteropod *Limacina retroversa*. Seasonal water changes off the coast of New Jersey regulate zooplankton productivity, species composition, and spatial distribution. In general, zooplankton display a strong seasonal pattern with a spring enhancement of biomass within the upper 656 ft (200 m) of the water column. Typically, maximum abundance occurs during spring between April and May on the outer shelf (dominated by *Pseudocalanus* sp. and *Calanus finmarchicus*) as well as late summer between August and September on the inner shelf (dominated by *C. typicus* and *Ternora longicornis*). The lowest abundance begins in November and reaches a minimum in February (NJDEP 2010a).

Estuarine Portion of the Offshore Export Cable Corridors

Extensive studies have been conducted on plankton in the Barnegat Bay-Little Egg Harbor Estuary to assess zooplankton and phytoplankton populations including surveys to collect data on ichthyoplankton, gelatinous macrozooplankton, and copepods, decapods, and bivalves. The zooplankton community in Barnegat Bay is characterized by strong spatial and seasonal trends in abundance and diversity. Northern and southern regions of the bay show the most apparent spatial variability in their community assemblage and water quality characteristics. The northern bay was characterized by higher nitrogen and chlorophyll a, higher abundances of copepods, ctenophores, and barnacle larvae, and the lowest species diversity of zooplankton and ichthyoplankton in the bay. Alkalinity and phosphorus were higher in the southern bay, as was species diversity of both zooplankton and ichthyoplankton (Nickels and Howson 2016). Water quality conditions driven by urbanization and lack of flushing in northern Barnegat Bay appear to be steering these trends. Similar extensive studies on zooplankton and phytoplankton assemblages and populations in Great Egg Harbor Bay are not readily available. However, because of its proximity, it is assumed the data collected from the Barnegat Bay-Little Egg Harbor Estuary provides representative information on zooplankton and phytoplankton communities, where spatial and seasonal variability are anticipated to be similar.

Weather patterns appear to be directly and indirectly affecting zooplankton abundance in Barnegat Bay. Density-independent factors such as temperature strongly contribute to variability in biological systems seen on an interannual basis (Nickels and Howson 2016).

2.2.6.1.5 Artificial Reefs

There are numerous artificial reefs (e.g., piers, docks, bulkheads, ship and plane wrecks) between Hereford Inlet, NJ in the south to just north of Barnegat Bay in the north (NJDEP 2009). The NJDFW started the New Jersey Reef Program in 1984, and has since developed fifteen artificial reef sites that support over 3,700 patch-reef communities, or an area of reef that has been created by various materials and can extend up to many square acres in size (NJDEP 2009). Reef balls, or hollow dome structures generally 4 ft (1.2 meters) wide by 3 ft (0.9 meters) high weighing approximately 1,600 pounds (726 kilograms), comprise the majority of the artificial reefs in use off the coast of New Jersey today (NJDEP 2009). Most reefs off the coast of New Jersey are located at depths of 60 ft (18 meters) or more (NJDEP). Reefs provide habitat for many commercially and recreationally important species (NJDEP 2009). Common sessile reef inhabitants of New Jersey artificial reefs include red algae colonies (*Phyllophora* spp.), sponges (*Halichondria* sp. and *Polymastia* sp.), anemones (*Metridium senile*, *Tealia* sp., and *Stomphia careoia*), northern stone coral, mollusks, barnacles, bivalves, bryozoans, and amphipods. Mobile fauna include lobsters, crabs, sea stars, urchins, polychaetes, Atlantic cod (*Gadus morhua*), gray triggerfish (*Balistes capriscus*), tautog (*Tautog onitis*), black sea bass (*Centropristis striata*), scup (*Stenotomus chrysops*), ocean pout (*Zoarces americanus*), hake (*Urophycis/Merluccius* spp.), conger eel (*Conger oceanicus*), and cunner (*Tautogolabrus adespersus*) (NJDEP 2009).

Artificial reef locations are well documented in the Ocean Wind Power EBS report (NJDEP 2010b), as well as available for download online at the Marine Cadastre National Viewer (BOEM and NOAA 2018). Several artificial reefs are documented in the Offshore Project Area (Wind Farm Area). Four artificial reef areas (Barnegat Light) are mapped offshore, adjacent to the Oyster Creek offshore export cable corridor and one is mapped offshore, adjacent to the BL England offshore export cable corridor (**Figure 2.2.6-2**). These areas have been avoided during indicative routing of the export cable routes.

2.2.6.1.6 Marine Protected Areas

Marine Protected Areas (MPAs) are intended to conserve vital marine habitats and resources, and include national marine sanctuaries, national parks, wildlife refuges, state parks, conservation areas, and fishery management closures. MPAs are defined by Executive Order 13158 as any area of the marine environment that has been reserved by Federal, State, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein (NOAA 2017c). MPAs do not prevent project development as construction activities are not regulated. The mapped MPAs in the Project Area consist of fishery management areas (**Figure 2.2.6-3**):

- Oyster Creek cable route study area - two areas with the MPA classification for Uniform Multiple Use (**Table 2.2.6-5**).
- BL England cable route study area - three areas with the MPA classification for Uniform Multiple Use (**Table 2.2.6-6**).
- Offshore Project Area - six areas with the MPA classification for Uniform Multiple Use (**Table 2.2.6-7**).

Table 2.2.6-5. Marine protection areas within the Oyster Creek cable route study area.

Marine Protected Area Name	Management Agency	Level of Protection	Designation
Waters off New Jersey Closure	National Marine Fisheries Service	Uniform Multiple Use	Fishery Management Area
Mid-Atlantic Coastal Waters Area	National Marine Fisheries Service	Uniform Multiple Use	Fishery Management Area

Source: NOAA 2018g

Table 2.2.6-6. Marine protected areas within the BL England cable route study area.

Marine Protected Area Named	Management Agency	Level of Protection	Designation
Waters off New Jersey Closure	National Marine Fisheries Service	Uniform Multiple Use	Fishery Management Area
Mid-Atlantic Coastal Waters Area	National Marine Fisheries Service	Uniform Multiple Use	Fishery Management Area
Southern Nearshore Trap/Pot Waters	National Marine Fisheries Service	Uniform Multiple Use	Fishery Management Area

Source: NOAA 2018g

Table 2.2.6-7. Marine protected areas within the Offshore Project Area.

Marine Protected Area Named	Management Agency	Level of Protection	Designation
Waters off New Jersey Closure	National Marine Fisheries Service	Uniform Multiple Use	Fishery Management Area
Mid-Atlantic Coastal Waters Area	National Marine Fisheries Service	Uniform Multiple Use	Fishery Management Area

Marine Protected Area Named	Management Agency	Level of Protection	Designation
Southern Nearshore Trap/Pot Waters	National Marine Fisheries Service	Uniform Multiple Use	Fishery Management Area
Northeastern United States Closed Area	National Marine Fisheries Service	Uniform Multiple Use	Area Closed to Commercial Fishing
Carl N Shuster, Jr. Horseshoe Crab Reserve	National Marine Fisheries Service	Uniform Multiple Use	Fishery Management Area

Source: (NOAA 2018g)

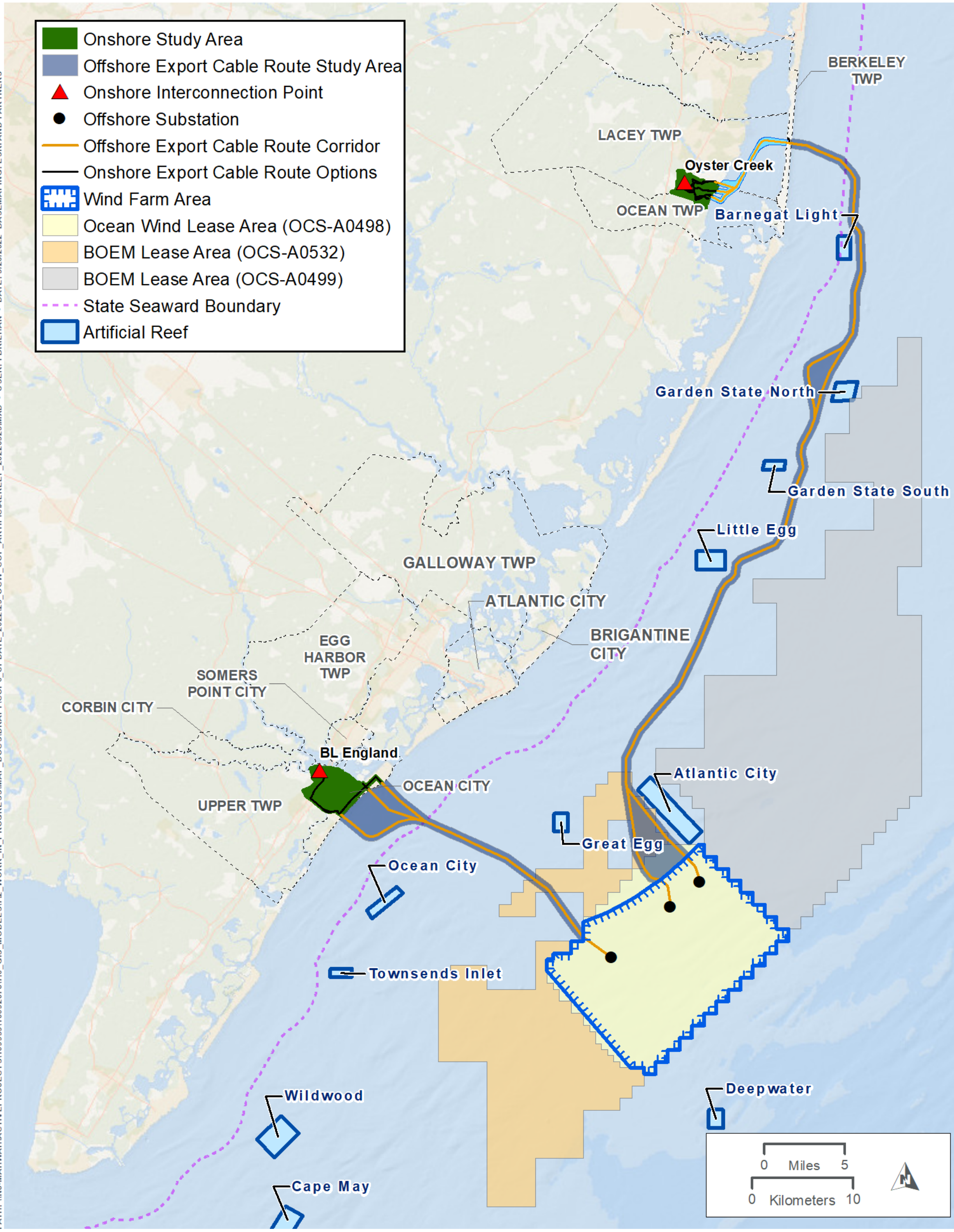

Figure 2.2.6-2. Artificial reefs along the coast of southern New Jersey.

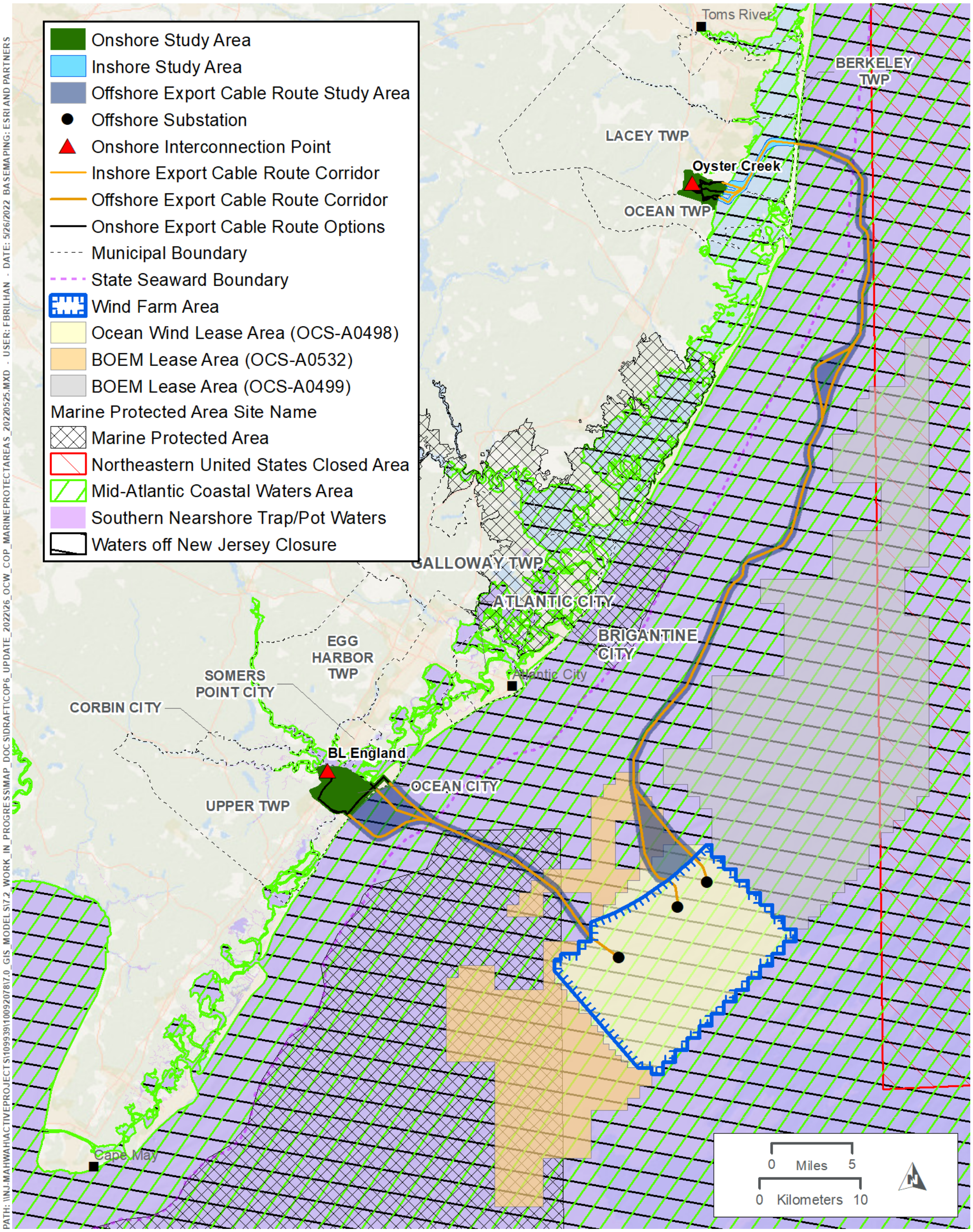

Figure 2.2.6-3. Protected areas - marine protected areas.

2.2.6.2 Potential Project Impacts on Finfish and Essential Fish Habitat

IPFs that may affect finfish and EFH are as follows and discussed in the following sections:

- Physical seabed/land disturbance
- Sediment suspension
- Discharge/releases/withdrawals
- Habitat conversion
- Noise
- EMF
- Vessel traffic

Potential impacts to the finfish community during construction include bottom disturbance including resuspension of sediments, habitat conversion, habitat loss for demersal species, noise from pile driving, and an increase in vessel traffic. Activities associated with bottom disturbance include seabed preparation (i.e., leveling), WTG and offshore substation foundation installation including scour protection, dredging if required, and cable installation. Impacts are associated with benthic prey species, EFH, and demersal fish habitat. Noise impacts are associated with pile driving and vessel noise. In situ UXO/MEC disposal during site preparation activities could also result in potential impacts.

Impacts to the Federally threatened Atlantic sturgeon are also discussed in this section. Supplemental information on potential impacts can be found in Appendix I. Impacts specific to shortnose sturgeon are not discussed because, as stated in Section 2.2.6.1.3, they are unlikely to be encountered within the marine waters of the Project Area. Additional detail regarding EFH is included in Appendix P. As noted in **Table 1.1-2**, a monitoring plan will be developed in consultation with resource agencies during the permitting process prior to construction, and implemented to monitor environmental impacts.

2.2.6.2.1 Construction

Offshore Project Area

Foundations and Scour Protection

In general, impacts from seabed disturbance will be localized and temporary with the exception of habitat conversion and/or loss due to the installation of the WTGs and offshore substations and associated scour protection, if required. It is anticipated that mobile life stages will move out of the area to avoid potential impacts. Demersal non-mobile life stages would be impacted due to the placement of foundations and scour protection in the immediate area of installation. Most juvenile and adult finfish will actively avoid all construction activities. However, immobile finfish life stages such as demersal eggs and larvae could experience mortality as a result of in-situ UXO/MEC disposal during site preparation or by being crushed or buried by the foundations, scour protection, and vessel anchors within the footprint.

As discussed in Section 2.1.2.2, most of the sediments to be encountered within the Wind Farm Area are likely to be medium to coarse grains, and resuspended sediment would be expected to resettle quickly. Therefore, no potential impacts on adult and juvenile finfish are expected, and impacts to demersal life stages are expected to be temporary.

Increased underwater noise during construction would primarily be associated with pile-driving activities in the construction area, although the potential also exists for in-situ UXO/MEC disposal. Underwater sounds are composed of both pressure and particle motion components and are perceived by fish in different ways. An underwater sound originates from a vibrating source, which causes the particles of the surrounding medium (water) to oscillate, which causes adjacent particles to move and transmit the sound wave. Particle motion can be measured in terms of displacement (m), velocity (m s^{-1}), or acceleration (m s^{-2}); however, there is not an internationally accepted standard unit for particle motion (Nedelec *et al*. 2016). Sound pressure is the variation in hydrostatic pressure caused by the compression and rarefaction of the particles caused by the sound and is measured in terms of dB relative to 1 microPascal (µPa).

All fish perceive the particle motion component of sound and have sensory structures in the inner ear that function to detect particle motion (Popper and Hawkins 2018, Nedelec *et al*. 2016). Particle motion is an important part of a fish's ability to orient itself in its environment and perceive biologically relevant sounds of prey, predators, and other environmental cues (Popper and Hawkins 2018). Those fish with a swim bladder or other air-containing organs are capable of detecting the pressure component of sound as the pressure wave causes the compression and vibration of the air-filled swim bladder. The extent to which the pressure component contributes to a fish's ability to hear varies from species to species and is related to the structures in the fish's auditory system, ability to process the signal from the swim bladder, the size of the swim bladder, and its location relative to the inner ear.

Current exposure criteria for the onset of behavioral and physiological effects to fish are based on sound pressure levels and not particle motion (Popper and Hawkins 2018, Popper *et al*. 2014, Faulkner *et al*. 2018). The following sound pressure level-based thresholds are regularly used during NMFS Section 7 consultations for listed species of fish, and represent the threshold at which the onset of behavioral or physiological effects could potentially be observed (Blackstock et al. 2018, NMFS 2018e, 2020c):

- Fish Behavioral: 150 dB re 1 µPA root mean square (RMS)
- Fish Physiological: 206 dB re 1 µPA Peak
- Fish Physiological (>2g): 187 dB re 1 µPa2s SEL_{cum}
- Fish Physiological (<2g): 183 dB re 1 µPa2s SEL_{cum}

Ocean Wind conducted sound propagation modeling for anticipated pile-driving and UXO/MEC disposal activities associated with Project construction, and results include distances to sound isopleths associated with behavioral and physiological impacts for fish (Appendix R-2). As noted in Section 2.2.5.2.1, low order (deflagration) or high order (detonation) in-situ disposal of UXO/MEC has the potential to affect fisheries resources and EFH. UXO/MEC disposal has the potential to cause disturbances to the seafloor (sediment suspension and deposition) as well as noise.

There is currently a lack of data on the potential adverse effects and responses of fish to exposure to elevated levels of particle motion caused by anthropogenic activities. The paucity of data has been attributed to the difficulty of measuring particle motion with readily available equipment, and the overall lack of scientists and engineers with the expertise to measure particle motion (Nedelec *et al.* 2016, Popper and Hawkins 2018).

The pressure wave from an intense underwater sound source has the potential to result in physiological effects and injuries to fish (California Dept. of Transportation [Caltrans] 2015). However, the same sound source with the ability to produce behavioral effects or potentially injurious levels of sound pressure also produces high levels of particle motion (Popper and Hawkins 2018). The contribution of the particle motion to potential adverse effects is not yet fully understood. The longfin squid has been found to exhibit an initial startle response, similar to that of a predation threat, to pile driving impulses recorded from a wind farm installation, but upon exposure to additional impulses, the squid's startle response diminished quickly, indicating potential habituation to the sound (Jones *et al*. 2020). After a 24-hour period, the squid seem to re-sensitize to the noise, which is an expected response to natural stimuli, as well. Squid schooling and shoaling behavior could be interrupted when exposed to pile driving impulse noises, which could impact predation risk (Jones *et al*. 2020).

The frequency of a given sound is measured in Hz and represents the number of compression and rarefaction cycles of the sound wave per unit time. The portion of the frequency spectrum that fish can hear varies from species to species. For a sound to be biologically relevant to a fish it must be physiologically capable of detecting sounds within the range of frequencies produced by the source. Most fish, including Atlantic sturgeon, can hear from 20 to 1,000 Hz (Lovel *et al.* 2005, Meyer 2010). However, due to physiological differences of the inner ear and air-filled sacs, clupieds species such as river herring (4,000 Hz) and American shad (100,000 Hz) can hear at much higher frequencies (Mann *et al*. 1997, Mann *et al*. 2001, Popper 2003). The majority of acoustic energy produced by pile driving sounds is typically lower frequency, in the range of 10-1,000 Hz (Caltrans 2015, Guan *et al*. 2017), however the amount of energy at higher frequencies varies with the type of pile, installation method, and substrate. The amount of acoustic energy at the higher frequencies that clupieds are capable of hearing typically represents a minority of the acoustic energy produced during pile driving, and likely remain below the sound pressure level exposure criteria discussed above.

Impacts of sound on fish vary with acoustic intensity but can include behavioral alterations and physiological damage such as minor ruptured capillaries in fins or severe hemorrhaging of major organs or burst swim bladders (Stephenson *et al.* 2010, Halvorson *et al.* 2011). However, there are limited studies that examine the circumstances under which immediate finfish mortality occurs when exposed to pile-driving activities. Mortality appears to occur when fish are within 30 ft of driving of relatively large diameter piles. Studies conducted by Caltrans (2001) resulted in some mortality for several different species of wild fish exposed to driving of steel piles 7.9 ft (2.4 m) in diameter, whereas Ruggerone *et al.* (2008) found no mortality to caged yearling coho salmon (*Oncorhynchus kisutch*) placed as close as 2.0 ft (0.6 m) from a 1.5 ft (0.45 m) diameter pile and exposed to over 1,600 strikes.

Increased vessel traffic would also likely increase noise levels and may cause fish to avoid areas around construction operations. Short-term and temporary sounds from vessels traveling to and from the Wind Farm Area and within the Wind Farm Area itself, and during installation of cables, WTGs, and offshore substations are not expected to affect fish because the area affected would be small compared to the abundant surrounding habitat available for fish to move to if they seek to avoid construction activities. Vessel noise associated with Project construction (or operations) would be similar to existing conditions, given the high vessel traffic in the region offshore of New York, New Jersey, and Delaware.

Impacts to fish and EFH resources during construction activities would be localized and short-term in duration resulting from loss of habitat. Potential direct mortality and tissue injury of fish and invertebrates may occur in the footprint of foundations or within the direct vicinity of the UXO/MEC disposal activities during site preparation. Indirect impacts causing displacement may also occur due to increased turbidity, noise, and vibration. At the scale of the New Jersey coastal waters or even the Wind Farm Area, these impacts will occupy just a fraction of the fishery resources and habitat available. Following construction, fishery resources are expected to recover quickly in areas of cable installation. Benthic prey species are expected to recolonize the area, and foraging habitat would be available for fish species. Benthic fish species are expected to move back into the Wind Farm Area following construction. With the addition of structures, the finfish community assemblage will be modified around the infrastructure foundations as the community will shift toward a more structure-oriented assemblage.

As noted in Section 2.1.2.2.1, potential contamination may be introduced by liquid wastes that are discharged to coastal and marine waters from vessels or facilities, such as sewage, solid waste or chemicals, solvents, oils, and greases from equipment. These potential impacts will be minimized by implementing an approved oil spill response plan (Appendix A), by following proper storage and disposal protocols on land, and by requiring vessel operators used for construction to have a vessel-specific spill response plan in the event of an accidental release, per the APMs.

<u>Atlantic Sturgeon</u>

Data suggest that sturgeon would be able to hear sounds produced by pile driving although the consequences of pile-driving on sturgeon hearing remain unknown. Lovell *et al.* (2005) studied the hearing abilities of paddlefish (*Polyodon spathula*) and the lake sturgeon (*Acipenser fulvescens*) and reported that both species were responsive to sounds ranging from 100 to 500 hertz (Hz), with lowest hearing thresholds of 119 decibels (dB) (re 1 µPa) at 200 Hz for paddlefish and 120 dB (re 1 µPa) at 250 Hz for lake sturgeon[12]. Based on the limited data available, Atlantic sturgeon may be able to detect sounds from below 100 Hz to about 1,000 Hz and should be able to localize sound sources (Meyer and Popper [unpublished] cited in Popper 2005). These data are based on a small number of individuals and, therefore, may not be representative of all Atlantic sturgeon.

More is known about the physical impacts of pile-driving on sturgeon. Because of their swim bladders, Atlantic sturgeon would be sensitive to underwater impulsive sounds with a sharp sound pressure peak occurring in short intervals of time (Caltrans 2001). As pressure waves pass through a fish, its swim bladder would be rapidly squeezed by the high pressure then would rapidly expand as the under-pressure component of the wave passes through the fish. The pneumatic pounding on tissues contacting the swim bladder may rupture capillaries in internal organs as indicated by observed blood in the abdominal cavity and maceration of kidney tissues (Caltrans 2001).

The information available suggests that, based on its detectability, duration, spatial extent, and severity, pile driving would have little or no measurable impact on the hearing of sturgeon that might be exposed to the sound field. Pile-driving would be expected to have detectable, short-term, and potentially severe impacts on the behavior of sturgeon that might be exposed within 0.6 miles (1 km) of pile driving operations, and it would have detectable and potentially severe impacts on the physiology of sturgeon that might occur with 246 ft (75 m) of pile driving operations.

Monitoring associated with the Pile Installation Demonstration Project associated with the Tappan Zee bridge replacement (in New York State) suggests Atlantic sturgeon may avoid the area close to an active pile-driving operation. Impacts to Atlantic sturgeon, including impacts to behavior and injury, could occur within the direct vicinity of the UXO/MEC disposal activities during site preparation (NMFS 2018d). Additional information related to Atlantic Sturgeon can be found in Appendix I, Atlantic Sturgeon Supplementary Material, Appendix R-2 Underwater Noise Supplementary Material, and Appendix AA, PSMMP.

Array Cables

The installation of array cables will take place within areas that were previously disturbed during the seabed preparation activities and foundation installation. Similar impacts to finfish species are expected to occur. Overall, impacts associated with installation include direct burial of life stages along the route, entrainment of early life stages when operating hydroplow or jetplow, or removal of demersal life stages during dredging, if required. It is anticipated that pelagic species and life stages will move out of the way based on typical installation speeds, and direct impacts are not anticipated. Direct impacts to foraging habitat are expected to be localized to the width of the trench and temporary as benthic organisms would recolonize the area. As discussed in Section 2.1.2.2, grain sizes within the Wind Farm Area are generally medium to coarse grained, which are likely to settle to the bottom of the water column quickly. Sand re-deposition would be minimal and close in vicinity to the trench centerline, minimizing impacts to demersal fish eggs.

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[12] These thresholds are based on sound fields dominated by particle motion rather than sound pressure. The authors estimated both, but they concluded that both species were more responsive to particle motion than sound pressure and recommended measuring their audiogram using particle motion. This narrative follows that recommendation.

<u>Atlantic Sturgeon</u>

About 95 percent of all Atlantic sturgeon captured in sampling off New Jersey occurred in depths less than 66 ft (20 m) with the highest CPUE at depths of 33 to 49 ft (10 to 15 m). At these depths in open coastal and marine environments, which would not constrain the distribution or movement of Atlantic sturgeon, they are not likely to be struck by Project-related vessels. Because Atlantic sturgeon would rarely occur within the Offshore Project Area (Dunton *et al*. 2010, Erickson *et al*. 2011, Eyler *et al*. 2009, Stein *et al.* 2004), they are also unlikely to be affected by seabed disturbance. In nearshore cable export areas, sturgeon are more likely to be present. However, they would avoid the cable burying activities during construction. As discussed for other fish, if present, Atlantic sturgeon are expected to move out of the way based on typical installation speeds, and direct impacts are not anticipated.

Estuarine Project Area (Offshore Export Cable Corridor)

The estuarine portion of the Project Area will be affected by cable installation within backbay areas behind barrier islands in Barnegat Bay. These areas have a more diverse fish assemblage than seen in the Wind Farm Area. Species that inhabit estuarine waters utilize the unique in-shore habitats such as shellfish and SAV beds and shoreline structures for shelter, feeding, and spawning. During cable installation, habitat alteration will likely cause adult and juvenile fish to relocate temporarily. Summer flounder, whose HAPC exists within SAV beds in its EFH range, would be an example of a species that could be impacted by the loss of SAV habitat during construction. A maximum of 19.3 acres of summer flounder HAPC within SAV could be disturbed as a result of the installation of the cable along the Oyster Creek indicative offshore export cable corridor. Impacts to SAV will be minimized, where practicable, by the use of trenchless installation methods which install the cable beneath overlying sediments and SAV without direct physical disturbance. Trenchless installation has the potential for impact in the event of inadvertent return of drilling fluids. An Inadvertent Return Plan will be developed and implemented to prevent and minimize impacts as described in **Table 1.1-2**. These unique habitats will be avoided wherever possible and impacts minimized should the cable need to traverse a unique habitat (e.g., complying with seasonal work windows and other BMPs). Impacted species will likely relocate to surrounding similar habitat during and immediately following construction. Following construction, the areas of cable burial would be restored to previous elevations and natural succession would proceed, reestablishing the HAPC areas.

Finfish will also experience temporary displacement due to sediment resuspension. In inshore areas (i.e., back bays), sediments are comprised of fine to medium grains. Therefore, suspension and settlement of sediments is expected. As noted in Section 2.1.2.2, the finer sediments in these areas would become suspended and extend above the trench and take longer to settle to the seabed than in areas of sand or coarser grained sediments. These impacts to water quality for finer sediments are anticipated to be temporary in nature. Direct impacts are associated with early life stages of demersal species. Immediately following installation, indirect impacts from suspended sediments can potentially cause mortality to demersal fish eggs due to burial and reduced hatching success (Berry *et al.* 2011). However, across many different USACE dredging projects in New York Harbor, even when dredging sediments with high percentage of fine grain particles, plumes dissipated rapidly over distance (within 650 ft [200 meters] in the upper water column and 2,000 feet [600 meters] in the lower water column) to levels not detectable against background conditions. Active swimmers would be able to easily avoid plumes, and passive drifters would only be exposed over short distances (USACE 2015). Indirect impacts are also associated with potential changes to benthic habitat along the trench.

In areas where the cable may not be able to be buried to the required depth or additional cable protection is required, rock, concrete mattresses, or other measures as described in Volume I may be used to provide additional protection for the cable. In these instances, soft bottom habitat that makes up the majority of these estuarine bays (Greene *et al.* 2010) will be permanently altered within the width of the cable trench. It is expected that adult and juvenile fish will move out of the area during installation, however benthic demersal life stages may be impacted by direct burial. The fish and benthic community will be modified in localized areas due to the addition of structure. However, the impact area would be small compared to the scale of the surrounding suitable habitat within the back bays.

Construction vessels may also cause temporary finfish displacement during the installation process as a result of anchoring and vessel traffic and the increased noise associated with these activities. This impact will be short-term with fish returning to the area after the vessels leave.

As discussed previously, indirect impacts of cable installation also include mortality from entrainment of eggs and larvae during water withdrawals from jet plowing. Those impacts will be as discussed in previous sections.

Atlantic Sturgeon

As discussed for other fish, if present, Atlantic sturgeon are expected to move out of the way based on typical cable installation speeds, and direct impacts are not anticipated. Impacts would be similar to those discussed for other fish species, and the impact area would be small compared to the scale of the surrounding suitable habitat within the back bays.

2.2.6.2.2 Operations and Maintenance

Offshore Project Area

Foundations and Scour Protection

Maintenance and operation of monopile or piled jacket foundations along with scour protection will permanently shift a portion of the sandy, smooth-bottom habitat to a structure-based habitat, and these structures will act as artificial reefs (fish attractants). Approximately 0.2 percent (176 acres) of the primarily sand bottom habitat within the Wind Farm Area will be converted to structure habitat (i.e., WTG and offshore substation foundations and scour and indicative cable protection). Newly-installed piles will offer hard substrate habitats for a new, more diverse community of finfish and invertebrates. Abundance and biodiversity were observed to have increased following the installation of pilings and wind turbines in Europe (Inger *et al.* 2009, Linley *et al.* 2007). Studies focusing on habitat alteration associated with wind farms have shown that rocky habitat fish communities establish near turbine infrastructure while sandy bottom communities remain unchanged between turbines (Stenberg *et al.* 2015). Structure-oriented and hard bottom species such as black sea bass, pollock (*Pollachius virens*), red hake (*Urophycis chuss*), and Atlantic cod (*Gadus morhua*) will begin to inhabit the area around these foundations and scour protection. Certain species that rely on ambush predation would use the structures as cover to enhance feeding activities around the foundation structures. Areas of the seabed that are converted to hard substrate habitat will no longer be suitable for sandy, soft-bottom species such as Atlantic croaker, scup, Atlantic herring, skates, and rays.

The operation of the turbines is not expected to generate substantial sound levels above baseline sound in the area. For the Cape Wind Project, Minerals Management Service (MMS; now BOEM) reported existing underwater sound levels for the design condition were 107.2 dB, and the calculated sound level from operation of a WTG was 109.1 dB at 65.6 ft (20 m) from the monopile (i.e., about 1.9 dB above baseline sound levels), which dropped to 107.5 dB at 164 ft (50 m) and to ambient levels at about 360 ft (110 m) (MMS 2008). Increased underwater ambient noise during the operation of the turbines for the life of the Project could cause mild impacts to finfish communities. Ambient noise will increase as a result of the Project in general. However, when the Project is in operation and during periods of high wind, ambient noise will further increase. Some research suggests that increased ambient noise levels related to wind turbines drive fish away from the turbines during high wind events. Wahlberg and Westerberg (2005) found that at high wind speeds, fish avoid the area within 13 ft of the foundation. Atlantic cod catch rates were found to be significantly higher in areas around turbines when turbines were stopped than catch rates when turbines were in operation (Thomsen *et al.* 2006). Other studies suggest that during the operational phase, disturbances caused by noise are considered to be of minor importance to the marine environment (Raoux *et al.* 2017).

<u>Atlantic Sturgeon</u>

The lowest hearing thresholds with the sound field dominated by particle motion are 119 dB (re 1 μPa) at 200 Hz for American paddlefish and 120 dB (re 1 μPa) at 250 Hz for lake sturgeon (Lovell *et al.* 2005). At 66 ft (20 m), the sounds produced by operating wind turbines are below these hearing thresholds, so Atlantic sturgeon are not likely to hear these sounds beyond 66 ft (20 m). These sound levels are well below intensities that might cause Atlantic sturgeon to experience physical injuries or physiological stress responses (Halvorsen *et al*. 2010, Popper *et al*. 2014).

About 95 percent of all Atlantic sturgeon captured in sampling off New Jersey occurred in depths less than 66 ft (20 m) with the highest CPUE at depths of 33 ft to 49 ft (10 to 15 m) (Dunton *et al*. 2010). At these depths in open coastal and marine environments, which would not constrain the distribution or movement of Atlantic sturgeon, they are not likely to be struck by Project-related vessels. In addition, in the Wind Farm Area, where the vast majority of the Project operations and maintenance activity will occur, Atlantic sturgeon do not occur at the lowest depths of the water column. Atlantic sturgeon are also unlikely to be affected by seabed disturbance or suspended sediments associated with operations and maintenance of the Project. Supplemental information for Atlantic Sturgeon can be found in Appendix I.

Maintenance of the area around the foundations could also result in increased vessel traffic, anchoring, and noise should a repair be needed. Impacts would be similar to those described above for construction.

Cable Operation and Maintenance

Cable operation during the life of the Project could result in impacts related to the EMF emitted by the cables. As noted in Section 2.2.5.2.2, EMF occurs naturally in the ocean, with the primary source being the geomagnetic field of the earth. Shielding of cables eliminates electric fields; magnetic fields cannot be shielded. Additional detail on EMF in the Project area is provided in Section 2.2.5.2.2. Species most likely to experience impacts from the cable EMF would be to benthic and demersal fish and invertebrates. Sharks, rays, and skate species have been well documented to detect electric fields with anatomical structures known as ampullae of Lorenzini, a feature absent in most bony fish. These species utilize this feature to locate and capture prey (Normandeau *et al.* 2011). While these species can detect EMF, little research has been done to conclusively determine the extent to which these impacts are manifested (Acres 2006). Recent evidence indicated that the Atlantic halibut (*Hippoglossus hippoglossus*), Dungeness crab (*Metacarcinus magister*), and American lobster (*Homarus americanus*) showed few behavioral responses that would indicate explicit avoidance or attraction to EMF in a laboratory setting (Pacific Northwest National Laboratory 2013, Hutchison *et al*. 2018).

As noted in Section 2.2.5.2.2, the University of Rhode Island evaluated the behavioral response of little skate, contained in netted enclosures, to EMF from the Cross Sound Cable, a 330 MW capacity HVDC subsea cable, south of New Haven, CT (Hutchison *et al*. 2018). The study found that while behavioral responses did occur in skate and lobsters when exposed to EMF, "neither of the species showed spatial restriction in their movements and at the power levels transmitted, the cable did not act as a barrier to movement." Skates appeared to demonstrate an attraction response to the EMF, which could be linked with benthic elasmobranch foraging behavior, and researchers stated that "…there is a low likelihood of significant biological impact associated with a single cable with a constant EMF". The researchers concluded "While the behavioral studies conducted in this project provided clear evidence of a behavioral response when receptive animals encountered the EMF, the evidence for a biological impact of a single HVDC cable under the conditions observed in this study would most likely be assessed as minor" (Hutchison *et al*. 2018).

Little evidence to date has been published that suggests major behavioral or biological impact on fish species. As noted in Section 2.2.5.2.2, BOEM has evaluated EMF from power cables by conducting *in-situ* studies of both powered and unpowered cables (Love *et al.* 2015, 2016). Results from three years of surveys included:

- "Researchers did not observe any significant differences in the fish communities living around energized and unenergized cables and natural habitats;
- They found no compelling evidence that the EMF produced by the energized power cables in this study were either attracting or repelling fish or macroinvertebrates;
- EMF strength dissipated relatively quickly with distance from the cable and approached background levels at about one meter from the cable[13]; and
- Cable burial would not appear necessary strictly for biological reasons" (BOEM 2016b).

EMF produced by cables decreases rapidly with distance from the cable (**Figures 2.2.5-6** and **2.2.5-7**). Shielding and burial of the cables will further minimize potential EMF impacts.

Impacts from sediment resuspension and deposition during operations and maintenance would result from the same activities causing bottom disturbances within the Wind Farm Area, such as vessel anchoring and maintenance of monopiles, scour protection, and cables. Bottom disturbances are not anticipated to occur frequently and impacts to fish and EFH species are anticipated to be similar to those experienced during the construction and decommissioning phases of Project activities, but shorter in duration.

<u>Atlantic Sturgeon</u>

As noted above, because Atlantic sturgeon do not occur at the lowest depths of the water column in the Wind Farm Area, where the vast majority of the Project cables will be located, they are unlikely to be affected by EMF associated with subsea cables. Based on the information available and considering probability of exposure, detectability, duration, spatial extent, and severity, EMF resulting from Project operations is likely to have little or no measurable impact on the behavior, physiology, and ecology of Atlantic sturgeon.

Cable maintenance activities, including vessel anchoring, may cause temporary impacts to benthic community. Potential impacts associated with maintenance would be temporary and short in duration unless an emergency repair to foundations or array cables is required. If repairs are needed, impacts would be similar to those described above under construction.

2.2.6.2.3 Decommissioning

Decommissioning of the Project would include removal of all structures above the seabed in a general reversal of the installation activities. Similar equipment and number of vessels to those used during construction will be used to remove infrastructure. The offshore substation will be decommissioned by dismantling and removing its topside and foundation (substructure). As with the turbine components, this operation will be a reverse installation process subject to the same constraints as the original construction phase. It is anticipated that monopole foundations will be cut below the seabed level in accordance with standard practices at the time of demolition, which may include mechanical cutting, water jet cutting, or other industry standing practices. Removal of structures during decommissioning as well as vessel anchoring could cause injury or mortality to fish and EFH species. Removal of turbine foundations will mean loss of the unique hard substrate and vertical habitat that had established itself over the life of the Project.

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[13] EMF readings from a 35-kV unburied AC power cable measured ~110-120 μT at cable surface (Love *et al.* 2016).

The scour protection placed around the base of monopile, as required, will be left *in-situ* as the default option in order to preserve the marine life that may have established itself on this substrate during the period of operation and limit the amount of material that would need to be raised through the water column for removal. If it is necessary to remove the scour protection, then its removal will proceed according to the best practices applicable at the time of decommissioning.

Offshore cables will either be left *in-situ* or removed, or a combination of both, depending on the regulatory requirements at the time of decommissioning. It is anticipated that the array cables will be removed using controlled flow excavation or a grapnel to lift them from the seabed. Alternatively, depending on available technology, a remotely operated vehicle may be used to cut the cable so that it can be recovered to the vessel. The export cables will be left in situ or wholly/partially removed. Any cable ends will be weighed down and buried if the cables are to be left in-situ to ensure that the ends are not exposed or have the potential to become exposed post-decommissioning. Cables may be left in-situ in certain locations, such as pipeline crossings, to avoid unnecessary risk to the integrity of the third-party cable or pipeline. The removal of cables has the potential to result in temporary localized disturbance and resuspension of benthic sediments.

These impacts to fish and EFH species are anticipated to be short-term and localized due to the disturbance of a relatively small area and would not cause long-term impacts once decommissioning activities are completed. Pelagic fish species are anticipated to avoid the area during Project decommissioning activities. Benthic and pelagic finfish species are anticipated to move back into the area. However, benthic habitat that serves as forage area for bottom-dwelling species may take longer to recover to pre-impact conditions. Successional epifaunal and infaunal species are anticipated to recolonize the sediments, gradually providing the continuation of foraging habitat for fish and EFH species. Fish and invertebrate communities will transition back to a sandy, soft-bottom community structure, recolonizing from the surrounding sandy bottom habitat.

There will be temporary increases in sediment suspension and deposition during bottom disturbance activities. These increases in sediment suspension and deposition may cause temporary adverse impacts to mobile fish and EFH species because of decrease in habitat quality for benthic species. Less mobile egg and larval life stages may experience injury or loss of individuals similar to that described for construction. Juveniles and adults are anticipated to vacate the habitat due to suspended sediment levels in the water column and avoid impact. Pelagic habitat quality and EFH is expected to quickly return to pre-disturbance levels.

Increased underwater noise during construction would primarily be associated with structure removal activities which may include mechanical cutting, water jet cutting, or other industry standing practices. The noise produced by the pile cutting activities is not expected to be impulsive and is therefore unlikely to produce noise levels with the potential for injury. The elevated noise levels may make the habitat temporarily less suitable and may cause fish and EFH species to temporarily vacate the Project area during decommissioning activities. This impact is anticipated to be short-term and temporary, and limited to the location of active pile removal which represents a small portion of the total available habitat. Further, short-term impacts to fish EFH species are expected for mobile species that can detect sound associated with vessel or other decommissioning activity noises. These adverse impacts are anticipated to be similar and temporary in nature to the current noise levels of vessels that transit the area. Direct impacts to fish and EFH species may result from a degradation of habitat for species that vacate the area during increased noise levels during Project decommissioning activities. Both pelagic and demersal life stages would experience a temporary impact from vessel and other decommissioning activity noise.

2.2.6.2.4 Summary of Potential Project Impacts on Fish and EFH

The IPFs affecting fish and EFH include physical seabed/land disturbance, sediment suspension, discharge/ releases and withdrawals, habitat conversion, noise, EMF, and vessel traffic.

Long-term habitat conversion would result from the introduction of hard bottom habitat resulting from placement of scour protection and cable protection on the seabed, and WTG foundations in the water column. Seabed disturbance could result in short-term suspended sediment/sedimentation and direct mortality of sessile or slow-moving organisms. Noise from vessel traffic, pile driving, and potential in-situ UXO/MEC disposal will result in short-term impacts. Long term impacts include tissue injury or mortality due to potential in-situ UXO/MEC disposal and direct burial or mortality due to foundation installation. EMF produced by cables decreases rapidly with distance from the cable, and shielding and burial of the cables will further minimize potential EMF impacts. These impacts to fish and EFH would be minimized by implementing APMs.

2.2.6.3 Avoidance, Minimization, and Mitigation Measures

The proposed measures for avoiding, minimizing, reducing, eliminating, and monitoring environmental impacts for the Project are presented in **Table 1.1-2**.

2.2.7 Marine Mammals

2.2.7.1 Affected Environment

This section describes marine mammal species that occur in the Offshore Project Area, which includes the Wind Farm Area and offshore export cable corridors. Summary information on threatened or endangered marine mammals protected under the Federal ESA are presented in Section 2.2.7.1.1 with more detailed narratives presented in Appendix J. The information contained in this section was obtained from literature review, agency consultations, and ongoing site investigations. Information reviewed included published scientific literature; reports prepared by government agencies, academic institutions, and non-governmental organizations; protected species observer (PSO) daily reports from ongoing site investigation surveys; NEPA documents; biological opinions issued on actions in or near the Project Area; and regulatory documents associated with Marine Mammal Protection Act (MMPA) authorizations.

All marine mammals are protected under the MMPA (16 U.S.C. §§ 1361 *et seq.*). The MMPA requires NOAA and the USFWS to continuously monitor the population status of marine mammals. If that monitoring determines that a population has dropped below its optimum level, the population is designated as "depleted." In such case a conservation plan is developed to guide research and management actions to restore the population to healthy levels.

The MMPA also established a moratorium, with certain exceptions, on the taking of marine mammals in U.S. waters and by U.S. citizens on the high seas, and on the importing of marine mammals and marine mammal products into the United States. The MMPA authorizes NOAA and the USFWS to permit the incidental "taking" of marine mammals for certain specified activities provided the taking is of small numbers and would result in a negligible impact on marine mammals. These "incidental take" authorizations, in the form of either a Letter of Authorization or an Incidental Harassment Authorization (IHA), require that either regulations or a proposed IHA be published in the Federal Register outlining the methods and geographical region of taking, the means of limiting adverse impacts on the species or stock and its habitat, and requirements for monitoring and reporting of any proposed activity. Public comments are then received on these proposed actions before NOAA Fisheries or USFWS finalizes their regulations or IHA[14].

Several studies of marine mammal occurrence and distribution have been conducted in or near the Project Area. The NJDEP funded the New Jersey EBS from January 2008 through December 2009: surveys conducted by Geo-Marine, Inc. employed visual line-transect (aerial and shipboard) methods and passive acoustic monitoring (PAM) to estimate the abundance and density of marine mammals from the shoreline to

[14] As part of Ocean Wind's HRG and geotechnical surveys conducted in the Lease Area in 2017, vessel-based monitoring for marine mammals was conducted in conjunction with survey activities as specified in the Project IHA issued by NMFS in June 2017.

around 20 nm (37 km) off the coast of New Jersey between Stone Harbor and Seaside Park (NJDEP 2010b) (**Figure 2.2.7-1**, **Figure 2.2.7-2, Figure 2.2.7-3**). Shipboard surveys were conducted once per month between January 2008 and December 2009. Aerial surveys were conducted once per month following the shipboard surveys between February and May 2008, and twice monthly (when possible) between January and June 2009 (NJDEP 2010b).

In addition, the Atlantic Marine Assessment Program for Protected Species (AMAPPS), which is an ongoing program that started in 2010, coordinates data collection and analysis to assess the abundance, distribution, ecology and behavior of marine mammals in the U.S. Atlantic. Although the majority of AMAPPS survey effort is focused on offshore areas beyond the 328 ft (100m) isobath, a portion of the survey effort was conducted in onshore WEAs off the coast of New Jersey (NEFSC & Southeast Fisheries Science Center [SEFSC] 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2018, 2019, 2020) (**Table 2.2.7-1**, **Figure 2.2.7-4**). **Table 2.2.7-1** provides a visual summary of the temporal coverage of AMAPPS surveys (aerial and shipboard) conducted in the Project Area from 2011-2019. Palka *et al.* (2017) derived abundance and density estimates for 15 marine mammal taxa (including pinnipeds) using AMAPPS survey data collected in the New Jersey WEA from 2011 to 2013.

Table 2.2.7-1. Temporal coverage of AMAPPS visual surveys (vessel and aerial) offshore of New Jersey from 2011-2019

Survey Year	Winter	Spring	Summer	Fall
2010			√	
2011			√	
2012		√		√
2013	√		√	
2014	√	√		
2015	√	√		
2016			√	√
2017		√		√
2018	√		√	
2019	√	√		√

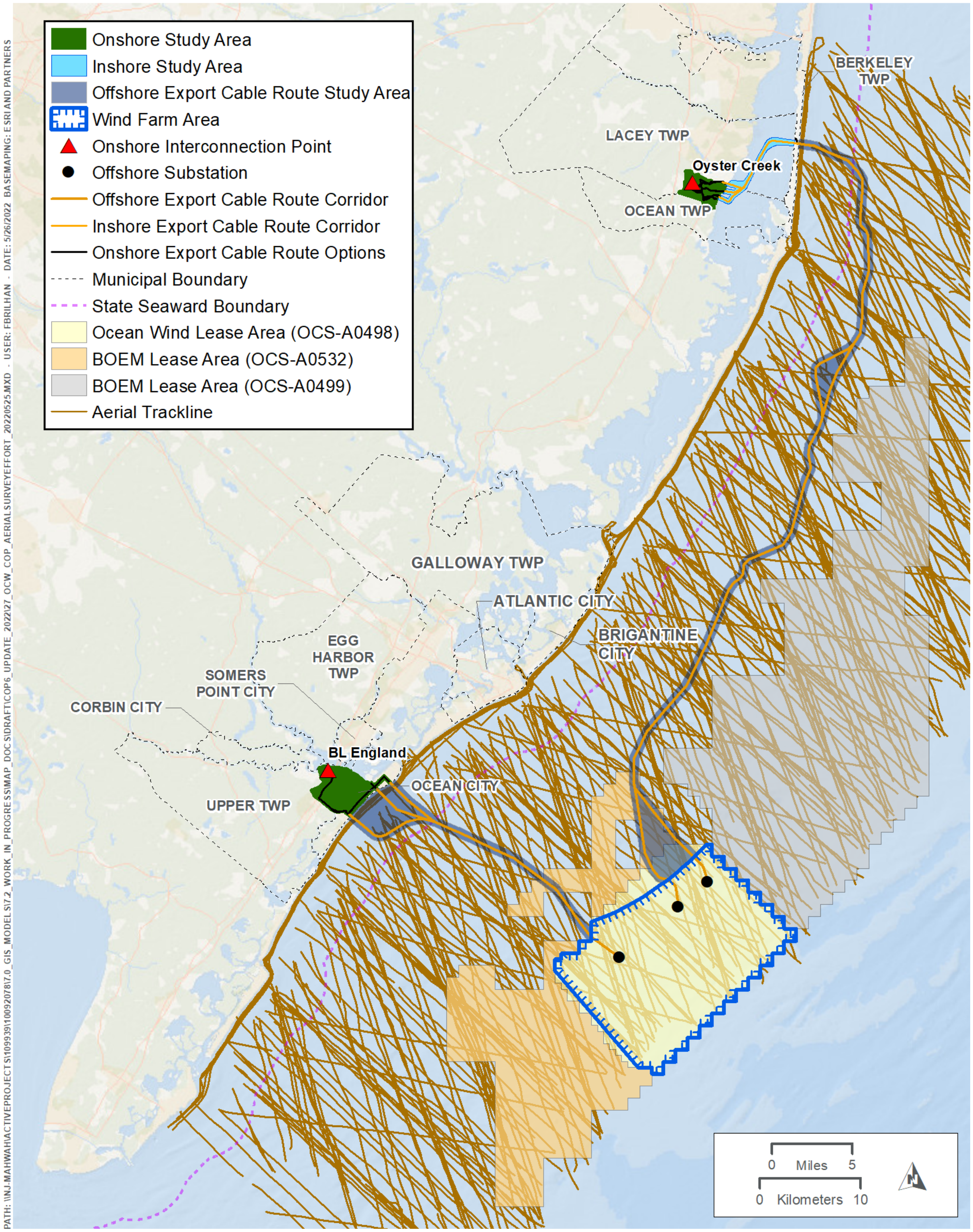

Figure 2.2.7-1. Aerial survey effort for NJDEP (2010b) surveys from December 2008 through January 2009, in relation to the Project Area.

Note: Aerial surveys were conducted once per month following the shipboard surveys between February and May 2008, and twice monthly (when possible) between January and June 2009.

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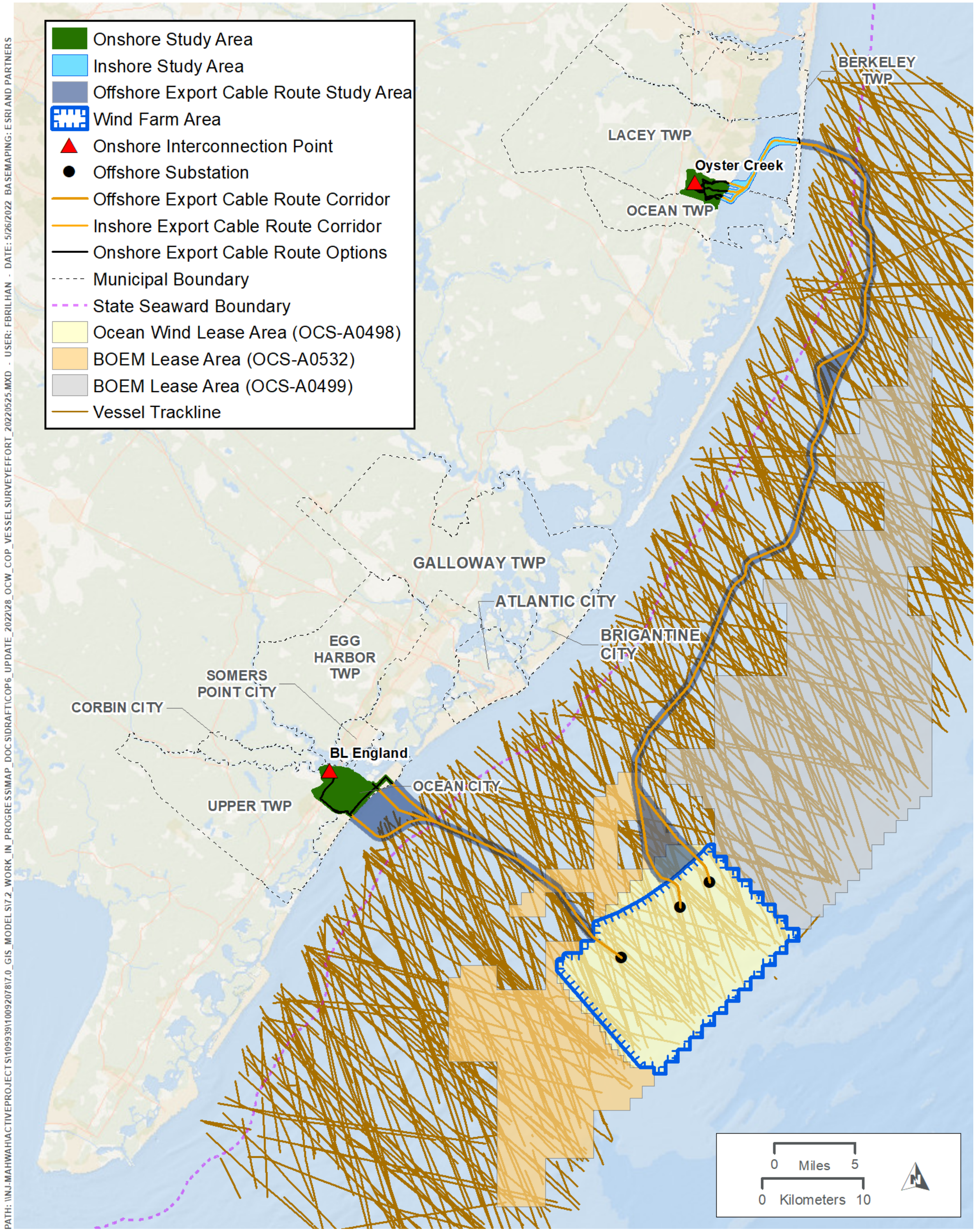

Figure 2.2.7-2. Shipboard survey effort for NJDEP (2010b) surveys, conducted once per month from December 2008 through January 2009. Survey effort is shown in relation to the Project Area.

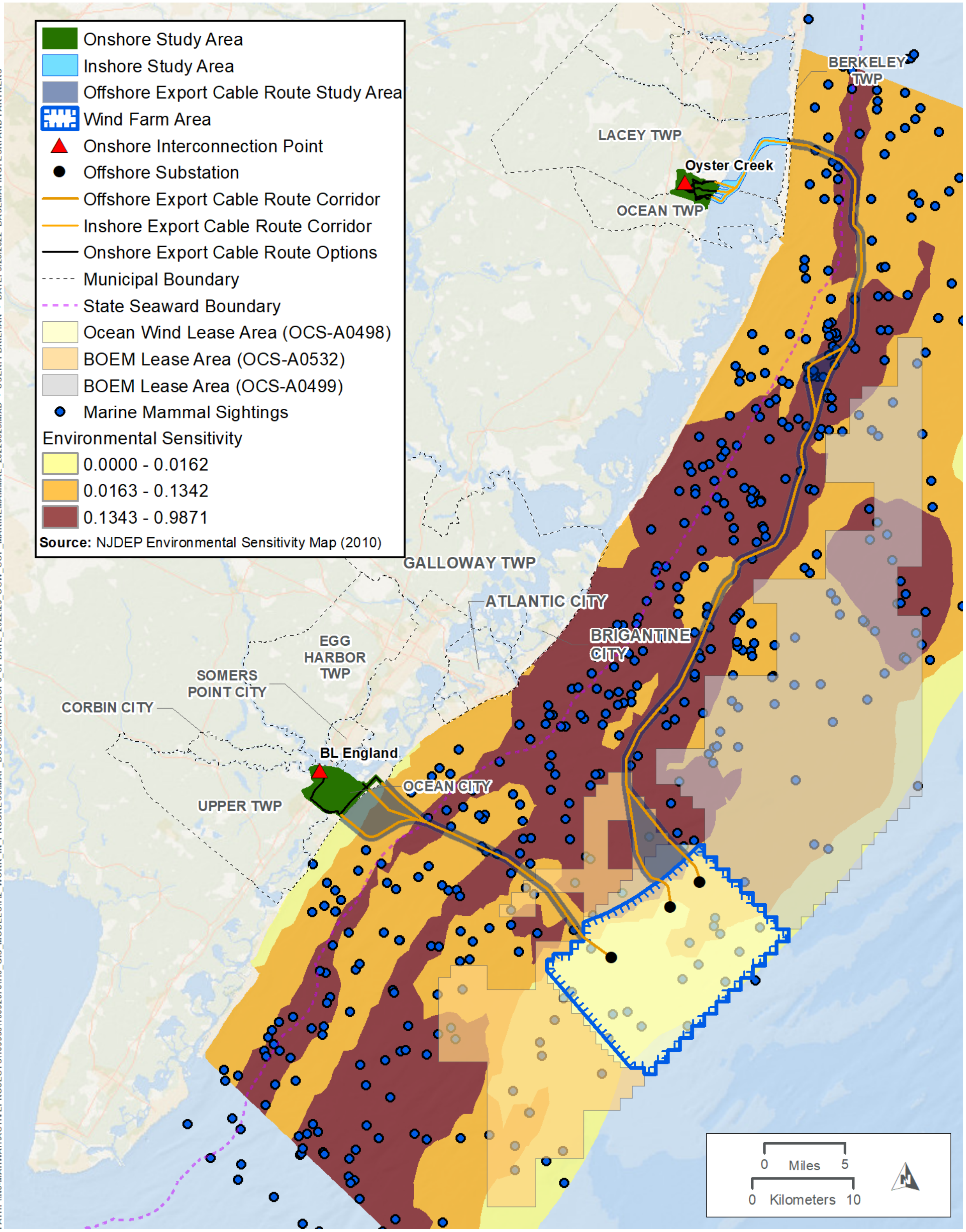

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Figure 2.2.7-3. Marine mammal sightings and density data collected during NJDEP (2010b) surveys, in relation to the Project Area.

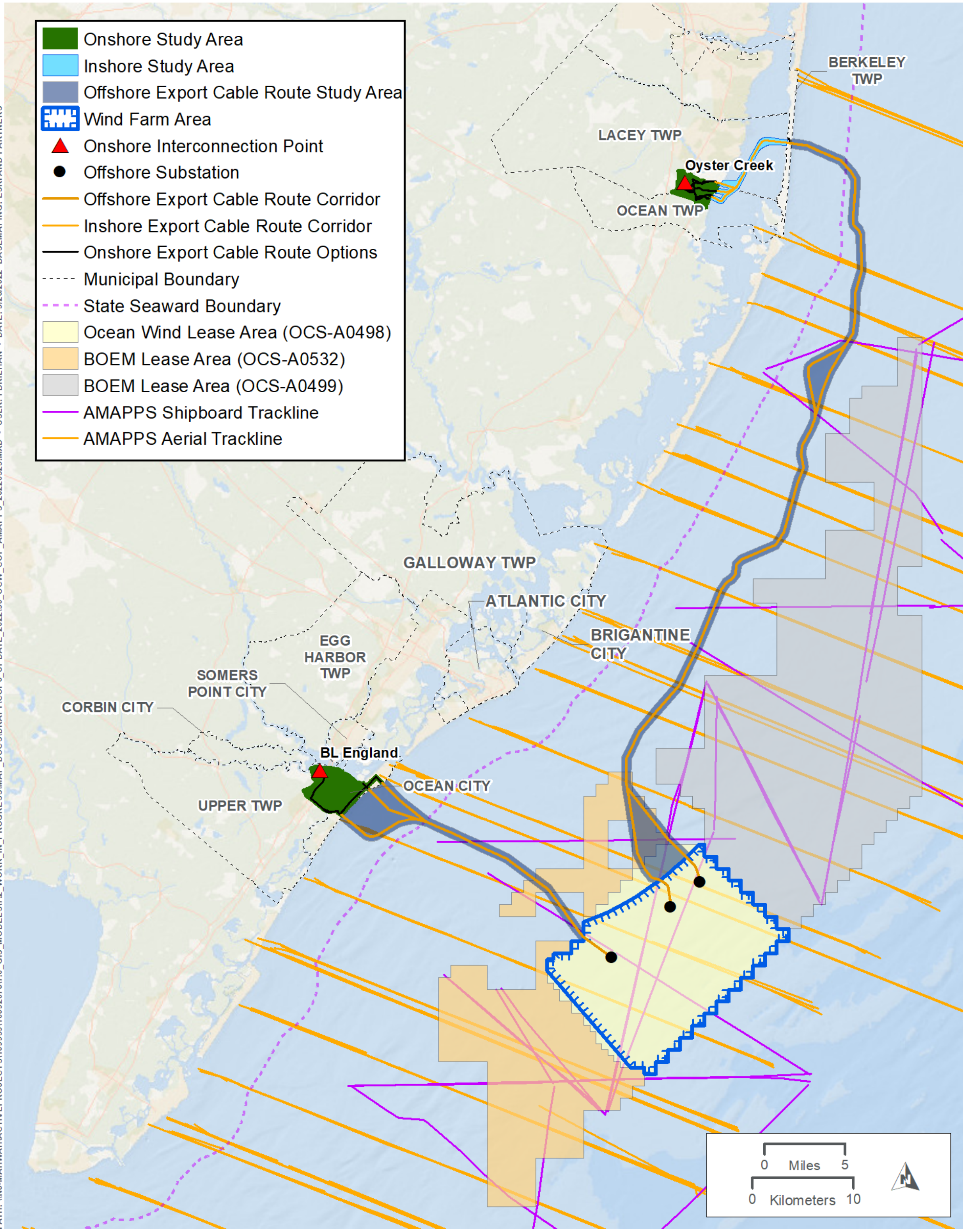

Figure 2.2.7-4. Spatial coverage of AMAPPS vessel and aerial surveys offshore of New Jersey from 2010-2016 (2015 effort data not pictured), shown in relation to the Project Area. Effort data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1288) on 4 June 2018.

In 2016, the Duke University Marine Geospatial Ecology Lab (MGEL) developed habitat-based cetacean density models for the U.S. Exclusive Economic Zone (EEZ) of the East Coast (eastern U.S.) and Gulf of Mexico (Roberts *et al.* 2016). MGEL updated these models in 2017 to include additional survey data, including the AMAPPS and Southeast North Atlantic Right Whale (NARW) surveys, and updated environmental predictor data (Roberts *et al.* 2017). Revised models were produced for the following species and species guilds: fin whale, humpback whale, minke whale, North Atlantic right whale, sei whale, sperm whale, harbor porpoise, and pilot whales (Roberts *et al.* 2017; Curtice *et al.* 2019). Additional species and species guild models were updated in fall 2018, along with minor method changes, which are documented in detail in Roberts *et al*. (2018). As part of this effort, MGEL also developed updated pinniped density models, which combine harbor and gray seals in a single guild (Roberts *et al.* 2018). Collectively, these updated products are referred to as the Second-Generation Marine Mammal Density results; the U.S. Navy refers to them as the "Phase IV models." Further updates were made in 2019-2020; namely, to the NARW model for the East Coast region (Roberts *et al.* 2020). Additional details on the base-layer models and summary products can be found in the MDAT Technical Report (Curtice *et al*. 2019). Collectively, these estimates have been determined by NMFS to be the best information currently available for marine mammal densities in the U.S. Atlantic.

As part of Ocean Wind's HRG and geotechnical surveys conducted in the Lease Area in 2017, vessel-based monitoring for marine mammals was conducted in conjunction with survey activities as specified in the Project IHA issued by NMFS in June 2017. In summer of 2017 (June-August), an HRG and geotechnical survey was conducted off the coast of New Jersey (Alpine 2017b). During vessel-based monitoring, 26 opportunistic visual sightings occurred of three cetacean and two sea turtle species (Alpine 2017b). During winter geotechnical surveys, five cetacean species were observed including a NARW. All PAM detections were clicks unidentified to species, and detections were not localized (Smultea Environmental Sciences 2018).

2.2.7.1.1 Threatened and Endangered Marine Mammals

Five of the marine mammals known or expected to occur off the coast of New Jersey are listed as endangered pursuant to the Federal Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq*.): blue, fin, North Atlantic right, sei, and sperm whales. Because of their status, these species are addressed separately from the other marine mammal species that are expected to occur in the Project Area.

Blue Whales

The distribution of blue whales (*Balaenoptera musculus*) in the Western North Atlantic generally extends from the Arctic to at least mid-latitude waters (see **Table 2.2.7-2** for summary data on the species' stock designation(s), best population estimate, MMPA status, ESA status, critical habitat designations, occurrence in the Project Area and vicinity, and seasonal occurrence). Although blue whales are sighted frequently off eastern Canada, most notably in the Gulf of St. Lawrence, some data suggest that blue whales rarely visit the U.S. Atlantic EEZ (Waring *et al.* 2011, CetMap 2018). However, a PAM study in the New York Bight funded by the New York State Department of Environmental Conservation reported that blue whales were present about 20 nm southeast of the entrance to New York Harbor in late winter and early spring (Muirhead *et al.* 2018). No blue whales were observed in the Project Area during the EBS or AMAPPS, but recent sightings of blue whales off the coast of Virginia include a vessel sighting of a juvenile in April 2018 (Engelhaupt *et al.* 2019), and a sighting of an adult whale made in February 2019 during a systematic aerial survey (Cotter 2019). The aerial sighting was recorded in deep waters beyond the shelf break, but the vessel sighting was over the shelf near the 50-m isobath. Both sightings are considered extremely rare and constitute the southernmost sightings of blue whales off the U.S. east coast in the U.S. EEZ. Nevertheless, this assessment assumes blue whales could occur in the Project Area. There have been no recorded strandings of blue whales in New Jersey since 2008 (Hayes *et al.* 2020; Henry *et al*. 2020).

Fin Whales

Fin whales (*Balaenoptera physalus*) are common in the U.S. Atlantic EEZ waters, from Cape Hatteras, North Carolina northward (see **Table 2.2.7-2** for summary data on the species' stock designation(s), best population estimate, MMPA status, ESA status, critical habitat designations, occurrence in the Project Area and vicinity, and seasonal occurrence). While they prefer deeper waters of the continental shelf (300 to 600 ft [91 to 183 m]), they are regularly observed anywhere from coastal to abyssal areas (Hayes *et al.* 2020).

Fin whales were observed during all seasons of the EBS. The EBS results indicate that the nearshore waters off New Jersey serve as nursery habitat because of the occurrence of a cow-calf pair. The EBS estimated a year-round abundance of two individuals offshore of New Jersey (NJDEP 2010b) (**Table 2.2.7-2**). Fin whales were observed in the WEAs in the fall 2012 aerial, spring 2013 aerial, spring 2014 aerial, spring and summer 2017 aerial, winter 2018 aerial, and summer 2016 shipboard AMAPPS surveys (NEFSC & SEFSC 2012, 2013, 2014, 2016, 2018, 2019). Fin whales were recorded in the Project Area during the summer 2017 HRG survey (Alpine 2017b) and during the Geotechnical 1A Survey in winter 2017-2018 (Smultea Environmental Sciences 2018). For the New Jersey WEA, seasonal estimates calculated for fin whales showed low numbers during the spring, summer and fall, with peaks in cooler months (Palka *et al.* 2017) (**Table 2.2.7-2**).

In addition, 10 fin whales are reported to have stranded along the New Jersey coast from 2008-2017 (Hayes *et al.* 2020; Henry *et al.* 2020). Of these 10 whales, 9 strandings were determined to be the result of vessel strikes, with the remaining individual being ruled an entanglement.

North Atlantic Right Whales

NARWs (*Eubalaena glacialis*) are known to occur off the coast of New Jersey (NJDEP 2010b; (see **Table 2.2.7-2** for summary data on the species' stock designation(s), best population estimate, MMPA status, ESA status, critical habitat designations, occurrence in the Project Area and vicinity, and seasonal occurrence; see **Figure 2.2.7-5** for sightings data). During the EBS surveys, NARWs were observed (i.e., detected visually or acoustically) in every season (NJDEP 2010). Feeding behavior was recorded, as was the presence of a cow−calf pair, suggesting that near shore waters off New Jersey serve as feeding and nursery habitat. Initial sightings of females, and subsequent confirmations of these same individuals in calving grounds, illustrate that these waters are part of the species' migratory corridor (Whitt *et al.* 2013). NARWs may use the waters off New Jersey for short periods of time as they migrate and/or follow prey movements, or they may remain in the area for extended periods of time.

NARWs were observed in the spring 2014 aerial, the winter/spring 2015 aerial, the spring 2019 aerial AMAPPS surveys (NEFSC & SEFSC 2014, 2015, 2020). A single NARW occurred in the Project Area during the Geotechnical 1A Survey in winter 2017-2018 (Smultea Environmental Sciences 2018), but no NARWs were observed during the Ocean Wind Offshore Wind Farm Survey in summer 2017 in the Project vicinity (Alpine 2017b). Three NARW sightings within the Project Area were reported between 13 and 14 December 2018 (NOAA Right Whale Sighting and Advisory System 2019).

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Table 2.2.7-2. Marine mammal species that have been documented, or are likely to occur, in the Project Area and their status, population estimate, abundance, and seasonal occurrence

	Species (Scientific Name)	Stock, as Designated by NMFS	Best Population Estimate in SAR[a]	Strategic Status Under MMPA[b]	ESA Status	Critical Habitat in the Project Area	Occurrence within Project Area[c]	Seasonal Occurrence within Project Area
Low-Frequency Cetaceans (7 Hz to 35 kHz)	North Atlantic Right Whale *(Eubalaena glacialis)*	Western North Atlantic	368	Strategic	Endangered	Cape Cod Bay, Stellwagen Bank, and the Great South Channel and calving areas off Cape Canaveral, Florida to Cape Fear, North Carolina	Regular	Year-round
	Humpback Whale (*Megaptera novaeangliae)*	Gulf of Maine	1,396	None	Delisted	N/A	Regular	Spring, Summer, Fall (possibly year-round)
	Fin Whale (*Balaenoptera physalus)*	Western North Atlantic	6,802	Strategic	Endangered	N/A	Regular	Spring, Summer, Fall (possibly year-round)
	Blue Whale *(Balaenoptera musculus)*	Western North Atlantic	402[d]	Strategic	Endangered	N/A	Not expected	Spring, Summer
	Sei Whale (*Balaenoptera borealis)*	Nova Scotia	6,292	Strategic	Endangered	N/A	Rare	Spring, Summer
	Minke Whale *(Balaenoptera acutorostrata)*	Canadian East Coast	21,968	None	None	N/A	Common	Spring, Summer and Winter (possibly year-round)
Mid-Frequency Cetaceans (150 Hz to 160 kHz)	Sperm Whale *(Physeter macrocephalus)*[e]	North Atlantic,	4,349[e]	Strategic	Endangered	N/A	Uncommon	Spring, Summer, Fall
	Atlantic White-Sided Dolphin *(Lagenorhynchus acutus)*	Western North Atlantic	93,233	None	None	N/A	Regular	Winter

	Species (Scientific Name)	Stock, as Designated by NMFS	Best Population Estimate in SAR[a]	Strategic Status Under MMPA[b]	ESA Status	Critical Habitat in the Project Area	Occurrence within Project Area[c]	Seasonal Occurrence within Project Area
	Risso's Dolphin *(Grampus Griseus)*	Western North Atlantic	35,493[e]	None	None	N/A	Uncommon	Year-round
	Short-finned Pilot Whale *(Globicephala macrorhynchus)*	Western North Atlantic	28,924	Strategic	None	N/A	Uncommon	Year-round
	Long-finned Pilot Whale *(Globicephala melas)*	Western North Atlantic	39,215	Strategic	None	N/A	Rare	Year-round
	Striped Dolphin *(Stenella coeruleoalba)*	Western North Atlantic	67,036	None	None	N/A	Rare	Fall, Winter (possibly year-round)
	Atlantic Spotted Dolphin *(Stenella frontalis)*	Western North Atlantic	39,921	None	None	N/A	Uncommon	Summer, Fall
	Common Dolphin *(Delphinus delphis)*	Western North Atlantic	172,974	None	None	N/A	Regular	Fall, Winter (possibly year-round)
	Common Bottlenose Dolphin *(Tursiops truncatus)*[e]	Western North Atlantic, Northern Migratory Coastal	6,639	Strategic	None	N/A	Regular	Year-round (most frequently in Spring and Summer)
	Common Bottlenose Dolphin *(Tursiops truncatus)*[e]	Western North Atlantic, Offshore	62,851	None	None	N/A	Regular	Year-round (most frequently in Spring and Summer)
High-Frequency Cetaceans (275 Hz to 160 kHz)	Harbor Porpoise *(Phocoena phocoena)*	Gulf of Maine-Bay of Fundy	95,543	None	None	N/A	Regular	Winter (possibly during Spring and Summer)

	Species (Scientific Name)	Stock, as Designated by NMFS	Best Population Estimate in SAR[a]	Strategic Status Under MMPA[b]	ESA Status	Critical Habitat in the Project Area	Occurrence within Project Area[c]	Seasonal Occurrence within Project Area
Phocid Pinnipeds (50 Hz to 86 kHz)	Harbor Seal *(Phoca vitulina)*[e]	Western North Atlantic	61,336	None	None	N/A	Regular	Spring, Fall, Winter
	Gray Seal *(Halichoerus grypus)*[e]	Western North Atlantic	27,300	None	None	N/A	Regular	Spring, Fall
	Harp Seal *(Pagophilus groenlandicus)*	Western North Atlantic	76 million	None	None	N/A	Rare	Spring, Winter
	Hooded seal (*Cystophora cristata*)	Western North Atlantic	Unknown	None	None	N/A	Not Expected	Spring, Winter

[a]Best population estimates reported in the 2020 Stock Assessment Report (SAR) and most recently updated 2020 Draft SAR (Hayes *et al.* 2020; NMFS 2020).

