ENVIRONMENTAL APPENDIX
TIER 1 ENVIRONMENTAL MITIGATION

NEW JERSEY BACK BAYS
COASTAL STORM RISK MANAGEMENT
FEASIBILITY STUDY

PHILADELPHIA, PENNSYLVANIA

APPENDIX F.4

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NJBB
NEW JERSEY BACK BAYS STUDY

U.S. Army Corps of Engineers
Philadelphia District

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1.0 PURPOSE OF THE ENVIRONMENTAL MITIGATION PLAN

The purpose of this document is to describe the methodology used to identify those areas requiring environmental mitigation and to describe the anticipated, required environmental mitigation with implementation of the Preferred Alternative (Tentative Selected Plan-TSP), Alternatives 2A+3E(2)+4G(8)+5A for the New Jersey Back Bays (NJBB) Coastal Storm Risk Management (CSRM) Project. This document describes the geospatial and environmental modeling analyses conducted and the proposed mitigation strategy to compensate for the functional loss of permanent impacts to wetlands, mudflats, and open water habitats from implementation of the Preferred Alternative (TSP).

The Tentatively Selected Plan (TSP) for Coastal Storm Risk Management (CSRM) will have permanent impacts to multiple different habitat types. The TSP will consist of three storm surge barriers or inlet closures at Manasquan Inlet, Barnegat Inlet, and Great Egg Harbor Inlet; two bay closures at Absecon Boulevard, and southern Ocean City; and

nonstructural solutions for 18,800 structures including elevation and flood proofing. Nonstructural solutions are considered for 11% of the study area and are concentrated in the Shark River region, and in Ocean and Atlantic Counties specifically on Long Beach Island and Brigantine as well as mainland shorelines between Beach Haven West and Absecon. Nonstructural solutions are also concentrated in Cape May County. The USACE is also actively pursuing Natural and Nature Based Features (NNBF) as a viable means of providing CSRM protection, which will be considered and further evaluated beyond the TSP milestone phase.

Currently, the NJBB has completed the TSP milestone phase of the U.S. Army Corps of Engineers' (USACE) Specific, Measurable, Attainable, Risk Informed, Timely (SMART) Civil Works planning process, where a plan has been tentatively selected for agency, technical, and public review, and vertical chain of command approval. At this stage of the planning, the major components of the plan have been identified and evaluated at a higher level of analysis, and will be analyzed in greater detail and refined in the next planning phase, following approval during the Agency Decision Milestone (ADM) meeting. Consistent with USACE policy in Planning Bulletin PB 2017-01, there is a certain level of uncertainty expected in the size and make-up of the TSP, and other plans identified from the suite of alternatives analyzed in this initial phase, including the National Economic Development (NED) Plan, or a variant preferred by the non-Federal sponsor (the Locally Preferred Plan). As such, the final size of the measures (width, length, etc.), and inclusion or exclusion of some of them in the TSP presented in this Draft Mitigation Plan may change in the next planning phase. These changes can affect the habitat impacted. Because of the conservative nature of economic and engineering assumptions used during the initial planning of the TSP, it is anticipated that the design of proposed structures will result in equal or greater environmental impacts.

2.0 PURPOSE AND NEED FOR THE PROPOSED ACTION

The U.S. Army Corps of Engineers (USACE) is the lead federal agency for this project and the New Jersey Department of Environmental Protection (NJDEP) is the non-federal sponsor for the project. The study will develop and evaluate CSRM measures for the entire back bay system from Monmouth County in the north to Cape May County in the South.

The Atlantic Ocean coast of New Jersey is fronted by a system of existing Federal CSRM projects along the ocean coast that extend from Sea Bright on the north to Cape May Point on the south (USACE, 2013). However, the NJBB study area, which encompasses portions of five counties and includes about 950 square miles of land and water, currently lacks a comprehensive CSRM program. As a result, the NJBB region experienced major impacts and devastation during Hurricane Sandy and other coastal storm events, including extensive inundation from storm surge due to the combination of low-lying topography, densely populated residential and commercial areas, extensive low-lying infrastructure, and degraded coastal ecosystems.

