ENVIRONMENTAL APPENDIX
ENDANGERED SPECIES ACT
BIOLOGICAL ASSESSMENT

NEW JERSEY BACK BAYS
COASTAL STORM RISK MANAGEMENT
FEASIBILITY STUDY

PHILADELPHIA, PENNSYLVANIA

APPENDIX F.3

August 2021

NJBB
NEW JERSEY BACK BAYS STUDY

U.S. Army Corps of Engineers
Philadelphia District

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1.0 INTRODUCTION

1.1 Purpose

This biological assessment (BA) was prepared to fulfill the U.S. Army Corps of Engineers (USACE), Philadelphia District requirements as outlined under Section 7(c) of the Endangered Species Act (ESA) of 1973, as amended. The New Jersey Back Bays Coastal Storm Risk Management Feasibility Study (the NJBB Study) is being conducted by the USACE and the New Jersey Department of Environmental Protection, the non-Federal sponsor.

The proposed Federal action (also referred to as the Tentatively Selected Plan or TSP) consists of nonstructural measures (e.g., elevation and floodproofing of buildings and structures), storm surge barriers, and bay closures within the NJBB Study Area. This BA evaluates the potential impacts of the NJBB Study TSP and options that have not been eliminated and may have on federally listed threatened and endangered species identified by the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) within the NJBB Study Area.

The NJBB Study Area (study area) includes the bays and river mouths located landward of the barrier islands and Atlantic Ocean-facing coastal areas in the State of New Jersey. The study area covers more than 950 square miles, and 3,500 linear miles of shoreline from Long Branch at the northern study area boundary to Cape May Point at the southern boundary. It comprises portions of ninety municipalities and five counties including Monmouth, Ocean, Atlantic, Burlington and Cape May Counties. The study area has been subdivided into five regions based on problems and opportunities, geomorphology and hydraulic interconnectedness of water bodies (see Figure 1).

1.2 Species and Critical Habitat Considered

The USFWS Information for Planning and Conservation and NMFS ESA mapper databases were queried on 13 December 2019 to determine which species protected under the ESA have the potential to occur in the NJBB Study Area (Attachment 1). Tables 1 and 2 provide an initial screening on whether or not these threatened and endangered species have the potential to be impacted by the proposed action, based on a description of each species' habitat this includes habitat impacts). Species potentially affected were carried forward in the biological assessment for consideration.

The initial screening indicates the following species would not occur in the action area based on a lack of habitat or known occurrences; therefore, these species are eliminated from further consideration in this biological assessment.

- Bog Turtle (*Clemmys muhlenbergii*)
- Northeastern Beach Tiger Beetle (*Cincindela d. dorsalis*)
- American Chaffseed (*Schwalbea americana*)
- Knieskern's Beaked-rush (*Rhynchospora knieskernii*)
- Sensitive Joint-vetch (*Aeschynomene virginica*)
- Swamp Pink (*Helonias bullata*)
- Shortnose Sturgeon (*Acipenser brevirostrum*)

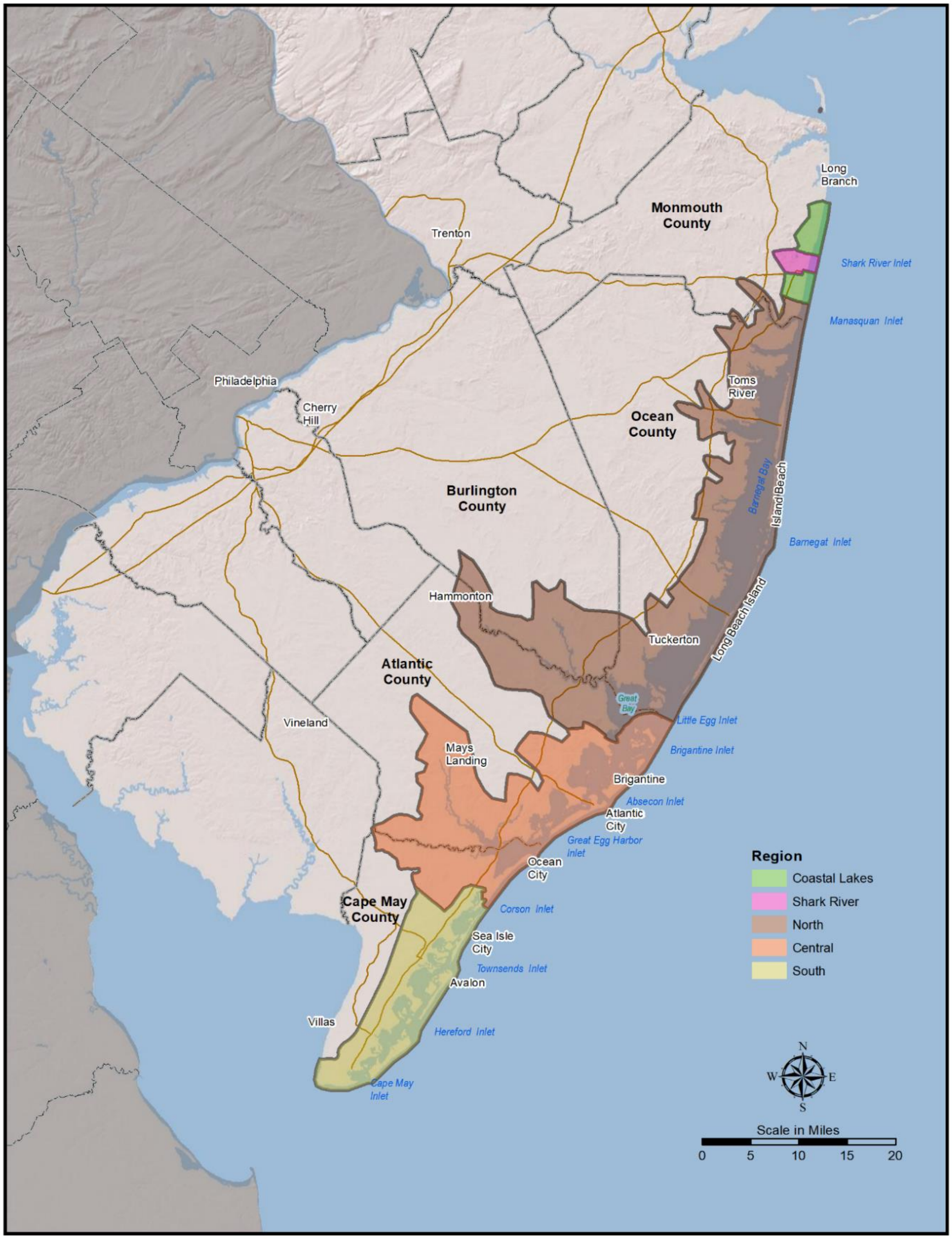


Figure 1. New Jersey Back Bay Study Area

Table 1. Potential Impacts of the TSP and Options on Threatened and Endangered Species under USFWS Jurisdiction

Species	**Status**	**Habitat in NJBB**	**Potential for Impact**	**Carried Forward for Consideration**
Northern Long-Eared Bat (*Myotis septentrionalis*)	FT	Summertime roosts beneath the bark of live and dead trees.	Impacts to occupied habitat would be avoided to the maximum extent practicable.	Yes
Piping plover* (*Charadrius melodus*)	FT*, SE	Ocean beaches, inlets, washover areas, tidal flats	Potential disturbance to nests/foraging areas on beaches and inlet dunes. Indirect impacts through disruptions in food chain.	Yes
Eastern Black Rail *(Laterallus jamaicensis spp. Jamaicensis)*	FT, SE	Salt and freshwater marshes	Direct habitat impacts/losses are likely on breeding in higher saltmarshes. Indirect impacts through disruptions in food chain.	Yes
Roseate Tern (*Sterna dougallii*)	FE, SE	Beaches w/ vegetated dunes	No breeding population currently in NJ. Potential disturbance to foraging areas. Indirect impacts through disruptions in food chain.	Yes
Red Knot (*Calidris canutus*)	FT, SE	Foraging and resting habitat on gently sloping, sandy beaches.	Potential disturbance to foraging areas. Indirect impacts through	Yes

Species	Status	Habitat in NJBB	Potential for Impact	Carried Forward for Consideration
			disruptions in food chain.	
Bog Turtle (*Clemmys muhlenbergii*)	FT, SE	Open-canopy, herbaceous sedge meadows and fens bordered by wooded areas	Habitat is not known to occur in the studdy area. Impacts to this habitat will be avoided.	No
Northeastern Beach Tiger Beetle (*Cincindela d. dorsalis*)	FT, SE	Atlantic coast sandy beaches. Considered extirpated from the study area.	Potential disturbance to habitat on beaches and inlet dunes tie-ins. This species is known to be extirpated from the study area and was not included in the IPAC results. Impacts to occupied habitat will be avoided.	No
American Chaffseed (*Schwalbea americana*)	FE, SE	Sandy (sandy peat, sandy loam), acidic, seasonally-moist to dry soils in early successional habitats described as open, moist pine flatwoods, fire-maintained savannas.	Habitat is not known to occur in the study area. Impacts to occupied habitat will be avoided.	No
Knieskern's Beaked-rush (*Rhynchospora knieskernii*)	FT, ST	An obligate wetland species endemic to New Jersey; occurs in early successional wetland habitats, often on bog-iron substrates adjacent to slow-moving streams in the Pinelands region.	Habitat is not known to occur in the study area. Impacts to occupied habitat will be avoided.	No
Seabeach amaranth*	FT, SE	Upper sandy beaches, accreting ends of inlets	Potential disturbance to habitat on	Yes

Species	**Status**	**Habitat in NJBB**	**Potential for Impact**	**Carried Forward for Consideration**
(*Amaranthus pumilus*)			beaches and inlet dunes.	
Sensitive Joint-vetch (*Aeschynomene virginica*)	FT, ST	Intertidal zone of fresh to slightly salty (brackish) tidal river segments, typically in areas where sediments accumulate and extensive marshes are formed.	Habitat is not known to occur in the action area. Impacts to this habitat will be avoided.	No
Swamp Pink (*Helonias bullata*)	FT, ST	Forested wetland.	Habitat is not known to occur in the action area. Impacts to this habitat will be avoided.	No

Notes: FE=Federally Endangered, FT=Federally Threatened, PFT=Proposed Federally Threatened, SE=State Endangered, ST=State Threatened.

Table 2. Potential Impacts of TSP and Options on Threatened and Endangered Species under NMFS Jurisdiction

Species	Status	Habitat in NJBB	Potential for Impact	Carried Forward for Consideration
Fin Whale (*Balaenoptera physalus*)	FE, SE	Marine pelagic	Construction/noise vibrations could impact overwintering, foraging, or calving habits of adults and juveniles. Indirect impacts through disruptions in food chain.	Yes
North Atlantic Right Whale (*Eubalaena glacialis*)	FE, SE	Marine pelagic	Construction/noise vibrations could disturb migrating habits of adults.	Yes
Atlantic Loggerhead	FT, SE	Marine/Estuarine Pelagic	Construction/noise vibrations could disturb	Yes

(*Caretta caretta*)			migrating/feeding habits of adults and juveniles. Indirect impacts through disruptions in food chain.	
Kemp's Ridley (*Lepidochelys kempii*)	FE, SE	Marine/Estuarine Pelagic	Construction/noise vibrations could disturb migrating/feeding habits of adults and juveniles. Indirect impacts through disruptions in food chain.	Yes
Atlantic Green Sea Turtle *(Chelonia mydas*)	FT, ST	Marine/Estuarine Pelagic	Construction/noise vibrations could disturb migrating/feeding habits of adults and juveniles. Indirect impacts through disruptions in food chain.	Yes
Leatherback Sea Turtle (*Dermochelys coriacea*)	FT, ST	Marine/Estuarine Pelagic	Construction/noise vibrations could disturb migrating/feeding habits of adults and juveniles. Indirect impacts through disruptions in food chain.	Yes
Atlantic Sturgeon* (*Acipenser oxyrinchus oxyrinchus*)	FT, FE, SE	Anadromous, marine/estuarine Demersal/pelagic	Construction/noise vibrations could disturb migrations/feeding habits of adults and subadults. Indirect impacts through disruptions in food chain.	Yes
Shortnose Sturgeon	FE, SE	Amphimodrous, freshwater/brackish tidal Demersal/pelagic	This species is not expected to occur in the action area.	No

(*Acipenser brevirostrum*)				

Notes: FE=Federally Endangered, FT=Federally Threatened, PFT=Proposed Federally Threatened, SE=State Endangered, ST=State Threatened.

The following species have the potential to occur in the action area and are considered in detail in this BA.

- Northern Long-Eared Bat (*Myotis septentrionalis*)
- Piping plover (*Charadrius melodus*)
- Eastern Black Rail (*Laterallus jamaicensis spp. Jamaicensis*)
- Roseate Tern (*Sterna dougallii*)
- Red knot (*Calidris canutus*)
- Seabeach amaranth (*Amaranthus pumilus*)
- Fin Whale (*Balaenoptera physalus*)
- Atlantic Loggerhead(*Caretta caretta*)
- Kemp's Ridley (*Lepidochelys kempii*)
- Atlantic Green Sea Turtle (*Chelonia mydas*)
- Leatherback Sea Turtle (*Dermochelys coriacea*)
- North Atlantic Right Whale (*Eubalaena glacialis*)
- Fin Whale (*Balaenoptera physalus*)
- Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*)

1.3 Consultation History

No formal or informal consultation has been conducted prior to this document. USACE held a variety of regular public and interagency coordination meetings with State and Federal stakeholders to discuss the NJBB Study status, impact assessment, and modeling efforts (see Appendix E, Table2 of the EIS for a complete list of meeting dates). USACE also held meetings with NMFS and USFWS to discuss the NJBB One Federal Decision Path, on 20 December 2020 and 23 December 2020, respectively

2.0 ACTION AREA

The action area is defined as all areas that may be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action. It encompasses the geographic extent of environmental changes (i.e., the physical, chemical and biotic effects) that will result directly and indirectly from the action and is a subset of the NJBB Study Area.

For the NJBB Study, the action area is all areas directly and indirect affected by the tentatively selected plan (TSP), presented Figure 2. The TSP includes the following project components:

- Three inlet closures or storm surge barriers (SSB)
    - Manasquan Inlet
    - Barnegat Inlet
    - Great Egg Harbor Inlet
- Two bay closures
    - Absecon Blvd
    - South Ocean City
- Non-structural measures
    - 18,800 structures eligible for elevation and floodproofing

Additionally, the action area considers the effects of the following options, which have not yet been eliminated.

- Non-structural measures only (elevation and floodproofing for 23,152 structures) in the North Region (Alternative 3A; see Figure 3).
- Non-structural measures only alternative (elevation and floodproofing for 10,895 structures) in the Central Region (Alternative 4A; see Figure 4).
- Non-structural measures for (elevation and floodproofing for 1,189 structures) and perimeter plan alternative in the Central Region (Alternative 4D1; see Figure 4).
- Non-structural measures for (elevation and floodproofing for 2,340 structures) and perimeter plan alternative in the Central Region (Alternative 4D2; see Figure 4).
- Non-structural (656 structures) and perimeter plan alternative in the South Region (Alternative 5D2; see Figure 5).

Note that non-structural measures consist of elevating or floodproofing already existing structures in previously developed areas. Therefore, the action area would primarily be defined by the direct and indirect effects of the storm surge barriers, bay closures, and perimeter plans assessed in this BA. Detailed alignments of the inlet closures, bay closures, and perimeter plans are presented in Appendix A.

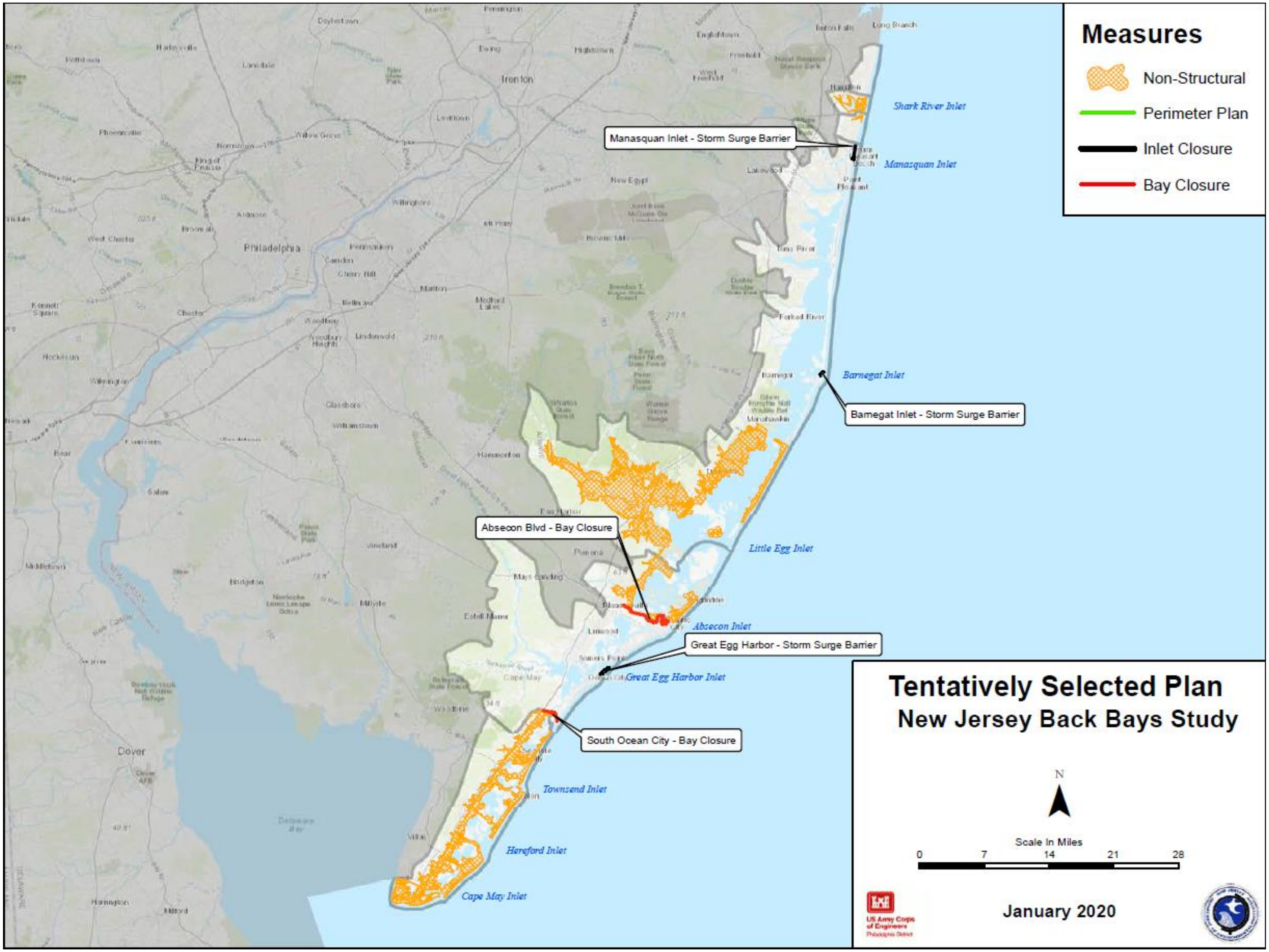
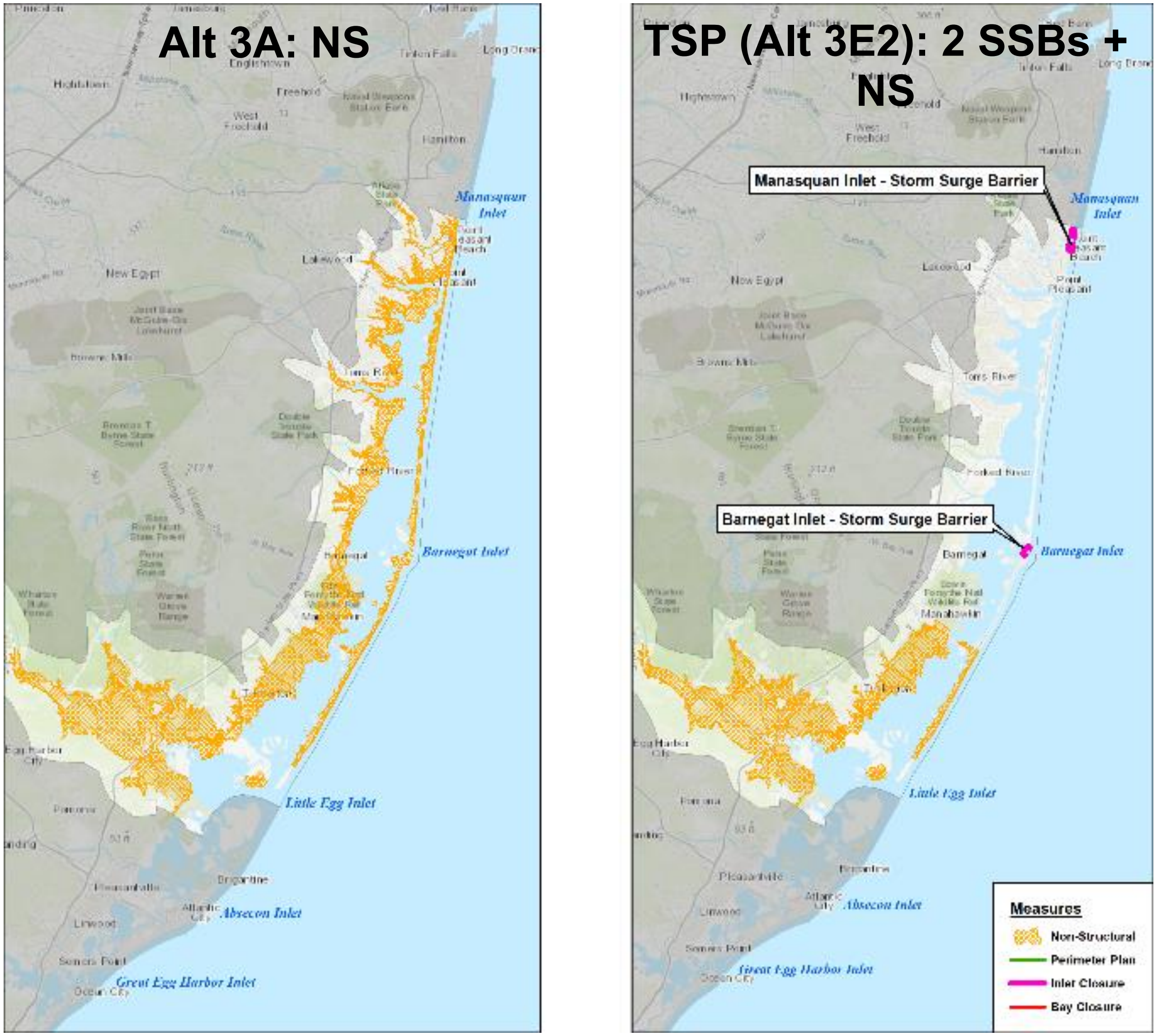
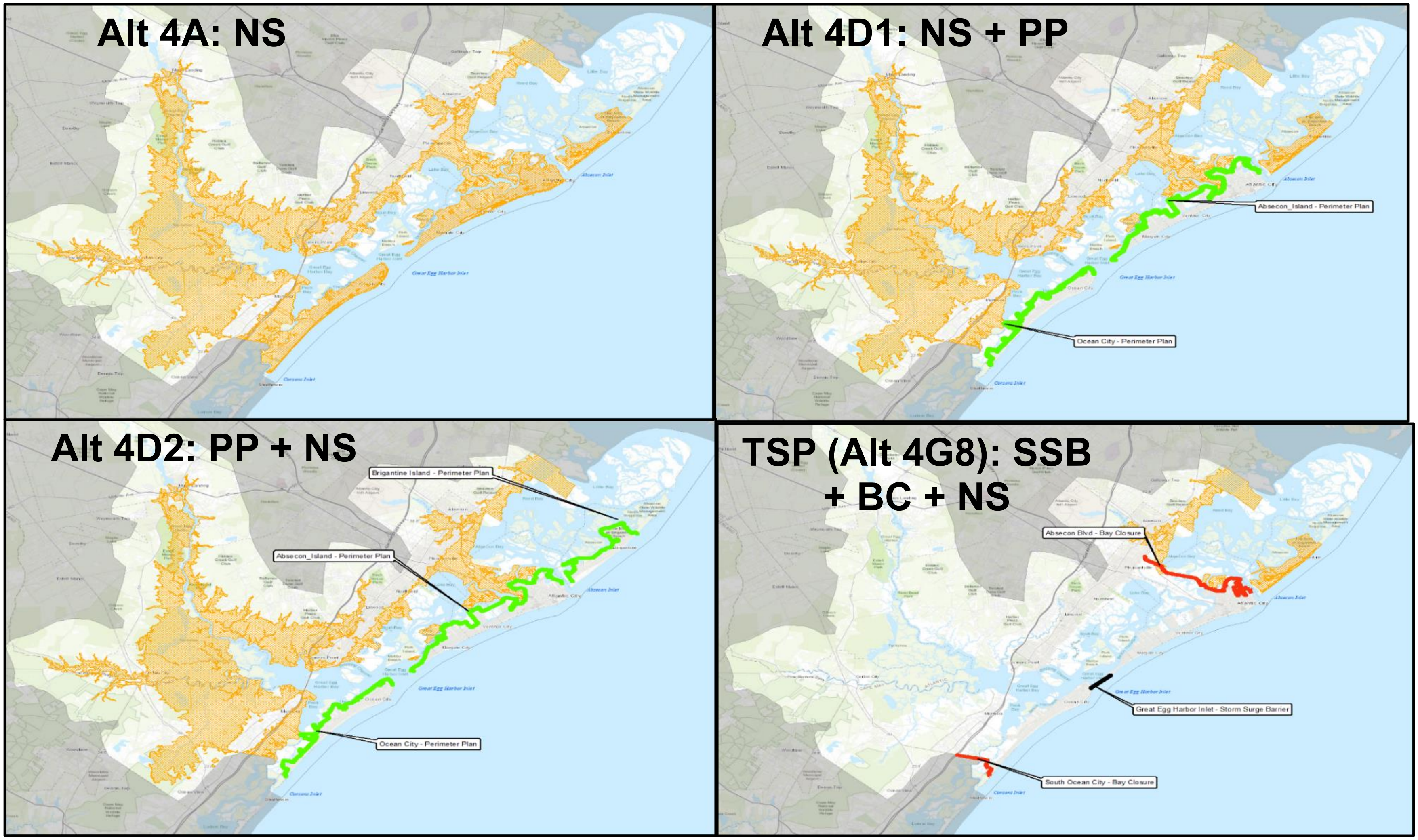