[b]The MMPA defines a "strategic" stock as a marine mammal stock (a) for which the level of direct human-caused mortality exceeds the potential biological removal level; (b) which, based on the best available scientific information, is declining and is likely to be listed as a threatened species under the ESA within the foreseeable future; or (c) which is listed as a threatened or endangered species under the ESA, or (d) is designated as depleted.

[c]Occurrence in the Offshore Survey Corridor was derived from sightings and information in NJDEP 2010b; NEFSC & SEFSC 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2018, 2019, 2020; Roberts *et al.* 2016; Palka *et al.* 2017; and Hayes *et al.* 2020, 2021. The species known to occur in the Project Area and vicinity, and expected to occur in the survey area, are addressed based on their reported occurrence of rare to regular (i.e., common).

[d]The minimum population estimate is reported as the best population estimate in the most recently updated 2020 Draft SAR (NMFS 2020).

[e]Density models (Palka *et al.* 2017) predicted that typically deep-water species such as Risso's dolphins and sperm whales are present at very low densities in offshore edges of several wind energy study areas that are either close to the continental shelf break or extend into deeper waters.

[e]Palka *et al.* (2017) pooled the Offshore and Northern Migratory Coastal Stocks of bottlenose dolphin in a single density estimate; likewise gray, harbor and unidentified seals were pooled in a single estimate.

Seasonal abundance estimates for marine mammals, derived from density models in the New Jersey Wind Energy Study Area. From: Supplement to Final Report BOEM 2017-071, Atlantic Marine Assessment Program for Protected Species: 2010-2014 Appendix I (Palka *et al.* 2017). Seasons are depicted as follows: Spring (March - May); Summer (June - August); Fall (September - November); Winter (December - February).

Hearing ranges taken from NMFS 2016; Hz = hertz, kHz = kilohertz

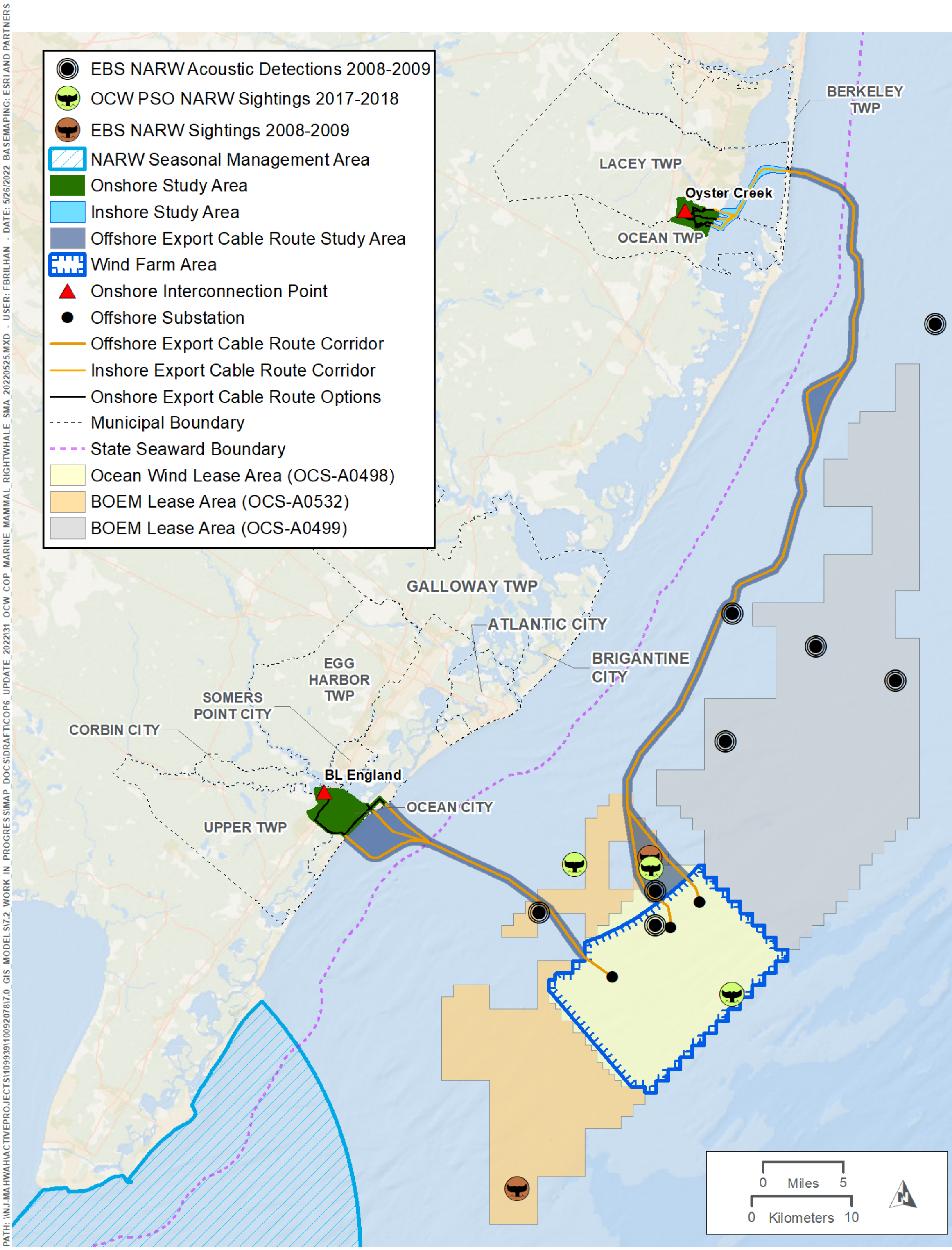


Figure 2.2.7-5. Sightings, acoustic detections, and Seasonal Management Areas for North Atlantic right whales in relation to the Project Area. EBS = Ecological Baseline Studies (NJDEP 2010b); OCW PSO = Ocean Wind Protected Species Observer reports (Smultea Environmental Sciences 2018; NOAA Right Whale Sighting and Advisory System 2019).

A 2008 study reported that between 2002 and 2006, NARWs in the western Atlantic were subject to the highest proportion of entanglements (25 of 145 confirmed events) and vessel strikes (16 of 43 confirmed occurrences) of any marine mammal studied (Glass *et al.* 2008). Bycatch of NARWs has also been reported in pelagic drift gillnet operations by the Northeast Fisheries Observer Program; however, no mortalities have been reported (Glass *et al.* 2008). From 2013 through 2017, the minimum rate of annual human-caused mortality and serious injury to this species from fishing entanglements averaged 6.85 per year, while vessel strikes averaged 1.3 whales per year (Hayes *et al.* 2020). Environmental fluctuations and anthropogenic disturbance may be contributing to a decline in overall health of individual NARWs that has been occurring for the last 3 decades (Rolland *et al.* 2016).

To mitigate the potential for vessel strikes, in 2008 NMFS designated certain nearshore waters of the Mid-Atlantic Bight (within a 20 nm radius of ports and bays) as Mid-Atlantic U.S. Seasonal Management Areas (SMAs) for NARWs (73 FR 60173). NMFS requires that all vessels 65 ft (19.8 m) or longer must travel at 10 nm/hr or less within the SMAs from November 1 through April 30 when NARWs are most likely to pass through these waters. An SMA is in place for this species at the entrance of the Delaware Bay between November 1 and April 30 (**Figure 2.2.7-5).**

Sei Whales

Sei whales (*Balaenoptera borealis*) occur in every ocean except the Arctic Ocean (see **Table 2.2.7-2** for summary data on the species' stock designation(s), best population estimate, MMPA status, ESA status, critical habitat designations, occurrence in the Project Area and vicinity, and seasonal occurrence). Sei whales are often associated with deeper waters and areas along the continental shelf edge (Hain *et al.* 1985); however, this general offshore pattern of sei whale distribution is disrupted during occasional incursions into more shallow and inshore waters (Waring *et al.* 2004).

In the western Atlantic Ocean, sei whales occur from Labrador to Nova Scotia in the summer months and migrate south to Florida, the Gulf of Mexico, and the northern Caribbean (Mead 1977, Gambell 1985).

Sei whales are most common on Georges Bank and into the Gulf of Maine and the Bay of Fundy during spring and summer, primarily in deeper waters. There are occasional influxes of sei whales further into Gulf of Maine waters, presumably in conjunction with years of high copepod abundance inshore. Sei whales are occasionally seen feeding in association with right whales in the southern Gulf of Maine and in the Bay of Fundy.

Sei whales are occasionally killed in collisions with vessels. Of three sei whales that stranded along the Atlantic Coast of the U.S. between 1975 and 1996, two showed evidence of collisions with ships (Laist *et al.* 2001). Between 1999 and 2005, there were three reports of sei whales being struck by vessels along the Atlantic Coast of the U.S. and the Maritime Provinces of Canada (Cole *et al.* 2005, Nelson *et al.* 2007). Two of these vessel strikes were reported as having resulted in the death of the sei whale.

Sei whales are unlikely to be encountered in the Project Area, although small numbers have been documented there during the spring and summer months (Hayes *et al.* 2020). No sei whales were recorded during EBS surveys, but a fin/sei whale (could not be identified to species) was documented in the waters off New Jersey during the summer 2016 and 2017 AMAPPS surveys (NJDEP 2010; NFFSC & SEFSC 2016, 2018). This species is encountered closer to shore during years when oceanographic conditions force planktonic prey, such as copepods and euphausiids, to shelf and inshore waters (Payne *et al.* 1990). There have been no recorded strandings of sei whales in New Jersey since 2008 (Henry *et al*. 2020); however, in summer of 2017, a sei whale carcass was found on a bow of a ship in the Hudson River, Newark, New Jersey (Hayes *et al*. 2020).

Sperm Whales

Sperm whales (*Physeter macrocephalus*) occur in every ocean except the Arctic Ocean (see **Table 2.2.7-2** for summary data on the species' stock designation(s), best population estimate, MMPA status, ESA status, critical habitat designations, occurrence in the Project Area and vicinity, and seasonal occurrence). In the western Atlantic Ocean, sperm whales are distributed in a distinct seasonal cycle, concentrated east-northeast of Cape Hatteras in winter and shifting northward in spring when whales are found throughout the Mid-Atlantic Bight. Distribution extends further northward to areas north of Georges Bank and the Northeast Channel region in summer and then south of New England in fall, back to the Mid-Atlantic Bight.

Sperm whales have a strong preference for the 3,281 ft (1,000 m) depth contour and seaward. While deep water is their typical habitat, sperm whales have been observed near Long Island, New York, in water between 135 and 180 ft (41-55 m; Scott and Sadove 1997). When they are found relatively close to shore, sperm whales are usually associated with sharp increases in bottom depth where upwelling occurs and biological production is high, implying the presence of a good food supply (Clarke 1956).

Sperm whales could potentially occur in the Project Area. During the summer 2017 AMAPPS aerial survey, a sperm whale was documented in the waters off New Jersey, in the deeper portion of the shelf edge (NEFSC & SEFSC 2018). There have been no recorded strandings of sperm whales in New Jersey since 2008 (Henry *et al*. 2020).

2.2.7.1.2 Non-Endangered Marine Mammals

The following marine mammals are protected by the MMPA but are not listed as endangered or threated under the ESA.

Pinnipeds

Four species of pinnipeds have the potential to occur in the coastal waters of New Jersey: harbor seals *(Phoca vitulina)*, gray seals *(Halichoerus grypus)*, hooded seals *(Cystophora cristata)*, and harp seals *(Pagophilus groenlandicus)* (NJDFW ENSP 2009), although harbor and gray seals are the most likely to occur in the Project Area. Abundance estimates for these species in the Project Area have been pooled (Palka *et al.* 2017) so, for the purpose of this analysis, these species will be treated as a single group, "phocid pinnipeds."

The effects on pinnipeds of various IPFs associated with offshore wind farm development have been relatively well-studied in the U.K. and Europe (BOEM 2018a). The acoustic ecology of harbor and gray seals is similar, although gray seals have a slightly lower hearing threshold and bandwidth (Asselin *et al*. 1993, Ruser *et al.* 2014).

Harbor seals are the dominant pinniped species in the Project Area. They are year-round inhabitants of the coastal waters of eastern Canada and Maine, occur seasonally along mid-Atlantic shores from September through late May (Hayes *et al*. 2020), but are typically observed in New Jersey between November and April. The three major haul out (resting) sites in New Jersey are 1) Great Bay, which is adjacent to the offshore wind area (and the largest haul out south of Long Island, NY), 2) Barnegat Inlet/Barnegat Lighthouse, and 3) Sandy Hook (Slocum *et al.* 2005, Slocum and Davenport 2009, NJDEP 2010b, CWF 2018).

One harbor seal was recorded in the offshore wind area during NJDEP EBS in shallow waters east of Little Egg Inlet in June. Other unidentified pinnipeds recorded near Ocean City in April were likely also harbor seals, but species could not be confirmed (NJDEP 2010b). An unidentified seal was observed in the spring 2013 aerial AMAPPS survey (NEFSC & SEFSC 2013).

Little is known about the habitat use and foraging grounds of harbor and gray seals in mid-Atlantic waters. Individuals of both species were captured and instrumented with telemetry tags from 2012-2015 as part of the

AMAPPS effort, and spatially explicit at-sea density models were developed for seals sighted during aerial surveys (Palka *et al.* 2017). However, all animals were captured in Maine and Massachusetts, and results did not pertain to the Project Area.

Historically, harbor seals were observed only sporadically south of New Jersey, but in recent years this species has been seen regularly as far south as North Carolina, and regular seasonal haul-out sites of up to 40-60 animals have been documented on the eastern shore of Virginia and the Chesapeake Bay (Rees *et al.* 2016). Gray seals were considered locally extinct in U.S. waters prior to the 1980s due to human exploitation, but in recent decades have been recolonizing their former range from Maine to New Jersey (Wood *et al.* 2011). Population trends for harbor seals are not available, but gray seal abundance is likely increasing, and both species are extending the seasonal intervals in which they inhabit mid-Atlantic waters (Hayes *et al.* 2020).

In March 2019, Ocean Wind conducted aerial surveys for seals along the New Jersey coastline from Sandy Hook to Great Bay, New Jersey, with a focus on three known haul-out sites: Sandy Hook, Barnegat Bay, and Great Bay (Appendix E). This timeframe was selected to coincide with the maximum number of seals expected to be hauled out (Slocum 2009). Of the three main seal colony locations, only Barnegat Light overlapped with a potential cable landfall route (Oyster Creek). Aerial surveys with a visual observer aboard were conducted on March 9, but no seals were observed. On March 17 a high-resolution aerial digital survey of the three haul-out sites was conducted. Surveys were flown using a 1974 Cessna U206F, flying at an altitude of approximately 1,000 ft. In total, 45 seals were detected in the digital images: six in the Sandy Hook area, five in the Barnegat Light area, and 34 in the Fish Island-Great Bay area. The majority of the seals detected were in the water, with very few hauled out, making species identification difficult. Only seven of the 45 seals were identified to species, of which all were identified as probable harbor seals. In addition to the aerial survey data, results from a ground-based haul-out count survey conducted by the Rutgers University Marine Field Station at the Great Bay site from March 5-14 indicated a maximum of 145 harbor seals at this site on March 14. No corresponding ground-or vessel-based count data were available for the Barnegat Bay or Sandy Hook sites.

Palka *et al*. (2017) used AMAPPS survey data collected from 2010 through 2013 to generate seasonal, spatially explicit in-water abundance estimates for phocid pinnipeds in nine WEAs, including the New Jersey WEA, which included the Ocean Wind Lease Area and a surrounding 6.2 mile (10 km) buffer zone. Spring densities were highest, followed by summer and fall, with no estimate during the winter. The best abundance estimates for harbor seals in the Western North Atlantic stock (U.S. and Canada) is 75,834 (**Table 2.2.7-2**) (Hayes *et al.* 2020). NOAA SARs denote the population sizes of gray seals species as "unknown", because systematic surveys have not been conducted within the U.S.; however, they report that estimates based on surveys at pupping areas north of the U.S. have resulted in Canadian population estimates of 424,300 gray seals in 2016 (Hayes *et al.* 2020). The minimum number of pups born at U.S. breeding colonies (n=6,308) were used to approximate the total size of the gray seal population in U.S. waters. Although there is some uncertainly in the abundance numbers, this approach estimates the U.S. gray seal population at 27,131, putting the combined Western North Atlantic stock population at 451,431 (Hayes *et al.* 2020).

Pinniped stranding records for the New Jersey coast were reported by NMFS for the years 2011-2015. These records included a total of 32 harbor seals (five of which were pups), 35 gray seals (14 of which were pups), and 22 harp seals (none of which were pups) (Hayes *et al.* 2020). Since July 2018, increased numbers of gray seal and harbor seal mortalities have been recorded across Maine, New Hampshire, and Massachusetts (NOAA Fisheries 2020). This event has been declared a UME by NMFS, and encompasses 3,152 seal strandings from Maine to Virginia (NOAA Fisheries 2020). Off New Jersey, 172 seals have stranded between July 2018 and March 2020 (NOAA Fisheries 2020). Phocine distemper virus was the predominant pathogen found in the deceased seals upon completion of full or partial necropsies, and based on this finding, has been attributed as the cause of the UME.

Cetaceans

Atlantic Spotted Dolphin

Atlantic spotted dolphins (*Stenella frontalis*) in the western Atlantic belong to the Western North Atlantic stock (Hayes *et al.* 2020). They occur in U.S. Atlantic waters year-round, ranging from New England south through the Caribbean and Gulf of Mexico (Hayes *et al.* 2020). This species inhabits inshore waters and along the continental shelf edge and slope with sightings concentrated north of Cape Hatteras (Hayes *et al.* 2020).

Atlantic spotted dolphins are common in U.S. Atlantic waters and are regularly observed during surveys. However, Atlantic spotted dolphins were not documented during the EBS and no abundance estimates were calculated from these survey data. Nevertheless, the single animal that stranded in New Jersey between 2010 and 2015 suggests these dolphins could be expected to occur in the Project Area. Seasonal abundance estimates were calculated using data from AMAPPS surveys conducted in the New Jersey WEA. Atlantic spotted dolphins' seasonal abundance estimates off New Jersey were approximately the same for spring, summer and fall, with no estimate during the winter (Palka *et al.* 2017).

Atlantic White-Sided Dolphin

During the EBS, Atlantic white-sided dolphins (*Lagenorhynchus acutus*) were not observed, and no abundance estimates could be calculated using these survey data; however, the single animal that stranded in New Jersey between 2011 and 2015 suggests that these dolphins could be expected to occur in the Project Area. Seasonal abundance estimates were calculated using data from AMAPPS surveys conducted in the New Jersey WEA. Atlantic white-sided dolphin's seasonal abundance estimates off New Jersey were highest in the spring, followed by fall with very low numbers in the fall to no estimate during the winter (Palka *et al*. 2017). Atlantic white-sided dolphins could potentially be observed in the Project Area.

Common Dolphin

The Western North Atlantic stock of the common dolphin (*Delphinus delphis*) is distributed from Massachusetts to the South Carolina/Georgia border, but are less common south of Cape Hatteras (Hayes *et al.* 2020). Common dolphins were only recorded in the EBS in fall and winter (late November through mid-March) and accounted for a majority of the dolphins recorded in the winter (NJDEP 2010b). During the EBS these dolphins were observed in water depths of 33 to 102 ft (10 to 31 m) and 2 to 20 nm (3 to 37 km) from shore, which suggests they occur much closer to shore than earlier reports suggest. These dolphins are expected to occur within the Project Area.

A winter abundance estimate of 82 individuals was generated for this species in the Project Area, but this estimate might be high (NJDEP 2010b). Common dolphins were observed in the wind planning areas offshore of New Jersey in spring surveys (2012 and 2014), fall surveys (2016), winter/spring surveys (2015), summer surveys (2017), and winter AMAPPS surveys (2017-2018; NEFSC & SEFSC 2012, 2014, 2015, 2016, 2018, 2019; Smultea Environmental Sciences 2018). They were not present during the summer 2017 survey (Alpine 2017b).

Seasonal abundance estimates generated by Palka *et al.* (2017) showed that common dolphins were more abundant during the fall off New Jersey than the spring and summer.

Bottlenose Dolphin

Bottlenose dolphins (*Tursiops truncatus*) occur in estuarine, coastal, continental shelf, and offshore waters of the western North Atlantic Ocean. Bottlenose dolphin in the Project Area could belong to either the Western North Atlantic Offshore Stock or the Western North Atlantic Northern Migratory Coastal Stock. During warm water months, dolphins in the Northern Migratory Coastal Stock occupy coastal waters from the shoreline to approximately the 65.6 ft (20-m) isobath between Assateague, Virginia, and Long Island, New York (Garrison *et al.* 2017).

Bottlenose dolphins were the most frequently sighted marine mammals during EBS surveys. They were sighted in all seasons, but most frequently in spring and summer (NJDEP 2010b). Results of the EBS suggest bottlenose dolphins occur off New Jersey from the beginning of March until around mid-October (NJDEP 2010b). Fewer bottlenose dolphins were observed the fall in comparison with other seasons, since fall is potentially a transitional period when bottlenose dolphins move south of the survey area (NJDEP 2010b). Bottlenose dolphins were observed off New Jersey during the 2017 winter AMAPPS surveys (NEFSC & SEFSC 2018).

EBS results also indicate that nearshore waters are important to bottlenose dolphins, but distribution is not thought to be limited to a particular depth or distance from shore. Bottlenose dolphins were sighted within 0.16 nm (0.3 km) of the shore, with peak densities from the shore to 3 nm (5.5 km) off Atlantic City and Little Egg Inlet in the spring, but further offshore of Barnegat Light and Barnegat Bay in the summer. However, several bottlenose dolphin sightings were also recorded in deeper waters (112 ft [34 m]) and farther offshore (maximum 21 nm [38 km] from shore).

Seasonal abundance estimates for bottlenose dolphins off New Jersey showed they are more prevalent in the summer, followed by spring and fall, with the lowest densities during the winter (Palka *et al.* 2017).

Harbor Porpoise

Harbor porpoises (*Phocoena phocoena*) in the western Atlantic belong to the Gulf of Maine-Bay of Fundy stock (Hayes *et al.* 2020). Their distribution in the western North Atlantic is seasonal, concentrated in the northern Gulf of Maine during summer (July to September); widely dispersed between Maine and New Jersey during fall (October-December) and spring (April-June) with lower densities north and south of this area; distributed from New Jersey to North Carolina in the winter (January-March) in intermediate densities and lower densities off New York to New Brunswick, Canada (Westgate *et al.* 1998 as cited in NJDEP 2010b; Hayes *et al.* 2020). More than 90 percent of the harbor porpoise sightings recorded in the EBS occurred during winter (mainly February and March) and few sightings were recorded in April, May, and July. No harbor porpoises were observed during the fall survey; however, conditions were not optimal to sight this species and they are likely to occur in the Lease Area throughout the fall.

Harbor porpoises were observed in the spring 2013 and 2014, and summer 2017 and 2019 aerial AMAPPS surveys (NEFSC & SEFSC 2013, 2014, 2018, 2020). Seasonal abundance estimates generated for harbor porpoise off New Jersey showed the highest densities during the spring, with very low numbers in the fall and no estimate during the summer and winter (Hayes *et al.* 2020).

Humpback Whale

Humpback whales (*Megaptera novaeangliae*) were observed during all seasons of the EBS. Based on feeding behavior and cow-calf pairs observed off New Jersey, waters of the Project Area may support feeding and nursery habitat as well as a migratory pathway. Abundance estimates generated from the EBS surveys predict a year-round abundance of one humpback off the coast of New Jersey (NJDEP 2010b). Humpback whales were also observed during the spring and fall AMAPPS aerial survey (NEFSC & SEFSC 2013, 2016, 2018, 2019, 2020). A single humpback whale was recorded during the Ocean Wind Offshore Wind Farm Survey in summer 2017 in the Project vicinity (Alpine 2017) and one individual occurred during the Geotechnical 1A Survey in winter 2017-2018 (Smultea Environmental Sciences 2018). Seasonal estimates for humpback whales showed low numbers during the spring, summer and fall in the New Jersey WEA (Palka *et al.* 2017).

Humpback whales are found year-round off New Jersey, with peak numbers in cooler months (fall to winter) (Geo-Marine 2010a, 2010b, Palka *et al.* 2017).

A UME (UME Number 63) for humpback whales was declared in January 2016. Since then, 145 humpback whales have stranded between Maine and Florida, with approximately 50 percent due to vessel strike or entanglement (NOAA Fisheries 2021b). Since 2016, there have been 16 humpback strandings off New Jersey (NOAA Fisheries 2021b). Necropsy examinations were conducted on approximately half of the whales, and about 50 percent of those examined had evidence of human interaction, either vessel strike or entanglement (NOAA Fisheries 2021b).

Minke Whale

Minke whales (*Balaenoptera acutorostrata*) were observed during EBS surveys (NJDEP 2010b), and during winter, spring, and summer AMAPPS surveys (NEFSC & SEFSC 2013, 2015, 2018). Seasonal abundance estimates calculated for minke whales in waters off New Jersey showed moderate numbers during the spring, and low numbers during the summer and fall in the waters off New Jersey (Palka *et al.* 2017).

Since 2011, 13 minke whale strandings have occurred in New Jersey. In January 2017, a UME (UME Number 65) was declared for this species, with 102 total strandings from Maine to South Carolina due to entanglement and infectious disease (NOAA Fisheries 2021c). Preliminary results of necropsy examinations indicate evidence of human interactions or infectious disease; however, these results are not conclusive (NOAA Fisheries 2021c).

Pilot Whales

Two species of pilot whale (*Globicephalus* spp.) occur along the edge of the U.S. continental shelf in the winter and early spring: the long-finned pilot whale (*Globicephalus melas*) and the short-finned pilot whale (*Globicephalus macrorhynchus*). They move onto the Georges Bank and into the Gulf of Maine and more northern waters in late spring and remain there until late autumn (Hayes *et al.* 2020). The ranges of both species overlap along the shelf break between New Jersey and the southern edge of the Georges Bank (Rone and Pace 2012, Hayes *et al.* 2020). Because they are difficult to distinguish when they are at sea, they are often identified as *Globicephala* sp. Pilot whales in the western Atlantic are members of the Western North Atlantic stock (Hayes *et al.* 2020).

Although pilot whales were not observed during the EBS, the three pilot whales that stranded along the coast of New Jersey between 2011 and 2014 indicate that this species could occur in the Project Area. One of the stranded whales was identified as a short-finned pilot whale, one as a long-finned pilot whale, and the third could not be assigned to either species. Recent surveys undertaken for offshore wind projects in New York and New Jersey found pilot whales near the continental shelf break (NYDOS 2013; New York State Energy Research and Development Authority [NYSERDA] 2017), but not in nearshore waters (Whitt *et al.* 2015).

Risso's Dolphin

Risso's dolphin (*Grampus griseus*) are distributed globally in tropical to warm temperate waters. Off the U.S. Atlantic coast, Risso's dolphins typically occur year-round along the continental shelf edge (Hayes *et al.* 2020). During spring, summer and fall, they occur from Cape Hatteras north to Georges Bank, and during winter, they associate with slope waters within the Mid-Atlantic Bight (Hayes *et al.* 2017). There were no stranding records of Risso's dolphins off the New Jersey coast.

Density models predicted typically deep-water species such as Risso's dolphins present at very low densities in offshore edges of several WEAs that are either close to the shelf break or extend into deeper waters (Palka *et al.* 2017).

Striped Dolphin

The striped dolphin (*Stenella coeruleoalba*) is distributed worldwide in temperate, tropical, and subtropical seas. In the western North Atlantic, striped dolphins occur year-round from Nova Scotia south into the Caribbean and the Gulf of Mexico, frequently in continental shelf waters along the 3,281 ft (1,000 m) isobaths (Waring *et al.* 2007). Striped dolphins occur year-round along the continental slope in the mid-Atlantic region (Hayes *et al.* 2020). Palka (1997) reported that all striped dolphins observed during a survey of the New England Sea Mounts were in waters between 68° and 80.6°F (20° and 27°C) and deeper than 2,953 ft (900 m). Although striped dolphins were not observed during the EBS, the 11 striped dolphins that stranded along New Jersey from 2007-2011 establish that they occur in waters off coastal New Jersey.

2.2.7.2 Potential Project Impacts on Marine Mammals

The Project Description in Volume I of this COP describes the routine activities associated with the construction, operation and maintenance, and decommissioning phases of the Project. The primary IPF associated with these activities that are relevant to the marine mammals that are expected to occur in the Project Area are:

- Noise
- Vessel traffic
- Seabed disturbance

Specifically, these IPFs would result from (1) underwater noise associated with the construction or installation of Project structures, and noise and blast impulse within the direct vicinity of the UXO/MEC disposal activities during site preparation, (2) collision risks, noise, and disturbance associated with Project-related vessel traffic, and (3) seabed disturbance resulting from Project activities.

Three other potential IPFs — suspended sediment, water quality impacts, and EMF — have been associated with offshore wind projects in the literature. However, based on the information available and using the variables discussed previously (probability of exposure, detectability; duration; spatial extent; and severity), suspended sediments, water quality impacts, and EMF resulting from routine activities associated with Project construction, operation and maintenance, and decommissioning would have little or no measurable adverse effect on the behavior, physiology, and social ecology of marine mammals that might be exposed to these IPFs. As a result, these IPFs are not considered further.

2.2.7.2.1 Construction

The three primary IPFs associated with the construction phase of the Project can be divided into the following sub-categories: pile-driving noise, risk of collision with surface vessels during construction, noise produced by construction vessels, disturbance created by construction vessels, and alteration of benthic habitat.

Of these IPFs, pile-driving noise and collisions appear to pose the greatest potential risk to marine mammals exposed the Project construction activities. Over the past two decades, a considerable body of scientific information on anthropogenic sound and its effects on marine mammals and other marine life has become available. Many investigators have studied the potential effects of human-generated sounds in marine environments on marine mammals (for syntheses of these data, see Reeves 1992; Bowles *et al.* 1994; Norris 1994; Croll *et al.* 1999, 2001; Richardson *et al*. 1995; Frankel and Clark 1998; Gisiner 1998; McCauley and Cato 2001; NRC 1994, 1996, 2000, 2003, 2005; Southall *et al.* 2007; Tyack 2000, 2007; Wright *et al.* 2007; Abgrail *et al*. 2008, and Erbe *et al.* 2018). Despite this apparent abundance of information, substantial uncertainty remains about how marine mammals use sounds as environmental cues, how they perceive acoustic features of their environment; the importance of sound to the normal behavioral and social ecology of marine mammals; the mechanisms by which human-generated sounds affect the behavior and physiology (including the non-auditory physiology) of marine mammals, and the circumstances that are likely to produce outcomes that have adverse consequences for marine mammals (see NRC 2000 for further discussion).

Wind Farm Area

The primary IPFs associated with the construction of WTGs and substation foundations include pile-driving noise, in-situ UXO/MEC disposal, and vessel traffic and the collision risks, disturbance, and noise associated with it. The addition of scour protection for WTGs and cables, as well as the impacts of the foundations for the offshore substations on benthic habitat, was discussed in Section 2.2.5.2.

UXO/MEC removal noise

Ocean Wind conducted sound propagation modeling for anticipated pile-driving (impact and vibratory) activities associated with Project construction, and results include distances to sound isopleths associated with injury and harassment of marine mammals (Appendix R-2).

While non-explosive methods may be employed to lift and move UXO/MEC, some may need to be removed by explosive detonation. Underwater explosions of this type generate sound waves with high pressure levels that could cause disturbance and/or injury to marine fauna. Low order (deflagration) or high order (detonation) in-situ disposal of UXO/MEC has the potential to affect marine mammals via mortality, physical injury, auditory damage, physiological stress, acoustic masking, and behavioral responses (Merchant et al. 2020). Marine vertebrates, including marine mammals, can suffer lethal and sub-lethal effects from the shock waves generated by underwater explosions (Koschinski 2011). Acoustic trauma via damage to the cochlear structures can either be temporary (temporary threshold shift [TTS]) due to sensory cells being overwhelmed by intense acoustic energy, or permanent (permanent threshold shift [PTS]) due to neural cell damage and loss of hair cell bodies (Koschinski 2011). The rapid changes in pressure and short signal rise time involved in explosions may lead to PTS (Ketten 1995). Marine mammals that communicate in the high-frequency range, such as harbor porpoise, are particularly sensitive to the effects of underwater explosions. Studies also indicate that smaller cetacean species are at greatest risk for shock wave or blast injuries (Ketten 2004). Non-auditory injury includes slight injury from lung and gastrointestinal compressions.

Ocean Wind also conducted modeling for UXO/MEC removal associated with Project construction site preparation (Appendix R-2). Underwater explosions can result in masking, a phenomenon which occurs when the perception of a biologically important signal is interfered with by another signal in the environment (i.e., noise) (Department of the Navy [DoN] 2018). For marine mammals, masking could result in a reduced ability to communicate with conspecifics, find food, and navigate in their environment. However, masking only occurs when the sound source is operating, and direct masking effects stop immediately upon cessation of the sound-producing activity (DoN 2018). Underwater explosions can also result in behavioral changes such as disturbance to regular migration and movement patterns, feeding, mating, calving/pupping, and resting (von Benda-Beckmann et al. 2015). Behavioral responses consist of reactions ranging from very minor and brief changes in attentional focus, changes in biologically important behaviors, and avoidance of a sound source or area, to aggression or prolonged flight (DoN 2018). In the case of single explosions, however, significant behavioral responses are not anticipated for exposures below TTS thresholds (Appendix R-2). Associated noise impacts are expected to be short term and direct within the direct vicinity of the disposal activities.

Pile-driving removal noise

Based on empirical studies of animal responses to pile-driving and other stationary sources of anthropogenic noise, free-ranging animals exposed to pile-driving noise at onset (when it is initiated) and free-ranging animals who encounter a sound field later in time can be expected to exhibit different responses (Kastelein *et al*. 1995). The former will not be able to control their exposure and will respond accordingly. Free-ranging animals that are outside of a particular sound field will be aware of the sound field at low received levels and would be able to decide whether to approach and be exposed and, if so, the exposure they are willing to tolerate.

Animals exposed to a pile-driving operation, particularly impact pile driving, at onset risk tissue damage, loss of hearing sensitivity, and are likely to engage in evasive or avoidance behavior to avoid continued exposure accompanied by acute stress physiology. Tissue damage or acoustic resonance results from hydraulic damage in tissues that are filled with gas or air that resonates when exposed to acoustic signals (Rommel *et al.* 2007). Based on studies of lesions in beaked whales that stranded in the Canary Islands and Bahamas associated with naval training exercises, investigators identified two physiological mechanisms that might explain some of those stranding events: tissue damage resulting from resonance effects (Cudahy and Ellison 2001, Ketten 2004) and tissue damage resulting from “gas and fat embolic syndrome” (Jepson *et al.* 2003, 2005; Fernandez *et al.* 2005). Fat and gas embolisms are believed to occur when tissues are supersaturated with dissolved nitrogen gas and diffusion facilitated by bubble-growth is stimulated within those tissues (the bubble growth results in embolisms analogous to the “bends” in human divers).

Although tissue damage has been reported in fish exposed to pile driving noise (Halvorsen *et al.* 2010, Popper *et al.* 2014), this kind of damage has not been reported in marine mammals. However, Cudahy and Ellison (2001) concluded that the expected threshold for in vivo (in the living body) tissue damage in marine mammals exposed to low frequency active sonar underwater sound is on the order of 180 to 190 dB. There is limited direct empirical evidence (other than Schlundt *et al.* 2000) to support a conclusion that 180 dB is “safe” for marine mammals; however, because many marine mammal vocalizations are close to 180 dB, it is unlikely that these received levels physically injure marine mammals. For example, Frankel (1994) estimated the source level for singing humpback whales to be between 170 and 175 dB; McDonald *et al.* (2001) calculated the average source level for blue whale calls as 186 dB, Watkins *et al.* (1987) found source levels for fin whales up to 186 dB, and Møhl *et al.* (2000) recorded source levels for sperm whale clicks up to 223 dB_{rms}.

Crum and Mao (1996) hypothesized that marine mammals exposed to low-frequency active sonar would have to be exposed at received levels exceeding 190 dB for significant bubble growth due to super-saturation of gases in the blood to occur. Jepson *et al.* (2003, 2005) and Fernández *et al.* (2004, 2005) concluded that in vivo bubble formation, which may be exacerbated by deep, long-duration, repetitive dives, may explain why beaked whales appear to be particularly vulnerable to exposure to mid-frequency active sonar (as opposed to low-frequency sound sources).

Noise-Induced Loss of Hearing Sensitivity

Noise-induced loss of hearing sensitivity[15] or “threshold shift” refers to an ear’s reduced sensitivity to sound following exposure to loud noises; when an ear’s sensitivity to sound has been reduced, a sound must be louder for an animal to detect and recognize it. Noise-induced loss of hearing sensitivity is usually represented by the increase in intensity (in decibels) sounds must have to be detected. These losses in hearing sensitivity rarely affect the entire frequency range an ear might be capable of detecting; instead, they affect the frequency ranges that are roughly equivalent to or slightly higher than the frequency range of the noise itself.

Acoustic exposures can result in three main forms of noise-induced losses in hearing sensitivity: permanent threshold shift, temporary threshold shift, and compound threshold shift (Miller 1974, Ward 1998, Yost 2007). When permanent loss of hearing sensitivity, or PTS, occurs, there is physical damage to the sound receptors (hair cells) in the ear that can result in total or partial deafness, or an animal’s hearing can be permanently

[15] Animals can experience losses in hearing sensitivity through other mechanisms. The processes of aging and several diseases cause some humans to experience permanent losses in their hearing sensitivity. Body burdens of toxic chemicals can also cause animals, including humans, to experience permanent and temporary losses in their hearing sensitivity (for example, see Mills and Going 1982 and Fechter and Pouyanos 2005).

impaired in specific frequency ranges, which can cause the animal to be less sensitive to sounds in that frequency range. Traditionally, investigations of temporary loss of hearing sensitivity, or TTS, have focused on sound receptors (hair cell damage) and have concluded that this form of threshold shift is temporary because hair cells damage does not accompany TTS and losses in hearing sensitivity are short-term and are followed by a period of recovery to pre-exposure hearing sensitivity that can last for minutes, days, or weeks. More recently, however, Kujawa and Liberman (2009) reported on noise-induced degeneration of the cochlear nerve that is a delayed result of acoustic exposures that produce TTS, that occurs in the absence of hair cell damage, and that is irreversible. They concluded that the reversibility of noise-induced threshold shifts, or TTS, can disguise progressive neuropathology that would have long-term consequences on an animal's ability to process acoustic information. If this phenomenon occurs in a wide range of species, TTS may have more permanent effects on an animal's hearing sensitivity than earlier studies suggest.

Compound threshold shift occurs when some loss in hearing sensitivity is permanent and some is temporary (for example, there might be a permanent loss of hearing sensitivity at some frequencies and a temporary loss at other frequencies or a loss of hearing sensitivity followed by partial recovery).

Although the published body of science literature contains numerous theoretical studies and discussion papers on hearing impairments that can occur with exposure to a strong sound, only a few studies provide empirical information on noise-induced loss in hearing sensitivity in marine mammals. Most of the few studies available have reported the responses of captive animals exposed to sounds in controlled experiments. Schlundt *et al.* (2000; see also Finneran *et al.* 2001, 2003) provided a detailed summary of the behavioral responses of trained toothed whales[16] during TTS tests conducted at the Navy's SPAWAR Systems Center with 1-second tones. Schlundt *et al.* (2000) reported on eight individual TTS experiments that were conducted in San Diego Bay. Fatiguing stimuli durations were 1 second. Because of the variable ambient noise in the bay, low-level broadband masking noise was used to keep hearing thresholds consistent despite fluctuations in the ambient noise.

Finneran *et al.* (2001, 2003) conducted TTS experiments using 1-second duration tones at 3 kilohertz (kHz). Their test method was similar to that of Schlundt *et al.* (2000) except their tests were conducted in a pool with a very low ambient noise level (below 50 dB re 1 μPa^2/Hz) with no masking noise. The signal was a sinusoidal amplitude modulated tone with a carrier frequency of 12 kHz, modulating frequency of 7 Hz, and sound pressure level (SPL) of approximately 100 dB re 1 μPa. Two separate experiments were conducted. In the first, fatiguing sound levels were increased from 160 to 201 dB SPL. In the second experiment, fatiguing sound levels between 180 and 200 dB re 1 μPa were randomly presented.

Richardson *et al.* (1995) hypothesized that marine mammals within less than 328 ft (100 m) of an active sonar source might be exposed to mid-frequency active sonar transmissions at received levels that might cause TTS (that is, greater than 205 dB re 1 μPa). There is no empirical evidence that exposure to sounds with this kind of intensity cause PTS in cetaceans; instead the probability of PTS has been inferred from studies of TTS (see Richardson *et al* 1995). However, Kujawa and Liberman (2009) argued that traditional testing of threshold shifts, which has focused based on recovery of threshold sensitivities after exposure to noise, would miss acute loss of afferent nerve terminals and chronic degeneration of the cochlear nerve, which would have the effect of permanently reducing an animal's ability to perceive and process acoustic signals. Based on their studies of small mammals, Kujawa and Liberman (2009) reported that two hours of acoustic exposures produced moderate temporary threshold shifts but caused delayed losses of afferent nerve terminals and chronic degeneration of the cochlear nerve in test animals.

[16] The marine mammal species involved in the test were bottlenose dolphin, beluga whales, and California sea lions.

Several variables affect the amount of loss in hearing sensitivity: the level, duration, spectral content, and temporal pattern of exposure to an acoustic stimulus as well as differences in the sensitivity of individuals and species. All of these factors combine to determine whether cetacean is likely to experience a loss in hearing sensitivity as a result of acoustic exposure (Miller 1974, Ward 1998, Yost 2007). In free-ranging marine mammals, an animal's behavioral responses to a single acoustic exposure or a series of acoustic exposure events would also determine whether the animal is likely to experience losses in hearing sensitivity as a result of acoustic exposure. Unlike humans whose occupations or living conditions expose them to sources of potentially-harmful noise for long periods of time, in most circumstances, free-ranging animals are unlikely to endure continued exposure to potentially harmful levels of noise unless they have a compelling reason to do so (for example, if they must feed, reproduce, or rear their young in a specific location).

Hastie *et al.* (2015) estimated sound exposure levels of harbor seals during installation of monopiles, which were estimated to have a maximum single pulse sound exposure level (SEL) of 211 dB re 1 lPa2-s at the maximum blow energy of 2000 kJ (monopile installation during the proposed Project may involve up to 5000 kJ of blow energy). Cumulative Sound Exposure Levels (SEL_{cum}) of tagged harbor seals ranged from 1707 to 1953 dB re 1lPa2-s. According to published acoustic exposure criteria for phocid seals, approximately half of the tagged seals were exposed to noise levels that exceeded estimated permanent auditory injury thresholds (Hastie *et al.* 2015).

<u>Evasive behavior</u>

A study of the effects of mid-frequency active sonar on tagged killer whales (*Orcinus orca*) provides an empirical example of this kind of evasive response (Miller *et al.* 2011). When exposed to a sound source of 197 dB @ 6 - 7 kHz with a 1.0 second upsweep every 10 seconds for 10 minutes, the tagged whales and the larger group of whales they had been feeding with stopped feeding during the approach of the sonar and moved rapidly away from the source. One tagged killer whale seemed to try to avoid further exposure to the sound field by (1) immediately swimming away (horizontally) from the source of the sound; (2) engaging in a series of erratic and frequently deep dives that seemed to take it below the sound field; or (3) by swimming away while engaged in a series of erratic and frequently deep dives. This would qualify as the kind of evasive or acute avoidance behavior whales, dolphins, and porpoises might exhibit if they were close to the pile-driving operation when it began.

The evidence available also suggests that marine mammals might experience more severe consequences if the onset of pile-driving noises leads them to perceive they face an imminent threat, but circumstances do not allow them to avoid or "escape" further exposure. At least six circumstances might prevent an animal from escaping further exposure to a seismic survey and could produce any of one the following outcomes:

1. When swimming away (an attempted "escape") brings marine mammals into a shallow coastal feature that causes them to strand;
2. They cannot swim away because the exposure occurred in a coastal feature that leaves marine mammals no "escape" route (for example, a coastal embayment or fjord that surrounds them with land on three sides, with the sound field preventing an "escape");
3. They cannot swim away because they are exposed to multiple sound fields in a coastal or oceanographic feature that act in concert to prevent their escape;
4. They cannot dive "below" the sound field while swimming away because of shallow depths;
5. To remain "below" the sound field, they must engage in a series of very deep dives with interrupted attempts to swim to the surface (which might lead to pathologies similar to those of decompression sickness);
6. Any combination of these phenomena.

Because pile-driving associated with the Project will be conducted in deeper waters well away from any coastline, these conditions are not likely to apply to cetaceans in the Project Area.

Behavioral avoidance and displacement

After the sound field has been established, and is somewhat predictable, cetaceans are most likely to avoid the sound field produced by pile-driving and other stationary sources. Several investigations have demonstrated that harbor porpoises avoided the sound field produced by pile-driving during the construction phases of off-shore wind farms off Denmark (Teilmann *et al.* 2006a; Tougaard *et al.* 2003a, b, 2005, 2009), Germany (Dähne *et al.* 2014), the Netherlands (Scheidat *et al.* 2011), Scotland (Bailey *et al.* 2010a), and the United Kingdom (Vallejo *et al.* 2017). In almost all of these cases, harbor porpoises occurred in the area surrounding the sound field and returned to the ensonified area after pile-driving activities stopped (Vallejo *et al.* 2017). Behavioral disruption of harbor porpoise has been measured out to distances of at least 12.4 mi (20 km) from the piling site (Tougaard *et al*. 2009, Brandt *et al.* 2011, Dähne *et al.* 2013, Haelters *et al.* 2015), although Vallejo *et al*. (2017) reported that they remained less than 11.2 miles (18 km) from pile driving operations off the United Kingdom. Behavioral disruption effects for harbor porpoises have been documented at distances beyond 13 mi (21 km) where received levels were approximately 175 dB peak, equating to estimated received levels of 130 dB re 1 μPa RMS (Tougaard *et al.* 2009). Tougaard *et al.* (2015) related these avoidance distances to an exposure limit of 45 dB above the hearing threshold at a given frequency. Duration of the deterrence/ disturbance appears to be in the range of some hours to as many as 3 days after cessation of pile driving (Tougaard *et al*. 2006, 2009; Brandt *et al.* 2011; Dähne *et al*. 2013; Brandt *et al.* 2018). Several studies have reported gradients in effects, with shorter-lasting spatial and temporal effects at greater distances (e.g., Brandt *et al.* 2011, Russell *et al.* 2016; Graham *et al*. 2019; Rose *et al.* 2019).

Limited information is available about dolphins' behavioral avoidance/displacement during in-water construction. Bailey *et al.* (2010b) argued that the pile-driving noise they studied would be audible to bottlenose dolphins up to 24.9 miles (40 km) from the source, although they did not discuss the probable responses of these dolphins to the sound at these distances. Behavioral monitoring during Navy recapitalization projects reported no reactions attributed to pile driving noise (NMFS 2019b). Protected species observers detected fewer surfacing bottlenose dolphins during piling activities that were part of a wharf renewal project in Fremantle Harbour (Western Australia) (Paiva *et al.* 2015). The authors were unable to determine whether decreased detections were due to decreased use of that habitat or in response to the piling. Graham *et al.* (2017) remarked on a lack of strong behavioral response by bottlenose dolphins to vibratory and impact pile driving to harbor construction works in northeast Scotland. Overall abundance during piling was similar to baseline, though there was a small spatial and temporal scale disturbance to bottlenose dolphins as a result of impact piling activities. Repeated sightings of recognizable bottlenose dolphins confirmed that some individuals continued to use the impacted area throughout the construction period. While there is the potential for disturbance and displacement to affect individual behavior, bottlenose dolphins are well-known for their adaptability and ability to tolerate certain levels of disturbance (e.g., Shane *et al.* 1986). Additional information on dolphin responses to pile driving comes from Indo-Pacific humpback dolphins (*Sousa chinensis*) in Hong Kong. Würsig *et al.* (2000) reported no significant change in abundance or any overt behavioral changes (i.e., no difference in re-orientations between surfacing) during a study of effectiveness of a bubble screen in Hong Kong, but did observe that dolphins increased their travel speeds by as much as double during piling.

Although data on the response of baleen whales to pile-driving noise is also limited, their responses to other anthropogenic sound sources suggests these whales are also likely to avoid pile-driving noise. Several authors have reported that migrating baleen whales avoid stationary sound sources by deflecting their course slightly as they approached a source (LGL and Greenridge 1987 in Richardson *et al.* 1995). For example, Malme *et al.* (1983, 1984) studied the behavioral responses of gray whales (*Eschrictius robustus*) migrating along the

California coast to various sound sources located in their migration corridor. The whales showed statistically significant responses to four different underwater playbacks of continuous sound at received levels of approximately 120 dB (playback sources were typical of a drillship, semisubmersible, drilling platform, and production platform).

Richardson *et al.* (1995) and Richardson (1997, 1998) used controlled playback experiments to study the response of bowhead whales in Arctic Alaska. In their studies, bowhead whales tended to avoid drill ship noise at estimated received levels of 110 to 115 dB and seismic sources at estimated received levels of 110 to 132 dB. Richardson *et al.* (1995) concluded that some marine mammals would tolerate continuous sound at received levels above 120 dB re 1 Pa for a few hours. These authors concluded that most marine mammals would avoid exposures to received levels of continuous underwater noise greater than 140 dB when source frequencies were in the animal's most sensitive hearing range. Other investigators have reported similar responses to active sonar (Watkins *et al.* 1985, Maybaum 1993, International Whaling Commission [IWC] 2005) and seismic surveys (Brownell 2004). Bowhead whale behavioral responses include alterations in surfacing, respiration, and dive cycles, as well as changes in calling rates depending on the received level of airgun sounds (Carlson *et al.* 2012; Blackwell *et al.* 2015; Robertson *et al*. 2016). When subjected to playbacks of seismic survey noise, humpback whale (*Megaptera novaeangliae*) behavioral responses included frequent alterations of course, with changes in the duration of their dives and the speed of their migrations (Cato *et al.* 2019). Based on these observations, Kraus *et al*. (2019) concluded that there is reason to believe that displacement of large whales away from the pile driving source sounds is likely.

Watkins (1986) reviewed observations of the behavioral responses of 122 minke whales, 2,259 fin whales, 833 right whales, and 603 humpback whales to various sources of human disturbance, and concluded that fin, humpback, minke, and North Atlantic right whales ignored sounds that occurred at relatively low received levels, sounds whose energy was concentrated at frequencies below or above their hearing capacities, or were distant from them, even when those sounds had considerable energies at frequencies well within the whales' range of hearing. He argued that most negative reactions occurred within 328 ft (100 m) of a sound source or when sudden increases in received sound levels were judged to be in excess of 12 dB, relative to previous ambient sounds.

Based on the data available, whales, dolphins, and porpoises that are near pile-driving operations when they begin are likely to actively avoid or evade additional exposure. If a relatively large area is ensonified by pile-driving, cetaceans that avoid the sound field would therefore experience potential social and physiological costs related to displacement.

Responses of both gray and harbor seal responses to pile driving activities have been studied in the North Sea. Gray seals are considered to tolerate higher levels of disturbance than harbor seals (SeaGreen Wind Energy 2018). Numbers of seals at haulout sites in the vicinity of construction activities at nearby wind farms have been found to decrease temporarily. Using remote video monitoring for harbor seals at Rødsand seal sanctuary located 6.2 mi (10 km) from the Danish Nysted wind farm, the number of seals hauled out on land decreased significantly (20 to 60 percent) during piling (Edrén *et al.* 2010). Seals both entered and left the haul-out site during these pile driving periods (Edrén *et al.* 2010). A significant decrease in the number of seals on land during sheet pile driving carried out at a single foundation located approximately 6.2 mi (10 km) southwest of the seal sanctuary (Edrén *et al.* 2010). Similarly, a study conducted by Teilmann *et al.* (2006b) and in the Danish North Sea found fewer harbor and gray seals hauled out at Rødsand seal sanctuary near the Nysted wind farm and observed no seals in the Horns Rev wind farm on days while pile driving was conducted, but abundance was not affected. Skeate *et al*. (2012) also reported a significant decline in haul-out counts of harbor seals located 1.2 mi (2 km) off construction activities at Scroby Sands offshore wind farm (U.K. part of the North Sea) that did not rebound post-construction. In fact, pinniped community shifted from harbor seal dominance prior to construction to gray seal dominance during and after construction.

Harbor seals (*n*=24) were tagged as part of a behavioral study during Lincs wind farm construction in the North Sea (southeast England) (Hastie *et al*. 2015; Russell *et al.* 2016). Seal abundance was reduced overall (19 to 83 percent) during piling across an area of 15.5 mi (25 km) radius from the activity. The closest distance of tagged seals to pile driving varied from 2.9 to 25.1 mi (4.7 to 40.5 km), and the predicted maximum cumulative SELs ranged from 171 to 195 dB re 1lPa2-s. Displacement starting from predicted received levels of between 166 and 178 dB re 1 µPa$_{(p-}$ Displacement response of seals was short-term, limited to piling activity only and within 2 hr of piling ending.

Potential responses of tagged gray seals (*n*=20) to construction of Luchterduinen and Gemini windfarms in the Dutch North Sea was investigated by Aarts *et al.* (2018). Most often gray seals reduced descent speed and reduced their bottom time (i.e., foraging) during pile-driving events, particularly within 22 mi (36 km) from the pile-driving and occasionally at distances well beyond this. There was considerable individual variation in the dive profile as well as in the change in movement, with gray seals moving both towards and away from the pile-driving site, though they swam significantly more often away from the sound source. On average at Gemini, seals would move away from the pile-driving site, at least up to 20.5 mi (33 km). Up to 18.6 mi (30 km), the vast majority of seals moved away from pile-driving (19 out of 25). On one occasion a seal was observed swimming in a large circle at a high speed (~1.8 m/s) for nearly an hour. During another exposure, a seal suddenly changed its course, but the new course was not directed away from pile-driving. On several occasions, seals did move into shallower water during pile-driving, but again, this response was not consistent. Occasionally, a seal would move toward deeper water during pile-driving. Other examples of individual variation include that on different occasions, gray seals were observed to stop resting at the surface; increase their time at the surface; decrease the dive time spent near the maximum depth; increase their time at depth; or show no apparent response. In many cases, no response was observed. This study indicated that a behavioral response by grey seals to pile-driving occurred in response to an SEL of 133 dB re 1 µPa2s. Harbor seal (*n*=9) movements only relative to Gemini windfarm were reported for the same time period by Aarts *et al*. (2018). Harbor seals like gray seals displayed variability in response to pile driving but did have a greater tendency towards shallower dives during piling and were located at further distances (all beyond 12.4 mi [20 km]) of exposure than the gray seals. Some seals showed no clear avoidance of the pile driving site, remaining in the same general area, while others appeared to flee in response to the pile driving towards the Frisian Islands during or after pile driving.

Some information is also available from monitoring reports for construction projects involving pile driving on the U.S. Pacific Coast and in Alaska. There were no reports made by PSOs of overt behavioral responses indicating disturbance from pile driving by harbor seals (e.g., Thorson and Reyff 2006, HDR 2012, ABR, Inc. 2016, Cornick and Seagars 2016; NAVFAC SW 2017, WRA, Inc. 2018, AECOM 2019). Reported observations include vigilance behavior (i.e., looking while sinking in the water in a stationary position). HDR (2012) noted that harbor seals (particularly juveniles) appeared to be attracted to pile driving activities associated with a pile replacement project at Naval Base Kitsap at Bangor (Washington State), and often moved towards the construction area when pile driving was initiated.

In addition to evasive and avoidance behavior, the sound field produced by the pile-driving operation is likely to affect the ability of whales, dolphins, and porpoises to communicate. Communication is an important component of the daily activity of animals and ultimately contributes to their survival and reproductive success. Animals communicate to find food (Stokes 1971, Marler *et al*. 1986, Elowson *et al*. 1991), acquire mates (Stokes 1971, Ryan 1985, Patricelli *et al*. 2002), assess other members of their species (Parker 1974, Sullivan 1984, Owings *et al*. 2002), evade predators (Marler 1955, Greig-Smith 1980, Vieth *et al.* 1980), and defend resources (Falls 1963, Alatalo *et al.* 1990, Zuberbuehler *et al.* 1997). Human activities that impair an animal's ability to communicate effectively might have significant effects on the animals experiencing the impairment.

Communication usually involves individual animals that produce vocalizations or visual or chemical displays for other individuals. Masking, which is discussed separately below, affects animals that are trying to receive acoustic cues in their environment, including cues vocalizations from other members of the animals' species or social group (Dunlop *et al.* 2010). However, anthropogenic noise presents separate challenges for animals that are vocalizing. This subsection addresses the probable responses of individual animals whose attempts to vocalize or communicate are affected by active sonar.

When they vocalize, animals are aware of environmental conditions that affect the "active space" of their vocalizations, which is the maximum area within which their vocalizations can be detected before it drops to the level of ambient noise (Lohr *et al.* 2003, Brenowitz 2004, Brumm *et al.* 2004). Animals are also aware of environment conditions that affect whether listeners can discriminate and recognize their vocalizations from other sounds, which are more important than detecting a vocalization (Marten and Marler 1977, Brenowitz 1982, Brumm *et al.* 2004, Dooling 2004, Patricelli *et al*. 2006, Dunlop *et al.* 2010).

Most animals that vocalize have evolved with an ability to modify their vocalizations (and other signals) to increase the signal-to-noise ratio, active space, and recognizability of those vocalizations in the face of changes in background noise (Cody and Brown 1969, Brumm *et al.* 2004, Patricelli *et al.* 2006, Dunlop *et al*. 2010, Francis and Barber 2013). Signaling animals have been reported to make one or more of the following adjustments to preserve the active space and recognizability of their vocalizations:

1. They adjust the amplitude of their vocalizations (often called the "Lombard effect"). Animals responding in this way increase the amplitude or pitch of their calls and songs by placing more energy into the entire vocalization or, more commonly, shifting the energy into specific portions of the call or song.
2. They adjust the frequency structure of their vocalizations. For example, animals responding in this way adjust the frequency structure of their calls and songs by increasing the minimum frequency of their vocalizations while maximum frequencies remain the same. This reduces the frequency range of their vocalizations and reduces the amount of overlap between their vocalizations and background noise.
3. They adjust the temporal structure of their vocalizations. Animals responding this way adjust the temporal structure of their vocalizations by changing the timing of modulations, notes, and syllables within vocalizations or increasing the duration of their calls or songs.
4. They change when they vocalize. Animals responding in this way change when they vocalize or change the rate at which they repeat calls or songs.

With the exception of the "Lombard effect," these vocal adjustments were first reported in studies of bird vocalizations in urban settings using quiet environments as controls (Cody and Brown 1969, Ficken *et al.* 1974, Brenowitz 1982, Slabbekorn and Peet 2003, Slabbekorn and den Boer-Visser 2006, Slabbekorn and Ripmeister 2008). However, these signal modifications have been reported for a variety of terrestrial mammals as well (Rabin *et al.* 2003, Brumm *et al.* 2004).

Studies of marine mammals have identified the same responses in marine mammals faced with anthropogenic noise. For example, Dahlheim (1987) studied the effects of man-made noise, including ship, outboard engine and oil-drilling sounds, on gray whale calling and surface behaviors in the San Ignacio Lagoon, Baja, California. She reported statistically significant increases in the calling rates of gray whales and changes in calling structure (as well as swimming direction and surface behaviors) after exposure to increased noise levels during playback experiments. Although whale responses varied with the type and presentation of the noise source, she reported that gray whales generally increased their calling rates, the level of calls received, the number of frequency-modulated calls, number of pulses produced per pulsed-call series, and call repetition rate as noise levels increased.

Miller *et al.* (2000) reported that humpback whales stopped vocalizing when exposed to active sonar. For the six humpback whales whose songs they analyzed in detail, songs were 29 percent longer, on average, during the playbacks. Song duration returned to normal after exposure, suggesting that the whale's response to the playback was temporary. Parks *et al.* (2007) reported that surface active groups of North Atlantic right whales would adopt this strategy as the level of ambient noise increased. As ambient noise levels increased from low to high, the minimum frequency of right whale "scream calls" increased from 381.4 Hz (± 16.50), at low levels of ambient noise, to 390.3 Hz (± 15.14) at medium noise levels, to 422.4 Hz (± 15.55) at high noise levels. Surface active groups of North Atlantic right whales would also increase the duration and the inter-call interval of their vocalizations as the level of ambient noise increased.

Holst *et al.* (2007) reported that endangered southern resident killer whales in Haro Strait off the San Juan Islands in Puget Sound, Washington, increased the amplitude of their social calls in the face of increased sounds levels of background noise. Melcón *et al.* (2012) reported that 0.4287 (95 percent CI: 0.3583 to 0.5020) of blue whale vocalizations (d-calls) stopped when the whales were exposed to ship noise off Southern California.

The consequences of these vocal adjustments remain unknown. However, like most other trade-offs animals must make, they are likely to incur costs that affect animal's energy budgets (Patricelli *et al.* 2006, Dunlop *et al*. 2010). For example, vocalizing more loudly in noisy environments may have energetic costs that decrease the net benefits of vocal adjustment and alter bird's energy budgets (Brumm 2004, Wood and Yezerinac 2006). Lambrechts (1996) argued that shifting songs and calls to higher frequencies was also likely to incur energetic costs. In addition, Patricelli *et al.* (2006) argued that females of many species use the songs and calls of males to determine whether a male is an appropriate potential mate (that is, they must recognize the singer as a member of their species); if males must adjust the frequency or temporal features of their vocalizations to avoid masking by noise, they may no longer be recognized by conspecific females (Slabbekorn and Peet 2003, Brumm 2004, Wood and Yezerinac 2006). Fin and sei whales might experience the latter problem because the structures of their vocalizations are similar to one another.

In addition to incurring costs if they modify their signals, animals may also incur costs if they fail to make vocal adjustments in presence of masking noise. Specifically, that failure might cause the animal to experience reduced reproductive success or longevity because it fails to communicate effectively with other members of its species or social group, including potential mates.

Masking

Cetaceans use acoustic signals for a variety of purposes, which differ among species, but include communication between individuals, navigation, foraging, reproduction, and learning about their environment (Erbé and Farmer 2000, Tyack 2000, Dunlop *et al*. 2010). Masking, or auditory interference, generally occurs when sounds in the environment are louder than, and of a similar frequency to, auditory signals an animal is trying to receive. Masking, therefore, is a phenomenon that affects animals that are trying to receive acoustic information about their environment, including sounds from other members of their species, predators, prey, and sounds that allow them to orient in their environment. Masking these acoustic signals can disturb the behavior of individual animals, groups of animals, or entire populations.

Richardson *et al.* (1995) argued that the maximum radius of influence of an industrial noise (including broadband low frequency sound transmission) on a marine mammal is the distance from the source to the point at which the noise can barely be heard. This range is determined by either the hearing sensitivity of the animal or the background noise level present. Industrial masking is most likely to affect some species' ability to detect communication calls and natural sounds (i.e., vocalizations from other members of its species, surf noise, prey noise, etc.; Richardson *et al.* 1995).

Sperm whales have been observed to stop echolocating in the presence of underwater pulses produced by echosounders and submarine sonar (Watkins and Schevill 1975, Watkins *et al.* 1985). They also stop vocalizing for brief periods when codas are being produced by other individuals, perhaps because they can hear better when not vocalizing themselves (Goold and Jones 1995). Sperm whales have moved out of areas after the start of air gun seismic testing (Davis and Farion 1996). Seismic air guns produce loud, broadband, impulsive noise (source levels are on the order of 250 dB) with "shots" every 15 seconds, 240 shots per hour, 24 hours per day during active tests. Because they spend large amounts of time at depth and use low frequency sound, sperm whales are likely to be susceptible to low frequency sound in the ocean (Croll *et al*. 1999). Furthermore, because of their apparent role as important predators of mesopelagic squid and fish, changes in their abundance could affect the distribution and abundance of other marine species.

The echolocation calls of toothed whales are subject to masking by high frequency sound. Human data indicate low frequency sound can mask high frequency sounds (i.e., upward masking). Studies on captive odontocetes by Au *et al.* (1974, 1985, 1993) indicate that some species may use various processes to reduce masking effects (e.g., adjustments in echolocation call intensity or frequency as a function of background noise conditions). There is also evidence that the directional hearing abilities of odontocetes are useful in reducing masking at the high frequencies these cetaceans use to echolocate, but not at the low-to-moderate frequencies they use to communication (Zaitseva *et al.* 1980). David (2006) noted that pile-driving noise has the potential to mask bottlenose dolphin vocalizations at distances up to 40 km, but that the potential impacts from masking are somewhat mitigated by dolphins' directional hearing, the intermittent nature of pile driving, and dolphins' ability to adjust the amplitude and frequency of their vocalizations.

Foote *et al.* (2004) compared recordings of endangered southern resident killer whales that were made in the presence or absence of boat noise in Puget Sound during three time periods between 1977 and 2003. They concluded that the duration of primary calls in the presence of boats increased by about 15 percent during the last of the three time periods (2001 to 2003). They suggested that the amount of boat noise may have reached a threshold above which the killer whales need to increase the duration of their vocalization to avoid masking by the boat noise.

Construction vessel traffic

The installation of wind turbines for the Project will involve installation vessels, dedicated transport vessels, tugboats for turbine transport, anchored hotel vessels, and support vessels (including crew boats), and other support vessels (see Volume I, Section 6). In addition, there will also be helicopter traffic during the turbine installation phase of the Project (Volume I, Section 6). During construction, a few different temporary construction laydown areas and construction ports will be used (see Volume I, Section 4.1.1).

The number of vessels that will be required to install offshore substations will depend on final decisions about how substations will be transported and installed on foundations (foundations and topsides may be transported to installation sites together or separately). In either case, installation vessels will be used to lift topsides onto pre-installed foundations. Primary installation vessels may include self-propelled jack-up vessels, jack-up barges (towed by tugs), sheerleg barges (either self-propelled or towed by tugs), or heavy-lift vessels. Support vessels may be required including tugboats, dredging vessels, crew boats, drilling vessels, and guard boats. Transport vessels may be required including transport barges, each supported by tugs. Helicopters will be used for crew changes and other miscellaneous purposes.

IPFs associated with this traffic include collision risks, vessel noise, and vessel disturbance. The potential impacts of these activities are discussed below.

Risk of collisions with construction vessels

While all marine mammals present in the Project Area at the time of construction are potentially at risk of collision with construction vessels (i.e., "vessel strikes"), a variety of factors influence the probability of these collisions. These include vessel speed, vessel type, and visibility, as well as the animal's size, behavior, and habitat preferences (Laist *et al.* 2001; Douglas *et al.* 2008; Pace 2011 as cited in CSA Ocean Sciences Inc. [CSA] 2020). Vessel strikes to marine mammals have been reported at vessel speeds from 2 to 51 knots, with the majority of lethal strikes or serious injuries caused by vessel speeds above 14 knots (MMS 2007 as cited in CSA 2020). In addition, the most severe or lethal vessel strikes have been found to involve large ships, typically over 262 ft (80 m) in length (Laist et al. 2001). Slow-moving large whales that tend to rest and feed on the surface, most notably the NARW, are frequently involved in vessel collisions (Parks *et al.* 2012). Other large whale species including fin, humpback, minke, sperm, sei, and blue whales are also vulnerable to vessel strikes (Dolman et al., 2006 as cited in CSA 2020). All known vessel strike events involving marine mammals are tracked and reported by NMFS and can play a role in the declaration of a UME event (Hayes et al. 2020). Smaller cetaceans and pinnipeds are also at risk of vessel strikes; however, these species tend to be more agile swimmers and as such are more capable of avoiding collisions with oncoming vessels (MMS, 2007 as cited in CSA 2020).

Despite the risks vessel strikes pose to vulnerable marine mammal species, relatively few quantitative approaches have been developed to estimate the probability of encounters between whales and ships. Vanderlaan et al. (2008) developed a method for estimating the probability of an encounter between NARW and surface vessels in the Bay of Fundy and the Scotia Shelf. More recently, a vessel encounter risk model tool is currently in development which attempts to standardize potential vessel strike impacts to large whales from offshore wind development along the United States Atlantic Outer Continental Shelf and allows users to assess these potential impacts (Barkaszi 2020).

Because of their slow speeds, construction vessels such as installation vessels and tugboats pose minor risks to marine mammals that might occur in the Project Area, and these risks could be further minimized with existing mitigation measures. Because of their higher speeds, smaller vessels pose moderate risks to marine mammals in the Project Area although those risks could also be minimized with existing mitigation measures. In both cases, potential impacts are expected to be short-term and localized.

Vessel noise and disturbance

Numerous studies of interactions between surface vessels and marine mammals have demonstrated that free-ranging marine mammals engage in avoidance behavior when surface vessels move toward them. It is not clear whether these responses are caused by the physical presence of a surface vessel, the underwater noise generated by the vessel, or an interaction between the two (Lusseau 2006). However, several authors suggest that the noise generated during motion is probably an important factor (Blane and Jackson 1994; Evans *et al.* 1992, 1994). These studies suggest that the behavioral responses of marine mammals to surface vessels are similar to their behavioral responses to predators.

As discussed previously, based on the suite of studies of cetacean behavior to vessel approaches (Au and Perryman 1982; Bryant *et al*. 1984; Hewitt 1985; Watkins 1986; Bauer 1986; Au and Green 2000; Würsig *et al*. 1998; Bejder et al. 1999, 2006a, 2006b; Corkeron 1995; Erbé 2000, Félix 2001, Nowacek *et al*. 2001; David 2002; Magalhães *et al.* 2002, Williams *et al.* 2002, 2006, 2009; Ng and Leung 2003; Lusseau 2003, 2006; Richter *et al.* 2003, 2006; Scheidat *et al.* 2004; Goodwin and Cotton 2004; Bain *et al*. 2006; Williams and Ashe

2007; Lusseau and Bejder 2007), the set of variables that help determine whether marine mammals are likely to be disturbed by surface vessels include:

1. *Number of vessels*. The behavioral repertoire marine mammals have used to avoid interactions with surface vessels appears to depend on the number of vessels in their perceptual field (the area within which animals detect acoustic, visual, or other cues) and the animal's assessment of the risks associated with those vessels (the primary index of risk is probably vessel proximity relative to the animal's flight initiation distance).

   Below a threshold number of vessels (which probably varies from one species to another, although groups of marine mammals probably share sets of patterns), studies have shown that whales will attempt to avoid an interaction using horizontal avoidance behavior. Above that threshold, studies have shown that marine mammals will tend to avoid interactions using vertical avoidance behavior, although some marine mammals will combine horizontal avoidance behavior with vertical avoidance behavior (Bryant *et al.* 1984, Kruse 1991, Mattson *et al*. 2005, Nowacek *et al*. 2001, David 2002, Lusseau 2003, Stensland and Berggren 2007, Williams and Ashe 2007);
2. *The distance between vessel and marine mammals* when the animal perceives that an approach has started and during the course of the interaction (Au and Perryman 1982, Hewitt 1985, Kruse 1991, David 2002);
3. *The vessel's speed and vector* (David 2002);
4. *The predictability of the vessel's path*. That is, cetaceans are more likely to respond to approaching vessels when vessels stay on a single or predictable path (Acevedo 1991; Angradi *et al.* 1993; Browning and Harland 1999; Lusseau 2003, 2006; Williams *et al.* 2002, 2006, 2009) than when they engage in frequent course changes (Evans *et al. 1*994, Williams *et al*. 2002, Lusseau 2006)
5. *Noise associated with the vessel* (particularly engine noise) and the rate at which the engine noise increases (which the animal may treat as evidence of the vessel's speed; David 2002, Lusseau 2003, 2006);
6. *The type of vessel* (displacement versus planning), which marine mammals may be interpreted as evidence of a vessel's maneuverability (Goodwin and Cotton 2004);
7. *The behavioral state of the marine mammals* (David 2002; Würsig *et al*. 1998; Lusseau 2003, 2006). For example, Würsig *et al.* (1998) concluded that whales were more likely to engage in avoidance responses when the whales were "milling" or "resting" than during other behavioral states.