The NJBB Region is a dynamic environment that supports densely populated areas with billions of dollars of largely fixed public, private, and commercial investment. Hurricane Sandy emphasized our vulnerability to coastal storms and the potential for future, more devastating events due to rising sea levels and climate change. Rising sea levels represent an inexorable process causing numerous, significant water resource problems such as: increased, widespread flooding along the coast; changes in salinity gradients in estuarine areas that impact ecosystems; increased inundation at high tide; decreased capacity for storm water drainage; and declining reliability of critical infrastructure services such as transportation, power, and communications. Addressing these problems requires a paradigm shift in how we work, live, travel, and play in a sustainable manner as a large extent of the area is at a very high risk of coastal storm damage as we move into the future of changing sea levels.

Individual system-wide problem statements are grouped within three categories to be carried forward to inform the plan formulation process, and include:

Coastal Storm Risk Management:

Inundation: The NJBB study area currently lacks a comprehensive CSRM program to protect against inundation (economic disruption to residential and infrastructure & life and safety risks).

SLC/Climate Change: The study area that is currently at risk will likely see an increase in future damages with the potential for sea level rise in the future without project condition.

Erosion: The study area experiences disruption of shoreline from wave attack, wind forces and other elements.

Municipal Jurisdiction Disconnect: The study area lacks a comprehensive, multi-jurisdictional, multi-agency effort that can integrate storm risk management efforts in a way that crosscuts Federal/State/Local business lines, study authorities and agency missions.

Environment:

Degraded Ecosystems: The study area's coastal ecosystems fail to provide their natural ecosystem services (provisioning, regulating, supporting and cultural).

Economy and Infrastructure:

High-Frequency Flooding: The study area experiences high-frequency flooding, also known as nuisance flooding, recurrent flooding, or sunny-day flooding, caused by tides and/or minor storm surge that mostly affects low-lying and exposed assets or infrastructure, such as roads, public storm-, waste- and fresh-water systems and is likely more disruptive (a nuisance) than damaging. However, the cumulative effects of high-frequency flooding may be a serious problem to residents who live and work in these low-lying areas.

Municipal Storm water Infrastructure: The study area experiences flooding from rainfall and inadequate municipal storm water infrastructure that mostly affects low-lying and exposed assets or infrastructure, such as roads, public storm-, wastewater- and fresh-water systems.

Flood Forecasting Inconsistencies: The study area lacks a clear, timely, comprehensive forecasting tool for local flood risk managers and Emergency Operations Officials for determining local evacuation priorities based on projected surge levels.

Floods have been and continue to be the most frequent, destructive, and costly natural hazard facing the State of New Jersey (New Jersey, 2011). The study area is vulnerable to damage from storm surge, wave attack, erosion, and rainfall-storm water runoff events that cause riverine and/or inland flooding. The State of New Jersey, in the state hazard mitigation plan, has documented the numerous, historic instances of flooding, Presidential disaster declarations, and damage estimates. Historic sea level change has exacerbated the problem over the past century, and the potential for accelerated sea level change in the future will only increase the magnitude and frequency of the problem. These forces constitute a threat to human life and increase the risk of flood damages to public and private property and infrastructure.

The shorelines of most of New Jersey's back bays are characterized by low elevation areas developed with residential and commercial infrastructure and are subject to tidal flooding during storms. Public and private property at risk involves densely populated sections of the barrier island back bay coastline and also mainland portions of the areas bordering the bays and tidal tributaries of the study area. It includes private residences, businesses, schools, infrastructure, roads, and evacuation routes for coastal emergencies. Additionally, the NJBB study area includes undeveloped areas that provide ecological, fishery, and recreational benefits. Healthy marshes in the back bay areas have the potential to reduce coastal flooding and storm surge. These areas are subject to erosion, loss and alteration due to coastal storms. Back bay dune, beach, marsh and estuarine ecosystems are quite fragile in some locations and are threatened by sea level change. Inundation of sites identified through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), otherwise referred to as Superfund sites, or other hazardous waste sites may also severely impact water quality.

Based on recorded history, the National Flood Insurance Program (NFIP) records, and analysis of engineering data about flood plains it is clear that New Jersey is one of the more flood-prone States in the nation. The NOAA National Climatic Data Center (NCDC) database reported 1169 flood events just since 1996 (NOAA NCDC, 2011). According to NFIP statistics, flood claims payouts have totaled more than $5.3 billion since the beginning of the NFIP program in 1978 through July 2013. Out of that, nearly $2.9 billion was paid for flood damages to the coastal counties of Monmouth, Ocean, Atlantic and Cape May from Hurricane Sandy damages alone.