Figure 2. The TSP for the NJBB Study



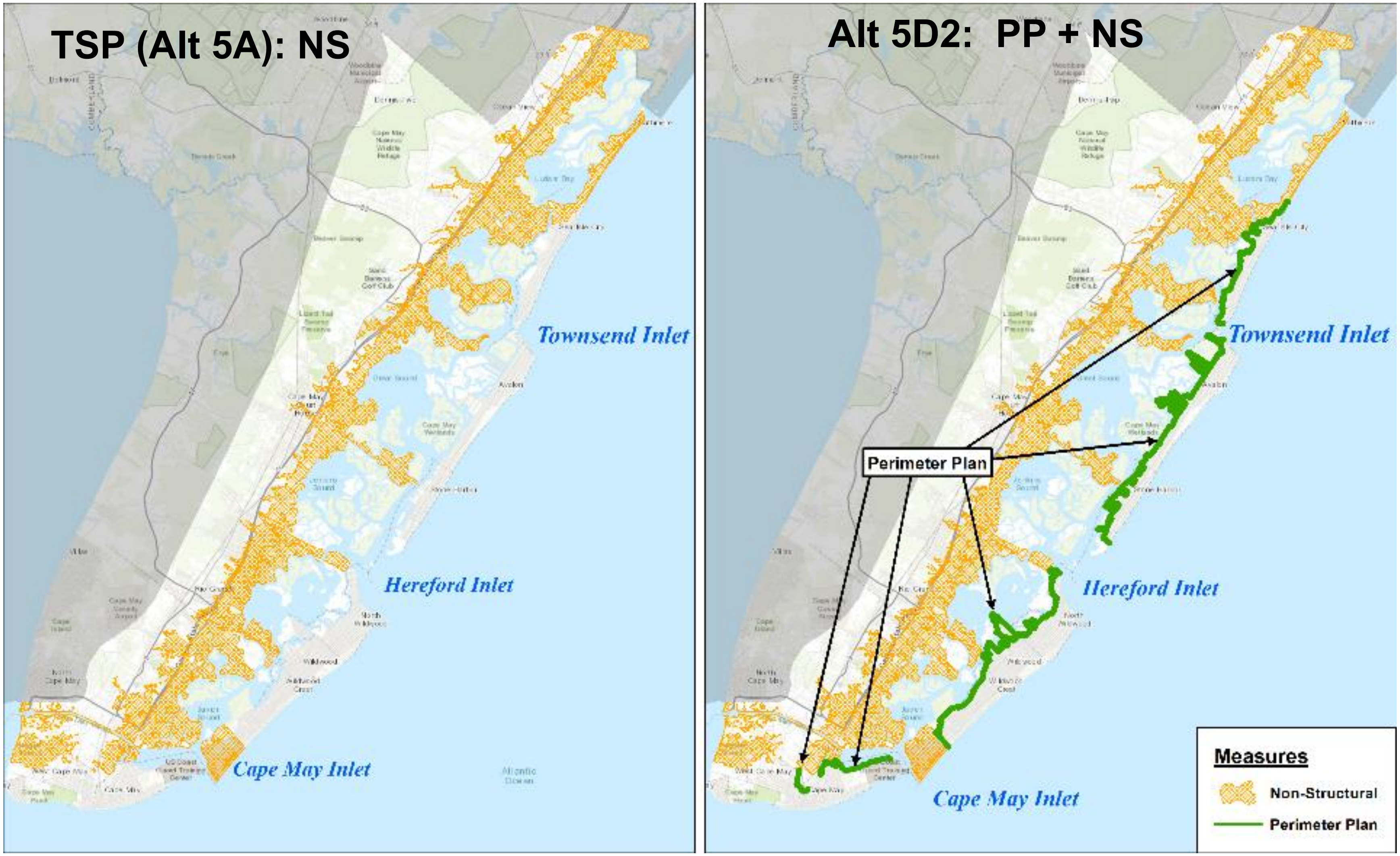
Notes: TSP = Tentatively Selected Plan; Alt = Alternative, NS = Nonstructural; SSB = Storm Surge Barrier

Figure 3. Comparison of the Non-Structural Alternative and the TSP in the North Region



Notes: TSP = Tentatively Selected Plan; Alt = Alternative, NS = Nonstructural; SSB = Storm Surge Barrier, PP = Perimeter Plan

Figure 4. Comparison of the Non-Structural and Perimeter Plan Alternatives and the TSP in the Central Region



Notes: TSP = Tentatively Selected Plan; Alt = Alternative, NS = Nonstructural; PP = Perimeter Plan

Figure 5. Comparison of the TSP and the Perimeter Plan and Nonstructural Alternative in the South Region

3.0 PROJECT DESCRIPTION

3.1 Storm Surge Barriers and Bay Closures

Three storm surge barriers at inlets (Manasquan Inlet, Barnegat Inlet, Great Egg Harbor Inlet) and two interior bay closure barriers across the bay (Absecon Blvd and Southern Ocean City) are included in the TSP. The selected storm surge barriers reduce storm surge from propagating into the bays from the ocean during storm events lowering flood elevations. The storm surge barriers across the bay (Bay Closures) reduce storm surge from propagating into Central Region from adjacent inlets (Absecon Inlet, Little Egg Inlet, and Corson's Inlet) that would remain open and unaltered in the TSP. Storm surge barriers span the inlet opening with a combination of static impermeable barriers and dynamic gates that are only closed during storm events. Each storm surge barrier includes a navigable gate (sector gate) to provide a navigable opening with unlimited vertical clearance and a series of auxiliary flow gates, vertical lift gates, to maintain tidal flow during non-storm conditions. An example of storm surge barrier at the Seabrook Flood Complex in New Orleans, LA which is constructed with a sector gate and vertical lift gates is shown in Figure 6. Detailed engineering drawings, layouts and cross-sections, for the storm surge barriers are included in Appendix B. Storm surge barrier gate types and alignments are considered tentative and may change in future phases of the study with more detailed engineer analyses and designs.

Navigable sector gates span the full width of the federal navigation channel with a 10-foot buffer on either side with opening spans ranging from 120 feet at the Bay Closures to 340 feet at Manasquan Inlet. Auxiliary flow gates have an opening span of 150 feet and are located along the storm surge barrier in water depths that are deemed constructible and practical. In shallow water, where vertical lift gates are impractical, shallow water gates (SWG) consisting of 24-foot x 8-foot box culverts with sluice gates are used. Bottom sill elevations for the navigable and auxiliary flow gates are designed at or near the existing bed elevations to promote tidal flow and are well below the federally authorized depths at the federal navigation channels.

Impermeable barriers are open water structures that flank the navigable and auxiliary flow gates to tie the barrier into high ground or existing CSRM features (i.e. dunes or seawalls). Site specific impermeable barrier types have not been selected at this stage of the study but will be further investigated as the study continues. Several of the storm surge barriers, particularly the bay closures, include levees, floodwalls, and seawalls along roads, shorelines, and low-lying areas to tie into high ground or existing CSRM features (i.e. dunes or seawalls). The crest elevation of the storm surge barriers are between 17 and 20 feet NAVD88. A summary of the storm surge barrier components is provided in Table 3.

Table 3. TSP – Storm Surge Barrier Components

Storm Surge Barrier	Navigable Gate	Auxiliary Flow Gates	Impermeable Barrier	Perimeter Barrier
Manasquan Inlet Inlet Closure	1 Sector Gate Length = 340 FT Crest Elev = 20 FT Sill Elev = -18.25 FT	None	None	Levee = 7,280 FT Seawall = 2,366 FT
Barnegat Inlet	1 Sector Gate	15 Vertical Lift Gates	Length = 798 FT	Floodwall = 897 FT
Inlet Closure	Length = 320 FT	Length = 150 FT each	Area = 18,365 SF	Seawall = 795 FT
	Crest Elev = 17 FT	Crest Elev = 17 FT		1 Road Closure Gate
	Sill Elev = -25 FT	Sill Elev = -5 to -11 FT		
		18 Shallow Water Gates		
		Length = 24 FT each		
		Crest Elev = 17 FT		
		Sill Elev = -4 FT		
Great Egg Inlet Inlet Closure	1 Sector Gate Length = 320 FT Crest Elev = 19 FT Sill Elev = -35 FT	19 Vertical Lift Gates Length = 150 FT each Crest Elev = 19 FT Sill Elev = -5 to -18 FT	Length = 863 FT Area = 20,716 SF	Levee = 974 FT Seawall = 1,275 FT
Absecon Blvd.	1 Sector Gate	4 Shallow Water Gates	Length = 869 FT	Levee = 27,524 FT
Bay Closure	Length = 120 FT	Length = 24 FT each	Area = 14,772 SF	Floodwall = 28,890 FT
	Crest Elev = 13 FT	Crest Elev = 13 FT		4 Road Closure Gates
	Sill Elev = -20 FT	Sill Elev = -2 FT		5 Mitre Gates
Southern Ocean City Bay Closure	1 Sector Gate Length = 120 FT Crest Elev = 13 FT Sill Elev = -10 FT	None	None	Levee = 9,467 FT Floodwall = 4,124 FT 1 Mitre Gate 1 Sluice Gate

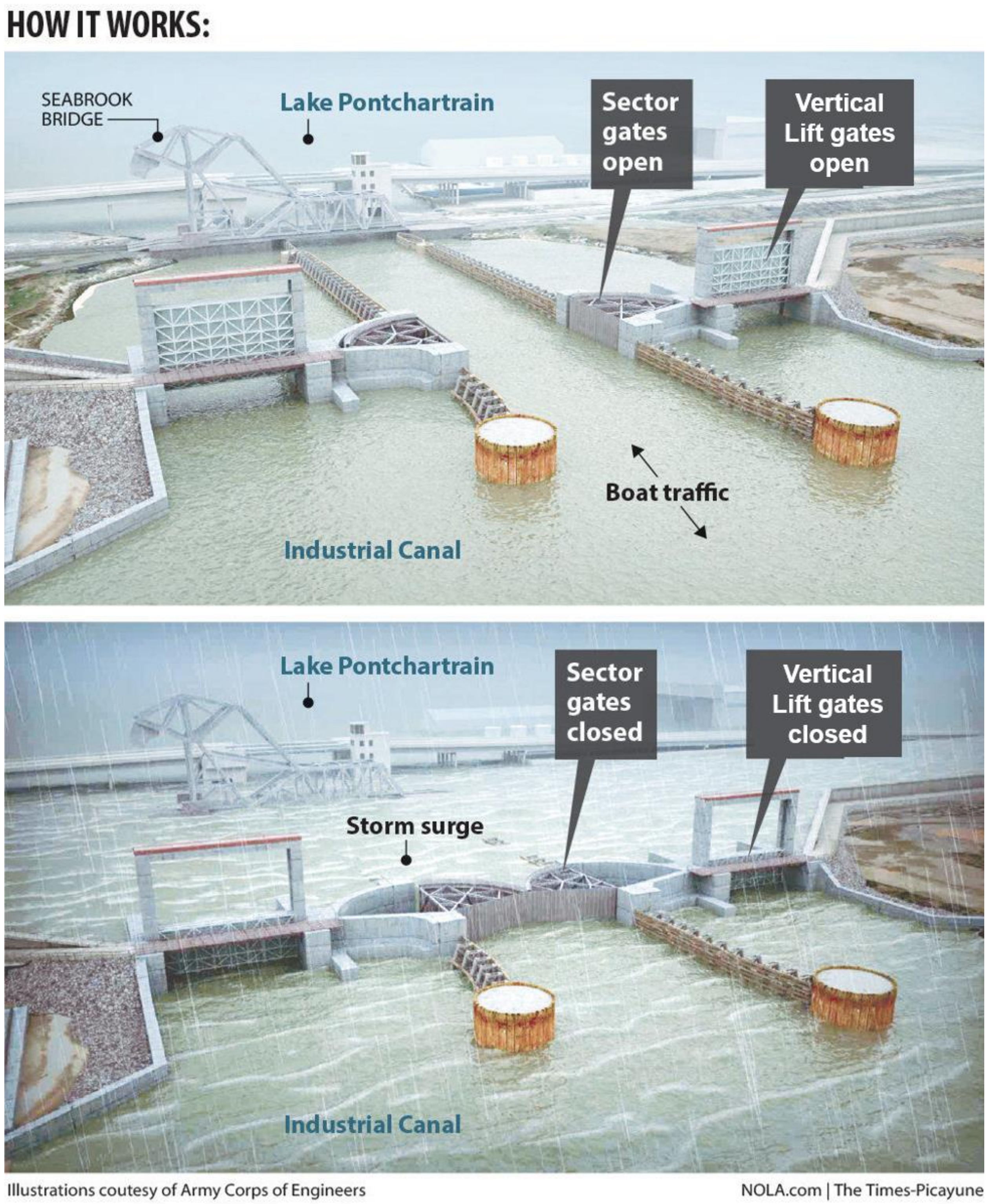


Figure 6. Example Storm Surge Barrier at Seabrook Flood Complex in New Orleans, LA

3.1.1 Pre-construction

Prior to construction investigations may include, wetland delineation, a subsurface geotechnical investigation, and HTRW sampling. These investigations are being developed.

3.1.2 Construction

In-water construction activities for the construction of storm surge barriers and bay closures include installation and removal of temporary cofferdams, temporary excavations, fill and rock placement, concrete work, and pile driving. On land construction activities include clearing, grading, excavations, backfilling, movement of construction equipment, concrete work, pile driving, and soil stockpiles.

3.1.3 Operation and Maintenance

The purpose of Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) is to sustain the constructed project. The most significant OMRR&R is associated with the Storm Surge Barriers. At this point of the study, it is estimated that storm surge barriers and bay closures would be closed for a 5-yr and higher storm surge event, with an average of one closure operation every five years. In the next phase of the study the storm surge barrier operations plan and closure criteria will be revaluated. OMRR&R for storm surge barriers typically include monthly startup of backup generators/systems, annual closure of surge barrier gates pre-hurricane season, dive inspections, gate adjustments/greasing, gate rehab and gate replacement.

3.2 Nonstructural Measures

The TSP includes Nonstructural solutions, elevating structures and floodproofing, in areas where the storm surge barriers will not significantly reduce flood elevations. These areas are concentrated in the Shark River region Ocean and Atlantic Counties (between Route 72 and Absecon Blvd.) and Cape May County. A total of 18,800 structures located within the 5% AEP floodplain (20-year return period) in these areas are targeted for nonstructural solutions under the TSP; this includes 135 structures in the Shark River Region; 8,869 structures in the North Region; 1,255 structures in the Central Region; and 8,579 structures in the South region.

In addition, to the TSP, two completely nonstructural options are still under consideration.

- Non-structural measures only (elevation and floodproofing for 23,152 structures) in the North Region (Alternative 3A; see Figure 2).
- Non-structural measures only alternative (elevation and floodproofing for 10,895 structures) in the Central Region (Alternative 4A; see Figure 3).

Additionally, the number of structures under consideration for nonstructural measure changes with the perimeter plan options considered.

3.2.1 Pre-construction

Prior to construction detailed investigation of the eligibility of individual structures for non-structural measures would be conducted.

3.2.2 Construction

Nonstructural measures involve a significant construction effort whether it be from building retrofits such as elevation (including raising a structure on fill or foundation elements such as solid perimeter walls, pier, posts, columns, or pilings) or buyout/ relocations that are likely to involve demolition, grading, and soil stabilization/revegetation. The majority of the construction would occur within the footprint of the existing structure and would most likely be in upland urbanized settings.

3.2.3 Operations and Maintenance

There is no operations and maintenance associated with non-structural solutions.

3.3 Perimeter Plans

The perimeter plan options that are still being considered in the Central and South regions include floodwalls and levees that would be constructed on the western side of the barrier islands along residential bayfronts and would tie into existing dunes at the northern and southern ends of the barrier islands. Figure 7, Figure 8, and Figure 9show typical sections which have been used in the perimeter plan design to date.

Options. The following are the perimeter plan options still under consideration. The number of structures under consideration for nonstructural measures is noted for each perimeter plan option.

- Non-structural measures for (elevation and floodproofing for 1,189 structures) and perimeter plan alternative in the Central Region (Alternative 4D1; see Figure 3).
- Non-structural measures for (elevation and floodproofing for 2,340 structures) and perimeter plan alternative in the Central Region (Alternative 4D2; see Figure 3).
- Non-structural (656 structures) and perimeter plan alternative in the South Region (Alternative 5D2; see Figure 4).

The location, length, and construction duration for the perimeter plans for these options are presented in Table 4.

Table 4. Location, Length, and Construction Duration for Perimeter Plan Options

ALTERNATIVE	LOCATION	BARRIER LENGTH (LF)	CONSTRUCTION DURATION (MONTHS)
4D1	Ocean City	78,732	89
	Absecon Is.	111,111	126
4D2	Ocean City	78,732	89
	Absecon Is.	111,111	126
	Brigantine	48,699	55
5D2	Cape May City	15,825	18
	Wildwood Is.	54,171	62
	West Wildwood	11,726	13
	Sea Isle City	35,167	40
	West Cape May	4,480	5

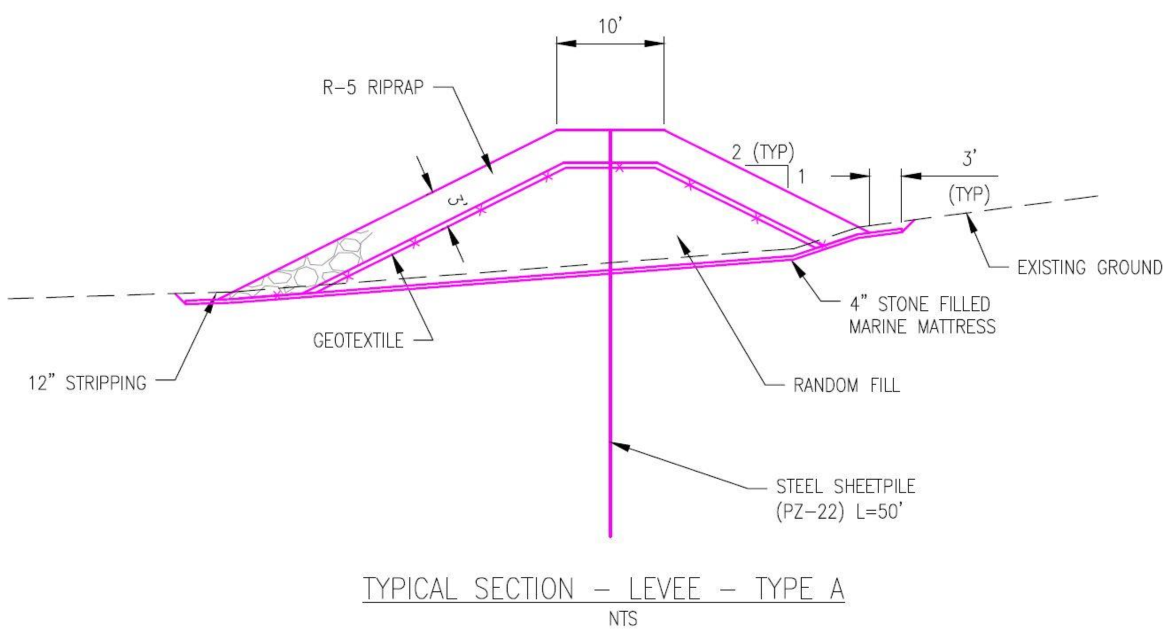


Figure 7. Typical Section – Levee – Type A

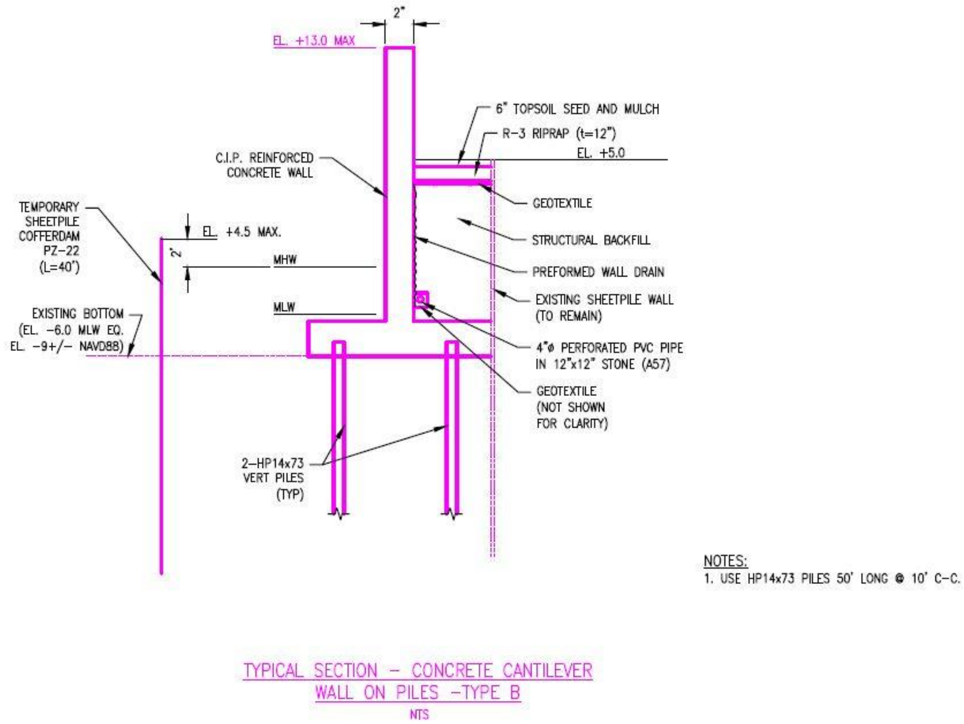


Figure 8. Typical Section – Concrete Cantilever Wall on Piles – Type B

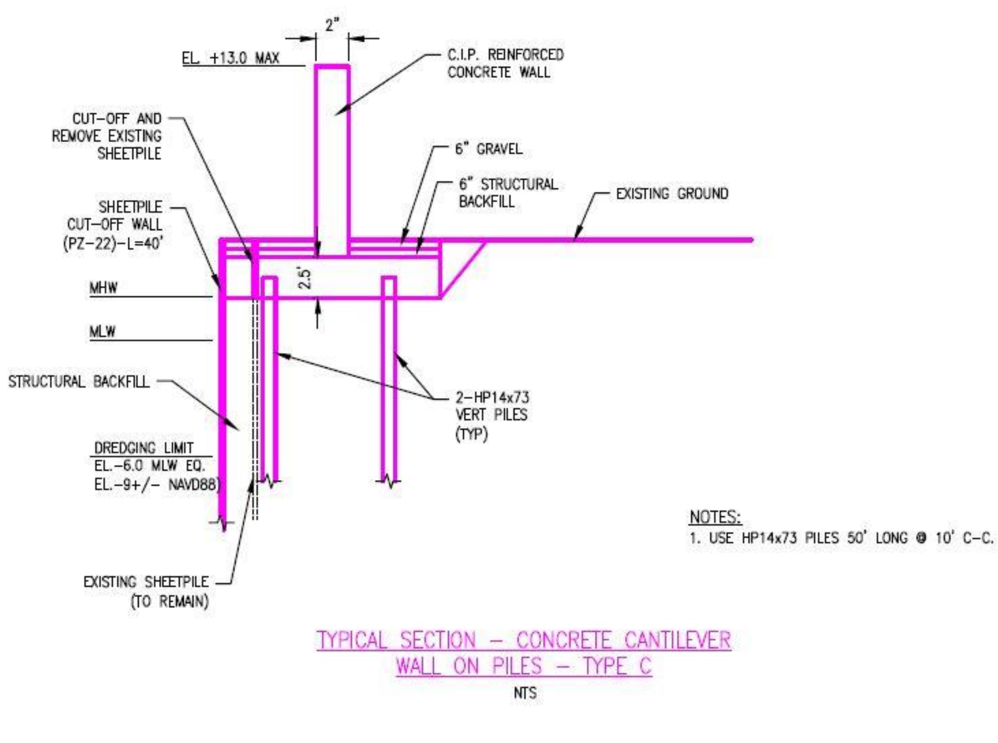


Figure 9. Typical Section – Concrete Cantilever Wall – Type C

3.3.1 Pre-construction

Prior to construction investigations may include, wetland delineation, a subsurface geotechnical investigation, and HTRW sampling. These investigations are being developed.