Most of the investigations cited earlier reported that animals tended to reduce their visibility at the water's surface and move horizontally away from the source of disturbance or adopt erratic swimming strategies (Corkeron 1995, Notarbartolo di Sciara *et al*. 1996, Nowacek *et al*. 2001, Van Parijs and Corkeron 2001, Williams *et al*. 2002, Lusseau 2003, 2004, 2005*a*). In the process, their dive times increased, vocalizations and jumping were reduced (with the exception of beaked whales), individuals in groups moved closer together, swimming speeds increased, and their direction of travel took them away from the source of disturbance (Edds and Macfarlane 1987, Baker and Herman 1989, Polacheck and Thorpe 1990, Kruse 1991, Evans *et al.* 1992, Lütkebohle 1996, Nowacek *et al.* 1999). Some individuals also dove and remained motionless, waiting until the vessel moved past their location. Most animals finding themselves in confined spaces, such as shallow bays, during vessel approaches tended to move towards more open, deeper waters (Stewart *et al.* 1982, Kruse 1991). It is assumed that this movement would give them greater opportunities to avoid or evade vessels as conditions warranted.

Although most of these studies focused on small cetaceans (for example, bottlenose dolphins, spinner dolphins, spotted dolphins, harbor porpoises, beluga whales, and killer whales), studies of large whales have reported similar results for fin and sperm whales (Notarbartolo di Sciara *et al.* 1996, 2002; David 2002). Baker *et al.* (1983) reported that humpbacks in Hawaii responded to vessels at distances of 1.2 to 2.5 miles (2 to 4 km). Richardson *et al.* (1985) reported that bowhead whales (*Balaena mysticetus*) swam in the opposite direction of approaching seismic vessels at distances between 0.6 and 2.5 miles (1 and 4 km) and engage in evasive behavior at distances under 0.6 miles (1 km). Fin whales also responded to vessels at a distance of about 0.6 mile (1 km) (Edds and Macfarlane 1987).

Some cetaceans detect the approach of vessels at substantial distances. Finley *et al.* (1990) reported that beluga whales seemed aware of approaching vessels at distances of 52 miles (85 km) and began to avoid the approach at distances of 28-37 miles (45-60 km). Au and Perryman (1982) studied the behavioral responses of eight schools of spotted and spinner dolphins (*Stenella attenuata* and *S. longirostris*) to an approaching ship (the NOAA vessel *Surveyor*: 300 ft , steam-powered, moving at speeds between 11 and 13 knots) in the eastern Pacific Ocean (10°15 N lat., 109°10 W long.). They monitored the response of the dolphin schools to the vessel from a Bell 204 helicopter flying a track line ahead of the ship at an altitude of 1,201-1,801 ft (366-549 m) (they also monitored the effect of the helicopter on dolphin movements and concluded that it had no observable effect on the behavior of the dolphin schools). All of the schools continuously adjusted their direction of swimming by small increments to continuously increase the distance between the school and the ship over time. The animals in the eight schools began to flee from the ship at distances ranging from 0.9 to 6.9 nm. When the ship turned toward a school, the individuals in the school increased their swimming speeds (for example, from 2.8 to 8.4 knots) and engaged in sharp changes in direction.

Hewitt (1985) reported that five of 15 schools of dolphin responded to the approach of one of two ships used in his study and none of four schools of dolphin responded to the approach of the second ship (the first ship was the NOAA vessel *David Starr Jordan*; the second ship was the *Surveyor*). Spotted dolphin and spinner dolphins responded at distances between 0.5 to 2.5 nm and maintained distances of 0.5 to 2.0 nm from the ship while striped dolphins allowed much closer approaches. Lemon *et al.* (2006) reported that bottlenose dolphin began to avoid approaching vessels at distances of about 328 ft (100 m).

Würsig *et al.* (1998) studied the behavior of cetaceans in the northern Gulf of Mexico in response to survey vessels and aircraft. They reported that *Kogia* species and beaked whales (ziphiids) showed the strongest avoidance reactions to approaching ships (avoidance reactions in 11 of 13 approaches) while spinner dolphins, Atlantic spotted dolphins, bottlenose dolphins, false killer whales, and killer whales either did not respond or approached the ship (most commonly to ride the bow). Four of 15 sperm whales avoided the ship while the remainder appeared to ignore its approach.

Because of the number of vessels involved in seismic surveys, their slow speeds, the predictability of their track lines (which involve limited course changes), and sounds associated with their engines and displacement of water along their bowline, the available evidence leads us to expect marine mammals to treat seismic vessels as potential stressors. Animals that perceive an approaching potential predator, predatory stimulus, or disturbance stimulus have four behavioral options (see Nonacs and Dill 1990 and Blumstein *et al.* 2003):

a) Ignore the disturbance stimulus entirely and continue behaving as if a risk of predation did not exist;
b) Alter their behavior in ways that minimize their perceived risk of predation, which generally involves fleeing immediately;
c) Change their behavior proportional to increases in their perceived risk of predation which requires them to monitor the behavior of the predator or predatory stimulus while they continue their current activity, or
d) Take proportionally greater risks of predation in situations in which they perceive a high gain and proportionally lower risks where gain is lower, which also requires them to monitor the behavior of the predator or disturbance stimulus while they continue their current activity.

The latter two options are energetically costly and reduce benefits associated with the animal's current behavioral state. As a result, animals that detect a predator or predatory stimulus at a greater distance are more likely to flee at a greater distance (see Holmes *et al.* 1993, Lord *et al.* 2001). Some investigators have argued that short-term avoidance reactions can lead to longer term impacts such as causing marine mammals to avoid an area (Salden 1988, Lusseau 2005b) or alter a population's behavioral budget (Lusseau 2004) which could have biologically significant consequences on the energetic budget and reproductive output of individuals and their populations.

Jones *et al.* (2017) estimated sound exposure levels for tagged harbor seals exposed to commercial shipping noise around the British Isles. Predicted SEL_{cum} (M_{pw}) levels ranged from 170.2 dB re 1µPa^{2}s (95 percent CI 168.4-171.9) to 189.3 dB re 1µPa^{2}s (95 percent CI 172.6-206.0). For 20 of 28 animals in the study, 95 percent CI for SEL_{cum} (M_{pw}) had upper bounds above levels known to induce temporary threshold shift (Jones *et al.* 2017). Automatic Identification System (AIS) data were used from 17 types of commercial, pleasure, and military vessels (n= 1689) in U.K waters from 2014 to 2015. The range of vessel types is like those found in and near the Project Area.

Helicopters associated with the construction phase of the Project also generate noise that has the potential to affect marine mammals, depending on their altitude. Sounds produced by low-flying helicopters might create a sound field that extends within one meter of the ocean's surface. In some cases, marine mammals did not respond to helicopters overpassing them at 1,213 ft (370 m) (Au and Perryman 1982, Hewitt 1985) while in the majority of cases marine mammals exhibited startle or avoidance responses (sudden dives) to helicopter overpasses between 492 and 1,394 ft (150 and 425 m) (Leatherwood *et al.* 1982, Malme *et al.* 1983, Koski *et al.* 1988, Sergeant and Hoek 1988, SRA 1988 as cited in Richardson *et al.* 1991). In all cases, marine mammals returned to their pre-disturbance behavior shortly after the helicopter had passed.

Efroymson and Suter (2001) reviewed the effects of low-altitude overflights (fixed- and rotary-wing aircraft) on pinnipeds, including harbor seals. Seals may react to the sounds and vibrations emitted by low-flying aircraft, the visual image of the aircraft, or both (Efroymson and Suter 2001). The most common reaction of hauled-out seals to low-flying aircraft is to charge into the water, or "flush", from their haul-out location on land. Flushing will not result in interruption of foraging, since seals forage in-water only, or in interruption of nursing/breeding, because New Jersey is well south of the southern extent of the breeding ranges for both harbor and gray seals. Although SPL thresholds for pinnipeds were not available, Efroymson *et al.* (2000) reported distance thresholds at which hauled-out seals will react to overflights. This distance ranges from 492 to 6,562 ft (150 to 2,000 m), with a conservative (90th percentile) distance effects level of 3,773 ft (1,150 m). There is less information about the effect of overflights on seals that are in the water. Depending on the angle of incidence, aerial sound sources do not penetrate well into the water column (Buckingham *et al.* 2002). Therefore, seals underwater would be less likely to be impacted by overflight disturbance, although seals resting at the water's surface would likely detect, and possibly react to, overflights occurring within about 0.6 mile (1 km).

Nevertheless, noise and disturbance associated with surface vessels and helicopter traffic during the construction phase of the Project would likely have little or no measurable impact on the behavior, biology, or ecology of marine mammals exposed to it. In all cases, potential impacts are expected to be short-term and localized.

Seabed Disturbance

The footprint of permanent impacts within the Wind Farm Area would be up to 176 acres (or 0.2 percent of the Wind Farm Area). Monopile foundations for WTGs and the offshore substations (as well as the piled jackets foundation option for the offshore substations) are expected to function as new benthic substrate, which will act much like artificial reefs and attract numerous species of algae, shellfish, finfish and sea turtles (Wilhelmsson *et* *al.* 2006a, Maar *et al*. 2009, Reubens *et al.* 2013b, NRC 1996, Barnette 2017). The areas off New Jersey have minimal hard bottom habitat or structural relief and this addition of new benthic substrate will add habitat diversity.

Harbor and gray seals target both benthic and epibenthic prey, including sand lance, gadids, flatfish, and redfish (*Sebastes spp.*) (Payne and Selzer 1989, Bowen and Harrison 1996, Ampela 2009, Kenney and Vigness-Riposa 2010). Seabed disturbance that kills or displaces these species may prevent seals from accessing potential prey in disturbed areas. However, these impacts are likely to be highly localized and short-lived.

In the longer term, foundations for wind farm structures can create an artificial “reef effect” by serving as substrate for sessile invertebrates, in turn attracting fish and other potential prey species (NRC 1996, Wilhelmsson *et al.* 2006a, Maar *et al*. 2009, Reubens *et al.* 2013b, Barnette 2017). Tagged harbor seals have been observed tracing these structures at sea and exhibiting area-restricted search behavior, an indication of foraging (Russell *et al.* 2014). It should be noted that, should human fishing activities increase as a result of the “reef effect”, increased fishing vessel traffic could increase the risk of collision with and disturbance of marine mammals.

Based on these data, seabed disturbance associated with the placement of WTG and offshore substation foundations will impact relatively small benthic areas that will remain altered for the life of the Project. The loss of this benthic habitat is expected to be offset by the introduction of new, hard-bottom substrate that will support new benthic communities and either attract or have no effect on the distribution or abundance of marine mammals in the Project Area.

Offshore Export Cables and Array Cables

Cable installation involves installation of array cables and substation interconnector cables, and installation of offshore export cables. Vessel traffic associated with cable installation for the Project will include main laying vessels, main burial vessels, dredging vessels, anchor handling tugs, jointing vessels, crew service vessels, diver vessels, and additional support vessels. During the cable laying operation, there will also be daily helicopter traffic between the major vessels and shore. The primary IPFs associated with cable installation that are relevant to marine mammals are in-situ UXO/MEC disposal, risk of collisions with cable-laying and support vessels, associated noise and disturbance, and seabed disturbance caused by the clearing, trenching, and cable-laying process.

UXO/MEC removal noise

For potential impacts related to UXO/MEC removal noise, please see above discussion for Wind Farm Area.

Risk of collisions with cable-laying vessels

During the process of laying cables, cable-laying ships would generally move at speeds ranging from 0.54 to 2 knots (1 to 3.7 km per hour). The ship would reduce speed or stop to maneuver cables into the water and onto the ocean bottom before resuming the cable installation process. Ships moving at these speeds in the open ocean are not likely to strike marine mammals, although a strike is not impossible.

Because of their slow speeds, installation vessels and tugboats pose minor risks to marine mammals that might occur in the Project Area. Because of their higher speeds, smaller vessels pose moderate risks to marine mammals in the Project Area. In both cases, potential impacts are expected to be short-term and localized.

Vessel noise and disturbance

Noise and disturbance associated with surface vessels and helicopter traffic during the installation of the offshore export and array cables would have little or no measurable impact on the behavior, biology, or ecology of marine mammals exposed to it. In all cases, potential impacts are expected to be short-term and localized.

Seabed disturbance

The cable-laying process involves pre-construction surveys; clearing the seabed of UXO/MEC, boulders, and sandwaves will occur as needed. If array cables will cross third party infrastructure, such as existing cables, both the existing infrastructure and the cable installed will be protected with a separation layer as described in Volume I. After cables are laid, they may be protected by placing additional cable protection.

As noted in Section 2.2.5.2.1, a study of the benthic community following installation of 59 mi (95 km) of subsea cable in California showed that there were few changes in the distribution or abundance of benthic fauna (epifauna and infauna) and that the cable had had minimal statistically-significant effect on the benthic community along the cable route (Kogan *et al.* 2006). In some instances, the presence of the cable had created habitat diversity that increased the density of sea anemones (Actiniarians) and some fish along the cable's route. As discussed previously, this increased diversity probably exemplifies the "reef effect," which refers to the introduction of a new hard bottom habitat that has been shown to attract numerous species of algae, shellfish, finfish and sea turtles to new benthic habitat (Wilhelmsson *et al.* 2006a, Reubens *et al.* 2013b).

Based on these data, the cable-laying process will impact a relatively small area along cable routes and the seabed is expected to recover quickly from the disturbance. The short-term loss of benthic habitat along the cable route is not expected to affect the distribution or abundance of marine mammals in the Project Area or how they use the benthic habitat along cable routes.

Entanglement risks

Several investigators have studied the potential risk of entanglement between marine vertebrates and submarine cables (ICPC (no date), Heezen 1957). The marine mammals that had become entangled were believed to have encountered slack cable as they swam along the ocean floor; when they struggled to break free of the cable, they became more entangled or broke the cable (Heezen 1957). Since 1960, the ICPC has no reports of whales becoming entangled in submarine cables or of cables that required repairs as a result of such entanglements. The ICPC attributes the difference to improved methods of installing submarine cable (for example, installing cable under tension) and burying the cable at greater depths.

Benjamins *et al.* (2014) assessed the potential risk of phocid pinnipeds becoming entangled in mooring systems and power cables. Based on their foraging strategies, body size, body flexibility, and ability to detect mooring devices, the potential risk of pinnipeds becoming entangled in these systems is apparently small, at least when these systems are tethered and taut from being in active use. However, gray seals and harbor seals feed on benthic and epibenthic prey (Payne and Selzer 1989, Bowen and Harrison 1996, Ampela 2009, Kenney and Vigness-Riposa 2010), and commonly become entangled in discarded fishing gear, or "ghost gear", that accumulates on the seabed (Bogomolni *et al.* 2010). Should construction activities result in marine debris consisting of discarded tether lines, or other mooring systems or cables which become slack when discarded, these could pose an entanglement risk for harbor and gray seals, since they could become involved in discarded gear during foraging activities.

Because cables associated with the Project will generally be buried, they do not pose any risk of entangling marine mammals. Cables that are not buried are expected to be large enough and installed with sufficient tension to avoid entangling marine mammals.

2.2.7.2.2 Operations and Maintenance

The three primary IPFs associated with the operations and maintenance phase of the Project can be divided into the following sub-categories: noise produced by operating turbines, risk of collision associated with operations and maintenance vessels, and noise and disturbance produced by these vessels. Collision risk and vessel disturbance are similar to what has been described for construction in the preceding section, though as outlined in Volume I, more vessel traffic is associated with construction than with operations and maintenance, and therefore there is less of a risk to marine mammals during the operations and maintenance phase. Noise produced by operating turbines is discussed below.

Wind Farm Area and Offshore Export Cable Corridors

Noise

Once installed, the operation of the WTGs is not expected to generate substantial sound levels above baseline sound in the area. For the Cape Wind Project, MMS (now BOEM) reported existing underwater sound levels for the design condition were 107.2 dB (re 1 μPa[17]), the calculated sound level from operation of a WTG was 109.1 dB (re 1 μPa) at 65.6 ft (20 m) from the monopile (i.e., about 1.9 dB above baseline sound levels) which dropped to 107.5 dB (re 1 μPa) at 164 ft (50 m) and to ambient levels at about 360 ft (110 m) (MMS 2008).

With one exception, studies of behavioral responses of whales, dolphins, and porpoises to operating wind turbines suggest that marine mammals avoid the sound field associated with the construction phase, but return to pre-disturbance densities, distributions, and abundances once the wind farms are operating (Teilmann *et al.* 2006a; Tougaard *et al.* 2003a, 2003b, 2005, 2009; Bailey *et al*. 2010a; Scheidat *et al.* 2011; Dähne *et al.* 2014; Vallejo *et al.* 2017). In almost all of these cases, harbor porpoises occurred in the area surrounding the sound field and returned to the ensonified area after pile-driving activities stopped (Vallejo *et al.* 2017).

2.2.7.2.3 Decommissioning

Wind Farm Area and Offshore Export Cable Corridors

In general, the IPFs associated with this phase of the Project fall into the following sub-categories: noise produced by pile cutting activities and disturbance associated with their removal, risk of collision associated with vessels associated with decommissioning, and noise and disturbance produced by these vessels.

Noise from removal activities

Pile driving would not occur during decommissioning. Noise during decommissioning would include cutting the piled foundations, most likely using acetylene cutting torches, mechanical cutting, high-pressure water jets, and vacuum pumps. Sound pressure levels are not expected to be higher than construction vessel noise (generally between 150 dB re 1 μPa and up to 180 dB re 1 μPa; Pangerc *et al.* 2016) (BOEM 2018a). Noise from decommissioning activities could cause marine mammals to avoid or leave the Project Areas; this disturbance would be short-term and temporary.

Vessel noise and disturbance

Decommissioning activities are expected to result in comparable levels of vessel traffic as construction. Potential impacts of vessel traffic to marine mammals are expected to be similar to Project construction as discussed above. Noise and disturbance associated with surface vessels and helicopter traffic during the decommissioning phase of the Project should have little or no measurable impact on the behavior, biology, or

[17] Decibels are a relative unit, indicating the magnitude of a level relative to a reference level. For in-air sound, the reference is typically 20 μPa, while for underwater sound the reference is typically 1 μPa. Therefore, decibel levels for airborne and waterborne noise are not directly comparable.

ecology of marine mammals exposed to it. In all cases, potential impacts are expected to be short-term and localized.

Collision risks

Because of their slow speeds, decommissioning vessels and tugboats should pose minor risks to marine mammals that might occur in the Project Area. Because of their higher speeds, support vessels pose moderate risks to marine mammals in the Project Area. In both cases, potential impacts are expected to be short-term and localized.

Entanglement risks

Should decommissioning activities result in marine debris consisting of discarded tether lines, or other mooring systems or cables which become slack when discarded, these could pose an entanglement risk for harbor and gray seals, since they could become involved in discarded gear during foraging activities.

2.2.7.2.4 Summary of Potential Project Impacts on Marine Mammal Resources

The IPFs affecting marine mammals include seabed disturbance, noise, and traffic.

Operation and maintenance of the Project may result in long-term impacts due to collision risks and disturbance associated with Project-related vessel traffic. Other potential impacts would be short-term. Specifically, potential temporary impacts to marine mammals would result from underwater noise associated with the construction of Project structures (e.g., pile driving, in-situ UXO/MEC disposal); construction related collision risks, noise, and disturbance associated with construction vessel traffic; and seabed disturbance resulting from construction, maintenance, or decommissioning activities. Temporary noise from pile driving is anticipated to be the most important IPF for marine mammals. Construction related direct impacts to marine mammals from UXO/MEC disposal activities during site preparation could include serious injury/mortality, acoustic harassment injury, acoustic harassment behavioral, and less likely behavioral harassment.

2.2.7.3 Avoidance, Minimization, and Mitigation Measures

The proposed measures for avoiding, minimizing, reducing, eliminating, and monitoring environmental impacts for the Project, including preparation of a PSMMP, are presented in **Table 1.1-2**.

2.2.8 Sea Turtles

Five sea turtle species have been reported to occur in the Project Area: green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), Kemp's ridley (*Lepidochelys kempii*), leatherback (*Dermochelys coriacea*), and loggerhead (*Caretta caretta*) sea turtles. There are no known nesting locations along the coast of New Jersey, other than a few reports of animals coming ashore without successfully nesting. Although sea turtles have been reported in these waters throughout the year, most sea turtles are more likely to occur there from spring through autumn as they migrate through New Jersey waters to foraging areas in the North Atlantic and wintering area near Cape Hatteras (NJDEP 2010b). Therefore, sea turtles that occur in the Project Area would be migrating through the Project Area or foraging in the area. All of these turtles are listed as endangered or threatened pursuant to the ESA and by the State of New Jersey.

Although hawksbill sea turtles have been reported from the Project Area and are listed as endangered by the State of New Jersey, they rarely occur north of Florida. They were not observed in NJDEP's Ocean/Wind Power Ecological Baseline Studies (NJDEP 2010b), the AMAPPS study (Palka *et al.* 2017), or the other baseline data collection studies discussed previously in this document. There are also no records of them having stranded along the New Jersey coast since 1995 (unpublished Marine Mammal Stranding Center

[MMSC] data). Based on these data, these turtles are not likely to be exposed to the activities or IPFs associated with the Project and will not be considered further in this document.

Similarly, the Project Area does not overlap with critical habitat that has been designated for sea turtles. Critical habitat for green sea turtles has been designated on Culebra Island, Puerto Rico (63 Federal Register [FR] 46693), for hawksbill sea turtles on Mona and Monita Islands, Puerto Rico (63 FR 46693), and for leatherback sea turtles on Sandy Point on Saint Croix in the U.S. Virgin Islands (44 FR 17710). Therefore, critical habitat for sea turtles will not be discussed further in this document.

2.2.8.1 Affected Environment

This section summarizes information on the sea turtle species in the Project Area. A more detailed narrative is presented in Appendix K. A number of visual surveys have been completed in and around the Project Area starting in the early 2000s to monitor the occurrence and abundance of sea turtles (NJDEP 2010b [**Figure 2.2.8-1**], Palka *et al.* 2017, NMFS 2017a).

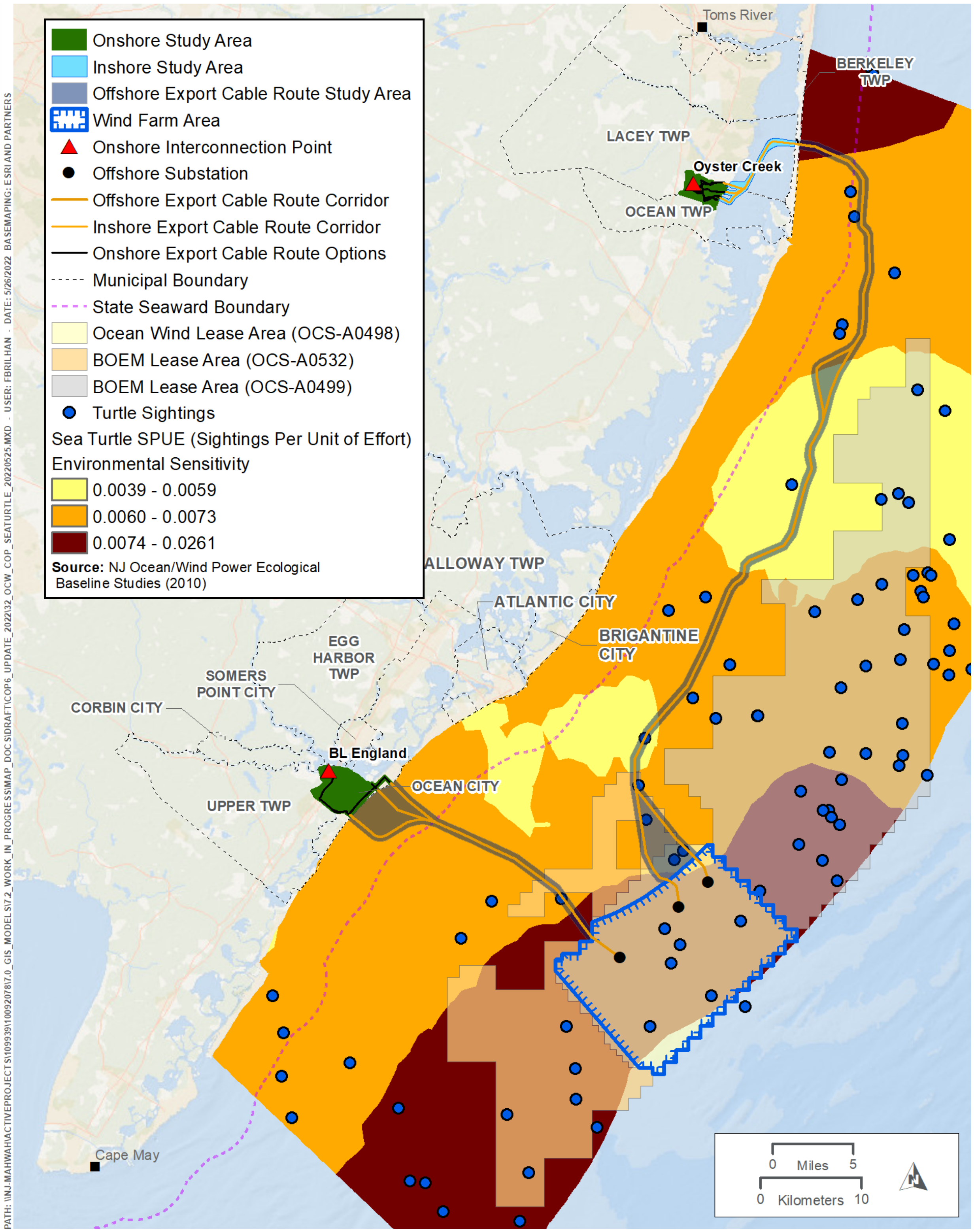


Figure 2.2.8-1. Sea turtle sighting locations and sightings per unit effort (sightings per km), shown in relation to the Project Area, during NJDEP (2010b) surveys conducted from January 2008 through December 2009.

2.2.8.1.1 Threatened and Endangered Sea Turtles within the Project Area

The narratives that follow summarize information necessary to understand patterns of sea turtle occurrence in the Project Area, pre-existing IPFs (or stressors) that affect sea turtles in the Project Area, their status and trends in the Project Area, and information necessary to evaluate potential impacts. For the latter, these narratives present information on the diving and social behavior of the different sea turtles and their hearing and vocalizations. More detailed information is presented in Appendix K or is available in the general literature - for example, recovery plans (NMFS and USFWS 1992, 2008, NMFS *et al.* 2011,USFWS and NMFS 1991) and five-year status reviews for these sea turtles (NMFS and USFWS 2013, 2015; Seminoff *et al.* 2015; Conant *et al*. 2009).

Green Sea Turtle

Green turtles are found in the Pacific Ocean, Atlantic Ocean, Indian Ocean, Caribbean Sea, and Mediterranean Sea, primarily in tropical or, to a lesser extent, subtropical waters. Green sea turtles in the Project Area belong to the North Atlantic DPS of green sea turtles and listed as threatened (81 FR 20057; see Appendix K for more information on the species' listing).

Green turtles are generally associated with warmer water masses and appear most frequently in U.S. coastal waters with temperatures exceeding 18°C (Stinson 1984). Because of their association with warm waters, green turtles are typically found in New Jersey waters during the summer. Green turtles do not nest on beaches in the Project Area. Instead they forage on marine algae and marine grasses (CWFNJ 2018b).

In the western Atlantic Ocean, green turtles are commonly associated with drift lines or surface current convergences which commonly contain floating *Sargassum* capable of providing small turtles with shelter and sufficient buoyancy to raft upon (NMFS and USFWS 1991, 1992). These turtles rest underwater in coral recesses, the underside of ledges, and sand bottom areas that are relatively free of strong currents and disturbance from natural predators and humans.

The MMSC in New Jersey rescued eight green turtles between 1995 and 2005 and another 17 between 2013 and 2018 (see Appendix K). Of the eight green turtles rescued between 1995 and 2005, six had evidence of human interactions including with fishing activities, boat strike, and impingement on a power plant grate (Schoelkopf 2006). In 2017 one green turtle had evidence of human interactions.

Kemp's Ridley Sea Turtle

Adult Kemp's ridley turtles are restricted to the Gulf of Mexico in shallow near shore waters, although adult-sized individuals sometimes are found as far north as the Grand Banks and Nova Scotia (Bleakney 1955, Márquez 2001, Watson *et al.* 2004). Adult females rarely leave the Gulf of Mexico and adult males do not migrate. Juveniles feed along the east coast of the United States up to the waters off Cape Cod, Massachusetts (Spotila 2004). A small number of individuals reach European waters (Brongersma 1972, Spotila 2004) and the Mediterranean (Pritchard and Marquez-M. 1973). Kemp's ridley sea turtles were listed as endangered on December 2, 1970 (35 FR 18320; see Appendix K for more information on the species' listing). No DPS or subpopulations are currently recognized.

Juvenile Kemp's ridley sea turtles are the second most abundant sea turtle in the mid-Atlantic region from New England, New York, and the Chesapeake Bay, south to coastal areas off North Carolina. Juvenile Kemp's ridley sea turtles migrate into the North Atlantic during May and June and forage for crabs in submerged aquatic vegetation (Keinath *et al*. 1987, Musick and Limpus 1997). In the fall, they migrate south along the coast, forming one of the densest concentrations of Kemp's ridley sea turtles outside of the Gulf of Mexico (Musick and Limpus 1997).

Kemp's ridley turtles forage in a variety of benthic habitat types, including seagrass beds (Byles 1988; Carr and Caldwell 1956), oyster reefs (Schmid 1998), sandy bottoms (Morreale *et al.* 1992), mud bottoms (Ogren 1989; Schmid 1998), or complexes of these communities (Ogren 1989; Rudloe *et al*. 1991). In New Jersey, Kemp's ridley sea turtles are typically found in shallow coastal waters in the summer and fall where they forage on mollusks and crustaceans (CWFNJ 2018b).

The MMSC in New Jersey rescued 45 Kemp's ridley turtles each year between 1995 and 2005 and another 15 between 2013 and 2018 (see Appendix K). Of the turtles rescued between 1995 and 2005, 18 percent had become impinged on power plant grates, 4 percent had been struck by boat propellers, and 20 percent showed signs of other impacts (Schoelkopf 2006).

Leatherback Sea Turtle

Leatherback turtles are found in the Pacific Ocean, Atlantic Ocean, Indian Ocean, Caribbean Sea, and Mediterranean Sea. Leatherback sea turtles are highly migratory, exploiting convergence zones and upwelling areas in the open ocean, along continental margins, and in archipelagic waters (Morreale *et al.* 1994, Eckert 1998, Eckert 1999). In the North Atlantic Ocean, leatherback turtles regularly occur in deep waters (>328 ft or 100 m) and have been reported in depths ranging from 3 to 13,618 ft, with a median sighting depth of 131.6 ft (CeTAP 1982). They occur in waters ranging from 44.6 °F to 81 °F (7 to 27.2 °C) (CeTAP 1982). They can be found in the coastal waters of New Jersey throughout the year, but primarily in the summer and fall where they forage on soft-bodied animals such as jellyfish and sea squirts (CWFNJ 2018b).

Leatherback sea turtles were listed as endangered on December 2, 1970 (35 FR 18320; see Appendix K for more information on the species' listing). No DPS or subpopulations are currently recognized although the NMFS and USFWS have been petitioned to list leatherback turtles in the Northwest Atlantic as a DPS.

The MMSC in New Jersey rescued 177 leatherback turtles between 1995 and 2005 and another 10 between 2013 and 2018 (see Appendix K). Of the turtles rescued in this time interval, 14 percent had been struck by boat propellers, 8 percent had an interaction with fishery equipment, and 2 percent had been struck by a boat (Schoelkopf 2006).

Loggerhead Sea Turtle

Loggerhead sea turtles are found in tropical and temperate regions of the Pacific Ocean, Atlantic Ocean, Indian Ocean, Caribbean Sea, and Mediterranean Sea. Loggerhead turtles in the Project Area belong to the North Atlantic DPS of loggerhead turtles and are listed as threatened (76 FR 58868; see Appendix K for more information on the species' listing).

Loggerhead turtles commonly occur throughout the inner continental shelf from Florida through Cape Cod (Massachusetts). However, there is a seasonal pattern to their occurrence: they tend to be associated with water masses with surface temperatures between 44.6° and 86°F (7 ° and 30 °C) with a stronger associated with temperatures of about 51.8 °F (11 °C) (Shoop and Kenney 1992, Epperly *et al.* 1995, Braun and Epperly 1996). Aerial surveys conducted over the continental shelf reported loggerheads at water depths of 72 to 161 ft (22 to 49 m) (Shoop and Kenney 1992).

Using geostatistical mixed effects models, Winton *et al*. (2018) estimated the distribution and density of satellite-tagged loggerhead turtles in shelf waters along the U.S. Atlantic coast and found that predicted spatial distribution of tagged loggerheads was concentrated in the region of central Florida to New Jersey. From May to September, predicted densities of tagged turtles were highest in the shelf waters from Maryland to New Jersey, and from November to April, the highest densities occurred on the shelf off Cape Hatteras, North Carolina.

The MMSC in New Jersey rescued an average of 47 loggerhead turtles each year between 1995 and 2005 and another 138 between 2013 and 2018 (see Appendix K). Of the loggerhead turtles rescued between 1995 and 2005, 16 percent had been struck by propellers, 3.9 percent had evidence of boat collisions, and 3.7 percent had evidence of fisheries interactions (Schoelkopf 2006).

2.2.8.2 Potential Project Impacts on Sea Turtles

The Project Description (Volume 1) section of this COP describes the routine activities associated with the construction, operations and maintenance, and decommissioning phases of the Project. The IPFs associated with these activities that are relevant to the sea turtles that are expected to occur in the Project Area (green, Kemp's ridley, leatherback, and loggerhead sea turtles) are:

- Noise
- Vessel traffic
- Seabed disturbance

Specifically, the IPFs are (1) underwater noise associated with the construction or installation of Project structures, and noise and blast impulse within the direct vicinity of the UXO/MEC disposal activities during site preparation, (2) collision risks, noise, and disturbance associated with Project-related vessel traffic, (3) seabed disturbance. Two other potential IPFs - suspended sediment and EMF - have been discussed in the literature. However, based on the information available and using the variables discussed previously (probability of exposure, detectability; duration; spatial extent; and severity), suspended sediments and EMF resulting from routine activities associated with Project construction, operations and maintenance, and decommissioning would have little or no measurable impact on the behavior, physiology, and social ecology of sea turtles that might be exposed to these IPFs. As a result, suspended sediments and EMF will not be considered further.

2.2.8.2.1 Construction

The three primary IPFs associated with the construction phase of the Project can be divided into the following sub-categories: pile-driving noise, risk of collision with surface vessels during construction, noise produced by construction vessels, disturbance created by construction vessels, and alteration of benthic habitat.

The data available on the potential impacts of these IPFs on sea turtles is very limited. There are no studies of the effects of impulsive and continuous noise sources, such as pile driving, on sea turtles. Some data are available on interactions between sea turtles and physical structures constructed below the ocean surface (Gitschlag 1992, Gitschlag *et al.* 1997, Lohoefener *et al.* 1990). Fewer data are available on sea turtle hearing (Bartol and Ketten 2006, Bartol and Musick 2003, Bartol and Ketten 2006, Dow Piniak *et al.* 2012, Wever 1978, Wever and Vernon 1956) and are summarized in Popper *et al.* (2014). There are some data on the response of sea turtles to acoustic exposures, particularly seismic airguns (McCauley *et al.* 2000, Holst *et al.* 2007, Weir 2007, DeRuiter and Doukara 2012) although those data only reflect the responses of a small number of individuals. Data on the response of sea turtles to vessel noise and disturbance are the most limiting and generally consist of a single study (Hazel *et al.* 2007).

Wind Farm Area

The primary IPFs associated with the construction of WTGs and offshore substations include pile-driving noise, in-situ UXO/MEC disposal, and vessel traffic and the collision risks, disturbance, and noise associated with it. The addition of scour protection for WTGs and cables, as well as the benthic impacts of the substation foundations, was discussed in Section 2.2.5.2. However, the loss of this benthic habitat is expected to be offset by the introduction of new, hard-bottom substrate that will support new benthic communities and either attract or have no effect on the distribution or abundance of sea turtles in the Project Area.

Pile-driving and UXO/MEC removal noise

Ocean Wind conducted sound propagation modeling for anticipated pile-driving activities associated with Project construction, and results include distances to sound isopleths associated with behavioral and physiological impacts on sea turtles (Appendix R-2). In-situ disposal of UXO/MEC has the potential to affect sea turtles. Associated noise impacts are expected to be short term and direct within the direct vicinity of the disposal activities. Low order (deflagration) or high order (detonation) in-situ disposal of UXO/MEC has the potential to affect sea turtles by serious injury/mortality, acoustic harassment injury, acoustic harassment behavioral, and less likely behavioral harassment. Ocean Wind also conducted modeling for UXO/MEC removal associated with Project construction site preparation (Appendix R-2).

Adult sea turtles appear to hear sounds in frequencies ranging from 50 Hz to 1,200 Hz; juvenile sea turtles can hear frequencies up to 1,600 Hz (Ridgway *et al*. 1969; Bartol and Ketten 2006; Dow Piniak *et al*. 2012, Bartol *et al*. 1999; Lavender *et al*. 2012, 2014; Martin *et al*. 2012). Ridgway *et al*. (1969) measured the cochlear potential of three Pacific green turtles and reported best in-air hearing sensitivity of 300-500 Hz with an effective hearing range of 60-1,000 Hz. Moein *et al.* (1994) used low frequency (20-80 Hz) sounds to induce startle responses in loggerhead turtles. He suggested that sea turtles have a range of best hearing from 100-800 Hz, an upper limit of about 2,000 Hz, and serviceable hearing abilities below 80 Hz. Lenhardt *et al.* (1996) used a behavioral "acoustic startle response" to measure the underwater hearing sensitivity of one juvenile Kemp's ridley and one juvenile loggerhead turtle to a 430-Hz tone. They concluded that the underwater hearing of both sea turtles was about 10 dB less sensitive than their in-air hearing. More recently, Bartol *et al*. (1999) measured the auditory evoked potentials of 35 juvenile animals and concluded that their effective hearing range is 250-750 Hz with most sensitive hearing at 250 Hz. Although these data are based on a small number of individuals and, therefore, may not be representative of all sea turtle species and life stages, they suggest that sea turtles are likely to hear sounds produced by pile driving.

A search of the published literature and agency reports did not identify sea turtle deaths or injuries caused by impact or vibratory pile driving. Underwater detonations are known to kill or injure sea turtles (Klima *et al*. 1988; Gitschlag and Herczeg 1994; Viada *et al*. 2008); however, those impacts appear to result primarily from barotrauma associated with shock waves produced by underwater detonations. McCauley *et al*. (2000) reported that sea turtles exposed to seismic airguns increased their swimming speeds at received levels of 166 dB re 1μPa RMS and exhibited behavioral avoidance at received levels greater than 175 dB re 1μPa RMS. Sea turtles have also been reported to exhibit agitated behavior when exposed to seismic airguns or avoid sound fields produced by those airguns (Holst *et al*. 2007; Weir 2007; DeRuiter and Doukara 2012). However, Weir (2007) made it clear that the source of the turtles' agitation could not be determined.

Absent empirical data, some assessments have used low-frequency cetaceans as surrogates to develop criteria for TTS for sea turtles (Finneran and Jenkins 2012). However, other investigators argued that fish that do not hear well would be better surrogates for sea turtle hearing (Popper *et al*. 2014). The latter investigators argued that sea turtle's rigid anatomy may protect them from the impacts of lower energy impulsive sounds (Madin 2009, Popper *et al*. 2014).

Nevertheless, Popper *et al*. (2014) recommended using acoustic exposures of 210 dB SEL_{cum} or greater than 207 dB peak as thresholds for potential sea turtle mortality and mortal injuries. They argued that the risk of "recoverable injury" and TTS was high when sea turtles were near pile-driving operations but was low at greater distances. They concluded that the risks of masking and behavioral impacts were high when sea turtles were near pile-driving operations, moderate at intermediate distances, and low at greater distances. In contrast, an acoustics tool developed by NMFS' Greater Atlantic Regional Office (2018), following the McCauley *et al*.

(2000) data, uses 166 dB re 1 μPa^2 RMS as the threshold for behavioral impacts to sea turtles and 180 dB re 1 μPa^2 RMS for physiological (injury) impacts.

Distances to the injury threshold recommended by Popper *et al*. (2014; 207 dB re 1 μPa^2, unweighted) ranged from <32 ft to 243 ft (<10 m to 74 m) from the pile source (Tetra Tech 2016a). During the 2015 Block Island pile driving operations, distances to this behavioral threshold ranged from 3,314 ft to 7,382 ft (1,010 m to 2,250 m) from the pile source (Tetra Tech 2016a).

The limited information available suggests that, based on its detectability, duration, spatial extent, and severity, pile driving would have little or no measurable impact on the hearing of sea turtles that might be exposed to the sound field. Pile-driving would be expected to have detectable, short-term impacts on the behavior of sea turtles that might be exposed within 0.6 mi to 1.2 mi (1 km to 2 km) of pile driving operations when those sea turtles are submerged and it would have detectable, lasting impacts on the physiology of sea turtles that might occur with 246 ft (75 m) of pile driving operations. However, because of the amount of surface and subsurface disturbance produced by activities associated with pile-driving operations, the probability of sea turtles occurring within 246 ft (75 m) of pile driving operations is anticipated to be low.

Construction Vessel Traffic

The installation of WTGs will involve installation vessels, dedicated transport vessels, tugboats for turbine transport, anchored hotel vessels, and support vessels (including crew boats), and other support vessels (Volume I, Section 6). In addition, there will be helicopter traffic during the turbine installation phase of the Project (Volume I, Section 6).

The number of vessels that will be required to install substations will depend on final decisions about how substations will be transported and installed on foundations (foundations and topsides may be transported to installation sites together or separately). In either case, primary installation vessels will be used to lift topsides onto pre-installed foundations. Primary installation vessels may include self-propelled jack-up vessels, jack-up barges (towed by tugs), sheerleg barges (either self-propelled or towed by tugs), or heavy-lift vessels. Support vessels may be required including tugboats, dedicated dredging vessels, crew boats, drilling vessels and guard boats. Transport vessels may be required including transport barges, each supported by tugs. Helicopters may be used for crew changes and other miscellaneous purposes.

IPFs associated with this traffic include collision risks and vessel noise and disturbance. The potential impacts of these activities are discussed below.

<u>Risk of collisions with construction vessels</u>

Sea turtles spend at least 20 to 30 percent of their time at the ocean surface (Lutcavage *et al*. 1997) during which they would be vulnerable to being struck by vessels or struck by vessel propellers. Vessel strikes and injuries to sea turtles from boats within New Jersey is not uncommon. In 2017, 19.6 percent of the sea turtles that stranded along the coast of New Jersey had evidence of interactions with vessels (boat or propeller strikes). By November 2018, 23 percent of the stranded turtles had evidence of boat or propeller strikes. Variables that contribute to the likelihood of a collision include vessel speed, vessel size and type, and visibility (Southeast Fisheries Science Center 2018).

Sea turtles are able to avoid collisions with slow-moving (<5 knots) vessels. The most informative study of the relationship between ship speed and collision risk was conducted on green sea turtles (Hazel *et al*. 2007). In that study, green turtles avoided approaching vessels at distances of 39 ft (12 m); the proportion of turtles that avoided those vessels decreased as vessel speeds increased. Turtles fled frequently in encounters with vessels moving at speeds of 2.2 knots (4 km/hr), infrequently in encounters with vessels moving at moderate speeds (5.9 knots or 11 km/hr), and rarely in encounters with a fast vessel (10.3 knots or 19 km/hr; Hazel *et al*.

2007). It is important to note that these speeds are based on sea turtle behavior in relatively warm water; cold water temperatures would decrease their ability to avoid vessels moving at even slow speeds.

Increased vessel traffic associated with construction and installation will be relatively short-term and localized and is anticipated to represent a negligible addition to normal traffic in the area. The larger vessels associated with WTG installation move slowly over short distances. Transport vessels will travel to and from the Wind Farm Area over the duration of the Project. Ocean Wind is developing a PSMMP in coordination with regulatory agencies and has developed APMs associated with construction and operational measures (Appendix AA). With the implementation of environmental protection measures included in APMs and the PSMMP, the probability of a strike would be reduced, and therefore, an adverse impact to sea turtles caused by vessel traffic is considered unlikely to occur.

Vessel noise and disturbance

Data on the response of sea turtles to vessel noise and disturbance are very limited. Hazel *et al*. (2007) reported that sea turtles reacted to approaching vessels in a variety of ways. Turtles lying on the seabed launched upwards at a shallow angle and began swimming when vessels approached. The majority of the turtles swam away from the vessel while some swam along the vessel's track and some crossed in front of the vessel's track before swimming away. Sea turtle reaction time was greatly dependent on the speed of the vessel; sea turtles were able to react faster to slower moving vessels than to faster moving vessels. All of these responses were short-term responses that did not seem likely to have adverse long-term consequences for the individual sea turtles.

Although sea turtles have been observed to avoid surface vessels, Hazel *et al*. (2007) argued that it was the vessel's movement, not the vessel's noise, which caused the avoidance behavior. Therefore, surface vessel noise is expected to cause minimal behavioral disturbance to sea turtles. If a sea turtle detects a surface vessel (whether or not the turtle actually hears the vessel) and avoids it, or has a temporary stress response from the noise disturbance, these responses are expected to be temporary and only endure while the vessel passes through the area where the sea turtle encountered it.

Helicopters associated with the construction phase of the Project also generate noise that has the potential to affect sea turtles, depending on their altitude. Sounds produced by low-flying helicopters might create a sound field that extends within 3 ft (1 m) of the ocean's surface. Sea turtles located at or near the ocean's surface may exhibit startle reactions to helicopter overflights or to the currents and waves helicopters produce while hovering. Nevertheless, noise and disturbance associated with surface vessels and helicopter traffic during the construction phase of the Project would have little or no measurable impact on the behavior, biology, or ecology of sea turtles exposed to it.

Offshore Export Cables and Array Cables

Cable installation involves installation of array cables, substation interconnector cables and offshore export cables. Vessel traffic associated with cable installation for the Project will include main laying vessels, main burial vessels, dredging vessels, anchor handling tugs, jointing vessels, crew service vessels, diver vessels, and additional support vessels (see Volume I, Section 6 for number of vessels involved in the different operations). During the cable laying operation, there will also be daily helicopter traffic between the major vessels and shore. The primary IPFs associated with cable installation that are relevant to sea turtles are risk of collisions with cable-laying and support vessels, associated noise and disturbance, and seabed disturbance caused by the clearing (e.g., in-situ UXO/MEC disposal), trenching, dredging, and cable-laying process.

Risk of collisions with cable-laying vessels

During the process of laying cables, cable-laying ships would generally move at speeds ranging from 0.5 to 2 knots (1 to 3.7 km per hour). The ship would reduce speed or stop to maneuver cables into the water and onto the ocean bottom before resuming the cable installation process. Ships moving at these speeds in the open ocean are not likely to strike a sea turtle, although a strike is not impossible.

As discussed above, vessel speed appears to be the primary factor that determines whether sea turtles are likely to be struck by surface vessels. Although the data available on the response of sea turtles to vessels are limited, they suggest that slow-moving vessels associated with the cable-laying activities have minimal risk of striking sea turtles because of their slow speeds. Slow-moving vessels associated with the installation of wind turbines and offshore substations have little or no risk of striking sea turtles. With the implementation of environmental protection measures included in APMs and the PSMMP (Appendix AA), the probability of a strike would be reduced, and therefore, an adverse impact to sea turtles caused by vessel traffic is considered unlikely to occur.

Seabed disturbance

Installation of cable systems and seafloor levelling (e.g., sandwave clearance) will result in some disturbance of the seabed. As noted in Volume I, cables will be installed via jet plow, mechanical plow, and/or mechanical trenching. Clearing the seabed of UXO/MEC and boulders will also occur as needed. If array cables must cross third party infrastructure, such as existing cables, both the existing infrastructure and the cable installed will be protected with a separation layer as described in Volume I. After cables are laid, they may be protected by placing additional cable protection.

As noted in Section 2.2.5.2.1, a study of the benthic community following installation of 59 mi (95 km) of subsea cable in California showed that there were few changes in the distribution or abundance of benthic fauna (epifauna and infauna) and that the cable had had minimal statistically-significant effects on the benthic community along the cable route (Kogan *et al.* 2006). In some instances, the presence of the cable had created habitat diversity that increased the density of sea anemones (Actiniarians) and some fish along the cable's route. As discussed previously, this increased diversity probably exemplifies the "reef effect," which refers to the introduction of a new hard bottom habitat that had been shown to attract numerous species of algae, shellfish, finfish, and sea turtles to new benthic habitat (Wilhelmsson *et al.* 2006b; Reubens *et al.* 2013a).

Based on these data, the cable-laying process will impact a relatively small area along cable routes and the seabed is expected to recover quickly from the disturbance. The short-term loss of benthic habitat along the cable route is not expected to affect the distribution or abundance of sea turtles in the Project Area or how they use the benthic habitat along cable routes. In the longer term, as mentioned above, foundations for wind farm structures can create an artificial "reef effect" by serving as substrate for sessile invertebrates, in turn attracting fish and other potential prey species (NRC 1996, Wilhelmsson *et al.* 2006a, Maar *et al.* 2009, Reubens *et al*. 2013b, Barnette 2017). It should be noted that, should human fishing activities increase as a result of the "reef effect", increased fishing vessel traffic could increase the risk of collision with and disturbance of sea turtles.

Sandwave clearance will also be undertaken during Project construction. As discussed in Section 2.2.5.2, several methods may be used to accomplish this, including, if necessary, traditional dredging using a trailing suction hopper dredge. Sea turtles have been known to become entrained in trailing suction hopper dredge (that is, sucked into the draghead) or trapped beneath the draghead as it moves across the seabed (Dickerson *et al*. 2004). Entrainment typically results in injury or mortality. The risk of sea turtles becoming entrained in trailing suction hopper dredges is dependent upon a variety of factors, including sea turtle behavior and relative abundance, water depth and temperature, bottom substrate and rugosity, and direction and strength of ocean currents (Ramirez *et al*. 2017). Ramirez *et al.* (2017) note that high abundances of sea turtles in a given area does not necessarily result in high entrainment risk, and that the role of specific factors in entrainment risk are still being investigated.

Entanglement risks

Cables associated with the Project will generally be buried, and therefore they do not pose any risk of entangling sea turtles. Cables that are not buried are expected to be large enough and with sufficient tension to avoid entangling sea turtles.

2.2.8.2.2 Operations and Maintenance

In general, the IPFs associated with the operations and maintenance phase of the Project fall into the following sub-categories: noise produced by operating turbines, risk of collision associated with operations and maintenance vessels, and noise and disturbance produced by these vessels.

Wind Farm Area

Noise produced by operating turbines

Once installed, the operation of the WTGs is not expected to generate substantial sound levels above baseline sound in the area. For the Cape Wind Project, MMS (now BOEM) reported existing underwater sound levels for the design condition were 107.2 dB (re 1 µPa[18]), and the calculated sound level from operation of a WTG was 109.1 dB (re 1 µPa) at 65.6 ft (20 m) from the monopile (i.e., about 1.9 dB above baseline sound levels) which dropped to 107.5 dB (re 1 µPa) at 164 ft (50 m) and to ambient levels at about 360 ft (110 m) (MMS 2008).

An analysis of predicted underwater sound levels perceived by sea turtles from operation of the Project show that no injury or harassment to sea turtles are predicted even if an individual were to approach as close as 65.6 ft (20 m) to a monopile when the Project is operating at the design wind speed as all increases over hearing threshold at this minimum distance are well below 90 dB. In fact, the Project's operation will be inaudible for sea turtles. Therefore, no behavioral impacts to sea turtles are anticipated even if an individual were to approach within 65.6 ft (20 m) of the structures.

Collision risks

Vessel traffic during the operations and maintenance phase of the Project will include vessels required to maintain the foundations, turbines, electrical plant, and cables. Vessel traffic would include crew transport vessels, service operation vessels, supply and jack-up vessels, and bathymetry survey vessels. In addition, air traffic would include helicopter transits associated with maintenance of wind turbines and platforms. The annual number of trips associated with these activities are described in Volume I, Section 6.

The potential risks of vessel striking sea turtles have been discussed previously. With the implementation of environmental protection measures included in APMs and the PSMMP (Appendix AA), the probability of a strike would be reduced, and therefore, an adverse impact to sea turtles caused by vessel traffic is considered unlikely to occur.

Vessel noise

As discussed above, vessel noise is expected to cause minimal behavioral disturbance to sea turtles. Noise associated with surface vessels and helicopter traffic during the construction phase of the Project would have little or no measurable impact on the behavior, biology, or ecology of sea turtles exposed to it.

[18] Decibels are a relative unit, indicating the magnitude of a level relative to a reference level. For in-air sound, the reference is typically 20 µPa, while for underwater sound the reference is typically 1 µPa. Therefore, decibel levels for airborne and waterborne noise are not directly comparable.

Impacts during cable repair activities would be smaller and shorter duration, but of similar type, to those that would occur during cable installation. A relatively short distance along the seabed would be disturbed by the jetting process used to uncover the cable and allow it to be cut so that the ends could be retrieved to the surface. In addition to the temporary loss of some benthic organisms, there would be increased turbidity for a short period, and a localized increase in disturbance due to vessel activity, including noise and anchor cable placement and retrieval. Given the small area, short duration, and low probability of a cable repair occurrence, sea turtles are not likely to be exposed and, if exposed, are not likely to experience a change in their behavior or physiology.

2.2.8.2.3 Decommissioning

In general, the IPFs associated with this phase of the Project fall into the following sub-categories: noise produced by pile cutting activities and disturbance associated with their removal; noise and disturbance produced by vessels associated with decommissioning; and risk of collision associated with these vessels.

Pile driving would not occur during decommissioning. Noise during decommissioning would include cutting the piled foundations, most likely using acetylene cutting torches, mechanical cutting, high-pressure water jets, and vacuum pumps. Sound pressure levels are not expected to be higher than construction vessel noise (generally between 150 and up to 180 dB re 1 μPa; Pangerc *et al.* 2016) (BOEM 2018a). Noise from decommissioning activities could cause sea turtles to avoid or leave the Project Areas, but this disturbance would be short-term and temporary. Decommissioning activities are expected to result in levels of vessel traffic comparable to construction.

Potential impacts of vessel traffic to sea turtles is expected to be similar to Project construction as discussed above.

2.2.8.2.4 Summary of Potential Project Impacts on Sea Turtle Resources

The IPFs affecting sea turtles include seabed disturbance, noise, and traffic.

Operation and maintenance of the Project may result in long-term impacts due to collision risks and disturbance associated with Project-related vessel traffic. Other potential impacts would be short-term. Specifically, potential temporary impacts to sea turtles would result from underwater noise associated with the construction of Project structures (e.g., pile driving, in-situ UXO/MEC disposal); construction related collision risks, noise, and disturbance associated with construction vessel traffic; and seabed disturbance resulting from construction, maintenance or decommissioning activities. Construction related direct impacts to sea turtles from UXO/MEC disposal activities during site preparation could include serious injury/mortality, acoustic harassment injury, acoustic harassment behavioral, and less likely behavioral harassment.

2.2.8.3 Avoidance, Minimization, and Mitigation Measures

The proposed measures for avoiding, minimizing, reducing, eliminating, and monitoring environmental impacts for the Project, including a PSMMP, are presented in **Table 1.1-2**.

2.3 Socioeconomic Resources

This section describes the socioeconomic activities in the Project Area including Demographics, Employment and Economics; Environmental Justice; Recreation and Tourism; Commercial and For-hire Fishing; Land Use and Coastal Infrastructure; Navigation and Vessel Traffic; and Other Marine Uses. Ocean Wind has conducted extensive stakeholder outreach to engage stakeholders and understand how the Project Area is being used. Stakeholder outreach activities are described in Volume I, Section 2.3, Stakeholder Outreach.

2.3.1 Demographics, Employment, and Economics

2.3.1.1 Affected Environment

The following sections describe existing socioeconomic activities and resources within the Project Area, including onshore, coastal and offshore, that may be affected by the Project, including demographic, economic and employment, and housing baselines.

2.3.1.1.1 Project Area Overview

Onshore components will be located in coastal communities in Ocean, Atlantic, and Cape May Counties which are some of the most densely populated coastal communities in the U.S. In addition to the Project components located in the Offshore Project Area and the Onshore Project Area, an onshore operations and maintenance facility in Atlantic City will be used. This facility may serve multiple projects; therefore, it is not a specific part of the Project. The Jersey Shore encompasses 127 miles of ocean beaches from Sandy Hook to Cape May and offers swimming, fishing, surfing, sailing and other ocean-related and coastal activities. Coastal communities provide hospitality, entertainment and recreation for hundreds of thousands of visitors each year. Four counties make up the Shore regions of the State (Atlantic, Cape May, Ocean and Monmouth) and benefit from high tourism employment. Commercial and recreational fishing are important contributors to the economy and are discussed in Section 2.3.3 and 2.3.4 below.

Although many of the coastal and ocean amenities, such as beaches, that attract visitors to these regions are accessible to the public for free, and thus do not directly generate direct employment, these nonmarket features function as key drivers for recreation and tourism businesses.

New Jersey is known as the Garden State, and food and agriculture are New Jersey's third largest industry by revenue, behind pharmaceuticals and tourism. In 2015, the State's more than 9,000 farms generated cash receipts of about $1 billion (New Jersey Department of Agriculture, 2016).

The study area consists of the three counties in which onshore facilities would be constructed. The BL England study area is in Atlantic and Cape May Counties and the Oyster Creek study area is in Ocean County.

Ocean County

Ocean County is about 50 miles east of Philadelphia, 70 miles south of New York City, and 25 miles north of Atlantic City. Ocean County, including its mainland and barrier island beaches, contains 33 municipalities with the county seat in Toms River. Ocean County occupies about 629 square miles of land area (U.S. Census Bureau 2016) within the Atlantic Coastal Plain of central New Jersey. It is one of New Jersey's coastal counties and has the longest stretch of coastal beaches. Ocean County is the second largest county in the State of New Jersey (Ocean County Planning Board, 2011). There are three municipalities in the Oyster Creek study area in Ocean County: Berkeley Township, Lacey Township, and Ocean Township.

Atlantic County

Atlantic County occupies about 556 square miles of land in the coastal region of New Jersey. The county is about 60 miles east of Philadelphia and 100 miles south of New York City. Atlantic County has three barrier islands along its eastern coast. Like the other barrier islands in New Jersey, they are separated from the mainland by the Intracoastal Waterway. One municipality in the BL England study area is in Atlantic County: Egg Harbor Township.

Cape May County

Cape May County is a triangular peninsula that forms the southern tip of New Jersey, occupying about 251 square miles of land area. Cape May County is approximately 150 miles south of New York City, 80 miles southeast of Philadelphia, and 130 miles due east of Washington, D.C. The county is bounded on two sides by the Atlantic Ocean and Delaware Bay and on the third by two rivers and the Great Egg Harbor Inlet. The eastern part of Cape May County is composed of five barrier islands extending 32 miles from Cape May City to Ocean City. These barrier beaches contain most of the county's infrastructure and are the heart of Cape May County's economy (Cape May County 2005). Two municipalities in the BL England study area are in Cape May County: Ocean City and Upper Township.

2.3.1.1.2 Demographics

Population and educational attainment data for the State of New Jersey and for Ocean, Atlantic, and Cape May Counties are provided in **Table 2.3.1-1**. The population of Atlantic and Cape May Counties declined between 2010 and 2017 while the population of New Jersey and Ocean County increased. Census data for the racial and ethnic distribution of the population in the study area are presented in Section 2.3.2, Economic Justice.

Table 2.3.1-1. Population, educational, and age characteristics in the vicinity of the Project.

Location	2010 Population[a]	2017 Population Estimate [b]	Population Change, percent, (2010-2017) [a,b]	High school graduate or higher, percent [c]	Bachelor's degree or higher, percent [c]	Persons Under Age 18, percent [d]	Persons Over Age 65, percent [d]
New Jersey	8,791,894	9,005,644	2.4	88.9	37.5	22.0	15.8
Ocean County	576,567	597,943	3.7	90.9	27.5	23.8	22.4
Atlantic County	274,549	269,918	-1.7	85.7	25.9	21.5	17.3
Cape May County	97,265	93,553	-3.8	90.1	30.5	17.7	25.6

[a] 2010 U.S. Census.

[b] 2017 Population Estimates (July 1, 2017);

[c] As a percent of persons age 25 years or older, U.S. Census Bureau: American Community Survey (ACS) 5-year estimates 2012-2016

[d] U.S. Census Bureau: ACS 5-year estimates 2012-2016

Ocean County

The U.S. Census Bureau estimates that there are approximately 600,000 residents of Ocean County. Population within the county is concentrated in the northeastern and central municipalities, along the barrier island beaches and the Route 9 corridor. Much of the southern and western areas of Ocean County are located in the Pinelands Comprehensive Management Area and are primarily rural. Ocean County's population is expected to increase by 54,033 from 2010 to 2020 (New Jersey Department of Labor and Workforce Development [NJDLWD] 2014a).

Atlantic County

The U.S. Census Bureau estimated the 2017 population of Atlantic County at about 270,000 residents. As shown in **Table 2.3.1-1**, Atlantic County has the lowest percentage of residents over age 65 in the study area.

Cape May County

About 93,500 residents lived in Cape May County in 2017. During summer months, the population increases to at least six times the size of the permanent winter population because of tourism (Cape May County 2005). In

2013 Cape May County estimated its summer population at 796,695, or about eight times the permanent population (Cape May County 2013). Cape May County has the highest percentage of residents aged 65 and over in the study area, and the lowest percentage of children, as shown in **Table 2.3.1-1**.

2.3.1.1.3 Economy and Employment

Table 2.3.1-2 presents income and employment statistics for the study area. Incomes in the study area are lower than the average for New Jersey, but generally similar to the U.S. average (per capita income of $29,829 and median household income of $55,322). As a measure of seasonality of employment, Bureau of Labor Statistics (BLS) monthly employment data in 2017 in the U.S., New Jersey, and the three counties in the study area is presented in**Table 2.3.1-2**. Employment in the State reached its highest level in June, at a level 1.06 times higher than the month with the lowest employment, January. Employment was slightly more seasonal in Ocean and Atlantic Counties, with the employment in July 1.15 times higher than employment in January. However, employment in Cape May County was extremely seasonal, with July employment more than double the January employment.

Table 2.3.1-2. Income (in 2016 Dollars) and employment in the vicinity of the Project.

Location	Per Capita Income in Past 12 Months[a,b]	Median Household Income[a,b]	Percentage of Population Below Poverty Level (2016)[b]	Civilian Labor Force, 2017[C]	Unemploymen t Rate, Percent (year)[c]	Seasonal Employment Ratio, 2017[d]
New Jersey	$37,538	$73,702	10.9	4,699,613	4.1 (2018)	1.06
Ocean County	$31,903	$63,108	11.2	269,946	4.8 (2017)	1.15
Atlantic County	$28,575	$55,456	15.5	121,591	6.6 (2017)	1.15
Cape May County	$34,550	$59,338	10.4	49,997	5.9 (2017)	2.04

[a] 2016 Dollars

[b] U.S. Census Bureau, ACS 5-year estimates 2012-2016

[c] BLS, Local Area Unemployment Statistics, 2018c

[d] Seasonal Employment Ratio for 2017 is defined as employment in month with highest employment (June or July) divided by the employment in the month with the lowest employment (January or February). Source: BLS 2018a

Ocean County

The largest industries in Ocean County are Education and Healthcare, with 28 percent of Ocean County's private employment, and Trade/Transportation/Utilities, with 26 percent (NJDLWD 2014a). Traditionally a tourist resort area, the year-round population of Ocean County is increasing. The Oyster Creek Generating Station shut down in September 2018. About 300 employees will decommission the nuclear power plant over the next 8 years (Exelon 2018). The county's oldest age group, persons over 65, is expected to grow the fastest. A large concentration of retirement communities is found in Ocean County (NJDLWD 2014a).

The 2012 Economic Census of the United States tabulated 1,145 accommodation and food service establishments in Ocean County (Census 2012). These establishments generated over $802 million in sales in 2012 (Census 2012). Additionally, 258 arts, entertainment, and recreation establishments in Ocean County brought in about $391 million in revenue (Census 2012). The largest employer in Ocean County is the amusement park Six Flags Theme Park in Jackson Township, with about 4,000 employees (NJ.com 2017).

Atlantic County

Atlantic County's largest employment sector is Leisure and Hospitality, largely due to the concentration of casino hotels and other entertainment centers such as the Boardwalk in Atlantic City (BLS 2018b). Nearly 42 percent of Atlantic County's private sector jobs in 2011 were in the Leisure/Hospitality industry. Trade/ Transportation/Utilities is the second largest industry in Atlantic County, with fewer than half as many employees as the Leisure/ Hospitality sector (NJDLWD 2014b). Higher annual wages in this sector can be traced to the gaming industry's unionized hotel and restaurant workers, higher tipping rates, and a greater proportion of higher paying jobs compared to similar nongaming establishments along the Jersey Shore (NJDLWD 2014b). The top four largest employers in the county are large casinos in Atlantic City, each employing more than 3,000 workers (Rutgers University 2016). Leisure and Hospitality accounted for 46.7 percent of the approximately 140,500 jobs in Atlantic City in July 2018 (BLS 2018b). The unemployment rate in Atlantic County was 7.1 percent in 2016 (U.S. Census Bureau 2016). Meanwhile, agriculture remains an important part of the local economy in the western half of the county.

The 2012 Economic Census of the United States for Atlantic County tabulated 860 accommodation and food service establishments, generating over $4.0 billion in annual sales (Census 2012). In addition, 123 arts, entertainment, and recreation establishments generated $103 million in revenue in Atlantic County (U.S. Census Bureau 2012).

NOAA Fisheries classifies Atlantic City as one of the Greater Atlantic Region's major ports. Recreational fishing is a common pursuit, and Atlantic City is home to the largest fleet of charter boats and party boats on the East Coast. Most charter boats exceed 120 ft in length and can accommodate over 150 passengers. In addition, commercial fishing from the port of Atlantic City provides much of the world's supply of minced clams and clam strips. In addition to the large commercial clam industry, numerous small-scale fishing operations in Atlantic City fish for clams on the bay side (NOAA 2018a). About 90 percent of New Jersey's clam aquaculture facilities are in Atlantic County (Rutgers New Jersey Agricultural Experiment Station 2013). Commercial fishery landings at Atlantic City were 26 million pounds in 2015 and 24 million pounds in 2016 (NOAA 2017a).

Cape May County

The Cape May County economy is heavily reliant on oceanfront tourism. Leisure and Hospitality is the largest industry in the county, accounting for 33 percent of employment. The second largest industry in Cape May County is Trade/Transportation/Utilities (NJDLWD 2013). Employment is quite seasonal in Cape May County. In 2017, 23,486 persons were employed in the county in January. In July, employment had more than doubled to 47,920, increasing by a factor of 2.04 as shown in **Table 2.3.1-2**.

The 2012 Economic Census of the United States tabulated about 900 accommodation and food service establishments in the county (U.S. Census Bureau 2012). Together, these generated over $593 million in annual sales (Census 2012). Additionally, 139 art, entertainment, and recreation establishments generated about $151 million in revenue in Cape May County (U.S. Census Bureau 2012). Cape May County statistics indicate that as of 2015, the tourism industry generated approximately $6 billion worth of income in Cape May County, which represents 56.6 percent of total county private employment (Cape May County 2016). Boardwalks, beaches, and other marine attractions are concentrated in the barrier islands on the eastern coast of Cape May County. The United States Coast Guard Training Center, the Woodbine Development Center, and the Cape Regional Medical Center are among the largest employers in the county (NJ.com 2017).

Although Cape May has developed as a tourist destination, the area remains New Jersey's largest seaport with an active fishing fleet. The combined port of Cape May/Wildwood is the largest commercial fishing port in New Jersey, and is one of the largest ports on the East Coast. Cape May/Wildwood is the center of fish processing and freezing in New Jersey. Some of the largest fishing vessels on the East Coast are based in the Cape May/Wildwood port (NOAA 2018b). Commercial fishery landings in 2015 at Cape May/Wildwood amounted to 77 million pounds, valued at $72 million. Landings in 2016 decreased to 47 million pounds, but the value increased to $85 million (NOAA 2017a).

2.3.1.1.4 Housing

Table 2.3.1-3 presents housing information for the State of New Jersey and for the counties in the study area. The study area is characterized by a high proportion of housing units designated for seasonal, occupational, or occasional use, and by a high vacancy rate, especially in Cape May County.

Table 2.3.1-3. Housing statistics in the vicinity of the Project.

Location	Housing Units, 2016	Owner Occupancy Rate, percent, 2016	Vacant Housing Units, percent, 2016	Persons per Household, 2016	Median Value of Owner-occupied Housing Units, 2016	Percent of Housing Units for Seasonal, Occupational, or Occasional Use (2010)
New Jersey	3,586,442	89.1	10.9	2.73	$316,400	3.8%
Ocean County	280,508	79.4	20.6	2.6	$264,200	15.1%
Atlantic County	127,617	79.2	20.8	2.65	$222,200	12.0%
Cape May County	98,900	40.5	59.5	2.31	$296,100	49.7%

Source: U.S. Census Bureau, ACS 5-year estimates 2012-2016; U.S. Census Bureau, 2010 U.S. Census

Ocean County

The percentage of housing units classified as for seasonal, occupational, or occasional use is higher in Ocean County than for the State of New Jersey, reflecting Ocean County's status as a tourist destination. Ocean County also has a higher percentage of vacant housing units (20.6 percent, compared to 10.9 percent in New Jersey), which may reflect the intensity of seasonal population growth noted above.

Temporary housing is abundant along the Jersey Shore. Ocean County has over 100 hotels/motels and more than 20 campgrounds and RV parks.

Atlantic County

In the study area, Atlantic County has the lowest percentage of housing units for seasonal, occupational, or occasional use at 12 percent. However, this percentage is still well above the New Jersey average of 3.8 percent. The rate of vacant housing is similar to Ocean County at 20.8 percent.

Temporary housing accommodations are plentiful in Atlantic County, with over 200 hotels/motels and 20 campgrounds/RV parks. Short-term apartment rentals are readily available in Atlantic City.

Cape May County

Cape May County has high rates of seasonal and vacant housing when compared to the rest of the study area or to the State of New Jersey. The U.S. Census Bureau estimates that there is a total of 98,900 housing units in Cape May County, of which 59.5 percent are categorized as vacant. The proportion of seasonal, occupational, or occasionally used housing is also high at 49.7 percent. The high vacancy rate may reflect the intensity of seasonal use and seasonal population growth noted above.

Over 100 hotel/motels, 20 campgrounds, and 4 RV parks are found in Cape May County.

2.3.1.2 Potential Project Impacts on Demographics, Employment, and Economics

Construction and operation of the Project would impact socioeconomic conditions in the study area and vicinity, and related impact producing factors include the following:

- Noise
- Traffic
- Land use, economic change

Potential impacts on demographics, employment, and economics are related to the number of construction workers that would work on the Project and their impact on population, public services, and temporary housing during construction. Other potential impacts are related to construction, such as increased traffic or noise. Increased job opportunities, increased property tax revenue, and increased income associated with local construction employment are potential beneficial impacts of the Project. Potential Project impacts to commercial and for-hire fishing are discussed in Section 2.3.4 and impacts to recreation and tourism are discussed in Section 2.3.3.

The Project will create employment in New Jersey during the phases of development, construction, operations, and decommissioning. The development phase will employ engineers, environmental scientists, financial analysts, and other professional roles. The construction phase will employ steel workers, welders, electrical workers, ship workers, wind technicians, and other construction jobs. The operations phase will employ plant technicians, maintenance crews, and other support jobs. Finally, the decommissioning phase will employ construction and other support roles. Ocean Wind would thus have beneficial impacts on local employment and the local economy during all phases of the Project. Ocean Wind plans to obtain many supplies and services from providers in the study area and other areas of New Jersey. The Project will help the State of New Jersey meet its nation-leading offshore wind target, as well as its goals of establishing an enduring local supply chain with the first-in-the-nation permanent large-scale offshore wind workforce.

E2, a national, nonpartisan group of business leaders, investors, and others who advocate for smart policies that are good for the economy and good for the environment, commissioned a study on the economic benefits of offshore wind on the East Coast. The study, conducted by BW Research Partnership, analyzed a scenario in which each of five states along the U.S. Eastern seaboard added a 352-MW offshore wind energy farm. The five states were New York, New Jersey, Virginia, North Carolina, and South Carolina. The E2 analysis showed that for every $1.00 spent building an offshore wind farm, $1.83 would be generated in the New Jersey economy (E2 2018).

To estimate the economic value of the Project, Ocean Wind retained the Bloustein School of Planning and Public Policy at Rutgers University to conduct an input/output analysis using its proprietary R/ECON model, one of the suggested models set forth in N.J.A.C. 14:8-6.5(a)(11)(i)(1). R/ECON is a comprehensive econometric model incorporating numerous interrelating factors that is used to calculate the total impact of a given project to the New Jersey economy. The results of analysis conducted for the Project are presented in the following sections.

2.3.1.2.1 Construction

Population

Employment impacts for the Project are shown in **Table 2.3.1-4.** The population in the study area would increase because of the arrival of non-local workers during construction. However, population impacts on the socioeconomic study area are expected to be temporary. Because of the relatively short duration of construction, it is anticipated that most non-local workers would not travel with their families to the study area. Based on the populations within the study area, the temporary addition of the non-local workforce to the study area for the duration of construction would not result in a sizable population change. The temporary increase in population would be distributed throughout the study area and would have no permanent impact on the population. Additionally, the communities within the study area experience seasonal influx of tourists, and therefore, the increase in local workforce would provide benefits to the local community during the off season.

Table 2.3.1-4. Estimated employment impacts of the Ocean Wind Project in New Jersey.

Type	Job-Years* by Project Phase					Jobs Total
	Development	Construction	Operations	Decommissioning	Supplier	
Direct	292	3,103	2,780**	289	301	6,765
Indirect	129	1,111	1,116	468	92	2,916
Induced	241	2,384	2,218	446	186	5,476
Sub-total	**663**	**6,598**	**6,114**	**1,202**	**579**	**15,157**

* Job-years is an economic term that converts dollars spent into job equivalents based upon historic multipliers that consider factors such as salary, overhead, hours worked, etc. The estimate was generated by utilizing the R/ECON model, with the assistance of Rutgers Bloustein School. This was one of the models approved for use in the New Jersey OWEDA regulations. The job-year figures are estimates based upon the duration of each phase, which vary between 1 and 35 years. The Project is anticipated to have an operational life of 35 years.