New Jersey's low-lying coastline, stretching from Raritan Bay in the north, along the Atlantic Coast to Delaware Bay is highly susceptible to coastal flooding. This region has experienced frequent coastal flooding events over the years, causing extensive beach erosion, marsh loss, damage to dunes and other coastal flood risk management structures. Recent events in the coastal region include floods associated with Tropical Storm Ida in November 2009, a nor’easter in December 2009, a severe storm in April 2010, Hurricane Irene in August 2011 and more recently Hurricane Sandy in October 2012. Since Hurricane Sandy, there have been additional severe coastal storm events, including Hurricane Joaquin in September-October 2015, and extra-tropical cyclone (nor'easter) Jonas in January 2016. Both of these events caused significant oceanfront erosion and back bay flooding.

3.0 ENVIRONMENTAL MITIGATION BACKGROUND

The USACE Civil Works CECW-PC Memorandum for Implementation Guidance for Section 2036(a) of the Water Resources Development Act of 2007 (WRDA 07) – Mitigation for Fish and Wildlife and Wetlands Losses, dated August 31, 2009, reiterates mitigation requirements for any report being submitted to Congress for approval, but also adds the requirement for mitigation plans to comply with the mitigation standards and policies of the USACE Regulatory Program including specific mitigation plan components. The memo is applicable to Civil Works water resources projects that require specific authorization.

The USACE and U.S. Environmental Protection Agency (USEPA) published regulations entitled, "Compensatory Mitigation for Losses of Aquatic Resources" (Mitigation Rule) on April 10, 2008. One of the primary goals of these regulations (33 Code of Federal Regulation (CFR) Parts 4 325 and 332) was to improve the quality and success of compensatory mitigation plans that are designed to offset impacts to aquatic resources. The Mitigation Rule emphasizes the strategic selection of mitigation sites on a watershed basis and established equivalent standards for all types of compensatory mitigation (mitigation banks, in-lieu fee programs, and permittee-responsible mitigation plans). Per these regulations, compensatory mitigation means the restoration (re-establishment or rehabilitation), establishment (creation), enhancement, and/or in certain circumstances preservation of wetlands for the purposes of offsetting unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved. The three mechanisms for providing compensatory mitigation listed in order of preference as stated in the Mitigation Rule are the following: mitigation banks, in-lieu fee programs, and permittee-responsible mitigation. Compensatory mitigation is necessary to offset these unavoidable impacts to aquatic resource functions and services and to meet the programmatic goal of "no overall net loss" of aquatic resource functions and services.

Per 40 CFR 230.42, mud flats are defined as a type of Special Aquatic Site and are habitats along the sea coast and in coastal rivers to the head of tidal influence and in inland lakes, ponds, and riverine systems. Coastal mud flats are exposed at low tides and inundated at high tides with the water table at or near the surface of the substrate. Mudflats are either unvegetated or vegetated only by algal mats. Compensatory mitigation is typically required for impacts to mudflat habitats.

In accordance with USACE planning policy, credit for mitigation was determined by using USACE-certified ecosystem models to determine functional losses from impacts and functional gains (or "lift") from mitigation. USACE Civil Works policy contained in the CECW-CP policy memo *Policy Guidance on Certification on Ecosystem Output Models*, dated August 13, 2008, requires that only standard models already certified by the USACE Ecosystem Planning Center of Expertise (ECO-PCX) be used to determine mitigation, or that models proposed for use undergo the model certification process outlined by the USACE. Direct impacts of all the alternatives for consideration for CSRM were calculated based on National Oceanic and Atmospheric Administration (NOAA) Coastal Change Analysis Program (C-CAP) data and similar data sets for the region. The number of acres of each type of habitat that may be impacted by the actions being considered for CSRM were measured using GIS analysis (Table 1). Functional losses and gains of direct and indirect habitat impacts are being evaluated with two models. For direct impacts on tidal marsh ecosystems, the ECO-PCX approved New England Salt Marsh Model (Wigand, 2006) is being used, and for indirect and other aquatic ecosystem effects are being modeled with the New York Bight Ecological Model (NYBEM) that is currently under development, and will require approval by the USACE ECO-PCX and vertical team.