3.3.2 Construction

In-water construction activities for the construction of levee and floodwalls include installation and removal of temporary cofferdams, temporary excavations, fill and rock placement, concrete work, and pile driving. On land construction activities include clearing, grading, excavations, backfilling, movement of construction equipment, concrete work, pile driving, and soil stockpiles.

3.3.3 Operation and Maintenance

As part of the perimeter plan, miter gates will be installed and operated across smaller channels that require navigable access. These gates would remain open during normal conditions and would be closed during significant storm events. Regular maintenance is performed on the gates to keep the system running as designed.

3.4 Natural and Nature Based Features (NNBF)

An initial suite of NNBF opportunities for integration into the TSP are identified in this section for each of the NJBB Regions. NNBF opportunities are demonstrated in maps outlining location specific concepts. The features shown on the map are drawn to locate the general area an NNBF might be considered and are not representative of a specific design. Because these features are highly conceptual at this time, they would require subsequent rigorous site identification and planning, construction methods, impact assessments, and implementation schedules/plans. Because these features would require significant amounts of fill material, consideration would first be given to beneficial use of dredging sources and potential sources within existing dredged material confined disposal facilities (CDFs). These considerations will continue throughout the Feasibility Study Phase and into the Engineering and Design Phase as part of the Tier 2 EIS. A complete discussion of the entire range of NNBF strategies considered can be found in the Natural and Nature-Based Features Appendix G inclusive of key design concepts which are documented in Parts II and III of that Appendix.

3.4.1 Shark River and Coastal Lakes Region

Within the Coastal Lakes Region, due to the highly variable conditions of the various lakes, very few generalizable NNBF responses are possible within this region (Figure xx). The reduction of flood risk is something that must be considered on a lake-by-lake basis. However, the opportunity of terracing or lining lakes with vegetation that could serve as stormwater filters, habitat, and increased recreational amenities is one overall strategy that may be applicable. Other possibilities include the creation of islands within the river itself in order to reduce storm effects to the surrounding coastlines.

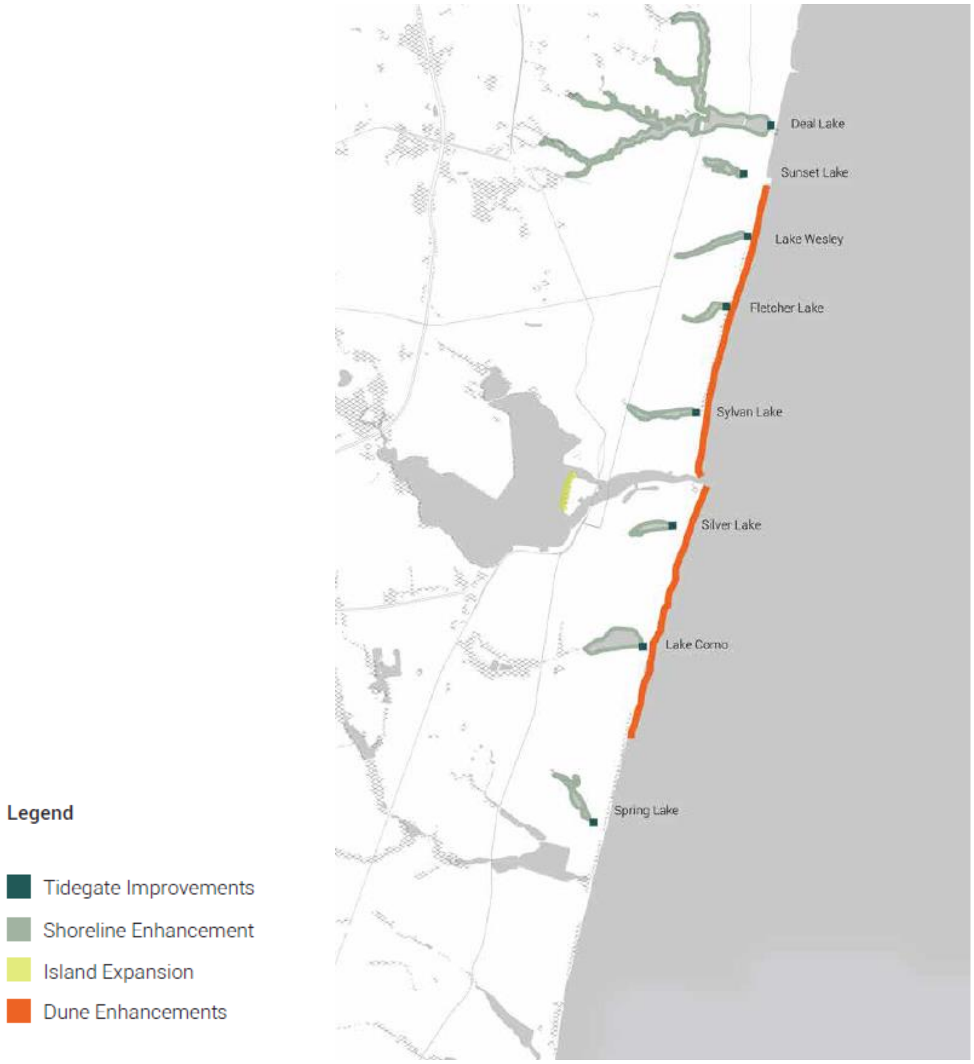


Figure 10. NNBFs within the Shark River/Coastal Lakes Region

3.4.2 North Region

As the largest region of the study, and a collection of somewhat similar conditions throughout the region, the North Region provides the opportunity to study a series of strategies that could be repeatedly deployed at large scale, calibrated to specific conditions. For this report, Barnegat Bay is used as an example for this approach, demonstrating the range of NNBF strategies that could be used at a bay-wide scale to address some of the more ubiquitous conditions there (Figure 101). Since the Holgate cross-bay barrier and the Little Egg-Brigantine Storm Surge Barrier are not included in the TSP, importance is placed on the performance of the Tuckerton Peninsula/Great Bay Boulevard wetland complex and the system of sedge islands to the northeast of the peninsula. Two possible NNBFs are included in this area, including possibilities for the Tuckerton Peninsula and the modifications of the sedge islands to enhance their performance as a surge filter.

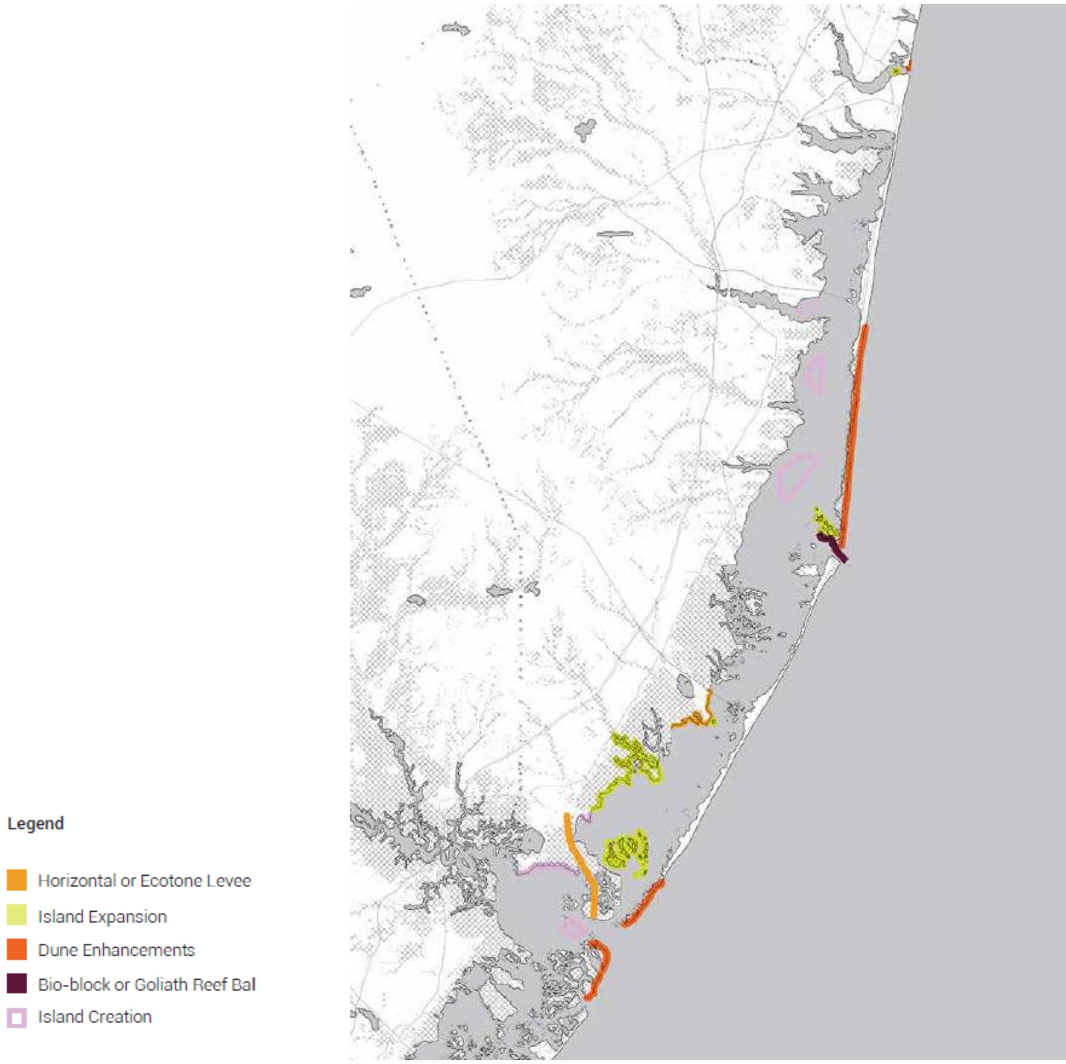


Figure 11. NNBFs within the North Region

3.4.3 Central Region

One of the significant challenges of the Central Region is the flooding of urban areas from the bay during periods of high water. In addition to the aforementioned SSB and bay closures, there is likely to be some consideration of flood wall or levee construction to protect urban populations on the barrier islands (Figure 102). Horizontal levee opportunities exist in Ocean City. Many previously wetland creation and bayfloor shallowing opportunities exist in this region particularly in and around Reed's Bay given inclusion of the Absecon cross-bay barrier in the TSP.

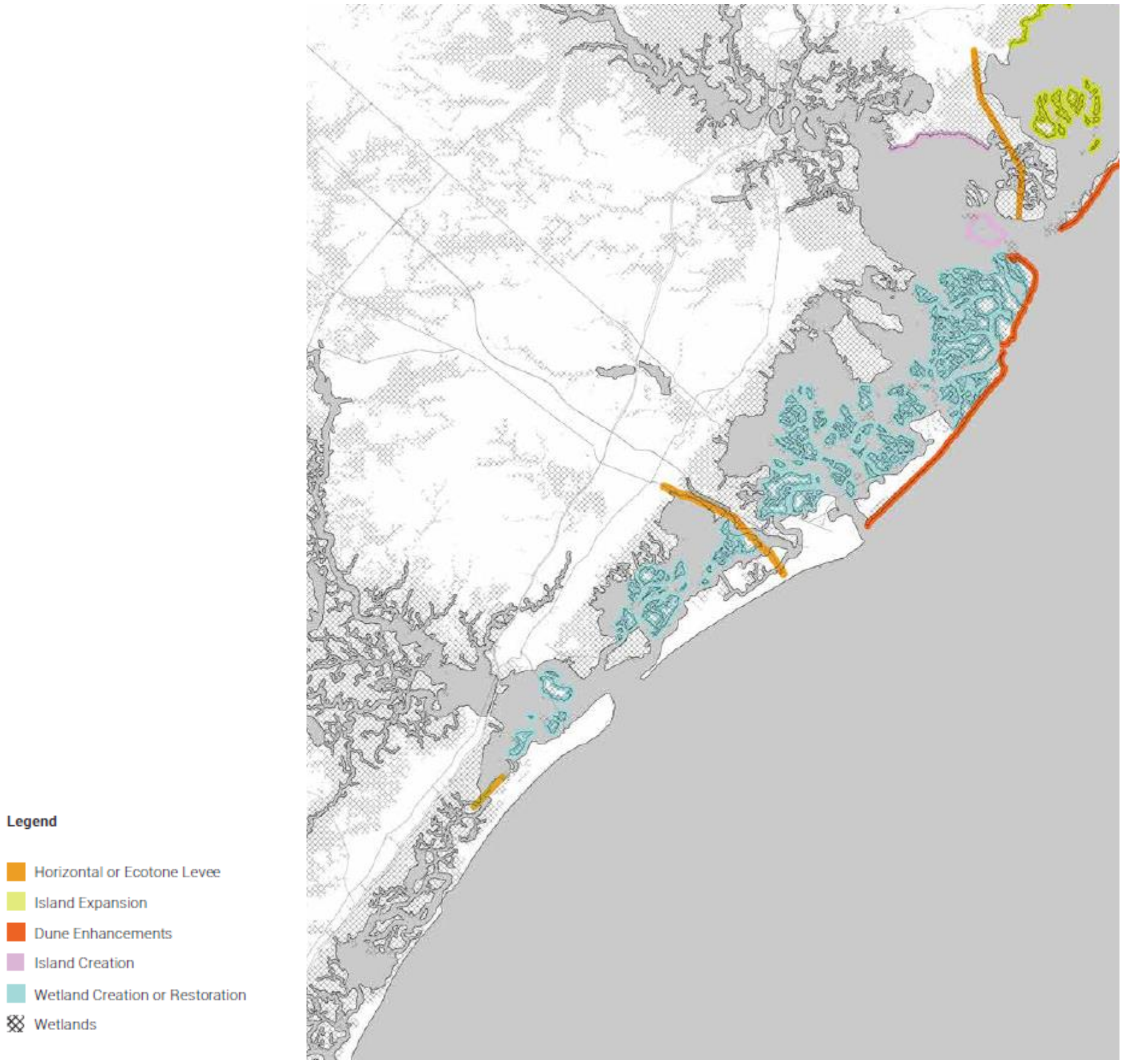


Figure 12. NNBFs within the Central Region

3.4.4 South Region

Due to the infeasibility of structural CSRM measures in the TSP in the South Region, this region will likely require significant investments to enhance wetlands to complement nonstructural strategies in order to provide enhanced storm protection (Figure 103). NNBFs similar to those described for Ocean City above or the wetland enhancement projects described elsewhere in this section may be applicable to the South Region. Dune enhancement and beach nourishment is also possible in this region as a method of protecting barrier island communities. An additional opportunity is the Seven Mile Island Innovation Lab which is a collaborative project between the USACE, the Wetlands Institute, and the State of New Jersey. It is developing innovative methods of sediment management that have significant potential to contribute to CSRM.

Figure 13. NNBFs within the South Region

3.4.5 Pre-construction

Prior to construction investigations may include, wetland delineation, a subsurface geotechnical investigation, and HTRW sampling. These investigations are being developed.

3.4.6 Construction

In-water construction activities for the construction of NNBF include installation and removal of temporary cofferdams, temporary excavations, dredging and filling and rock placement, and wetland/upland vegetation planting. On land construction activities include clearing, grading, excavations, backfilling, movement of construction equipment, and temporary roads.

3.4.7 Operation and Maintenance

As part of the perimeter plan, miter gates will be installed and operated across smaller channels that require navigable access. These gates would remain open during normal conditions and would be closed during significant storm events. Regular maintenance is performed on the gates to keep the system running as designed.

3.5 Measures to Avoid and Minimize Effects on Listed species

The following examples of measures that would be implemented, to the maximum extent practicable, to avoid effects on threatened and endangered species.

<u>Birds</u>

- Avoid construction of storm surge barriers and bay closures outside of the plover nesting season (April 1 - August 15). If construction activities during the nesting season cannot be avoided (due to monetary issues, quantity of sand required, weather constraints, etc.) the District would attempt to survey for nests and mark avoidance buffers around them and schedule activities in such a way as to avoid areas within the action area with active nests until nesting is complete.
- Avoid construction in marshes during black rail nesting and breeding season (April 1 – Aug 15). If construction activities during the nesting season cannot be avoided (due to monetary issues, quantity of sand required, weather constraints, etc.) the District would attempt to survey for nests and mark avoidance buffers around them and schedule activities in such a way as to avoid areas within the action area with active nests until nesting is complete.

<u>Seabeach Amaranth</u>

- Avoid construction in seabeach amaranth habitat during the growing season (April through September), to the maximum extent practicable. If construction in seabeach habitat can not be avoided during the growing season, conduct surveys in the appropriate habitat for seabeach amaranth would be conducted prior to construction during the growing season. USFWS would be consulted if seabeach amaranth is identified. Seabeach amaranth dies back in September and is no longer in a form that is easily impacted.

<u>Sea Turtles and Marine Mammals</u>

- Develop a protected marine species monitoring and shut down plan.
- Use a mechanical dredge rather than a pipeline or hopper dredge.
- For pile driving, use a vibratory hammer instead of an impact hammer, to the maximum extent practicable.
- Use cushion blocks or other noise attenuation devices when using an impact hammer for pile driving.
- Limit pile driving activities to no more than 12 hours per day.
- Use a “soft start” for a pile driving activities where driving does not occur at full power at first.

- Pile driving should be carried out in a way that avoids exceeding noise thresholds identified for the protected marine species that occur in the action area.
- Shallow draft vessels that maximize the navigational clearance between the vessel and the river bottom should be used where possible.
- Vessels should operate at speeds of less than 10 knots. Whenever operating in areas where whales or sea turtles are present, a look out should be posted and measures taken to slow down and avoid any whales or sea turtles spotted.

4.0 STATUS OF LISTED SPECIES

4.1 Piping plover

The Atlantic Coast population of piping plovers was designated as federally threatened on 10 January 1986 (Federal Register; 11 December 1985). This species is listed as endangered by the state of New Jersey. Primary threats to piping plovers include disturbance from humans and pets, predation, and habitat modification.

4.1.1 Range and Habitat

The Atlantic Coast population breeds and nests on sandy beaches along the east coast of North America from Newfoundland to South Carolina. Piping plovers typically nest above the high tide line along ocean shorelines, along gently-sloping foredunes, in blowout areas behind primary dunes, overwash fans and sandflats at inlets or ends of barrier islands, and in washover areas caused by the flow of water moving across the storm berm. Preferred foraging areas include intertidal zones along ocean beaches, washover areas that remain moist throughout the summer, mud and sandflats, wrack lines, and shorelines of ponds and saltmarshes (USFWS, 1995a).

Adults and chicks feed on small crustaceans, mollusks, marine worms, insects, insect larvae, and other invertebrates. They forage in the intertidal zone of bays and inlets and on oceanfront sand beaches, mud flats, and tidal wrack deposits. Most feeding occurs at low or falling tides during the daytime.

4.1.2 Presence within the Study Area

Piping plovers are present on New Jersey beaches generally between March 15 and August 31, during the breeding season (USFWS NJFO, 2019). Males begin to establish territories in open or sparsely vegetated areas on the upper beach by early April. Egg laying generally commences in late April, and eggs may be present on the beach from mid-April to late July. Shortly after hatching, the young leave the nest and begin foraging. Southward migration to the wintering grounds extends from late July through August and September, but plovers are occasionally sighted during October (USFWS, 1995a).

Nests are shallow scraped depressions, sometimes lined with small pebbles, shells, or other debris (USFWS, 1985). On average, eggs are 1.3 x 1.2 inches in diameter and are laid daily. A typical clutch usually has four eggs (USFWS 1995a). Eggs are usually incubated by males and females and usually in 27-28 days (occasionally as long as 31 days). Young birds can leave the nest within a few hours, and can fly at 30-35 days (Wilcox, 1959).

One brood a season is average, but frequent clutch failures due to predators and storms provide opportunities for birds to change mates within the breeding season. Piping plovers are known to exhibit high mate-retention within the nesting season, but do not typically retain the same mate between years, even if both birds return the following year (Haig and Oring, 1988, MacIvor, 1990). If the eggs or nest are destroyed during their initial attempt, the same pair will often rebuild another during the same season usually within 100-200 feet from the first. Wilcox found most pairs did not remain mated together beyond the first year; but that those that did had a much greater tendency to return closer to the previous year's nest (average nest distance of 204 feet between the two years, with a maximum of 1,150 feet) than those birds that chose a new partner (average nest distance of788 feet between the two years, with a maximum of 8,600 feet for males, and a much greater separation of up to 82,363 feet for females).

In 2019, 114 pairs of piping plovers nested in New Jersey in 2019, a 19% increase compared to 2018 (96 pairs, the third lowest since federal listing in 1986). The 2019 population is slightly below the long-term average (117 pairs) and well below the peak of 144 pairs in 2003. State-wide productivity (1.24 fledglings/pair) remained above the long-term average (1.03 fledglings/pair) for the sixth consecutive season but falls short of the federal recovery goal (1.50 fledglings/pair) and below last season's record high productivity (1.51 fledglings/pair) (Heiser and Davis 2020). The NJBB Study Area accounts for approximately half of the nesting pairs of piping plovers in in New Jersey (Heiser and Davis 2020).

4.2 Eastern Black Rail

The subspecies, eastern black rail (*Laterallus jamaicensis jamaicensis*) was was listed as Federally-threatened in October 2020. The species black rail (*Laterallus jamaicensis)* is listed as endangered by the state of New Jersey. Threats for eastern black rail include habitat fragmentation, altered hydrology, effects of climate change and sea level rise, disease, altered food webs, and oil and chemical spills, as well as other environmental contaminants.

4.2.1 Range and Habitat

The eastern black rail occupies portions of the eastern United States (east of the Rocky Mountains), Mexico, Central America, the Caribbean, and occasionally in Brazil. In the United States, eastern black rails primarily from coastal sites, but can also be found in inland areas. The eastern black rail has been historically present during breeding months from Virginia to Massachusetts, with 70 percent of historical observations (773 records from 1836 to 2010) in Maryland, Delaware, and New Jersey (Watts 2016).