** The total operations and maintenance direct job-years over that the Project lifetime was calculated to be 2,780, which equates to approximately 79 per year.

Residents would experience impacts from offshore construction activities, including temporary increases in vessel traffic and noise. Helicopter trips from port to the Wind Farm Area are anticipated during turbine installation, causing increased noise. Localized marine vessel traffic is not anticipated to interrupt existing vessel traffic during construction.

The transportation network in the study area and vicinity consists of U.S. highways, State highways, secondary State highways, county roads, and private roads. Movement of equipment and materials and workers commuting to Project sites could result in minor, short-term impacts to traffic along some roads and highways during construction.

Construction activities and the presence of non-local workers could create potential increased demand for emergency response services, but the effect is anticipated to be minor based on the wide range of public services in the study area, including hospitals, full-service law enforcement, and fire departments.

Communities in the study area experience substantial seasonal increases in population during the summer months as tourists visits the beaches along the Jersey Shore. The influx of seasonal visitors results in increased traffic and use of temporary accommodations and local businesses.

Economy

Ocean Wind opened an office in Atlantic City in May 2018 and would hire local workers to the extent practical. Ocean Wind would also hire non-local workers with specialized skills. The construction workforce would include civil and electrical construction workers for onshore facilities. Installation of offshore facilities (e.g., wind turbine generators, foundations, cables, and substations) would require specialized marine equipment and workers. Offshore cables would be installed by jet plow, mechanical plow, mechanical trenching, and/or dredging. Installation of offshore foundations, WTGs, and substations would require jack-up vessels and accompanying barges.

Ocean Wind estimates that a total of 6,598 job-years would be created during construction of the proposed Project (**Table 2.3.1-4**). Expenditures during the construction phase would include equipment and materials, labor installation, insurance, and development services such as engineering, public relations, and legal fees. Total local expenditures for the Project would be about $550 million during construction. These economic impacts are summarized in **Table 2.3.1-5**.

Table 2.3.1-5. Estimated economic benefit (GDP) of the Ocean Wind Project in New Jersey.

Type	GDP by Project Phase					Total
	Development	Construction	Operations	Decommissioning	Supplier	
Direct	$24,235,794	$310,753,679	$166,540,060	$11,796,800	$21,704,487	$535,030,820
Indirect	$12,349,357	$83,893,577	$41,632,047	$7,415,223	$6,318,778	$151,608,982
Induced	$15,831,542	$155,649,130	$69,194,978	$5,759,463	$11,256,870	$257,691,983
Sub-total	$52,416,693	$550,296,387	$277,367,085	$24,971,486	$39,280,135	$944,331,785

A brief decrease in the unemployment rate in the study area could occur as a result of hiring of local workers for construction and increased demands on the local economy. The non-local workforce would most likely spend a portion of their pay in local communities on housing, food, transportation, entertainment, and miscellaneous other items. These local communities have tourism-related infrastructure including hotels, restaurants, and entertainment facilities that could be used by the non-local workers. Additional temporary jobs would be created in the study area as purchases for goods and services increase along with the arrival of the non-local construction workforce. Indirect employment would include hiring additional staff in the retail and service industries to accommodate the increase in demand for food, clothing, lodging, gasoline, and entertainment. Indirect jobs would represent a temporary, minor increase in employment opportunities in the study area. The direct and indirect employment associated with the Project, along with an increased demand for goods and services, would have a temporary stimulating effect on the local economy.

Tax revenues for state and local governments would increase as a result of the Project. Equipment, fuel, and some construction materials would likely be purchased from local or regional vendors. These purchases would result in short-term impacts on local businesses by generating additional revenues and contributing to the tax base. Ocean Wind estimates that the Project will generate tax values during Project construction as shown in **Table 2.3.1-6**.

Table 2.3.1-6. Estimated tax value of the Ocean Wind Project (2018 dollars).

Type	Tax Value by Project Phase					Total
	Development	Construction	Operations	Decommissioning	Supplier	
Local	$2,035,204	$16,648,784	$482,551	$3,892,370	$1,322,264	$24,381,174
State	$2,617,570	$23,186,887	$732,954	$4,882,486	$1,861,026	$33,280,923
Federal	$13,641,932	$138,796,965	$4,125,081	$29,451,692	$10,852,138	$196,867,809
Total	**$18,294,706**	**$178,632,637**	**$5,340,587**	**$38,226,548**	**$14,035,429**	**$254,529,906**
State + Local	**$4,652,774**	**$39,835,672**	**$1,215,506**	**$8,774,856**	**$3,183,290**	**$57,662,097**

Note: Federal, State and local taxes based on effective tax rates (taxes per unit of taxable income for firms and per unit of personal income for households). This includes personal and business income taxes at both the State and Federal level, as well as property tax.

Housing

The non-local workforce would require temporary housing accommodations. Temporary housing is readily available in the study area, as indicated by the large number of housing units for seasonal, occupational, or occasional use, and numerous hotels, motels, campgrounds, and RV parks. Use of this temporary housing by the non-local workforce would result in a beneficial economic impact in the vicinity of the Project.

The Jersey Shore experiences an influx of recreational visitors during the summer months, and these visitors would compete with non-local workers for temporary accommodations. Competition for temporary housing could increase rents. Impacts on temporary housing could be reduced by scheduling construction activities outside of the summer tourist season.

2.3.1.2.2 Operations and Maintenance

Population

Given the population in the study area, the relatively small number of workers needed for operation of the Ocean Wind onshore and offshore facilities would result in a small, if detectable, increase in population (**Table 2.3.1-4**). Impacts on traffic, noise, and public services would not be noticeable.

Economy

Ocean Wind has committed to at least 69 permanent jobs in Atlantic City and estimates that over the 35-year life of the Project the operations phase could result in 2,780 job-years of skilled permanent labor (direct jobs), and over 6,000 total job-years created (inclusive of indirect and inducted job creation) (**Table 2.3.1-4**). These operation and maintenance workers would spend money in the study area for housing, food, entertainment, and transportation. The Ocean Wind Project would also have a beneficial economic impact in the study area and vicinity during operations.

Once the Project is operational, property taxes would be assessed on the value of the Ocean Wind facilities. The increased tax base during operations would be a long-term beneficial impact on local governments in the Project Area.

The operations phase of the proposed Project is estimated to result in additional value added to the New Jersey GDP of over $277 million (**Table 2.3.1-5**).

Ocean Wind estimates that the Project will generate tax values during Project operations as shown in **Table 2.3.1-6**.

To catalyze a strong and sustainable offshore wind industry in New Jersey, Ocean Wind is committing an initial investment of $15 million in a to-be-established Pro-NJ Trust, which will:

- Enable women and minority-owned business, women business enterprise, or small business entry to the offshore wind industry
- Advance in-state port development
- Build coastal grid resiliency and reliability

Ocean Wind is working with New Jersey SHARES, Inc. (NJ SHARES) to develop "Orsted Cares", a grant program designed to provide assistance for Atlantic and Cape May County electric and gas utility customers who are in an emergency situation or facing imminent service termination and in need of immediate utility bill payment assistance.

As part of its community relations outreach efforts, Ocean Wind will work with local industry through the company's Competitive Edge and Live Classroom programs that will identify and train Atlantic City residents and students who are interested in working in wind farm construction or in one of the permanent positions that will become available when the Project is completed.

Ocean Wind developed a Memorandum of Understanding (MOU) signed with the South Jersey Building and Construction Trades Council in December, calling for a Project Labor Agreement for offshore wind construction jobs that pay prevailing wage. Orsted has also signed MOUs with Rutgers, Stockton, and Rowan Universities to continue to support academic research, engineering programs and initiatives to further advance undergraduate and graduate students' knowledge of the offshore wind industry.

Housing

Permanent employees would be likely to live in the vicinity of the Project facilities. Relatively high vacancy rates in the study area indicate that sufficient housing for the operations and maintenance workforce would be readily available.

2.3.1.2.3 Decommissioning

Population

Impacts to the local population during decommissioning would be similar to construction. A temporary increase in population would have minor impacts on public services, traffic, and noise, and would not result in a permanent population change (**Table 2.3.1-4**).

Economy

Decommissioning would result in beneficial economic impacts similar in type to those of construction, including a temporary increase in employment in the study area through direct, indirect, and induced employment and increased tax revenues from retail sales and payroll (**Table 2.3.1-5**). Ocean Wind estimates that the Project will generate tax values during Project decommissioning as shown in **Table 2.3.1-6**. Removal of Project facilities would decrease property tax payments to state and local governments.

Housing

The impacts of decommissioning on housing in the study area would be very similar to those experienced during construction. Non-local workers would occupy temporary housing, including housing units for seasonal, occupational, or occasional use in addition to hotels, motels, campgrounds, and RV parks. The increased use of temporary housing would have beneficial impacts on the local economy.

2.3.1.2.4 Summary of Potential Project Impacts on Demographics, Employment, and Economics Resources

The IPFs affecting demographics, employment, and economics include noise, traffic, and land use and economic change.

There will be long-term employment opportunities during the operations phase through the creation of operations and maintenance jobs. Potential impacts during construction are related to the temporary increased construction employment required for the Project and the impact these workers could have on population, public services, and temporary housing during construction, increased job opportunities, increased property tax revenue, and increased income associated with local construction employment.

2.3.1.3 Avoidance, Minimization, and Mitigation Measures

The proposed measures for avoiding, minimizing, reducing, eliminating, and monitoring environmental impacts for the Project are presented in **Table 1.1-2**.

2.3.2 Environmental Justice

2.3.2.1 Affected Environment

2.3.2.1.1 Regulatory Framework

Executive Order 12898, Federal Action to Address Environmental Justice in Minority Populations and Low-Income Populations, requires Federal agencies to consider if impacts on human health or the environment (including social and economic aspects) would be disproportionately high and adverse for minority and low-income populations, and appreciably exceed impacts on the general population or other comparison group.

Executive Order 13985, Advancing Racial Equity and Support for Underserved Communities Through the Federal Government, strongly encourages independent agencies to "consult with members of communities that have been historically underrepresented in the Federal Government and underserved by, or subject to discrimination in, federal policies and programs."

Executive Order 13990, Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis calls for advancing environmental justice and states that U.S. policy is to improve public health and protect our environment; to ensure access to clean air and water; to limit exposure to dangerous chemicals and pesticides; to hold polluters accountable, including those who disproportionately harm communities of color and low-income communities; to reduce greenhouse gas emissions; to bolster resilience to the impacts of climate change; to restore and expand our national treasures and monuments; and to prioritize both environmental justice and the creation of the well-paying union jobs necessary to deliver on these goals.

Executive Order 14008, Tackling the Climate Crisis at Home and Abroad, prioritizes climate change considerations in national security and requires explorations of energy-generating resources that create a sustainable climate pathway. The Executive Order requires that the United States organize and deploy the full capacity of its agencies to combat the climate crisis and implement a Government-wide approach that reduces climate pollution in every sector of the economy; increases resilience to the impacts of climate change; protects public health; conserves our lands, waters, and biodiversity; delivers environmental justice; and spurs well-paying union jobs and economic growth, especially through innovation, commercialization, and deployment of clean energy technologies and infrastructure. The Federal Government, consistent with applicable law, is required to take steps to ensure that Federal infrastructure investment reduces climate pollution and that Federal permitting decisions consider the effects of greenhouse gas emissions and climate change. Executive

Order 14008 specifies that "The Secretary of the Interior shall review siting and permitting processes on public lands and in offshore waters to identify to the Task Force steps that can be taken, consistent with applicable law, to increase renewable energy production on those lands and in those waters, with the goal of doubling offshore wind by 2030 while ensuring robust protection for our lands, waters, and biodiversity and creating good jobs."

The State of New Jersey's Office of Environmental Justice, housed in the Department of Environmental Protection, works to incorporate environmental justice considerations into the actions of all state agencies, to engage with overburdened communities to remove barriers to accessing resources so that communities are better informed, heard, and able to advocate for justice locally, and to increase opportunities for meaningful public participation (NJDEP 2022).

2.3.2.1.2 Environmental Justice Study Area

The environmental justice study area consists of the onshore footprint of the BL England and Oyster Creek corridors, as depicted below. These two areas include any area that will need permanent electrical infrastructures such as onshore substations, connections to the electrical grid, and onshore export cables, and are known as the BL England study area and the Oyster Creek study area. The U.S. Census reports geographic data by census tracts and block groups (subdivided census tracts). Using GIS mapping tools, the BL England and the Oyster Creek study areas were overlaid on New Jersey county lines and U.S. Census 2018 TIGER/Line Shapefile Block Group data. The study areas overlap three counties in New Jersey and contain a total of 25 U.S. Census block groups.

Methodology to Identify Environmental Justice Populations and to Evaluate Impacts

The approach to identifying environmental justice populations and evaluating impacts is based on the Council on Environmental Quality environmental justice guidance under NEPA (Council on Environmental Quality, 1997), and the USEPA's Federal Interagency Working Group on Environmental Justice and NEPA Committee's publication, *Promising Practices for EJ Methodologies in NEPA Reviews* (EPA, 2016). A three-step approach has been used for this review. These steps are:

- Determine the existence of minority and low-income populations;
- Determine if the project results in high and adverse human health or environmental effects; and
- Determine if the high and adverse effects are disproportionately borne by environmental justice populations.

The following environmental justice assessment considers the following factors:

- The areas in which a proposed project may result in significant adverse environmental effects;
- The presence and characteristics of potentially affected minority and/or low-income populations (i.e., "communities of concern") residing in these areas; and
- The extent to which these communities are disproportionately affected in comparison to the effects experienced by the population of the greater geographic area within which the affected area is located (i.e., the county).

The data used for the environmental justice analysis were obtained from the U.S. Census Bureau 2016-2020 ACS 5-year Estimates (data revised March 17, 2022). The analysis identified the U.S. Census tracts and block groups within the study areas and then compared the population of each block group to a comparison group. For this analysis, the comparison group is the county in which the block group is located. The comparison group is used to determine whether potential adverse impacts of the Project are disproportionately borne by one or more minority or low-income populations in comparison to the greater area (i.e., the county level).

In addition, because of the overlap between climate change and environmental justice in Executive Order 14008, at the request of USEPA, Ocean Wind has used the EJScreen 2.0 tool, which includes new layers for climate change. The analysis using EJScreen is provided in Section 2.3.2.1.6 to address USEPA's goal to reduce climate pollution, increase resilience to the impacts of climate change, protect public health, deliver environmental justice, and deploy clean energy technology initiatives.

2.3.2.1.3 Minority Populations

A minority population exists when:

- The minorities in a U.S. Census Bureau-defined block group are more than 50 percent of the tract's population;
- The percentage of a minority in a block group is "meaningfully greater" than in the comparison group. (note: "meaningfully greater" is defined in this analysis when minority or ethnic populations are at least 10 percentage points more than in the comparison group, which is the county in which the block group is located.)

Minority categories used by the Census Bureau include: African American/Black, Native American or Alaska Native, Asian, Native Hawaiian and Other Pacific Islander, two or more races, other races, and Hispanic or Latino heritage (any race). Hispanic or Latino heritage is considered an ethnicity rather than a racial category in census data; therefore, the minority population is calculated by subtracting persons who are White only (not Hispanic) from the total population to avoid double counting. People may choose to report more than one race to indicate their racial mixture, such as "American Indian" and "White." People who identify their origin as Hispanic, Latino, or Spanish may be of any race (U.S. Census 2018a).

The most recent available data on minority populations in the study areas comes from the 2016-2020 U.S. Census ACS 5-Year Estimates.

2.3.2.1.4 Low-Income Population

A community of concern may also be identified by the presence of low-income populations. Low-income populations are identified using the poverty levels defined by the U.S. Census Bureau. The Census Bureau considers a variety of factors including family size, number of children, and the age of the householder. Households are classified as below the poverty level when the total income in a 12-month period is below the income threshold or poverty level. Income thresholds are not adjusted for regional or local variations in the cost of living. A low-income population exists when the percentage of all persons living below the Federally established poverty level is higher than the percentage for the county in which the block group is located.

The most recent available data on families in poverty in the study areas comes from the 2016-2020 U.S. Census ACS 5-Year Estimates.

2.3.2.1.5 Existing Conditions

Socioeconomic characteristics of the study areas have been examined to determine whether the proposed activities would disproportionately impact any minority or low-income populations. The study area for the environmental justice analysis focuses on locations where potential impacts resulting from construction, operations and maintenance, and decommissioning activities may occur. Relevant characteristics of county-level populations in the study areas are compared to their respective characteristics for the State of New Jersey to provide context for the assessment. Population and demographic data used in this analysis were obtained from the U.S. Census Bureau and are presented in **Table 2.3.2-1**.

Table 2.3.2-1. Racial and ethnic statistics in the study areas.

Geography	Asian	Black or African American	Hispanic or Latino	Native American	Two or More Races	Other	White	Total Minority (Percent)
State of New Jersey	9.7%	13.4%	20.4%	0.3%	4.8%	6.4%	65.5%	34.5%
Ocean County	1.8%	2.8%	9.2%	0.0%	1.3%	0.1%	84.7%	15.3%
Cape May County	0.9%	4.4%	7.7%	0.0%	1.6%	0.1%	85.3%	14.7%
Atlantic County	7.9%	14.0%	18.8%	0.2%	2.5%	0.1%	56.4%	43.6%

Source: 2016-2020 ACS 5-year estimates.

These data indicate that the minority population in Atlantic County is higher than the minority population for the state as a whole. However, minority populations in Ocean County and Cape May County are substantially lower than the overall minority population for the state of New Jersey.

As described in the following sections, the analysis was then refined from the county level to the smaller units of the U.S. Census Block Groups within the BL England and Oyster Creek study areas to identify minority and low-income populations.

Minority Populations

The U.S. Census identifies 24 block groups within the two study areas. Minority populations for the census tracts were identified as those census block groups with either a percentage of racial minorities that is more than 50 percent of the population, or a percentage of minorities that is more than 10 percentage points higher than the county as a whole. Of the 24 block groups in the study areas, 3 block groups 2 in the Ocean County portion of the Oyster Creek study area and 1 block group in the Cape May County portion of the BL England study area, exceeded the minority threshold (**Figure 2.3.2-1, Figure 2.3.2-2**, and Appendix V)**.**

Appendix V provides an overview of the racial and ethnic characteristics of the population in the census tracts within the study areas in Atlantic, Ocean, and Cape May Counties. For the Oyster Creek study area, the minority threshold is 10 percentage points higher than the county average of 12.6 percent, or 22.6 percent. In the Oyster Creek study area, the minority population in two block groups is higher than the county average; however, neither of these two block groups exceed the minority threshold. For the BL England Study area, in Cape May County, the minority threshold is 10 percentage points higher than the county average of 10.3 percent, or 20.3 percent. Two block groups in the BL England study area have a minority population higher than the county average, but only one block group exceeds the minority threshold. This block group is Block Group 4, Census Tract 201.01, which has a minority population of 41.5 percent. The BL England study area overlaps a small portion of Atlantic County that is not populated.

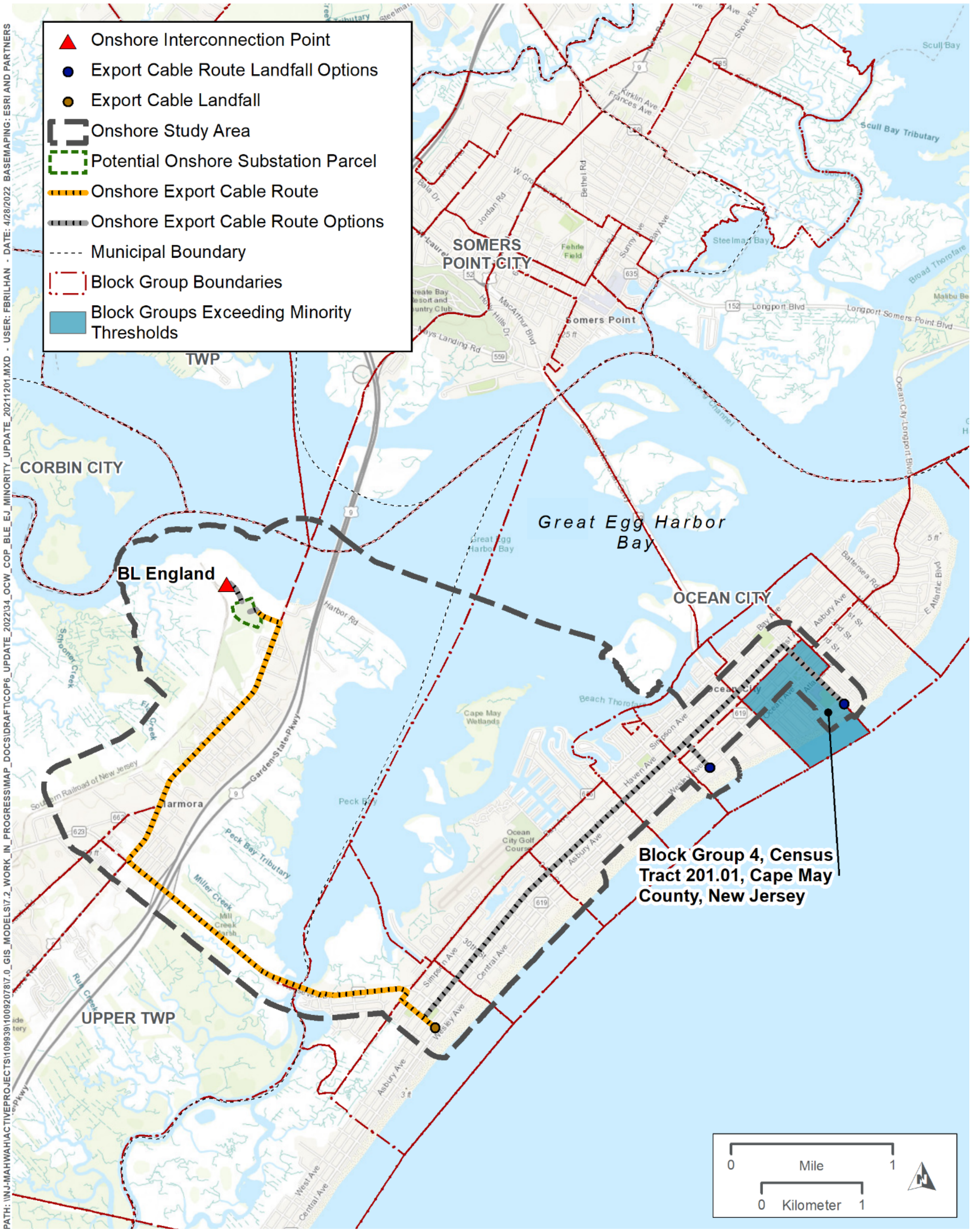
Figure 2.3.2-1 illustrates the census tracts located within the BL England study area in Atlantic and Cape May Counties, and indicates the block group that exceeds the minority threshold (Block Group 4 in Census Tract 201.01 of Cape May County, which has a minority population of 41.5 percent). **Figure 2.3.2-2** illustrates the census tracts in the Oyster Creek study area in Ocean County. No block groups exceed the minority threshold.

Low Income Populations

Low income populations have been analyzed using U.S. Census poverty data for the 24 block groups in which the study area is located. To determine whether any of these block groups would be identified as an environmental justice population based on income, the poverty rate within each block group was compared to the poverty rate in the county as a whole. Of the 24 block groups surveyed in the analysis, 6 block groups exceeded the county level poverty rate. These 6 block groups are shown in **Figure 2.3.2-3** and **Figure 2.3.2-4** and Appendix V.

Appendix V provides an overview of the households with incomes below the poverty line in the block groups in Ocean, Atlantic, and Cape May Counties that are within the Oyster Creek and BL England study areas. The BL England study area overlaps a small portion of Atlantic County that is not populated. In Ocean County, three block groups in the Oyster Creek study area have poverty rates that exceed the county rate of 8.6 percent. In Cape May County, three block groups in the BL England study area have a poverty rate higher than the county average of 9.5 percent.

Figure 2.3.2-3 shows the block groups within the Oyster Creek study area. The block groups with poverty rates exceeding the rate for Ocean County have been highlighted. **Figure 2.3.2-4** shows the block groups within the BL England study area. The block groups with poverty rates exceeding the rate for their respective county have been highlighted.



Source: U.S. Census Bureau, 2016-2020 American Community Survey 5-Year Estimates.

Figure 2.3.2-1. BL England - Block groups with higher minority population than County.

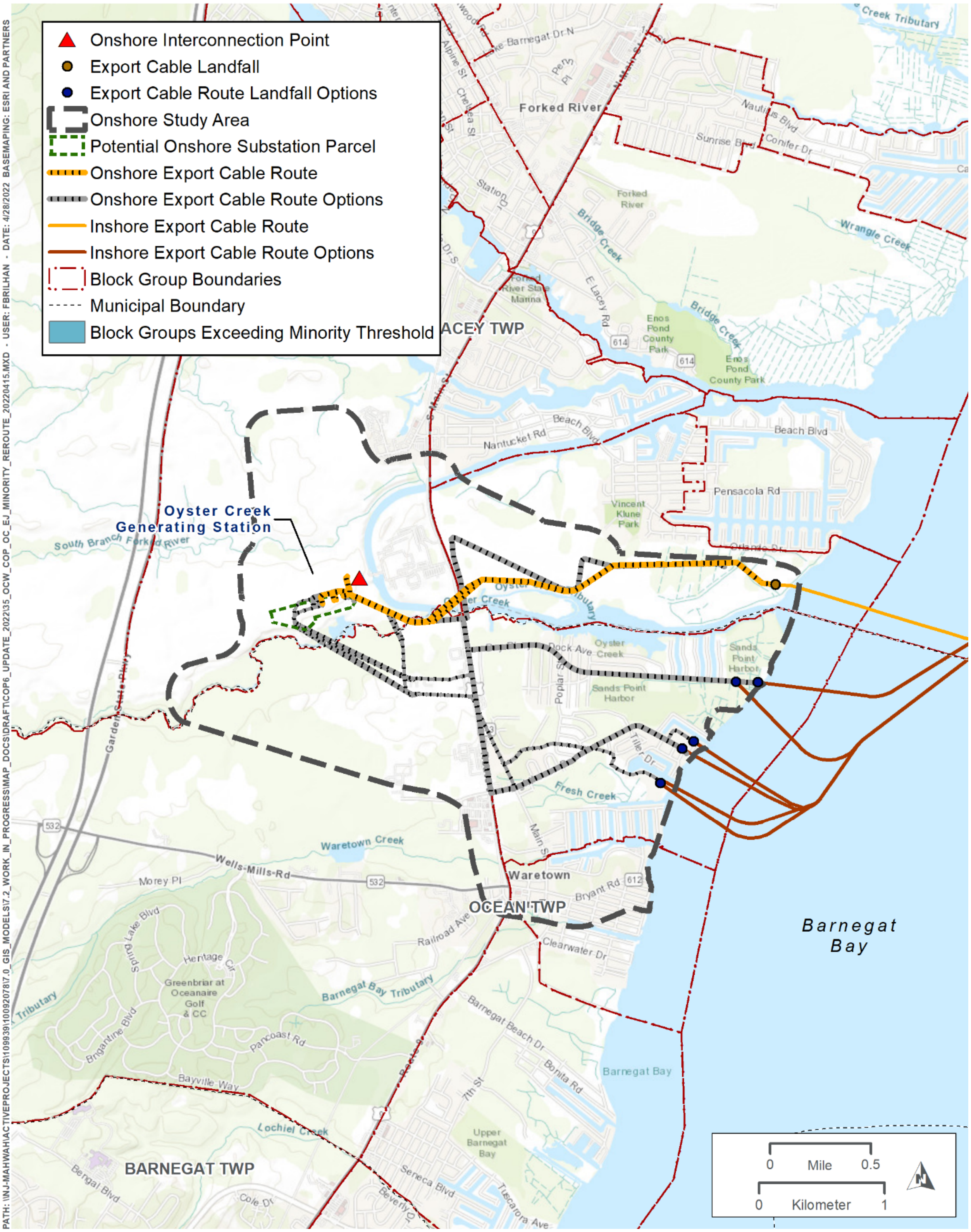
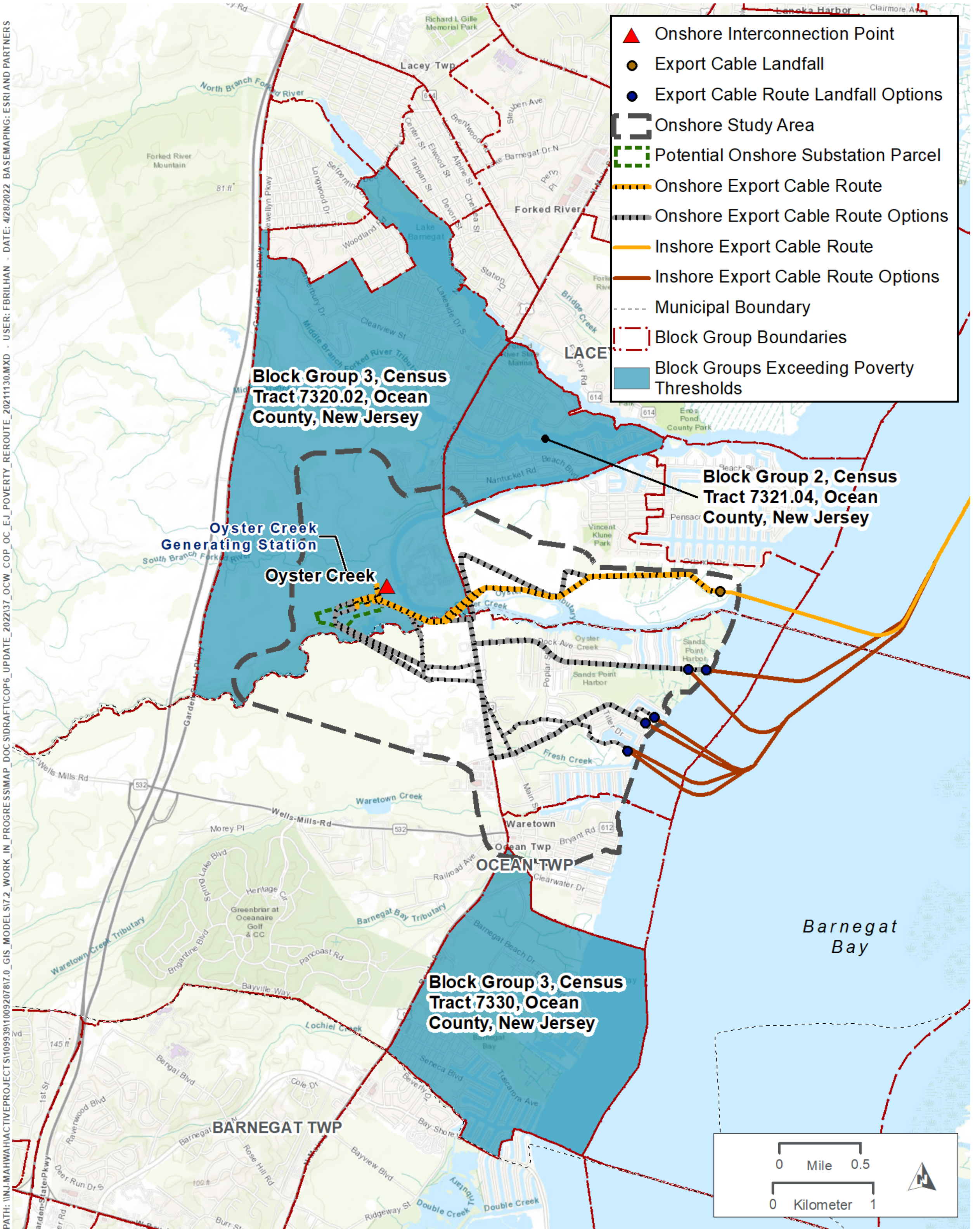
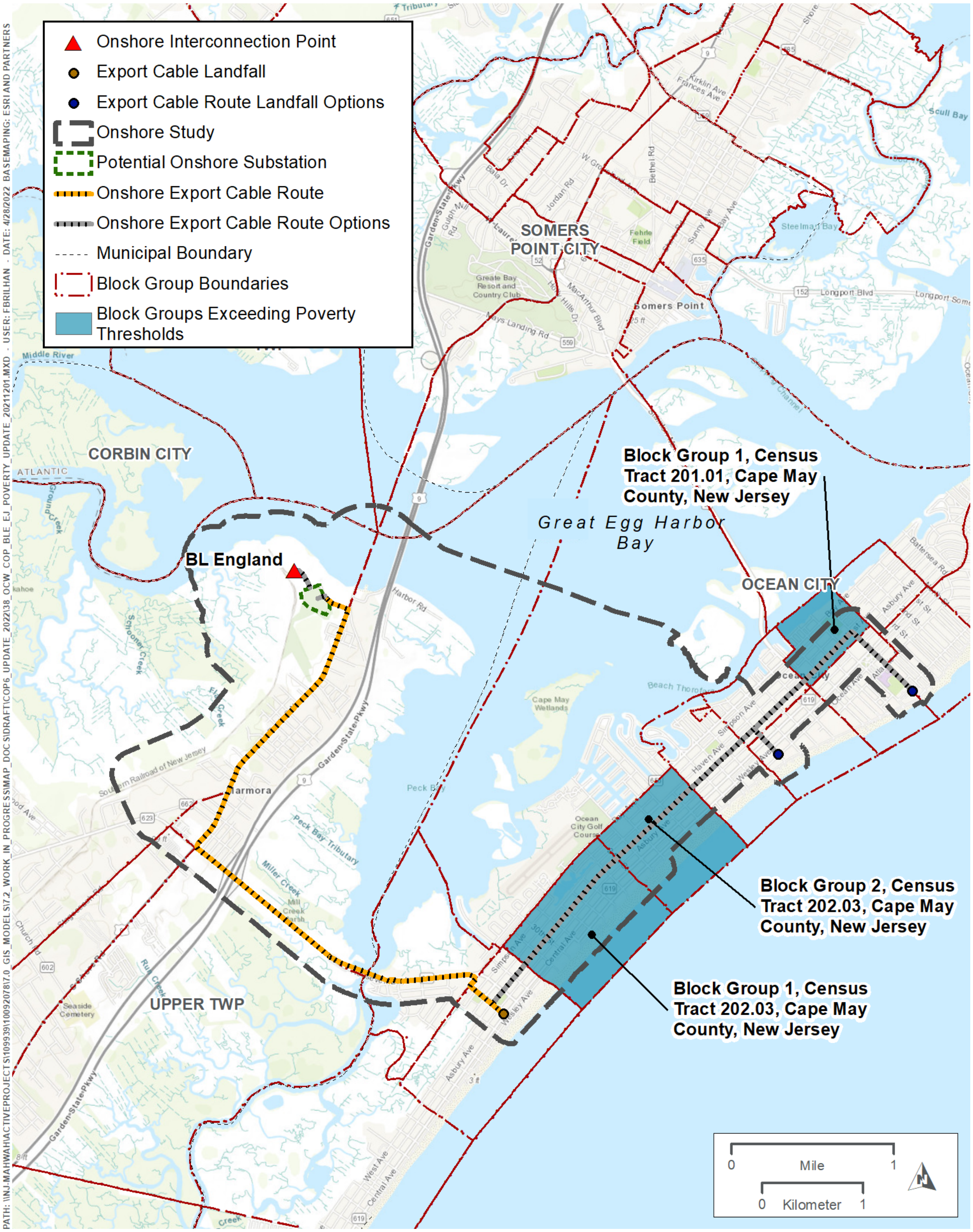


Figure 2.3.2-2. Oyster Creek – Block groups with higher minority rate than County.



Source: U.S. Census Bureau, 2016-2020 American Community Survey 5-Year Estimates.

Figure 2.3.2-3. Oyster Creek - Block groups with higher poverty rate.



Source: U.S. Census Bureau, 2016-2020 American Community Survey 5-Year Estimates.

Figure 2.3.2-4. BL England - Block groups with higher poverty rate.

2.3.2.1.6 Climate Change

Because of the overlap between climate change and environmental justice in Executive Order 14008, at the request of USEPA, Ocean Wind has used the EJScreen 2.0 tool, which includes new layers for climate change. EJScreen was used to address USEPA's goal to reduce climate pollution, increase resilience to the impacts of climate change, protect public health, deliver environmental justice, and deploy clean energy technology initiatives. EJScreen is an environmental justice mapping and screening tool that provides USEPA with a nationally consistent dataset and approach for combining environmental and demographic indicators. EJScreen provides demographic and environmental information for a chosen geographic area (up to a maximum of 20 miles). An EJScreen 2.0 analysis was performed using a 20-mile radius around the midpoint of the Wind Farm Area (Latitude 39.117947, Longitude -74.239472). Ocean Wind considered emissions in the Wind Farm Area because the Project is subject to air regulations for emissions on the outer continental shelf in 40 CFR Part 55.

The EJScreen tool combines demographic information with 12 environmental indicators to create 11 Environmental Justice (EJ) Indexes:

1. Particulate Matter 2.5
2. Ozone
3. Diesel Particulate Matter
4. Air Toxics Cancer Risk
5. Air Toxics Respiratory Hazard Index
6. Traffic Proximity
7. Lead Paint
8. Risk Management Plan Facility Proximity
9. Hazardous Waste Proximity
10. Superfund Proximity
11. Underground Storage Tanks (UST) and Leaking UST
12. Wastewater Discharge

The EJScreen report shows the state, regional and national EJ Indexes for the selected area in tabular form and in a bar chart. "Percentiles" are an important part of EJScreen. Every indicator in EJScreen is put into perspective by showing its associated percentiles. The percentiles allow the user to compare a community to the rest of the state, EPA region and nation. For example, the national percentile indicates what percent of the US population has an equal or lower value, meaning less potential for exposure/ risk/ proximity to certain facilities, or a lower percent minority.

The EJScreen report for the 20-mile ring surrounding the midpoint of the Wind Farm Area indicates that although some socioeconomic indicators in the buffer area are higher than the state, regional, or national percentiles, most environmental indicators are lower. For example, 78 percent of the population within the 20-mile ring are people of color, which is higher than the state average of 45 percent, and 57 percent of the population within the 20-mile ring are low-income, which is higher than the state average of 23 percent. The percentage of the population within the 20-mile ring that is linguistically isolated is 16 percent, higher than the state average of 7 percent. In comparison, for the 12 EJ indexes listed above, the 20-mile buffer is higher than the state average for only 3 indexes: Traffic Proximity (81st percentile), Lead Paint (60th percentile), and Underground Storage Tanks (80th percentile).

The full EJScreen Report is included in Appendix V.

Subsistence Fishing

Although USEPA's EJSCREEN 2.0 does not include data on subsistence fishing[19], USEPA has found that "Communities of color, low-income communities, tribes, and other indigenous peoples depend on healthy aquatic ecosystems and the fish, aquatic plants, and wildlife that these ecosystems support. While there are important differences among these various affected groups, their members generally depend on the fish, aquatic plants, and wildlife to a greater extent and in different ways than does the general population. These resources are consumed and used to meet nutritional and economic needs. For some groups, they are also consumed or used for cultural, traditional, or religious purposes" (USEPA 2002).

The State of New Jersey does not have any Federally recognized tribes, nor does the State of New Jersey have any agreements with State-recognized tribes regarding subsistence fishing (ASMFC undated).

2.3.2.2 Potential Project Impacts on Environmental Justice

The potential for impacts on environmental justice can be introduced during construction, operation and maintenance of facilities, and during decommissioning activities. IPFs include the following:

- Air quality
- Noise
- Traffic
- Visible structures/lighting
- Land use, economic change

Within the Onshore Project Area, there are minority and low-income communities. Potential impacts to these communities are associated with onshore and offshore construction activities.

While the proposed WTGs will not generate air emissions during operation, the Project will emit air pollutants during construction, operation, and decommissioning phases. Impact producing factors are air emissions resulting from Project-related traffic during these project phases. As explained in section 2.1.3, the air emissions from these phases of the Project will be offset by the Project's displacement of fossil fuel-generated electricity on the regional power grid for 35 years, the lifespan of the Project, and would result in a net reduction in air pollution.

2.3.2.2.1 Construction

Air pollutants will be emitted during construction. Emissions associated with Project construction equipment will be temporary and cease at completion of construction. Project related air emissions over the two-year construction period will have minor localized impacts to air quality. These impacts will be temporary during construction; estimates of regulated air pollutants are presented in Section 2.1.3. Ocean Wind will comply with proposed APMs and permit conditions related to air emissions.

Additionally, to support the issuance of the OCS air permit, the Project is required to demonstrate that air pollutants emitted during construction will not cause or contribute to an exceedance of the NAAQS or potentially adversely impact ambient air quality. The Environmental Appeals Board has recognized that compliance with the NAAQS is "emblematic of achieving a level of public health protection that, based on the level of protection afforded by a primary NAAQS, demonstrates that minority or low-income populations will not experience disproportionately high and adverse human health or environmental effects due to the exposure to relevant criteria pollutants."[20]

[19] Personal communication with USEPA (2022).
[20] Environmental Appeals Board order In re Shell Gulf of Mexico, Inc. & in re Shell Offshore, Inc., 15 E.A.D. 103, 156 (December 30, 2010).

Noise generated from construction activities would include pile driving, dredging, increased traffic, and activities such as trenchless drilling and excavation. Noise and traffic may be notable at times within the immediate construction areas, but are expected to be localized and temporary. Ocean Wind would comply with proposed APMs and proposed permit conditions related to noise level restrictions.

Potentially adverse environmental impacts associated with construction of the Project would be minimized and/or mitigated, as applicable, and are not characterized as high and adverse. The location of facilities within minority and low-income block groups are not disproportionate to the project facilities located outside environmental justice areas. The sites of project facilities were dictated by a number of screening criteria as presented in Volume I, and were not influenced by demographics. Based on environmental analysis, the Project would not cause a disproportionate share of high and adverse environmental or socioeconomic impacts on any racial, ethnic, or socioeconomic group.

In accordance with the goals of these Executive Orders, the New Jersey Office of Environmental Justice, and guidance from the Council on Environmental Quality (1997) and USEPA (2016), Ocean Wind has and will involve the public throughout the development of the Project. Ocean Wind has established a website (http://oceanwind.com/en) and maintains an active Twitter account, @OceanWindUS.

2.3.2.2.2 Operations and Maintenance

During Project operations, the Project would result in a net reduction of regional air pollution (and associated health and environmental benefits), which would benefit all communities, including low income and minority communities. The operation and maintenance of onshore export cables and potential onshore substations within minority and low-income block groups would not cause a disproportionate share of high and adverse environmental or socioeconomic impacts on any racial, ethnic, or socioeconomic group.

2.3.2.2.3 Decommissioning

The impacts of decommissioning of project facilities in minority and low-income block groups, including removal of export cables and substations, would be similar to the impacts during construction.

2.3.2.2.4 Summary of Potential Project Impacts on Environmental Justice Resources

The IPFs affecting environmental justice include air emissions, noise, traffic, visible structures/lighting, and land use and economic change.

The Project would not cause a disproportionate share of high and adverse environmental or socioeconomic impacts on any racial, ethnic, or socioeconomic group.

It is likely that not all emissions from the Project will reach onshore populations, as described in Section 2.1.2.3. Furthermore, the benefits of the Project's 1.2 GW of renewable energy will result in a net beneficial impact on climate change over the life of the Project.

2.3.2.3 Avoidance, Minimization, and Mitigation Measures

The proposed measures for avoiding, minimizing, reducing, eliminating, and monitoring environmental impacts for the Project are presented in **Table 1.1-2**.

2.3.3 Recreation and Tourism

This section summarizes information on recreation and tourism, including recreational fishing in the Project Area and assesses the potential impacts of Project-related activities on these resources. For the purpose of identifying and assessing recreation and tourism, this area includes the Onshore Project Area (i.e., landfalls, onshore export cable corridor, onshore substation, and grid connections) and the Offshore Project Area (offshore export cable corridor and the Wind Farm Area) in Ocean, Atlantic, and Cape May Counties.

2.3.3.1 Affected Environment

The coastal communities in the Project Area are popular recreation and tourism areas, which contribute to New Jersey's nearly $40 billion tourism industry (NJDEP 2014a).

2.3.3.1.1 Offshore Project Area Overview

As discussed in more detail below, the Jersey Shore offers a variety of recreational activities including boating, swimming, surfing, scuba diving, sailing, and paddle sports.

Recreational boating activities occur along the coastline, especially during the summer months (MARCO 2018). Swimming is also popular during the summer months along the miles of white sand beaches in New Jersey (NJDEP 2018j). Surfing can occur year-round with the prime season in the fall (New Jersey Division of Travel and Tourism 2018a). Surfers frequent several towns and cities along the coastline, including Ocean City and Atlantic City (New Jersey Division of Travel and Tourism 2018a). Scuba diving and snorkeling are identified as a dominant use offshore from approximately Atlantic City south through the coastline of Cape May County (NJDEP 2018j) with dive sites that include shipwrecks, artificial reefs, beach dives, and various inland sites. The sailing season typically runs from May to October in New Jersey (New Jersey Division of Travel and Tourism 2018b) and primarily occurs in relatively small areas within the bays and inlets and just along the coastline (NJDEP 2018j).

There is a large and robust recreational fishery in New Jersey. Collectively, there have been close to 74 million recreational angler trips (i.e., party boats, rental/private boats, and shore) made in New Jersey from 2012 to 2017 (NOAA 2018a), **Table 2.3.3-1**. There are several areas classified as Prime Fishing Areas by the NJDEP, which are areas that have a history of supporting a significant local quantity of recreational and commercial fishing activity (NJDEP 2003) (See Section 2.3.4, Commercial Fisheries and For-Hire Fisheries). Popular recreational saltwater species in New Jersey are identified in **Table 2.3.3-2**. The majority of species can be caught from May to October.

Recreational crabbing is particularly important to the region and occurs primarily along the bays and creeks on the Jersey Shore (New Jersey Leisure 2018), especially in the upper portion of Barnegat Bay, Little Egg Harbor and the Maurice River estuary, which comprise 65 to 86 percent of the total recreational harvest (NJDEP 2018h). The peak crabbing season occurs from mid-June until early October and is especially good in August (New Jersey Leisure 2018). There are also annual recreational fishing tournaments held in coastal towns in New Jersey. Saltwater fishing tournaments target a variety of fish including stripers, fluke, bluefish, black drum, weakfish, northern kingfish, sea bass, tautog, tuna, and shark.

Table 2.3.3-1. Number of angler trips by mode for inland and oceanic waters in New Jersey, 2012 - 2017.

Year	Inland (does not include freshwater areas)				Ocean (≤3 miles)				Ocean (> 3 miles)			Total
	Party Boat	Private/ Rental Boat	Shore	Total	Party Boat	Private/ Rental Boat	Shore	Total	Party Boat	Private/ Rental Boat	Total	
2012	67,356	4,585,601	7,027,143	11,680,100	34,648	1,598,835	3,631,755	5,265,238	112,446	922,345	1,034,791	17,980,129
2013	126,735	3,872,031	4,585,736	8,584,502	66,630	1,556,635	4,173,197	5,796,462	142,111	1,047,001	1,189,112	15,570,076
2014	70,750	4,104,480	7,588,420	11,763,650	59,760	1,375,434	2,670,829	4,106,023	131,145	779,606	910,751	16,780,424
2015	81,169	3,140,889	4,932,265	8,154,323	35,210	1,410,379	4,089,001	5,534,590	100,976	461,958	562,934	14,251,847
2016	65,023	2,826,976	5,855,149	8,747,148	32,310	1,333,248	3,021,463	4,387,021	61,789	580,891	642,680	13,776,849
2017	32,874	2,628,587	4,680,087	7,341,548	33,870	1,681,361	2,544,538	4,259,769	78,739	538,404	617,143	12,218,460
											Total	**73,797,361**

Source: NOAA 2018a

Table 2.3.3-2. Popular fish species targeted by recreational fishers off New Jersey.

Species	General Location of Species			Mode to Catch Species		Month to Catch Species (may vary with fishing regulations)											
	Surf	Bays	Deep Sea	Shore	Boat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Black Drum		X			X					X	X						
Black Sea Bass		X	X	X	X					X	X	X	X	X	X	X	
Blowfish	X	X		X	X					X				X	X		
Bluefish	X	X	X	X	X					X	X	X	X	X	X	X	X
Blue Crab		X		X	X					X	X	X	X	X	X	X	
Bonito			X		X							X	X	X			
Cod			X		X	X	X	X	X							X	X
Croaker		X	X		X							X	X	X	X		
Dolphin (Mahi Mahi)			X		X							X	X	X	X		
False Albacore			X		X								X	X	X		
Fluke (Summer Flounder)	X	X	X	X	X					X	X	X	X	X	X		
Hard Clam (Quahog)		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X

Species	General Location of Species			Mode to Catch Species		Month to Catch Species (may vary with fishing regulations)											
	Surf	Bays	Deep Sea	Shore	Boat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Kingfish		X	X	X	X							X	X	X			
Ling (Red Hake)			X		X	X	X	X	X	X	X	X	X	X	X	X	X
Mackerel	X		X	X	X				X	X							
Marlin			X		X							X	X	X			
Porgy (Scup)		X	X		X								X	X	X		
Shark	X	X	X	X	X						X	X	X	X	X		
Spot		X		X	X						X	X	X	X			
Striped Bass	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X
Tautog	X	X	X	X	X				X	X	X	X	X	X	X	X	
Tuna			X		X							X	X	X	X	X	
Weakfish	X	X	X	X	X					X	X	X	X	X	X	X	
Whiting (Silver Hake)	X		X	X	X	X	X	X	X	X						X	X
White Perch		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Winter Flounder		X		X	X	X	X	X	X	X						X	X

Source: NJDFW n.d.-b

2.3.3.1.2 Onshore Project Area Overview

In the Project Area, there are several natural areas, parks, open spaces, and wildlife management areas[21], which attract local recreationists and tourists alike. There have been over 1.5 million acres of open space and farmland preserved throughout the State (NJDEP 2014a) and more than 352,000 acres of wildlife management areas, which are prime locations for hunting, birding, wildlife viewing and photography, cross country skiing, hiking, biking, and other activities (NJDFW 2018b). In October 1992, a total of 129 miles of the Great Egg Harbor River and its tributaries, which is located adjacent to the proposed BL England interconnection point, were designated as a National Scenic and Recreational River through the National Park Service Wild and Scenic River System (NPS 2018).

State- and county-owned land in the BL England study area includes seven designated wildlife management areas (this includes one unnamed wildlife management area, Oyster Creek Fishing Access, Absecon Lighthouse Historic Site, Senator Frank S. Farley State Marina, and three Natural Land Trust preserves). In the BL England area, coastal recreation activities are concentrated along the shoreline of the Atlantic Ocean; however, there are some pockets of coastal recreation activity in Lakes Bay and Great Egg Harbor Bay, NJ (MARCO n.d.). Shore-based activities, surface water activities, and wildlife and sightseeing activities are less popular in this area with the exception of points along the Absecon Inlet, north of Atlantic City and south of Brigantine, and the northern tip of Ocean City near the Great Egg Harbor Inlet (MARCO n.d.). Underwater activities are almost non-existent in the BL England area, with a very low number of patrons participating in free diving/snorkeling in the Absecon Inlet, the Great Egg Harbor Bay, and off the northern coast of Ocean City (MARCO n.d.). Recreational boating routes are highly concentrated in Great Egg Harbor Bay and Great Egg Inlet, with mid-level concentrations in Absecon Inlet (MARCO n.d.).

State- and county-owned open space located in the Oyster Creek study area includes one Ocean County Natural Lands Trust property (Sands Point Harbor Preserve), the Barnegat Branch Trail, and Island Beach State Park, Barnegat Light House State Park, and Forked River and Sedge Island Mountain wildlife management areas. Baseline studies of coastal and ocean recreation use patterns reveal that coastal recreation activities in the Oyster Creek area are more concentrated on the ocean side and bay side of the barrier island (i.e., Long Beach Island), as opposed to the coastline of mainland New Jersey that borders the western side of Barnegat Bay (MARCO n.d.). Barnegat Light and Island Beach State Park are the primary areas in the Oyster Creek area where shore-based activities, surface water activities, and wildlife and sightseeing activities are popular (MARCO n.d.). Bay Parkway has public use access points for shoreline fishing. Recreational boating routes are highly concentrated in Barnegat Bay and the Barnegat Inlet (MARCO n.d.). Several waterfront homes on the mainland side of the bay have docks for boats.

General information on recreation and tourism within each county (i.e., Ocean, Atlantic, and Cape May Counties) is discussed in greater detail below.

2.3.3.1.3 Ocean County

Ocean County is located in the center of the Jersey Shore region and is approximately 916 square miles (BOEM 2012a). The county provides an array of recreational beaches, boardwalks, and wildlife areas. There are 19 beaches, six harbors, and nearly 50 marinas/boatyards, and 25 yacht clubs (BOEM 2012a). Beaches in the county vary from remote, undeveloped areas, to more developed stretches with shops, restaurants, and amusement rides. The majority of tourism in Ocean County is focused on barrier beaches, such as Island Beach State Park, as well as the natural, shoreline areas. Island Beach State Park is a narrow barrier island

[21] Wildlife Management Areas are multi-use public lands administered by the NJDFW and managed by the New Jersey Division of Bureau of Land Management. They are maintained and managed for a diversity of wildlife species through forest/field manipulation and habitat improvement, as well as for public access (NJDFW 2018b).

stretching for 10 miles between the Atlantic Ocean and historic Barnegat Bay (NJDEP 2018i) (**Figure 2.3.3-1**). Popular activities in these areas include sunbathing, swimming, and beachcombing. The shoreline is also popular for recreational fishing, with multiple bait and tackle shops, marinas, boat rentals, and public fishing piers. Other popular activities in the county include hiking, biking, kayaking, golfing, and sightseeing (Ocean County Department of Parks and Recreation 2018).

Ocean County also has 27 parks and conservation areas, with over 4,000 acres of preserved and well-maintained land, including the Fork River Mountain Wildlife Management Area, which consists of approximately 2,100 acres (NJDFW 2018b). The Edwin B. Forsythe National Wildlife Refuge, which consists of more than 47,000 acres of coastal habitats (USFWS 2018d) and provides wildlife viewing and nature trails (USFWS 2009). The Barnegat Lighthouse State Park is located on the northern tip of Long Beach Island and provides panoramic views of Barnegat Inlet and provides trails through maritime forests, birding sites for waterfowl, fishing sites, and nature walks (Division of Travel and Tourism 2018).

There were 1,145 accommodation and food service establishments in the county in 2012 (USCB 2012). Together, these generated over $802 million in annual sales (USCB 2012). There were 258 arts, entertainment, and recreation establishments in Ocean County, which brought in approximately $391 million in revenue (USCB 2012). Approximately 15.1 percent of all housing units in Ocean County are for seasonal, occupational, or occasional use (USCB 2010).

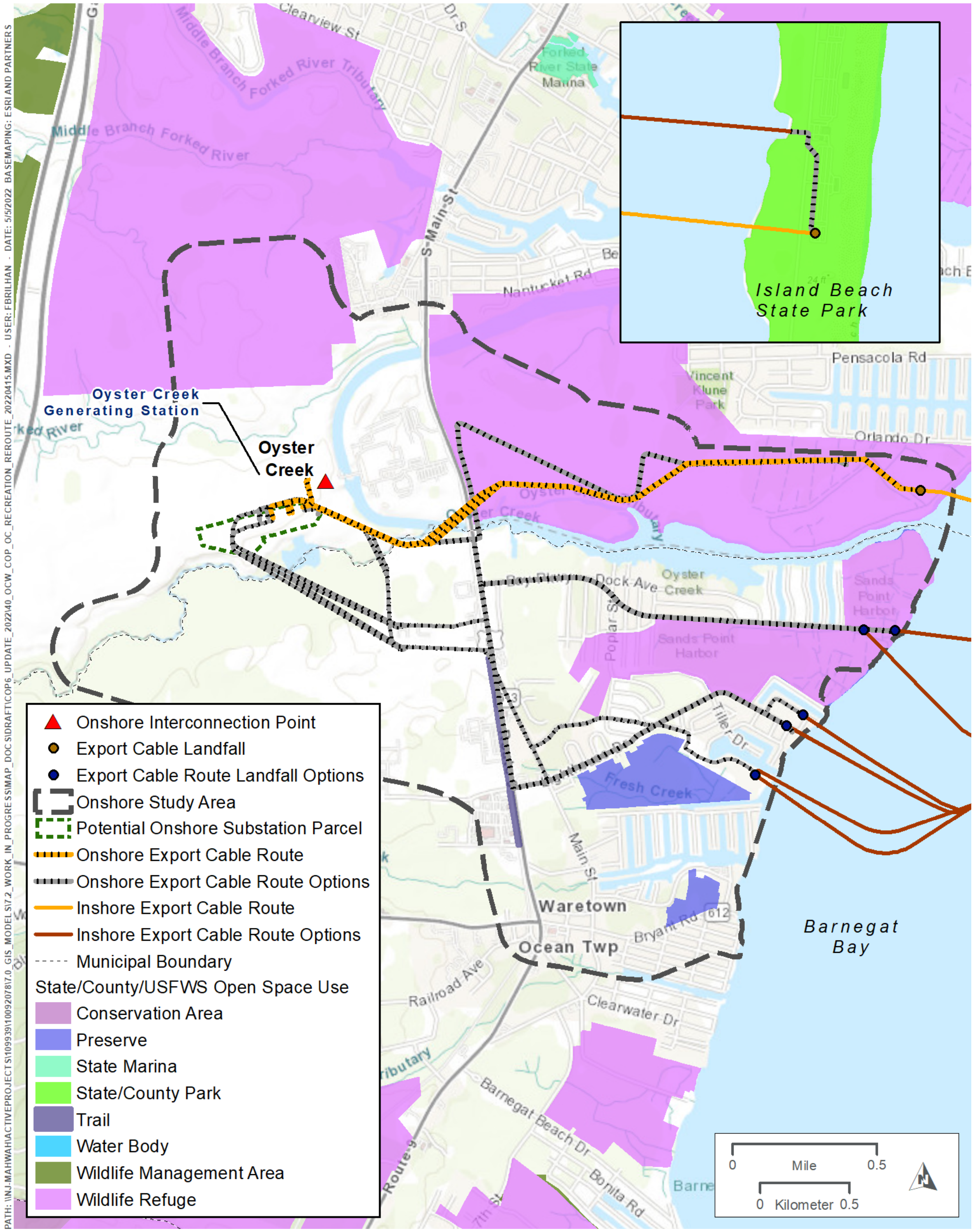


Figure 2.3.3-1. Recreation areas within the Oyster Creek study area in Ocean County.

2.3.3.1.4 Atlantic County

Atlantic County lies in the southern peninsula of New Jersey and encompasses approximately 671 square miles (BOEM 2012a). There are 9 harbors, 12 marinas/boatyards, and one yacht club (BOEM 2012a). The county is best known for its boardwalk along the beach of Atlantic City, which is the largest casino resort area on the east coast comprised of twelve 24-hour, seven day a week, casinos with restaurants, nightclubs, and game rooms. It has approximately 20 miles of shoreline with four public beaches, which collectively total over 14 miles (BOEM 2012a). There are several boat launches and marinas in the county, which include small boat rentals (Atlantic County 2018). Recreational fishing is permitted on the beaches, outside of guarded areas, and from the jetties. There are also multiple fishing piers available to the public. The seawall is a popular area for fishing and crabbing.

A majority of the Tuckahoe-Corbin City Fish and Wildlife Management Area is located within the county and consists of approximately 17,500 acres of tidal marsh, woodlands, fields, and impoundments (USFWS 2018e) (**Figure 2.3.3-2**). The approximate 96-acre Malibu Beach Wildlife Management Area and 867-acre Pork Island Wildlife Management Area are also located in Atlantic County (NJDFW 2018b).

According to the most recent U.S. Census Bureau data available, there were 860 accommodation and food service establishments in the county in 2012 (USCB 2012). Together, these generated over $4.0 billion in annual sales (USCB 2012). There were 123 arts, entertainment, and recreation establishments in Atlantic County, which brings in approximately $103 million in revenue (USCB 2012). Approximately 12.0 percent of all housing units in Atlantic County are for seasonal, occupational, or occasional use in (USCB 2010).

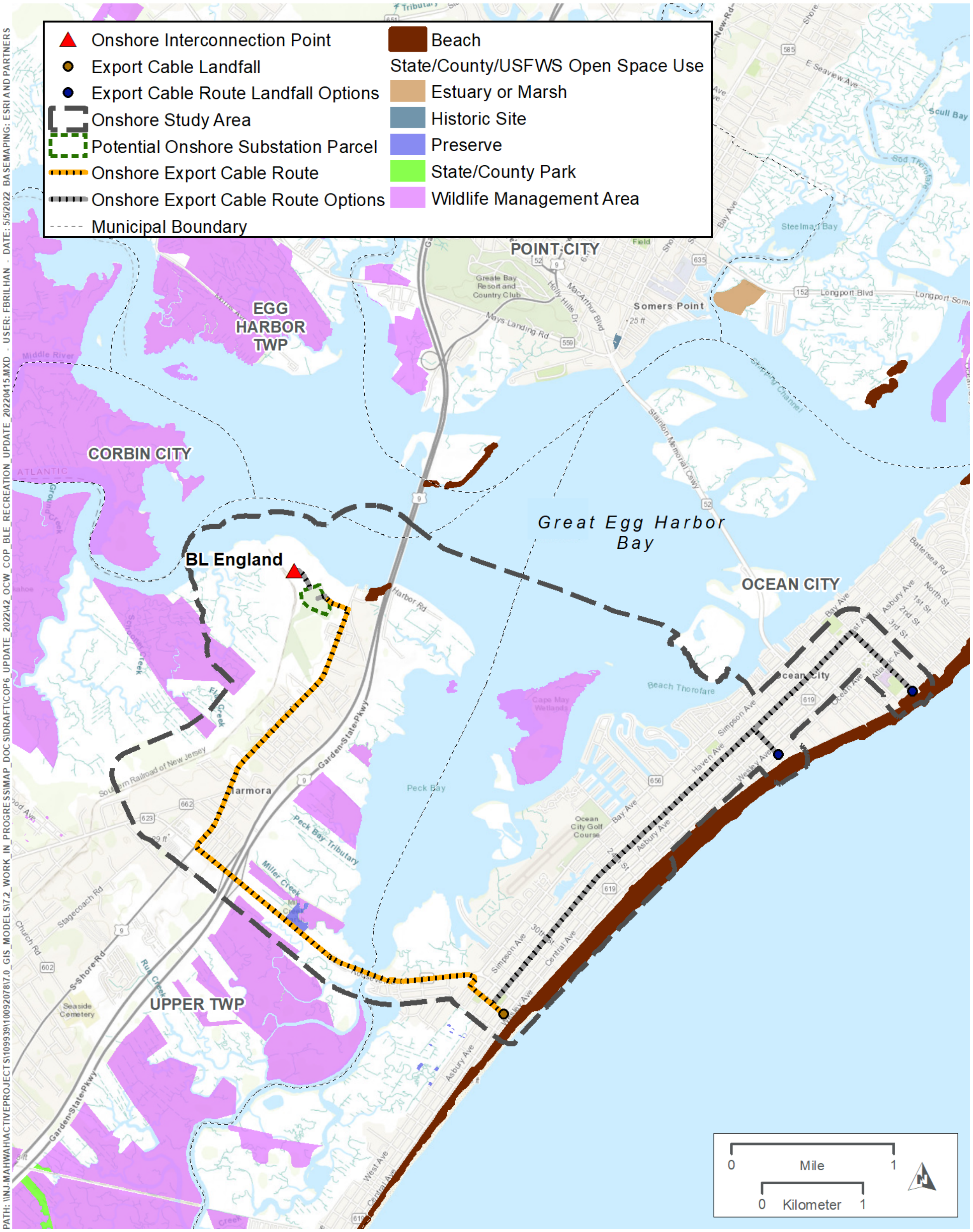


Figure 2.3.3-2. Recreation areas within the BL England study area in Cape May County and Atlantic County.

2.3.3.1.5 Cape May County

Cape May is New Jersey's southern-most county and encompasses 620 square miles (BOEM 2012a). It has 30 miles of shoreline and is considered one of the premiere remote beach destinations along the Mid-Atlantic coast (BOEM 2012a). As a result, it is visited by millions every year (Cape May County 2018). The county has about 14 beaches, six harbors, 32 marinas/boatyards, and six yacht clubs (BOEM 2012a). It has two boardwalk beaches, but the majority of oceanfront property is undeveloped with few stores, beachside amenities, and amusement rides (BOEM 2012a). Popular activities at the boardwalks include shopping, dining, rides, and walking along the boardwalk. The more remote beaches are utilized for sunbathing, swimming and beachcombing. Surfing, sailing, boating, fishing, diving, and kayaking are also popular offshore activities. Recreational fishing occurs along the back bays and from the surf, piers and boats along the Jersey Cape (Cape May County 2018).

There are many parks, State forests, and wildlife management areas in Cape May County. The Cape May National Wildlife Refuge encompasses 11,500 acres of grasslands, saltmarshes, and beachfront (BOEM 2012a) (**Figure 2.3.3-2**). The Cape May Coastal Wetlands wildlife management area extends along the coast of Cape May County and occupies approximately 17,800 acres (NJDFW 2018b).

According to the most recent U.S. Census Bureau data available, there were just over 900 accommodation and food service establishments in the county in 2012 (USCB 2012). Together, these generated over $593 million in annual sales (USCB 2012). Additionally, there were approximately 140 arts, entertainment, and recreation[22] establishments in the county that brought in approximately $151 million in revenue in 2012 (USCB 2012). Approximately 49.7 percent of all housing units in Cape May County are for seasonal, occupational, or occasional use (USCB 2010).

2.3.3.2 Potential Project Impacts on Recreation and Tourism

As discussed above, the New Jersey Shore provides onshore and offshore recreation and tourism opportunities year-round. Offshore wind projects can provide both benefits and impacts based on public and community support for the Project. Project impacts on recreation and tourism would be primarily associated with the development of visible structures/lighting in the Wind Farm Area including WTGs and offshore substations, as well as onshore, through the development of onshore substations. The development of underground cables does not typically preclude recreational and tourist activities. Factors that may impact recreation and tourism are as follows, and discussed in the following sections:

- Physical seabed/land disturbance
- Habitat conversion
- Noise
- Traffic
- Visible structures/lighting
- Land use, economic change
- Sediment suspension
- EMF

Sediment suspension is discussed in Section 2.1.2.2, Water Quality; Section 2.2.5.2, Benthic Resources; and Section 2.2.6.2, Finfish and EFH. EMF is discussed in Sections 2.2.5.2 and 2.2.6.2.

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[22] The arts, entertainment, and recreation sector includes a wide range of establishments that operate facilities or provide services to meet varied cultural, entertainment, and recreational interests of their patrons (USCB 2012).

2.3.3.2.1 Construction

The Ocean County Natural Lands Trusts lands along Bay Parkway could be impacted by landfall workspace. Impacts would include temporary ground disturbance and excavation of HDD pits associated with onshore HDD landfall workspace. The impacts would be temporary during construction, and the areas would be restored to preconstruction conditions following construction.

Public access to the Wind Farm Area, offshore export cable corridors, and Onshore Project Area would be temporarily restricted during construction activities in the immediate area of construction activities. Within the Wind Farm Area and offshore export cable corridors, there are prime fishing areas that would not be accessible when vessels were on site conducting construction activities. Other popular offshore recreational activities (e.g., boating, swimming, surfing, scuba diving, sailing, paddle sports, and whale watching) would also be limited near construction activities.

The noise, traffic, and visual impacts generated during construction activities may also temporarily deter recreation in the Offshore Project Area. Within the Wind Farm Area and offshore export cable corridors, noise generated from construction activities would include pile driving, dredging and other site preparation activities, installation of the offshore export cable and WTGs, and increased vessel traffic. Airborne noise monitoring was conducted during active construction periods at the Block Island Wind Farm to observe and measure levels of airborne noise produced during installation of the wind turbine foundations (HDR 2018). Noise levels were measured at onshore and offshore locations. Noise during piling was always audible at the closest coastal measurement station (3.1 miles from piling), intermittently audible at a mid-point coastal location (7 miles from piling), and was never audible at the furthest location (17 miles from piling). At the closest station (3 miles from piling), noise levels were measured at over 50 dB LAeq,1s[23], more than 10 decibels (dB) above background noise levels. Overwater, the piling noise was barely audible at 7 miles downwind (127 dB weighted energy-averaged sound level at approximately 1 mile from the pile). Of all construction-related sources of noise, pile driving generates the highest level (HDR 2018); therefore, the noise generated by other sources would be expected to emit substantially lower levels. Impacts to recreation and tourism from noise will be temporary and distant, as the proposed Project will be built 15 miles offshore. Ocean Wind will coordinate offshore construction activities with annual fishing tournaments and boat races.

Access to specific areas utilized by recreational users and tourists may be temporarily restricted during the construction phase of the Onshore Project Area, which could result in short-term traffic or pedestrian diversions and exclude recreational users and tourists from accessing certain areas. Ocean Wind will coordinate construction activities to try to avoid community events (e.g., annual marathons or parades) and, as noted in **Table 1.1-2**, develop a construction schedule to minimize activities in the onshore export cable corridors during the peak summer recreation and tourism season, where practicable.

Within the Onshore Project Area, noise would be generated from such activities as trenchless drilling, installation of the onshore export cables, and construction of the substations. Construction activities would generate additional vehicular traffic in the area. Noise and traffic may be notable at times within the immediate construction areas, but is expected to be localized and temporary.

BOEM conducted a qualitative analysis of impacts on recreational fisheries for the construction phases of offshore wind development in the Atlantic OCS region (Kirkpatrick *et al.* 2017). Results showed the construction phase is expected to have a slightly negative to neutral impact on recreational fisheries due to both direct exclusion of fishing activities and displacement of mobile target species by the construction noise. Recreational

[23] The A-weighted, Equivalent Average Sound Pressure Level.

anglers have a wide variety of options for offshore fishing destinations and should have suitable alternatives to fish if displaced from within the array (Kirkpatrick *et al.* 2017).

Construction activities would be temporary and localized. The New Jersey Shore is 127 miles and there is a vast amount of recreation and tourism resources available within the State; as such, recreational users and tourist activities are expected to utilize other areas for similar uses.

2.3.3.2.2 Operations and Maintenance

Access to the Wind Farm Area would not be limited during the operation of the Project. The operation of the Wind Farm Area is expected to have benefits on recreational fishing and other offshore recreation/tourism activities as seen at Block Island, Rhode Island, with the development of the Block Island Wind Farm. Recreation and tourism activities within these areas are anticipated to be consistent with pre-existing conditions, while recreational fishing could increase.

Operational noise would not be expected to deter recreational uses in the vicinity of the Wind Farm Area. Noise generating activities during operation and maintenance would consist primarily of vessel traffic and service and maintenance equipment and vessels that would be similar to construction activities, but would be limited to specific areas and occur over short periods of time.

Operation and maintenance activities would also result in visible disturbances, including lighting of the turbines, as required for navigation and aviation safety. Results of the Visual Impact Assessment are discussed in Section 2.3.5. BOEM and NOAA funded a study conducted by Parsons and Firestone (2018), *Atlantic Offshore Wind Energy Development: Values and implications for Recreation and Tourism*. The report presented results of a stated-preference survey designed to estimate the potential impact of offshore wind development on recreational beach use on the East Coast of the United States. Individuals were questioned about their reaction to wind energy projects from distances ranging from 2.5 to 20 miles (2.2 to 17.4 nm) offshore. Attention in this report is focused on the results ranging from 12.5 to 20 miles since most BOEM leases and planning areas for wind energy projects are close to this range. At 12.5 miles (10.9 nm) offshore, 20 percent of the respondents reported that their experience would have been worsened by the turbines, 13 percent reported that it would have been improved, and 67 percent reported no effect. At 20 miles (17.4 nm), the shares were 10 percent worse, 17 percent better, and 73 percent no effect. A “break-even point” occurred at 15 miles (13 nm), where the percentage worse and better were about the same (Parsons and Firestone 2018). These results indicated that the visual disturbance of the Ocean Wind Project, located 15+ miles offshore, would be viewed by more than 80 percent of recreation users as having no effect or improving their experience.

2.3.3.2.3 Decommissioning

Impacts of Project decommissioning would result in temporary impacts that would be less than or equivalent to those associated with construction.

2.3.3.2.4 Summary of Potential Project Impacts on Recreation and Tourism Resources

The IPFs affecting recreation and tourism include physical seabed/land disturbance, habitat conversion, noise, traffic, visible structures/lighting, land use and economic change, sediment suspension, and EMF.

During Project operations, recreation and tourism activities are anticipated to be consistent with pre-existing conditions, and result in slight benefits on recreational fishing and other offshore recreation/tourism activities. Other impacts would be short-term. The noise, traffic, and visual impacts generated during construction activities may temporarily deter recreation in the Offshore Project Area and the Onshore Project Area. Access would only be restricted to isolated areas along the Offshore Project Area and Onshore Project Area for maintenance activities.

2.3.3.3 Avoidance, Minimization, and Mitigation Measures

The proposed measures for avoiding, minimizing, reducing, eliminating, and monitoring environmental impacts for the Project are presented in **Table 1.1-2**.

2.3.4 Commercial Fisheries and For-Hire Recreational Fishing

Marine resources along the New Jersey coast generate recreational and commercial fish revenues of about $4.5 billion annually (NJDEP 2010b) and support a tourism industry worth $16 billion. In 2015, the seafood industry supported 1.2 million full-and part-time jobs and generated $6.0 billion in sales, $1.3 billion in income, and $2.1 billion in value-added impacts to New Jersey (NMFS 2017b). Recreational fishing trips reported for New Jersey numbered 4.3 million in 2015, generating more than $1.8 billion in sales impacts, $0.8 billion in income impacts, and $1.2 billion in value-added impacts. Commercial fisheries in New Jersey may include over 100 different species of finfish and shellfish, the most economically important being Atlantic sea scallops, surfclams, Atlantic mackerel, hard clams, blue crabs, ocean quahogs, summer flounder, monkfish (also known as goosefish), Atlantic herring, and American lobster (NJSGC n.d.).

This section summarizes information about commercial fisheries and for-hire recreational fishing in the Project Area that are likely to be affected by the Project related activities.