An evaluation of the structural components of the TSP has identified that the direct impacts to wetlands and other aquatic habitats are moderate to significant. This is inherent in the proposed use of floodwalls, levees, and miter gates for the perimeter plans, the proposed use of floodwalls, levees, sector gates and lift gates for the storm surge barriers (SSBs), and the proposed use of bay closures (BCs), which are all water dependent features required for flood and erosion control.

When potential significant impacts are identified, CEQ regulations direct Federal agencies to "[u]se the NEPA process to identify and assess the reasonable alternatives to proposed actions that will avoid or minimize adverse effects of these actions…" 40 CFR § 1500.2(e); see 40 CFR § 1500.2(f). The practice of avoidance and minimization is also inherent in the Clean Water Act Section 404(b)(1) guidelines when evaluating the effects of the discharge of dredged or fill material into waters of the United States including wetlands. USACE has adopted a mitigation hierarchical sequencing for civil works projects as defined in ER 1105-2-100. This mitigation sequencing includes:

(a) Avoiding the impact altogether by not taking a certain action or part of an action;

(b) Minimizing impacts by limiting the degree or magnitude of the action and its implementation;

(c) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment;

(d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action;

(e) Compensating for the impact by replacing or providing substitute resources or environments. "Replacing" means the replacement of fish and wildlife resources in-kind. "Substitute" means the replacement of fish and wildlife resources out-of-kind. Substitute resources, on balance, shall be at least equal in value and significance as the resources lost.

The current focused array of alternatives is a result of screening that considered the Environmental Quality (EQ) account. Several preliminary alternatives were screened out based on EQ criteria that eliminated them based on their unacceptable level of adverse impacts. These alternatives including storm SSBs located at Little Egg Harbor Inlet, Hereford Inlet, and BCs at North Point (Edwin B. Forsythe NWR), which would have induced significant impacts on critical fish and wildlife resources. By eliminating these alternatives, the practice of "avoidance" has been accomplished at an early stage. However, additional avoidance measures with the current focused array will be considered, where practicable for development of the final array and TSP. Avoidance could be accomplished through design modifications in either the structures themselves or by moving the structure to another location, wherever practicable. An example would be to seek locations where a floodwall or levee could be set-back further from a sensitive habitat. "Minimization" of the impact will also be considered, and some of the same means for avoidance could be applied. An example of minimization could be to maximize the location of a structure feature outside of a sensitive habitat such as a wetland or aquatic area even though avoidance is not practicable. Additionally, minimization can also be practiced if NNBF alternatives are employed that can effectively offset some of the impacts of a structural alternatives' impacts by providing an ecological uplift through an NNBF feature implementation. Table 1 provides an overview of practicing avoidance and minimization for NJBB alternatives by study region.

Table 1. Avoidance and Minimization Applied to Alternatives Selection

Region	Avoidance	Minimization
Coastal Lakes -Shark River	EQ screening did not eliminate any structural measures where avoidance could be practiced since non-structural measures are the TSP.	Minimization would be considered for any structural measures in the Coastal Lakes region as appropriate with the level of detail available.
Northern Region	An SSB was initially considered at Little Egg Harbor Inlet, which included approximately 10 miles of barrier constructed on undeveloped beaches, intertidal mudflats, and marshes. Additionally, a cross-bay barrier at Holgate was considered and eliminated as part of the EQ account. These measures were screened out as having substantial impacts on critical habitats for endangered species. The ultimate result of this screening was a selection of non-structural measures as part of the TSP along the southern portion of Long Beach Island and communities inland.	The proposed SSB at Barnegat Inlet was moved further inland from the inlet to minimize adverse effects on currents and the general geomorphology of the inlet complex. This relocation also moves the structure further away from critical nesting habitat for threatened and endangered beach nesting birds. The use of vertical lift gates and box culverts are intended to promote better tidal flow and exchange through the barrier. Refinements of the SSB structure design will be considered to further minimize direct and indirect adverse effects during the Engineering and Design Phase and Tier 2 EIS.
Central Region	A cross-bay closure structure (North Point) was considered across Reed Bay from the northern end of Brigantine through the EBFNWR. Impacts resulting from the North Point interior bay closure were the primary drivers behind the failure of these alternatives. The North Point interior bay closure includes the construction of a seawall along the beach in a sensitive piping plover habitat within a State Natural Area and would pass through environmentally sensitive wetland habitat within the Edwin B. Forsythe National Wildlife Refuge. The ultimate result of this screening was a selection of non-structural measures as part of the TSP at Brigantine and communities inland.	The Absecon Boulevard Bay Closure will have unavoidable impacts on aquatic and terrestrial habitats. However, the alignment for a large portion of the structure follows along existing roadway (Absecon Blvd.) embankments that minimize the footprint of this structure. The use of vertical lift gates and box culverts for the SSB are intended to promote better tidal flow and exchange through the barrier. Refinements of the SSB structure design will be considered to further minimize direct and indirect adverse effects during the Engineering and Design Phase and Tier 2 EIS.
Southern Region	An SSB was initially considered at Hereford Inlet, which is within a Coastal Barrier Resources Act (CBRA) zone and a Federal coastal storm risk project in the area would not comply with CBRA. Additionally, a SSB would result in significant impacts to critical habitat for Piping Plover at Stone Harbor Point. The ultimate result of this screening was a selection of non-structural measures as part of the TSP for a number of communities in Cape May County.	