The eastern black rail can typically be found in salt and brackish marshes with dense cover but can also be found in upland areas of these marshes. The habitat can be tidally or non-tidally influenced, and with a wide range in salinity (salt to brackish to fresh), tidal range, and tidal volume (USFWS 2020).

4.2.2 Presence within the Study Area

New Jersey has the largest number and longest running record of black rail observations of any state throughout the species' range. Black rails have been detected during the breeding period (spring and summer) within ten New Jersey counties between the early 1800s and 2016. Breeding has been confirmed in seven counties including Ocean, Atlantic, Cape May, Burlington, Cumberland, Sussex and Mercer (Watts 2016). Within the study area, more than 100 black rail nests were collected from back island marshes including Long Beach, Little Island Beach, Brigantine Island, Ludlam's Beach (Sea Isle City), Seven Mile Beach (Stone Harbor) and Atlantic City between 1910 and 1940. More than 20 nests and 20 individuals were collected in the "Tuckerton Marshes" which now comprise Edwin B. Forsythe National Wildlife Refuge. The only reports of black rails from barrier islands were from 1946 through 1964 in the Holgate Marsh on the south end of Long Beach Island. The last nest was reported in 1955 and the last individual was reported in 1964. More recently, black rails have been observed within sound and mainland marshes in Ocean, Atlantic and Cape May counties. This includes three birds recorded at the Ocean County portion of Forsythe National Wildlife refuge in 1988; 50 birds recorded in the Manahawkin Wildlife Management Area in 1975, but these numbers declined to a smaller number by 1986; 3 birds were reported from Tuckahoe Wildilfe Management Area in 1988; and one reported from Tuckahoe Wildilfe Management Area in 2009 (Watts 2016). Recent (after 2011) black rail occurrences are listed as probable for Cape May and Ocean counties (Watts 2016).

4.3 Roseate Tern

The northeastern breeding population of the roseate tern was designated as endangered in Northeastern North America in the Federal Register on 2 November 1987. This species is listed as endangered by the state of New Jersey. Threats to roseate terns include habitat loss, climate change, collisions, and predation.

4.3.1 Range and Habitat

The roseate tern is a coastal species that occurs in both temperate and tropical areas throughout the world. The North Atlantic breeding population is located from Nova Scotia to Long Island, New York, with historic nesting records south to Virginia (USFWS 1998).

Roseate tern is nest on barrier islands and salt marshes and forage over shallow coastal waters, inlets, and offshore seas. Nesting colonies are located above the high-tide line, often within vegetated dunes. Roseate terns do not currently nest in New Jersey and typically nest at sites with more vegetative cover than the terns that nest in New Jersey (USFWS 1998).

4.3.2 Presence within the Study Area

Roseate terns are considered rare spring migrants (May to mid-June), extremely rare summer transients, and very rare fall migrants (late August to early September). They have been recently recorded in the study area in Cape May, Avalon, Corson’s Inlet, Holgate, and Sedge Island. Nesting is considered extirpated from New Jersey, with the last breeding pair in New Jersey was documented in 1980. Nesting pairs of roseate terns were documented in New Jersey in the 1970s at Little Egg Inlet, Brigantine, Sandy Hook, Holgate, and Barnegat Bay (CWFNJ 2020).

4.4 Red Knot

The red knot was listed as threatened under ESA on 12 January 2015 (Federal Register, 11 December 2014). Threats to red knot include beach stabilization (beach armoring, sand fences, sea walls, groins, jetties, and riprap); habitat loss; and intensive recreational use (USFWS pers. com.).

4.4.1 Range and Habitat

Red knots fly up to 9,300 miles from south to north every spring and reverse the trip every autumn, making the red knot one of the longest-distance migrating animals. Migrating birds break their spring migration into non-stop segments of 1,500 miles or more, ending at stopover sites called staging areas.

Red knots winter at the southern tip of South America, northern Brazil, the Caribbean, and the southeastern and Gulf coasts of the U.S. and breed in the tundra of the central Canadian Arctic (USFWS 2019).

Red knots prefer unimproved tidal inlets for nonbreeding habitat. Dynamic and ephemeral (lasting only briefly) features are important red knot habitats along the Atlantic Coast; these include sand spits, islets, shoals, and sandbars, features often associated with inlets. Red knots are found in significantly higher numbers at inlets than at other coastal sites from South Carolina to Florida, (CWFNJ 2020).

4.4.2 Presence within the Study Area

Small numbers of red knots may occur in New Jersey year-round, while large numbers of birds rely on New Jersey's coast for stopover habitats during the spring (mid-May through early June) and fall (late-July through November) migration periods (USFWS 2019). Smaller numbers of knots may spend all or part of the winter in New Jersey. During the fall migration, the red knot typically spends time foraging and resting within and above the intertidal zone.

Red knots have been observed in Holgate, Little Beach, and nearby State managed lands (i.e., Island Beach State Park, Barnegat Lighthouse State Park, North Brigantine Natural Area, Malibu Beach Wildlife Management Area, Corson's Inlet State Park, Strathmere Natural Area, Cape May Point State Park) (USFW pers. com.). During the fall migration, red knots have concentrated in the study area at the northern tip of Corson's Inlet and from Prescott Terrace in Strathmere south to the northern tip of Sea Isle City, utilizing beaches, back bays, and marshes for foraging and roosting (USFWS pers. com.).

In 2014, the US Army Corps of Engineers (Corps) contracted a red knot survey along the coast of New Jersey to aid in identifying areas frequented by red knots during the fall migration. A total of 31 one-mile transects were surveyed over 7 survey events from September to November of 2014. Only 20 red knots were observed during the surveys and those birds were only found in 3 transects. The survey report concluded that, overall, the results of the 2014 surveys indicated a low usage of red knots at beach nourishment projects during the survey period (late September to late November). None of the transect surveys identified high concentrations of red knots using any part of beach nourishment projects as a focal point for foraging, roosting, or migration during the survey period.

4.5 Seabeach amaranth

Seabeach amaranth was designated as federally threatened on May 7, 1993 (Federal Register; April 22, 1993). Threats to seabeach amaranth include habitat stabilization, off-road beach vehicle use, mechanical beach raking, and herbivory.

4.5.1 Range and Habitat

Seabeach amaranth is an annual plant endemic to the barrier island beaches of the Atlantic coast. The species occurs on coastal beaches from New York to South Carolina and has historically occurred in Rhode Island and Massachusetts.

Primary habitat for seabeach amaranth consists of overwash flats at accreting ends of islands, lower foredunes, and upper strands of non-eroding beaches. Higher densities of this plant are generally encountered along island-end flats and inlet edges as opposed to beaches (USFWS, 1995b). This species prefers temporary habitats and does not occur on well-vegetated beaches. It sometimes establishes small temporary populations in other areas, including bay-side beaches, blow- outs in foredunes, and beach nourishment material. According to Weakley and Bucher (1992), "Seabeach amaranth appears to need extensive areas of barrier island beaches and inlets, functioning in a relatively natural and dynamic manner. This allows it (seabeach amaranth) to move around in the landscape, as a fugitive species, to occupy suitable habitat as it becomes available."

Seabeach amaranth occupies elevations from 8 inches to 5 feet above mean high tide and is usually found growing on nearly pure silica sand substrates, occasionally with a few shell fragments. Seabeach amaranth occupies a lower topographic position on beaches than any other plant, although several others, such as saltwort (*Salsola australis*) and sea rocket (*Cakile edentula*), occur with amaranth.

Seabeach amaranth is an annual plant that germinates from April to July. Upon germinating, the plant becomes a small unbranched sprig, but quickly branches into a clump consisting of 5-20 branches. The stems are fleshy and pink-red with small rounded leaves approximately 0.8 inches in diameter. The leaves are found at the tip of the stem and usually a spinach-green color with a small notch at the rounded tip. Flowering begins as early as June, but more typically starting in July and continues until September, when the plant dies. Seed production begins in late summer and continues until the death of the plant. Seeds are regularly produced by nearly all adult plants and seed fertility is assumed to be high. Under favorable conditions (without extreme weather events or webworm predation), the reproductive season may extend until January, or even later in the south (Weakley and Bucher, 1992). The presence of plants in any given year is evidence of reproduction in the former year, or even earlier reproduction and seedbanking. Ehrenfeld (1990) indicates that seed-banking in dune soils is almost nonexistent, likely due to the instability of the soil. Continual disturbance through deposition and erosion could either bury seeds too deeply for emergence or remove them entirely. Based on the morphology of the flower and inflorescence, seabeach amaranth is likely wind pollinated.

Seed dispersal is one of the most important characteristics of the biology of annual plants such as seabeach amaranth. Lincoln *et al.* (1982) describes the species as a classic example of a fugitive species, "an inferior competitor which is always excluded locally under interspecific competition, but which persists in newly disturbed habitats by virtue of its high dispersal ability: a species of temporary habitats."

Seabeach amaranth habitat requirements are very similar to those of piping plovers. Just like plovers, its habitat is maintained by overwash actions, which prevent establishment of competing vegetation, yet hurricane flooding generally curtails seed production and may locally eliminate seabeach amaranth populations.

4.5.2 Presence within the Study Area

Seabeach amaranth occurs in Monmouth, Ocean, Atlantic, and Cape May counties in New Jersey. Seabeach amaranth was absent from New Jersey from 1913 until 2000 when it was discovered during a piping plover survey. A total of 919 plants were recorded from Monmouth Beach to Sandy Hook, outside the action area. In 2001, 5,813 plants were recorded in all four coastal counties (NJDEP 2002). In 2018, NJDEP documented 1,053 plants which is a 91 percent increase from 2017, when 550 plants were counted. The 2018 count included 647 plants documented in Monmouth County, 404 plants in Ocean County, and one plant each in Atlantic and Cape May Counties (NJDEP 2020).

4.6 Northern Longeared Bat

The northern long-eared bat as threatened by the USFWS on 16 February 2016 (Federal Register, 14 January 2016). The primary threat to this species is the disease white-nose syndrome.

4.6.1 Range and Habitat

The northern long-eared bat occurs in the midwest and northeast of the United States, and all Canadian provinces west to the southern Yukon Territory and eastern British Columbia.

During the summer, NLEB typically roost singly or in colonies underneath bark, crevices, or hollows of both live and dead trees and/or snags (typically ≥ 3 inches diameter at breast height [dbh]). The NLEB bat is opportunistic in selecting roosts, selecting varying roost tree species throughout its range. During the winter, NLEBs predominately hibernate in caves and abandoned mine portals. Maternity colonies generally consist of 30 to 60 females and young. Males and non-reproductive females may occur within the breeding and foraging range of maternity colonies, but some individuals are solitary in the summer and may roost in cooler places such as caves and mines. Roosting NLEBs have also been observed in man-made structures, such as buildings, barns, sheds, cabins, under eaves of buildings, and in bat houses (USFWS pers. com.).

4.6.2 Presence within the Study Area

The proposed Study Area is located within the summer range of the northern long-eared bat. Known maternity roosts and roosts trees within municipalities in the study area in Ocean and Atlantic counties are presented in Table 5 (USFWS 2017). No roost trees or maternity roosts have been identified in Cape May County.

Table 5. Known maternity roosts and roosts trees within municipalities in the study area in Ocean and Atlantic counties

County	Municipality	Type of Roost
Atlantic	Absecon City	Maternity
Atlantic	Egg Harbor Township*	Maternity/Known Roost Trees
Atlantic	Galloway Township	Maternity
Atlantic	Hamilton Township	Maternity
Atlantic	Hammonton Town	Maternity
Atlantic	Pleasantville City	Maternity
Atlantic	Port Republic City	Maternity
Ocean	Barnegat Township	Maternity
Ocean	Eagleswood Township	Maternity
Ocean	Jackson Township	Maternity
Ocean	Lakehurst Borough	Maternity
Ocean	Little Egg Harbor Township	Maternity
Ocean	Long Beach Township	Maternity
Ocean	Manchester Township	Maternity
Ocean	Ocean Township	Maternity
Ocean	Plumsted Township	Maternity
Ocean	Stafford Township	Maternity
Ocean	Surf City Borough	Maternity
Ocean	Tuckerton Borough	Maternity

Source: USFWS 2017

4.7 North Atlantic right Whale

The North Atlantic right whale (*Eubalaena glacialis*) has been listed as endangered since the passage of the ESA in 1973. This species is also listed as endangered by the State of New Jersey. While critical habitat is designated for this species, it does not occur within the action area. Two critical habitat areas have been designated for this species (Federal Register, 27 January 2016):

- Off the coast of New England (foraging area).
- Off the southeast U.S. coast from Cape Fear, North Carolina, to below Cape Canaveral, Florida (calving area).

These are outside of the action area.

Threats to the North Atlantic right whale include entanglement in fishing lines attached to gillnets and traps, vessel strikes, and ocean noise.

4.7.1 Range and Habitat

North Atlantic right whales primarily occur in Atlantic coastal waters, close to the continental shelf break, with some movements over deeper waters. Right whales feed and mate in waters off New England and the Canadian Maritimes in the spring, summer and early fall. In the fall, they migrate to the winter calving grounds in the shallow coastal waters off of South Carolina, Georgia, and northeastern Florida (NMFS 2020).

4.7.2 Presence within the Study Area

Not a lot is known about right whales' use of New Jersey coastal water; it is hypothesized that they only use New Jersey waters as a migratory pathway between the southern winter breeding grounds and the summer feeding grounds in the north, but are not spending a significant time in the area. This was supported by aerial shipboard marine mammal surveys conducted in 2008 and 2009 in New Jersey from Seaside Park to Stone Harbor from the barrier islands and extending 37 kilometers offshore (Geo-Marine 2010). While sightings in this study area sightings, they were observed within 32 km (17 NM) from shore. Right whales were acoustically detected off New Jersey during all seasons, with a peak in March through June (Geo-Marine 2010).

4.8 Fin Whale

Fin whales have been listed as endangered since the passage of the ESA in 1973.

Threats to the fin whales include entanglement in fishing lines attached to gillnets and traps, vessel strikes, and ocean noise.

4.8.1 Range and Habitat

Fin whales occur throughout the world in continental shelf and offshore waters (Jefferson et al. 2008, as cited in Geo-Marine 2010). The U.S. western North Atlantic stock are range from Cape Hatteras north to Nova Scotia in the U.S. EEZ. Generally, fin whales migrate southward in the fall and northward in the spring. The species primarily feeds in the New England waters in the summer months (NMFS 2019). Data suggest that fin whales calve in the mid-Atlantic region, but it is generally unknown where calving, mating and wintering occurs for most of the population (NMFS 2019). Fin whales have been documented from the mid-Atlantic region north to the Gulf of Maine in all seasons (NMFS 2019).

4.8.2 Presence within the Study Area

Fin whales typically occur in deep offshore waters, but have been encountered in New Jersey's coastal waters (CWFNJ 2020). This is supported by the results of the aerial and shipboard marine mammal surveys were conducted in 2008 and 2009 in New Jersey from Seaside Park to Stone Harbor from the barrier islands and extending 37 kilometers offshore. During these surveys, fin whales were the most frequently sighted large whales. Fin whales were observed in all seasons between 3.1 and 33.9 km (1.7 and 18.3 NM) from shore with a mean distance of 20.0 km (10.8 NM) (Geo-Marine 2010).

4.9 Atlantic Loggerhead

The loggerhead turtle was first listed under the ESA as threatened throughout its range in 1978. In 2011, NOAA Fisheries and the USFWS determined that the loggerhead sea turtle was composed of nine distinct population segments (DPS). A DPS is the smallest division of a species permitted to be protected under the ESA. On 24 October 2011, the Western North Atlantic DPS of loggerhead turtles was listed as threatened (Federal Register, 22 September 2011). Threats to loggerhead turtles include bycatch in fishing gear, intentional killing, and entanglement in marine debris.

4.9.1 Range and Habitat

Loggerhead turtles inhabit continental shelves, bays, lagoons, and estuaries in the temperate, subtropical and tropical waters of the Atlantic, Pacific and Indian Oceans (Dodd 1988, Mager 1985). In the western Atlantic Ocean, loggerhead turtles occur from Argentina northward to Nova Scotia, including the Gulf of Mexico and the Caribbean Sea (Carr 1952, Dodd 1988, Mager 1985, Nelson 1988).

The foraging range of the loggerhead sea turtle extends throughout the warm waters of the U.S. continental shelf (Shoop et al. 1981). Loggerhead turtles are common as far north as the Canadian portions of the Gulf of Maine on a seasonal basis (Lazell 1980), but during cooler months of the year, distributions shift to the south (Shoop et al. 1981).

Sporadic nesting is reported throughout the tropical and warmer temperate range of distribution, but the majority of the nesting areas are the Atlantic coast of Florida, Georgia and South Carolina (Hopkins and Richardson 1984). The Florida nesting population of loggerheads has been estimated to be the second largest in the world (Ross 1982).

Hatchling loggerheads emerge from the nest as a group at night, orient themselves seaward, and rapidly move towards the water (Richardson 1984). Many hatchlings fall prey to sea birds and other predators following emergence. Those hatchlings that reach the water quickly move offshore and exist in pelagic ocean waters (Carr 1986).

4.9.2 Presence within the Study Area

Loggerhead turtles forage in the New Jersey coastal waters, as well as in the Barnegat, Delaware, and Raritan bays, usually between the months of May through November (CWF 2020). Loggerheads frequently forage around coral reefs, rocky places and old boat wrecks; they commonly enter bays, lagoons and estuaries (Dodd 1988). Aerial surveys of loggerhead turtles at sea indicate that they are most common in waters less than 50-meters in depth (Shoop et al. 1981), but they occur in pelagic ocean waters as well (Carr 1986).

This species does not nest as far north as New Jersey.

4.10 Kemp's Ridley

The Kemp's ridley sea turtle has been listed as endangered since 1970 (Federal Register, December 2, 1970).

4.10.1 Range and Habitat

Kemp's ridley turtles inhabit sheltered coastal areas and frequent larger estuaries, bays and lagoons in the temperate, subtropical and tropical waters of the Atlantic Ocean and Gulf of Mexico (Mager 1985). The foraging range of the adult Kemp's ridley sea turtle appears to be restricted to the Gulf of Mexico. However, juveniles and subadults occur throughout the warm coastal waters of the U.S. Atlantic coast (Hopkins and Richardson 1984, Pritchard and Marquez 1973). On a seasonal basis, Kemp ridleys are common as far north as the Canadian portions of the Gulf of Maine (Lazell 1980), but during cooler months of the year they shift to the south (Morreale et al. 1988).

Kemp's ridley nesting is mainly restricted to a stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Pritchard and Marquez 1973, Hopkins and Richardson 1984). Occasional nesting has been reported on Padre Island, Texas and Veracruz, Mexico (Mager 1985). Hatchling emerge from the nest as a group at night, orient themselves seaward, and rapidly move towards the water (Hopkins and Richardson 1984). Following emergence, many hatchlings fall prey to sea birds, raccoons and crabs. Those hatchlings that reach the water quickly move offshore. Their existence after emerging is not well understood but is probably pelagic (Carr 1986).

4.10.2 Presence within the Study Area

New Jersey coastal waters provide important seasonal foraging habitat for Kemp's ridley turtles from late May until November (CWF 2020). This species is typically found in nearshore shallow waters and may enter the New Jersey back bays to forage. Kemp's ridley sea turtles have been observed within Barnegat Bay. Kemp's ridleys are omnivorous and feed on crustaceans, swimming crabs, fish, jellyfish and mollusks (Pritchard and Marquez 1973).

Kemp's ridley turtles do not nest as far north as New Jersey.

4.11 Atlantic Green Sea Turtle

The green turtle was listed under the ESA in the Federal Register on 28 July 1978. Breeding populations of the green turtle in Florida and along the Pacific Coast of Mexico were listed as endangered; all other populations were listed as threatened.

4.11.1 Range and Habitat

Green turtles are circumglobally distributed mainly in waters between the northern and southern 20° C isotherm (Mager 1985). In the continental U.S. green turtles are only known to nest on the Atlantic coast of Florida, from June to September (Mager 1985, Hopkins and Richardson 1984). Hatchlings emerge, mostly at night, travel quickly to the water, and swim out to sea. At this point, they enter a period which is poorly understood but is likely spent pelagic ocean waters in areas where currents concentrate debris and floating vegetation such as sargassum (Carr 1986).

4.11.2 Presence within the Study Area

New Jersey coastal waters provide important seasonal foraging habitat for green sea turtles from late May until November (CWF 2020). Green sea turtles may enter New Jersey back bays to forage. This species has been observed in Barnegat Bay. Adult green sea turtles are the only sea turtles that are exclusively herbivores, eating sea grasses and algae. Juveniles may eat aquatic vegetation such as eelgrass, which grows in beds in Barnegat Bay (CWF 2020). Other organisms living on sea grass blades and algae add to the diet (Mager 1985, Burke et al. 1992, CWF 2020).

This species does not nest as far north as New Jersey.

4.12 Leatherback Sea Turtle

The leatherback turtle was listed as endangered on 2 June 1970 in the Federal Register.

4.12.1 Range and Habitat

Leatherbacks have a circumglobal distribution and occur in the Atlantic, Indian and Pacific Oceans. They range as far north as Labrador and Alaska to as far south as Chile and the Cape of Good Hope. They are found farther north than other sea turtle species, probably because of their ability to maintain a warmer body temperature over a longer period of time.

Leatherback turtle nesting occurs on the mid-Atlantic coast of Florida from March to September (Hopkins and Richardson 1984). Hatchlings emerge, mostly at night, travel quickly to the water, and swim out to sea. The early history of leatherbacks is poorly understood since juvenile turtles are rarely observed.

4.12.2 Presence within the Study Area

While New Jersey coastal waters provide important seasonal foraging habitat for leatherback turtles from late May until November, they are typically found in deeper, more offshore waters than the other sea turtles (CWFNJ 2020). There are documented leatherback turtles have stranded along the outer shores of New Jersey. The diet or the leatherback consists primarily of soft-bodied animals such as jellyfish and tunicates, together with juvenile fishes, amphipods and other organisms (Hopkins and Richardson 1984).

This species does not nest as far north as New Jersey.

4.13 Atlantic Sturgeon

Five Atlantic sturgeon DPSs were listed as endangered or threatened under the ESA on (Federal Register, 6 February 2012). These are the endangered New York Bight, Chesapeake Bay, South Atlantic, and Carolina DPSs, and the threatened Gulf of Maine DPS. The primary threats to Atlantic sturgeon include bycatch in some commercial fisheries, dams that block access to spawning areas, poor water quality (which harms the development of sturgeon offspring), dredging of spawning areas, water withdrawals from rivers, and vessel strikes (NMFS 2020).

4.13.1 Range and Habitat

Atlantic sturgeon are anadromous, spending the majority of their adult phase in marine waters, migrating up rivers to spawn and hatch in freshwater and migrating to brackish waters in juvenile growth phases. Atlantic sturgeon initially emigrate to sea as subadults (at a size of 30-36 inches) (NMFS 2020, NJDEP 2020). After emigration from the natal estuary, subadults and adults travel within the marine environment, typically in waters less than 40 m in depth, using coastal bays, sounds, and ocean waters (Vladykov and Greeley, 1963; Murawski and Pacheco, 1977; Dovel and Berggren, 1983; Smith, 1985; Collins and Smith, 1997; Savoy and Pacileo, 2003; Stein et al., 2004; Laney et al., 2007; Dunton et al., 2010; Erickson et al., 2011; D. Fox, pers. comm.; T. Savoy, pers. comm.).

The historical and current range of Atlantic sturgeon includes major estuaries and river systems from Canada to Florida. While still found throughout their historical range, Atlantic sturgeon spawning is known to occur in only 22 of 38 historical spawning rivers (NMFS 2020). While most Atlantic sturgeon may migrate back to natal rivers to spawn, there is some Atlantic sturgeon enter nonnatal rivers to spawn.