2.3.4.1 Affected Environment

2.3.4.1.1 Fisheries Management

Fisheries resources that occur within State waters (from the New Jersey shoreline extending out 3 miles) are managed by the State and resources that occur in Federal waters (the U.S. EEZ extends from 3 to 200 nm off the coast) are managed by NOAA under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended, 16 USC. § 1801 et seq. The MSA created eight regional fishery management councils charged with the development of fishery management plans with the goal to provide fishing opportunities and create economic benefits in their region, while also meeting conservation and management requirements. These plans propose rules for fishermen operating in Federal waters and include fishing seasons, quotas, and closed areas. Council members represent the commercial and recreational fishing sectors in addition to environmental, academic, and government interests. Management plans developed by the regional councils go through a public review process that involves stakeholders, government, researchers, and the fishing industry, and are implemented by NMFS, an office of NOAA.

The Atlantic States Marine Fisheries Commission (ASMFC) represents the fifteen Atlantic coast states that work together to manage migratory species within multiple state jurisdictions. The ASMFC coordinates with NOAA and the regional councils in the management of Atlantic coastal fishery resources. Species managed only in State waters include the American eel, Atlantic croaker, Atlantic menhaden, American shad and river herring, red drum, horseshoe crab, and northern shrimp. American lobster is managed under the authority of the Atlantic Coastal Act and not under the MSA. The lobster resource and fishery are cooperatively managed by the states under the framework of the ASMFC and the NMFS in Federal waters. American lobster is managed under Amendment 3 of the Interstate Fishery Management Plan (FMP) and its Addenda (I - XXVI). Three coastal migratory stocks occur for lobster: Gulf of Maine, Georges Bank, and Southern New England. The stocks are further divided into seven management areas. The Project Area falls within the Inshore and Offshore Southern Mid-Atlantic (Area 5) lobster management area.

Fishery resources within the Project Area are managed by the MAFMC, NEFMC, ASMFC, and NMFS (**Table 2.3.4-1**).

Table 2.3.4-1. Management responsibility for species fished in Federal waters off the coast of New Jersey.

Species/Group	Fishery Management Authority			
	MAFMC	NEFMC	ASFMC	NOAA/NMFS
Finfish & Others				
Atlantic herring		X	X	
Atlantic mackerel	X			
Bluefish	X		X	
Butterfish	X			
Goosefish (also called monkfish)	X	X		
Scup	X		X	
Sea bass	X		X	
Spiny dogfish	X	X	X	
Squid	X			
Summer flounder	X		X	
Tilefish	X			
Northeast multi-species groundfish		X		
Coastal migratory pelagics			X	
Highly migratory species				X
Shellfish				
Surfclam and ocean quahog	X			
Atlantic sea scallop		X		X
American lobster[1]				X

[1] The American lobster is cooperatively managed by ASMFC in state waters and the NMFS in Federal waters.

The NJDFW oversees commercial fishing for New Jersey. Within the NJDEP, the Marine Fisheries Council advises the commissioner in the planning, development, and implementation of all departmental programs related to marine and shellfish, has the authority to disapprove proposed regulations, contributes to fishery management plans and studies and analyses economic, social and ecological data relating to the operation of the marine fisheries program (New Jersey Statutes Annotated [N.J.S.A.] 23:2B). The Shellfisheries Council advises the Commissioner of the NJDEP specifically on regulations for the management and conservation of the sea clam resource and industry (N.J.S.A. 50:2-6.3) and sets the terms and fees for leasing shellfish grounds (N.J.S.A. 50:1-27).

2.3.4.1.2 Commercial Fishing Ports

There are six major commercial fishing ports in New Jersey (Atlantic City, Barnegat Light, Belford, Cape May, Point Pleasant, and Port Norris), four of which rank in the top fifty ports in the country in terms of economic value (NJSGC n.d.). The economic benefits associated with the commercial fishing industry extend far beyond the industry itself and can provide direct economic support to other waterfront industries and surrounding communities. Commercial fishing in the Project Area may occur out of any of these major ports and may also include ports outside of New Jersey.

The ports likely to be most affected by development within the NJ WEA as measured by total revenue are those that process clams in the region—Atlantic City, NJ; Cape May, NJ; and Newport News, VA (Kirkpatrick *et al.* 2017). Menhaden fishing also occurs in the NJ WEA and accounts for significant landings in New Jersey and Virginia, but is not represented in the Federal data. Data on purse seine fishing indicates landings are sent primarily to Cape May, NJ and Gloucester, MA.

A brief description of each port using information provided from NOAA Fisheries Greater Atlantic Region (NOAA Fisheries Greater Atlantic Region n.d.), is provided below. Commercial fishermen active in the Project Area may be operating from harbors in addition to those described below (NOAA Fisheries n.d.).

Atlantic City, NJ

Atlantic City's commercial fishing fleet is largely conducted by larger vessels, 70 to 150 ft in length, equipped with hydraulic dredges. Atlantic City's fishery provides much of the world's supply of minced clams and clam strips. These products are then trucked elsewhere for processing. In addition to the large commercial clam industry, numerous small-scale fishing operations in Atlantic City fish for clams on the bay side using rakes and tongs or fishing by hand. There are also some clam aquaculture facilities there. In addition to clams, other species landed in port include Atlantic scallop, summer flounder, scup, black sea bass, American lobster, monkfish, bluefish, and butterfish.

In 2013 Atlantic City commercial fishermen caught 27 million pounds of fish. The port ranked 33rd in the country in pounds of fish caught. The vast majority of the catch is surfclams and ocean quahogs. Between the years of 1997-2006 the port averaged over $20.8 million profit from just these two species.

Numerous recreational fishing charters operate out of Atlantic City year-round. Key species caught include flounder, black sea bass, Atlantic cod, striped bass, weakfish, bluefish, tuna, shark, and mahi mahi. Most charter boats exceed 120 ft in length and can accommodate over 150 passengers.

Barnegat Light, NJ

Barnegat Light is a small town located at the northern tip of Long Beach Island that contains one of the most important commercial fishing ports in Ocean County New Jersey. The town relies heavily on commercial fishing year-long along with tourism, but in the winter months, commercial fishing is the mainstay of the economy. Three kinds of fishing are done: scallops, long-line (including tuna, swordfish, mako sharks, tilefish), and net (including monkfish, skate, bluefish, croakers). The boats bring in about 2 million pounds in each category annually. Viking Village, one of Barnegat Light's two commercial docks, is home to 45 commercial fishing boats and is one of the largest suppliers of fish and seafood on the Eastern Seaboard. Each year over 4 million pounds of seafood are packed out of Viking Village and shipped locally and internationally. Also, Blue Water Fishermen's Association is located in Barnegat Light. This association is made up of tuna and sword fishermen, as well as others involved in the commercial fishery of highly migratory species.

Many recreational and charter fishing boats can be found in Barnegat Light and surrounding communities, along with marinas, boat rental facilities, and bait and tackle shops. The two largest docks have 36 full-time resident commercial boats, working year-round, as well as recreational vessels and transient vessels. Charters offer in-shore and deep-sea fishing and party boat trips. The Beach Haven Charter Fishing Association represents many charter boat operators on Long Beach Island. The Recreational Fishing Alliance, a lobbying group, is headquartered near Barnegat Light.

Cape May, NJ

Located on the southern tip of New Jersey, Cape May Seaport is on Cape Island. The combined port of Cape May/Wildwood is among the top 25 producing commercial fishing ports in the country, and the largest commercial fishing port in New Jersey (Cape May County New Jersey n.d.). Commercial fishing is the second largest industry in Cape May County, producing millions of dollars in revenue each year. In 2012 the commercial fishing industry landed 28 million pounds of fish, worth an estimated $72 million (NOAA Fisheries n.d.). In 2013, commercial landings were 20 million pounds, with an estimated value of $35 million. Cape May's fishing industry makes most of its money from the sale of scallops, squid, mackerel, and butterfish. Other species landed in port include summer flounder, scup, black sea bass, surfclams, ocean quahog, lobster, herring and monkfish.

The Cape May/Wildwood port is the center of fish processing and freezing in New Jersey. The primary seafood supply company in Cape May is Cold Spring Fish and Supply Company. This company is the third largest employer in the county, providing 500 jobs. This company specializes in the sale of black sea bass, bluefish, American eel, red hake, tautog, shellfish, and lobster. A large clam cannery based outside of Cape May in Lower Township, Snow's/Doxsee, is the only domestic manufacturer to harvest its own clams and has the nation's largest allocation for fishing and harvesting ocean clams. Lund's Fisheries, Inc. is a freezer plant and a primary producer of various species of fish found along the eastern seaboard. The Atlantic Capes Fisheries Inc., another major seafood exporter, deals with oysters, scallops, clams and squids.

Some of the largest vessels fishing on the East Coast have home ported in the southern end of the Jersey Cape. Commercial fishing fleets are currently located in Sea Isle City at Fish Alley, Wildwood at Ottens Harbor and Two Mile in Lower Township and Cape May at Schellengers Landing.

Party and charter boats go out from February to November and run daily through the peak summer season. In Cape May, the fishing season starts early compared to other coastal towns due to the warmer bay waters that lure mackerel and herring. The early spring season starts with mackerel, herring, striped bass and is followed chronologically by tautog, flounder, weakfish (or sea bass), bluefish, croakers, porgies, shark, marlin, swordfish and tuna. Striped bass return in the fall. The Cape May County Fishing Tournament begins January 1 and closes December 31 each year.

Point Pleasant, NJ

The community of Point Pleasant is located along the Manasquan Inlet in Ocean County New Jersey. Point Pleasant supports a small commercial fleet targeting summer flounder, squid, silver and red hake, and scallops (mostly in local waters) and surfclams among other valuable species. The Fishermen's Dock Cooperative on Channel Drive in Point Pleasant Beach is one of two active fishing cooperatives in New Jersey. The development of the shellfishery here has been key to maintaining a commercial fishing industry in Point Pleasant. Surfclams and ocean quahogs are an essential part of this port's industry, with an increasing number of home port vessels, landings, and level of fishing over the last several years. In addition to surfclams and ocean quahogs, scallops, summer flounder, scup, black sea bass, and lobster are landed here.

Point Pleasant also supports a large recreational fishing fleet where fishermen travel from all over the State and beyond to fish from the numerous party and charter boats, from their own private recreational boats, or to participate in surf-fishing from several key spots. Much of the economy of Point Pleasant and Point Pleasant Beach is based on tourism, and a substantial segment of the tourist population travels to this area to fish. The Recreational Fishing Alliance has played a large role in lobbying the ASMFC and the State to minimize restrictions for the economic health of the recreational fishery. Other recreational fishing groups are also active in Point Pleasant. The Jersey Coast Anglers Association is an association of over 75 saltwater fishing clubs throughout the State. The Greater Point Pleasant Charter Boat Association holds the yearly two-day Mako Mania event, one of the premier shark-fishing tournaments in New Jersey.

Newport News, VA

Fishing vessels from Newport News were identified as fishing in the NJ WEA, primarily for clams and menhaden (Kirkpatrick *et al.* 2017). The commercial fishing port of Newport News is within the larger metropolitan region comprised of Virginia Beach-Norfolk-Newport News-Hampton, Virginia. The Seafood Industrial Park is located in Newport News. More than 70 ocean-going trawlers and 20 inshore fishing vessels have landed seafood products at this port, which contains 4 seafood processors, including a crab processor, and other ancillary fishing support services. The diversity of species landed, and gear types used are high. The top species landed in the larger Hampton region by value are Atlantic sea scallops, summer flounder, scup, and black sea bass. In addition, menhaden is one of Virginia's largest commercial fisheries, with 58 percent of the total coast-wide harvest from 1996 to 2004 coming from the Chesapeake Bay. In 2004, commercial menhaden landings generated about $24 million for the Virginia economy and about 395 full time jobs. Gear types used in these fisheries include: scallop dredge, handlines, haul seines, pound nets, sink gillnets, pots, patent tong for hard clams, and otter trawls. There is also a small amount of pelagic longlining occurring from Hampton, targeting various sharks and tuna.

2.3.4.1.3 Landings and Revenue

Total domestic commercial fishing landings for New Jersey were 190.5 million pounds valued at $170.6 million in 2018 (NMFS 2020a). New Jersey landings ranked second highest in landing weight and value compared to the other Mid -Atlantic States. The total landings and landings revenue for key species and species groups (finfish and shellfish) for the years 2013 to 2017 (NMFS 2018b; NOAA Fisheries n.d.) are presented in **Tables 2.3.4-2** and **2.3.4-3**. While more finfish were landed in terms of weight (5-year average at 79.9 million pounds compared to 50.4 million pounds for shellfish), shellfish landings were valued nearly five times higher than finfish landings (5-year average at $129.2 million compared to $27.1 million for finfish). Atlantic sea scallop is the highest valued fishery at $94.6 million (5-year average), followed by the combined ocean quahog & Atlantic surfclam, Atlantic menhaden, blue crab, and summer flounder. The primary landed commercial species in tonnage are the Atlantic menhaden, and the combined ocean quahog and Atlantic surfclam with five-year average of 61.4 million pounds and four-year average of 18.0 million pounds per year, respectively. Atlantic sea scallop is the most economically valuable species commercially fished in New Jersey with a five-year average value of $94.6 million per year. Not all landings are reported for all species. Some landings data is considered confidential and therefore not disclosable (NOAA Fisheries n.d.). In NMFS (2018c), ocean quahog and surfclam 2017 landings data for New Jersey are listed as 16.5 million pounds and 18.3 million pounds, respectively. The most recently published data found in NMFS (2020) lists ocean quahog 2018 landings data for New Jersey at 17.7 million pounds valued at $17.8 million and surfclam 2018 landings are listed as 17.1 million pounds valued at $14 million (estimated based on an average $0.82 ex-vessel price per pound).

In addition to the direct economic impacts in the way of landings, indirect impacts occur through economic activity generated in the form of sales of fish landed and sales made between businesses and households resulting from the original sale to the seafood industry, employment, and spending by employees on personal and household expenditures. In 2015, commercial fishing in New Jersey supported 37,127 jobs, and had the largest income impacts ($1.4 billion), sales impacts ($6.2 billion), and value-added impacts ($2.3 billion) within the mid-Atlantic region (NMFS 2018b).

Table 2.3.4-2. Total landings of key species/species groups in New Jersey.

Species	Total Landings of Key Species/Species Groups in New Jersey (thousands of pounds)					
	2013	2014	2015	2016	2017	Average
Total Landings	119,912	125,114	148,419	123,565	134,677	130,337
Finfish & Other[1]	61,790	64,901	94,220	62,297	116,461	79,934
Shellfish[1]	58,122	60,213	54,198	61,268	18,216	50,403
Key Species						
Atlantic herring[1]	2,344	4,087	3,428	2,798	3,353	3,202
Atlantic mackerel[1]	46	17	2,188	306	2,778	1,067
Atlantic menhaden[2]	39,685	43,881	72,107	52,817	98,654	61,429
Goosefish[1]	2,231	2,172	1,903	1,885	1,388	1,916
Scup[2]	2,035	2,352	2,982	2,336	1,841	2,309
Skates[2]	2,730	2,820	2,568	2,033	2,610	2,552
Spiny dogfish[2]	1,749	2,202	1,910	3,607	2,367	2,367
Summer flounder[1]	2,004	1,826	1,682	1,286	962	1,552
American lobster[1]	660	526	445	351	409	478
Atlantic sea scallop[1]	5,640	7,133	7,847	10,481	10,961	8,412
Blue crab[1]	4,391	3,233	7,247	6,910	6,410	5,638
Ocean quahog & surfclams[1]	35,960	19,447	18,283	16,492	NA	18,036

[1] Years 2013-2016 from NMFS 2018b - Fisheries Economics for US, 2016. All 2017 data from NMFS n.d.

[2] NMFS Commercial Fisheries Database n.d. (as of January 23, 2019).

NA = These data are confidential and therefore not disclosable.

Skates includes unidentified Skates, Little Skate, and Winter Skate

Table 2.3.4-3. Total landings revenue of key species/species groups in New Jersey.

Species	Total Landings Revenue of Key Species/Species Groups in New Jersey (thousands of dollars)					
	2013	2014	2015	2016	2017	Average
Total Revenue	132,860	149,301	166,181	193,011	140,342	156,339
Finfish & Other[1]	25,951	24,911	29,095	26,218	29,481	27,131
Shellfish[1]	106,909	124,390	137,086	166,794	110,861	129,208
Key Species						
Atlantic herring[1]	401	615	308	292	482	420
Atlantic mackerel[1]	18	12	546	79	596	250
Atlantic menhaden[2]	7,399	5,774	10,687	8,607	16,651	9,824
Goosefish[1]	2,453	2,428	2,364	2,470	1,558	2,255
Scup[2]	1,066	1,207	1,556	1,572	1,128	1,306
Skates[2]	590	730	447	324	435	505
Spiny dogfish[2]	297	352	295	621	401	393
Summer flounder[1]	4,899	4,862	5,059	5,389	4,296	4,901

Species	Total Landings Revenue of Key Species/Species Groups in New Jersey (thousands of dollars)					
	2013	2014	2015	2016	2017	Average
American lobster[1]	2,797	2,380	2,249	1,892	2,245	2,313
Atlantic sea scallop[1]	65,190	87,746	97,856	123,266	99,253	94,662
Blue crab[1]	8,111	4,145	8,704	7,696	8,946	7,520
Ocean quahog & surfclams[1]	22,962	11,455	10,889	9,970	NA	13,819

[1] Years 2013-2016 from NMFS 2018b - Fisheries Economics for US, 2016. All 2017 data from NMFS n.d.

[2] NMFS Commercial Fisheries Database n.d. (as of January 23, 2019).

NA = These data are confidential and therefore not disclosable.

Skates includes Skates, Little Skate and Winter Skate

NMFS conducted an analysis of 2012 landings by distance from shore and found that 52.5 percent of finfish came from within 3 miles of shore and 47.5 percent came from 3 to 200 miles, with none reported in the high seas (NOAA Fisheries n.d.). For shellfish, 15.8 percent of landings by weight came from within 3 miles of shore and 84.2 percent came from 3 to 200 miles from shore. Reviewing data for individual species fisheries, 100 percent of scallops and 88.5 percent of clams came from 3 to 200 miles offshore and 100 percent of blue crab and 11.5 percent of clams came from within 3 miles of shore. For finfish, 63.0 percent of Atlantic menhaden came from within 3 miles of shore while 96 percent of summer flounder and 98 percent of goosefish came from 3 to 200 miles offshore.

Within the New Jersey Wind Energy Study Area[24], the clam dredge, targeting Atlantic surfclam and ocean quahog, was the primary commercial fishing gear utilized in terms of value and landings. The primary landed commercial species in tonnage was the Atlantic surfclam, whereas the Atlantic sea scallop was the most economically valuable species within the New Jersey Wind Energy Study Area (NJDEP 2010b).

The ports of Cape May-Wildwood, Point Pleasant, and Atlantic City ranked highest for commercial fishery landings in New Jersey, and Long Beach-Barnegat ranked third highest in New Jersey based on value. Commercial Fisheries landings data available from NMFS for each of these ports is presented in **Table 2.3.4-4**.

Table 2.3.4-4. Commercial fishery landings for major ports with fishing activity in the Wind Development Area.

Port	Quantity - Million Pounds				Value - Million Dollars			
	2013	2014	2015	2016	2013	2014	2015	2016
Cape May-Wildwood, NJ	20.4	49.9	77.2	46.6	35.3	59.0	71.6	84.7
Point Pleasant, NJ	15.4	24.2	24.4	26.3	23.1	25.8	28.2	32.1
Atlantic City, NJ	27.3	29.9	25.9	24.3	21.4	22.1	19.6	19.7
Long Beach-Barnegat, NJ	8.6	7.1	6.3	7.2	25.3	25.4	25.4	26.9

[24] The New Jersey Wind Energy Study Area borders a barrier island chain along part of the New Jersey shoreline. It encompasses approximately 4,665 square kilometers (km2; 1,360 square nautical miles [NM2]) and stretches from the area adjacent to Seaside Park in the north (approximate latitude [lat]/longitude [lon] 39°55’ 56 seconds ["] N, 74°04’10” West [W]) to Stone Harbor in the south (approximate lat-lon 39°01’58”N, 74°46’11”W) and extends 37 km (20 nm) perpendicular to the shoreline (i.e., 126 x 37 km [68 x 20 nm] in size) and flanked by the Hudson and Delaware rivers (NJDEP 2010).

Port	Quantity - Million Pounds				Value - Million Dollars			
	2013	2014	2015	2016	2013	2014	2015	2016
Hampton Roads Area*, VA	16.5	14.7	11.5	12.3	52.7	52.1	56.4	61.0

*Landings data for the single port of Newport News was not available at this source.
Source: NOAA Fisheries. n.d.

Ocean Wind conducted visits to various fishing interests involved in the area of the Project. Forty-seven interviews were held with commercial and recreational fishermen between July 2019 and January 2020. From those interviews it was determined that there is very little commercial fishing taking place in the Lease Area. A majority of commercial fishing that does occur in the Project vicinity includes squid and groundfish trawls, conch and lobster pots, and clam and scallop dredging.

Commercial fishing regulations include Vessel Monitoring Systems (VMS) and Vessel Trip Report (VTR) (NOAA Fisheries n.d.). VMS is a satellite surveillance system that monitors the location and movement of commercial fishing vessels. The VMS dataset, supplemented with extensive outreach to fishermen, agencies, and organizations across the region, characterizes the density of commercial fishing vessel activity for seven fisheries in the northeast and mid-Atlantic regions: multispecies, monkfish, herring, scallop, surfclam/ocean quahog, pelagics (herring/squid/mackerel), and squid (Fontenault 2018). Data from 2011 to 2016 uses speed over ground information to assess the possibility of identifying transit versus fishing activity based on speed thresholds identified by industry and agency interviews. A speed threshold of <4 or 5 knots is considered indicative of fishing activity, but may also include slower movement of vessel transit or other activities such as processing at sea. The resultant information is used to prepare density maps of fishing vessels in the vicinity of the Lease Area and export cable routes presented in **Figures 2.3.4-1** to **2.3.4-7** (MARCO n.d.). The maps also show the OCS-A 0499 Lease Area next to the Ocean Wind Farm Area. Based on the VMS data for the most recent set of years at vessel speeds of <4 or 5 knots, commercial species harvested in the Project Area consist primarily of Atlantic sea scallop, surfclam, and ocean quahog. Atlantic menhaden, which are not included with the Federally managed species, are also fished in the Project Area based on an analysis by Kirkpatrick *et al.* (2017). Based on the VMS data, most of the commercial fishing activity, including the scallop fishery, is located outside the Ocean Wind Lease Area.

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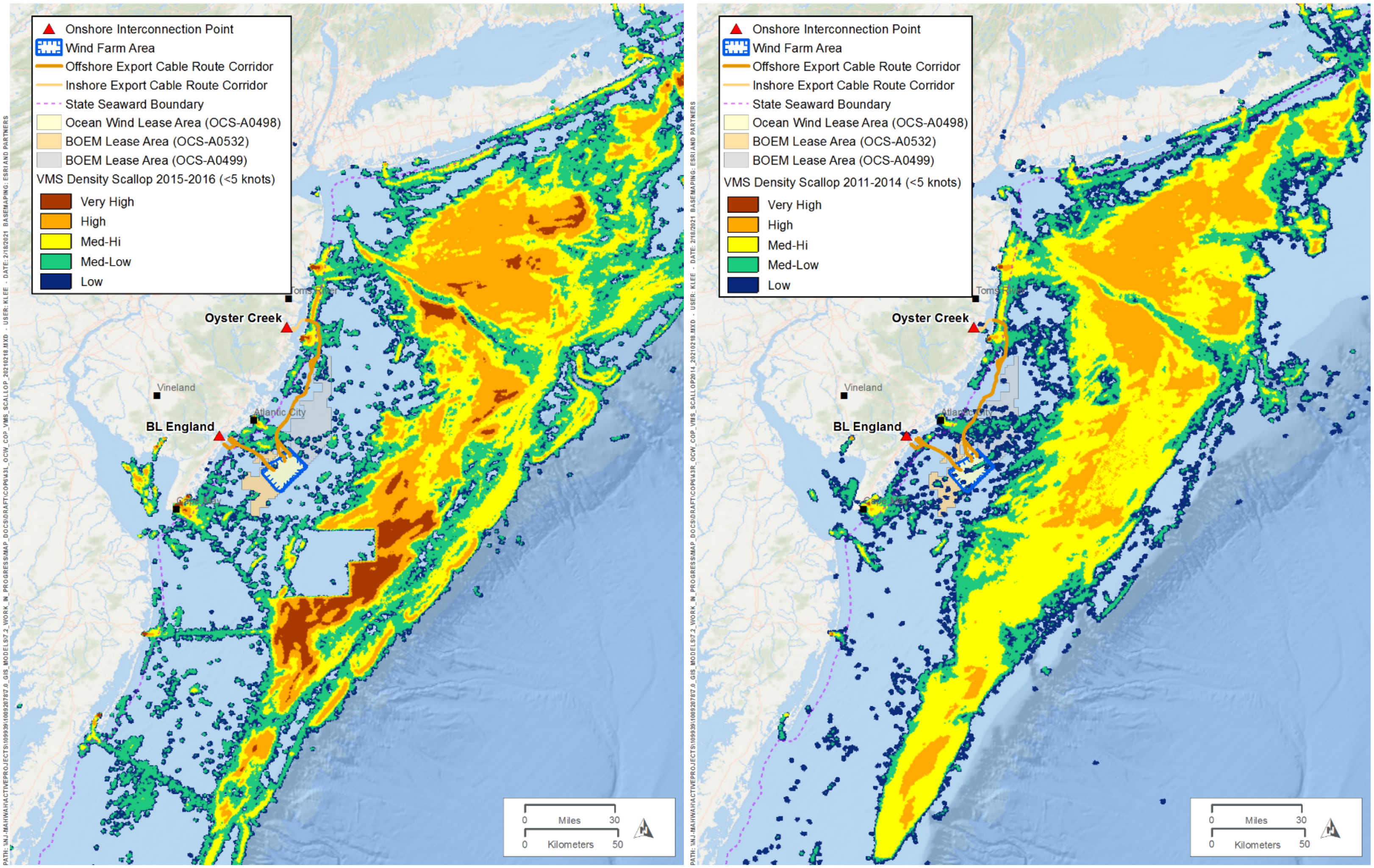

Figure 2.3.4-1. NMFS VMS data - sea scallop (<5 knots) commercial fishing density (Source: MARCO n.d.) (left – 2015-2016; right – 2011-2014).

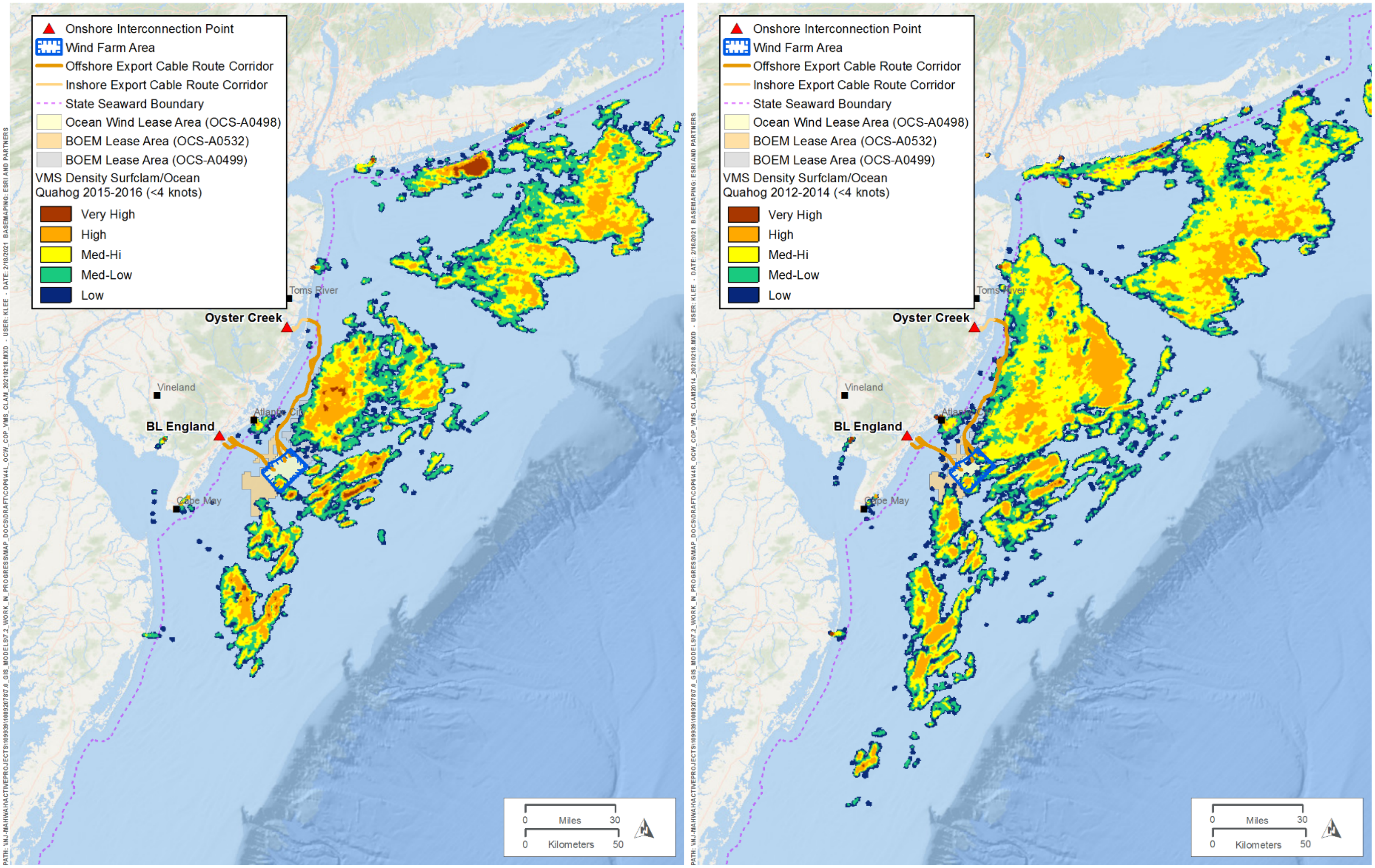

Figure 2.3.4-2. NMFS VMS data - surfclam/ocean quahog (<4 knots) commercial fishing density (Source: MARCO n.d.) (left – 2015-2016; right – 2012-2014).

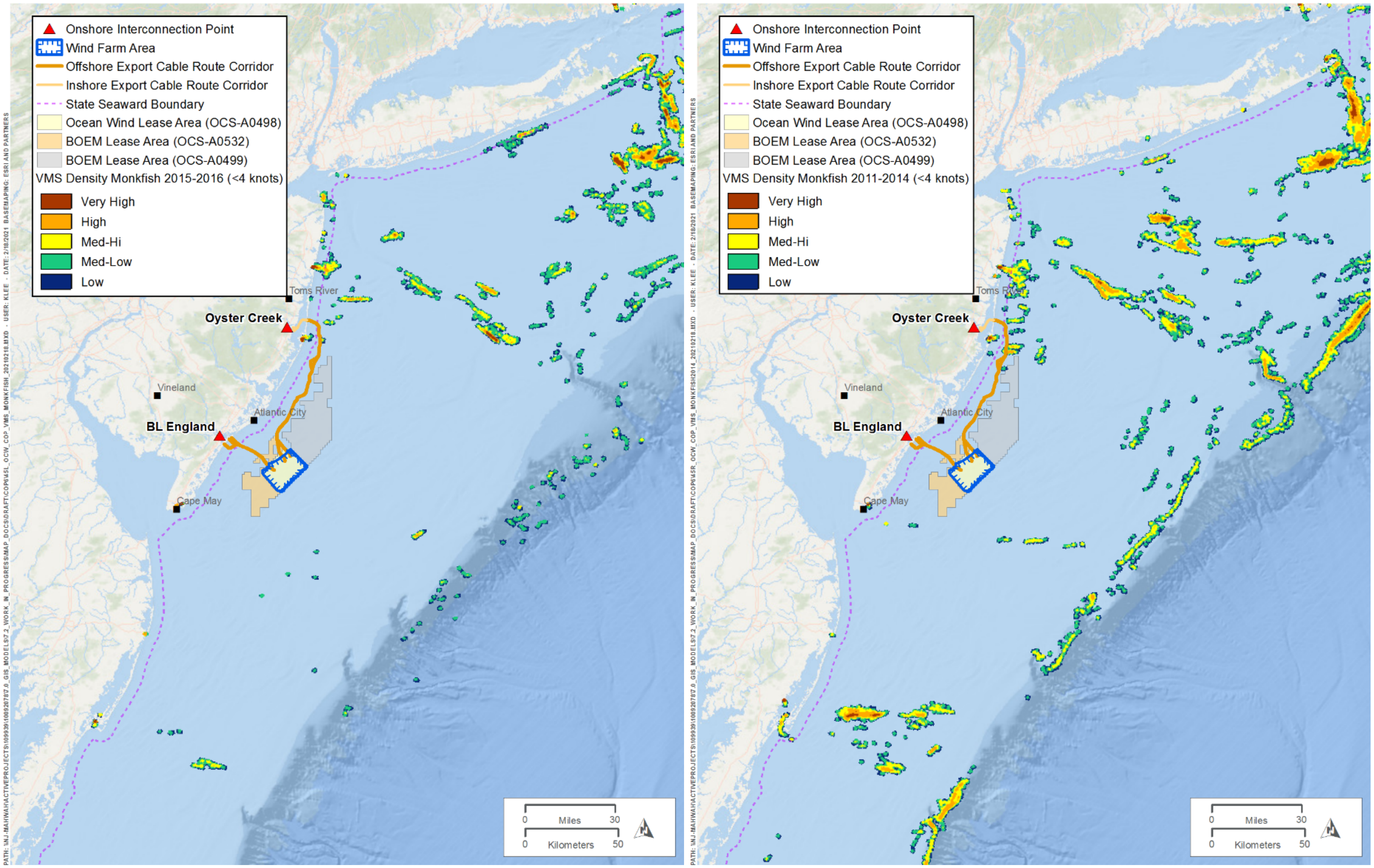

Figure 2.3.4-3. NMFS VMS data - monkfish (<4 knots) commercial fishing density (Source: MARCO n.d.) (left – 2015-2016; right – 2011-2014).

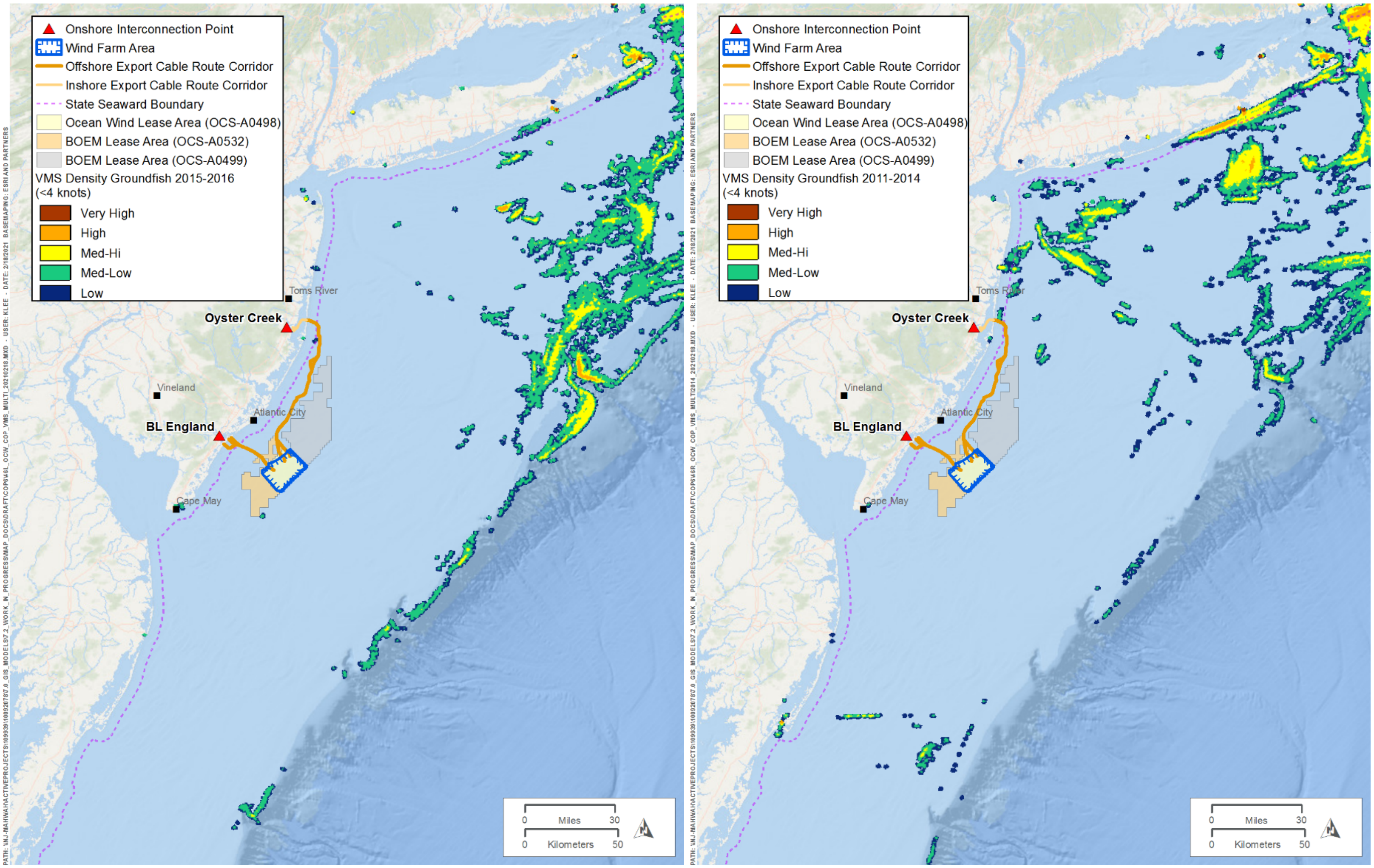

Figure 2.3.4-4. NMFS VMS data - multi-species Groundfish (<4 knots) commercial fishing density (Source: MARCO n.d.) (left – 2015-2016; right – 2011-2014).

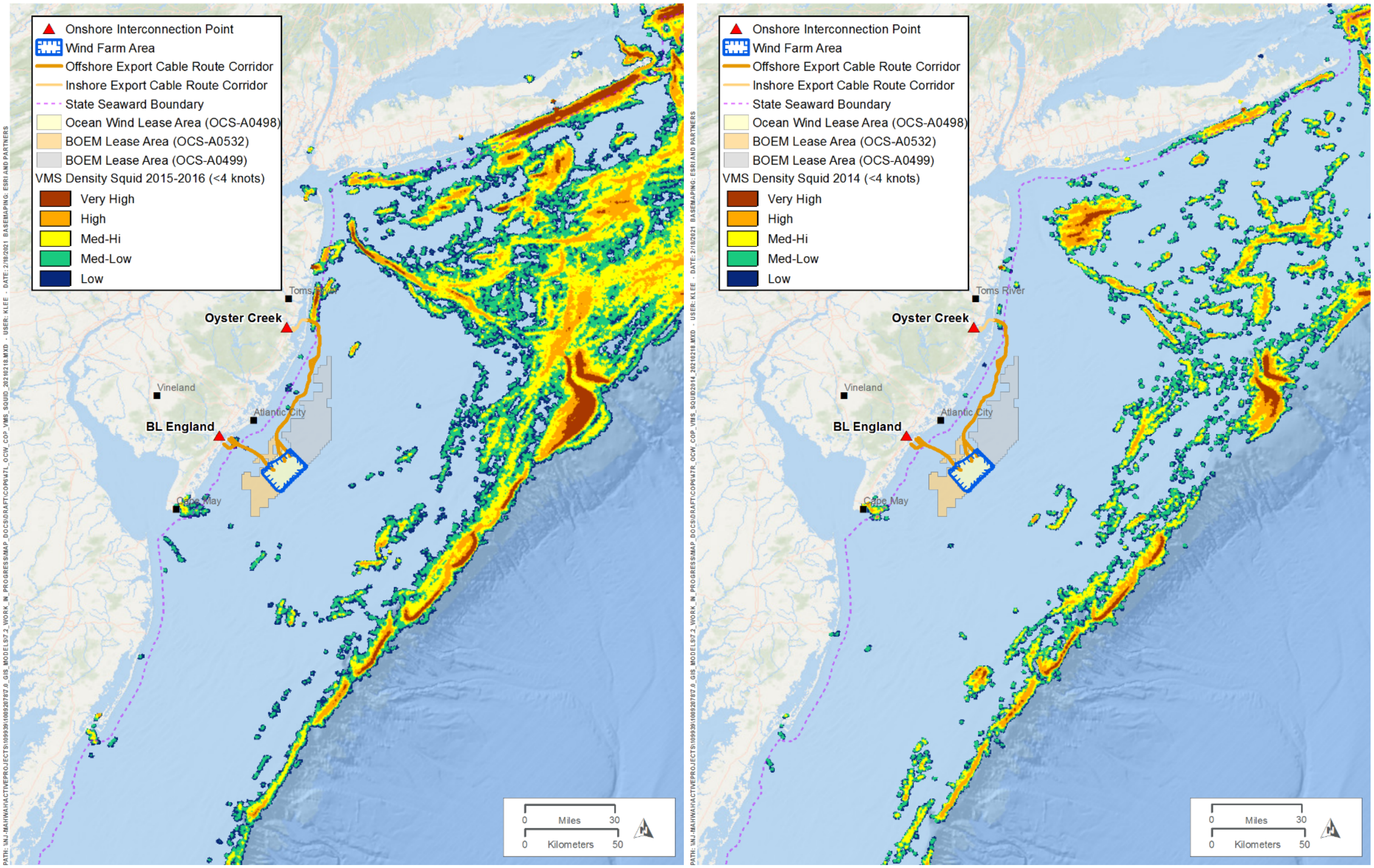

Figure 2.3.4-5. NMFS VMS data - squid (<4 knots) commercial fishing density (Source: MARCO n.d.) (left – 2015-2016; right – 2014).

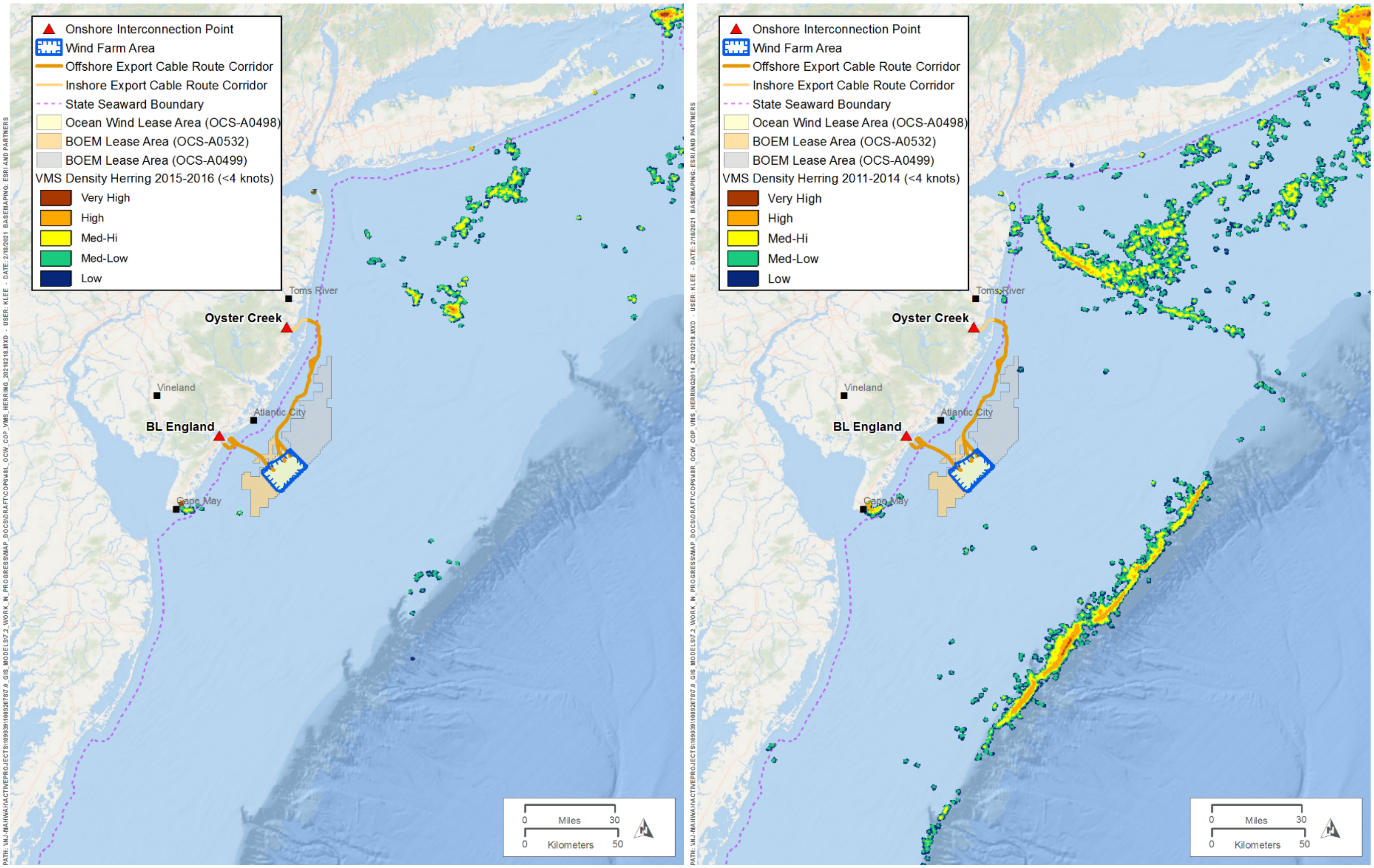

Figure 2.3.4-6. NMFS VMS data - herring (<4 knots) commercial fishing density (Source: MARCO n.d.) (left – 2015-2016; right – 2011-2014).

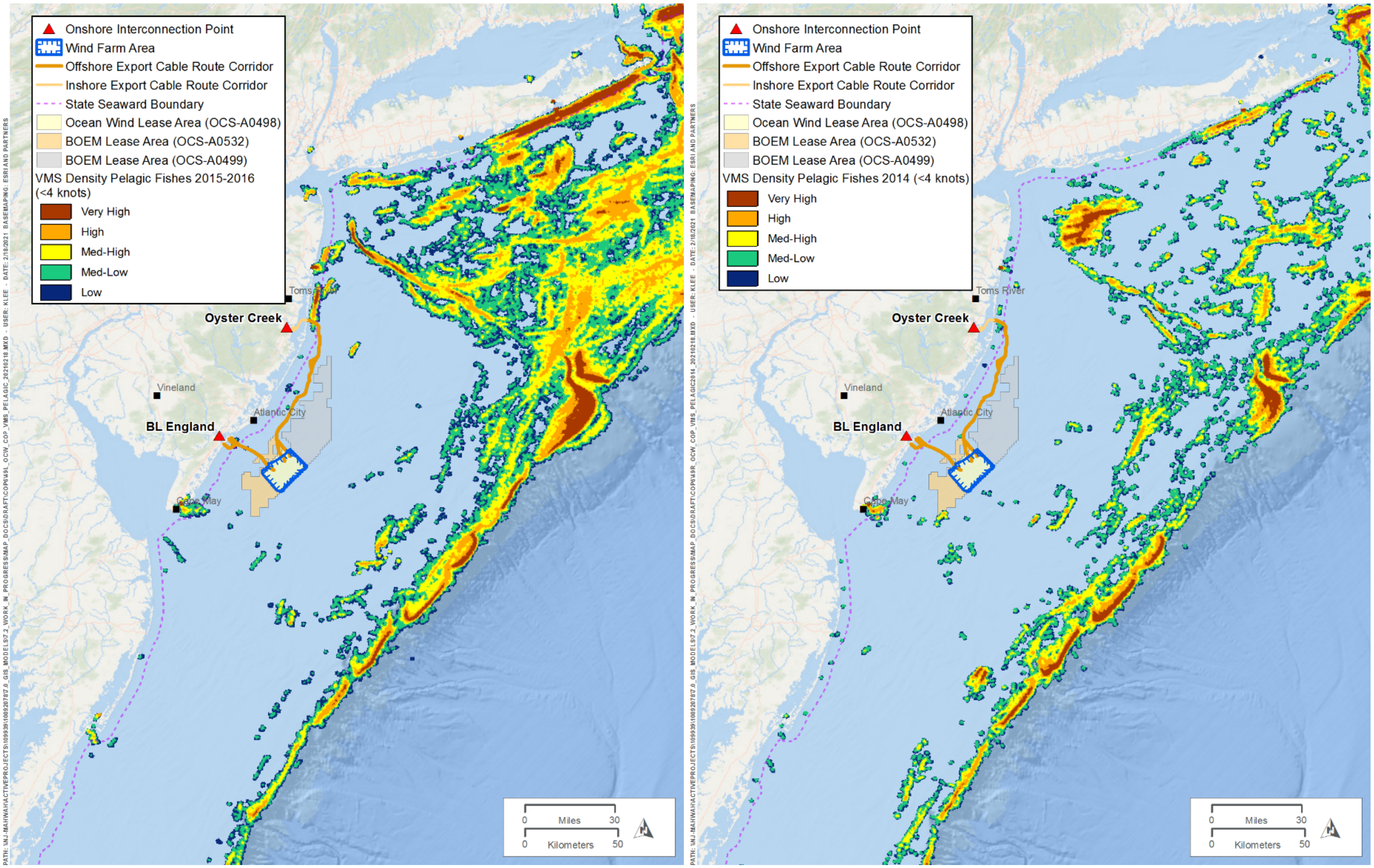

Figure 2.3.4-7. NMFS VMS data - pelagic fishes (<4 knots) commercial fishing density (Source: MARCO n.d.) (left – 2015-2016; right – 2014).

Commercial Fisheries in the New Jersey Wind Energy Area

BOEM conducted an economic analysis of commercial fisheries active in the NJ WEA during the study years 2007-2012 (Kirkpatrick *et al.* 2017). Fisheries revenue data specific to the Project footprint is provided in Section 2.3.4.2. Based on Kirkpatrick *et al.* (2017) and for the overall NJ WEA, which also includes an offshore wind lease area to the north of the Ocean Wind Project, the fishery producing the most revenue from the NJ WEA is the Atlantic Surfclam/Ocean Quahog fisheries, followed distantly by Atlantic sea scallop, and the summer flounder, scup, and black sea bass fishery. With the exception of clams, each of the fisheries revenue derived from the NJ WEA represented less than one percent of their respective total average annual revenue (**Table 2.3.4-5**).

Table 2.3.4-5. Average annual revenue for commercial fisheries active in the NJ WEA from 2007-2012.

Fishery Management Plan	Average Annual Revenue from NJ WEA	Average Total Annual Revenue	Percent Total Revenue from NJ WEA
Surfclam and Ocean Quahog	$3,048,870	$64,967,095	4.7
Summer Flounder, Scup, Black Sea Bass	$103,854	$33,166,172	0.3
Monkfish	$38,816	$19,759,447	0.2
Bluefish	$2,517	$1,578,705	0.2
Skate	$8,760	$7,796,915	0.1
Sea Scallop	$363,559	$428,413,267	0.1
Unmanaged	$193,494	$248,316,185	0.1
Squid, Mackerel, Butterfish	$23,722	$40,849,295	0.1
Atlantic Herring	$2,225	$23,241,713	~0
Small Mesh Multispecies	$998	$10,675,728	~0

Source: Kirkpatrick *et al.* 2017

Table 2.3.4-6 lists which species were most often harvested from within the NJ WEA based on a percentage of the total average revenue generated from that species. Atlantic sea scallop had the highest value but comprised a very small percentage (0.1 percent) of the total value of the scallop fishery.

Table 2.3.4-6. Average annual revenue from the NJ WEA, by species.

Species	Average Annual Revenue from NJ WEA	Species Average Total Revenue	Exposed Species Revenue (Percent)
Surfclam	$3,031,617	$35,291,040	8.6%
Menhaden	$137,788	$3,870,799	3.6%
Sea Bass, Black	$62,734	$5,422,180	1.2%
Channeled Whelk	$18,132	$2,419,819	0.7%
Atlantic Croaker	$13,179	$3,081,688	0.4%
Monkfish	$38,816	$19,759,447	0.2%
Summer Flounder	$40,688	$22,019,367	0.2%
Squid (Illex)	$14,888	$9,961,263	0.1%
Atlantic Sea Scallop	$363,559	$428,413,267	0.1%
Ocean Quahog	$17,253	$27,233,867	0.1%

Source: Kirkpatrick *et al.* 2017

Fishermen Outreach

Overall, commercial fishing activity within the Wind Farm Area was characterized as limited, both in the number of vessels and the complexity of fleet activities.

Based on outreach efforts to commercial fishing industry in 2017, the majority (>90 percent) of the surfclam and ocean quahog annual quotas are held by five companies that operate out of New Jersey (Truex Family, La Monica Fine Foods, Lund's Fisheries, Atlantic Capes Fisheries, and Bumblebee Foods/Snow's Clam Products). Rutgers is currently conducting BOEM-funded research to better evaluate the importance of the Lease Area to the surfclam/ocean quahog commercial fishery (BOEM 2019)[25]. A few fishing vessels operating out of Barnegat Light inlet occasionally fish within the Lease Area, gillnetting for fluke, monkfish, or skate, along with small-scale scallop dredging or fluke trawling. Catch rates for these fisheries were also characterized as low in the Lease Area.

It was also reported that 12 pot and trap fishermen operated within the Wind Farm Area and that peak season extended from June through October. The season for conch/whelk was characterized as September through January. The season for black sea bass was characterized as March through December, with a peak in August.

For a summary of fishermen outreach, please see Volume I, Section 2.3 and Appendix O, Ocean Wind's Fisheries Communication and Outreach Plan, which contains Project-specific details on fisheries engagements. The current fisheries liaison, Kara Gross, serves as Orsted's public outreach representative to the fishing industry for the Project.

Near-Shore Commercial Shellfish Resources

The marine aquaculture industry, which is predominantly focused on shellfish, is also an important and growing trade along the coast of New Jersey. The New Jersey Shellfisheries Council manages the leasing of coastal tidal waters for shellfish aquaculture, providing recommendations to the NJDEP for approval (NJDFW 2018c). As of April 16, 2018, a total of 888 individual leases are currently held, accounting for 2,300 acres and 30,137 linear ft (Mullica River) in New Jersey's Atlantic coastal bays and rivers (NJDFW 2018c). No leases presently occur in the vicinity of the BL England onshore interconnection. Four shellfish leases (37 acres) and one research lease occur in the vicinity of Oyster Creek (**Figure 2.3.4-8**) with the primary shellfish growout of oysters and hard clams. NJDFW (2018c) states an existing issue with shellfish leases not in compliance with Coastal Zone Management due to the presence of mapped SAV. As such, any leases that become vacant will remain as public bottoms.

[25] Rutgers will use a "spatially explicit surfclam fishery economic modeling approach, to simulate fishing behavior under the offshore wind development scenarios. This model was created prior to 2013 and thus required upgrades to the model will be necessary. These updates will be minimal and largely limited to updating parameterization associated with vessel operations and economics, and configuration of the clam stock spatial distribution. Model modifications will require approximately 6 months to complete, with most of the time allocated to obtaining necessary details about the current state of the fishery from the Industry Advisory Team, and to re-configuring input files to properly parameterize (the model)" (BOEM 2019).

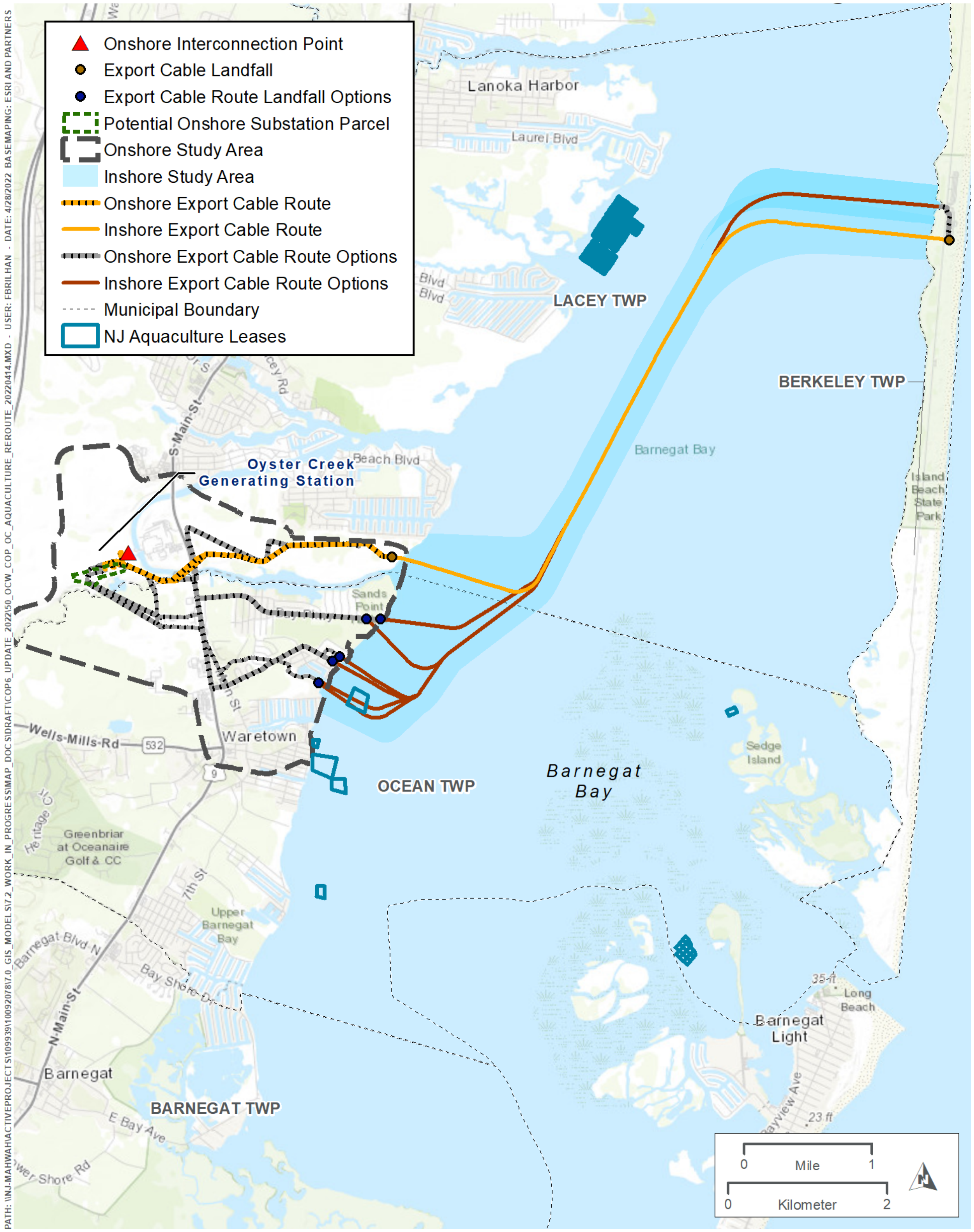

Figure 2.3.4-8. Aquaculture lease sited near Oyster Creek (Source: NJDFW 2018c).

2.3.4.1.4 For-Hire Recreational Fishing

Recreational fishing has an important economic impact on the local and regional communities in New Jersey. The annual number of angler trips in New Jersey from 2003 to 2007 ranged from 6.5 million in 2004 to 7.4 million in 2007. According to the New Jersey Anglers Association, there are 75 fishing clubs and approximately 30,000 active members within the association. Aside from private vessels, New Jersey's recreational fleet also consists of approximately 100 party and 300 charter boats, which are docked near all major inlets and bays (NJDEP 2010b). Recreational fishing in New Jersey includes hook and line, hand line, rod and line, and hand fishing (NJDEP 2010b). New Jersey has compiled information from charter boat, party boat and private boat captains to identify the areas they consider recreationally significant fishing areas or prime fishing areas (**Figure 2.3.4-9**) (NJDEP n.d.-b Prime Fishing Areas Map). These specific areas are described as those that consistently produce good catches of fish, most likely because the physical characteristics of those locations provide optimum fish habitat. Historically productive fishing grounds, for example, often occur around rock piles, shallow ridges, artificial and natural reefs, deep sloughs and bay inlets.

BOEM conducted an economic analysis of recreational for-hire boats, as well as for-hire and private-boat angler trips that might be affected by designated WEA. Recreational fishing was considered "exposed" to potential impact if at least part of the trip occurred within one nautical mile of a WEA during the study period (2007-2012). **Table 2.3.4-7** presents the average annual exposure of recreational for-hire boat trips, for-hire and private angler trips, and angler expenditures to development of the NJ WEA (Kirkpatrick *et al.* 2017). On average, approximately 8,177 for-hire boat trips and 153,989 for-hire angler trips were made from a home port in NJ annually during the study period (2007-2012). Of these annual estimates, approximately 4.6 percent of boat trips and 3.8 percent of for-hire angler trips were estimated to be exposed to the NJ WEA (Kirkpatrick *et al.* 2017). Only the recreational fisheries in Maryland and New Jersey indicate trips to the NJ WEA, with a negligible amount from Delaware or New York. The percentage of those exposed to the Wind Farm Area would be much smaller. Recreational for-hire trips out of Atlantic City, Barnegat, Long Beach, and Ocean City are most exposed to development of the NJ WEA (**Table 2.3.4-8**).

Table 2.3.4-7. State-level average annual exposure of recreational fishery to NJ WEA, 2007-2012.

State	Total For-Hire Boat Trips	Percent Total For-Hire Boat Trips Exposed	Total For-Hire Angler Trips	Percent Total For-Hire Angler Trips Exposed	Total Private Angler Trips	Percent Total Private Angler Trips Exposed	Total Angler Expenditures (Private and For-Hire)	Percent Total Expenditures Exposed
DE	1,093	~0	12,512	~0	522,766	~0	$4,473,090	~0
MD	696	1.1	12,422	1.2	1,704,515	~0	$12,328,325	0.3
NJ	8,177	4.6	153,989	3.8	3,028,511	7.7	$171,048,700	9.0
NY	7,027	~0	128,062	~0	2,652,092	~0	$9,504,089	~0

Source: Kirkpatrick *et al.* 2017.

As with the commercial fishing industry, the for-hire recreational fishing fleets contribute to the economy through direct employment, income, and gross revenues of the for-hire businesses, as well as through spending on products and services to maintain and operate their vessels, triggering further indirect multiplier effects that are dependent upon the initial demands of the for-hire fleet (Steinback and Brinson 2013).

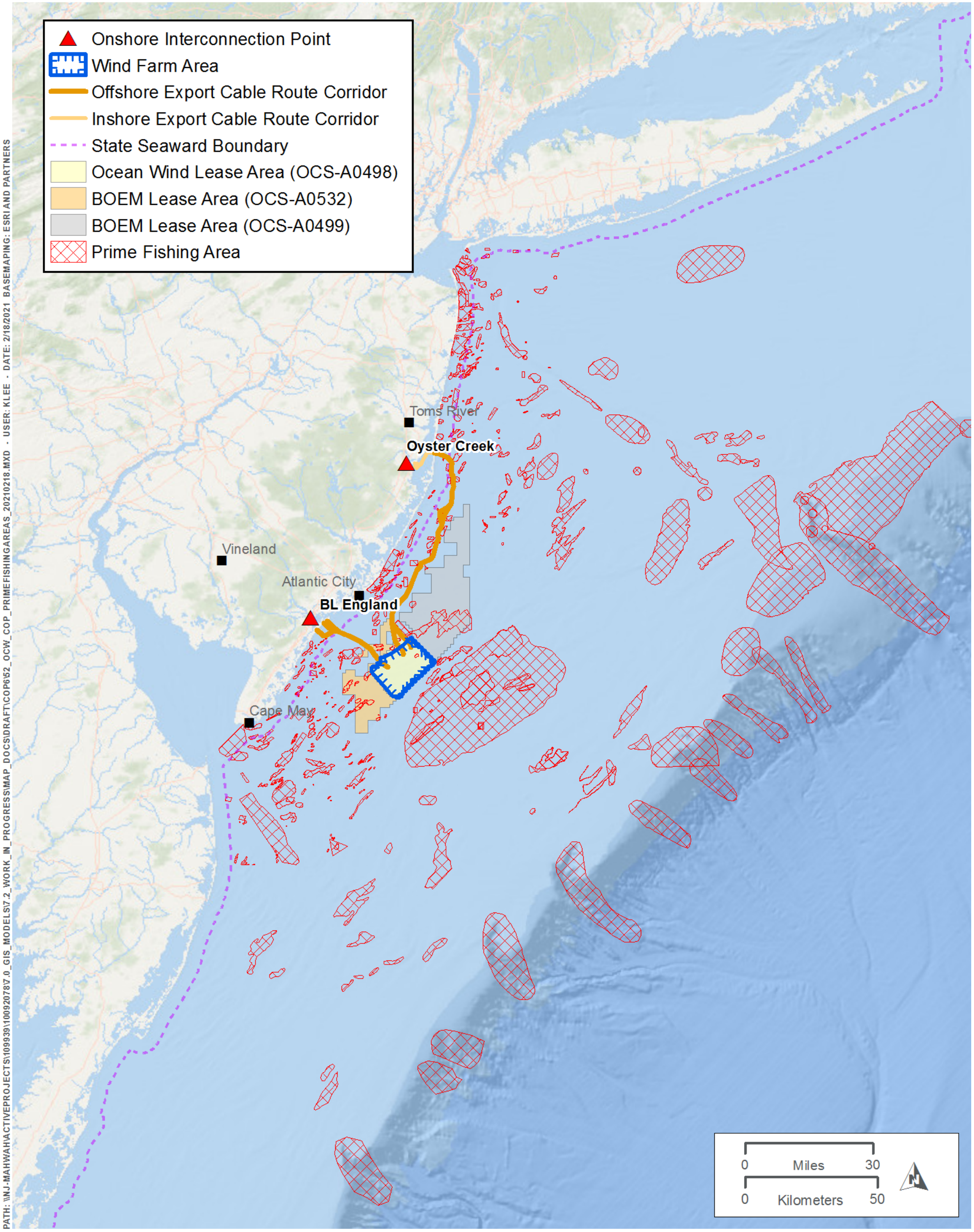

Figure 2.3.4-9. Prime fishing areas in the vicinity of the New Jersey Wind Energy Lease Area (NJDEP n.d.-b).

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Table 2.3.4-8. Average annual private and for-hire exposure of recreational fishing trips to the NJ WEA, 2007-2012.

State	Port Group	Exposed For-Hire Boat Trips	Percent For-Hire Boat Trips Exposed	Exposed For-Hire Angler Trips	Exposed Private Angler Trips	Percent Total Angler Trips Exposed	Total Angler Expenditures (Private and For-Hire)	Percent Total Expenditures Exposed
DE	Indian River	~0	0.1	2	0	~0	$4,473,090	~0
MD	Ocean City	8	1.1	152	0	~0	$12,328,325	0.3
NJ	Absecon	4	29.9	23	13,933	10.0	$8,817,397	10.0
	Atlantic City	148	73.4	1,500	1,992	16.1	$1,481,501	20.8
	Avalon	9	4.1	107	2,722	9.0	$2,224,241	8.3
	Barnegat	64	9.2	1,678	19,780	10.0	$14,550,903	10.0
	Belmar	1	0.1	3	0	~0	$8,117,633	~0
	Brielle	0	0	0	4,249	7.7	$4,266,892	6.3
	Brigantine	4	5.1	30	14,979	9.9	$9,633,502	9.9
	Cape May	8	0.6	52	47,348	9.7	$32,011,401	9.4
	Eagleswood	2	10.1	7	1,063	10.0	$680,056	10.0
	Forked River	0	0	0	5,910	10.0	$3,738,344	10.0
	Galloway	6	57.8	37	318	10.9	$208,874	11.8
	Highlands	~0	~0	1	893	3.2	$2,893,798	2.0
	Little Egg Harbor	25	34.4	132	950	11.0	$646,028	11.8
	Long Beach	51	9.81	1,239	1,340	10.6	$2,177,627	10.8
	Manasquan	0	0	0	1,008	9.9	$646,370	9.9
	Margate City	6	17.6	21	11,233	10.0	$7,177,014	9.9
	Middle	0	0	0	7,408	10.0	$4,697,579	10.0
	Ocean City	37	28.2	869	2,042	12.5	$1,646,222	14.3
	Other Atlantic	~0	2.0	2	25,966	10.0	$16,423,263	10.0
	Other Cape May	0	0	0	5,728	10.0	$3,621,507	10.0
	Other Cumberland	0	0	0	13,593	10.0	$8,603,913	10.0
	Other Gloucester	0	0	0	386	10.0	$244,232	10.0
	Other Ocean	~0	1.2	1	4,618	10.0	$2,926,625	10.0
	Point Pleasant	1	~0	13	4,180	5.8	$6,400,534	4.2
	Port Norris	0	0	0	11,391	10.0	$7,202,550	10.0

State	Port Group	Exposed For-Hire Boat Trips	Percent For-Hire Boat Trips Exposed	Exposed For-Hire Angler Trips	Exposed Private Angler Trips	Percent Total Angler Trips Exposed	Total Angler Expenditures (Private and For-Hire)	Percent Total Expenditures Exposed
	Sea Isle City	9	6.9	184	3,333	9.9	$2,373,273	9.8
	Stone Harbor	~0	2.2	0	3,312	10.0	$2,095,571	10.0
	Toms River	~0	2.4	1	472	10.0	$301,910	9.9
	Tuckerton	3	11.8	17	5,709	10.0	$3,626,342	10.0
	Waretown	~0	1.7	4	5,525	10.0	$3,509,089	10.0
	Wildwood	~0	~0	1	10,549	9.0	$8,104,510	8.2
NY	Freeport	~0	0.1	6	0	~0	$3,313,952	~0
	Point Lookout	~0	~0	11	0	~0	$6,190,136	~0
Total		**386**	**8.0**	**6,089**	**231,930**	**7.9**	**$197,354,204**	**7.8**

Source: Kirkpatrick *et al.* 2017.

NOAA works with state and local partners to monitor the recreational fishery catch and effort through the Marine Recreational Information Program (NOAA Fisheries. n.d.). The for-hire recreational fishing data reported for New Jersey (March to December) was reviewed by area (Inland/nearshore, State waters, and Federal waters), and by two-month interval. The catch data includes fish discarded, landed, and used as bait. Approximately 1.8 million fish were reported caught in New Jersey in 2017. A wide variety of species/groups were reported, with highest numbers and diversity of species in offshore areas. Striped bass was the primary species caught in Inland waters in March/April and again in November/December. Summer flounder dominated the Inland catch from May to October with sea robins co-dominating during summer months. The highest catch numbers reported caught in State waters off New Jersey occurred from July/August and September/October with approximately 200,000 fish caught each interval. The reported catch was dominated primarily by black sea bass, followed by scup, summer flounder, sea robin, striped bass, and skates/rays. Other species reported in higher numbers consist of cunner, tautog, dogfish sharks, Atlantic cod, and bluefish. The highest reported catch numbers occurred in Federal waters, ranging from more than 25,000 reported in March/April to nearly 675,000 for July/August. The species composition for Federal waters was similar to State waters, with additional species of tunas/mackerels. Large numbers of black sea bass, nearly 300,000, were reported in November/ December (NOAA Fisheries n.d.). In addition to these numbers reported for New Jersey, for-hire recreational fishing may be occurring in the Project Area by boats whose home ports are in other states.

The blue crab fishery is not included in the Marine Recreational Information Program. Blue crabs are abundant all along the Jersey coast, in tidal creeks and rivers, and in shallow, saltwater bays, from the Hudson River to Delaware Bay. Recreational fishing effort in New Jersey is greater for blue crab than any other single species (NJDFW n.d.-a). Recreation crabbing is done by small boats, shoreline bank, bulkhead, bridge or pier bordering tidal waters and not by for-hire party boats or charters.

2.3.4.1.5 Key Fishery Seasonal and Status Information

Atlantic Sea Scallop Fishery

The Atlantic sea scallop fishery is one of the most valuable fisheries in the U.S., occurring from the mid-Atlantic region north to the U.S.-Canada border. The fishery primarily uses paired or single scallop dredges, but the mid-Atlantic region also uses trawl gear. South of New England, sea scallops typically occur in commercial concentrations at depths between 115 and 328 ft (35 and 100 m), in sand and gravel sediments where bottom temperatures remain below 20°C. The fishery is open year-round, and is managed as two primary fleets, the Limited Access (LA) fleet and the Limited Access General Category (LAGC) fleet (NOAA Fisheries Greater Atlantic Region n.d.). The LA fleet is assigned a number of fishing days per year and an access area rotation program. The rotation program closes areas with small scallops to allow growth to marketable size. When the areas are open (access areas), vessels are allocated a number of trips with corresponding trip limits that they may use in those dedicated access areas. The LAGC scallop fleet uses Individual Fishing Quotas which are allocated yearly. The LAGC vessels must fish in specific exemption areas within the open areas. The Project Area occurs within the Mid-Atlantic Exemption Area (**Figure 2.3.4-10**). Harvesting of Atlantic sea scallops in Federal waters is not allowed by recreational anglers (NOAA Fisheries Greater Atlantic Region n.d.).