After the practice of minimization is considered, compensation is the most likely form of mitigation in this situation. For unavoidable impacts, compensatory mitigation is required to replace the loss of wetland, stream, and/or other aquatic resource functions and area. Compensatory mitigation would require intensive coordination with resource agencies on site selection and mitigation methods. In accordance with USACE policy, a habitat model is required to assess the baseline habitat values, and to determine the severity of the impact to derive an appropriate compensation for the impact. The selection of compensatory mitigation requires the utilization of "cost effectiveness and incremental cost analysis" to determine the optimal level of ecosystem outputs that meet or exceed the level of impact compared with cost considerations.

4.0 DESCRIPTION OF THE PREFERRED ALTERNATIVE (PA) (TENTATIVELY SELECTED PLAN-TSP) AND ALTERNATIVES OVERVIEW

4.1 No Action Alternative

The forecast of the future without-project (FWOP) condition reflects the conditions expected during the period of analysis. The future without-project condition provides the basis from which alternative plans are formulated and impacts are assessed. Since impact assessment is the basis for plan evaluation, comparison and selection, clear definition and full documentation of the without-project condition are essential. Gathering information about historic and existing conditions requires an inventory. Gathering information about potential future conditions requires forecasts, which should be made for selected years over the period of analysis to indicate how changes in economic and other conditions are likely to have an impact on problems and opportunities. Information gathering and forecasts will most likely continue throughout the planning process. The most likely future without project condition is considered to be if no NJBB action is taken, and is characterized by CSRM projects and features, and socio-economic, environmental, and cultural conditions. This condition is considered as the baseline from which future measures will be evaluated with regard to reducing coastal storm risk and promoting resilience. The Future-Without Project Condition serves as the baseline for evaluating the anticipated performance of alternatives. It documents the need for Federal action to address the water resources problem.

A base year of 2030 has been identified as the year when USACE projects associated with the NJBB CSRM Feasibility Study will be implemented or constructed. Several trends have been identified for the NJBB Region which are projected to continue into the future and will likely effect the future without-project condition for this study. It is anticipated that the study area will continue to experience damages from coastal storms, and that the damages may increase as a result of more intense storm events. These coastal storm events will likely continue to effect areas of low coastal elevations within the study area with pronounced localized effects in some areas.

In the future without project condition, it is anticipated that sea level is increasing throughout the study area that shorelines are changing in response to sea level change, and historic erosion patterns will continue and accelerate. It is anticipated that there will continue to be significant economic assets within the NJBB region, and that population and development will continue to increase. Based on a desktop inventory of structures compiled for the HEC-FDA model, the New Jersey Back Bays study area experiences a total of $1,571,616,000 in FWOP Average Annual Damages (AAD) over a 50-year period of analysis based on the intermediate rate of relative sea level change (RSLC).

The FWOP condition no-action alternative would see no additional federal involvement in storm damage reduction as outlined within this study. Current projects and programs that the USACE conducts in conjunction with other Federal and non-Federal entities would continue and would be constructed by 2030.