Atlantic sturgeon were once abundant in all major estuaries along the Atlantic coast. By the late 1800's, the Delaware River Atlantic sturgeon fishery was the largest in the United States producing 75% of the total US harvest from 1890-1899 (Townsend, 1900). Factors contributing to the precipitous decline of Atlantic sturgeon during the latter part of the 19th century include overharvesting, reduced water quality, and anthropogenic influences. In 1998, the Atlantic States Marine Fisheries Commission (ASMFC) determined that populations of Atlantic sturgeon are either extirpated or at historically low abundances throughout their range and closed the fishery. The 2017 assessment indicates a slight positive trend coastwide for Atlantic sturgeon since the 1998 moratorium with variable signs of recovery by DPS (ASMFC 2017).

The Delaware River historically supported one of the largest population of Atlantic sturgeon in the world. By 1900 the total catch was less than 10% of the peak harvest years and considered collapsed by 1901 (Ryder, 1890; Cobb 1900, NJDEP 2020). Just 130 Atlantic sturgeon; 64 commercially fished with gill nets and 66 incidental to fishery and ecological studies, were reported captured in the Delaware Estuary between 1958 and 1980 (Brundage and Meadows 1982). This is based on an evaluation of literature, unpublished data, and logs maintained by commercial fishermen who caught sturgeon incidentally. In 2014, NMFS estimated that juvenile abundance in the Delaware River at 3,656 individuals (NMFS 2020).

Female Atlantic sturgeon from New Jersey waters most likely first breed at an age of about 11-19 years. Atlantic sturgeon may not breed every year with gaps between each spawning ranging from 1-5 years for males and 2-5 years for females (NJDEP 2020). Spawning may occur as far upstream as Bordentown, NJ in the Delaware River. The stretch of river between the Marcus Hook Anchorage and the mouth of the Schuylkill River, PA is a critical concentration area for sturgeon less than 2 years old (NJDEP 2020).

4.13.2 Presence within the Study Area

Sub-adult and adult individuals from all five Atlantic sturgeon DPSs could occur within the study area. Early (eggs, larvae, young-of-year) and juvenile1 life stages are found in large rivers and their estuaries and will not be present as they are not able to tolerate the high salinity of marine and coastal waters (NMFS pers. com.).

The use of marine habitat by Atlantic sturgeon larger subadults and adults is not completely understood. Depth is considered a primary environmental characteristic defining the Atlantic sturgeon distribution in marine habitat (Dunton, et al. 2010). Essential habitat for juvenile marine migrant Atlantic sturgeon as coastal waters <20m deep, concentrated in areas adjacent to estuaries such as the Hudson River-NY Bight, Delaware Bay, Chesapeake Bay, Cape Hatteras, and Kennebec River (Dunton et al. 2010). Bycatch records also suggest a preference for relatively shallow (<50m) habitat composed of a sand substrate (Stein et al., 2004). Depth distribution appears seasonal, with sturgeon inhabiting the deepest waters during the winter and the shallowest waters during summer and early fall (Erickson, et al., 2011). Marine bycatch tends to be the heaviest during the fall, winter and spring months, when spawning sturgeon undergo their migration upstream (Bain, 1997). Since spawning does not generally occur in successive years, juveniles and adults may remain in marine foraging areas in high numbers from the fall through spring (Dadswell, 1979: Kieffer and Kynard, 1993; Moser and Ross, 1995; Kynard, 1997; Auer, 1999).

5.0 ENVIRONMENTAL SETTING

The back bays of New Jersey comprise a vast and rich coastal ecosystem which includes: barrier islands; beaches and dunes; salt, brackish, and freshwater marshes; tidal mud flats and maritime forests; rocky (predominantly manmade) and hardened shorelines; submerged aquatic vegetation; oyster and rock reefs; shallow bays and bay islands; terrestrial uplands; flood plains, and riparian zones. In the coastal barrier island complex areas, the mainland areas are generally separated from the barrier island by vast wetlands and open water bays. These habitats contain a remarkable array of biodiversity and are recognized as an important ecological resource for migratory birds including waterfowl, wading birds, shorebirds, and other species. The entire study area is part of the Atlantic Flyway. These habitats also serve as Essential Fish Habitat (EFH) for federally managed fish species.

With the exception of public lands, the beach communities along the coast including headland and barrier islands contain the most intense development in the upland areas consisting of residential (seasonal) homes, commercial – tourist oriented (amusement areas, marinas, and various smaller attractions and facilities), and some light industrial uses such as fishing related industry. The mainland communities also include dense residential, commercial development, transportation, utilities services and some sporadic industrial development.

Coastal features that provide habitat for threatened and endangered species in in the action area Table 6. Table 7 provides a snapshot of these habitats within the action area (based on the footprint of the proposed measures) (see Figure 2, Figure 3, and Figure 4 for the measures proposed in each region). Detailed maps of existing habitat within the Action Area are provided in Appendix A.

Table 6. Coastal Features that Provide Habitat for the Threatened and Endangered Species

Habitat	**Species that Use the Habitat**
Woodlands: Live and dead trees and/or snags (typically ≥ 3 inches dbh	Northern longeared bats
Vegetated Dunes and Upper Beaches: Beach above the high tide line, gently sloping foredunes, blowout areas, overwash fans and sand flats	Piping plover (nesting), seabeach amaranth
Wetland Habitats: Salt and brackish marshes and associated uplands	Black rail
Intertidal Habitats: Beaches, tidal inlets, sand spits, islets, shoals, sandbars, intertidal sand or mudflats	Piping plovers (foraging), red knots (resting foraging), roseate terns (resting and foraging),
Subtidal Habitats: Benthic and demersal habitat such shellfish beds or structure	Atlantic sturgeon, sea turtles
SAV	Sea turtles

Estuarine open waters	Atlantic sturgeon, sea turtles
Open ocean waters	North Atlantic right whale, fin whale, sea turtles, Atlantic sturgeon

Table 7. Presence of Threatened and Endangered Species Habitat within the Action Area Based on the Footprint of Measures Proposed in Each Region

Threatened and Endangered Species Habitat	**Habitat Present within the Footprint [1]**			
	Shark River	**North Region**	**Central Region**	**South Region**
Live and dead trees and/or snags (typically ≥ 3 inches dbh)	NS: Yes	MI SSB: No BI SSB[2]: No NS: Yes	GE SSB[2]: No AB BC: Yes SO BC: No PP: No NS: Yes	NS: Yes PP: Yes
Beach above the high tide line, gently sloping foredunes, blowout areas, overwash fans and sand flats	NS: No	MI SSB: Yes BI SSB[2]: Yes NS: No	GE SSB[2]: Yes AB BC: Yes SO BC: No PP: Yes NS: No	NS: No PP: Yes
Tidal inlets, sand spits, islets, shoals, sandbars, intertidal sand or mudflats	NS: No	MI SSB: Yes BI SSB[2]: Yes NS: No	GE SSB[2]: Yes AB BC: Yes SO BC: No PP: Yes NS: No	NS: No PP: Yes
Salt and brackish marshes and associated uplands	NS: No	MI SSB: No, but could be indirectly affected. BI SSB[3]: Yes NS: No	GE SSB[4]: Yes AB BC: Yes SO BC: Yes PP: Yes NS: No	NS: No PP: Yes
Estuarine open waters	NS: No	MI SSB: Yes BI SSB[2]: Yes NS: No	GE SSB[2]: Yes AB BC: Yes SO BC: Yes PP: Yes	NS: No PP: Yes

Threatened and Endangered Species Habitat	Habitat Present within the Footprint [1]			
	Shark River	North Region	Central Region	South Region
			NS: No	
SAV	NS: No	MI SSB: No, but could be indirectly affected. BI SSB[2]: No, No, but could be indirectly affected. NS: No	GE SSB[2]: No, but could be indirectly affected. AB BC: No SO BC: No PP: No NS: No	NS: No PP: Yes
Benthic and demersal habitat such shellfish beds or structure	NS: No	MI SSB: Yes BI SSB[2]: NS: No	GE SSB[2]: Yes AB BC: Yes SO BC: Yes PP: Yes NS: No	NS: No PP: Yes
Pelagic open ocean waters	Outside of study area but could be indirectly affected.	Outside of study area but could be indirectly affected.	Outside of study area but could be indirectly affected.	Outside of study area but could be indirectly affected.

Notes: [1]Measures include non-structural (NS), storm surge barriers (SSB), bay closures (BC), and perimeter plan (PP).
[2] All alignments.
[3] C1 Alignment only.
[4] B1 and C1 Alignments only.

Abbreviations: NS=Non-structural; MI SSB=Manasquan Inlet Storm Surge Barrier; BI SSB=Barnegat Inlet Storm Surge Barrier; GE SSB = Great Egg Harbor Storm Surge Barrier; AB BC=Absecon Boulevard Bay Closure; SO BC=South Ocean City Bay Closure; PP=Perimeter Plan (see Figure 3, Figure 4, and Figure 5).

In general, in the future without the project, these project habitats will be subject to more stress resulting from human population increases, climate change, and sea level rise. In the NJBB study area, upland habitats, coastal wetlands, and tidal mudflats are highly susceptible to the effects of sea level rise. As surface water elevations increase, upland categories may transition into freshwater marsh, and freshwater marsh areas may transition into brackish, salt marsh, or unconsolidated shore habitats, based on changes tidal thresholds. Appendix B provides additional detail on the habitat changes that could occur in response to intermediated and high sea level rise scenarios during the NJBB Study Period between 2030 and 2080.

5.1 Woodlands

Woodlands provide habitat for northern longeared bats and includes forested wetlands and deciduous forest. These habitat types are not common in the study area but occur in the Central Region within the footprint of the Absecon Boulevard Bay Closure and in the South Region in the footprint of the Perimeter Plan Alternative. Northern longeared bat roost trees can also be found in urbanized areas and in maritime forests. There are no maritime forests within the footprint of the proposed measures. Landscape trees can occur within parcels that are targeted for non-structural measures.

In the future without the project, forested wetlands in the NJBB Study Area may transition into another habitat type such as freshwater marsh, in response to sea level rise. It is estimated that in the entire NJBB Study Area (of which the action area is a subset), approximately 14,655 acres of forested wetlands will be lost under an intermediate sea level rise scenario and 26,936 acres of forested wetlands would be lost under a high sea level rise scenario during the 2030 - 2080 study period (see Appendix B).

5.2 Upper Beach and Dune

Upper beach and dune habitats are along the Atlantic Ocean coast and are above mean high water. These areas receive frequent salt spray, and possess sparse vegetation in the higher elevations. Vegetated primary and secondary dunes occur along the coastal barrier islands, inlets and undeveloped back-bay areas. Beaches and dunes and other associated features such as gently sloping foredunes, blowout areas, overwash fans and sand flats provide nesting habitat for piping plover and habitat for seabeach amaranth. These habitats occur in all regions of the NJBB Study Area.

In response to sea level rise without the project, dune habitat may transition into another habitat type such as estuarine or brackish wetland or unconsolidated shoreline, beach habitat may transition to open water. It is estimated that in the entire NJBB Study Area (of which the action area is a subset), approximately 5,300 acres of upland habitat will be lost under an intermediate sea level rise scenario, with 8,500 acres lost under a high sea level rise scenario (see Appendix B).

5.3 Wetland Habitats

Wetlands data from different agencies with various classifications, were grouped into the broad category of "Wetland Habitats" (NJDEP 2012). The “Wetland Habitats” category includes estuarine marshes (saline marshes), scrub shrub marshes, and supratidal wetlands. Scrub shrub marshes include estuarine and palustrine deciduous and coniferous scrub shrub. Estuarine marshes includes saline high and low marshes. Supratidal marshes are occasionally inundated by exceptionally high spring tides or by tides that are extremely high due storm surge and include palustrine and estuarine emergent marshes (herbaceous wetlands), disturbed wetlands, managed wetlands, and phragmites-dominated marshes.

Salt and brackish marshes and associated uplands (i.e., wetlands habitat) provide habitat for the eastern black rail. These habitats occur within the footprint of the Barnegat Inlet storm surge barrier alignment C1, the Great Egg Harbor stormsurge barrier alignments B1 and C1, and the perimeter plans.

Intertidal low marsh wetlands are present throughout much of the study area and are dominated by saltmarsh cordgrass (*Spartina alterniflora*). High saltmarsh habitats are generally found near the mean high tide level and are generally dominated by saltmarsh hay (*Spartina patens*), seashore saltgrass (*Distichlis spicata*), and glasswort (*Salicornia* spp.). Scrub/shrub habitats are common at the transition from high marsh to uplands. Common vegetation includes switchgrass (*Panicum virgatum*), groundsel tree (*Baccharis halimifolia*), bayberry (*Myrica* spp.), eastern red cedar (*Juniperus virgini*ana), hightide bush (*Iva frutescens*), seaside rose (*Rosa rugosa*) and poison ivy (*Toxicodendron radicans*). Common reed (*Phagmites australis*), often found in monotypic stands, competes with these species for dominance in these areas.

Coastal wetlands can adapt and keep pace with sea level rise through vertical accretion and inland migration, but must remain at the same elevation relative to the tidal range and have a stable source of sediment. Under intermediate and high sea level rise scenarios, marsh accretion at a rate of 4 mm per year would not keep pace with sea level rise. Estuarine wetlands may transition to another habitat type such as brackish wetlands, palustrine emergent wetlands, unconsolidated shore, or open water.

In the future without the project during the 2030 – 2080 study period, estuarine wetlands in the NJBB Study Area are projected to decrease by approximately 12,000 acres and 95,700 acres under the intermediate and high sea level rise scenarios, respectively. This loss is accompanied by increases other habitat types. Under the intermediate and high sea level rise scenarios:

- Brackish water wetlands would increase by approximately 7,400 acres and 7,000 acres, respectively.
- Palustrine emergent wetlands would increase by approximately 280 acres and 220 acres, respectively.
- Unconsolidated shoreline is also expected to increase by approximately 17,500 acres and 72,300 acres under the intermediate and high sea level rise scenarios, respectively.
- Open water habitat is projected to increase by approximately 6,700 acres under the intermediate sea level rise scenario and 51,700 acres under the high sea level rise scenario.

5.4 Intertidal and Subtidal Benthic Habitats

Intertidal habitat occurs between the high and low tide lines and is subject to daily tidal fluctuations. Intertidal substrates within the study area are primarily sand and mud. Subtidal habitat includes the waters seaward of the low tide, meaning the substrate, primarily sand and mud, is constantly inundated.

Intertidal habitats including tidal inlets, sand spits, islets, shoals, sandbars, intertidal sand or mudflats provide foraging habitat for roseate terns, red knots, and piping plovers. Rip rap and other hardened manmade structures can also provide intertidal habitat, but natural hard structures are uncommon in the study area. Intertidal mudflats or sand flats often border saltmarsh habitats, pocket beaches along developed shorelines, or locations where either erosion or marsh dieback has removed vegetation or depositional shoals have formed in areas that were previously subtidal. Natural structure habitat (such as rocky outcrops and boulders) is expected to be uncommon in the action area. Riprap and other hardened manmade structures occur in intertidal zone. Intertidal habitats are often rich in benthic food sources available to wading birds and shorebirds that forage at low tide.

Intertidal sand habitats occur within the footprints of all storm surge barriers, bay closures, and perimeter plans. These habitats are principally associated with backwater sound and bay areas such as Richardson Sound and Grassy Sound, Great Sound, Jenkins Sound, Townsend Sound, Corson's Sound, Great Egg Harbor, Peckman Bay, Lakes Bay, Absecon Bay, Great Bay, Little Bay, Little Egg Harbor, and Barnegat Bay. In addition, nearshore and intertidal habitats are present within various channels and thoroughfares.

Subtidal habitats are always inundated and subtidal substrates within the study area are primarily sand and mud. Other than SAV, natural structure habitat (such as rocky outcrops and boulders) is expected to be uncommon in the action area. Rip rap and other hardened manmade structures occur in subtidal zone. Nearshore waters are strongly influenced by weather and the adjacent high-energy sandy beach which influence sediment transport. Along beach areas, shifting sands and pounding surf affect the available habitat. Subtidal benthic habitats occur within the footprints of all storm surge barriers, bay closures, and perimeter plans.

Shellfish habitats are located throughout the intertidal and subtidal NJBB study area, which include beds containing hard clams (*Mercenaria mercenaria*), soft clams (*Mya arenaria*), and eastern oysters (*Crassostrea virginica*). Other notable benthic invertebrates common to estuarine and marine habitats within the New Jersey coast include mollusks such as bay scallop (*Aequipecten irradians*), hard clam, common blue mussel (*Mytilus edulis*), moon snail (*Lunatia heros)*, and knobbed whelk (*Busycon carica*); crustaceans such as common rock crab (*Cancer irroratus*), blue crab (*Calinectes sapidus*), snapping shrimp (*Crangon septemspinosa*), and grass shrimp (*Palaemontes spp*.); and sea stars (*Asterias forbesi*), which are echinoderms. The horseshoe crab (*Limulus polyphemus*) is a common, yet important, invertebrate inhabiting the New Jersey Back Bays and nearby Atlantic Ocean waters, and is notable for pharmaceutical applications, and their eggs are a critical food source for the red knot migratory shorebirds. Benthic macroinvertebrates such as marine worms, mollusks and amphipods also live in nearshore waters and may provide prey for Atlantic sturgeon. Tunicates may provide prey for sea turtles.

In response to sea level rise, intertidal habitats could experience increased inundation and/or their tidal regimes could change from intertidal to subtidal. Some habitats may transition to unconsolidated shoreline. Distributions of intertidal and subtidal shellfish beds could change in New Jersey Back Bays in response to changing sea levels and habitats.

5.5 Submerged Aquatic Vegetation

Submerged aquatic vegetation (SAV) or "seagrass" beds provide important habitat for foraging sea turtles, as well as for small fish, shellfish, and other invertebrates that serve as prey for other threatened and endangered species. SAV are rooted vascular flowering plants that exist within the photic zone of shallow bays, ponds, and rivers.

SAV beds exist in localized areas of the New Jersey Back Bay estuarine system. The Barnegat Bay – Little Egg Harbor Estuary have the most extensive beds and account for nearly 75% of the beds in New Jersey (Kennish et al. 2010). The most important species of SAV in New Jersey is eelgrass (*Zostera marina*), which is also the most common SAV that can form extensive beds important for fish, shellfish and other wildlife species. Other species of submerged vegetation found in the more brackish waters of the estuary that are also of ecological importance include widgeon grass (*Ruppia maritima*) and other more freshwater and slightly brackish species of pondweeds (*Zanichellia palustris* and *Potomogeton* spp.) and wild celery (*Vallisneria americana*) as reported in the Great Egg Harbor River, Tuckahoe River, Patcong Creek, and the Mullica River (USFWS, 1997).

SAV beds provide an important direct food source via the grazing chain, indirect food source via the detritus chain, a substrate for epiphytes, and cover and protective habitat. Large numbers of fish are also typically associated with eelgrass beds, although most do not feed directly on the plants (Good, et al., 1978). Additionally, eelgrass beds have been recognized as an important habitat for juvenile and adult blue crabs, and the leaves are used by the bay scallop (*Argopecten irradians)* as a setting substrate, and are also associated with hard clam (*Mercenaria mercenaria*) beds. SAV beds provide important habitat for foraging sea turtles in New Jersey waters.

Historically, SAV beds occurred within the footprint of some of the storm surge barriers, they could be indirectly affected by them. In the future without project, distribution of SAV beds could change in New Jersey Back Bays in response to changing sea levels and habitats.

SAV surveys have not been conducted along any of the preliminary storm surge barrier and bay closure alignments. Additionally, mapping of SAV beds is only available for Barnegat Bay (spatial data adopted from http://crssa.rutgers.edu/projects/coastal/sav/ and Lathrop and Haag, 2010).

5.6 Estuarine Open Waters

Estuarine open waters include Richardson Sound and Grassy Sound, Great Sound, Jenkins Sound, Townsend Sound, Corson's Sound, Great Egg Harbor, Peckman Bay, Lakes Bay, Absecon Bay, Great Bay, Little Bay, Little Egg Harbor, and Barnegat Bay and various channels and thoroughfares, present throughout the study area. These habitats occur within the footprints of all storm surge barriers, bay closures, and perimeter plans. The estuarine open waters of the New Jersey back bays potentially provide habitat for Atlantic sturgeon, sea turtles, and roseate terns.

Water quality is a primary determinant of habitat quality for fish and wildlife. Water quality within the coastal waters of the New Jersey Atlantic Coast was comparable to that of similar coastal water bodies along the New York Bight and was indicative of similar coastal tidal river and estuary complexes along the Mid-Atlantic coast (USFWS, 1997). In 2017, the coastal waters and estuaries of NJ were generally good for recreation and shellfish harvesting (NJDEP 2017). However, there remain some areas where dissolved oxygen does not meet water quality criteria, which is a concern relative to aquatic life support particularly in Barnegat Bay.

Water quality in this coastal region is dependent largely on the influence of the major coastal freshwater rivers that flow into the bays that make up the study area reaches (e.g. the Mullica River empties in the Great Bay). Other factors that influence water quality over time include tides, time of year, ocean current fluctuations, nutrient enrichment, water depth, biotic communities, and other temporal and spatial variables. The results of prior studies conducted on the bays and estuaries within the study area indicate that the water quality has historically been impacted by pollutants such as nutrients, pathogens, heavy metals (cadmium, lead, and zinc) and fecal coliform bacteria. (USACE, 1998; BBEP, 2001; Zimmer and Groppenbacher, 1999). As a result, fish and wildlife habitat has been degraded in many areas relative to historical pre-developed conditions. In recent years, however, improvements in water quality have been seen in the region resulting from implementation of the Clean Water Act, and state programs such as discharge permitting programs, coupled with improvements in wastewater treatment technology.

The back bays generally exhibit lower mean salinities and higher water temperatures than the ocean. The lower salinities reflect the stronger influence of ocean dynamics on water within these bays as opposed to adjacent rivers which are more distant from the ocean. Warmer mean water temperatures in the back bays result from greater heating capability owing to shallow water depth, productivity, mixing, and influx of freshwater which may be warmed by seasonal shifts in sun strength, predominant winds, weather, and ambient air temperature. Summer water temperatures along New Jersey coastal waters averages between 20°C and 30°C throughout most of the coastal waters. During winter months the average water temperature ranges from 0°C and 10°C (Zimmer and Groppenbacher, 1999).

Turbidity is a measure of the clarity of the water column, which is a function of suspended particles (Thurman, 1975) and is recorded as nephelometric turbidity units (NTUs). Turbid (cloudy) water can be caused by natural conditions (e.g., tidal flushing and resultant suspension of sediments), water from aquifer formations that is naturally elevated in total dissolved solids, or human activities, such as the release of suspended particles in urban runoff or wastewater discharges into the river. As a general trend, turbidity is somewhat lower in the winter months when biological productivity is lowest (Zimmer and Groppenbacher, 1999). Conversely high phytoplankton biomass and production during the warmer months of the year contribute to elevated turbidity readings. Other factors that may influence turbidity over the short term include storms, wind, and rain supplying energy that causes erosional processes that entrain suspended particles. Turbidity is also often elevated in areas near the mouth of estuaries, where tidal action and river flows result in great mixing.

Dissolved oxygen is one of the most important water quality parameters, as most biota cannot survive without adequate DO levels. Dissolved oxygen concentrations in the water column are influenced by temperature, photosynthesis, respiration of aquatic life, aeration from physical processes, amount of organic matter, and pollutant inputs (USEPA, 1986). Generally DO is highest in the winter months and lowest in summer months (Zimmer and Groppenbacher, 1999), as its solubility increases when temperature decreases. DO can vary greatly over time within a specific area due to changes in presence of other nutrients that stimulate productivity. Furthermore, DO is highly dependent on salinity as the latter affects the solubility of oxygen in water.

The level of nutrients currently measured in coastal waters as a measure of non-point source pollution is among one of the higher priority management issues for the state and federal agencies (CBP, 2002). Two major nutrients (nitrogen and phosphorus) are monitored in water quality studies, although they may take many forms. Nitrogen is always present in aquatic systems although it exists in many forms simultaneously as ammonia ($NH4+$), nitrate ($NO3-$), nitrite ($NO2-$), and urea. The availability of the various nitrogen compounds generally influences the variety, abundance, and nutritional value of aquatic plants and eventually animals in an aquatic system.

Many of New Jersey’s coastal waters experience high nutrient loadings that negatively impact water quality and biotic communities. For example, high nutrient inputs (especially nitrogen) can lead to a variety of adverse conditions that can severely impact the water quality of an estuary

(BBEP, 2001). These include increased algal biomass and production, toxic or nuisance algal blooms, elevated turbidity, loss of SAV, exhausted DO levels, and a decline in biodiversity.