Surfclams and Ocean Quahog Fishery

One of the most important commercial fisheries active in the region is the surfclam and ocean quahog fishery. This commercial fishery is generally concentrated on the populations off the coast of New Jersey as well as the Delmarva Peninsula (eastern coasts of Maryland, Delaware and New Jersey). Surfclams are found from beach zones out to depths of 151 ft (46 m) while ocean quahogs inhabit near shore area and offshore to depths of 755 ft (230 m). The gear types most used in this fishery consists primarily of the hydraulic clam dredge, which uses jets of water to dislodge the clams from sediment. The fishery is operated year-round under individual

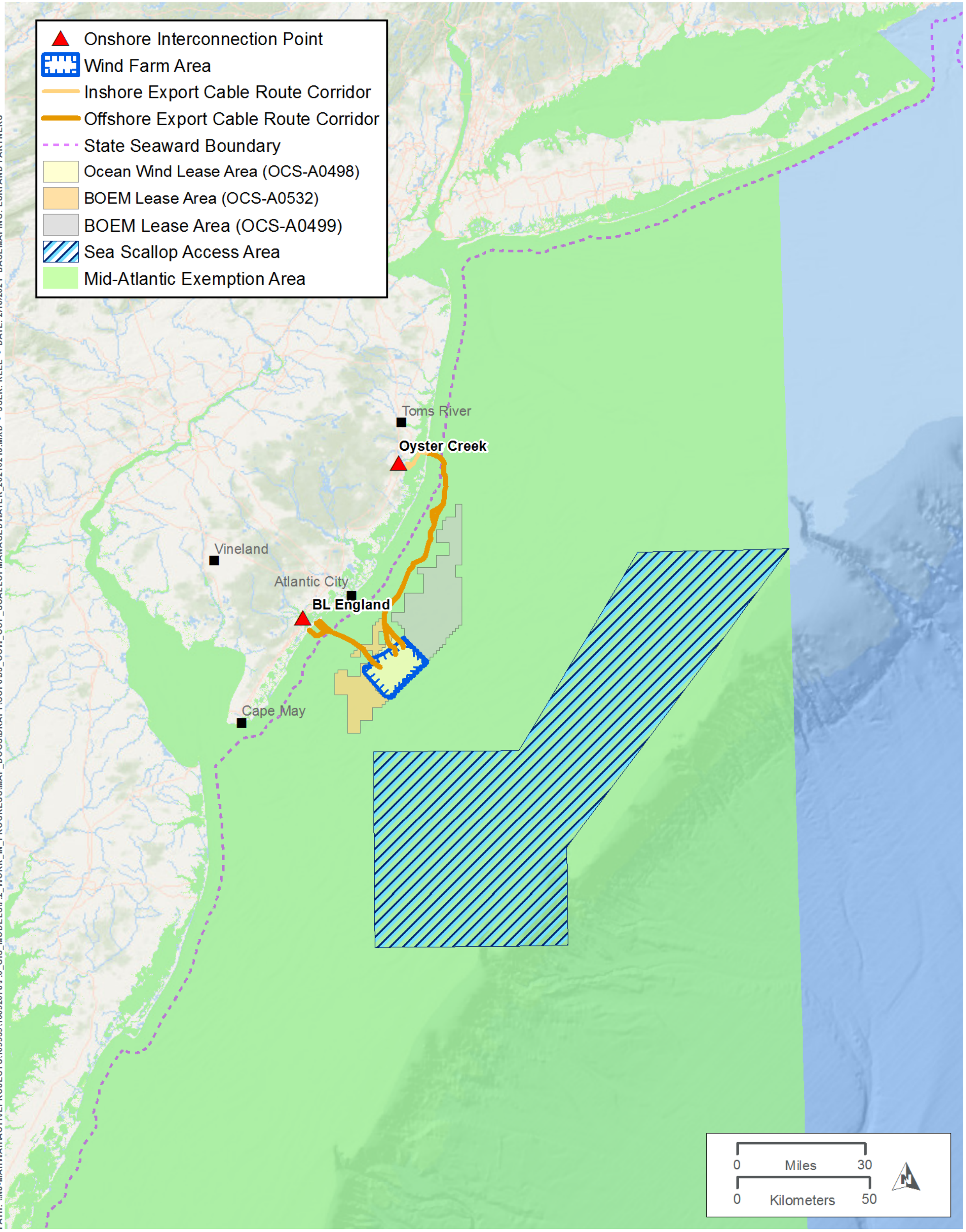

Figure 2.3.4-10. Atlantic sea scallop management areas (NOAA Fisheries Greater Atlantic Regional Fisheries Office 2019c).

transferable quota management system. Each individual permit holder has their own quota such that they can fish on their own schedule until their quota is filled. Based on the most recent stock assessments conducted in 2015 for surfclams and 2016 for ocean quahog, the fishery is not being overfished (NOAA Fisheries Greater Atlantic Region n.d.). Recreational harvest is limited to hand harvest (New Jersey Marine Digest 2018) so there is no for-hire recreational fishery.

Harvesting also occurs within State waters. The New Jersey National Shellfish Sanitation Program Shellfish Classifications map indicates most of the New Jersey coastline is open to shellfish harvesting, with few exceptions. However, areas are monitored regularly, and closures may occur temporarily when testing indicates shellfish has been "subjected to pollution or other conditions that may render the shellfish dangerous to health" (NJDEP 2018m).

Atlantic Menhaden

Atlantic menhaden is a coastal migrating species that may spawn over a wide spatial range from Southern New England to South Carolina. ASMFC (2017) characterized seasonal movement patterns as north and inshore from the major spawning area off the North and South Carolina coasts in early spring and south again in late fall. A study of menhaden spawning and recruitment by Simpson *et al* (2017) determined that spawning was likely occurring in near shore areas over an extremely large spatial range from North Carolina to southern New England and that spawning occurred during most of the year, peaking in November and December. Based on this information, adults would be susceptible to fishing throughout the year. The Atlantic menhaden commercial fishery has two major components, a purse-seine reduction sector that harvests fish for fish meal and oil, and a bait sector that supplies bait to other commercial and recreational fisheries. The most recent stock assessment update determined the Atlantic menhaden stock status is not overfished and overfishing is not occurring (ASMFC 2017). Landings in the reduction fishery are currently at their lowest levels because only one plant remains in operation along the coast. In contrast, bait landings have increased in recent years as demand has grown because of recent limitations in other species used as bait (e.g., Atlantic herring) (ASMFC 2017).

The New Jersey Atlantic menhaden season is open year-round unless gear quotas are filled. The full commercial quota for 2018 was set at 51.2 million pounds, with 95 percent of the quota allocated to the purse seine fishery (approx. 48.7 million pounds) and 5 percent allocated to all other gear types combined, i.e., pound net, gill net, trawl, and bait net licensed gear such as cast nets and beach seines (approx. 2.6 million pounds) (NJDEP 2018n).

Blue Crab Fishery

Most of the blue crab fishery occurs in State waters or areas on the continental shelf close to State waters using crab pot/trot line or crab dredge. The use of crab pot/trot line is closed from December 1 to March 14 each year for most areas but closed from December 5 - April 5 in the Delaware Bay (NJDEP 2018n). The use of crab dredges is closed April 1 to November 30 for all waters except Delaware Bay. The crab fishery in Delaware Bay is closed from April 16 to November 14 each year. Recreational crabbing is done primarily by private boat and from shore and not through for-hire charters or party boats.

American Lobster Fishery

The American lobster fishery uses lobster traps primarily, though incidental catches in other gear is permitted to a limited extent. The lobster trap fishery is closed from February 1 through March 31 each year in Area 5, which includes the Project Area, and all lobster traps must be removed from Federal waters within that area (NJDEP 2018n). Based on Ocean Wind's outreach efforts, the lobster season is primarily April through January with peaks in April and October.

Summer Flounder Fishery

There are two major commercial trawl fisheries for summer flounder based on seasonal movements; a winter offshore and summer inshore fishery (ASMFC n.d.). Summer flounder are also taken by pound nets and gill nets in estuarine waters. Some gear restrictions may apply depending on the permit held. The commercial fishery is managed on a quota basis and allocated on a 60/40 basis to commercial and recreational fisheries, respectively. Commercial quotas have ranged from 9.5 to 19.2 million pounds annually. The 2016 stock assessment update indicated the summer flounder stock is not overfished but is experiencing overfishing. The preliminary 2018 coast wide commercial quota was set at 6.6 million pounds with 16.7 percent, or 1.1 million pounds, allotted to New Jersey. Set quotas are adjusted based on any quota overages the year prior. New Jersey establishes seasonal quotas (there are 5 seasons in a year) for the State summer flounder fishery, such that the fishery is closed prior to the end of one season once the quota is reached (NJDEP 2018n; NJDEP n.d.-a Commercial Marine Quotas and Trip Limit Information).

2.3.4.2 Potential Project Impacts on Commercial Fisheries and For-Hire Recreational Fishing

Construction, operations and maintenance, and decommissioning activities may impact the ability to fish certain areas or may affect fishing (negative or positive), including fishing for shellfish, as well as shore-based support services for these fisheries. IPFs that may impact commercial and for-hire fisheries include the following:

- Physical seabed/land disturbance
- Habitat conversion
- Noise
- Traffic
- Land use, economic change
- Sediment suspension
- Visible structures/lighting

Sediment suspension is discussed in Section 2.1.2.2, Water Quality; Section 2.2.5.2, Benthic Resources; and Section 2.2.6.2, Finfish and EFH. Visible structures/lighting is discussed in Section 2.3.6.2, Navigation and Vessel Traffic.

The commercial fishing communities play a critical role in the cultural and economic fabric of New Jersey. The commercial fishing industry representatives are critical stakeholder groups for Ocean Wind, and it is Ocean Wind's belief that commercial fishing can co-exist with offshore wind. Orsted has designed, developed, built, and now operates 25 wind farms with active fishing communities around each of these 25 sites. Using BMPs, Orsted has successfully co-existed with the fishing community in Europe and at the Block Island Wind Farm. Ocean Wind will bring that record of success to the fishing community in and around New Jersey.

Ocean Wind is committed to maintaining a strong working relationship with all commercial and recreational fishermen who may be affected by the Project. Ocean Wind developed a Fisheries Communication and Outreach Plan (Appendix O) in accordance with BOEM Guidelines; this plan outlines key strategies that Ocean Wind will use to communicate with fishermen and fishing industry representatives associated with the Project. The plan includes the appointment of a dedicated fisheries liaison as well as fisheries representatives who will serve as conduits for providing information to, and gathering feedback from, the fishing industry. See Section 2.3.4.1.3 (Fishermen Outreach) and Appendix O for additional detail.

2.3.4.2.1 Construction

Wind Farm Area

During construction of the facilities within the Wind Farm Area, commercial and recreational for-hire fishing practices are expected to be temporarily disturbed. Fishing vessels would avoid the active construction areas due to physical obstructions, increased vessel traffic and the safety concerns to fishers, construction workers, and construction equipment. Fishers that typically navigate through the Wind Farm Area on the way to other fishing locations would need to navigate around areas of active construction, resulting in slightly increased travel time and associated expenses such as fuel.

Impacts associated with noise from installation activities for WTGs, offshore substations, and offshore export cables are expected to include avoidance by targeted commercial and for-hire fish species. These species are expected to return to the area once construction activities are completed. Individuals of benthic species with limited mobility, such as clams, scallops, whelks, and lobsters, that occur within bottom disturbance areas associated with turbine and substation footprints and offshore export cable corridors may be lost to the fishery.

While no vessel or fishing exclusion is planned, the conservative approach to assessing impacts to the commercial fishery would be the complete removal of the Wind Farm Area from the currently fished area during construction. Commercial fisheries sourced from within the Wind Farm Area vary depending on gear and species and not all fisheries are obtained from within the Wind Farm Area. For example, based on a review of NOAA VMS fishing density data, fisheries such as Atlantic herring are not fished within the Wind Farm Area to any substantial degree (**Figure 2.3.4-6**). Thus, that fishery may not be directly impacted by construction of the Project.

As noted in Section 2.3.4.1, based on the VMS data for the most recent set of years, 2015-2016, commercial species harvested in the Project Area consist primarily of Atlantic sea scallop, surfclam, and ocean quahog. Atlantic menhaden, which are not included with the Federally managed species, are also fished in the Project Area based on an analysis by Kirkpatrick *et al.* (2017). Based on the VMS data, most of the commercial fishing activity, including the scallop fishery, is located outside the Ocean Wind Lease Area (**Figures 2.3.4-1** to **2.3.4-7)** (MARCO n.d.).

To evaluate the potential costs associated with reduced fishing revenues that may result from temporarily closing the Wind Farm Area to commercial fishing during construction, information on fisheries revenue sourced from within the Project Area (Wind Farm Area, inshore and offshore export cable corridors) and the surrounding area was obtained from the BOEM GIS database. The estimated annual revenue (adjusted to 2019 dollars) by FMP was calculated based on the average revenue per square kilometer for each of the project component areas. This information was also compared to the total value of each fishery. Fisheries revenue density by FMP was analyzed for two time periods; 2013 to 2017 (**Table 2.3.4-9,** BOEM GIS database) and 2007 to 2012 (**Table 2.3.4-10,** Kirkpatrick *et al.* 2017). Fishing revenue density for both time periods, mapped by FMP, provide a visual presentation of the estimated revenue value levels within the Wind Farm Area and offshore export cable corridors compared to surrounding areas (**Figures 2.3.4-11** to **2.3.4-17**). **Table 2.3.4-10** provides the data by FMP for the years 2007 to 2012. As discussed in Section 2.3.4.1, the scallop and clam fisheries have the highest value based on landings in New Jersey. The Wind Farm Area supports a low to moderate value for these two fisheries (**Figure 2.3.4-11** and **2.3.4-12)** while the remaining fisheries are estimated to be of low revenue value within the Wind Farm Area (**Figures 2.3.4-13** to **2.3.4-17**). The annual average revenue (2013 to 2017) sourced from within the Wind Farm Area for all fisheries combined ($209,927 in 2019 dollars), was 0.02 percent of the total fishery. This average annual value is down from the 1.1 percent of the total fishery estimated for the years 2007 to 2012.

Table 2.3.4-9. Annual average fisheries revenue (2013-2017) and percentage of total fishery for Project Area by Fishery Management Plan.*

Fishery Management Plan	Wind Farm Area	Inshore BL England**	Offshore BL England**	Inshore Oyster Creek**	Offshore Oyster Creek**	Total Fishery Annual Average (USD$2019)	Percentage of Total Fisheries				
							Wind Farm Area	Inshore BL England	Offshore BL England	Inshore Oyster Creek	Offshore Oyster Creek
Atlantic Sea Scallop	$64,591	$47	$1,224	$735	$20,182	$467,985,461	0.01%	0.00%	0.00%	0.00%	0.00%
SurfClam/Ocean Quahog	$81,932	$35	$1,204	$91	$19,962	$58,564,253	0.14%	0.00%	0.00%	0.00%	0.03%
Unmanaged***	$42,141	$1,163	$22,597	$1,488	$27,305	$136,841,870	0.03%	0.00%	0.02%	0.00%	0.02%
Summer Flounder/ Scup/Black Sea Bass	$9,787	$82	$1,689	$1,224	$19,702	$39,991,475	0.02%	0.00%	0.00%	0.00%	0.05%
Mackerel/Squid/Butterfish	$5,402	$10	$429	$101	$2,074	$45,818,092	0.01%	0.00%	0.00%	0.00%	0.00%
Monkfish	$3,845	$0	$21	$240	$8,177	$18,895,636	0.02%	0.00%	0.00%	0.00%	0.04%
Atlantic Herring	$407	$0	$14	$8	$108	$29,105,849	0.00%	0.00%	0.00%	0.00%	0.00%
Skate	$1,560	$15	$314	$180	$5,683	$8,672,592	0.02%	0.00%	0.00%	0.00%	0.07%
NE Multispecies Small Mesh	$14	$0	$2	$2	$24	$10,163,011	0.00%	0.00%	0.00%	0.00%	0.00%
Bluefish	$56	$0	$5	$201	$4,285	$1,469,227	0.00%	0.00%	0.00%	0.01%	0.29%
NE Multispecies Large Mesh	$1	$0	$0	$8	$176	$55,849,075	0.00%	0.00%	0.00%	0.00%	0.00%
Highly Migratory Species	$156	$2	$89	$4	$408	$1,595,889	0.01%	0.00%	0.01%	0.00%	0.03%
Spiny Dogfish	$28	$3	$32	$233	$13,632	$3,282,752	0.00%	0.00%	0.00%	0.01%	0.42%
Golden Tilefish	$7	$7	$45	$2	$17	$5,116,427	0.00%	0.00%	0.00%	0.00%	0.00%
River Herring/ American Shad	$0	$0	$0	$0	$1	$34,740	0.00%	0.00%	0.00%	0.00%	0.00%
Totals	$209,927	$1,364	$27,667	$4,518	$121,735	$883,386,350	0.02%	0.00%	0.00%	0.00%	0.01%

* Each year's dollar values were adjusted to 2019 dollars using Bureau of Labor formula.

** Inshore and offshore cable route areas reflect the study area with a variable corridor width for the purposes of this analysis.

*** Species not managed under a Fishery Management Plan. 139 species or species groups were included in the unmanaged group, such as crabs (e.g., Cancer spp.), striped bass (*Morone saxatilis*), groupers (e.g., Epinephelus spp.), snappers (e.g., Lutjanus spp.), etc.

Source: BOEM GIS Data; data on the menhaden fishery was not available.

A more intensive analysis of fisheries revenue was conducted by Kirkpatrick *et al*. (2017) for the overall NJ WEA as part of multiple studies to evaluate the development of wind energy projects along the Atlantic coast. BOEM coordinated with NMFS to analyze the potential economic impacts to commercial and recreational fisheries and their shore side dependents (e.g., seafood dealers, bait shops), that may result from siting offshore wind energy projects along the Atlantic coastal region (Kirkpatrick *et al.* 2017). The study evaluated fisheries spatial and revenue data from 2007 to 2012, sourced from within each WEA and for the overall U.S. Atlantic coast fishery.

The study conducted by Kirkpatrick *et al* (2017) conducted additional analysis of fisheries revenue sourced to ports which was not available for the years 2013 to 2017. The ports most affected by revenue sourced from within the Wind Farm Area in the years 2007 to 2012 is Atlantic City, New Jersey, followed distantly by Cape May, New Jersey, Newport News, Virginia, and New Bedford, Massachusetts (**Table 2.3.4-11**). It is important to note that higher valued fishing areas are nearby to the Project Area so it is likely that most fishers will be able to continue fishing in a nearby area during the temporary construction activities. The temporary displacement of fisheries to a nearby area would minimize the potential impact to revenues associated with these ports. This is most notable for the higher valued clam, scallop, and menhaden fisheries (**Figures 2.3.4-11** to **2.3.4-13**).

The surfclam and ocean quahog fisheries have experienced declines in commercial landings in New Jersey from 1980 through 2016. Landings per unit effort in the New Jersey region is at an all-time low and catches are composed of relatively small clams that are not favored by processors (NEFSC 2016). Southern areas (Delmarva Peninsula and New Jersey) have experienced declines in surfclam biomass during recent years due primarily to poor recruitment and slow growth rates associated with warm water conditions (Weinberg 2005). New information indicates that ocean quahog recruitment has declined 65 percent since 1993. Quahog commercial landings have also declined at the historical fishing grounds in Delmarva Peninsula and New Jersey, causing fishing efforts to shift to the north, particularly in the Long Island region. Today, it is estimated that only 22 percent of the total fishing effort for ocean quahog occurs in the Delmarva Peninsula and New Jersey (NJDEP 2010b). This decrease in commercial fishing effort for the surfclam and ocean quahog fisheries is evident in the decline in fishing revenue density from 2007 to 2017, particularly within the Wind Farm Area (**Figure 2.3.4-12**).

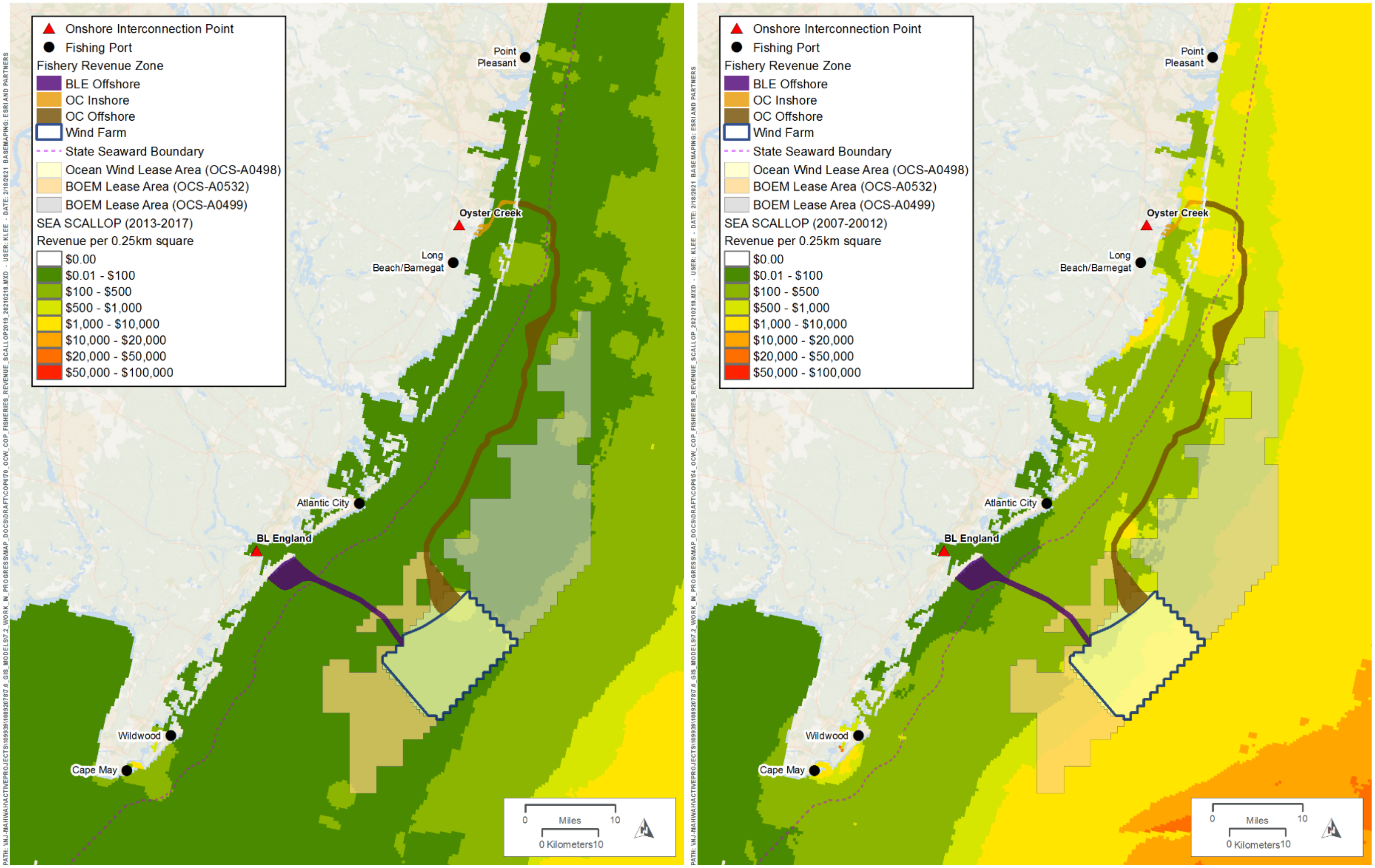

Figure 2.3.4-11. Revenue density for the scallop fishery (Source: BOEM GIS Data) (left – 2013-2017; right – 2007-2012).

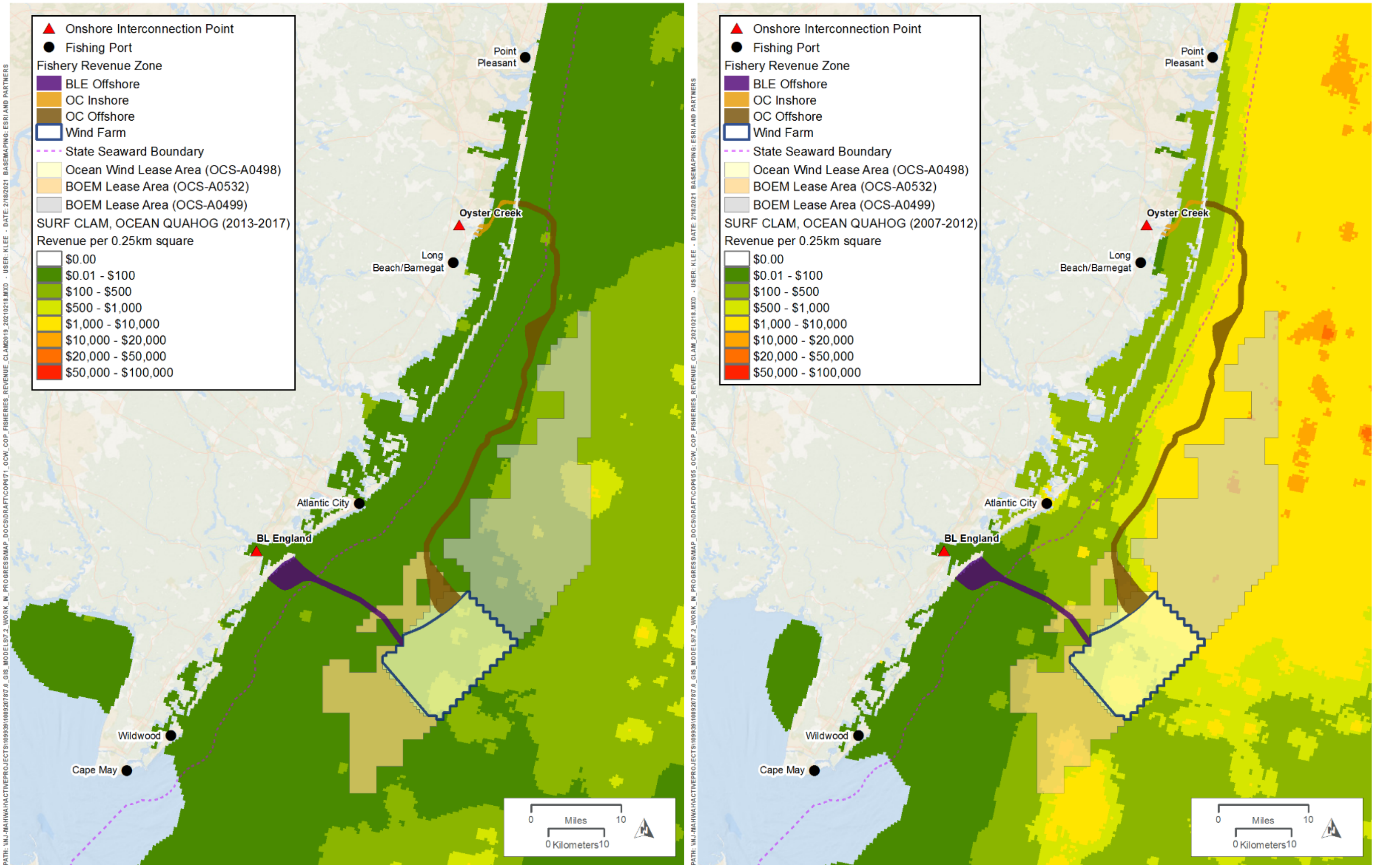

Figure 2.3.4-12. Revenue density for the surfclam/ocean quahog fishery (Source: BOEM GIS Data) (left – 2013-2017; right – 2007-2012).

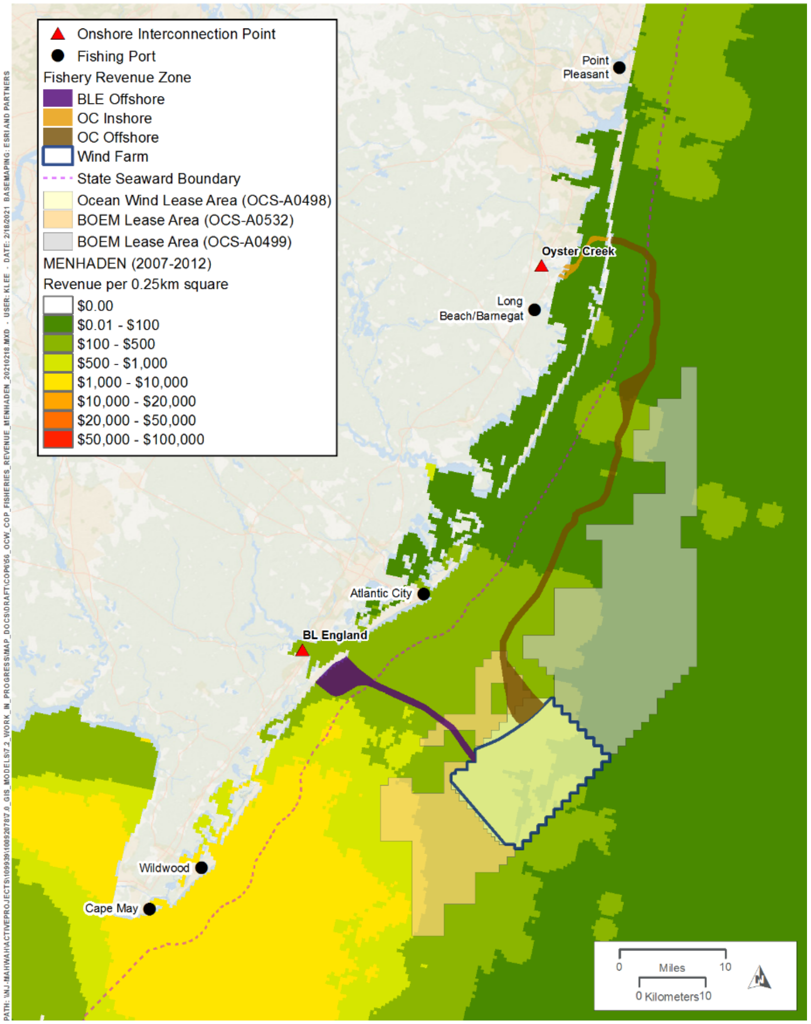

Figure 2.3.4-13. Revenue density for the menhaden fishery for the years 2007-2012 (Source: BOEM GIS Data)

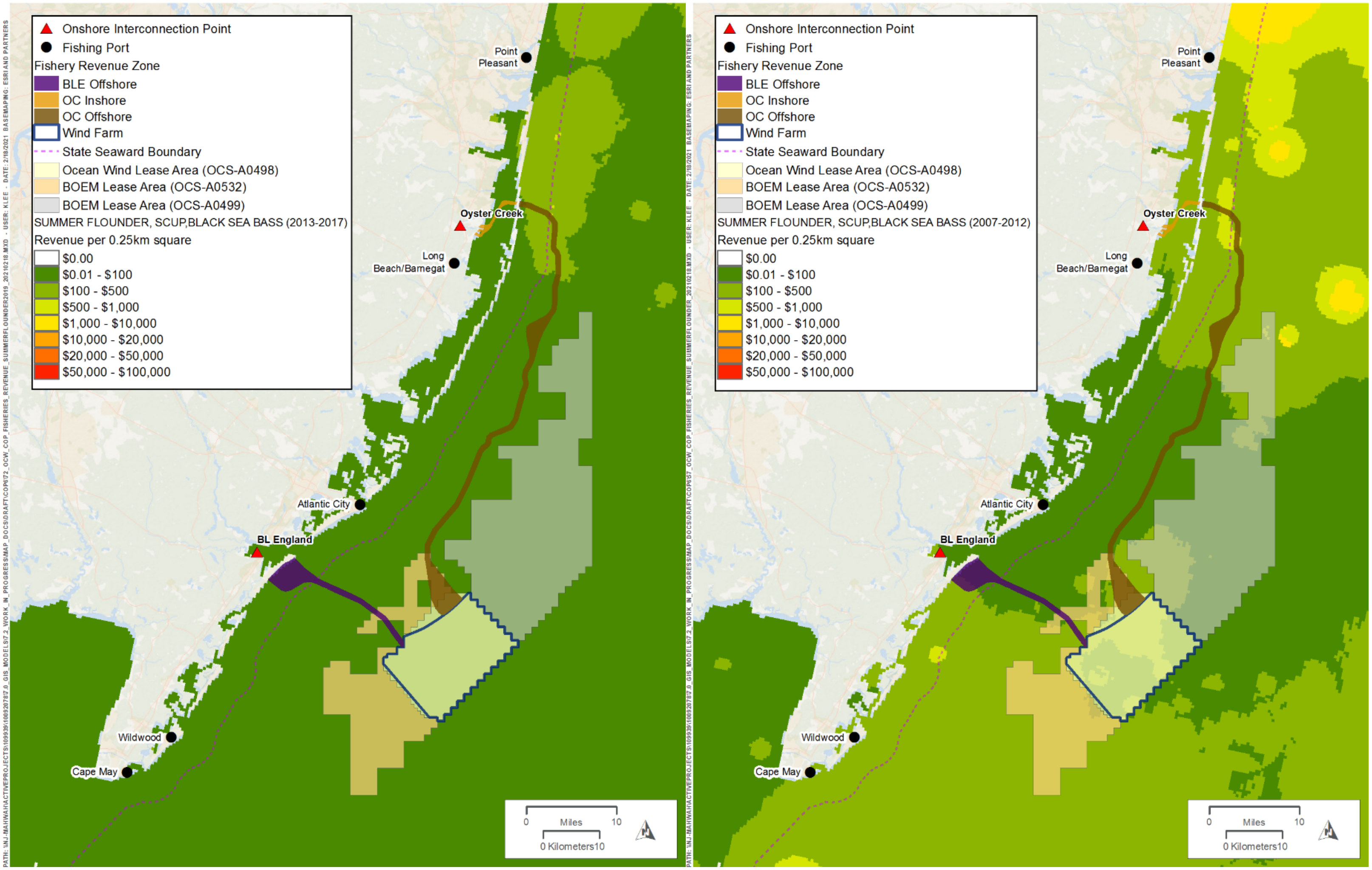

Figure 2.3.4-14. Revenue density for the summer flounder, scup, and black sea bass fishery (Source: BOEM GIS Data) (left – 2013-2017; right – 2007-2012).

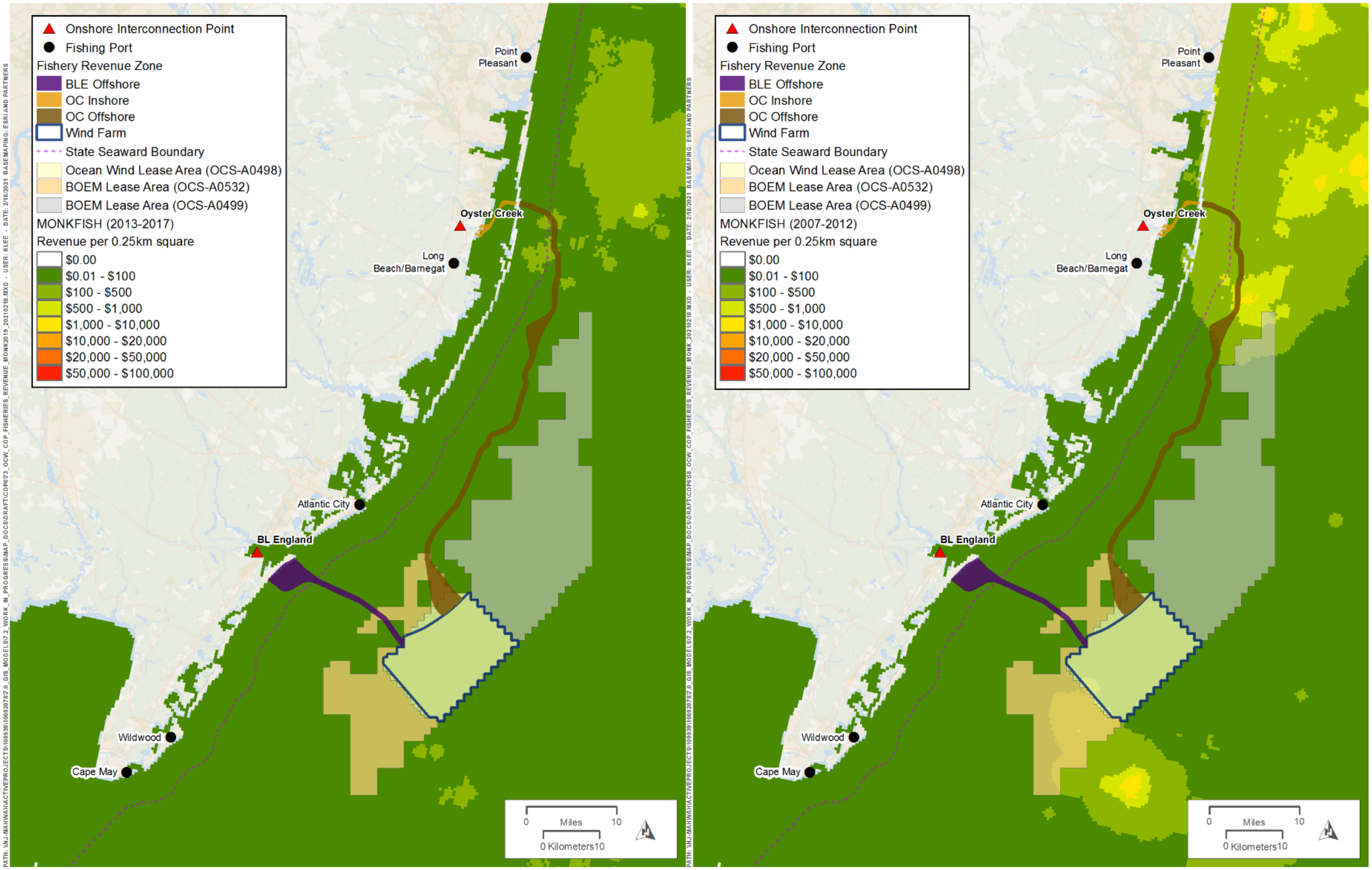

Figure 2.3.4-15. Revenue density for the monkfish fishery (Source: BOEM GIS Data) (left – 2013-2017; right – 2007-2012).

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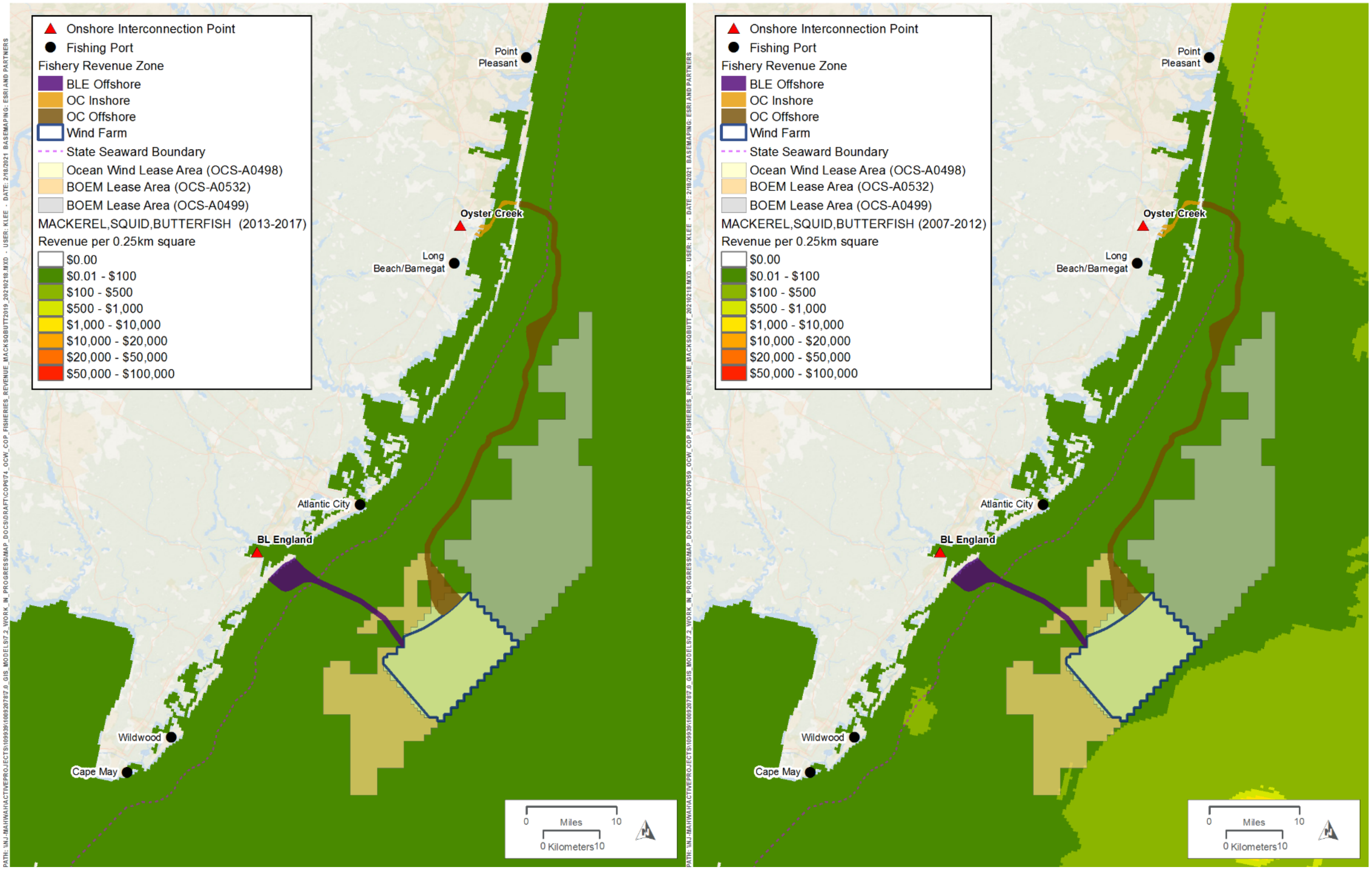


Figure 2.3.4-16. Revenue density for the mackerel, squid, and butterfish fishery (Source: BOEM GIS Data) (left – 2013-2017; right – 2007-2012).

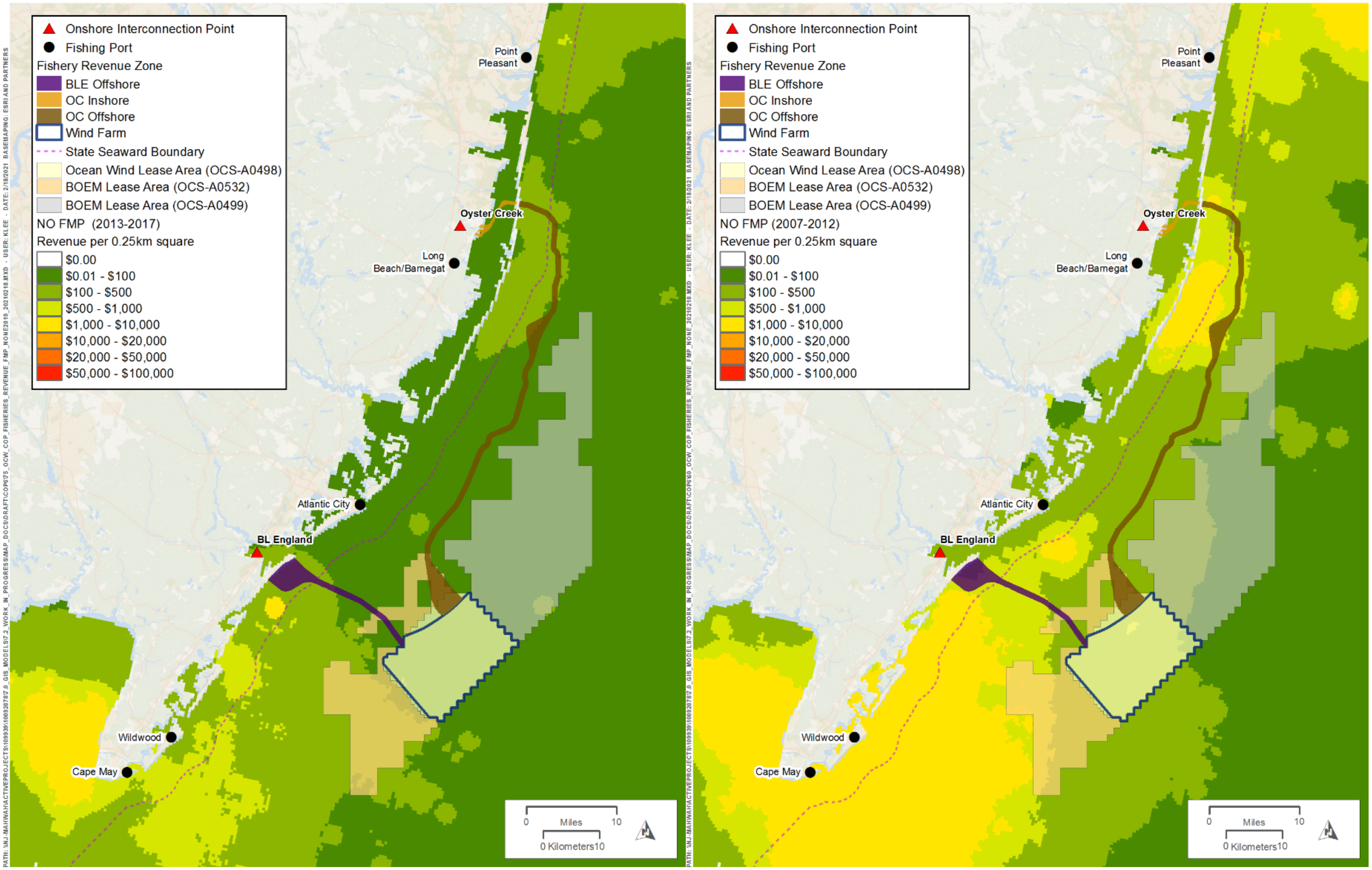


Figure 2.3.4-17. Revenue density for unmanaged species (Source: BOEM GIS Data) (left – 2013-2017; right – 2007-2012).

Table 2.3.4-10. Annual average fisheries revenue (2007-2012) and percentage of total fishery for Project Area by Fishery Management Plan.*

Fishery Management Plan	Wind Farm Area	Inshore BL England**	Offshore BL England**	Inshore Oyster Creek**	Offshore Oyster Creek**	Total Fishery Annual Average (USD$2018)	Percentage of Total Fisheries				
							Wind Farm Area	Inshore BL England	Offshore BLE	Inshore Oyster Creek	Offshore Oyster Creek
Atlantic Sea Scallop	$194,743	$83	$2,683	$3,516	$49,107	$467,992,687	0.04%	0.00%	0.00%	0.00%	0.01%
SurfClam/Ocean Quahog	$185,598	$25	$1,053	$636	$113,887	$70,997,428	0.26%	0.00%	0.00%	0.00%	0.16%
Unmanaged***	$43,326	$659	$16,929	$1,111	$34,788	$112,523,284	0.04%	0.00%	0.02%	0.00%	0.03%
Summer Flounder/ Scup/Black Sea Bass	$24,521	$119	$2,408	$694	$15,817	$36,251,444	0.07%	0.00%	0.01%	0.00%	0.04%
Menhaden	$25,969	$314	$9,300	$148	$10,312	$4,231,909	0.61%	0.01%	0.22%	0.00%	0.24%
Mackerel/Squid/Butterfish	$11,809	$35	$699	$161	$3,082	$44,663,476	0.03%	0.00%	0.00%	0.00%	0.01%
Monkfish	$5,851	$1	$47	$221	$9,046	$21,603,002	0.03%	0.00%	0.00%	0.00%	0.04%
Atlantic Herring	$1,170	$1	$39	$43	$485	$25,414,596	0.00%	0.00%	0.00%	0.00%	0.00%
Skate	$981	$12	$227	$197	$6,357	$8,524,993	0.01%	0.00%	0.00%	0.00%	0.07%
NE Multispecies Small Mesh	$111	$0	$6	$15	$252	$11,673,386	0.00%	0.00%	0.00%	0.00%	0.00%
Bluefish	$73	$1	$12	$520	$7,922	$1,724,574	0.00%	0.00%	0.00%	0.03%	0.46%
NE Multispecies Large Mesh	$41	$0	$3	$80	$1,156	$83,719,006	0.00%	0.00%	0.00%	0.00%	0.00%
Highly Migratory Species	$36	$0	$2	$5	$122	$1,992,382	0.00%	0.00%	0.00%	0.00%	0.01%
Golden Tilefish	$5	$0	$0	$0	$6	$4,714,568	0.00%	0.00%	0.00%	0.00%	0.00%
River Herring/ American Shad	$0	$0	$0	$7	$46	$29,900	0.00%	0.00%	0.00%	0.02%	0.15%
Totals	$494,233	$1,251	$33,410	$7,356	$252,385	$896,056,635	1.10%	0.01%	0.25%	0.07%	1.24%

* 2012 dollar values were adjusted to 2018 dollars using Bureau of Labor formula (*1.0935).

** Inshore and offshore cable route areas reflect the study area with a variable corridor width for the purposes of this analysis.

*** Species not managed under a Fishery Management Plan. 139 species or species groups were included in the unmanaged group, such as crabs (e.g., Cancer spp.), striped bass (*Morone saxatilis*), groupers (e.g., Epinephelus spp.), snappers (e.g., Lutjanus spp.), etc.

Source: BOEM GIS Data

Table 2.3.4-11. Annual average port revenue (2007-2012) for Project Area for ports with revenue greater than $1,000 annual average.

Port	Wind Farm Area	Inshore BL England	Offshore BL England	Inshore Oyster Creek	Offshore Oyster Creek	Sum of Annual Average
Atlantic City	$209,792	$273	$6,174	$559	$117,911	$351,201
Cape May	$101,112	$333	$9,974	$2,165	$15,175	$138,478
Newport News	$42,623	$40	$1,009	$489	$15,613	$63,014
Barnegat	$7,020	$1	$45	$1,840	$42,878	$52,071
New Bedford	$40,091	$34	$805	$213	$6,460	$49,609
Long Beach	$4,151	$1	$41	$819	$20,739	$25,953
Seaford	$16,095	$2	$141	$54	$2,237	$19,144
Gloucester	$7,895	$53	$1,382	$85	$6,920	$18,457
Sea Isle City	$8,172	$153	$3,487	$0	$553	$15,724
Point Pleasant	$3,191	$0	$18	$625	$8,561	$12,468
Hampton	$8,124	$7	$138	$16	$1,964	$10,593
North Kingstown	$3,568	$8	$199	$31	$910	$5,185
Ocean City	$3,225	$13	$326	$36	$534	$4,670
New London	$1,668	$0	$6	$5	$70	$1,775
Stonington	$1,304	$0	$26	$1	$77	$1,513
Narragansett	$635	$2	$34	$51	$497	$1,282
Wanchese	$600	$4	$59	$3	$210	$1,011

Very little recreational for-hire fishing occurs within the Wind Farm Area (**Figure 2.3.4-19**). Construction activities will result in temporarily displacing some recreational fishing trips to abundantly available fishing areas nearby.

Offshore Export Cable Corridors

The Project has two landfall connection sites, BL England at Ocean City and Oyster Creek in Barnegat Bay. Construction activities in the offshore export cable corridors are expected to be similar to the impacts described for the Wind Farm Area but are likely to be of shorter duration. At landfall locations, the offshore export cable will be installed by open cut installation (i.e., trenching) or by trenchless technologies. Cables will be installed in sections so disruptions of fishing activities in these routes are expected to be minimized and of short duration. Shellfish and benthic fisheries, such as conch, crab, and lobster, may be displaced and experience direct mortality if they occur within the direct cable footprint (See Section 2.2.5.2). These species are expected to quickly repopulate once the construction activity is completed. Fisheries using bottom gear, such as dredging, may be permanently disrupted in areas where the cable may need protective cover (e.g., rock or concrete mattresses) as those gear types have the potential to snag onto bottom structures. The associated revenue for commercial fisheries sourced from within the offshore export cable corridors is small compared to the overall fishery (**Table 2.3.4-9**). The port most affected by revenue sourced from within the Oyster Creek cable corridor would be Atlantic City, New Jersey (**Table 2.3.4-11**). However, revenue estimates are based on the entire study area. The final cable route will impact a smaller area and thus impact a smaller level of revenue. The landfall at Oyster Creek will be located to avoid impacts to existing aquaculture lease sites to the extent practicable, however the aquaculture lease near the marina landfall may be impacted by cable installation and anchor lines for installation vessels (**Figure 2.3.4-8**). Any impacts to the aquaculture lease area would be temporary. Construction activities will result in temporarily displacing some recreational for-hire fishing trips to nearby fishing areas (**Figure 2.3.4-9**), but the effect on fishing revenues will be minimal, given the availability of other fishing areas nearby.

2.3.4.2.2 Operations and Maintenance

Impacts associated with maintenance activities for the Project will be similar to those described for construction activities, including noise and increased vessel traffic. Further, EMF would be generated by the array cables, substation interconnector cables and offshore export cables. The impacts associated with vessel traffic, EMF, and changes in habitat and aquatic communities are discussed in Section 2.2.5.2 and 2.2.6.2.

Wind Farm Area

As noted for the construction phase, higher valued fishing areas are nearby so it is likely that most fishers will be able to continue fishing nearby. The displacement of fisheries to a nearby area would minimize the potential impact to revenues associated with these ports. This is most notable for the higher valued clam, scallop, and menhaden fisheries (**Figures 2.3.4-11** to **2.3.4-13**). The revenue for commercial fisheries sourced within the Wind Farm Area is presented in **Table 2.3.4-9** and the ports affected by that revenue are listed in **Table 2.3.4-11**. As shown in **Table 2.3.4-9**, the percentage of revenue sourced within the Wind Farm Area is 0.02 percent of the total commercial fishing revenue for the mid-Atlantic and northeast U.S.

Very little recreational for-hire fishing occurs within the Wind Farm Area (**Figure 2.3.4-9**). The wind turbines and offshore substations installed within the Wind Farm Area are expected to serve as additional artificial reef structures, providing additional locations for recreational for-hire fishing trips, potentially increasing the number of trips and revenue. The increased number of fishing trips out of nearby ports could also support increased angler expenditures at local bait shops, gas stations, and other shore side dependents (Kirkpatrick *et al.* 2017).

A number of scientific surveys are conducted along the northeast and mid-Atlantic coast in support of stock assessments and fisheries management policies. The following is a listing of ones that may be impacted by Project development.

- NOAA Fisheries NEFSC Ecosystems Surveys Branch collects fishery-independent data during standardized research vessel surveys from Cape Hatteras to the Scotian shelf. These surveys gather data that is used for stock assessments and management (NOAA Fisheries NEFSC n.d.-a). NEFSC conducts spring and fall seasonal bottom trawl surveys, Atlantic surfclam and ocean quahog surveys, and Dredge and Habitat Camera Surveys along the Mid-Atlantic states. NEFSC also conducts annual fisheries acoustic surveys using acoustic, midwater trawling, and underwater video technologies to improve fisheries-independent stock assessments for pelagic species (NOAA Fisheries NEFSC n.d.-b).
- The New Jersey Department of Fish and Wildlife conducts an Ocean Trawl Survey along the coastal ocean bounded by New York Harbor, the entrance to the Delaware Bay, and the 92 ft (28 m) depth contour offshore. Sampling is conducted in January, April, June, August, and October each year and data is used in the following stock assessments: American shad, Atlantic menhaden, Atlantic sturgeon, black sea bass, bluefish, horseshoe crab, river herring, striped bass, summer flounder, tautog, weakfish, and winter flounder (MAFMC 2015).
- Virginia Institute of Marine Science, Northeast Area Monitoring and Assessment Program Mid-Atlantic/Southern New England Nearshore Trawl Survey program operates from Martha's Vineyard, Massachusetts to Cape Hatteras, North Carolina. This survey program samples spring and fall within the outer bounds depth contour of 60 ft (18.3 m). Results are intended to compliment the NEFSC Bottom Trawl Survey, which occurs in deeper waters. Data from this bottom trawl survey is used in the following stock assessments: American lobster, Atlantic menhaden, bluefish, butterfish, long-finned squid, river herring, scup, and summer flounder (MAFMC 2015).

Portions of these surveys may overlap with portions of the Wind Farm Area where turbine foundations may permanently remove a small area from one sample strata. It is expected that the survey programs will be able to continue sampling within the same sample strata while removing the Wind Farm Area from the sample area.

Offshore Export Cable Corridors

It is expected that benthic communities, including clams and scallops, will be able to repopulate cable areas once the offshore export cables are installed and buried. There may be continued impacts to certain fisheries, such as dredges, in areas where cables are buried and are protected with concrete mattresses, rock or other material that may hang up nets and other bottom fishing gear. The offshore export cable routes avoid high valued fishing areas identified in **Figures 2.3.4-11** and **2.3.4-12** to the extent practicable, though the cable route to Oyster Creek overlaps with some medium valued clam and scallop fishing areas. The ports most impacted by revenue sourced within the cable routes are Atlantic City, followed distantly by Barnegat, Cape May, Long Beach, and Newport News (**Table 2.3.4-10**). Cable inspection and repair activities may also result in temporary avoidance of those areas. The areas are expected to be small relative to the larger commercial fishing areas as discussed previously. Additional discussion of impacts to fish and benthic communities associated with Project operation, including impacts associated with noise, EMF, and increased vessel traffic associated with cable inspection and repairs is provided in previous sections.

The areas where the offshore export cables are buried are not expected to impact recreational for-hire fishing as current artificial reefs and prime fishing areas are abundant in the nearby areas. Portions of the nearshore scientific surveys described previously may cross inshore waters where cable lines are buried and may result in temporary avoidance of the cable lines during repair and inspections.

2.3.4.2.3 Decommissioning

Impacts associated with decommissioning activities are expected to be similar to temporary construction activities described above. At the end of the operational lifetime of the Project, it is anticipated that all structures above the seabed level or aboveground will be removed. The decommissioning sequence will generally be the reverse of the construction sequence, will involve similar types and numbers of vessels, and similar equipment.

Wind Farm Area

After removing structures, commercial fishing is expected to resume as fish and shellfish communities transition back to a sandy, soft-bottom community structure recolonizing from the surrounding sandy bottom habitat. Scour material is expected to be left in place and as such may serve as hazards to bottom fishing gear such as dredges and bottom trawling. A small increase in vessel activity would occur during the decommissioning phase but this level of activity is not expected to measurably affect commercial or recreational fishing opportunities, catchability of fish and shellfish resources, or navigation.

Removal of structures that act as artificial reefs would result in loss of recreational for-hire fishing opportunities that would have developed during the operational phase, but it is expected these trips will take place at alternative locations that are abundant offshore of New Jersey.

Offshore Export Cable Corridor/Landfall

Offshore cables generally will be abandoned in place and cable protection will be left in place. Exposed cables may be removed to ensure that they do not become hazards to other users of the seabed. Commercial and recreational for-hire fishing activities are expected to be temporarily excluded during removal of any exposed cables. A small increase in vessel activity would occur during the decommissioning phase but this level of activity is not expected to measurably affect commercial or recreational fishing opportunities, catchability of fish and shellfish resources, or navigation.

2.3.4.2.4 Summary of Potential Project Impacts on Commercial and For-Hire Recreational Fishing Resources

The IPFs for commercial and for-hire recreational fishing include physical seabed/land disturbance, habitat conversion, noise, traffic, and land use and economic change.

WTGs and other in-water structures are expected to serve as artificial reef structures, providing additional locations for recreational for-hire fishing trips, potentially increasing the number of trips and revenue. Other potential impacts are expected to be short-term. During construction of the facilities within the Wind Farm Area, commercial and recreational for-hire fishing practices are expected to be temporarily disturbed. The offshore export cable corridors avoid high density, high value commercial fishing grounds to the extent practicable. Very little recreational for-hire fishing occurs within the Wind Farm Area. Construction activities will result in temporarily displacing some recreational fishing trips to abundantly available fishing areas nearby.

2.3.4.3 Avoidance, Minimization, and Best Management Practices

The proposed measures for avoiding, minimizing, reducing, eliminating, and monitoring environmental impacts for the Project are presented in **Table 1.1-2**.

2.3.5 Land Use and Coastal Infrastructure

2.3.5.1 Affected Environment

The following sections describe the existing land uses and coastal infrastructure in the Project Area and the potential impacts from the Project. The land use discussion below focuses on resources found along the onshore export cable route as well as at the onshore substation and interconnection points.

The NJDEP Division of Land Use Regulation regulates land use activities through a permit process in accordance with the rules promulgated in support of the following statutes: Freshwater Wetlands Protection Act (N.J.S.A. 13:9B et seq.), Flood Hazard Area Control Act (N.J.S.A. 58:16A), Wetlands Act of 1970 (N.J.S.A. 13:9A-1 et. seq.), Coastal Area Facility Review Act (N.J.S.A. 13:19-1 et seq.), Waterfront Development Law (N.J.S.A. 12:5-3), Tidelands Act (N.J.S.A. 12:3), NJ Water Pollution Control Act (N.J.S.A. 58:10A et seq.), and the Highlands Water Protection and Planning Act (P.L. 2004, c.120). Various activities in support of the Ocean Wind Offshore Wind Farm Project may be subject to these permits.

2.3.5.1.1 Land Use

The proposed onshore export cable routes near BL England are located on the barrier island of Ocean City and mainland New Jersey west of the Garden State Parkway in Upper Township, New Jersey. Based on the NJDEP land use/land cover (LULC) data, land uses in the vicinity of the onshore export cable routes near BL England are classified in six different land-use groups: water, wetlands, barren land, forest, urban, and agriculture (**Figure 2.3.5-1**; NJDEP 2015). Dominant land uses along the onshore export cable corridors include wetlands, forest, and urban development.

Urban land use dominates the barrier island of Ocean City, New Jersey; therefore, proposed onshore export cable routes in Ocean City are primarily in areas with urban development. The proposed routes are located in areas with one and two-family residences, as well as residential neighborhoods and commercial and public facilities. In addition to urban development, portions of proposed routes located along the Atlantic coastline are adjacent to barren land or beaches and portions of proposed routes along the bayside are in the vicinity of managed regulated wetlands. Dominant land use along the proposed onshore export cable corridors that cross over Peck Bay to the Garden State Parkway include urban development and water (e.g., tidal bays, tidal river, and other tidal waters). These routes are characterized primarily by commercial zoning (e.g., drive-in business, central business) and a conservation district is located along Peck Bay (Ocean City Zoning Map 2016).

Wetlands, forest, and urban land uses are found primarily on the mainland in Upper Township, New Jersey (NJDEP 2015). Proposed onshore export cable corridors along the Garden State Parkway and through Marmora and Beesley’s Point, New Jersey are dominated by urban land use with forest land use southeast of BL England. Wetlands and forest land use dominates the proposed routes adjacent to and within the Tuckahoe Fish and Wildlife Management Area, with minimal urban and agriculture land use also located in the vicinity.

Commercial development in North Cape May County, which includes Ocean City and Marmora and Beesley’s Point, primarily serves local needs. There are minimal (if any) large manufacturing, production, or “big box/high cube” distribution facilities in the region. Regional retail is clustered along the Garden State Parkway interchanges at US Route 30 and US Route 40/322. Commercial centers for the region are located north of BL England in Atlantic County, New Jersey in Linwood and Somers Point. Residential development in the vicinity of the onshore export cable corridors includes a variety of tract housing, from single families to townhouse, patio homes, and “over 55” communities that complement a few farming and historic structures (AECOM 2018).

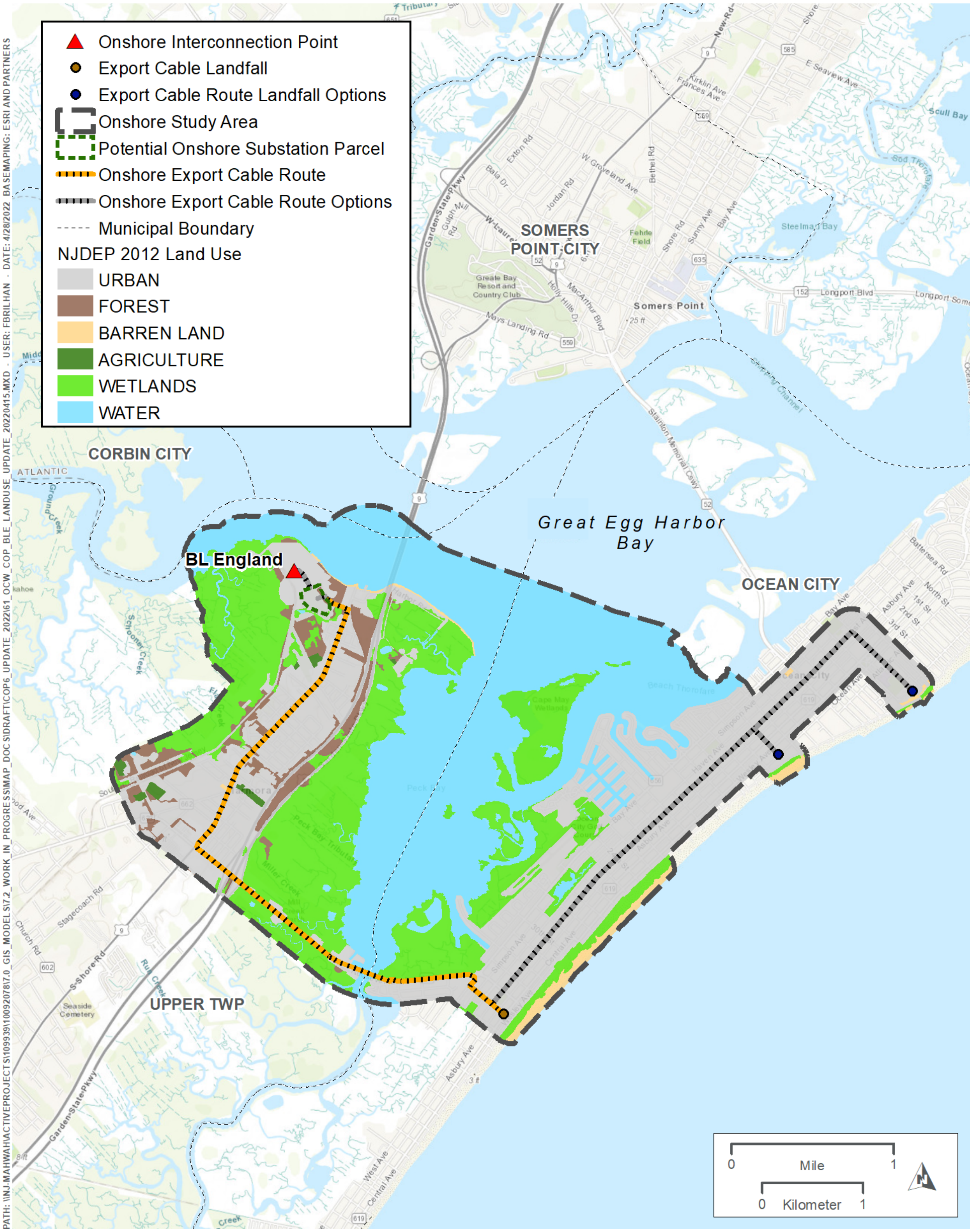


Figure 2.3.5-1. BL England - NJDEP land use (NJDEP 2015).

The entirety of the Project Area falls outside of the New Jersey Pinelands Area; however, portions of the onshore and inshore export cable corridors fall within the Pinelands National Reserve. The proposed onshore export cable corridors on the mainland are located within the following Pineland Management Areas (PMAs) as designated by the New Jersey Pinelands Commission: Forest Area and Regional Growth Area (NJDEP GIS 2016). Each PMA has goals, objectives, development intensities, and permitted uses that are implemented through local zoning and must conform to the land use standards of the Pinelands (Pinelands Commission 2018). All future land use in PMAs is subject to guidelines and regulations established in the Pinelands Comprehensive Management Plan. Proposed onshore export cable corridors in Marmora and Beesley's Point are located within the Regional Growth Area PMA. Within Regional Growth Areas, permitted residential densities range from two to six homes per acre with sewers; sewered and industrial uses are also permitted (Pinelands Commission 2018). Within the Forest Area PMA, permitted residential densities include clustered housing on one acre lots at an average residential density of one home per 28 acres. Roadside retail within 300 ft of pre-existing commercial uses is permitted, as are low intensity recreation uses (Pinelands Commission 2018). Proposed onshore export cable corridors on the barrier island do not fall within the Pinelands National Reserve.

Onshore export cable corridors near Oyster Creek are located on mainland New Jersey in Lacey Township and Ocean Township, as well as Berkeley Township where the cable crosses under Island Beach State Park. Based on the NJDEP LULC data, land use in the vicinity of the onshore export cable corridors near Oyster Creek is classified in five different land-use groups: water, wetlands, barren land, forest, and urban (**Figure 2.3.5-2**; NJDEP 2015). There are potential mainland onshore export cable corridors in Lacey Township and Ocean Township. The primary land use near the onshore export cable corridors in Lacey Township and Ocean Township is a combination of wetlands, urban development, and forest land, with urban development located primarily east of U.S. Route 9 (NJDEP 2015).

The proposed offshore export cable will go under Island Beach State Park. The primary land use near the offshore export cable route is water, which includes Barnegat Bay, tidal rivers and other tidal waters. Land use on Long Beach Island located on the barrier island to the north of Barnegat Inlet is primarily wetlands with barren land or beaches located along the Atlantic coastline and the inlet.

Three types of designated PMAs exist in the vicinity of the onshore export cable corridors near Oyster Creek: Forest Area, Regional Growth Area, and Rural Development Area (NJDEP 2016). Forest Area and Regional Growth Area development regulations are described above; within the Rural Development Area, limited, low-density residential development and roadside retail is permitted (Pinelands Commission 2018). Clustered housing on 1-acre lots is permitted at an average residential density of one home for every 5 acres and community commercial, light industrial, and active recreational uses served by septic systems are also permitted (Pinelands Commission 2018).

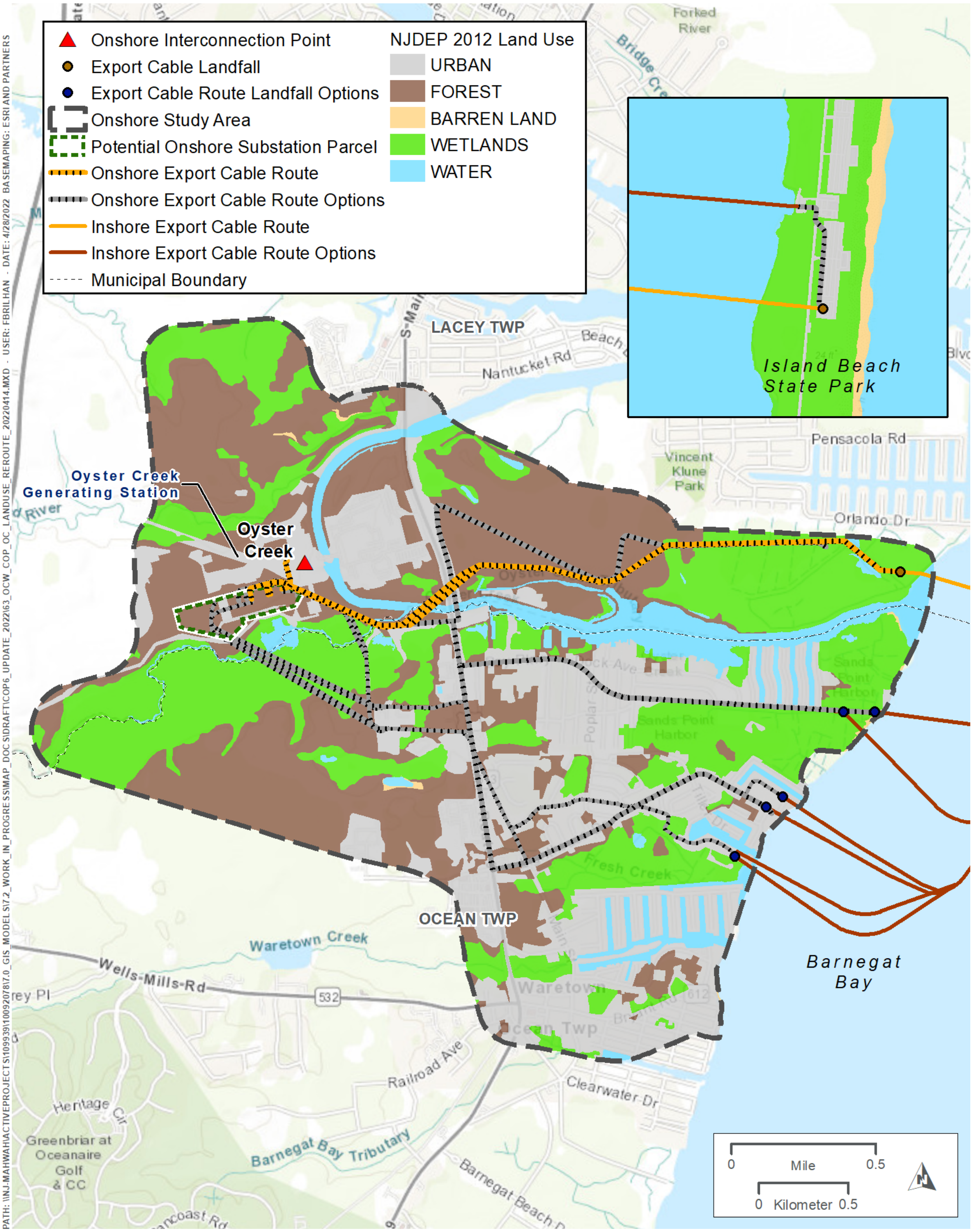


Figure 2.3.5-2. Oyster Creek - NJDEP land use (NJDEP 2015).

2.3.5.1.2 Sensitive Receptors

There are six pre-kindergarten through 12th grade schools in the vicinity of the onshore export cable corridors near BL England; four are located in Ocean City and two are located in Upper Township (NJOGIS 2018). Three medical centers (AtlantiCare Physician Group Primary Care, Ocean City Family Practice, and Shore Outpatient Center) are in the vicinity of the onshore export cable corridors in Ocean City. One medical center (AltantiCare Urgent Care Marmora) is in the vicinity of the onshore export cable corridors in Upper Township. In addition, several places of worship are located in the vicinity of the onshore export cable corridors in Ocean City and Upper Township. Three museums including Bayside Center, Ocean City Historical Museum, and Discovery Seashell Museum, and the Ocean City Free Public Library are in the vicinity of the onshore export cable corridors in Ocean City. A variety of hotels and motels are in the vicinity of the onshore export cable corridor near BL England, primarily concentrated in Ocean City. There are no colleges or universities in the vicinity of the onshore export cable corridors near BL England (NJOGIS 2017).

Residences are concentrated in Forked River, Lacey Township and south of Oyster Creek in Ocean Township. There are no formal education facilities (e.g., colleges, universities, or pre-kindergarten through 12th grade schools), libraries, museums, or health care facilities in the vicinity of the onshore export cable corridors near Oyster Creek (NJOGIS 2017 and NJOGIS 2018). The marina landfall would be located within an existing marina property.

2.3.5.1.3 Visual Resources

The landscape character in the vicinity of the onshore export cable corridors at BL England and Oyster Creek includes a combination of natural views such as beaches, shorelines, and scenic vistas, and man-made views such as unique buildings, landscaping, parks, and other cultural features. Important visual resources include those recognized as highly valued (e.g., identified by a visitor's organization or historic preservation office) and views and vistas that people are accustomed to seeing as part of the everyday landscape/seascape (e.g., boardwalks, skylines, the Atlantic Ocean, bays, and tidal rivers).