The FWOP condition does consider those projects that have been completed (existing), are under construction, or have been authorized for construction and are anticipated to be constructed by 2030. Any proposed projects, which are not yet authorized for construction, are not considered part of the FWOP conditions for analysis.

4.1.1 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 **Error! Reference source not found.**. The TSP includes the f ollowing 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 2).
- Non-structural measures only alternative (elevation and floodproofing for 10,895 structures) in the Central Region (Alternative 4A; see
- Figure 3).
- 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).

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.

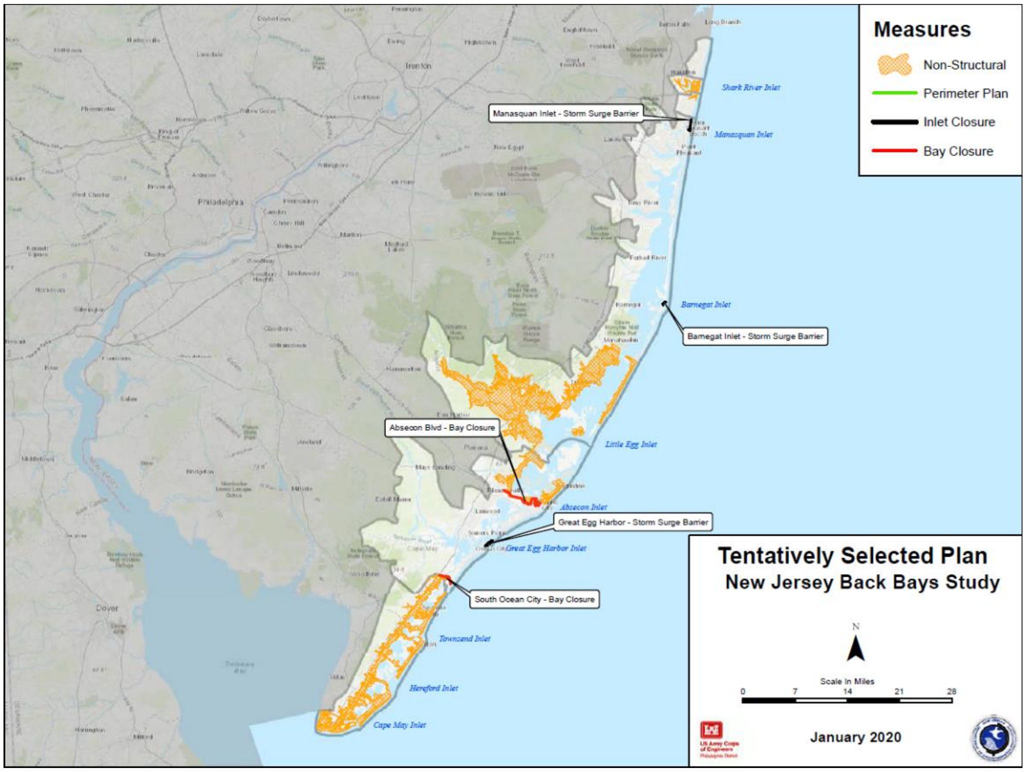

Figure 1. The TSP for the NJBB Study.

Table 2. Final Array of Alternatives

REGION	ALT	NONSTRUCTURAL Building Raising for structures with first floor w/in 20-yr floodplain	PERIMETER Floodwalls, Levees and Miter Gates	STORM SURGE BARRIER Inlet Navigable Sector Gates, Auxiliary Lift Gates, Impermeable Barriers, Levees	BAY CLOSURE Navigable Sector Gates, Auxiliary Lift Gates, Miter Gates, Sluice Gates, Impermeable Barriers, Levees	Natural and Nature-Based Features (NNBF) **Note: The measures presented here are proof of concept measures that have not been modeled for CSRM flood reduction and economic benefits. Further evaluation of these conceptual measures will be conducted in subsequent planning phases.**
SHARK RIVER	**2A* ▲**	**Portions of Belmar, Bradley Beach, Neptune City & Shark River Hills**				• Island Expansion in Shark River • Coastal Lakes Terracing for habitat and to increase flood storage capacity
NORTH **(Manasquan Inlet to**	**3A†**	**Point Pleasant, all communities on LBI, western shore of Barnegat Bay,**				• Horizontal (ecotone) Levee at **Tuckerton Peninsula** along Great Bay Boulevard • Living Breakwaters on