Kennish (2010) describes that the “nutrient enrichment of the Barnegat Bay-Little Egg Harbor Estuary is closely linked to a series of cascading environmental problems, notably increased growth of phytoplankton and benthic macroalgae (including both harmful and nuisance forms), loss of SAV, and declining shellfish resources. These problems have also led to deterioration of sediment and water quality, loss of biodiversity, and disruption of ecosystem health and function. Human uses of estuarine resources have also been impaired.”

Poor flushing (i.e., water exchange) and long residence times (i.e., length of time a parcel of water will remain in a water body) could result in the retention of nutrients longer in the system, which could lead to higher primary production rates, making waters more susceptible to eutrophication. Whereas, well-flushed estuaries demonstrate greater resilience to nutrient loading attributed to reduced residence time and greater exchange with less impacted coastal waters (Lancelot and Billen, 1984 as cited in Defne and Ganju, 2015). Barnegat Bay and Little Egg Harbor estuaries are the most studied concerning hydrodynamic modeling and residence times where Guo and Lordi (2000) estimated an average residence time at Barnegat Inlet based on velocity and salinity as occurring between 24 and 74 days (depending on season). Defne and Ganju (2015) performed systemic modeling using a combination of hydrodynamic and particle tracking modeling of the Barnegat Bay and Little Egg Harbor estuaries to determine a mean residence time of 13 days, but ranged between 0 and 30 days depending on the initial particle location. This modeling also demonstrated that there is a pronounced northward subtidal flow from Little Egg Inlet in the south towards Point Pleasant Canal in the north attributed to frictional effects in the inlets. This effect resulted in better flushing of the southern half of the estuary and more particle retention (poor flushing) in the northern estuary.

In the future without project, as other habitats decrease in response to sea level rise, estuarine open waters would increase in the study area. Estuarine open waters will experience changes similar to those expected in the open ocean due to climate change (NMFS 2016). These include increases in temperature including associated decreases in dissolved oxygen, ocean acidification, and changes in currents. These changes could change the productivity and species diversity of estuaries, which could in turn influence or changes abundance and distribution of prey of the threatened and endangered species, including floating and benthic invertebrates and SAV (NMFS 2016).

5.7 Open Ocean Water

Open ocean waters do not occur within the study area but are adjacent to the storm surge barriers. Open ocean waters provide migratory and foraging habitat for the North Atlantic right whale, fin whale, Atlantic sturgeon, roseate tern, and sea turtles.

Climate change and natural variability have been resulting in changes in the Northeast Shelf Ecosystem over the past 30-40 years and are expected to continue (NMFS 2016). These changes include increases in air and ocean temperatures, and associated ocean acifdification and decreases in dissolved oxygen. These changes can impact organisms such as fish, invertebrates, marine mammals, sea turtles, and marine plants and their habitats. Populations of marine organisms are changing as a result of indirect effects of climate change such as ocean acidification, predator-prey relationships, and shifts in distributions of a large number of species. Specifically, climate change may result in changes such as:

- distribution of sea turtle nesting habitat;
- marine mammal distribution in response to prey distribution
- changes in distribution of diadromous fish benthic and prey habitat,
- changes in the timing of migration cues and streamflow on the migration of diadromous fish and associated effect of the conditions on early life stages
- changes in fish and shellfish productivity (NMFS 2016).

6.0 DIRECT, INDIRECT, AND CUMULATIVE EFFECTS

The measures that make up the tentatively selected plan and alternatives, including non-structural, storm surge barriers, bay closures, and perimeter plans, have the potential to result direct and indirect effects on threatened and endangered species and their habitat. Table 8 and Table 9 provide estimates of threatened and endangered species habitat impact from the TSP measures and the perimeter plan options, respectively. Because it is early in the design phase and design details are details are limited, it is assumed that final impacts would vary by 20 percent (i.e., 20 percent higher or lower than estimated impacts). Additionally, impacts are estimated based on existing conditions , which would likely change during the 50-year study period because of sea level rise (as described in Section 5.0).

Based on current design, the Central Region perimeter plan options would result in an overall increase of 130 to 289 acres of habitat impacts, depending on the alignment. In the South Region, the TSP would not impact habitat because it only includes non-structural measures. If the perimeter plan option were to be used in the South Region, there would be 289 acres of

*Table 8. Habitat Impacts of the Measures that Comprise the TSP (NS=Nonstructural, SSB=Storm Surge Barrier, BC=Bay Closure)**

Region	**Shark River**	**North Region**			**Central Region**				**South Region**	**Total Impact**
	NS	**NS**	**Barnegat Inlet SSB (A1)**	**Manasquan Inlet SSB (A1)**	**NS**	**Great Egg Harbor Inlet SSB (A1)**	**Absecon Blvd. Bay Closure BC**	**South Ocean City 52nd St. BC**	**NS**	**All TSP Measures**
Habitat	**Impact**	**Impact**	**Impact**	**Impact**	**Impact**	**Impact**	**Impact**	**Impact**	**Impact**	**Impact**
Forested (acres)	0	0	0	0	0	0	0	0	0	**0**
Vegetated Dune and Upper Beach (acres)	0	0	3	20	0	2	1	1	0	**27**
Estuarine Marshes (acres)	0	0	0	0	0	0	50	24	0	**73**
Scrub Shrub Wetlands (acres)	0	0	0	0	0	0	1	2	0	**3**
Supratidal Marshes (acres)	0	0	0	0	0	0	4	0	0	**4**
Intertidal Sandy Beach	0	0	0	0	0	6	1	0	0	**7**
Intertidal Sandy Beach (shellfish) (acres)	0	0	1	0	0	0	2	0	0	**2**
Intertidal Mudflat	0	0	0		0	0	2	0	0	**2**

Region	Shark River	North Region			Central Region				South Region	Total Impact
	NS	**NS**	**Barnegat Inlet SSB (A1)**	**Manasquan Inlet SSB (A1)**	**NS**	**Great Egg Harbor Inlet SSB (A1)**	**Absecon Blvd. Bay Closure BC**	**South Ocean City 52nd St. BC**	**NS**	**All TSP Measures**
Habitat	**Impact**	**Impact**	**Impact**	**Impact**	**Impact**	**Impact**	**Impact**	**Impact**	**Impact**	**Impact**
Intertidal Mudflat (shellfish) (acres)	0	0	0	0	0	0	1	0	0	**1**
Intertidal Artificial Rocky Shoreline (linear feet)	0	0	0	2,280	0	0	1,831	0	0	**4,111**
Subtidal Soft Bottom (acres)	0	0	0	2	0	20	1	0	0	**23**
Subtidal Soft Bottom (shellfish)	0	0	12	0	0	0	2	2	0	**16**
Subtidal Artificial Hardened Shoreline (acres)	0	0	0	0	0	0	4	0	0	**4**
Subtidal Artificial Hardened Shoreline (shellfish) (acres)	0	0	0	0	0	0	13	0	0	**13**

Region	Shark River	North Region			Central Region				South Region	Total Impact
	NS	**NS**	**Barnegat Inlet SSB (A1)**	**Manasquan Inlet SSB (A1)**	**NS**	**Great Egg Harbor Inlet SSB (A1)**	**Absecon Blvd. Bay Closure BC**	**South Ocean City 52nd St. BC**	**NS**	**All TSP Measures**
Habitat	**Impact**	**Impact**	**Impact**	**Impact**	**Impact**	**Impact**	**Impact**	**Impact**	**Impact**	**Impact**
SAV Beds (subtidal)	0	0	3	0	0	0	0	0	0	**3**
Total Acres/ Linear Feet of Impacts	**0 acres/ 0 linear feet**	**0 acres/ 0 linear feet**	**19 acres/ 0 linear feet**	**22 acres/ 2,280 linear feet**	**0 acres/ 0 linear feet**	**27 acres/ 0 linear feet**	**83 acres/ 1,831 linear feet**	**28 acres/ 0 linear feet**	**0 acres/ 0 linear feet**	**179 acres/ 4,111 linear feet**

*Note: It is estimated that impacts could be 20 percent higher or lower than the values in this table.

*Table 9. Habitat Impacts of the Perimeter Plan Options That Have Not Been Eliminated from Consideration**

Region	**Central Region**			**Central Region**				**South Region**				
Habitat	**Ocean City**	**Absecon Island**	**Total**	**Ocean City**	**Absecon Island**	**Brigantine**	**Total**	**Cape May**	**Wildwood**	**Stone Harbor/ Avalon**	**Sea Isle City**	**Total (20% Variability)**
	Impact	**Impact**	**Impact**	**Impact**	**Impact**	**Impact**	**Impact**	**Impa ct**	**Impact**	**Impact**	**Impact**	**Impact**
Forested (acres)	0	0	**0**	0	0	0	**0**	4	0	0	0	**3.7**
Vegetated Dune and Upper Beach (acres)	0	0	**8**	0	0	0	**11**	0	1	5	3	**8.5**
Estuarine Marshes (acres)	41	21	**62**	41	21	18	**80**	6	33	24	33	**96**
Scrub Shrub Wetlands (acres)	6	4	**10**	6	4	0	**10**	4	8	4	3	**20**
Supratidal Marshes (acres)	28	1	**29**	28	1	0	**29**	3	1	1	6	**12**
Intertidal Sandy Beach		9	**9**	0	9	0	**9**	0	0	1	0	**1.0**
Intertidal Sandy Beach (shellfish) (acres)	1	2	**2**	1	2	1	**3**	7	2	0	0	**9.4**
Intertidal Mudflat	2	6	**8**	2	6	2	**10**	0	0	1	0	**1**

Region	Central Region			Central Region				South Region				
Habitat	**Ocean City**	**Absecon Island**	**Total**	**Ocean City**	**Absecon Island**	**Brigantine**	**Total**	**Cape May**	**Wildwood**	**Stone Harbor/ Avalon**	**Sea Isle City**	**Total (20% Variability)**
	Impact	**Impact**	**Impact**	**Impact**	**Impact**	**Impact**	**Impact**	**Impa ct**	**Impact**	**Impact**	**Impact**	**Impact**
Intertidal Mudflat (shellfish) (acres)	2	7	**8**	2	7	8	**16**	0	22	9	0	**31**
Intertidal Artificial Rocky Shoreline (linear feet)		4196	**4,196**	0	4,196	0	**4,196**	2,324	0	80	0	**2,404**
Subtidal Soft Bottom (acres)	0	1	**1**	0	1	0	**1**	0.11	0	0	0	**0.11**
Subtidal Soft Bottom (shellfish)	1	2	**3**	1	2	1	**4**	0	0.5	0.4	04	**1**
Subtidal Artificial Hardened Shoreline (acres)	10	33	**43**	10	33	2	**45**	0	0	3.5	0	**3.5**
Subtidal Artificial Hardened Shoreline (shellfish) (acres)	24	12	**36**	24	12	14	**50**	6	19	63	13	**102**

Region	Central Region			Central Region				South Region				
Habitat	Ocean City	Absecon Island	Total	Ocean City	Absecon Island	Brigantine	Total	Cape May	Wildwood	Stone Harbor/ Avalon	Sea Isle City	Total (20% Variability)
	Impact	Impact	Impact	Impact	Impact	Impact	Impact	Impa ct	Impact	Impact	Impact	Impact
SAV Beds (subtidal)	0	0	**0**	0	0	0	**0**	0	0	0	0	**0**
Total Acres and Linear Feet of Impacts	**114/ 0 linear feet**	**97/ 4,196 linear feet**	**220/ 4,196 linear feet**	**114/ 0 linear feet**	**97/ 4,196 linear feet**	**46/ 0 linear feet**	**268/ 4,196 linear feet**	**31/ 2,324 linear feet**	**86/ 0 linear feet**	**112/ 80 linear feet**	**60/ 0 linear feet**	**289/ 2,404 linear feet**

*Note: It is estimated that impacts could be 20 percent higher or lower than the values in this table.

habitat impacts, which would not occur under the TSP. The TSP would also impact 4,111 linear feet of artificial rocky intertidal shoreline. If one of the Central Region perimeter plan options were used there would be an increase of 2,365 linear feet in impacts to artificial rocky substrate. If the South Region perimeter plan is used there would be an increase in impacts of 2,404 linear feet of rocky substrate. Specific habitat impacts of the individual measures (i.e., non-structural, storm surge barriers and bay closures, perimeter plan and natural and nature-based features) are discussed in the subsequent paragraphs.

6.1 Non-structural

The majority of the construction associated with the non-structural plans would occur within the footprint of the existing structure and would most likely be in upland urbanized settings.

6.1.1 Woodlands

Nonstructural measures have the potential impact individual landscape trees. These are not expected to have high value for northern longeared bat summer roost habitat. In order to avoid direct effects, such as injury, on northern longeared bats, removal of potential roost trees would be avoided to the extent practicable. If potential roost trees cannot be avoided, the USFWS would be consulted as appropriate under the ESA 4(d) rule.

6.1.2 Upper Beach and Dune

Nonstructural measures would have no direct or indirect effects on beach and dune habitats. Therefore, threatened and endangered species associated with these habitats, including seabeach amaranth and piping plovers, would not be affected by nonstructural measures.

6.1.3 Wetland Habitats

Nonstructural measures would have no direct or indirect effects on wetlands, including saltwater and brackish water marshes and associated upland habitats. Therefore, the eastern black rail, which is associated with these habitats, would not be affected by nonstructural measures.

6.1.4 Intertidal and Subtidal Benthic Habitats

Nonstructural measures would have no direct or indirect effects on intertidal and subtidal habitats. Therefore, foraging red knots, piping plovers, and roseate terns, which are associated with intertidal habitats, would not be affected by nonstructural measures. Sea turtles and Atlantic sturgeon, which are associated with subtidal habitats would not be affected by nonstructural measures.

6.1.5 Submerged Aquatic Vegetation

Nonstructural measures would not have direct or indirect effects on SAV. Therefore, sea turtles, which are associated with this habitat would not be affected by nonstructural measures.

6.1.6 Estuarine Open Waters

Nonstructural measures would not have direct or indirect effects on saltwater and brackish water marshes. Therefore, Atlantic sturgeon, roseate terns, and sea turtles, which are associated with this habitat would not be affected by nonstructural measures.

6.1.7 Open Ocean Water

Nonstructural measures would not have direct or indirect effects on open ocean waters. Therefore, North Atlantic right whale, fin whale, sea turtles, and Atlantic sturgeon, which are associated with this habitat would not be affected by nonstructural measures.

6.2 Storm Surge Barriers and Bay Closures

The TSP includes storm surge barriers at Manasquan and Barnegat Inlets in the North Region and Great Egg Harbor Inlet in the Central Region. In addition to the A1 Barnegat Bay storm surge barrier alignment that is part of the TSP, two other Barnegat Inlet alignments (A3 and C1) are also being considered. The Great Egg Harbor storm surge barrier alignment B1 is part of the TSP, but alignment C1 is still under consideration. Detailed drawings of the storm surge barrier alignments are presented in Appendix A. In general, the storm surge barrier alignments would be constructed at the specified inlets and would tie into existing dunes at the northern and southern ends of the barrier islands. Some exceptions include:

- Manasquan Inlet: requires seawalls within the tidal inlet and a 1-mile levee/dune structure constructed along the upper beach.
- Barnegat Inlet Alignment C1: the storm surge barrier is in Barnegat Bay rather than Barnegat Inlet and ties into the existing dunes at Island Beach State Park and the spit inside the inlet.
- Great Egg Harbor Inlet Alignments B1: ties into the north end of Ocean City and into a levee and raised road at the Malibu Beach Wildlife Management area and then to an impermeable barrier on the back bay side of Longport with a sea wall at the inlet.
- Great Egg Harbor Inlet Alignments C1: ties into the north end of Ocean City and into a levee and raised road at the Malibu Beach Wildlife Management area and then to a floodwall on the back bay side of Longport with a sea wall at the inlet.

Table 8 provides estimates of habitats affected by the storm surge barriers. Appendix A provides detail alignments of all of the measures.

6.2.1 Woodlands

The storm surge barriers and bay closures would not result in direct impacts on forested wetlands. Design details are limited at this time, removal of potential roost trees would be avoided to the extent practicable. If potential roost trees cannot be avoided, the USFWS would be consulted as appropriate under the ESA 4(d) rule.

6.2.2 Upper Beach and Dune

All storm surge barriers require seawall or floodwall tie-ins to existing dunes at inlets identified in the focused array. Table 8 provides estimates impacts of the TSP to terrestrial vegetated dune and upper beach habitats, which serve as habitat for seabeach amaranth and piping plover.

The Barnegat Inlet storm surge barrier would impact approximately 3 acres of vegetated dunes under the TSP. In the case of Manasquan Beach, there is no existing dune along the upper beach; therefore, a levee type of structure would be constructed along the beach for a distance of about 6,000 linear feet from Manasquan Inlet and north. Although design details are limited at this time, this levee would likely include an impermeable core with an outer dune-like sandy layer that would be stabilized with American beachgrass and other suitable vegetation. The Manasquan Inlet storm surge barrier would create approximately 20 acres of vegetated dune habitat under the TSP. The Great Egg Harbor Inlet storm surge barrier would impact approximately 2 acres of vegetated dunes under the TSP.

Pump/generator stations for storm surge barriers will also be required, and would likely be sited in terrestrial locations adjacent to the barriers. At this level of design, it is not known where these features would be constructed.

Construction of the levee structures for the bay closures would temporarily affect vegetated dunes, particularly on the southern end of Ocean City where that flood walls associated with the bay closure ties into existing dunes. These areas would be stabilized and restored with coastal dune vegetation once construction is complete. Levee structures associated with the bay closures would likely be constructed along urbanized roadways and abandoned railroad embankments to avoid habitat impacts to the extent possible. The current design of the Absecon Boulevard and South Ocean City bay closures would impact approximately 0.9 acres and 1.1 acres of vegetated dunes, respectively.

Measures will be taken to avoid direct and indirect impacts of construction activities on seabeach amaranth and piping plover, to the extent possible. Construction activities will temporarily remove vegetation which could have direct effects on both species. Indirect impacts on upper beach and dune habitats, such as the suspension and settling of dust would be negligible and would be controlled under the erosion and sediment control plan. Noise from construction activities also disturb nearby piping plovers. Examples of measures that would be used to avoid and minimize impacts on these species and their habitat include:

- Avoid the introduction or spread of dense or invasive vegetation. Thoroughly clean construction equipment before use on a beach to avoid unintended spread of invasive plants.
- If possible, avoid or restrict work that might damage seabeach amaranth plants during the growing season of May 15 to November 30, particularly work involving use of motorized vehicles. Alternatively, in consultation with the USFWS, fence and avoid any plants by conducting a thorough survey of the area of disturbance no more than 1 week prior to the start of work and marking plants for avoidance.
- If possible, avoid noise and disturbance during the in piping plover nesting habitat during nesting season of March 15 through August 31. If this is not possible, fence and avoid piping plover nests by conducting a thorough survey of the area of disturbance no more

than 1 week prior to the start of work and marking nests and an appropriate buffer for avoidance.

The permanent seawall or floodwall tie-ins required to tie the storm surge barriers into existing dunes will result in a permanent loss of seabeach amaranth and piping plover habitat. However, the actual footprint of these structures is small, relative to the available habitat. Indirect impacts on upper beach and dune habitats would be minimal.

6.2.3 Wetland Habitats

The SSB and BC components of the tentatively selected plan have the potential to impact 73 acres of estuarine marshes (saline marshes), 3 acres of scrub shrub marshes, and 4 acres of supratidal wetlands that serve as habitat for the eastern black rail (see Table 8 for additional detail). The majority of these impacts are from the bay closures in the Central Region, because they span (generally east-west) across a number of habitats including low and high saltmarshes across the bays. Because storm surge barriers are located within existing stabilized inlets, they would have less of an effect of wetland habitats. Losses would result from excavations or fill placement. Additionally, temporary losses may be experienced through the placement of de-watering structures and either temporary fills or excavations for temporary access points to the work segment.

It should be noted that, to date, no wetland delineations have been conducted and no jurisdictional wetland determinations have been made. Therefore, impact estimates may be modified and refined based on a higher level of design detail, which includes surveyed wetland jurisdictional lines, and mitigation measures that first employ avoidance and minimization. It is assumed that for unavoidable wetland and aquatic habitats, compensatory mitigation will be required based on habitat modeling. Ecosystem modeling being considered for wetlands and aquatic habitat impacts and mitigation include the USACE EcoPcX approved New England Marsh Model (McKinney et al., 2009) and the and the New York Bight Ecological Model (NYBEM- currently under development).

Temporary indirect impacts from construction of the storm surge barriers and bay closures on wetlands are expected to be minimal to moderate and are related to impacts such as sedimentation during construction.

SSBs and BCs may pose long-term significant indirect effects on wetlands. Depending on the design of a storm surge barrier or bay closure, the available openings to pass tidal flows when open during normal conditions would be more constricted than existing inlets and other waterways. Estimates of these constrictions can range from 23%-46% of the existing inlets/waterways. A constriction could conceivably limit incoming (flood) tides resulting in a lowered high tide elevation and the outgoing (ebb) tides could result in higher low tides, thereby affecting wetland habitats at each end of the tidal range on a bay-wide scale. These changes, even if subtle, could significantly impact a whole wetland habitat such as high salt marsh/transitional wetlands at the upper end of the tidal range. Additional indirect impacts on these habitats relate to potential changes in salinity from gate closures and influxes of freshwater from precipitation, which could result in floral and faunal community shifts within these habitats.

Climate change and sea level rise also could compound these changes as evidenced in the SLAMM modeling where significant habitat shifts are predicted (see Section 4). Interactions of these types of structures with the existing tidal conditions and sea level rise are complex. Hydrodynamic and water quality modeling was conducted with the Adaptive Hydraulics (AdH) model to better understand the indirect effects of the storm surge barriers and bay closures using both open gate and closed gate scenarios.

Open Gate Scenario

AdH model open-gate scenario measured changes in tidal prisms, tidal amplitudes and salinity. The effects of SSBs and BCs on tidal amplitudes are not evenly distributed throughout the bays with individual reductions in tidal amplitude ranging from 1.3% to 8.3% through Barnegat Bay and 0.1% to 4.5% in Great Egg Harbor. With the exception of Watson Creek, a tributary to the Manasquan River, all locations showed slight reductions in amplitude. From a with-project condition at time of implementation, within the Manasquan River system, tidal amplitudes increased by 1.4 cm at Watson Creek to a decrease by 1.1 cm along the Manasquan River.

Within the northern region (Barnegat Bay to Little Egg Harbor) all stations showed reductions in tidal amplitudes ranging from 0.4 cm to 1.6 cm. An outlier in this zone was the Barnegat Light station that showed a reduction of 25 cm, which will require additional modeling. The Central Region AdH model results showed reductions in amplitude ranging from 0.4 to 2.4 cm and the Southern Region had amplitude reductions that showed the least in reductions from 0.3 to 1.2 cm.

The AdH model also considered the amplitude changes with sea level rise, which showed greater reductions in amplitude when compared to the baseline SLR condition. However, the effects of SLR appear to offset the reductions in amplitude caused by the TSP when compared to the current baseline condition where many of the stations showed net increases in amplitude with SLR.

Additional indirect impacts on these habitats relate to potential changes in salinity from gate closures and influxes of freshwater from precipitation, which could result in floral and faunal community shifts within these habitats. Changes in salinity were also modeled in the AdH model for the open-gate conditions. Little variability in mean salinity was evident between the baseline condition and with-project TSP at individual stations with station JACNEWQ (Lower Mullica River) showing the largest change at +0.34 ppt where the mean baseline salinity was measured at 4.80 ppt rising to a mean of 5.14 ppt with TSP. This suggest a response to the TSP SSBs and BCs showing that freshwater or oligohaline marsh habitats could be susceptible to increased salinity. However, with Sea Level Rise, the modeling with TSP and SLR suggests a small moderating effect at this location with a baseline salinity at JACNEWQ predicted to be 10.01 ppt and the with-project TSP at 9.90 ppt. As is the case with the tidal amplitudes and changes from SLR and the with-project TSP conditions, additional modeling in the next phase will need to be conducted to interpret these complex changes and effects on freshwater and saltwater tidal habitats.