The topography of the onshore export cable corridors in the vicinity of BL England is primarily flat and coastal with beaches and barrier islands characterized by dense populations east of the Garden State Parkway, including Ocean City, New Jersey. The study area contains several parks, including Ocean City Park, Emil Palmer Park, Sandcastle Park, and Stainton Wildlife Refuge in the vicinity of the proposed onshore export cable corridors in Ocean City. The Tuckahoe Wildlife Management Area is located in the vicinity of the proposed onshore export cable corridors in Upper Township. NJDEP public coastal access points in the vicinity of the onshore export cable corridors at BL England are concentrated along the coastlines of Ocean City, New Jersey (NJDEP 2018d). Additional public access points are located within Great Egg Harbor Bay and Peck Bay, as well as along Crook Horn Creek (NJDEP 2018k). Additional visual resources in the vicinity of the proposed onshore export cable corridors in Ocean City include the Ocean City Boardwalk, including Gillian's Wonderland Pier (SEARCH 2018).

The topography of the onshore export cable corridors near Oyster Creek is generally flat and coastal with beaches and small barrier islands. The mainland region in Lacey Township and Ocean Township is primarily residential and includes the tidal river of Oyster Creek, Sands Point Harbor, Vincent Klune Park, and a portion of Enos Pond County Park. Dominant man-made structures include the Barnegat Branch Trail and the Garden State Parkway. The barrier island region in the vicinity of the offshore export cable corridor includes Sedge Island and Island Beach State Park, which includes several kayak trails, and Barnegat Lighthouse State Park. Dominant man-made features include Barnegat Lighthouse. Visual access to coastal lands, water, and resources is afforded by New Jersey's Public Trust Doctrine and public coastal access points in the vicinity of the onshore export cable corridors near Oyster Creek are located near Sands Point Harbor, Oyster Creek, and

Forked River State Marina (NJDEP 2018k). On the barrier island region near the offshore export cable corridor, there are no public access points located along Sedge Island or Island Beach State Park (NJDEP 2018l). Visual resources within the general region of the proposed onshore export cable corridors on the mainland include Forked River State Marina, the designated National Natural Landmark Manahawkin Bottomland Hardwood Forest, the USFWS Edwin B. Forsythe National Wildlife Refuge, and the NJDFW Forked River Mountain wildlife management area and Upper Barnegat Bay wildlife management area (NPS 2016). The northern route of the Southern Pinelands Natural Heritage Trail is located south of the proposed onshore export cable corridors (NJDOT 2017). Additional visual resources in the vicinity of the offshore export cable corridor include Barnegat Lighthouse (SEARCH 2018).

Visual Impact Assessment

After extensive engagement with coastal communities, Ocean Wind strategically selected the Wind Farm Area to minimize the visual impacts on the New Jersey coastline while maximizing the wind resource captured by the WTGs. A visual impact assessment (VIA) has been completed for the Project, is further discussed in Section 2.3.5.2, and can be found in Appendix L. The VIA examines the potential visual effect of the offshore and onshore components of the Project on the landscape.

2.3.5.1.4 Infrastructure

A number of existing infrastructure resources can be found within the Project Area including buried or submarine utility lines, transmission and gas pipelines, sewer outfalls, stormwater inlet grates, roads, railroads and bridges. These resources are identified in the sections below.

Buried or Submarine Utility Lines, Pipelines, Water Intakes

The onshore export cable corridors within the vicinity of BL England and Oyster Creek are developed areas within New Jersey and have multiple utilities including electric and gas distribution lines, electric and gas transmission lines, communication cables, and water and sewer pipelines. There are a number of sewer pipelines and intake structures located along the coast of New Jersey that begin onshore and extend offshore. Coordination with utility, pipeline, and water intakes will be documented. Ocean Wind requested a departure for crossing agreements (Appendix T). As crossing agreements are typically negotiated closer to construction, Ocean Wind will provide crossing agreements post-COP submittal.

For the offshore component of the project, Ocean Wind will complete a utility assessment to identify owners and burial depths as needed to support development of the COP.

For the onshore infrastructure crossings, Ocean Wind will coordinate with owners to identify and better understand crossing agreements, as-builts, and recent or planned changes in infrastructure. Underground utility surveys will be conducted to determine existing underground infrastructure along and within routes.

Offshore Project Area

There are several cables crossing the offshore export cable corridors. Based on NOAA navigation charts, pipelines are present within the offshore export cable corridor near BL England (NOAA 2018d). There are no pipelines in the Wind Farm Area (NOAA 2018d). Based on North American Submarine Cable Association data, several in service and abandoned submarine telecommunication cables are present in the offshore export cable corridor and in the vicinity of the Wind Farm Area (**Figure 2.3.5-3**). In-service cables along the offshore export cable corridor include the TAT 14 Seg G, TAT 12 Seg L, GlobeNet Seg 1, and GlobeNet Seg 5 (North American Submarine Cable Association 2015). Out-of-service cables along the offshore export cable corridor include the TAT 3, TAT4, TAT 7, TAT 8, TAT 9, and TAT 11. Potential Export Cable routes from the Wind Farm Area to the landfall site at BL England would not cross any mapped submarine cables. Offshore export cable routes from the Wind Farm Area to the landfall site at Oyster Creek would cross all of the listed submarine cables.

NOAA navigation charts show several sewer or stormwater outfalls in navigable waters in the vicinity of the offshore export cable corridor (NOAA 2018d). These outfalls are located along the New Jersey coastline near populated areas extending from approximately 164 ft (50 m) from the shoreline to over 6,562 ft (2,000 m) from the shoreline (NOAA 2018d). There are multiple wastewater outfalls located upland of the offshore export cable corridor (Marine Cadastre 2018).

Based on the NOAA navigation charts there are several cables crossing the Absecon Inlet and inland bay navigable waters and several pipelines within the vicinity of BL England (NOAA 2018d). The pipelines are in the inland bays surrounding Atlantic City, predominantly associated with fixed bridges (NOAA 2018d) (**Figure 2.3.5-3**). There are no sewer or stormwater outfalls shown in navigable waters near BL England (NOAA 2018d). Multiple wastewater outfalls are shown in Marine Cadastre in the upland regions near BL England (Marine Cadastre 2018). Additionally, according to the Ocean City Master Drainage Plan, several stormwater inlet grates are located in the vicinity of the onshore export cable corridors in Ocean City (2015).

Based on NOAA navigation charts, no pipelines and one cable crossing area is identified within the navigation channel of Barnegat inlet and Barnegat Bay near Oyster Creek. There are several cables crossing the navigable waters of Barnegat Inlet and Barnegat Bay, but no pipelines are present in the vicinity of the onshore export cable corridors near Oyster Creek. Additionally, there are no sewer or stormwater outfalls shown in navigable waters near Oyster Creek (NOAA 2018d). Multiple wastewater outfalls were identified in Marine Cadastre in the upland regions near Oyster Creek (Marine Cadastre 2018).

The Oyster Creek nuclear generating station shut down operations in September 2018 and is in the process of decommissioning (Exelon 2018). Former operations at the site included cooling and dilution water through the intake channel, located on the north side of the generating station. Water flowing from Barnegat Bay towards the plant would enter into a series of pipes and then discharge into Oyster Creek, which runs to the south of the generating station (NJDEP n.d.-e). About 300 employees will decommission the plant over a period of 8 years (Exelon 2018).

Roads

In the vicinity of the onshore export cable corridors at BL England and Oyster Creek there are toll roads, interstate highways, US highways, and State highways. Major roadways in the vicinity of BL England include the Garden State Parkway, US Route 9, Atlantic City Expressway, US Route 40, US Route 322 (Black Horse Pike), and US Route 30 (Absecon Boulevard) in Atlantic County. Major roadways in the vicinity of Oyster Creek include US Route 9 and the Garden State Parkway. Detailed roadway information can be found in **Table 2.3.5-1.**

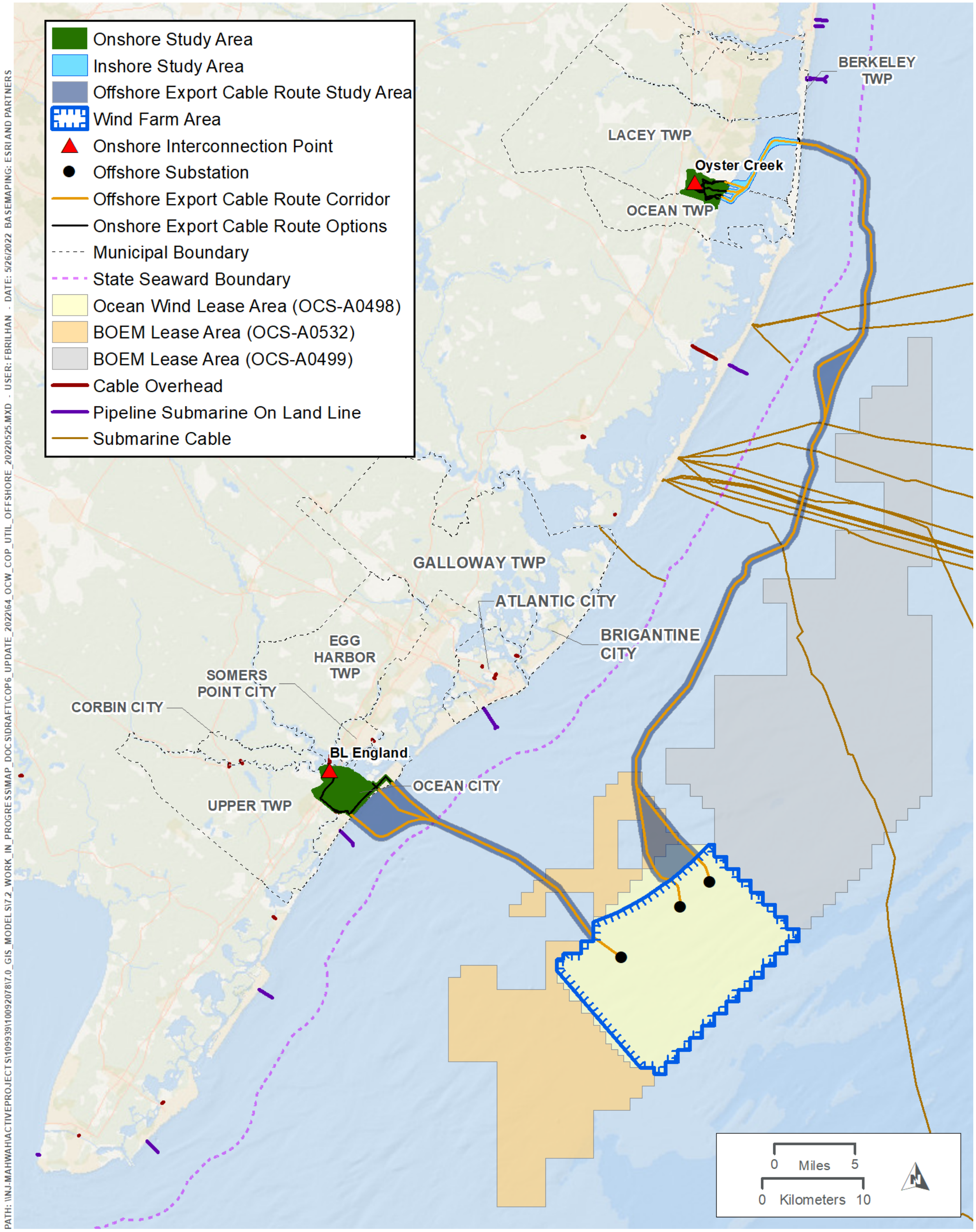


Figure 2.3.5-3. Buried or submarine utilities - NOAA Charts showing pipelines and crossings in the vicinity of the offshore export cable corridors.

Table 2.3.5-1. BL England - major roadways.

Roadway	County	Type	Functional Classification	Speed Limit (mph)	Number of Lanes (each direction)	AADT* (year)
Garden State Parkway	Atlantic	Toll Road	Urban Principal Arterial Expressway	65	2	N/A
US Route 9	Atlantic	US Highway	Urban Minor Arterial/Urban Principal Arterial	40	1-3	16,000 (2014)
Atlantic City Expressway	Atlantic	Toll Road	Urban Principal Arterial Expressway	55-65	3-4	50,000 (2013)
US Route 40	Atlantic	US Highway	Urban Principal Arterial	40-50	2	26,700 (2014)
US Route 322	Atlantic	US Highway	Urban Minor Arterial	55	2	17,600 (2014)
US Route 30	Atlantic	US Highway	Urban Principal Arterial/Rural Principal Arterial	50	2	49,500 (2014)

*Annual average daily traffic

Major roadways traversing the Oyster Creek Project Area include US Route 9 and the Garden State Parkway. Detailed roadway information can be found in **Table 2.3.5-2**.

Table 2.3.5-2. Oyster Creek - major roadways.

Roadway	County	Type	Functional Classification	Speed Limit (mph)	Number of Lanes (each direction)	AADT (year)
US Route 9	Ocean	US Highway	Urban Principal Arterial	45	1	18,200
Garden State Parkway	Ocean	Toll Road	Urban Principal Arterial Expressway	65	3	N/A

*Annual average daily traffic

Railroads

The Atlantic City Rail Line, a passenger rail line operated by New Jersey Transit, operates in the vicinity of BL England and provides service between Philadelphia, PA and Atlantic City, NJ. It services the area near BL England at the Atlantic City and Absecon Stations with 2,950 average weekday passenger boardings in 2011 (NJ Transit 2015). Additionally, the BL England Generating Station site is located in a rail easement that serves the facility (AECOM 2018).

Near Oyster Creek, the Barnegat Branch, an abandoned freight and passenger rail line formerly operated by the Central Railroad of New Jersey, traversed the Lacey Township area and was formally terminated in 1977. The Barnegat Branch was converted to a rail-to-trail park in 2007 (Ocean County Department of Planning 2007). There are no active rail lines or stations in the vicinity of Oyster Creek.

Bridges

There are over 100 bridges, including pedestrian, highway, and rail bridges, in the vicinity of the onshore export cable corridors near BL England. In the vicinity of the BL England Generating Station, Great Egg Harbor is spanned by multiple bridges with closed clearances of 50-65 ft (AECOM 2018). Notable bridges in the study area include major publicly and privately owned bridges that connect Absecon Island, Brigantine Island, and Ocean City to mainland New Jersey are listed in **Table 2.3.5-3**.

Table 2.3.5-3. Major bridges in the BL England Project Area.

Bridge	Height Clearance	Width Clearance	Feature Carried	Feature Crossed	Owner/Maintainer
Great Egg Harbor Bridge	50 ft	150 ft	US Route 9 (Garden State Parkway)	Great Egg Harbor Bay	NJDOT
34th Street (Roosevelt Boulevard) Bridge	35 ft	80 ft	County Route 623 (Roosevelt Boulevard)	Peck Bay	Cape May County

Sources: *ASPIRE* 2013, NJDOT 2015, and Waterway Guide 2018

There are four bridges in the vicinity of the onshore export cable corridors near Oyster Creek. Two bridges are highway carrying bridges located along US Route 9; the northern bridge spans over South Branch Forked River and the southern bridge spans over Oyster Creek. Both bridges along US Route 9 are owned and maintained by NJDOT. Two bridges carry Beach Boulevard in Bayside Beach, Lacey Township over South Branch Forked River. Both Beach Boulevard bridges are owned and operated by Ocean County.

2.3.5.2 Potential Project Impacts on Land Use and Coastal Infrastructure

Potential impacts on land use and coastal infrastructure may be introduced from the construction, operation and maintenance, and decommissioning phases of the Project. IPFs include:

- Physical land disturbance
- Noise
- Traffic
- Visible structures/lighting
- Discharges/releases and withdrawals
- Land use or economic changes

2.3.5.2.1 Land Use

No impacts to coastal land use are anticipated for construction, operations and maintenance, and decommissioning activities in the Wind Farm Area and along the offshore export cable corridor. Land use impacts will be limited to the upland portion of the Onshore Project Area and as far into the coastal area as mean low water. Impacts within the intertidal zone are included in the onshore impacts section below. Appendix Q contains Ocean Wind's Coastal Zone Consistency review for the Project.

Construction

In general, impacts from construction activities to coastal land use will be temporary in nature and consistent with the existing zoning and land use. Onshore construction will include landfalls, the onshore export cables, substations, interconnection points, and port facilities. Construction is expected to result in temporary or permanent impacts to local residents, businesses, and the community along the proposed onshore export cable route during construction of these Project components. Project activities that are anticipated to result in impacts to land use include trenchless installation operations at landfalls, installation of onshore export cable duct banks, and construction of substations.

Landfall construction methods will minimize impacts to land use by using trenchless methods such as HDD. Landfall construction may require temporary use of land. These impacts are anticipated to last for the duration of construction of the trenchless entry pit, landfall TJBs, and onshore export cable, but following construction, these areas will be returned to their previous condition and use.

If a route is selected that would pass through undeveloped areas (such as the Holtec property route for Oyster Creek (the northern route option), portions of the Oyster Creek onshore route west of Route 9, or a portion of Peck Bay for BL England options, described in Volume I, Section 5.1.2, there would be temporary impacts associated with construction. There will be a permanent conversion of land to utility right-of-way or easement, but operations and maintenance would not result in land disturbance except in the event that cable maintenance or replacement should be required. Land that is currently undeveloped would be permanently impacted due to the construction of project components such as TJBs, duct bank, or substations. These impacts would be minimized through the use of existing ROWs, co-locating project components, utilizing land that is zoned for commercial or industrial development, or restoring areas to pre-disturbed condition following construction.

Utilities, roadways, bridges, and railroad crossings would be completed per crossing agreements. There may be temporary impacts to the various resources during the construction phase, but they would be completed per the crossing agreement to minimize impacts during construction and avoid permanent impacts.

Project construction at the landfalls, along the onshore export cables, and at the substations will result in temporarily increased noise levels, lighting, and traffic in the vicinity of the construction. These temporary impacts may result in impacts to local sensitive receptors such as religious locations, recreational areas, schools, and other sensitive receptors described above. Construction noise and lighting can be minimized through BMPs, as appropriate, and these temporary impacts would not change the existing uses of the areas. Supplementary information on noise is contained in Appendix R.

Duct bank construction within the roadway can result in temporary traffic impacts such as lane closures, shifted traffic patterns, or closed roadways. BMPs and maintenance of traffic plans would be developed and coordinated with local and State agencies. Traffic impacts would be limited to the immediate construction area. Roadways would be returned to pre-construction conditions and would not result in changes to the existing land use.

The construction of the onshore substations would result in temporary and permanent impacts. However, the facilities would be consistent with surrounding land uses and in an industrial setting, therefore potential impacts to land use would be minor. Upgrades to existing facilities may be needed for interconnection, however those upgrades would be consistent with the existing land use.

Offshore Project components are expected to have limited visibility from onshore viewpoints due to distance from shore, curvature of the earth, wave height, and atmospheric conditions. WTGs will be installed over 15 miles from the closest point to New Jersey’s shore (including Ocean, Atlantic and Cape May Counties). Potential visual impacts associated with the construction of new aboveground facilities are described in Appendix L.

Operations and Maintenance

Onshore Project operation and maintenance will include regularly scheduled maintenance, emergency repairs, and similar daily operations associated with the onshore portions of the Project Area. Operations and maintenance is not expected to result in impacts to land use within the Project Area. Potential visual impacts associated with presence of the operating Project are described in Appendix L. Supplementary information on noise is contained in Appendix R.

Decommissioning

Decommissioning has the potential to result in similar land use impacts as construction. These impacts would be temporary in duration during the decommissioning phase of the Project.

2.3.5.2.2 Coastal Infrastructure

Onshore Project activities such as construction, operation and maintenance, and decommissioning are expected to have no impacts on coastal infrastructure. Coastal infrastructure impacts will be limited to the in-water portion of the Project Areas and are described above.

Construction

In-water infrastructure such as fiber optic cables, pipelines, and utilities may need to be crossed at various locations along the offshore export cable routes. Once the final export cable route is established, Ocean Wind will look to enter into cable crossing agreements with the owners of any offshore cables that might be crossed by the export cable. Crossing agreements in U.S. waters are supported by the ICPC, which is also active in Europe and provides a framework for establishing cable crossing agreements with which Ocean Wind is familiar. The onshore portions of this work will likely be located in areas with industrial use highly suitable for this work and already interconnected to the grid. Any conflicts with transmission lines and substations will be mitigated. During construction, there may be temporary impacts to utilities during the crossing, however these would be temporary in duration and coordinated in advance.

Operation and Maintenance

Operation and maintenance activities are not anticipated to impact coastal infrastructure. Regularly scheduled maintenance and repairs should not impact additional coastal infrastructure. If maintenance or repairs are required near coastal infrastructure, crossing agreements would be utilized to minimize impacts.

Decommissioning

Decommissioning activities and their impacts to coastal infrastructure would be similar to those described in the construction section above. No impacts are anticipated to coastal infrastructure during decommissioning.

2.3.5.2.3 Summary of Potential Project Impacts on Land Use and Coastal Infrastructure Resources

The IPFs affecting land use and coastal infrastructure include physical seabed/land disturbance, discharge//release and withdrawals, noise, traffic, visible structures/lighting, and land use and economic change.

Ocean Wind endeavors to locate Project components within land parcels that will avoid impacts or changes to the land use, such as within existing ROWs, industrial zoned areas, and avoiding sensitive receptors and habitats. However, some Project components may result in a long-term change to land use in the area where a project component is constructed or long-term impacts to a viewshed. Cable installation within a roadway can result in short-term, temporary traffic impacts. During cable installation, short-term, temporary impacts could occur to in-water infrastructure such as fiber optic cables, pipelines and utilities. Ocean Wind will secure crossing agreements with utility owners to avoid impacts.

2.3.5.3 Avoidance, Minimization, and Mitigation Measures

The proposed measures for avoiding, minimizing, reducing, eliminating, and monitoring environmental impacts for the Project are presented in **Table 1.1-2**.

2.3.6 Navigation and Vessel Traffic

A Navigation Safety Risk Assessment (NSRA) for the Project was conducted and can be found in Appendix M. The NSRA was developed based on 30 CFR 585.627(a)(8) and to meet the requirements of USCG Navigation and Inspection Circular (NVIC) 01-19, *Guidance on the Coast Guard's Roles and Responsibilities for Offshore Renewable Energy Installations* (USCG 2019). The NSRA summarizes information about navigation and vessel traffic in the Project Area, examines Project impacts on navigation and vessel traffic, and identifies mitigation strategies that would eliminate or reduce navigational safety risks. Ocean Wind conducted outreach with stakeholders such as the USCG, the Mariners Advisory Committee for the Bay and River Delaware, and commercial and recreational fishing interests, to gain an understanding of stakeholder issues and potential project impacts during development of the NSRA. A summary of the stakeholder outreach is provided in the NSRA.

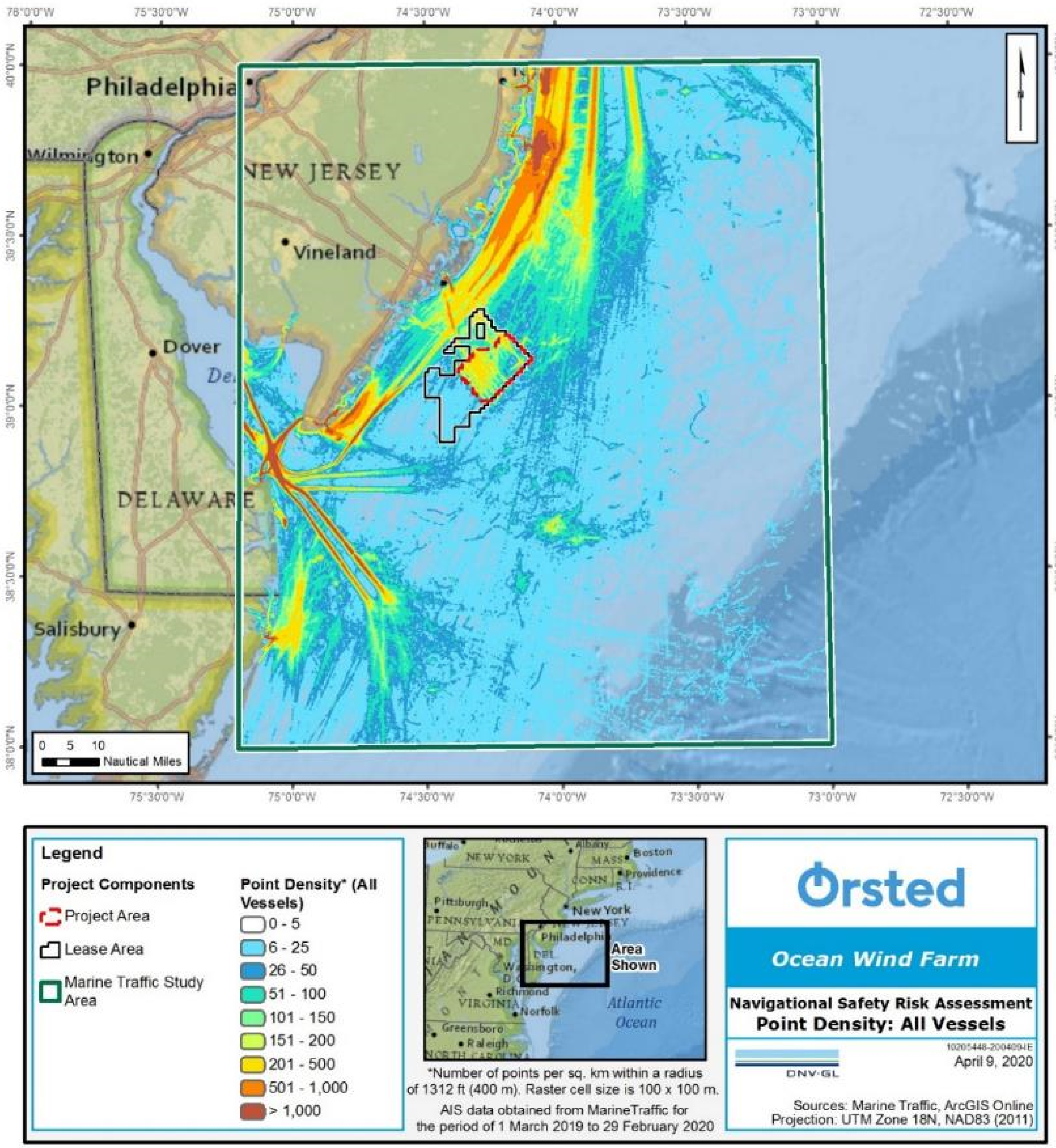
The study area of the NRSA included the Lease Area, Wind Farm Area, and Cable Route Corridors, which is the area where the Project development would occur for above and below water structures. The impact assessment included the gathering, analysis, and compilation of a variety of information including information on waterways, maritime traffic and events, vessel track lines, vessel characteristics, insight obtained during discussions with stakeholders, and a number of other considerations.

2.3.6.1 Affected Environment

The NSRA included a comprehensive vessel traffic survey in the study area using the 2019 AIS data. A density heat map for all AIS points is shown in **Figure 2.3.6-1**. As shown in **Figure 2.3.6-1**, the primary traffic patterns in the Project Area are in the north-northeast/south-southwest and northwest/southeast directions. The density within the Wind Farm Area includes research vessels that have been conducting studies to support the Project's development[26] . The degree to which high vessel traffic in the Wind Farm Area (**Figure 2.3.6-1**) is tied to Project research vessels can be seen by comparing the low vessel density in the Wind Farm Area evident from the 2017 AIS data (**Figure 2.3.6-2**).

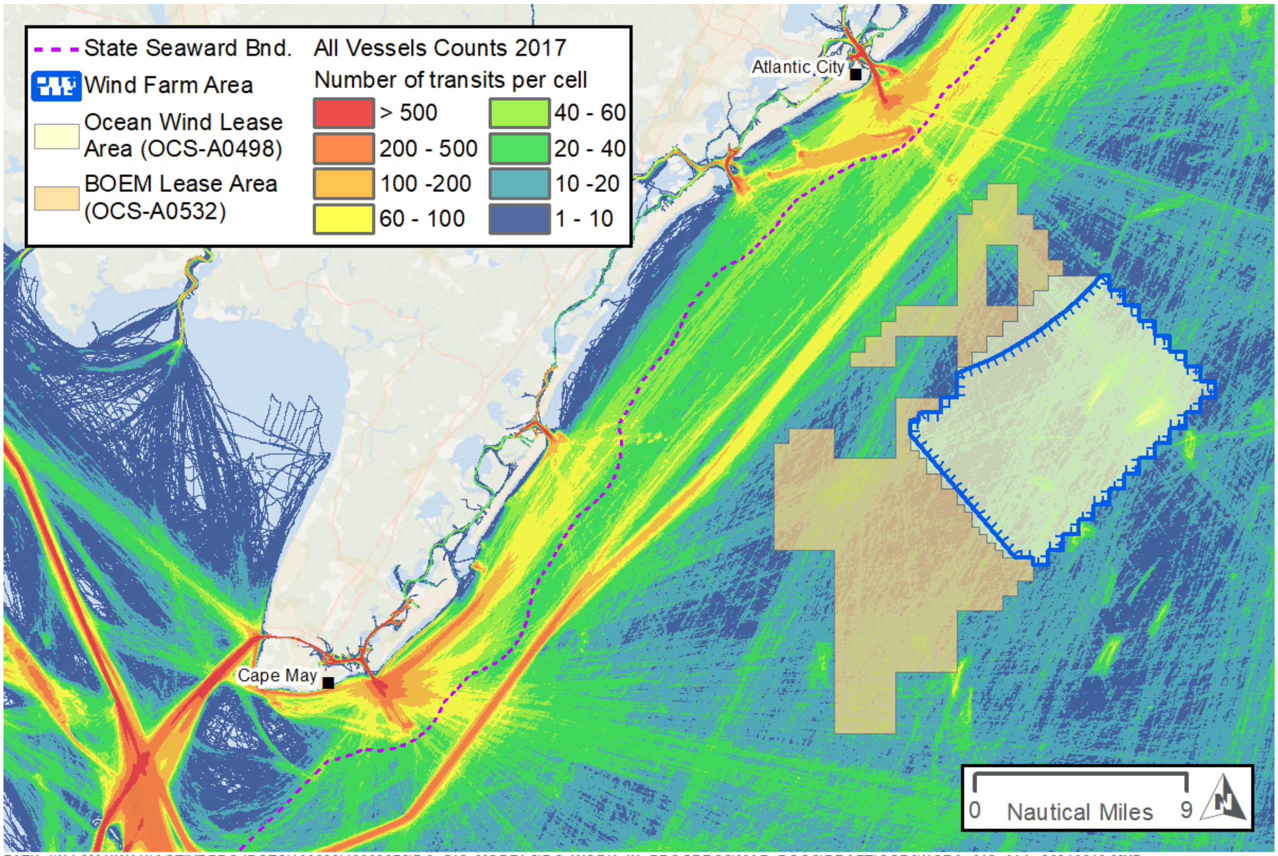
Density maps for each ship type, and additional analysis are shown in Appendix M.

[26] The AIS category for "Other" vessel types is for those vessels that do not clearly fit into other categories, including research, military, law enforcement, and unspecified vessels. Most of these tracks are visible adjacent to the coast and in the Project Area. Approximately 9 percent of "Other" transits occurred within the Project Area, and the vast majority of these (88 percent) are classified as "Research/Survey" vessels.



Note: Figure does not represent planned lease split.

Figure 2.3.6-1. Point density, all vessel transits near the Wind Farm Area, March 2019 to February 2020.



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Source: 2017 MarineCadastre.gov

Figure 2.3.6-2. All 2017 vessel transits near the Wind Farm Area.

2.3.6.1.1 Overview

The distribution of AIS-based tracks among the vessel types in the Marine Traffic Study Area is shown in **Figure 2.3.6-3**. The coastal traffic west of the Wind Farm Area is predominantly comprised of tug transits, while the majority of the coastal traffic further south is predominantly pleasure and fishing vessels. Vessel traffic in the vicinity of the Project is much less dense than near the coast. Traffic east of the Wind Farm Area is predominantly deep draft commercial vessels. AIS data for March 2019 to February 2020 (MarineTraffic 2020) show that about 5 transits per day enter the Wind Farm Area, 1,632 per year in total, including some minor double-counting. Deep draft vessels and tugs are not expected to enter the Wind Farm Area, except in emergency circumstances.

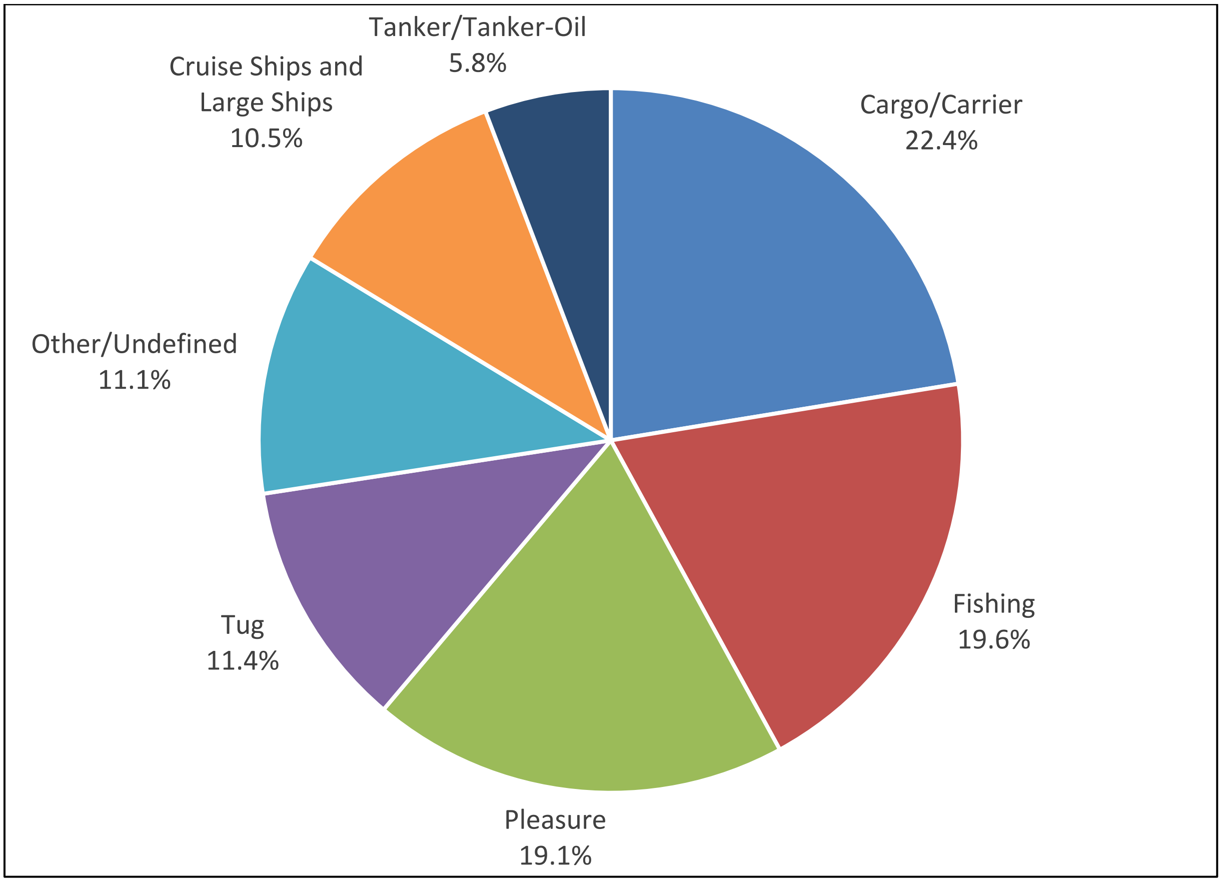

Figure 2.3.6-3. Distribution of vessel tracks in the marine traffic study area based on AIS data for the period 1 March 2019 through 29 February 2020 (MarineTraffic 2020).

2.3.6.1.2 Fishing

Fishing has been a mainstay in Southern New Jersey and Delaware, and commercial fishing continues to be an important economic driver for many coastal communities. The major commercial fishing ports closest to the proposed Wind Farm Area are Atlantic City, Sea Isle City, Wildwood, and Cape May. There are no significant commercial fishing fleets in Delaware that operate near the proposed Wind Farm Area.

As indicated in the NSRA, the fishing vessel tracks captured in the AIS data show the highest number of tracks adjacent to the coast (north and west of the Wind Farm Area). The data also show transits to apparent fishing grounds approximately 22 nm (41 km) southeast of the Wind Farm Area. Section 2.3.4 contains information on commercial fishing ports, targeted fisheries, and landings. Commercial fishing vessel activity is generally recognized as not fully captured in AIS data. A significant portion of commercial fishing vessels do not fall under the AIS carriage requirements. These smaller static and mobile gear fishing vessels, like all vessels, will not be prohibited from fishing within the array. However, their operators will be required to take into consideration the location of the above water structures of WTGs and associated infrastructure such as cables when choosing which courses to steer.

2.3.6.1.3 Pleasure Craft

There are countless recreational vessels located along the New Jersey Atlantic shore at marinas scattered along numerous inlets with ocean access. Data show that the majority of these vessels operate adjacent to the coast with comparatively few tracks in the Wind Farm Area[27]. Recreational vessels cruising along the East Coast generally fall into two categories, dependent on their size and seakeeping ability. Smaller coastal cruisers, sail and especially motor, will cruise along the shore, usually within a few miles from the coast, taking advantage of the ability to visually navigate and often day cruising from port to port. These vessels will transit well inshore of any above water obstructions of the Wind Farm Area. Vessels of greater seakeeping ability and underway on long distance transits may spend two or more days at sea between port calls. When traveling north-south along the East Coast of the United States, these vessels may travel a direct route, often further offshore, which could bring them near the proposed above water obstructions. Risk to these vessels is mitigated, among other factors, by better navigation equipment typical for vessels cruising offshore and better trained operators. However, most pleasure craft transits occurred west of the Lease Area.

The Oyster Creek mainland landfall at the marina would be within upland portions of the Holiday Harbor Marina and in-water areas near the marina's entrance to Barnegat Bay and the Long Beach/Holiday Harbor state navigation channel.

2.3.6.1.4 Cruise Ships and Large Ferries

Large and medium sized passenger vessels generally transit well east of the Wind Farm Area en route to/from the Ambrose/Barnegat Traffic lanes to the north. These vessels often were traveling between the Port of New York/New Jersey and foreign ports in the Caribbean or Bermuda.

2.3.6.1.5 Cargo/Carrier, Tanker, Tug, and Other Commercial Vessels

In June 2020, the USCG announced the Advanced Notice of Proposed Rulemaking in the Federal Register[28]. The USCG sought comments regarding the possible establishment of shipping safety fairways ("fairways") along the Atlantic Coast of the United States identified in the Atlantic Coast Port Access Route Study. This potential system of fairways is intended to ensure that traditional navigation routes are kept free from obstructions that could impact navigation safety. **Figure 2.3.6-4** shows these fairways.

The NSRA vessel traffic survey also considered towing, cargo, tanker, and other commercial vessel transits. Most towing vessel transits occurred west of the Wind Farm Area while deep draft cargo and tanker vessel transits typically occurred east of the Wind Farm Area. Most deep draft vessels that transited through the proposed Wind Farm Area in 2019 while transiting between the Ambrose to Barnegat Traffic Lane and the Five Fathom Bank to Cape Henlopen Traffic Lane appear to have cut the corner when entering or exiting the Delaware Bay Traffic Separation Scheme.

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[27] Similarly, for the Vineyard Wind Project, BOEM (2020) reported that "…NOAA estimated that 97 percent of the 2011 recreational boating from Massachusetts occurred within 3 nautical miles of shore (BOEM 2012c)."
[28] Shipping Safety Fairways Along the Atlantic Coast, Proposed Rules, 85 Fed. Reg. 37,034 (June 19, 2020).

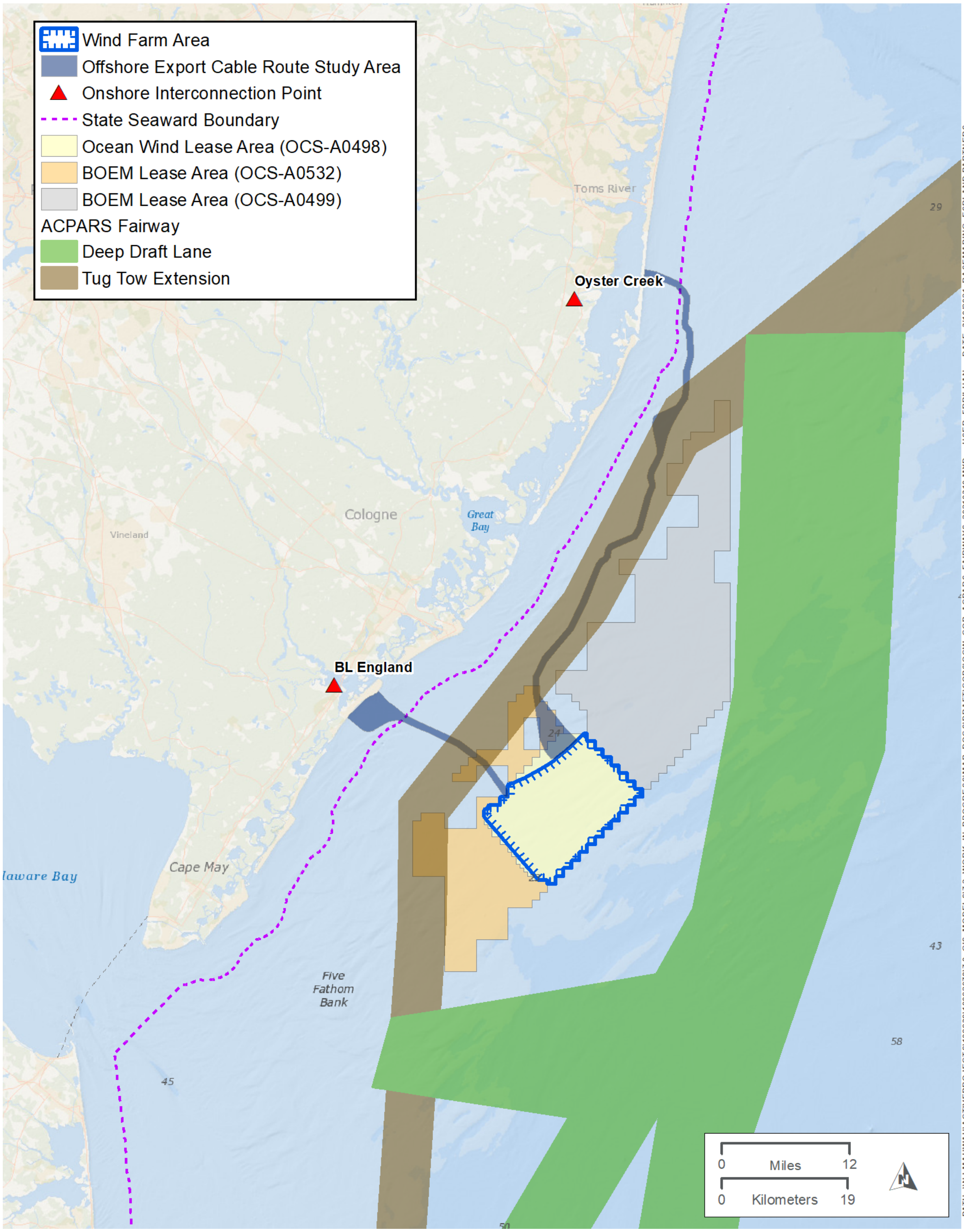

Figure 2.3.6-4. USCG-proposed shipping safety fairways.

2.3.6.2 Potential Project Impacts on Navigation and Vessel Traffic

Potential IPFs that may impact navigation and vessel traffic include the following:

- Traffic
- Visible structures/lighting
- Land use/economic change

Specific impacts include creating obstructions that may impact safe navigation, affecting the traditional uses of the waterway, and impacting Coast Guard search and rescue or other Coast Guard missions.

2.3.6.2.1 Construction

Construction activities within the Wind Farm Area and offshore export cable corridors would result in an increase in vessel traffic, which could overlap with existing marine navigation and traffic. During construction, the Project will involve temporary construction laydown areas and construction ports. The primary ports that will be used during construction are:

- Atlantic City, NJ - construction management base. The areas are intended to offer an opportunity for a combined base for crew transfer vessel operations for the construction phase.
- Paulsboro, NJ or Europe (directly) - for foundation scope. The port areas are intended to offer an opportunity for both foundation fabrication facilities as well as staging and load-out operations in collaboration with a key subcontractor.
- Norfolk, VA or Hope Creek, NJ - for WTG scope. The port area is intended to offer an opportunity for WTG pre-assembly and load-out facility without any airdraft clearance restrictions covering jack-up installation vessel assets.
- Port Elizabeth, NJ, Charleston, SC, or Europe (directly) - cable staging (unless transported directly from the supplier in Goose Creek, SC). The intended terminal area and quay infrastructure will be used for various cable staging and operation.

Construction vessels will include crew boats, construction barges and associated tugs, jack-up units, cranes, dredges, and cable laying vessels. Increased vessel traffic will interrupt regular traffic patterns of coastal towing vessels, transiting commercial fishing vessels, static gear fishing vessels, and recreational vessels. Vessel traffic within the Lease Area is expected to decrease once the above water obstructions are in place. Noise from construction activities is not anticipated to have negative effects on safe navigation or on the health of crew/personnel of passing vessels. During construction, global good industry practice is to implement a safety zone around construction activity. Vessel traffic and navigation impacts of construction will be similar to those during operations and maintenance (See Section 2.3.6.2.2) and are discussed further in the NSRA (Appendix M).

2.3.6.2.2 Operations and Maintenance

Potential impacts of Project operations and maintenance on navigation and vessel traffic are summarized as follows (see Appendix M for additional details):

- **Offshore above water structures**
  - Project structures will pose an allision and height hazard to vessels passing close by, and vessels will pose a hazard to the structures.
  - Allision risk is specifically discussed below. Typical good practice is to mark any structure that constrains the air gap over a waterway; and in line with this practice, the air gap will be indicated on each Project structure.

- Risk related to some types of fishing gear suggests that risk to vessels/crew and to the Project can be controlled by assuring the cable is buried at sufficient depth, assuring sufficient cable protection for relevant gear types, and/or using fishing gear that has limited penetration depth when fishing in the Wind Farm Area.
- Spacing between WTGs in the evaluated layout provides sufficient sea room for maneuvering for vessel types expected to transit and fish in the Wind Farm Area.
- Emergency rescue procedures will likely be adjusted to account for the Project structures once they are in place. In particular, helicopter-aided search and rescue will be a higher-risk activity in poor visibility, particularly within the Wind Farm Area.
- Noise from operation of WTGs is not anticipated to have negative effects on safe navigation or on the health of crew/personnel of passing vessels.
- In general, Project structures with monopile foundations could sustain significant damage from an allision by a deep draft vessel at speed; immediate collapse is not anticipated. A jacket foundation (proposed as an option only for the three offshore substations) is a weaker structure relative to horizontal loads. If the final foundation design for the offshore substation is a jacket, structural collapse from allision by a deep draft vessel at speed cannot be ruled out. Modeling shows it to be at most a 1-in-2,000-years event.

- **Offshore under water structures**
  - The Project components will not affect underkeel clearance for vessels transiting in the Wind Farm Area. No Project structures will lie above the seabed except those that rise above sea level.
  - During cable installation, up to four nearshore floating or bottom mounted ADCPs are to be deployed in 10 m of water directly in front of the cable landfall point and along the cable route to support the cable installation works. Ocean Wind will ensure that these instruments will not be a hazard to navigation for vessels transiting the Wind Farm Area; locations will be published in the local Notice to Mariners.
- **Navigation within or close to a structure**
  - In general, any offshore structure poses a potential risk of allision.
  - During operations, the safety of vessels and crews will rely on good seamanship as well as enhanced aids to navigation (ATON).
  - Standard industry practice is that anchoring in a wind farm is a potentially hazardous activity and should be undertaken only by Project related vessels or in emergency situations. To control this risk, Project cables will be buried and / or protected on the seabed, marked on charts, and their location will be monitored periodically to detect any movement.
- **Visual navigation**
  - Project structures are not anticipated to significantly obscure view of other vessels, ATON, or the coastline.
  - Project structures may serve as information navigation aids for mariners, particularly at night because they will be lighted and marked on navigation charts.
- **Communications, radar, and positioning systems**
  - The impacts on marine radar are variable, with the most likely effect being some signal degradation. Proximity to the WTGs is the primary factor that determines the degree of radar signal degradation.
  - The Coast Guard's advanced command, control and direction-finding system, "Rescue 21," is unlikely to experience degradation from the Project.
  - Due primarily to the quality of radars and the proficiency of professionally licensed crew, radar operations on commercial ships are not anticipated to be adversely affected by the Project.

    - Smaller vessels operating in the vicinity of the Project may experience radar clutter and shadowing. Risk controls relevant to this effect are:
        - vessel operator awareness and competence regarding radar effects and corrections;
        - placement of radar antenna at a favorable position on a vessel;
        - regular communications regarding changes and activities in the Wind Farm Area; and,
        - safety broadcasts from vessels operating in the vicinity of the Wind Farm Area.
- **Emergency response considerations**
    - An estimated maximum of 0.1 search and rescue missions per year are anticipated in the Project Area based on the modeling results for allisions. However, this is a conservative estimate because most allision events do not require emergency rescue operations.

2.3.6.2.3 Decommissioning

During decommissioning of the Project, there will be an appreciable increase in the vessel traffic transiting between shore to and within the Project Area. Similar to construction, during decommissioning, it is likely that, per best management practice, a 1,640 ft (500 m) safety zone will be implemented around construction activity. Due to the long lifespan of the Project, it is expected that technology would be enhanced by the time decommissioning occurs and impacts to traffic and navigation would be reduced. Therefore, impacts to marine traffic and navigation, as a result of decommissioning activities, would be less than or similar to those described in the construction section above. Vessel traffic and navigation impacts associated with decommissioning are discussed further in the NSRA (Appendix M).

2.3.6.2.4 Summary of Potential Project Impacts on Navigation and Vessel Traffic Resources

The IPFs affecting navigation and vessel traffic include traffic, visible structures/lighting, and land use/economic change, all of which are long-term.

Impacts on navigation and vessel traffic resources may be summarized in three categories:

- Some vessels will need to alter traditional routes when navigating near or through the Wind Farm Area. Given the ocean planning that designated the Lease Area location and the Wind Farm Area's distance from shore and typical shipping routes, these impacts will be felt by relatively few vessels. Commercial fishing vessels may transit through the rows of WTGs or may choose to transit around the Wind Farm Area altogether. Deep draft vessels will choose to alter their voyages east of the Wind Farm Area with minimum impact to operations. Most vessel traffic moves well west of the Wind Farm Area and will be unaffected by the Project.
- Presence of the offshore WTGs and substations may impact the efficacy of Coast Guard missions. Some impacts will be positive, such as introducing search and rescue datum points, and some impacts could be negative, such as adding difficulty to finding persons in the water among the WTGs. These impacts can be mitigated by training, exercises, and coordination between Ocean Wind and the USCG.
- Construction and operations phases will introduce more vessel traffic to the waterway. With more traffic comes relative increases in marine casualties and congestion. These impacts are minimal and may be mitigated by good seamanship.

2.3.6.3 Avoidance, Minimization, and Mitigation Measures

The proposed measures for avoiding, minimizing, reducing, eliminating, and monitoring environmental impacts for the Project are presented in **Table 1.1-2** and the NRSA in Appendix M.

2.3.7 Other Marine Uses

The Project Area hosts multiple marine uses and activities, including national security and military uses, aviation, marine mineral use, and ocean disposal. When developing new infrastructure, careful planning and consideration of other uses is required to minimize risk to these competing uses. The following sections describe other marine uses within the Project Area that may be affected by the Project.

As part of Ocean Wind's desktop study as well as BOEM's Wind Energy Area Environmental Assessment, other marine uses were identified that could be affected by the development of an offshore wind project. Other marine use resources include military use; mining; aviation, including airports; ocean disposal; land-based radar; and offshore energy. Additional marine use resources such as existing infrastructure, recreation, navigation and commercial fishing have been discussed in sections above.

2.3.7.1 Affected Environment

The Project Area is the geographic area that could be affected by Project-related activities, and consists of the Offshore Project Area, including the Wind Farm Area and offshore export cable corridors, and the communities within the onshore export cable corridors, which include the export cable route and interconnection points at BL England and Oyster Creek.

2.3.7.1.1 Federal Installations & Military Activities

The DOD operates in the airspace over and adjacent to the Ocean Wind Farm Project Area, which are controlled by the Fleet Area Control and Surveillance Facility, Virginia Capes, Virginia Beach, VA (FAA 2014).

Within the Project Area is the Atlantic City Range Complex and the Atlantic City Operating Area (OPAREA). The Atlantic City OPAREA extends from the shoreline seaward to approximately 100 nm from land at its farthest point; the subsurface portion of the Atlantic City OPAREA has the same boundaries as the surface water portion (Ecology and Environment 2016). This Range Complex is used for the U.S. Atlantic Fleet training and testing exercises and supports training and testing by other services, primarily the U.S. Air Force. The AEGIS Combat Systems Center conducts operations in this area. It is controlled by the Fleet Area Control and Surveillance Facility Virginia Capes, Naval Air Station, Oceana. In addition, the complex is composed of the Warning Area 107 (W-107) a non-instrumented warning area (**Figure 2.3.7-1**), which is a special-use airspace used for surface, and surface to air exercises. Subsurface operations are typically not conducted in the area. An aircraft training route is located along the westerly edge of the Wind Farm Area. Ocean Wind is coordinating with DOD regarding exercises within Warning Area 107 to inform turbine layout and design.

The U.S. Marine Corps uses a military flight route (VR-1709) that crosses the western portion of the Wind Farm Area. Ocean Wind has coordinated with the Marine Corps, and the Marine Corps indicated that, while their primary interest is in keeping VR-1709 as free from obstruction as possible, they are not seeking to impose any requirements on the Ocean Wind Project. Ocean Wind and the Marine Corps agreed to continue to coordinate as design progresses.

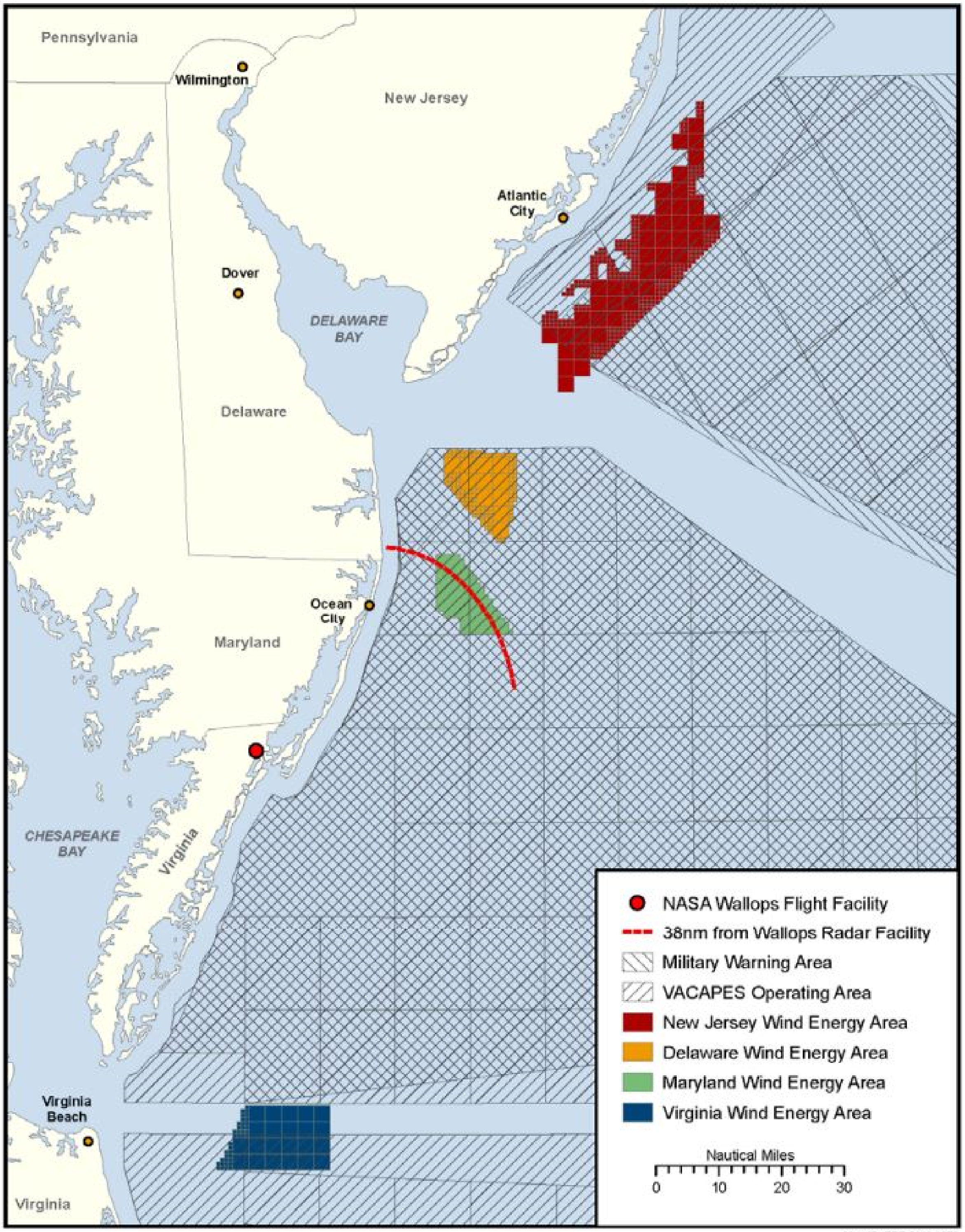

Figure 2.3.7-1. Military activity areas and uses (BOEM 2012b).

Several High Frequency radar stations, which use radio waves scattered off the ocean to make coastal observations, are located along the New Jersey continental shelf as part of both regional and local High

Frequency radar networks (Kohut and Glenn 2003). The Mid-Atlantic Regional Coastal Ocean Observing System High-Frequency Radar Network is comprised of 13 long-range sites, 2 medium-range sites, and 12 standard range-sites that provide consistent coverage from Cape Cod to Cape Hatteras (Roarty *et al.* 2010). Four SeaSonde High Frequency radars were purchased and installed as part of the Rutgers Board of Public Utilities project; the four sites are located in Brant Beach, Brigantine, Strathmere, and North Wildwood, New Jersey (Roarty *et al.* 2013). Data collected at these sites are made available to NOAA's High Frequency Radar Network (Roarty *et al.* 2013). There are also National Buoy Data Center platforms located off the New Jersey shore.

Portions of the onshore export cable corridors near Oyster Creek are in the vicinity of the Atlantic City Range Complex and Atlantic City OPAREA. Naval Weapons Station Earle is located outside of the general Project Area in Colts Neck, New Jersey. It provides all the ordnance for the Atlantic Fleet Carrier and Expeditionary Strike Groups and supports strategic DOD ordnance requirements. DOD also operates the North American Aerospace Defense Command national defense radar in the vicinity of the Project's proposed onshore and offshore facilities. Joint Base McGuire-Dix-Lakehurst is a military installation located approximately 18 miles south of Trenton, NJ. Additionally, the Manasquan Inlet USCG Station is located approximately 60 miles north of the onshore export cable corridors near Oyster Creek in Point Pleasant (DOI 2016). Military activities at the Manasquan Inlet Station could include various vessel training exercises, submarine and antisubmarine training, and U.S. Air Force exercises (DOI 2016). Even though this installation is north of the Project Area, vessel training exercises may be conducted closer to the Project.

The existing onshore substation, export cable routes or interconnection points are not located on Federal land or Federal facilities.

The onshore export cable corridors near BL England are in the vicinity of the Atlantic City Range Complex and the Atlantic City OPAREA. The Federal government is one of the largest landowners in Egg Harbor Township, which is located north of the onshore export cable corridor routes near BL England, holding more than 5,000 acres that include Atlantic City International Airport and the FAA William J. Hughes Technical Center (Polistina & Associates and Rutala Associates 2017). The Atlantic City International Airport is designated as a Federal or Military PMA (Pinelands Commission 2018) and is the base for the New Jersey Air National Guard's 177th Fighter Wing and the Coast Guard Air Station Atlantic City (ASAC) (Polistina & Associates and Rutala Associates 2017). The William J. Hughes Technical Center and the ASAC are also located nearby BL England.

Military activities at these facilities could include squadron training by the New Jersey Air National Guard, Search and Rescue missions conducted by the USCG, and laboratory research and development for FAA air systems. The 177th Fighter Wing uses the single seat F-16C as its mission aircraft and has had active involvement in Operation's Noble Eagle, Southern Watch, Northern Watch, Iraqi Freedom, and Enduring Freedom (Air National Guard n.d.). Nearby, ASAC houses 11 helicopters, 60 pilots, and 300 enlisted and support personal and has a wide range of missions from Search and Rescue to helping to protect significant national events, in addition to providing Public Affairs services (e.g., Search and Rescue Demonstration, Tours, Guest Speaker, Fly By) to the community, the public, and fellow Coast Guard units (USCG n.d.). Adjacent to ASAC, the FAA William J. Hughes Technical Center conducts test and evaluation, verification and validation, and sustainment of the FAA's full spectrum of aviation systems, and develops scientific solutions to current and future air transportation safety challenges through applied research and development (FAA 2016b).

The existing onshore substation, onshore export cable routes, and interconnection points are not located on Federal land or Federal facilities.

2.3.7.1.2 Airports

Various segments of airspace overlie the proposed onshore and offshore facilities, including: U.S. territorial airspace, various controlled airspace, and special use airspace. Territorial airspace is the airspace over the U.S. its territories and possessions, and over U.S. territorial waters out to 12 nm (22 km) from the coast (NOAA 2017b). Limited areas of the onshore export cable corridor routes near BL England and Oyster Creek are located within territorial airspace. These export cable corridors are also located within the limits of the Air Defense Identification Zone, into which all international flights entering the U.S. domestic airspace must provide the appropriate documentation (FAA 2019).

Project-related activities may occur within three different controlled airspace classifications: Class E, East Coast Low Area, and the Atlantic Low Area; however, this Project is only concerned with airspace in the location of the turbines within the Wind Farm Area. These classifications of airspace define the volumes of airspace within which air traffic control services are provided and often dictate different operating requirements that imposed upon pilots, including weather, communication, and equipment minimums (FAA 2018b).

As mentioned above, portions of the Wind Farm Area are within or in the vicinity of the Atlantic City Range Complex, which is composed of the Atlantic City OPAREA and W-107. Warning Area W-107 is a block of special use airspace over the Atlantic City OPAREA. Project-related activities within the Wind Farm Area, including installation and operation of the turbines, may occur in W-107Aand W-107C subareas of Warning Area W-107 (FAA 2014). W-107 subarea altitudes are as follows (FAA 2014):

- W-107A Surface to unlimited altitude.
- W-107C Surface to, but not including Flight Level 180.

Warning Area airspace is of defined dimensions, extending out 3 nm (6 km) from the coast, and is designated for aircraft operations containing activity that may be hazardous to nonparticipating aircraft (FAA 2016a). A warning area may be located over domestic or international water or both and is charted by the FAA on aeronautical charts with an identifying number (FAA 2016a).

There are no airports located in close proximity to the onshore export cable corridors near Oyster Creek. However, the Forked River Heliport in Forked River, Ocean County Airport in Bayville, Eagle’s Nest Airport in West Creek, Soaring Sun in Harvey Cedars, and Coyle Field in Barnegat are all located nearby.

Ocean City Municipal Airport, a city-owned public-use general aviation airport located two miles southwest of Ocean City is also located in close proximity to the proposed onshore export cable corridors near BL England. The airport covers an area of approximately 60 acres and contains one asphalt runway (FAA 2018a). Atlantic City International Airport is located north of the proposed onshore export cable corridors near BL England in Egg Harbor Township (21.5 nm from the Wind Farm Area). The airport conducts commercial and general aviation operations and the South Jersey Transportation Authority, and the Port Authority of New York and New Jersey operate the facility. Most of the land is owned by the FAA. The facility is also the base for the New Jersey Air National Guard’s 177th Fighter Wing and the ASAC (Polistina & Associates and Rutala Associates 2017). The Steeplechase Pier Heliport in Atlantic City and the Atlantic County Helistop in Northfield are also within the general region of the onshore export cable corridors near BL England.

2.3.7.1.3 Radar

Six DoD and FAA air traffic control and national defense radar sites are in the vicinity of the Project Area (Westslope Consulting 2019):

- Atlantic City Airport Surveillance Radar-9 (ASR-9) and co-located Air Traffic Control Beacon Interrogator-5 (ATCBI-5).

- Dover Air Force Base (AFB) Digital Airport Surveillance Radar (DASR) and co-located Monopulse Surveillance Secondary Surveillance Radar.
- Gibbsboro Air Route Surveillance Radar-4 (ARSR-4) and co-located Air Traffic Control Beacon Interrogator-6 (ATCBI-6).
- McGuire AFB DASR and co-located Monopulse Surveillance Secondary Surveillance Radar.

The co-located secondary surveillance radar are the main source of aircraft identification and positional data for air traffic control.

Additionally, two NOAA weather radar sites are in the vicinity of the Project Area (Westslope Consulting 2019):

- Dover AFB Weather Surveillance Radar model-88 Doppler (WSR-88D).
- Philadelphia WSR-88D.

2.3.7.1.4 Sand, Gravel Borrow, and Ocean Disposal Sites

Several sand and gravel borrow areas and ocean disposal sites designated and maintained by BOEM, as well as sand and gravel borrow areas designated by USACE in partnership with NJDEP, are mapped in the vicinity of the Wind Farm Area and the offshore export cable corridors to BL England and Oyster Creek (BOEM 2018c). A small available disposal site is located in the vicinity of the offshore export cable corridor near BL England (BOEM 2018c; NOAA 2018e) (**Figure 2.3.7-2**). The Project has been designed to avoid these sand and gravel borrow areas and ocean disposal sites.

No mapped sand or gravel borrow areas or ocean disposal sites are in the vicinity of the onshore export cable corridors near Oyster Creek or the offshore export cable corridor in Barnegat Bay.

There are no mapped sand or gravel borrow areas in the vicinity of the onshore export cable corridors in Upper Township near BL England. There is one mapped borrow area located in the vicinity of the offshore export cable corridor in Ocean City at the inlet to Great Egg Harbor (**Figure 2.3.7-2**). No mapped sand or gravel borrow areas or ocean disposal sites are in the vicinity of the onshore export cable corridor near Oyster Creek or the offshore export cable corridor in Barnegat Bay.

2.3.7.1.5 Other Offshore Energy Projects

Just north of the Ocean Wind Lease Area, another proposed wind energy project, Lease Area OCS-A 0499 is being developed. As noted in Volume I, Orsted is in the process of working with BOEM on the future development of other parts of its original Lease Area, which would be designated a new lease number (OCS-A 0532), Other offshore wind project sites are being considered in New York Bight. From North Carolina to Massachusetts, BOEM has noted there are currently 17 active wind energy lease areas (16 commercial and 1 research) covering approximately 1,744,289 acres (2,724 square miles; BOEM 2020). In February 2022, six additional lease areas were auctioned in New York Bight.

2.3.7.2 Potential Project Impacts on Other Marine Uses

Potential impacts may be introduced from the construction, operation and maintenance, and decommissioning phases of the Project on marine uses not covered in other sections, include Federal installations and military activities; aviation; and other offshore energy projects. As sand, gravel borrow and ocean disposal areas will be avoided, no potential Project impacts associated with construction, operations and maintenance and decommissioning are anticipated.

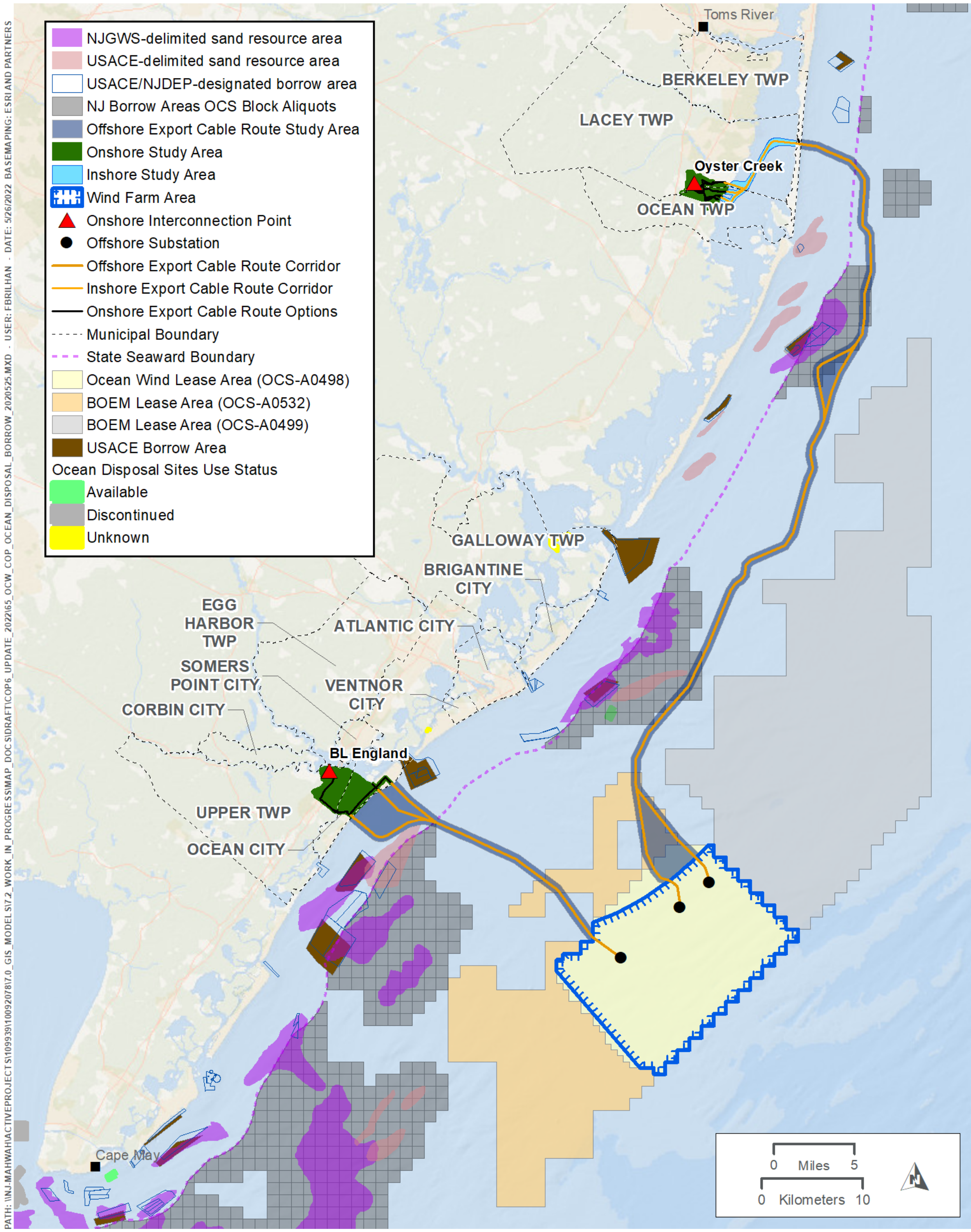

Figure 2.3.7-2. Ocean disposal and borrow areas (Borrow areas - USACE undated; Ocean disposal sites - marinecadastre.gov).

The sections below discuss the Project's potential impacts on these other marine uses within the Offshore Project Area, including the Wind Farm Area and offshore export cable corridors, and other marine uses related to the Onshore Project Area, including onshore components at BL England and Oyster Creek. Potential IPFs that may impact other marine uses include the following:

- Traffic
- Visible structures/lighting

2.3.7.2.1 Construction

Wind Farm Area and Offshore Export Cable Corridors

Construction activities would result in an increase in vessel traffic within the Wind Farm Area and offshore export cable corridors. Vessel traffic to support construction activities would be dependent on the ports of origin, destination in the Offshore Project Area, season, and time of day. Impacts to military operations from vessel traffic are expected to be short-term and localized. Vessel traffic and navigation impacts are summarized in the NSRA (Appendix M) and in Section 2.3.6. Impacts to commercial and recreational fisheries are discussed in Section 2.3.4. Appendix B includes Ocean Wind's Safety Management System and is applicable to other portions of this section.

Onshore Project Area

Anticipated vehicular traffic at the cable landfall, onshore export cable corridors, onshore substations, and grid connection points includes construction vehicles for construction of Project components. Vehicular traffic would be dependent on origin and destination, season, and time of day, and would be consistent with existing traffic conditions. Although there is one airport in close proximity to the onshore Project components at BL England and several additional airport facilities within the regions of BL England and Oyster Creek, it is likely that vehicular traffic related to the construction phases of the Project would go unnoticed due to the previously developed characteristic of the region. Therefore, impacts to military and airport operations from increased vehicular traffic (e.g., travel times to and from the airport, congestion in the vicinity of the airport, etc.) at onshore project components at BL England and Oyster Creek are not expected.

2.3.7.2.2 Operation and Maintenance

Wind Farm Area and Offshore Export Cable Corridors

Section 6 of Volume I provides the anticipated traffic in the Wind Farm Area and offshore export cable corridors related to operation and maintenance of the offshore export cables and Wind Farm Area. Helicopter flights for operation and maintenance in the Wind Farm Area are not expected to interfere with military or airport operations.

WTGs and offshore substations would be permanent structures within the water column and above the sea surface within the Wind Farm Area. WTGs would be constructed under the listed FAA flight level ceiling designated within the Wind Farm Area, and therefore, would not impact commercial or military flight operations. Low level flights would be permanently impacted within the Wind Farm Area due to the WTGs. WTGs and offshore substations would comply with lighting and marking regulations and be marked per FAA and USCG rules to minimize and mitigate impacts to air and vessel traffic. Lighting and marking are further discussed in Section 7.4 of Volume I.

The air traffic control and national defense radar in the vicinity of the Project's proposed offshore facilities may be impacted by operation and maintenance phases of the Project. Potential impacts to military operations from the permanent placement of structures within the water column and above the sea surface, within the Wind Farm Area, are expected to be long-term and localized.

The co-located secondary surveillance radar (see Section 2.3.7.1.3) are the main source of aircraft identification and positional data for air traffic control. A Department of Homeland Security (DHS) funded study found that "[s]econdary (i.e., transponder, or "beacon") tracks were rarely affected" by wind turbines (JASON 2008). Further, DOE, DOD, DHS, and FAA sponsored flight trials conducted by Massachusetts Institute of Technology (MIT)/Lincoln Laboratory and Sandia National Laboratories as part of an Interagency Field Test and Evaluation program noted that "primary surveillance radars are severely impacted by wind turbines while the beacon transponder-based secondary surveillance radars was not affected by wind turbines" (Sandia National Laboratories, MIT Lincoln Laboratory 2014).