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REGION	ALT	NONSTRUCTURAL Building Raising for structures with first floor w/in 20-yr floodplain	PERIMETER Floodwalls, Levees and Miter Gates	STORM SURGE BARRIER Inlet Navigable Sector Gates, Auxiliary Lift Gates, Impermeable Barriers, Levees	BAY CLOSURE Navigable Sector Gates, Auxiliary Lift Gates, Miter Gates, Sluice Gates, Impermeable Barriers, Levees	Natural and Nature-Based Features (NNBF) **Note: The measures presented here are proof of concept measures that have not been modeled for CSRM flood reduction and economic benefits. Further evaluation of these conceptual measures will be conducted in subsequent planning phases.**
Brigantine Inlet)		**Mystic Island, and along lower Mullica River Basin**				southwest side of **Tuckerton Peninsula** • Marsh Augmentation along **Tuckerton Peninsula** • Marsh Island Augmentation and Marsh Island Creation Along **Tuckerton Peninsula** • Beach Haven Surge Filter – island and wetland creation/expansion northeast of **Tuckerton Peninsula** and Great Bay Blvd. • **Barnegat Bay** – reforestation of maritime forests and shrublands in upland locations, • **Barnegat Bay** augmenting existing marshes by mosquito ditch filling and thin-layer placement • **Barnegat Bay** – mudflat expansion • **Barnegat Bay** - SAV bed expansion through "shallowing" and the filling-in of dredge holes.
	~~3D~~	~~All communities on LBI, western shore of Barnegat Bay, Mystic Island, and along lower Mullica River Basin~~	~~Manasquan Inlet/ Point Pleasant Area~~			
	3E(2)* ▲	**All communities on southern LBI (Cedar Bonnet Island and south), western shore of Barnegat Bay at Beach Haven West and south, Mystic Island, and along lower Mullica River Basin**		**1. Manasquan Inlet 2. Barnegat Inlet**		
	~~3E(3)~~	~~Cedar Bonnet Island, western shore of Barnegat Bay at Beach Haven West and south, Mystic Island, and along lower Mullica River Basin~~	~~Along western side of S. LBI from Ship Bottom to Holgate~~	~~1. Manasquan Inlet~~ ~~2. Barnegat Inlet~~		
CENTRAL (Brigantine Inlet to Corson Inlet)	4A‡	~~Brigantine, Absecon, Pleasantville, West A.C., A.C., Ventnor, Margate, Longport, Northfield, Linwood, Estell Manor, Mays Landing, Somers~~				• Horizontal or ecotone levee(s) • Island Creation/Expansion – Great Bay • Dune Enhancements • Wetland Creation or Restoration Great Bay, Reeds Bay, Absecon Bay, Lakes

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REGION	ALT	NONSTRUCTURAL Building Raising for structures with first floor w/in 20-yr floodplain	PERIMETER Floodwalls, Levees and Miter Gates	STORM SURGE BARRIER Inlet Navigable Sector Gates, Auxiliary Lift Gates, Impermeable Barriers, Levees	BAY CLOSURE Navigable Sector Gates, Auxiliary Lift Gates, Miter Gates, Sluice Gates, Impermeable Barriers, Levees	Natural and Nature-Based Features (NNBF) **Note: The measures presented here are proof of concept measures that have not been modeled for CSRM flood reduction and economic benefits. Further evaluation of these conceptual measures will be conducted in subsequent planning phases.**
		~~Point, Marmora, Ocean City, Palermo~~				Bay,Scull Bay, Great Egg Harbor
	4D(1)▲	Brigantine, Absecon, Pleasantville, West A.C., Northfield, Linwood, Estell Manor, Mays Landing, Somers Point, Marmora, Palermo	Along South Absecon Inlet and western side of A.C., Ventnor City, Margate City, Longport, & all Ocean City			
	4D(2)ꜛ	Absecon, Pleasantville, West A.C., Northfield, Linwood, Estell Manor, Mays Landing, Somers Point, Marmora, Palermo	Along Absecon Inlet and western side of Brigantine, A.C., Ventnor, Margate, Longport, & Ocean City			
	~~4E(2)~~	~~Absecon, Pleasantville, S. Ocean City, Marmora, & Palermo~~		~~1. Absecon Inlet~~ ~~2. Great Egg Harbor Inlet~~		
	~~4E(3)~~	~~Absecon, Pleasantville, Marmora, & Palermo~~	~~Western side of S. Ocean City~~	~~1. Absecon Inlet~~ ~~2. Great Egg Harbor Inlet~~		