The AdH modeling measured localized velocity changes within the storm surge barrier gate areas where significant velocity increases are expected to adjust for the constrictions imposed by these structures. Of concern, are potential geomorphic changes that may change the established shoaling patterns and create scour zones in the vicinity of these structures. The Barnegat Inlet SSB is nearest to intertidal wetlands and mudflats potentially affected by increases in tidal velocities. The jetties and rock revetments on the north and south sides of Barnegat Inlet offer more shoreline stability eastward of the structure, however, the velocity effects on intertidal areas and shorelines west of the gates such as at Sedge Islands on the north side could result in losses in intertidal habitats.

Gates Closed Scenario

The natural inputs of freshwater from tributaries and salinity inputs from the ocean make estuaries subject to great fluxes in salinity and turbidity depending on the seasonality, bathymetry and position and location within an estuary. Despite these fluxes brought on by tidal or other meteorological events, wetland habitats have become established over time where long-term biotic and abiotic factors such as sediment supply, nutrients and salinity contribute to the form and type of wetland present. Freshwater tidal marshes generally have little tolerance to any salinity, while brackish wetlands have the ability to persist in a range of saline conditions. Saltmarshes are composed of specialized vegetation that are physiologically adapted to thrive in saline conditions. The gates-closed scenario would fundamentally cut off all tidal inundation coming in from the ocean during the duration of a closure event, with a frequency expected to occur annually for maintenance/testing and predicted every 5 years (20% AEP) for significant storm events. The closure durations could last from several hours to several days depending on the activity or storm event duration. Therefore, it is likely that closure could occur during more than one tidal cycle. Depending on the state of tide at the time of closure, salinity changes are expected where heavy precipitation such as during a major storm, would increase freshwater discharges into brackish or saline wetlands. Although, this exposure is short-term, the effects are not well understood with such an extreme condition. Some plants such as smooth cordgrass may be fairly resilient to short-term exposure to freshwater (Hanson et al. 2011) while other wetland plants and fauna may become stressed during these events. Additionally, interruptions in sediment supplies resulting from gate closures may have geomorphic effects on saltmarshes. As noted in Orton et al. 2020, saltmarshes may become affected by the modification of edge erosion processes and/or sediment inputs from moderate or severe storms, respectively, which shape and form the horizontal and vertical dimensions of saltmarshes.

Impacts on Threatened and Endangered Species Habitat

Direct and indirect impacts on wetland habitat (estuarine marshes, scrub shrub, and supratidal wetlands) have the potential to adversely affect black rail. Direct impacts are expected to be negligible when considering the changes expected due to sea level rise during the study period. The extent of indirect effects on black rail habitat relative to sea level rise are still being considered.

6.2.4 Intertidal and Subtidal Habitats

Storm surge barriers and bay closures have the potential to impact 12 acres of intertidal habitat, 56 acres of subtidal habitat, and 4,111 linear feet of intertidal artificial rocky habitat. See Table 8 for additional detail. The majority of the intertidal impacts are from the bay closures in the Central Region. The majority of the subtidal impacts (predominantly subtidal soft bottom) result from the storm surge barriers. Storm surge barriers would also affect intertidal sandy beach and intertidal artificial rocky shorelines (inlet jetties). Losses would result from excavation or fill. Temporary losses of intertidal and subtidal habitats may be experienced through the placement of de-watering structures and either temporary fills or excavations for temporary access points to the work segment. As described in Section 5, intertidal habitats provide foraging habitat for roseate terns, red knots, and piping plovers. Subtidal habitats provide foraging habitat for sea turtles and potentially for Atlantic sturgeon, which are expected to occur further offshore.

The short-term indirect impacts of SSB and BC structures on intertidal and subtidal habitats are expected to be minimal to moderate and are related to temporary impacts such as sedimentation during construction. However, SSBs and BCs may pose long-term significant indirect effects on intertidal and subtidal habitats. Depending on the design of an SSB or BC, the available openings to pass tidal flows when open during normal conditions may be somewhat more constricted than existing inlets and other waterways. Estimates of these constrictions can range from 23%-46% of the existing inlets/waterways. A constriction could conceivably limit incoming (flood) tides resulting in a lowered high tide elevation and the outgoing (ebb) tides could result in higher low tides, aquatic habitats at each end of the tidal range on a bay-wide scale. These changes, even if subtle, could significantly impact habitat at the intertidal mudflat/open water subtidal transitional areas at the lower end of the tidal range over an entire bay-wide system. Flow constrictions could also result in increased velocities causing scour intertidal and subtidal habitat in the vicinity of the gates and decreased tidal velocities in areas further away, thereby increasing sediment deposition in other areas. Additional indirect impacts on these habitats relate to potential changes in salinity from gate closures and influxes of freshwater from precipitation, which could result in floral and faunal community shifts within these habitats.

Climate change and sea level rise also could compound these changes as evidenced in the SLAMM modeling where significant habitat shifts are predicted (see Section 4). Interactions of these types of structures with the existing tidal conditions and sea level rise are complex. Section 6.2.3 has initial AdH modeling results for storm surge barriers and bay closures using both open gate and closed gate scenarios.

Impacts on Threatened and Endangered Species Habitat

Direct and indirect impacts on intertidal habitats have the potential to adversely affect roseate terns, red knots, and piping plovers. Direct and indirect impacts on subtidal habitats have the potential to adversely affect sea turtles and to a less extent, Atlantic sturgeon, which are expected to occur further offshore. The extent of indirect effects on intertidal and subtidal habitat relative to sea level rise are still being considered.

6.2.5 Submerged Aquatic Vegetation

Construction of storm surge barriers could result in the mortality of SAVs and loss of SAV habitat. Impacts would result through either removal from excavations, burial from fill placement, or excessive turbidity, which may inhibit photosynthesis.

SAV surveys have not been conducted along any of the preliminary storm surge barrier and bay closure alignments. Additionally, mapping of SAV beds is only available for Barnegat Bay (spatial data adopted from http://crssa.rutgers.edu/projects/coastal/sav/ and Lathrop and Haag, 2010). According to the mapping, there are currently no SAV beds within a mile of the Barnegat Inlet SSB alignment; however, historical SAV beds occur within the footprint of the Barnegat Inlet SSB. This storm surge barrier has the potential to impact 3 acres of historical SAV beds. Impacts to SAVs from the other SSBs in the TSP (Manasquan Inlet and Great Egg Harbor Inlet) are unlikely due to the high energies and depths, which would be unsuitable for SAVs. No mapping is available for the two bay closures. A more precise estimate of temporary and permanent disturbance will be available upon completion of SAV surveys in all locations/waterways with SSB and BC structures and with a higher level of design and construction plan of the structures involved.

The operation of storm surge barriers and bay closures could potentially have significant indirect effects on SAV abundance and distribution in the affected bays by altering velocities, sediment scour and deposition, water quality, salinity levels and nutrient levels. These changes may be most significant in the Barnegat Bay and Little Egg Harbor estuaries, which have the most extensive beds and account for nearly 75% of the beds in New Jersey (Kennish et al. 2010). The potential changes associated with constrictions of flow while the gates are open during normal conditions may be negligible to significant. When storm surge barriers and bay closures are closed during storm events, changes could be more profound, albeit temporary, but could have the potential to affect the survival rate of SAVs due to fluctuations in temperature and salinity. While species such as eelgrass can be found in a wide range of salinity (0-30 ppt), eelgrass populations from different locations may have different genetic adaptations to salinity regimes and salinity/nutrient interactions. Changes in sediment deposition patterns could affect the distribution of eelgrass in the bay. Kukola (undated) reports that coarse-grained sediment substrates with less than 4% organic matter are ideal for eelgrass and that dark anaerobic silty sediments are not suitable. Additionally, eelgrass may become stressed and more susceptible to wasting disease from these changes (Kukola, undated draft white paper). Thus, any significant fluctuations in salinity and nutrients could potentially affect eel grass populations within the estuary.

Climate change and sea level rise also could compound these changes as evidenced in the SLAMM modeling where significant habitat shifts are predicted (see Section 4). Interactions of these types of structures with the existing tidal conditions and sea level rise are complex. Section 6.2.3 has initial AdH modeling results for storm surge barriers and bay closures using both open gate and closed gate scenarios.

Effects on SAV beds could have an indirect, adverse effect sea turtles, which forage in this habitat. Understanding of potential direct and indirect effects of SAV are speculative and SAV mapping does not exist for the entire footprint. Design details of storm surge barriers are unknown. Based on the current footprint of the storm surge barriers and bay closures, potential effects on SAV habitat are possible based on potential effects of historic SAV beds. SAV distributions are seasonal and can change from year to year. Additionally, indirect effects are not well understood at this time. Hydrodynamic and water quality modeling is being conducted to better understand potential indirect effects on SAVs, which can be used to consider associated effects on foraging sea turtles.

6.2.6 Estuarine Open Waters

Construction of the storm surge barriers and bay closures would result in direct impacts on water quality of estuarine open waters, which provide habitat for foraging sea turtles and potentially Atlantic sturgeon. These impacts would result from temporary localized increases in turbidity and total suspended solids during construction. Minor and temporary increases in turbidity are expected during construction from activities such as the installation and removal of temporary cofferdams, temporary excavations, fill and rock placement, concrete work, and vibrations during the pile driving (cylindrical and sheet piles).

Other activities such as earth disturbances resulting from construction access activities, staging/storage areas and upland excavations and soil stockpiles have the potential to generate turbidity as a non-point source. In accordance with Section 402 of the Clean Water Act, a sediment/erosion control plan will be submitted to the county conservation districts for their review and approval. Best management practices to avoid stormwater runoff from the construction sites, such as rock entrances, silt fencing, and physical runoff control, will be in the plan. Compliance with an approved sediment/erosion control plan/earth disturbance permit will result in negligible impacts in estuarine open waters as a result of sedimentation/turbidity. Areas disturbed during construction would be subsequently stabilized upon completion of construction activities and the potential for turbidity is expected to return to existing conditions.

The operation of barriers and closures has the potential for significant indirect impacts on water quality in the estuarine systems based on their potential for altering flow, circulation patterns, flushing, and residence time. These impacts are inherently based on the design of the barriers and closures such as the number of openings and widths of the openings, which could significantly alter the flow patterns through the inlets and bays by constricting flows and affecting current velocities.

A number of design components make up these barriers and closures, which include navigable sector gates, auxiliary flow lift gates, impermeable barriers, levees and seawalls. For the storm surge barriers, the navigable sector gates and auxiliary flow lift gates are the predominant in-water structures. The impermeable barrier structure is a hardened structure that is also an in-water structure that ties the gates into features on the adjacent land such as a levee, seawall or existing dune. The bay closures have the same components as the inlet barriers, but the bay closures also have other features such as road closures and miter gates and sluice gates, which are for smaller channels and tidal guts.

The navigable sector gate is open under normal conditions to allow for navigation traffic and tidal exchange. The auxiliary lift gates are vertical gates that are "up" during normal conditions to allow for tidal exchange. These gates would be designed to remain open during normal conditions. However, even with the gates in opened positions, there would be a net reduction (23% to 46%) in channel cross-sectional area that would act as a constriction to flood and ebb tidal currents through the inlets. Thus, increases in velocity through these gates are expected and decreases in velocity may occur in other parts of the bays that are farther removed from the inlet barriers and bay closures. These flow pattern changes may result in changes in circulation and increased residence times, which could have more profound effects in backwater areas that are already poorly flushed.

Restrictions in tidal flows and increases in residence times could affect salinity levels, nutrients, chlorophyll *a* and dissolved oxygen concentrations. These effects could be exacerbated at times when the gates are closed during a significant storm event when increased freshwater inputs, nutrients, bacteria and other pollutants discharged from tributaries and point and non-point sources are held in the bays for a longer period.

Climate change and sea level rise also could compound these changes as evidenced in the SLAMM modeling where significant habitat shifts are predicted (see Section 4). Interactions of these types of structures with the existing tidal conditions and sea level rise are complex.

Section 6.2.3 has initial AdH modeling results for storm surge barriers and bay closures using both open gate and closed gate scenarios.

Direct and indirect effects of the storm surge barriers and bay closures are primarily expected to affect sea turtles. Atlantic sturgeon and marine mammals are generally expected to occur offshore and are not likely to be adversely affected. These marine protected species highly mobile species and are expected to avoid the effects of turbidity, if necessary. Additionally, the action area is in the highly energetic,nearshore area; increases in suspended sediments are expected to be in the range of normal variability which these marine species would regularly experience. The net reduction in channel cross-sectional area and associated increase in flood and ebb tidal current velocities through the inlets may result in the potential for sea turtles to be trapped against the impermeable barriers of the storm surge barriers. This risk may increase in storm conditions when storm surge barriers are closed. Hydrodynamic and water quality modeling is being conducted to better understand potential indirect effects on water quality would affect foraging habitat for sea turtles.

6.2.7 Open Ocean Water

Storm surge barriers and bay closures would have no direct impacts on open ocean waters. Indirect impacts could occur during construction of storm surge barriers, which are near open ocean waters. This would be especially prevalent at the Great Egg Harbor Inlet storm surge barrier which in directly adjacent to open ocean waters. Indirect effects would be similar to those in estuarine open water and would temporary increases in turbidity and total suspended solids in the vicinity during construction. Minor and temporary increases in turbidity are expected during construction from activities such as the installation and removal of temporary cofferdams, temporary excavations, fill and rock placement, concrete work, and noise and vibrations during pile driving. These impacts are expected to be temporary and localized. Because nearshore open ocean waters is an energetic environment subject to wind and waves, turbidity is expected to diminish quickly and with distance. Fin whales, right whales, and Atlantic sturgeon typically occur in deeper offshore waters and are not expected to be affected by turbidity associated with the construction of storm surge barriers. Impacts on sea turtles are expected to be negligible and similar to those caused by a disturbance such as a storm.

Design and construction details are limited at this time and the sound-producing components of storm surge barrier construction and operation are unknown. Sounds associated with construction could cause injury or behavioral disturbance to protected marine species. Increases in vessel traffic could also result in an increased risk of collisions with protected marine species. Fin whales, right whales, and Atlantic sturgeon typically occur in deeper offshore waters and are not expected to be affected by noise or vessel traffic associated with the construction of storm surge barriers. Sea turtles occur in nearshore waters seasonally, but are less sensitive to noise.

Once the design and construction details are known, NMFS would be consulted to determine measures needed to avoid and minimized impacts on protected and marine species. These could include seasonal restrictions, protected species observers, and measures to avoid and vessel interactions with protected marine species.

6.3 Perimeter Plan

In general, the perimeter plan options that are still being considered in the Central and South regions include floodwalls and levees that would be constructed on the western side of the barrier islands along residential bayfronts and would tie into existing dunes at the northern and southern ends of the barrier islands.

The majority of the terrestrial habitats affected by the perimeter plan options are urbanized residential areas, where there are predominantly bulkhead structures that line the back bays and lagoons. The impacts of floodwall construction on terrestrial habitats in these areas would be temporary and minimal since they do not provide habitat for protected species.

The footprints of the perimeter plans pass through subtidal, intertidal, and supratidal regimes. The aquatic habitats most affected by the perimeter plans are the subtidal soft bottom areas with hardened (bulkhead, concrete wall) shorelines, intertidal mudflats and sandy beaches, low and high tidal saltmarshes, scrub-shrub habitats, and *Phragmites*-dominated marshes. A high number of these habitats are encountered as small pockets along heavily developed bay shorelines of the barrier islands. However, since the perimeter plan segments tend to be several miles long, the impacts are cumulative and significant.

Table 9 provides preliminary estimates of permanent habitat impacts of the perimeter plan options that are still under consideration. Additionally, Appendix F.1, provides figures demonstrating habitat interactions with current alignment; however, design details, including alignments are limited at this time.

6.3.1 Woodlands

Woodlands are not common in the study area; however, the perimeter plan in Cape May in the South Region would result in approximately 4 acres of direct impacts on forested wetlands. Although design details are limited at this time, removal of potential roost trees would be avoided to the extent practicable. If potential roost trees cannot be avoided, the USFWS would be consulted as appropriate under the ESA 4(d) rule.

6.3.2 Upper Beach and Dune

Perimeter plans require the construction of the levee structures through existing vegetated dune habitats particularly on the northern and/or southern ends of barrier islands where the perimeter plans tie into existing dunes. The perimeter plans in the Central Region would result in 8 – 11 acres of vegetated dune and beach habitat. The perimeter plan in the South Region would result in approximately 9 acres of vegetated dune and upper beach habitat. These areas would be stabilized and restored with coastal dune vegetation once construction is completed, and impacts on terrestrial habitat would, therefore, be temporary and minor.

Pump stations for interior drainage will be required for perimeter plans and would likely be sited in a terrestrial location behind the perimeters. At this time, it is not known where the location of pump stations would be constructed. Urbanized locations for these features would be used to the maximum extent practicable.

Measures will be taken to avoid direct and indirect impacts of construction activities on seabeach amaranth and piping plover, to the extent possible. Construction activities will temporarily remove vegetation which could have direct effects on both species. Indirect impacts on upper beach and dune habitats, such as the suspension and settling of dust would be negligible and would be controlled under the erosion and sediment control plan. Noise from construction activities also disturb nearby piping plovers. Examples of measures that would be used to avoid and minimize impacts on these species are provided in Section 6.2.2.

6.3.3 Wetland Habitats

Construction of the floodwalls, levees and miter gate structures within coastal wetlands and shallow bay waters result in the loss of these habitats within the footprint of the structures. In the Central Region the perimeter plan would result in losses of 62 – 80 acres of estuarine marshes, 10 acres of scrub shrub, and 29 acres of supratidal marshes. In the South Region the perimeter plan would result in losses of 96 acres of estuarine marshes, 20 acres of scrub shrub, and 12 acres of supratidal marshes. These losses would result from either their removal from excavations or burial from fill placement. Additionally, temporary losses may be experienced through the placement of de-watering structures and either temporary fills or excavations for temporary access points to the work segment. Preliminary estimates of the affected wetland and shallow water habitats are based on existing mapping (NJDEP wetland mapping and National Wetlands Inventory - NWI), the current (preliminary) alignments and an assumed width of the disturbance offset from the structure.

It should be noted that, to date, no jurisdictional wetland delineations have been conducted along any of the perimeter plan alignments. Therefore, these impact estimates may be modified and refined based on a higher level of design detail that include surveyed wetland jurisdictional lines, and mitigation measures that first employ avoidance and minimization. However, it is assumed that for unavoidable wetland and aquatic habitats, compensatory mitigation will be required based on habitat modeling. Ecosystem modeling being considered for wetlands and aquatic habitat impacts and mitigation include the USACE EcoPcX approved New England Marsh Model (McKinney et al., 2009) and the New York Bight Ecological Model (NYBEM- currently under development).

Temporary indirect impacts from construction of the perimeter plan components would be similar to those from construction of the storm surge barriers and bay closures. Indirect impacts on wetlands are expected to be minimal to moderate and are related to impacts such as sedimentation during construction. Long-term indirect impacts are related to hardened structures potential halting landward migration of marshes, particularly with sea level rise. However, this effect is not expected to be significant since the majority of the shorelines along the back bays already are hardened with bulkheads, concrete revetments and riprap.

Climate change and sea level rise also could compound these changes as evidenced in the SLAMM modeling where significant shifts in wetland types are predicted (see Section 4). Interactions of these types of structures with the existing tidal conditions and sea level rise are complex.

Direct and indirect impacts on wetland habitat (estuarine marshes, scrub shrub, and supratidal wetlands) have the potential to adversely affect black rail. Direct impacts are expected to be negligible when considering the changes expected due to sea level rise during the study period. The extent of indirect effects on black rail habitat relative to sea level rise are still being considered.

6.3.4 Intertidal and Subtidal Habitats

Based on current alignments, the footprints of the perimeter plans pass through intertidal and subtidal habitat. In the Central Region, the Perimeter Plan would result in 11-12 acres of impacts on intertidal sand, 16 – 26 acres impacts on intertidal mud, 4,196 linear feet of intertidal artificial rocky shoreline, 4 – 5 acres of subtidal soft bottom habitat, and 80 – 95 acres of subtidal hardened shoreline. In the South Region, the Perimeter Plan would result in 10 acres of impacts on intertidal sand, 32 acres impacts on intertidal mud, 2,404 linear feet of intertidal artificial rocky shoreline, 1 acre of subtidal soft bottom habitat, and 106 acres of subtidal hardened shoreline.

Permanent losses would result from excavation or fill. Temporary impacts on intertidal and subtidal habitats may be experienced through the placement of de-watering structures and either temporary fills or excavations for temporary access points to the work segment. As described in Section 5, intertidal habitats provide foraging habitat for roseate terns, red knots, and piping plovers. Subtidal habitats provide foraging habitat for sea turtles and potentially for Atlantic sturgeon, which are expected to occur further offshore.

Temporary indirect impacts from construction of the perimeter plan components would be minimal to moderate and are related to impacts such as sedimentation during construction. Long-term indirect impacts are related to hardened structures potential halting landward migration of marshes, particularly with sea level rise. However, this effect is not expected to be significant since the majority of the shorelines along the back bays already are hardened with bulkheads, concrete revetments, and riprap.

Direct and indirect impacts on intertidal habitats have the potential to adversely affect roseate terns, red knots, and piping plovers. Direct and indirect impacts on subtidal habitats have the potential to adversely affect sea turtles and to a less extent, Atlantic sturgeon, which are expected to occur further offshore. The extent of indirect effects on intertidal and subtidal habitat relative to sea level rise are still being considered.

6.3.5 Submerged Aquatic Vegetation

Construction of floodwalls and miter gate structures within shallow bay waters could result in the mortality of SAVs within the footprint of the perimeter plans. Impacts would result through either removal from excavations, burial from fill placement or excessive turbidity, which may inhibit photosynthesis. Additionally, temporary losses of SAVs may be experienced through the placement of de-watering structures and either temporary fills or excavation for temporary access points to the work segment. SAV estimates are not available for the Central and South regions; therefore, preliminary estimates of SAV beds for the perimeter plan options cannot be made at this time. An estimate of temporary and permanent disturbance will be available upon completion of SAV surveys in all locations/waterways within the footprint of the perimeter structures, when a higher level of design and construction plan of the structures are available.

Indirect impacts of the perimeter plan are not expected to be significant due to the duration of impact but could contribute additional stressors on an already biologically stressed community. Indirect impacts on SAV could result from resuspension of sediments containing nutrients and a decrease of transitional upland areas (by increasing hardened shoreline) that act as filters for non-point source run-off. Increased run-off and nutrients would contribute to increased turbidity, eutrophication and phytoplankton/filamentous algae and macroalgae blooms. Increased phytoplankton blooms could contribute to significant declines in SAV beds or a decrease in the density of the beds, by interfering with photosynthesis from shading of the water column and/or promoting the epiphytic growth on the leaves (wasting disease), and the smothering of beds with decaying algae. Reductions in SAV beds have further indirect impacts on the ecological services provided by SAVs including benthic invertebrate communities, shellfish beds, fish nurseries, sediment stabilization and wave attenuation. The level of these effects are difficult to quantify, but the temporary impacts can be managed by implementing best management practices during construction to minimize sedimentation and turbidity. Additionally, the perimeter plan options would be designed so that no increase in runoff would occur post-construction.

Effects on SAV beds could adversely affect sea turtles, which forage in this habitat. Understanding of potential direct and indirect effects of SAV are speculative. While no direct effects on existing SAV beds are expected, SAV mapping does not exist for the footprint. Additionally, SAV distributions are seasonal and can change from year to year.

6.3.6 Estuarine Open Water

Construction of floodwalls, levees, and miter gates would result in minor and temporary increases in turbidity and total suspended solids in the vicinity during construction. These would result from activities such as the installation and removal of temporary cofferdams, temporary excavations, fill and rock placement, and noise and vibrations during the pile driving. Other activities such as earth disturbances resulting from construction access activities, staging/storage areas and upland excavations and soil stockpiles have the potential to generate turbidity as a non-point source. In accordance with Section 402 of the Clean Water Act, a sediment/erosion control plan will be submitted to the county conservation districts for their review and approval. The plan will include measures to avoid these effects, such as rock entrances, silt fencing, physical runoff control, as well as other best management practices. Compliance with the approved sediment/erosion control plan/earth disturbance permit will result in minimal sedimentation/turbidity. Areas disturbed during construction would be subsequently stabilized upon completion of construction activities and turbidity is expected to return to normal levels.