Several U.S. agencies, including DOE, DOD Siting Clearinghouse, and the FAA have established the Wind Turbine Radar Interference Mitigation Working Group to study the effects of smaller, land-based wind turbines on air traffic control radar systems. A representative of Ocean Wind attended a June 27, 2019 meeting of the Wind Turbine Radar Interference Mitigation Working Group where participants generally agreed that the large size and increased distance between the offshore wind turbines would reduce any impacts to air traffic control radar.

An analysis of the impact of the radar systems was conducted and is summarized below (Westslope Consulting 2019). Ocean Wind will continue to coordinate with the FAA, DOD, and NOAA on impacts to radar operations to mitigate and minimize impacts.

- Atlantic City ASR-9 - WTGs in the entire Project Area will be within line-of-sight of and will interfere with the Atlantic City ASR-9. The radar effects will include unwanted radar returns (clutter) resulting in a partial loss of primary target detection and a number of false primary targets over, and in the immediate vicinity of, wind turbines in the Project Area. The Atlantic City ASR-9 includes the ASR-9 Processor Augmentation Card (9-PAC) Phase II modification that uses self-optimizing adaptive processing technique, which should remove false primary targets. Other possible radar effects include a partial loss of weather detection and false weather indications over, and in the immediate vicinity, of wind turbines in the Project Area. A Clear Day Map update should reduce false weather indications.
- Dover AFB DASR - WTGs sited in a very small area in the western corner of the Project Area will be within line-of-sight and may interfere with the Dover AFB DASR. The radar effects could include clutter resulting in a partial loss of primary target detection and a number of false primary targets over, and in the immediate vicinity of, WTGs in the Project Area within radar line-of-sight. Range-Azimuth Gate mapping should remove false primary targets in this very small area.
- Gibbsboro ARSR-4 - WTGs along the northwestern edges, in the northern corner, and along the northeastern edges of the Project Area will be within line-of-sight of, and may interfere with, the Gibbsboro ARSR-4. The radar effects could include clutter resulting in a partial loss of primary target detection and a number of false primary targets over, and in the immediate vicinity of, wind turbines in the Project Area within radar line-of-sight. Geocensoring in the Gibbsboro ARSR-4 should remove false primary targets.
- McGuire AFB DASR - WTGs in the Project Area will not be within line-of-sight of and will not interfere with the McGuire AFB DASR. As a result, radar effects are not expected (note: evaluated 880-ft tall turbines, not 906-foot tall turbines).
- Dover AFB WSR-88D - WTGs in the Project Area will not be within line-of-sight of and will not interfere with the Dover AFB WSR-88D. As a result, radar effects are not expected. Further, WTGs in the Project Area fall within a NOAA "No Impact" zone (note: evaluated 880-ft tall turbines, not 906-foot tall turbines).
- Philadelphia AFB WSR-88D - WTGs in the Project Area will not be within line-of-sight of and will not interfere with the Philadelphia AFB WSR-88D. As a result, radar effects are not expected. Further,

WTGs in the Project Area fall within a NOAA "No Impact" zone (note: evaluated 880-ft tall turbines, not 906-foot tall turbines).

As air traffic control and national defense radar, including High Frequency radar stations in the vicinity of the Project's proposed offshore facilities may be impacted by operation and maintenance phases of the Project, Ocean Wind will conduct additional coordination with FAA and BOEM. As the offshore wind industry grows, potential impacts to coastal radar systems are being evaluated. Ocean Wind will continue to work with BOEM and the owners of those systems to find acceptable and feasible mitigation solutions, as required. Other planned offshore wind projects, noted in Section 2.3.7.1.4, would have similar impacts during construction, operation and maintenance, and decommissioning phases as those described in previous sections for the Ocean Wind Project. BOEM has sited lease areas on the OCS so as to not interfere with each other, and development of the Ocean Wind Project should not affect development of the adjacent OCS-A 0499 Lease Area.

Onshore Project Area

Helicopters would be used in the Offshore Project Area for the operation and maintenance phases of the Project; trips to offshore substations are expected to be periodic and short in duration. Increased aircraft traffic could temporarily impact regional military and airport operations in the vicinity of BL England and Oyster Creek. As mentioned above, the national defense radar operated by the DOD in the vicinity of the Project's proposed onshore facilities may be impacted by operation and maintenance phases of the Project. Therefore, impacts to military and airport operations from operation and maintenance activities are expected to be long-term and localized.

2.3.7.2.3 Decommissioning

Due to the long lifespan of the Project, it is expected that technology would be enhanced by the time decommissioning occurs and impacts to other marine uses would be reduced. Therefore, impacts to other marine uses anticipated as a result of decommissioning activities would be less than or similar to those described in the construction section above.

2.3.7.2.4 Summary of Potential Project Impacts on Other Marine Uses

The IPFs affecting other marine uses include traffic and visible structures/lighting.

Impacts to military operations from vessel traffic are expected to be short-term and localized. No other potential impacts are expected for other marine uses such as aviation; sand, gravel borrow, and ocean disposal sites, and offshore energy sites.

2.3.7.3 Avoidance, Minimization, and Mitigation Measures

The proposed measures for avoiding, minimizing, reducing, eliminating, and monitoring environmental impacts for the Project are presented in **Table 1.1-2**.

2.4 Cultural, Historical, and Archaeological Resources

Cultural resources include archaeological sites, historic structures, and districts, and traditional cultural properties that represent important aspects of prehistory or history, or that have important and long-standing cultural associations with established communities or social groups. Significant archaeological and architectural properties are generally defined by the eligibility criteria for listing in the National Register of Historic Places (NRHP).

The Project Area encompasses State of New Jersey and Federal maritime jurisdictional areas, as well as terrestrial portions of Ocean, Atlantic, and Cape May Counties, New Jersey. Previous desktop reviews, cultural resource reconnaissance studies, and environmental assessments have determined that the Project Area has a high potential to contain cultural, historical, and archaeological resources (TRC Environmental Corporation 2012). Expectations of the high potential are due to the natural environment, geologic timeline, sea-level trends, and history of southern New Jersey and its offshore region.

Consultation under Section 106 of the National Historic Preservation Act (NHPA) (54 USC 306108)) is triggered when projects require Federal permits, funding, licensing, or certification, or when they occur on Federal lands. Such Federal undertakings require consultation by the lead Federal agency with the State Historic Preservation Officer (SHPO) and interested federally recognized Native American tribal organizations. These consultations identify the Area of Potential Effects (APE) and potential adverse effects to archaeological, architectural, or other cultural resources that are listed in or are potentially eligible for listing in the NRHP.

BOEM has an obligation to manage cultural resources located on the OCS that may be affected by activities under its jurisdiction. Additionally, as the Lead Federal Agency reviewing the project under Section 106 of the National Historic Preservation Act, BOEM's responsibility is to take into account the effects of the undertaking on historic properties within that undertaking's APE. Area of potential effects means the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist, and may extend beyond any agency's jurisdiction. In the case of the proposed project, portions of the APE lie not only on the OCS, but also onshore and in state waters, where other agencies have jurisdiction. Portions of the Project located in state waters or onshore fall under the authority of the NJDEP New Jersey Historic Preservation Office (NJHPO), but BOEM remains responsible for the undertaking's effects upon historic properties in these portions of the APE.

The OCSLA grants the lead enforcement of laws and regulations governing offshore leasing on Federal offshore lands to BOEM (CFR Title 30, Chapter V, Subpart B-Offshore). To ensure compliance with the NHPA and NEPA, BOEM prepared Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR Part 585 (BOEM 2020). The information in this section has been developed in compliance with those guidelines.

Ocean Wind has initiated coordination with BOEM, NJHPO, and outreach with the Narragansett Indian Tribe, the Delaware Tribe, the Shinnecock Indian Nation, and the Lenape Tribe of Delaware. The Section 106 process for the Project has not been formally initiated by BOEM. Per coordination with BOEM, Ocean Wind has included the following information to begin Section 106 coordination: the preliminary area of potential effect (PAPE) for archaeological and architectural resources, description of the undertaking, and the visual effects to historic properties report (Appendix F). The Maritime Archaeological Resources Assessment report (Appendix F-1) and the Terrestrial Archaeological Resources Assessment (Appendix F-2) report have been provided and will be updated following 2022 field investigations and submitted in Q3 2022. These reports will be based on the data collected during the HRG&G surveys and Phase 1A and 1B surveys, which will allow for the identification and characterization of potential cultural resources within the terrestrial and offshore PAPE. The visual impacts assessment is provided in Appendix L.

2.4.1 Preliminary Area of Potential Effects

As described in BOEM’s Guidelines for Providing Archaeological and Historical Property Information Pursuant to 30 CFR Part 585 and defined in the regulations implementing Section 106, the area of potential effects means the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. The area of potential effects is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking.

Per 36 CFR 800.16(d), the scope of these geographic areas should include the following:

- The depth and breadth of the seabed potentially impacted by any bottom-disturbing activities;
- The depth and breadth of terrestrial areas potentially impacted by any ground disturbing activities;
- The viewshed from which renewable energy structures, whether located offshore or onshore, would be visible; and
- Any temporary or permanent construction or staging areas, both onshore and offshore.

Therefore, the Project PAPE for marine archaeological resources is defined to include the Wind Farm Area and the offshore export cable corridor options identified (**Figure 2.4-1)**. The Lease Area encompasses 75,525 acres (30,564 hectares) with water depths ranging from 52 to 125 ft (16 to 38 m). Within the Lease Area, wind farm development will occur within a smaller footprint referred to as the Wind Farm Area. The Wind Farm Area PAPE acreage (including where export cable routes overlap with the Wind Farm Area) totals approximately 35,394 acres (14,323 hectares) (**Figure 2.4-1**). Proposed infrastructure to be installed within the Wind Farm Area PAPE includes up to 98 WTGs with array cables running between them, three offshore substations connected by substation interconnection cables, and portions of the export cable routes from the substation to the Wind Farm Area boundary. The final layout of the array and interconnection cables within the Wind Farm Area has not been determined. To allow for flexibility in siting of cables, SEARCH assessed the entire area contained within the Wind Farm Area PAPE depicted in **Figure 2.4-1**. The maximum vertical seafloor impact from the WTGs is approximately 164 ft (50 m), for offshore substations is approximately 230 ft (71 m), and for array and interconnection cables is 33 ft (10 m). The PAPE includes not just the foundation and scour protection, but anticipated sea seafloor impacts from construction. The PAPE has been surveyed with the exception of the Oyster Creek alternatives west of Route 9 and alternatives associated with Nautilus Drive and Marina landfalls. The surveyed PAPE as compared to areas not yet surveyed in the Oyster Creek study area is shown in **Figures 2.4-2** through **2.4-4**. In addition, a request from the USCG to provide a setback from the shared border between the Atlantic Shores and the Ocean Wind 1 projects to facilitate marine traffic, navigation safety, as well as USCG search and rescue operations between Lease Area OCS-A 0498 and Lease Area OCS-A 0499 prompted an adjustment to WTG Row A. This shift requires additional HRG and geotechnical survey which is scheduled to be completed during Spring/Summer 2022. Following data collection and processing, SEARCH will conduct a MARA of the data, and incorporate the results into this report. **Figure 2.4-5** depicts the area to be surveyed that is within the marine PAPE.

The Project consists of up to two submarine export cables, BL England export cable route and Oyster Creek export cable route (**Figure 2.4-1**). Export cable route study areas vary in width between 869 and 3,117 ft (265 and 950 m) which account for the proposed impacts from the bottom disturbing activity (i.e., anchor spreads, cable installation and trenchless technology exit pit). The BL England export cable route extends northwest through federal and New Jersey state waters approximately 32 mi (51 km) before making landfall near Ocean City, while the Oyster Creek export cable route extends north through federal and New Jersey state waters approximately 71 mi (114 km) before making landfall near Forked River. The total export cable route PAPE acreage (excluding portions of the export cable routes that overlap with the Wind Farm Area) is approximately 14,776 acres (5,980 hectares). The BL England export cable route measures approximately 3,406 acres (1,378 hectares), while the Oyster Creek export cable route measures approximately 11,371 acres (4,601 hectares). The maximum vertical seafloor impact from the export cable burial is approximately 1.8 m (6.0 ft) and 8.0 m (26 ft) for associated anchoring/spudding of construction vessels.

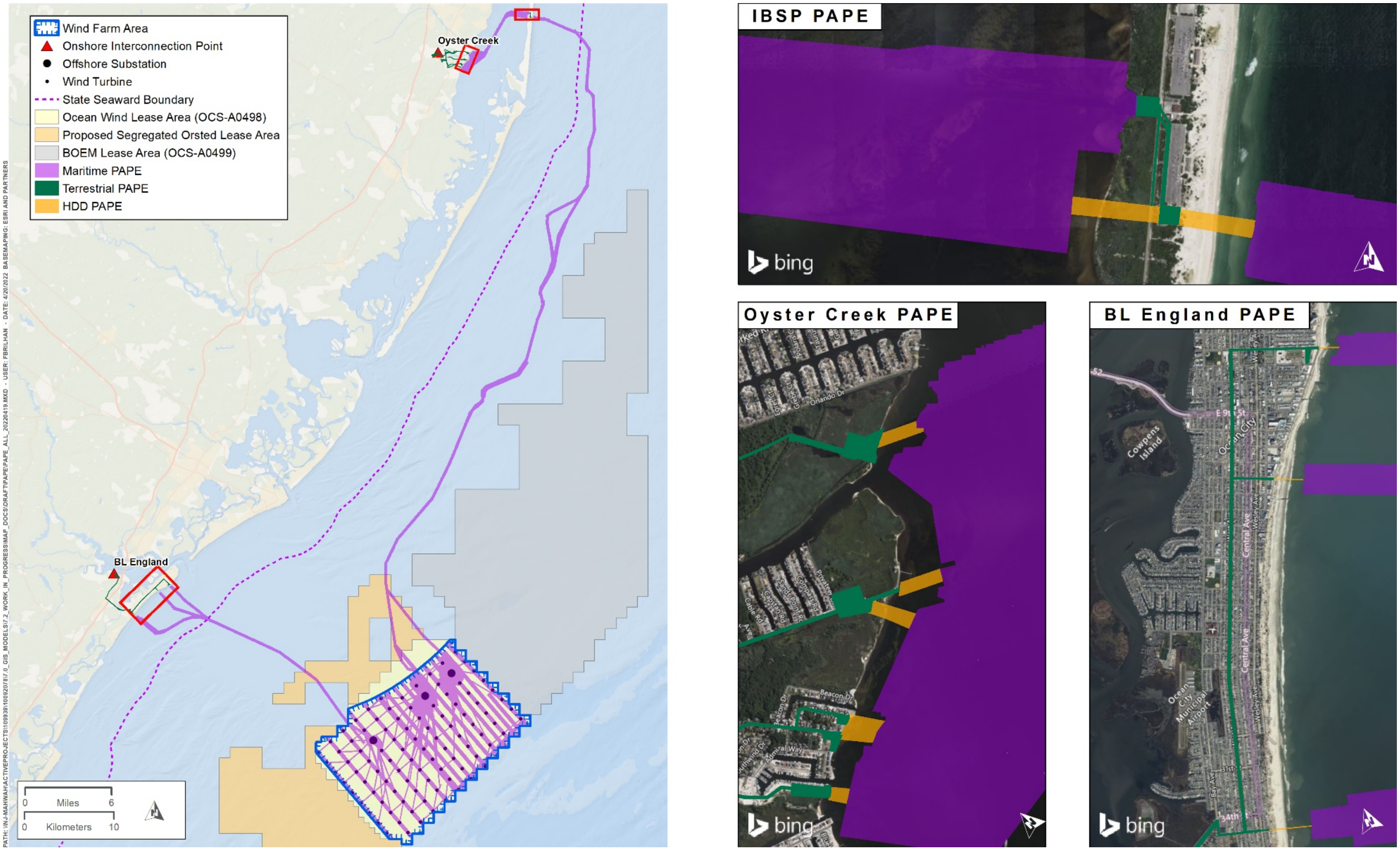

Figure 2.4-1. Archaeological Marine and HDD Preliminary Area of Potential Effect.

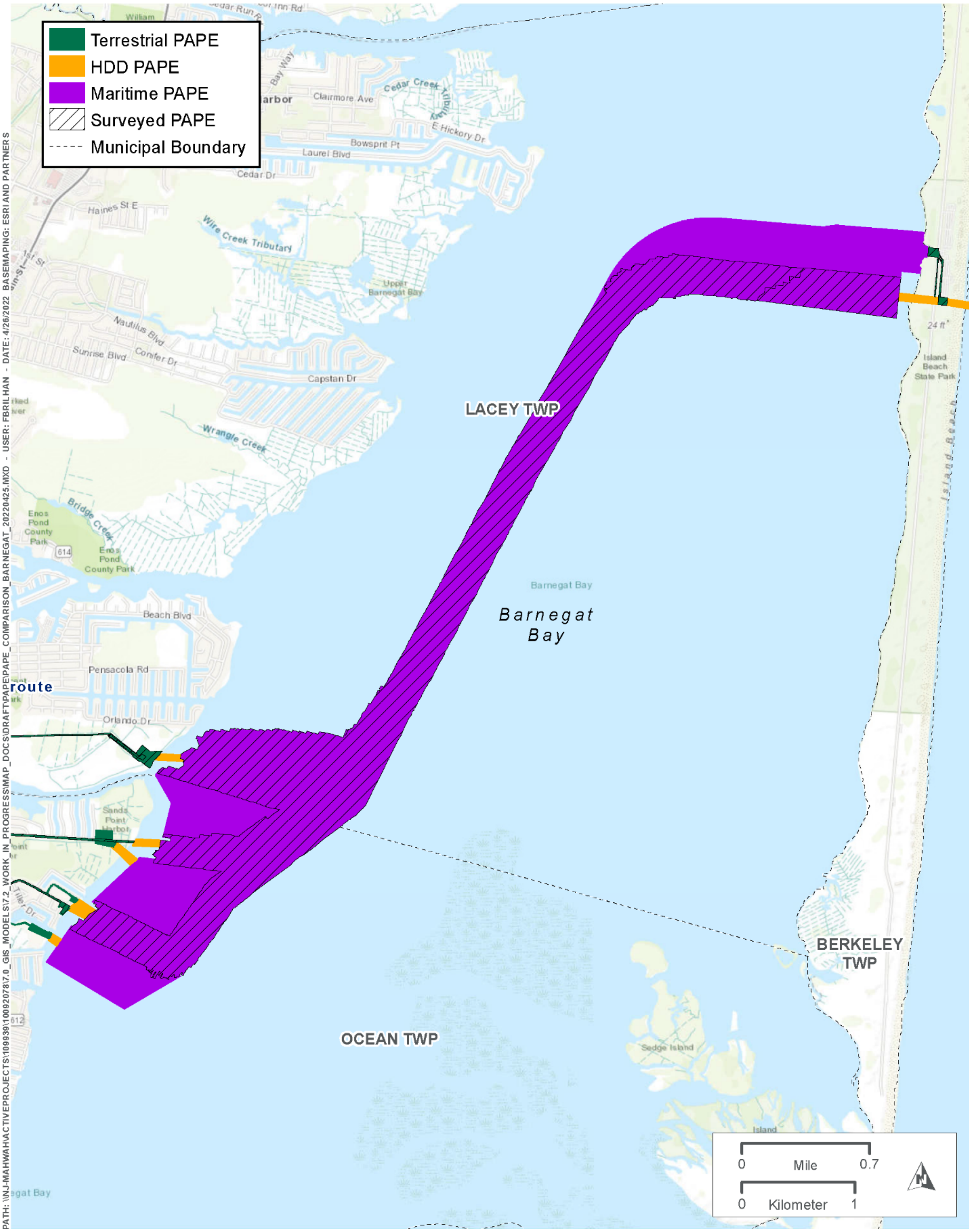

Figure 2.4-2. Surveyed maritime PAPE in Barnegat Bay as compared to areas not yet surveyed.

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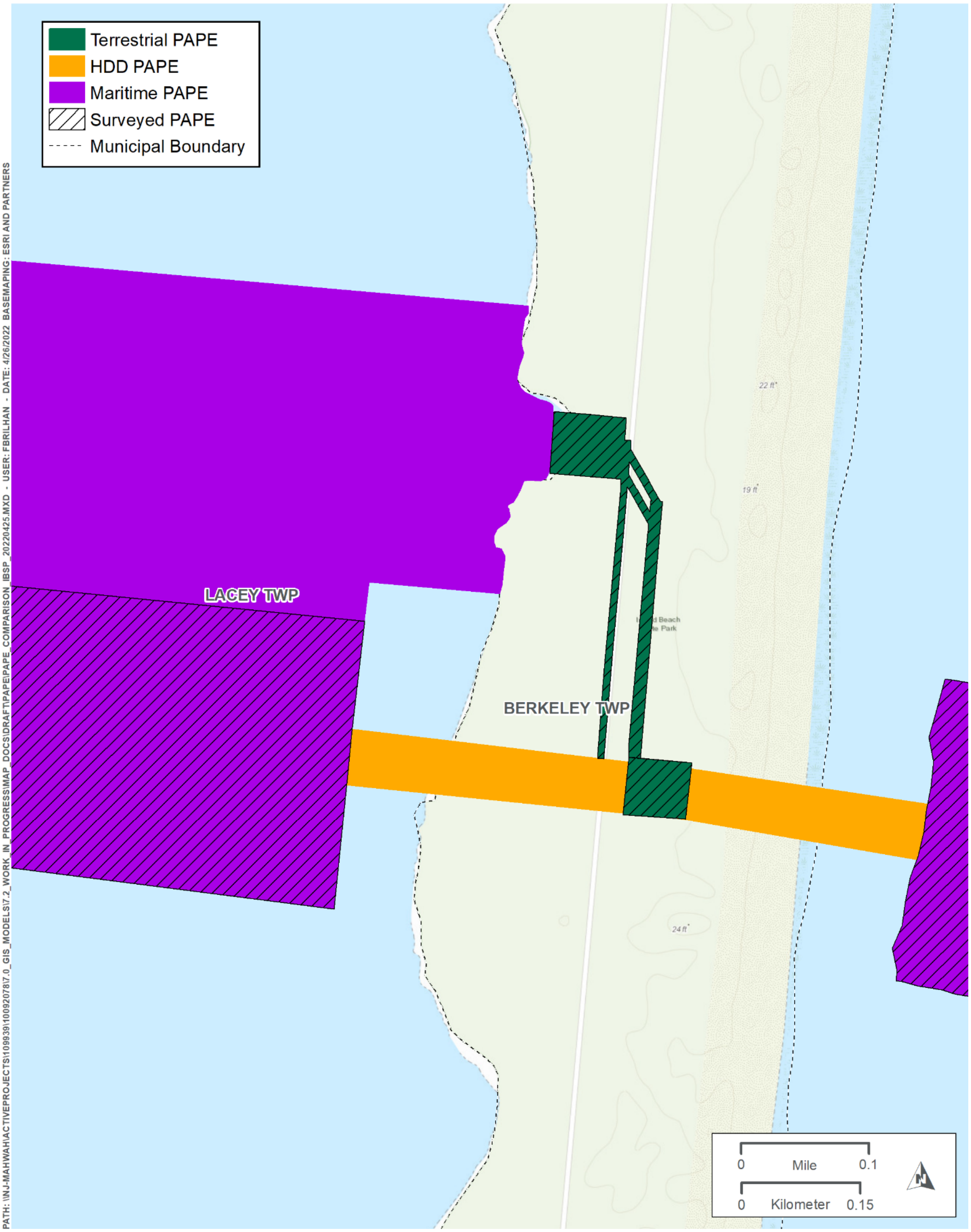

Figure 2.4-3. Surveyed PAPE at IBSP as compared to areas not yet surveyed.

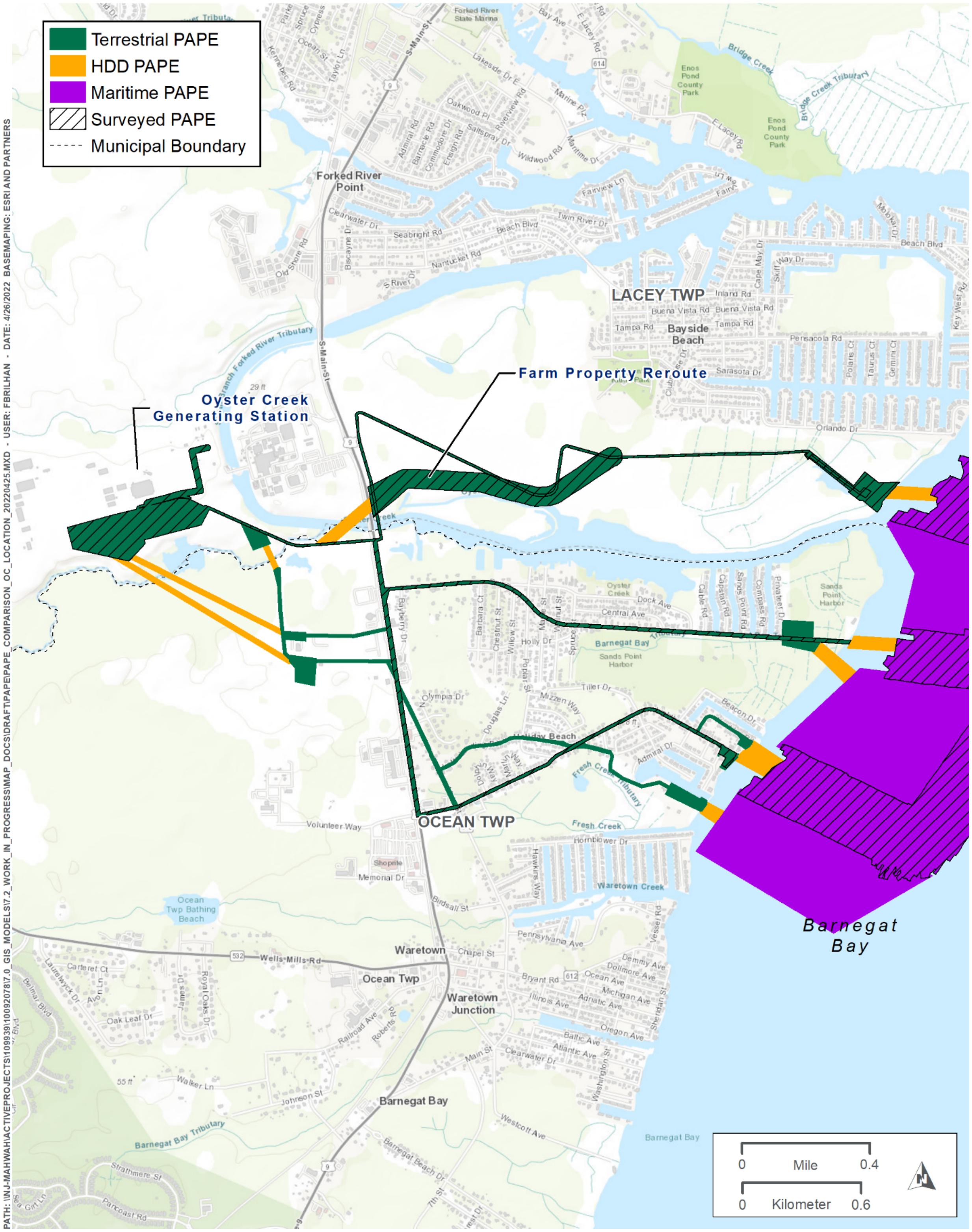

Figure 2.4-4. Surveyed terrestrial PAPE at Oyster Creek as compared to areas not yet surveyed.

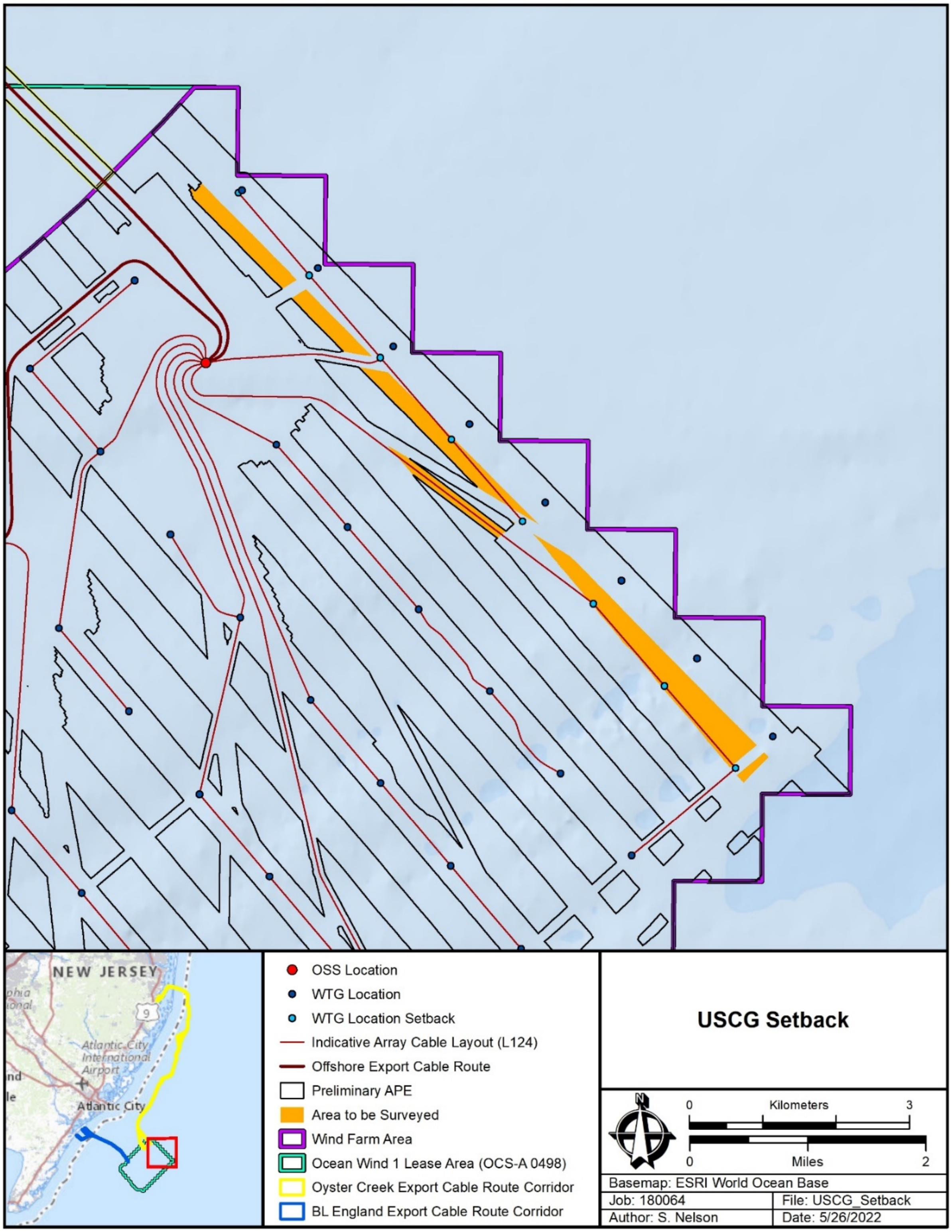

Figure 2.4-5. Surveyed WFA marine PAPE as compared to areas not yet surveyed.

Landfall will be accomplished using HDD technology within the HDD PAPE which connects that marine and terrestrial PAPE (**Figures 2.4-6** through **2.4-8**). The HDD will enter/exit through pits located in a beach-access parking lot at IBSP, and within parking lots, roadways, a marina and/or previously disturbed land on the mainland. Archeological deposits, if present, are likely to be located in relatively shallow deposits.

With respect to the HDD, the line will be directionally drilled to depths below sea level and will rise at an angle until it surfaces within the marine PAPE. All but a small portion of the directionally drilled line near the entry/exit pits will follow a drill path below modern sea level. Due to the disturbance from the parking lot at IBSP (and roadways, marina, parking lots, and disturbed farm property on the mainland) and the lack of ground level disturbance from the HDD lines under the barrier island and mainland, archaeological testing will not be conducted within the HDD PAPE. In addition, HDD will be used to install the cables under certain wetland and water features along the onshore export cable. Archaeological testing will not be conducted within the HDD PAPE for these crossings. The drilled portion of the cable will not adversely affect terrestrial archaeological deposits. The entry/exit pits and related surface disturbance are evaluated for potential effects within the marine PAPE for in water pits and terrestrial PAPE for onshore workspace, including but not limited to, additional shovel testing.

The Project PAPE for terrestrial archaeological resources includes the footprint of the proposed onshore facilities associated with construction, operations and maintenance, including the onshore export cable routes, onshore substations and grid connections (**Figures 2.4-5** and **2.4-6**), as well as temporary work areas including staging and laydown areas. Onshore routes are proposed for up to two interconnection points, at Oyster Creek and/or BL England.

For BL England, onshore cables will be buried within up to a 50-ft-wide construction corridor with a permanent easement up to 30-ft-wide. Both will be within the public ROW, as currently established. Joint bays and splice vaults will be required along the onshore route to provide clean and dry environments for jointing cable sections. HDD entry/exit points at landfall include a temporary work area approximately 0.75 acre on surface streets at the BL England landfall. At BL England one pit, approximately 200 by 125 feet, is proposed to be excavated to a depth between 15 to 20 feet below ground surface.

For Oyster Creek, onshore cables will be buried within up to a 50-ft-wide construction corridor with a permanent easement up to 30-ft-wide. The area between the Oyster Creek landfall in the Holtec parcel to the substation and the areas west of Route 9, between Route 9 and the substation would cross undeveloped land, the remaining cable route would be within public ROW. Joint bays and splice vaults will be required along onshore routes to provide clean and dry environments for jointing cable sections. HDD entry/exit points at landfall include a temporary work area of 4.8 acres on IBSP. Two 200 by 125 foot receiving pits at IBSP are proposed to be excavated to a depth between 15 to 20 feet below ground surface.

For landfall on the Holtec property, 6 acres of workspace would be required in previously disturbed wetlands. Two receiving pits at the Holtec property are proposed to be excavated to a depth between 15 to 20 feet below ground surface. The pits will measure approximately 200 by 125 feet. From the receiving pits, the cables will be installed in two trenches at Oyster Creek as they exit/enter the landfall area.

For the Bay Parkway landfall, 5.7 acres of landfall workspace within coastal wetlands would be required, with up to two pits (200 by 125 feet and excavated to a depth between 15 to 20 feet below ground surface). For Nautilus Drive 0.7 acres of landfall workspace would be required within an undeveloped lot and portions of Nautilus Drive and Pirate Drive, with one pit (200 by 125 feet and excavated to a depth between 15 to 20 feet below ground surface). For Lighthouse Drive, 1.6 acres of landfall workspace would be required within sand areas surrounding the Holiday Beach Club and portions of Lighthouse Drive and Shore Drive, with up to two pits (200 by 125 feet and excavated to a depth between 15 to 20 feet below ground surface). For the Marina landfall, 3.1 acres of landfall workspace would be required within the Holiday Harbor Marina, with up to two pits (200 by 125 feet and excavated to a depth between 15 to 20 feet below ground surface).

Up to 3.75 acres of additional HDD workspace for Oyster Creek onshore export cables would be required west of U.S. Highway 9 where cables would be installed under wetlands south of the substation.

A summary of anticipated impacts of onshore cable installation for Ocean Wind at both Oyster Creek and BL England is presented in **Table 2.4.1-1.**

Table 2.4.1-1. Summary of anticipated impacts of onshore cable installation for Ocean Wind at both Oyster Creek and BL England.

Routing	Max size	Max depth	Notes
Trench	10’ (width)	8’	
Transition Joint Bay (TJB)	62’x14’	20’	
Handhole	4’x4’	5’	Handholes are utilized as smaller access point; smaller than a manhole
Manhole	28’x10’	14’	

Two new onshore substations are proposed at Oyster Creek and BL England along with overhead or underground grid connections to the existing grid for each substation. The Oyster Creek substation will require up to 31.5 acres for the permanent site and an additional 2 acres for construction. The Oyster Creek substation will be constructed on aggregate piers 24 inches in diameter to a depth of 18 feet below current ground surface with a spread footing system. The BL England substation will require up to 13 acres for the permanent site and an additional 3 acres for construction. The BL England substation will be built on driven piles between 30 and 40 feet in depth. The average elevation at the Oyster Creek substation is 25 feet above MSL and about 12 feet above MSL at BL England.

The Oyster Creek and BL England overhead grid connections will each be up to 0.5 mile in length and will require up to 6 pole structures. From the substations, overhead lines will provide interconnection with the existing grid. It is anticipated that six H-frame utility structures will be installed on drilled pier foundations (two for each H-frame riser structure) at Oyster Creek and six at BL England. The piers will range in size from 8 to 10 feet in diameter and extend 30 to 40 feet in depth below the current ground surface. A summary of proposed impacts at the Ocean Wind Oyster Creek and BL England substations are presented in **Tables 2.4.1-2** and **2.4.1-3**, respectively.

Table 2.4.1-2. Proposed impacts at Ocean Wind Oyster Creek substation.

Item	Max size	Approximate max depth of ground disturbance
Overall footprint of substation including potential stormwater management features and related appurtenances	31.5 acres permanent construction Additional 2 acres for temporary use during construction	*N/A*
Approx. foundation depth of substation piles	*N/A*	Piles expected to reach elevation 30’ (NAVD88) = and are ~50’ long
H-Frames: drilled pier foundations (2 each)	diameter = 8’-10’	Drilled shafts for H-frames expected to range from 30’-40’ in depth

Table 2.4.1-3. Proposed impacts at Ocean Wind BL England substation.

Item	Max size	Approximate max depth of ground disturbance
Overall footprint of substation	11.13 acres permanent Additional 2 acres for temporary use during construction	*N/A*
Approx. foundation depth of substation	*N/A*	Aggregate piers 24 inches in diameter and 18 feet long will be installed for ground improvement. These will allow for use of spread footing systems.
H-Frames: drilled pier foundations (2 each)	diameter = 8'-10'	Drilled shafts for H-frames expected to range from 30'-40' in depth

Overhead transmission structures on this project are H-frame riser structures for the grid interconnection outside the Oyster Creek and BL England substations. The approximate diameter of the foundations for this structure will range between 8 and 10 feet; the approximate area of disturbance will be 2,827 sq ft per site (0.06 acres) with two foundations needed per structure. The approximate depth of the foundations is expected to range between 30 feet and 40 feet below current ground surface. As currently designed, the overhead poles will be constructed within the existing portion of the BL England decommissioned power plant, which has been previously disturbed and lacks the potential for intact archeological deposits or features. Similarly, the proposed overhead lines at Oyster Creek will be in areas of previous disturbance and the area of a filled wetland, as evidenced on historical maps and aerials.

For underground grid connections at Oyster Creek and BL England, the maximum length would be 0.5 mile, the temporary workspace would be 60 feet wide (30 feet from the centerline on each side) and the permanent row width would be 60 feet. The maximum overall trench depth will be 10 feet 3 inches. Trench width would be 4 feet 3 inches. Each underground grid connection will have a riser at the existing substation to bring the cable into the substation overhead.

As discussed in Volume I, the Project is evaluating use of several ports to serve as construction and/or operations and maintenance facilities, including use of an onshore operations and maintenance (O&M) facility in Atlantic City. Proposed uses at existing port facilities will be consistent with the current land uses occurring at these locations. Because there will be no impact to terrestrial archaeological resources at these port locations associated with the Project, these ports are not included in the PAPE. The O&M facility will serve as a regional operations and maintenance center for multiple projects that Orsted intends to develop in the mid-Atlantic. Marina upgrades, namely dredging in the marina and at Absecon Inlet would benefit multiple marina users, and both this activity and upland improvements are not dependent upon approval of the Project and are being separately reviewed and authorized by the US Army Corps of Engineers and are therefore not included in the PAPE for the Ocean Wind Project.

The Project includes both offshore and onshore infrastructure, and separate visual PAPEs were developed for the different infrastructure types. The Offshore Infrastructure visual PAPE was delineated by starting with a maximum theoretical visibility extent and limiting it to areas of actual visibility through visualization assessments, desktop computer analyses, field observations, and review of field photographs, aerial photographs, and street-level views on online mapping tools. Based on these analyses, a PAPE was delineated and is depicted in **Figure 2.4-8**. Generally, the Offshore Infrastructure PAPE extends from Wildwood in Cape May County in the south to Beach Haven in Ocean County in the north and includes the first developed block of the barrier islands and select inland areas with views across bays opening to the Atlantic Ocean. Visual PAPEs were also developed for onshore infrastructure and include a 0.25 mi boundary around the BL England substation location (**Figure 2.4-9**) and a minimum 0.25 mi boundary around the Oyster Creek substation location which encompasses the overhead grid connection for each. While overhead and underground grid connections are under consideration, overhead grid connections represent the greatest potential for visual impact so were used to determine potential visual impacts rather than underground grid connections. The Oyster Creek APE is enlarged in some areas lacking vegetation to block views (**Figure 2.4-10**). Additional information can be found in Appendix F.

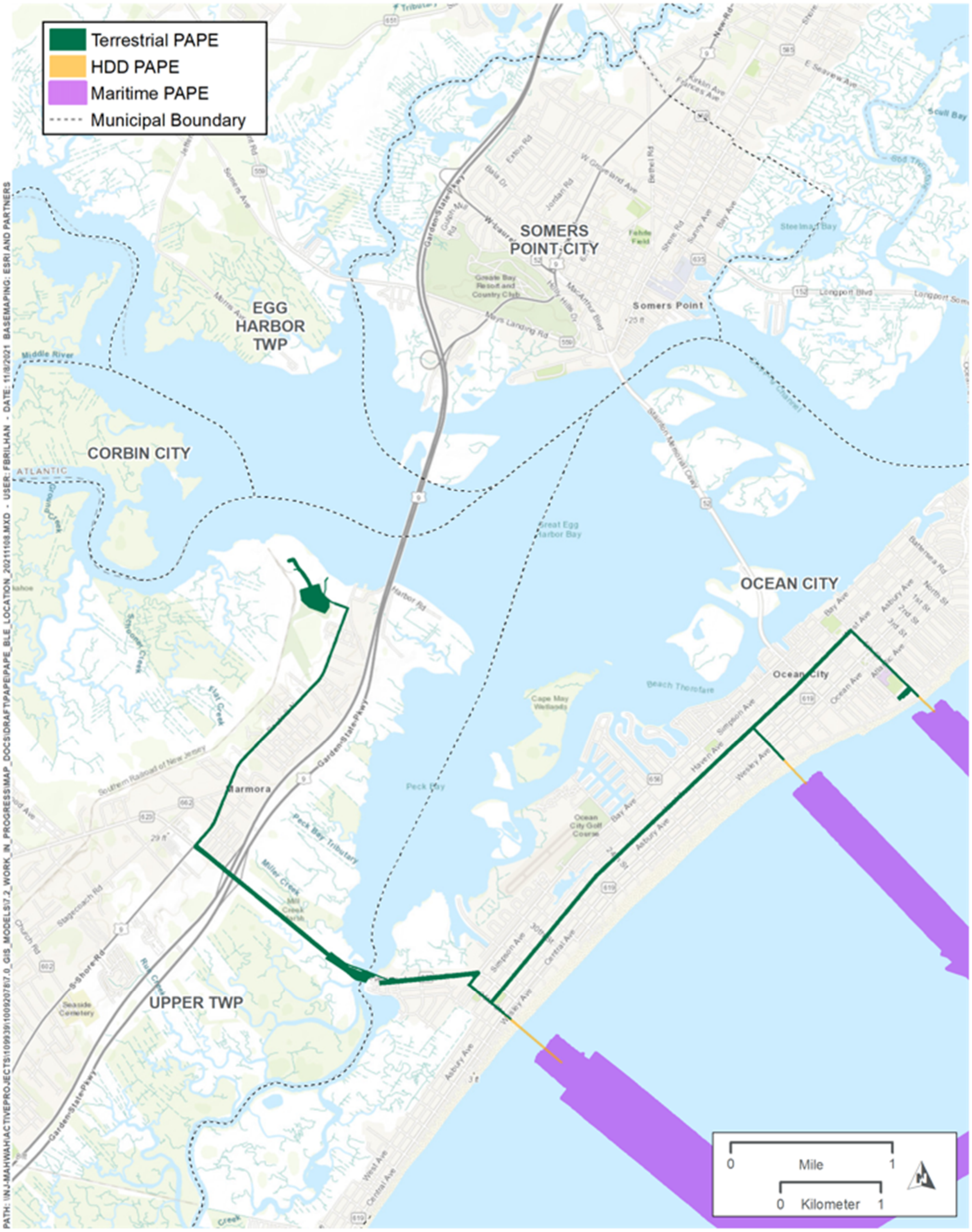

Figure 2.4-6. Archaeological Preliminary Area of Potential Effect for onshore infrastructure for BL England.

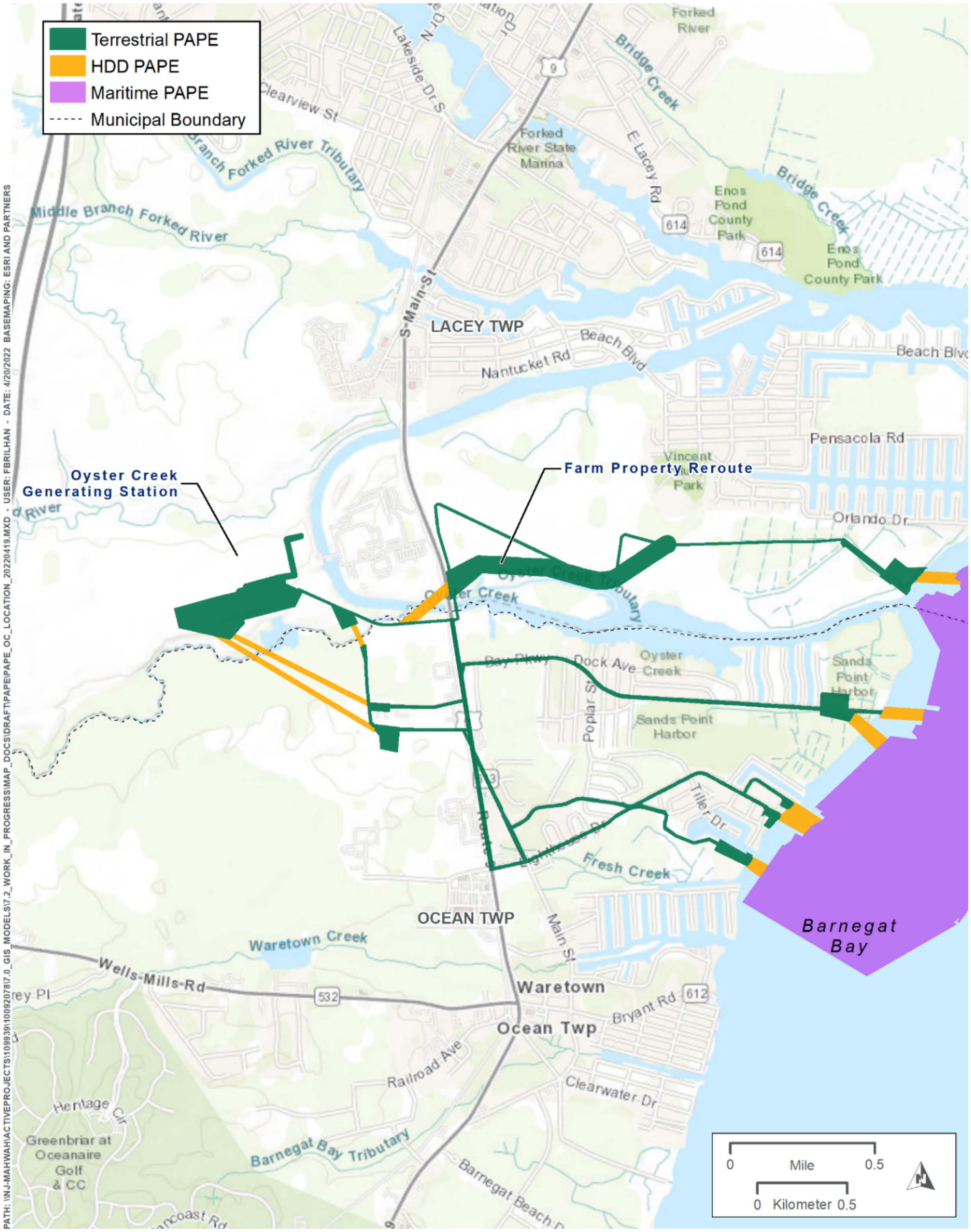

Figure 2.4-7. Archaeological Preliminary Area of Potential Effect for onshore infrastructure for Oyster Creek.

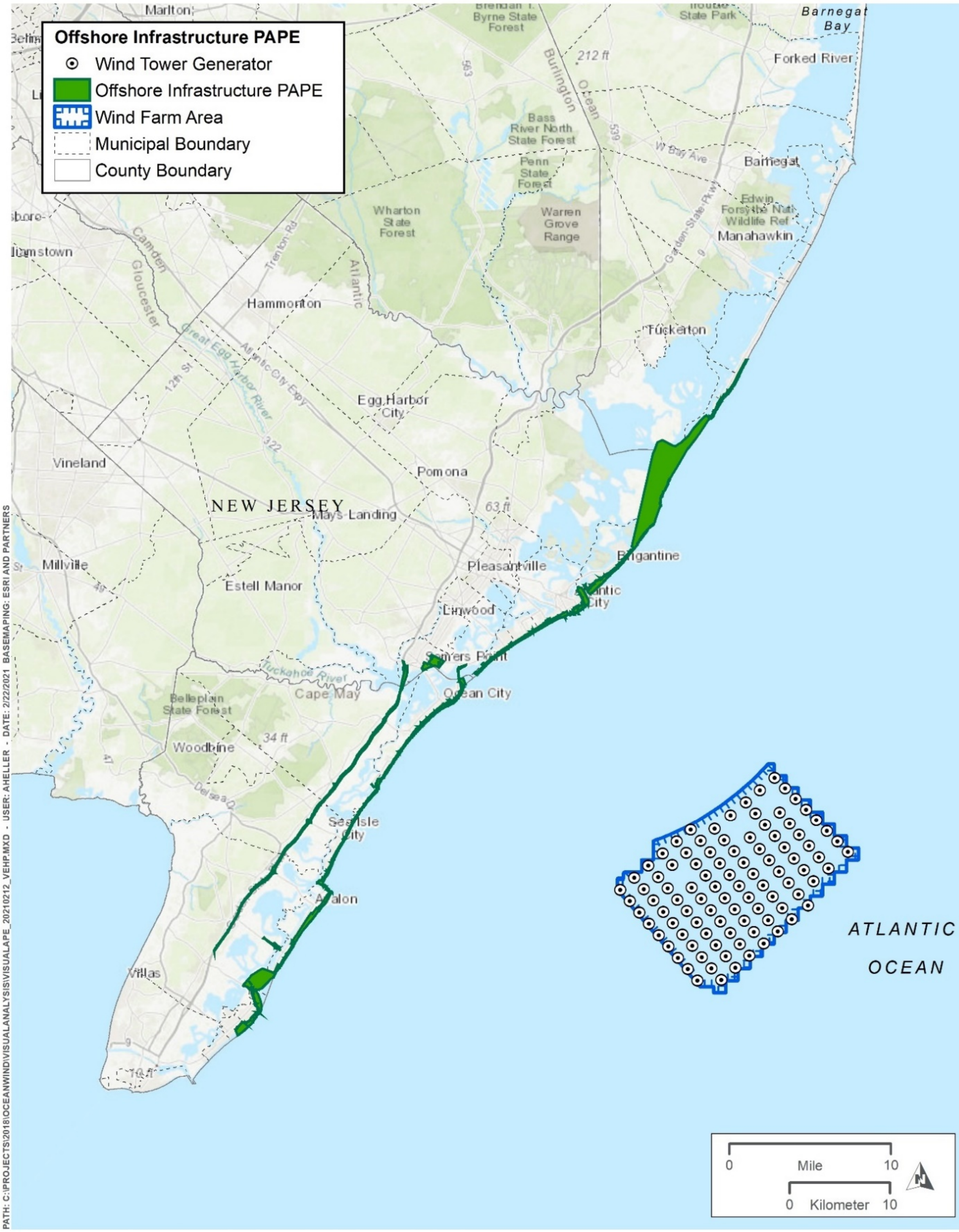

Figure 2.4-8. Visual Preliminary Area of Potential Effect for offshore infrastructure.

Figure 2.4-9. Visual Preliminary Area of Potential Effect for onshore infrastructure for BL England.

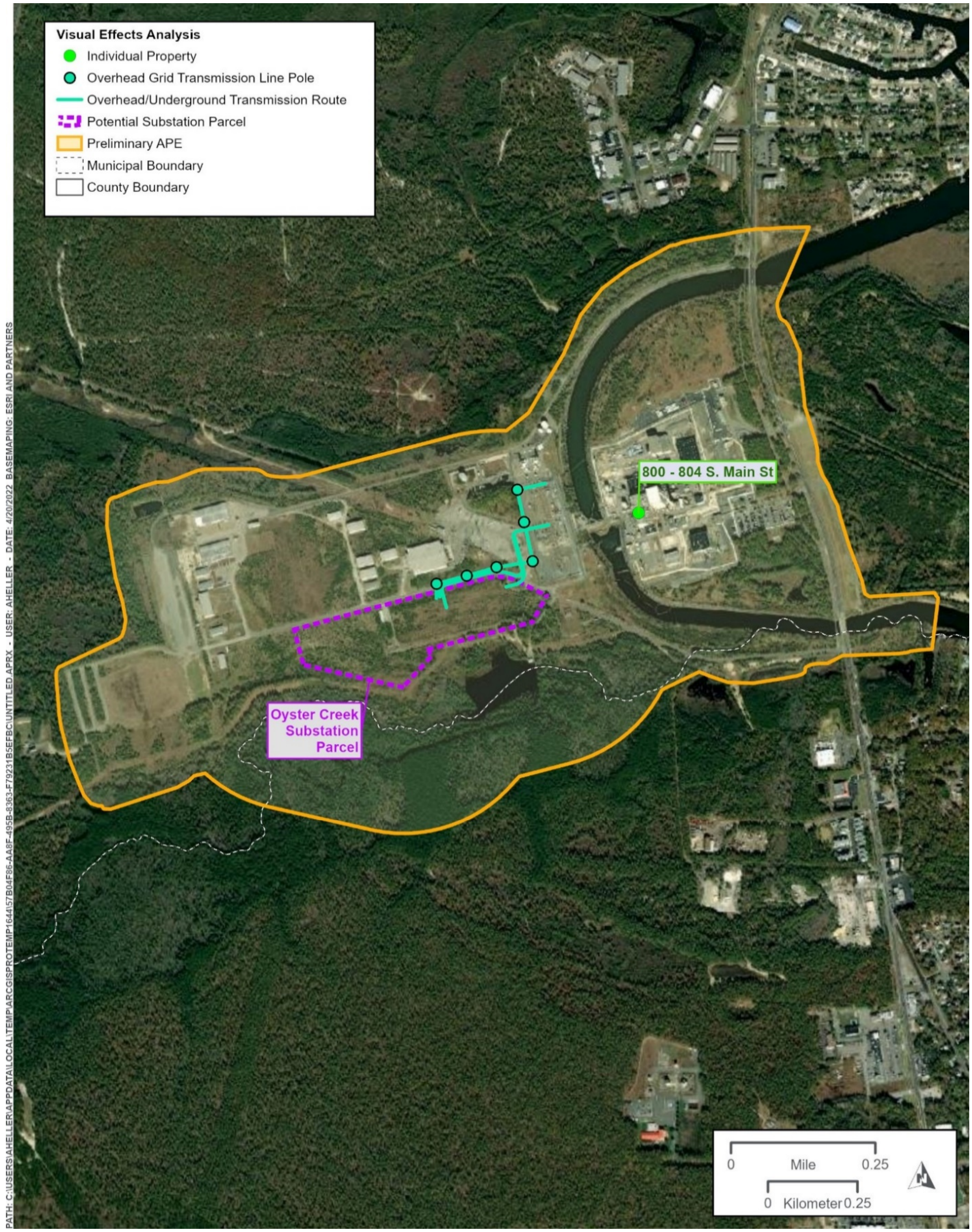

Figure 2.4-10. Visual Preliminary Area of Potential Effect for onshore infrastructure for Oyster Creek.

2.4.2 Affected Environment

The proposed Project will affect multiple environments within the Federal OCS and the State of New Jersey (**Table 2.4-1**). Wind development activities occurring within the Lease Area (OCS-A 0498) will potentially affect submerged historic properties within the offshore marine environment. Activities associated to the offshore export cable corridors have the potential to affect submerged historic properties within the Federal offshore and State nearshore marine environments. Onshore export cable corridor activities and substation and associated grid connection activities have the potential to affect historic properties within the onshore environment. No tribal lands are included within the Project PAPE. The Assessment of Visual Effects on Onshore Historic Properties has been completed and is included in Appendix F-3.

Table 2.4-1. Cultural aspects potentially affected by Project infrastructure.

Affected Environment	Potential Cultural Aspect	Ocean Wind Infrastructure			
		Lease Area	Offshore Export Cable Corridors	Onshore Export Cable Corridor	Onshore Substations and Overhead Grid Connections
Federal Offshore	Maritime	X	X		
State Nearshore	Maritime		X		
Onshore	Terrestrial & Architecture			X	X
Viewshed	Terrestrial & Architecture	X			X

Offshore and onshore study areas were developed that were designed to encompass the anticipated offshore, onshore, and viewshed PAPEs. The PAPEs will be defined through BOEM's consultation with relevant State, Federal, and tribal agencies. BOEM's standard definition for the onshore, terrestrial archaeology APE is defined in BOEM's Guidelines for Providing Archaeological and Historical Property Information Pursuant to 30 CFR Part 585 as "the depth and breadth of terrestrial areas potentially impacted by any ground disturbing activities." For the purposes of this study, the offshore study area is limited to the Lease Area (OCS-A 0498) and current proposed offshore export cable corridor options. The onshore study area is limited to the current proposed onshore export cable corridor options and the two proposed substation locations at BL England and Oyster Creek and associated overhead grid connections. The following datasets were reviewed to identify previously documented cultural, historical, and archaeological resources, thereby defining the existing conditions within both defined Study Areas:

- BOEM Archaeological Resource Information Database
- Global GIS Data Services, LLC, Global Maritime Wrecks Database (GMWD)
- NOAA Automated Wreck and Obstruction Information System (AWOIS)
- NOAA Electronic Navigation Charts Database
- New Jersey Maritime Museum (NJMM) Shipwreck Database
- New Jersey Geographic Information Network (NJGIN) Open Data Site
- Relevant archaeological site forms and reports collected at the NJHPO and New Jersey State Museum

2.4.2.1 Maritime Archaeology

Comprehensive cultural and historical contexts have been developed for the array, offshore, and inshore study areas. These contextual analyses were developed from extensive background research and will guide archaeological interpretation of HRG survey data.

In accordance with BOEM regulations and guidance, the Project's offshore PAPE has been thoroughly analyzed and assessed by the Qualified Marine Archaeologist (QMA), with the results detailed in Appendix F, Marine Archaeological Resource Assessment.

The QMA's assessment includes an analysis of potential cultural resources sitting on top of the seafloor, as well as partially or fully buried items. The QMA also assessed buried geomorphic features of archaeological interest that could represent paleolandscapes with traditional religious and cultural importance. It also includes a literature review and background research in order to understand the environmental and cultural contexts of the region and to determine the potential for undiscovered archaeological sites within the PAPE. Additionally, the QMA analysis includes a full marine archaeological resources assessment, utilizing data from HRG survey campaigns, including multibeam echosounder, side scan sonar, sub-bottom profiler, magnetometer, and geotechnical investigation data. The HRG survey plans were developed in coordination with the QMA in order to ensure that data collection methods provided valid and comprehensive data for the QMA to use during the marine archaeological analysis.

A marine survey contractor collected HRG data across the PAPE between 2018 and 2022 following BOEM archaeological survey guidelines and the Project's QMA data transfer protocol. Material recovered from 16 geotechnical vibracores collected during the 2020 Marine Archaeological Geotechnical Campaign with the Lease Area were submitted for third-party laboratory analysis that included radiocarbon, grain size and pollen analyses to assist in the characterization of the paleolandscapes and delineation of geomorphic features of archaeological interest. The marine archaeological resources assessment of the HRG data within the PAPE identified 19 potential submerged cultural resources within the gradiometer, side-scan sonar, and/or multibeam echosounder datasets, 12 are located within the Wind Farm Area; three are located along the BL England export cable route corridor; and four are located along the Oyster Creek export cable route corridor. Four targets appear to represent shipwrecks in the side-scan sonar imagery and are in close proximity to reported shipwrecks. Five targets consist of magnetic anomalies that share characteristics with verified shipwreck magnetic signatures and side-scan imagery of unknown origin; therefore, these targets may represent partially buried shipwreck sources. The remaining 10 targets consist of magnetic anomalies that share characteristics with verified shipwreck magnetic signatures and, therefore, may represent buried shipwreck sources. The QMA recommends avoidance of these targets by a distance of 50 meters (164 feet) from the outer edge of magnetic anomalies and acoustic contacts. HRG data identified 16 geomorphic features of archaeological interest within the PAPE, 13 are located within the Wind Farm Area; one is located along the BL England export cable route corridor; and two are located along the Oyster Creek export cable route corridor, which represent relict channel margins that may have been subaerially exposed and available for past human use. The features possess archaeological potential; however, no direct evidence of associated human occupation has been documented in the geophysical or geotechnical data. The features, therefore, represent portions of buried landscapes that may be of cultural significance to Native American communities. The QMA recommends avoidance of these features.

The PAPE on the west side of Barnegat Bay has been expanded and additional HRG survey will be conducted in 2022.

2.4.2.2 Terrestrial Archaeology

Archaeological surveys for the onshore study area, which consists of onshore sub-stations, grid connections and onshore export cables have been conducted. Results of this investigation, including comprehensive cultural and historical contextual analyses, are presented in Appendix F, Terrestrial Archaeological Resources Assessment.

A Phase I Archaeological Investigation of the Onshore Infrastructure PAPE was conducted in 2021 in accordance with BOEM's 2020 *Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR Part 585*, and the NJHPO's *Guidelines for Phase I Archaeological Investigations: Identification of Archaeological Resources* and *the Guidelines for Preparing Cultural Resources Management Archaeological Reports Submitted to the Historic Preservation Office*. The Phase I Archaeological Investigation included archaeological and environmental background research, an assessment of terrestrial archaeological potential and sensitivity, field reconnaissance, and a geomorphic analysis. Subsurface testing was conducted at locations within the Onshore Infrastructure PAPE identified as having medium to high archaeological sensitivity, and indicative subsurface tests were excavated along the shoulders of roadways within the PAPE. A total of 938 shovel tests and seven sampling units were excavated.

The results of the Phase I Archaeological Investigation of the Onshore Infrastructure PAPE indicated that the majority of the PAPE was previously disturbed by construction activities unrelated to the Project. Two archaeological sites were identified within the Onshore Infrastructure PAPE. A portion of a pre-contact period archaeological site was identified at the proposed location of the BL England substation, and an historic period archaeological site was identified along the shoulder of Route 9 along the BL England onshore export cable route. Portions of these sites within the Onshore Infrastructure PAPE were previously disturbed and therefore did not retain integrity. Based on the results of the Phase I Archaeological Investigation, there are no intact archaeological resources within the Onshore Infrastructure PAPE. In all, 238 tests were excavated, 146 at the substation and 92 along the cable route at indicative areas along the roadway, as well as two 1x1 meter units at the Roosevelt Boulevard Bridge approaches.

At Oyster Creek, the preferred alternative through the Farm parcel (Holtec property) was investigated with 475 shovel tests and one unit (1x1 meter). A Gainey-type projectile point (circa 12,400 years ago) from the Paleoindian Period was recovered in a test just east of modern US Route 9. After the initial shovel test, a larger unit was excavated over the test confirming the point was recovered within a recent disturbance, likely a drainage trench. Surrounding tests did not recover precontact materials, and the find is interpreted as an isolated artifact likely lost during hunting. The site does not retain its integrity and no further archaeological work is currently recommended. The parcel has witnessed extensive disturbance from the construction of the nearby nuclear generating plant, placement and spreading of dredged spoil from Oyster Creek, and the attempted farm reclamation project of the parcel in the mid 20th century by Norman Finninger. The reclamation project included the extensive construction of a system of irrigation and drainage ditches to remove salt water and provide fresh water to the cattle farm.

Tests at the landfall at Island Beach State Park also evidenced extensive landscape disturbance. In all, 30 test were excavated, and no sites identified. The cable routes were archaeologically surveyed with 126 shovel tests. Along Bay Parkway a precontact site was previously reported (28-OC-055) immediately adjacent to and south of the road. Testing in that location did not recover precontact material, and the area of the road ROW was extensively disturbed by water, sewer, and stormwater lines. It also seems likely the site location is inaccurate based on the local topographic conditions.

The onshore PAPE for Oyster Creek has been expanded and additional Phase 1 surveys will be conducted in spring 2022.

2.4.2.3 Architectural History

Background research, reconnaissance architectural surveys of the cable route options, intensive survey, and visual effects analysis have been completed for all historic properties within both the offshore and onshore visual PAPEs (included as Appendix F-3).

Publicly available geospatial data was collected to identify historic resources aged 45 years or older potentially impacted by the Project. Through review of existing records at the NJHPO and completion of an intensive-level survey, Ocean Wind identified 41 historic properties within the Offshore Infrastructure PAPE, which included 7 historic districts and 34 individual properties. All historic resources were analyzed and evaluated for effects in the Visual Effects on Historic Properties report (Appendix F-3).

Onshore infrastructure was reviewed under two different methods depending on the potential permanent visibility of the infrastructure. Onshore infrastructure associated with the Project includes buried cables, and construction of new substations, and potentially overhead grid connections connecting the new substations with the existing grid. The buried cables will pose no permanent visual effects. Visual effects associated with the cable routes will be temporary and related to initial construction. The proposed onshore cables will be buried and primarily within existing streets and utility corridors. Therefore, impacts to historic properties adjacent to the cable routes are anticipated to be atmospheric or access-related in nature and temporary during construction. Areas with planned aboveground infrastructure (substations and the potential overhead grid connections) were given individual visual PAPEs, and any historic resources within the PAPE aged 45 years or older were intensively surveyed and evaluated for NRHP-eligibility. Eligible or listed properties within the PAPE were evaluated for visual effects from the Project.

2.4.3 Potential Project Impacts on Cultural, Historical, and Archaeological Resources

The Project will consist of three phases: construction, operation and maintenance, and decommissioning. All phases of the Project have potential to affect documented cultural, historical, and archaeological resources of the area, as well as undiscovered resources. IPFs that may affect cultural, historical, and archaeological resources are listed below and discussed in the following sections:

- Physical seabed/land disturbance
- Visible structures/lighting

Specifically, the Wind Farm Area infrastructure (WTGs, array cables, array cables, and offshore substations) will require deep seabed disturbance that may potentially impact submerged cultural resources. The above water turbine infrastructure will influence the viewshed of historic properties and districts. The offshore export cables may potentially impact submerged cultural resources as the cables are anticipated to rest on, or be buried below, the seabed.

Onshore Project components include landfalls, onshore export cables, onshore substations, and overhead grid connections. The onshore export cables are expected to be predominantly buried within existing rights-of-way. The onshore export cables may potentially impact buried cultural resources; however, with limited aboveground infrastructure, aboveground historic properties and districts are not likely to be impacted. The onshore substations may potentially impact buried cultural resources and visually impact aboveground historic properties. The grid connection may visually impact aboveground historic properties.

2.4.3.1 Construction

2.4.3.1.1 Maritime Archaeology

The construction phase of the Project has the potential to affect offshore and nearshore submerged historic properties. The construction of Wind Farm Area and offshore export cable infrastructure will introduce direct bottom impact to these environments. Previously identified shipwrecks and unidentified cultural resources (pre-Contact and historic) may be impacted directly by installation or indirectly by other associated bottom disturbance activities, such as vessel anchoring, spudding, ingress/egress, etc., occurring during this Project phase. Disturbance to submerged marine archaeological and cultural resources will be avoided to the extent practicable through adherence to the QMA recommended avoidance buffers. Disturbance to known resources that cannot practicably be avoided would only occur with appropriate consultations and approvals. Additional archaeological investigation of resources that cannot be avoided may be needed in order to determine whether or not they are historic properties and to fully assess Project effects. Consultation between BOEM and the consulting parties under Section 106 of the NHPA will assist in the identification of, assessment of effects to, and mitigation measures to resolve effects for any HRG target or geomorphic feature potentially eligible for listing in the NRHP. Furthermore, Ocean Wind developed and will implement an Unanticipated Discoveries Plan to avoid and mitigate impacts to unknown resources (Appendix F-5).

2.4.3.1.2 Terrestrial Archaeology

The construction phase of the Project has the potential to affect onshore cultural resources. The construction of onshore export cable infrastructure, onshore substations and overhead grid connections will introduce direct ground impact to the onshore environment. Previously identified terrestrial archaeological resources and unidentified cultural resources (pre-contact and historic) may be impacted directly by ground disturbances associated with the onshore Project construction activities. Additionally, the construction of above water Wind Farm Area infrastructure has the potential to introduce visual impacts to archaeological sites sharing a view of the ocean.

A Phase I Archaeological Investigation was conducted to evaluate the effects of onshore infrastructure construction on arcaheological resources. The results of the Phase I Archaeological Investigation indicated that there are no archaeological properties within the Onshore Infrastructure PAPE that are listed in or eligible for the NRHP. The Phase I Archaeological Investigation recommended No Adverse Effect on terrestrial archaeological resources. Notwithstanding this recommendation, Ocean Wind developed and will implement an Unanticipated Discoveries Plan to avoid and mitigate adverse effects to unknown terrestrial archaeological resources (Appendix F-5).

2.4.3.1.3 Architectural History

The proposed Project has the potential to affect historic properties in three New Jersey Counties—Ocean, Atlantic, and Cape May. Potential visual effects on historic properties are anticipated from both offshore and onshore infrastructure of the proposed Project. The offshore infrastructure is approximately 15 mi from the shoreline of the barrier islands at its nearest point. The onshore infrastructure is limited to two onshore areas near the BL England and Oyster Creek generating stations.

To evaluate visual effects from the offshore infrastructure, 41 historic properties were reviewed within the Offshore Infrastructure PAPE, which included 7 historic districts and 34 individual properties. These 41 historic properties were evaluated for potential visual effects from the proposed Project using the Criteria of Adverse Effect in 36 CFR § 800.5. Visual effects recommendations are made of No Adverse Effect at 35 properties, and the potential for Adverse Effect at six properties. The potential for adverse effect should be considered at Riviera Apartments in Atlantic City; Vassar Square Condominiums, a house at 114 South Harveard Avenue in Ventnor City, and Charles Fischer House in Ventnor City; Ocean City Music Pier in Ocean City; and Villa Maria by the Sea in Stone Harbor. (Villa Maria by the Sea is conditionally considered here, as its demolition plans received municipal approval in December 2020 and Stone Harbor staff indicated 2021 demolition is anticipated.) These properties are on the seashore, all but one are within 16 miles of the Wind Farm Area, and ocean views are a character-defining feature of each property's significance.

Visual effects were also analyzed for historic properties within the visual PAPE for the identified onshore substation locations and overhead grid connections. This analysis evaluated potential visual effects on a total of three properties at the two proposed substation locations and overhead grid connections. Two properties within a visual PAPE surrounding the BL England substation and grid connection were evaluated for visual effects - both are recommended as No Adverse Effect. One property within the visual PAPE surrounding the Oyster Creek substation and grid connection was evaluated for visual effects and is recommended as No Adverse Effect.

2.4.3.2 Operations and Maintenance

2.4.3.2.1 Maritime Archaeology

While the offshore and nearshore marine environments will be most affected during the construction phase of the Project, the operations and maintenance phase may also affect these environments. Any indirect marine bottom disturbance activity, such as vessel anchoring, spudding, ingress/egress, etc., occurring during the operations and maintenance phase may impact submerged historic properties. The maritime archaeological resources potentially impacted by the operations and maintenance phase of the Project would include all of the resources potentially impacted by the construction and installment phase if bottom disturbance is required due to emergency repairs outside of previously disturbed areas.

2.4.3.2.2 Terrestrial Archaeology

Operations and maintenance activities will occur in the same areas that would have been cleared (evaluated for cultural resources) during construction, and therefore no impacts to cultural resources will be expected.

2.4.3.2.3 Architectural History

Operations and maintenance activities will occur in the same areas that would have been cleared (evaluated for cultural resources) during construction, and therefore no impacts to architectural history resources will be expected.

2.4.3.3 Decommissioning

2.4.3.3.1 Maritime Archaeology

While the offshore and nearshore marine environments will be most affected during the construction phase of the Project, the decommissioning phase may also affect these environments. Any indirect marine bottom disturbance activity, such as vessel anchoring, spudding, ingress/egress, etc., occurring during the decommissioning phase may impact submerged historic properties. The maritime archaeological resources potentially impacted by the decommissioning phase of the Project would include all of the resources potentially impacted by the construction and installment phase.

2.4.3.3.2 Terrestrial Archaeology

Decommissioning activities will occur in the same areas that would have been cleared (evaluated for cultural resources) during construction, therefore no impacts are anticipated.

2.4.3.3.3 Architectural History

The decommissioning of onshore Project components is anticipated to occur within existing rights-of-way and in areas evaluated for cultural resources prior to construction. Therefore, there should not be impacts to historic architectural resources.

2.4.3.4 Summary of Potential Project Impacts on Cultural, Historical, and Archaeological Resources

The IPFs affecting cultural, historical, and archaeological resources include physical seabed/land disturbance and visible structures/lighting.

The above water Wind Farm Area infrastructure has the potential to introduce impacts to the visual character defining feature of historic properties. Seabed disturbance may potentially impact submerged cultural resources. The onshore cables may potentially impact buried cultural resources, though this will be minimized because the onshore export cables are expected to be predominantly buried within existing ROW.

2.4.4 Avoidance, Minimization, and Mitigation Measures

The proposed measures for avoiding, minimizing, reducing, eliminating, and monitoring environmental impacts for the Project are presented in **Table 1.1-2** and in Appendix F-4 and F-5.

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