The perimeter plans will require pump stations to collect interior drainage from significant precipitation events. These pump stations would generally receive urban run-off from impermeable surfaces such as buildings, streets, and parking lots that may contain typical urban non-point source pollutants such as sediments, bacteria, nutrients, and oil and grease. The pumps would not necessarily increase these stormwater discharge but might focus stormwater at fewer locations based on the pump station location, rather than the current stormwater drainage systems. Currently, stormwater drainage systems might discharge directly into the bays at the street ends or through combined sewers. Stormwater drainage systems vary by community and would require further investigation to determine the appropriate locations and design for the interior drainage pumps and outfalls.

Miter gates will be installed and operated across smaller channels that require navigable access. These gates would remain open during normal conditions and would be closed during significant storm events. Some localized, but minor changes in hydrodynamics around the gates are expected, however, no significant changes in water quality are expected while the gates are open. Miter gate closures during storms may temporarily affect water quality in a localized area by inhibiting circulation and mixing.

Direct and indirect effects of the perimeter plan options are primarily expected to affect sea turtles. Atlantic sturgeon and marine mammals are generally expected to occur offshore and are not likely to be adversely affected. These marine protected species highly mobile species and should be expected to avoid the effects of turbidity if necessary. Additionally, the action area is in the highly energetic, nearshore area and increases in suspended sediments are expected to be in the range of normal variability, which these marine species would regularly experience.

6.3.7 Open Ocean Water

Construction and maintenance of floodwalls in the perimeter plan are not expected to result in direct or indirect impacts on open ocean waters or the protected marine species that use them.

6.4 Natural and Nature Based Features

NNBFs will be included in the TSP as standalone feature or complementary feature to a structural feature. NNBFs would include but not be limited to: living shorelines, reefs, wetland restoration, submerged aquatic vegetation (SAV), and modifications to structural measures including habitat benches to restore natural slope along shorelines and textured concrete to support colonization of algae and invertebrates.

6.4.1 Woodlands

Design details are limited for natural and nature-based features at this time, removal of potential roost trees would be avoided to the extent practicable. If potential roost trees cannot be avoided, the USFWS would be consulted as appropriate under the ESA 4(d) rule.

6.4.2 Beach and Dune

Impacts on upper beach and dune habitat would depend on the NNBF feature and method of construction. At this time, the degree and extent of impacts from NNBF measures are not known. For the most part, NNBFs would be constructed in aquatic habitats. It is assumed that access through and staging in terrestrial areas may be required and could result in temporary land disturbance. However, impacts on sensitive habitat, such as dune habitat, would be avoided to the maximum extent practicable. Terrestrial habitats could be incorporated into proposed NNBF measures. An example would be the creation of a supratidal open sandy area for colonial nesting birds on a predominantly saltmarsh island.

6.4.3 Wetlands Habitat

Impacts on wetland habitat would depend on the NNBF feature and method of construction. Some NNBFs like wetland restoration may require the aquatic placement of fill materials in the wetland being restored or in subtidal or intertidal habitats. The installation of NNBFs could result in conversions of habitat. For example, a subtidal soft-bottomed habitat may be changed to an intertidal saltmarsh. However, the installation of NNBFs would have beneficial impacts, by providing overall ecological uplifts of wetland habitats in the NJBB study area.

6.4.4 Intertidal and Subtidal Habitats

Impacts on subtidal and intertidal habitat would depend on the NNBF feature and method of construction. As discussed above, wetland restoration may require the aquatic placement of fill materials in aquatic habitats that would disturb existing substrates such as subtidal soft bottoms or intertidal mud or sand flats. These would be localized, but temporary, turbidity in the water column. These effects are expected to be temporary and would end after construction is complete and the areas become stabilized with vegetation or other biogenic processes. While the installation of NNBFs could also result in conversion of habitat, for example, a subtidal soft-bottom habitat may be changed to an intertidal saltmarsh, a restoration or ecological uplift is expected with the use of a NNBF. Therefore, the installation of NNBFs would have beneficial impacts.

6.4.5 Submerged Aquatic Vegetation

One of the criteria for choosing NNBF locations would be the avoidance of important SAV; therefore, no adverse effects on SAVs are expected. As discussed, SAVs can be utilized as an NNBF measure in the form of restoration. The implementation of SAV NNBFs would provide ecological services such as stabilizing substrates, resulting in less turbidity, nutrient uptake, providing suitable habitat for filter feeders (shellfish) in order to capture phytoplankton and suspended particles, and providing structure for various life stages of finfish.

6.4.6 Estuarine Open Waters

Construction of NNBFs may require the aquatic placement of fill materials that would disturb existing substrates (soil or sediments), and generate localized, but temporary, turbidity in the water column. These effects are expected to be temporary after construction is complete and the areas become stabilized with vegetation and/or other biogenic processes. NNBFs are expected to have long-term beneficial impacts on water quality by providing services such as sediment stabilization with reduced turbidity, nutrient uptake, and by providing habitat for filter feeders that can capture phytoplankton and suspended particles.

6.4.7 Open Ocean Water

Construction and maintenance of natural and nature-based features are not expected to result in direct or indirect impacts on open ocean waters or the protected marine species that use them.

7.0 EFFECTS ANALYSIS

7.1 Tentatively Selected Plan

7.1.1 Piping plover

Piping plovers have the potential to nest, forage, rest, and migrate through the Action Area. Noise associated with construction and maintenance structural or nonstructural measures in the TSP have the potential to result in minor direct and indirect impacts on piping plover flight, foraging, and nesting behaviors, including flushing from these activities. These disturbances could occur from upland or aquatic construction or maintenance activities. These impacts are expected to be temporary and localized and would be avoided by avoiding construction during piping plover breeding season, to the maximum extent practicable.

Construction of storm surge barriers, bay closures, and nonstructural measures have the potential to affect piping plover nesting habitat in the upper beach and dunes. Beach slope is a critical factor for piping plover habitat selection and use. It is important not to design a slope greater than the piping plover can utilize. In order to maintain existing habitat conditions, the slope of the placement material shall be consistent with adjacent existing beaches that contain successful brooding areas. It is the practice of the Philadelphia District to create stable beaches which mimic natural, pre-erosion conditions; therefore, the beach slope suitable for use by plovers for nesting or foraging will be maintained or created to the maximum extent practicable.

Noise and sediment disturbances caused by aquatic construction activities have the potential to indirectly affect the foraging success of the piping plover by disturbing benthic invertebrates in intertidal habitat. Studies have shown that most species within the benthic invertebrate community along the shoreline will repopulate the area of impact within a few months (National Research Council, 1995; USACE, 1999; Versar 2001). Closure of the storm surge barriers and tide gates could also result in upstream shifts in salinity, dissolved oxygen, and nutrients which could also temporarily limit prey species availability.

If construction of storm surge barriers and bay closures occurs outside of the plover nesting season (April 1 - August 15), these activities would not have any direct impacts on the piping plover nests, chicks, or the population itself. Similarly, if construction activities would not have direct effects on piping plovers if they are conducted during the plover nesting season in areas that do not provide piping plover habitat. If construction activities take place during the plover season when plovers are present however, these activities could have both direct and indirect impacts on nesting plovers and chicks, as well as their habitat. Trucks or bulldozers, for example, could trample plover chicks, or noise from their operation could impact mate selection, courtship displays, and territorial defense.

In order to avoid direct and indirect impacts, the District will try to avoid construction activities during the plover nesting where plover are present to the maximum extent practicable. If construction activities during the nesting season cannot be avoided (due to monetary issues, quantity of sand required, weather constraints, etc.) the District would attempt to survey for nests and mark avoidance buffers around them and schedule activities in such a way as to avoid areas within the action area with active nests until nesting is complete.

In summary, potential direct impacts to piping plovers, if construction takes place during nesting and breeding season in areas where plovers are present include: ·

- Temporary unavailability of suitable resting, foraging, and nesting habitat during construction.
- Decrease in available nesting and foraging habitat.
- Loss of productivity due to construction disturbance and harassment.
- Temporary unavailability or reduction of benthic prey resources.
- Injury to or loss of piping plover nests and/or chicks

The Corps would adopt measures to avoid impacts on piping plovers, to the maximum extent practicable.

Cumulative impacts to the piping plover include the reduction of beach nesting habitat, breeding, and foraging habitat. Increased sea levels and continued development also have the potential to impact this species, although the level of impact is relatively uncertain. The impact of the TSP is expected to be negligible relative to the impacts from past, present, and future development and sea level rise. The TSP is not predicted to cumulatively or synergistically interact with other past, present, or future projects in such a way that would significantly adversely the piping plover.

7.1.2 Eastern Black Rail

Eastern black rails have the potential to nest, forage, rest, and migrate through the Action Area. Noise associated with construction and maintenance structural or nonstructural measures in the TSP have the potential to result in minor direct and indirect impacts on eastern black rail flight, foraging, and nesting behaviors, including flushing from these activities. These disturbances could occur from upland or aquatic construction or maintenance activities. These impacts are expected to be temporary and localized and would be avoided by avoiding construction during breeding season, to the maximum extent practicable.

Construction of storm surge barriers and bay closures in the TSP have the potential to permanent and temporary impacts on wetland habitats that provide nesting habitat for Eastern black rails. It is assumed that for unavoidable wetland and aquatic habitats, compensatory mitigation will be required based on habitat modeling.

Sediment disturbances caused by aquatic construction activities has the potential to indirectly affect the foraging success of the Eastern black rail by disturbing benthic invertebrates in intertidal habitat. Studies have shown however that most species within the benthic invertebrate community along the shoreline will repopulate the area of impact within a few months (National Research Council, 1995; USACE, 1999; Versar 2001). Closure of the storm surge barriers and tide gates could also result in upstream shifts in salinity, dissolved oxygen, and nutrients which could also temporarily limit prey species availability.

In summary, potential direct impacts to eastern black rail, if construction takes place during nesting and breeding season in areas where rails are present include: ·

- Temporary unavailability of suitable resting, foraging, and nesting habitat during construction.

- Decrease in available nesting and foraging habitat.
- Temporary unavailability or reduction of benthic prey resources.

Cumulative impacts to Eastern black rail include the loss of nesting habitat, breeding, and foraging habitat. Increased sea levels and continued development also have the potential to impact these species, although the level of impact is relatively uncertain. The impact of the TSP is expected to be negligible relative to past, present, and future development and sea level rise. The TSP is not predicted to cumulatively or synergistically interact with other past, present, or future projects in such a way that would significantly adversely the Eastern black rail.

7.1.3 Roseate Tern

Roseate terns have the potential to forage, rest, and migrate through the Action Area. Noise associated with construction and maintenance structural or nonstructural measures in the TSP have the potential to result in minor impacts on roseate flight and foraging behaviors, including flushing from these activities. These disturbances could occur from upland or aquatic construction or maintenance activities. These impacts are expected to be temporary and localized and would be avoided to the maximum extent practicable.

Noise and sediment disturbances caused by aquatic construction activities have the potential to indirectly affect the nesting foraging success of the roseate by disturbing fish in estuarine waters. Closure of the storm surge barriers and tide gates can result in upstream shifts in salinity, dissolved oxygen, and nutrients which could also temporarily limit prey species availability.

In summary, potential direct impacts to roseate terns if construction takes place during when they are present include:

- Temporary unavailability of suitable resting and foraging habitat during construction.
- Temporary unavailability or reduction of prey resources.

Cumulative impacts to the roseate tern could include a change in distribution of species related to indirect impacts from storm surge barriers and from sea level rise, although the level of impact is relatively uncertain. The impact of the TSP is expected to be negligible relative to the impacts from sea level rise. The TSP is not predicted to cumulatively or synergistically interact with other past, present, or future projects in such a way that would significantly adversely the roseate tern.

7.1.4 Red Knot

Red knots have the potential to forage, rest, and migrate through the Action Area. Noise associated with construction and maintenance structural or nonstructural measures in the TSP have the potential to result in minor impacts on red knot flight and foraging behaviors, including flushing from these activities. These disturbances could occur from upland or aquatic construction or maintenance activities. These impacts are expected to be temporary and localized and would be avoided to the maximum extent practicable.

Noise and sediment disturbances caused by aquatic construction activities have the potential to indirectly affect red knot by disturbing benthic invertebrates in intertidal habitat. Closure of the storm surge barriers and tide gates can result in upstream shifts in salinity, dissolved oxygen, and nutrients which could also temporarily limit prey species availability.

In summary, potential direct impacts to red knots if construction takes place during when they are present include:

- Temporary unavailability of suitable resting and foraging habitat during construction.
- Temporary unavailability or reduction of prey resources.

Cumulative impacts to the red knot could include a change in distribution of species related indirect impacts from storm surge barriers and from sea level rise, although the level of impact is relatively uncertain. The impact of the TSP is expected to be negligible relative to the impacts from sea level rise. The TSP is not predicted to cumulatively or synergistically interact with other past, present, or future projects in such a way that would significantly adversely the red knot.

7.1.5 Seabeach amaranth

Construction of storm surge barriers and bay closures have the potential to affect vegetated dunes and upper beaches that provide habitat for seabeach amaranth. Direct sand placement onto the plant species during the growing season will result in mortality with no chance of seed production. Also, if seeds are buried, the population could suffer adverse impacts that could significantly impact the local population.

Beach slope is also a critical factor for seabeach amaranth habitat selection and use. It is important not to engineer a slope greater than what is exhibited at seabeach amaranth locations, if present. In order to maintain existing habitat, the slope of the placement material must be consistent as compared to the current habitat.

If construction activities occur during the seabeach amaranth growing season, potential trampling of the plants by workers, vehicles, or construction equipment could also destroy the plants directly.

Construction impacts on seabeach amaranth would be avoided to the maximum extent practicable. Surveys in the appropriate habitat for seabeach amaranth would be conducted prior to construction during the growing season. USFWS would be consulted if seabeach amaranth is identified. Seabeach amaranth dies back in September and is no longer in a form that is easily impacted.

7.1.6 North Atlantic Right and Fin Whales

North Atlantic right use the waters off New Jersey as a migratory pathway, but typically occur further offshore than the action area. Fin whales also use the waters off New Jersey for migration, but also potentially calve there. It is unknown where calving, mating and wintering occur for the majority of the fin whale population. Fin whale also typically occur outside the action area in New Jersey.

These species have the potential to be affected by noise and vessel operations associated with construction, operation, and maintenance of the storm surge barrier; however, they are generally expected occur further offshore than the extent of these impacts making the potential for these impacts discountable.

7.1.7 Atlantic Loggerhead, Kemp's Ridley, Atlantic Green, and Leatherback Sea Turtle

Construction, operation, and maintenance of the storm surge barriers, which are part of the TSP have the potential to result in direct and indirect effects on sea turtles. Atlantic Loggerhead, Kemp's Ridley, Atlantic Green, and leatherback sea turtles have the potential to occur in the action area, typically from May through November. Leatherback sea turtles generally occur further offshore than the other sea turtles.

Construction of the storm surge barriers have would temporary direct impacts on estuarine open waters, intertidal and subtidal benthic habitat, including SAV, which serve as sea turtle forging habitat. Minor and temporary increases in turbidity are expected during construction from activities such as the installation and removal of temporary cofferdams, temporary excavations, fill and rock placement, concrete work, and noise and vibrations during pile driving. Temporary disturbances of intertidal and subtidal habitats, including SAV, may be experienced through the placement of de-watering structures and either temporary fills or excavations for temporary access points to the work segment. Temporary habitat impacts could also sedimentation from sediment disturbance. Benthic habitats are expected to recover quickly. Because these impacts are temporary and localized, impacts are expected to be insignificant.

Storm surge barriers and bay closures have the potential to result in the loss of 12 acres of intertidal habitat, 56 acres of subtidal habitat, and 3 acres of historical SAV beds. See Table 8 for additional detail. The presence of the storm surge barriers could result in additional long-term impacts from increased velocities and scouring described in Section 6.2.4.

Turbidity and noise associated with construction, maintenance, and operation of the structures could disturb sea turtles foraging in New Jersey back bays, causing them to move away from these activities. This could result in an adverse effect in their daily movement patterns or foraging in the Action Area. Depending on the noise source, noise could result in injuries to sea turtles. Interactions with mechanical equipment could also result in injury to sea turtles. If possible, construction would be scheduled to avoid times when sea turtles are present in the action area. If construction cannot be avoided when sea turtles are present in the action area, BMPs would implemented to avoid and minimize impacts on sea turtles; examples include:

- Develop a protected marine species monitoring and shut down plan.
- Use a mechanical dredge rather than a pipeline or hopper dredge.
- For pile driving, use a vibratory hammer instead of an impact hammer, to the maximum extent practicable.
- Use cushion blocks or other noise attenuation devices when using an impact hammer for pile driving.

- Limit pile driving activities to no more than 12 hours per day.
- Use a “soft start” for a pile driving activities where driving does not occur at full power at first.
- Pile driving should be carried out in a way that avoids exceeding noise thresholds identified for the protected marine species that occur in the action area.

Construction and maintenance of the storm surge barriers and bay closures could result in a slight increased risk of a sea turtle-vessel interaction or collision. A risk of a vessel strike would be low because of the very limited amount of time construction or maintenance barges or vessels would be in the water associated with construction and maintenance of features and likely due to the limited speed of the vessels. Additionally, NMFS vessel operation BMPs would be implemented to the maximum extent practicable to avoid and minimize impacts; these include:

- Shallow draft vessels that maximize the navigational clearance between the vessel and the river bottom should be used where possible.
- Vessels should operate at speeds of less than 10 knots. Whenever operating in areas where whales or sea turtles are present, a look out should be posted and measures taken to slow down and avoid any whales or sea turtles spotted.

Indirect impacts on sea turtle foraging habitat could result from potential changes in salinity from gate closures and influxes of freshwater from precipitation, which could result in changes in floral and faunal community. Indirect effect on sea turtle foraging habitat and prey species could result from the operation of storm surge barriers by altering velocities, sediment scour and deposition, water quality, salinity levels, and nutrient levels. The changes could occur from both from the presence of the storm surge barriers and bay closures, as well as the closing of the barriers. Gate closures would occur with influxes of freshwater from precipitation. These changes could result in the effects on the abundance and distribution of SAV, as well as benthic and floating invertebrates that serve as foraging habitat and prey for sea turtles. See Sections 6.2.4, 6.2.5, and 6.2.6 for additional detail.

Understanding of potential direct and indirect effects of SAV are speculative. While no direct effects on existing SAV beds are expected, SAV mapping does not exist for the entire footprint. Additionally, SAV distributions are seasonal and can change from year to year. A more precise estimate of temporary and permanent disturbance will be available upon completion of SAV surveys in all locations/waterways with SSB and BC structures and with a higher level of design and construction plan of the structures involved

Closure of the storm surge barriers and tide gates could result trap sea turtles or impede their passage into the Action Area. This could potentially affect their daily movement patterns, migrations in and out of the Action area, and potentially could also impact their foraging in the Action Area. Storm surge barriers could also result in indirect effects in the Action Area, which could, in turn, foraging opportunities for sea turtles in the Action Area while turtles are trapped behind the storm surge barriers. This would only occur storm surge barriers and bay closures are closed during storm conditions. This would be a temporary effect as the storm surge barriers and bay closures would not likely be closed for a period of more than a week at a time and mortalities are not expected.

In summary, construction, operation, and maintenance of the storm surge barriers associated with the TSP have the potential for direct and indirect effects on sea turtles. These include

- Loss of habitat;
- Changes in distribution of SAV and prey species;
- Noise impacts including changes in behavior or injury;
- Potential for injury from mechanical equipment associated with construction;
- Vessel interactions; and
- Entrapment within storm surge barriers.

The impacts from the TSP could result in potential cumulative on sea turtles from the following past, present and future impacts which occur throughout the sea turtles' range:

- Ship strikes from commercial and recreational vessel traffic;
- Noise impacts from other water front construction and development;
- Exposure to contaminants such as oil spills;
- Loss of habitat from development and sea level rise;
- Changes in the abundance and distribution of foraging habitat and prey species associated with climate change.
- Fishery bycatch and entanglement in derelict fishing gear.

The impact of the TSP is expected result be negligible relative to the effects, injuries, and mortalities resulting from these stressors.

7.1.8 Atlantic Sturgeon

Atlantic sturgeon might use the New Jersey Back Bay and the nearshore coastal waters off New Jersey during their adult marine lifestage, but typically occur further offshore than the action area. While this species have the potential to be affected by noise and vessel operations associated with construction, operation, and maintenance of the storm surge barrier, because it is expected occur further offshore than the extent of these impacts, the potential for these impacts is discountable.

7.2 Perimeter Plan Options

Impacts on threatened and endangered species associated with the Perimeter Plan Options would be similar to impacts from the TSP, with additional habitat impacts provided in Table 9.

8.0 MITIGATION

Because of the direct impacts that TSP structural components will have on aquatic habitats, a compensatory mitigation plan is being developed that would account for the functional losses of ecosystem services that these habitats provide. The TSP components would directly affect over 153 acres of aquatic habitats, which includes about 60 acres of subtidal soft-bottom habitats, about 2 acres of intertidal mud/sand flats, about 9 acres of intertidal sandy beach, and 73 acres of low and high marshes. The remaining 10 acres are adjacent scrub-shrub and other supratidal wetlands. Mitigation estimates for losses of saltmarshes were determined by the use of the New England Marsh Model and the subtidal and intertidal habitat impacts were based on the presence of shellfish bed or SAV mapping. Mitigation estimates for these habitats were based on a replacement of a higher quality habitat such as an SAV bed (subtidal) or a living shoreline (intertidal). The New York Bight Ecological Model (NYBEM) ecosystem model that considers all key aspects of the various marine, estuarine, and freshwater aquatic habitats within the affected area is currently in development and will be applied in subsequent phases to better determine the functional aspects and effects on habitat suitability and new mitigation estimates will be derived.

Table 10. Preliminary Estimates of Direct Habitat Impacts and Compensatory Mitigation Estimates of the TSP

		Subtidal		Intertidal		Saltmarsh		Other Supratidal wetlands	
TSP Alt.	Structural Feature	Est. Losses (acres)	Est. Mitigation* (acres)	Est. Losses (acres)	Est. Mitigation (acres)	Est. Losses (acres)	Est. Mitigation (acres)	Est. Losses (acres)	Est. Mitigation (acres)
3E(2)	Manasquan Inlet SSB	2.1	1.7	0	0	0	0	0	0
	Barnegat Inlet SSB	14.8	21.5	0.8	1.1	0	0	0	0
4G(8)	GEHI SSB	20	16	5.6	4.4				
	Absecon Blvd. BC	21	25.2	6.0	6.4	49.7	83	6.7	9.7
	SOC BC	1.6	2.1	0	0	23.5	44.4	2.1	3.6
TOTAL		**59.5**	**66.5**	**12.4**	**11.9**	**73.2**	**127.4**	**8.8**	**13.3**

Compensatory mitigation estimates for indirect effects have not been fully assessed at this time. It is assumed that there could be significant losses of saltmarsh and intertidal habitats over large areas due to small tidal amplitude changes along with potential effects on fish larval/egg transport with increases in velocity in the vicinity of the SSB and BC gates. Therefore, the cost estimates currently include a 5% contingency (based on first construction costs of the TSP feature) for indirect effects for compensatory mitigation and adaptive management. It is assumed that as modeling is further advanced (AdH -closed gates scenarios and NYBEM), impact estimates would become better quantified and compensatory mitigation can be derived based on applying the available NYBEM ecosystem model. Additionally, subsequent design phases will continually investigate avoid/minimization measures that would reduce hydrodynamic changes that drive these indirect effects.

9.0 CONCLUSION AND DETERMINATION OF EFFECTS

The USACE has concluded that the TSP is likely to adversely affect the following species:

- Piping plover
- Eastern black rail
- Seabeach amaranth
- Atlantic loggerhead sea turtle
- Kemp's ridley sea turtle
- Atlantic green sea turtle
- Leatherback sea turtle

The USACE has concluded that the TSP is not likely to adversely affect the following species:

- Roseate tern
- Red knot
- North Atlantic right whale
- Fin whale
- Atlantic sturgeon

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