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REGION	ALT	NONSTRUCTURAL Building Raising for structures with first floor w/in 20-yr floodplain	PERIMETER Floodwalls, Levees and Miter Gates	STORM SURGE BARRIER Inlet Navigable Sector Gates, Auxiliary Lift Gates, Impermeable Barriers, Levees	BAY CLOSURE Navigable Sector Gates, Auxiliary Lift Gates, Miter Gates, Sluice Gates, Impermeable Barriers, Levees	**Natural and Nature-Based Features (NNBF)** **Note: The measures presented here are proof of concept measures that have not been modeled for CSRM flood reduction and economic benefits. Further evaluation of these conceptual measures will be conducted in subsequent planning phases.**
	~~4E(4)~~	~~Absecon & Pleasantville~~		~~1. Absecon Inlet~~ ~~2. Great Egg Harbor Inlet~~	~~1. Southern Ocean City (52nd St.)~~	
	~~4G(6)~~	~~Brigantine, Absecon, Pleasantville, West A.C., Marmora, S. Ocean City, Palermo,~~		~~1. Great Egg Harbor Inlet~~	~~1. Absecon Blvd.~~	
	~~4G(7)~~	~~Brigantine, Absecon, Pleasantville, West A.C., Marmora~~	~~Western side of S. Ocean City~~	~~1. Great Egg Harbor Inlet~~	~~1. Absecon Blvd.~~	
	4G(8)*	**Brigantine, Absecon, Pleasantville, West A.C.,**		**1. Great Egg Harbor Inlet**	**1. Absecon Blvd.** **2. Southern Ocean City (52nd St.)**	
	~~4G(10)~~	~~Absecon, Pleasantville, West A.C., Marmora, S. Ocean City, Palermo~~	~~Western side of Brigantine~~	~~1. Great Egg Harbor Inlet~~	~~1. Absecon Blvd.~~	
	~~4G(11)~~	~~Absecon, Pleasantville, West A.C., Marmora, Palermo~~	~~Western side of Brigantine and S. Ocean City~~	~~1. Great Egg Harbor Inlet~~	~~1. Absecon Blvd.~~	

Table 2. Final Array of Alternatives

REGION	ALT	NONSTRUCTURAL Building Raising for structures with first floor w/in 20-yr floodplain	PERIMETER Floodwalls, Levees and Miter Gates	STORM SURGE BARRIER Inlet Navigable Sector Gates, Auxiliary Lift Gates, Impermeable Barriers, Levees	BAY CLOSURE Navigable Sector Gates, Auxiliary Lift Gates, Miter Gates, Sluice Gates, Impermeable Barriers, Levees	Natural and Nature-Based Features (NNBF) **Note: The measures presented here are proof of concept measures that have not been modeled for CSRM flood reduction and economic benefits. Further evaluation of these conceptual measures will be conducted in subsequent planning phases.**
	~~4G(12)~~	~~Brigantine, Absecon, Pleasantville, West A.C.,~~	~~Western side of Brigantine~~	~~1. Great Egg Harbor Inlet~~	~~1. Absecon Blvd.~~ ~~2. Southern Ocean City (52nd St.)~~	
SOUTH **(Corson Inlet to Cape May Inlet)**	**5A*▲**	**All Atlantic Coast and bayside communities from Ludlam Island (Upper Twp.) south to Cape May and W. Cape May**				• No defined NNBF strategies identified at this time
	~~5D(1)~~	~~All Atlantic Coast and bayside communities from Ludlam Island (Upper Twp.) south to Cape May and W. Cape May except for SIC, all WW, and Cape May~~	~~Western side of Sea Isle City, all Wildwoods, and southern shore along Cape May Harbor in Cape May~~			
	5D(2)†	All bayside communities from Ludlam Island (Upper Twp.) south to Cape May and W. Cape May; Strathmere and N. Cape May Inlet along Atlantic Coast.	Western side of Sea Isle City, Seven Mile Island, all Wildwoods, and southern shore along Cape May Harbor in Cape May, and West Cape May			

Table 2. Final Array of Alternatives

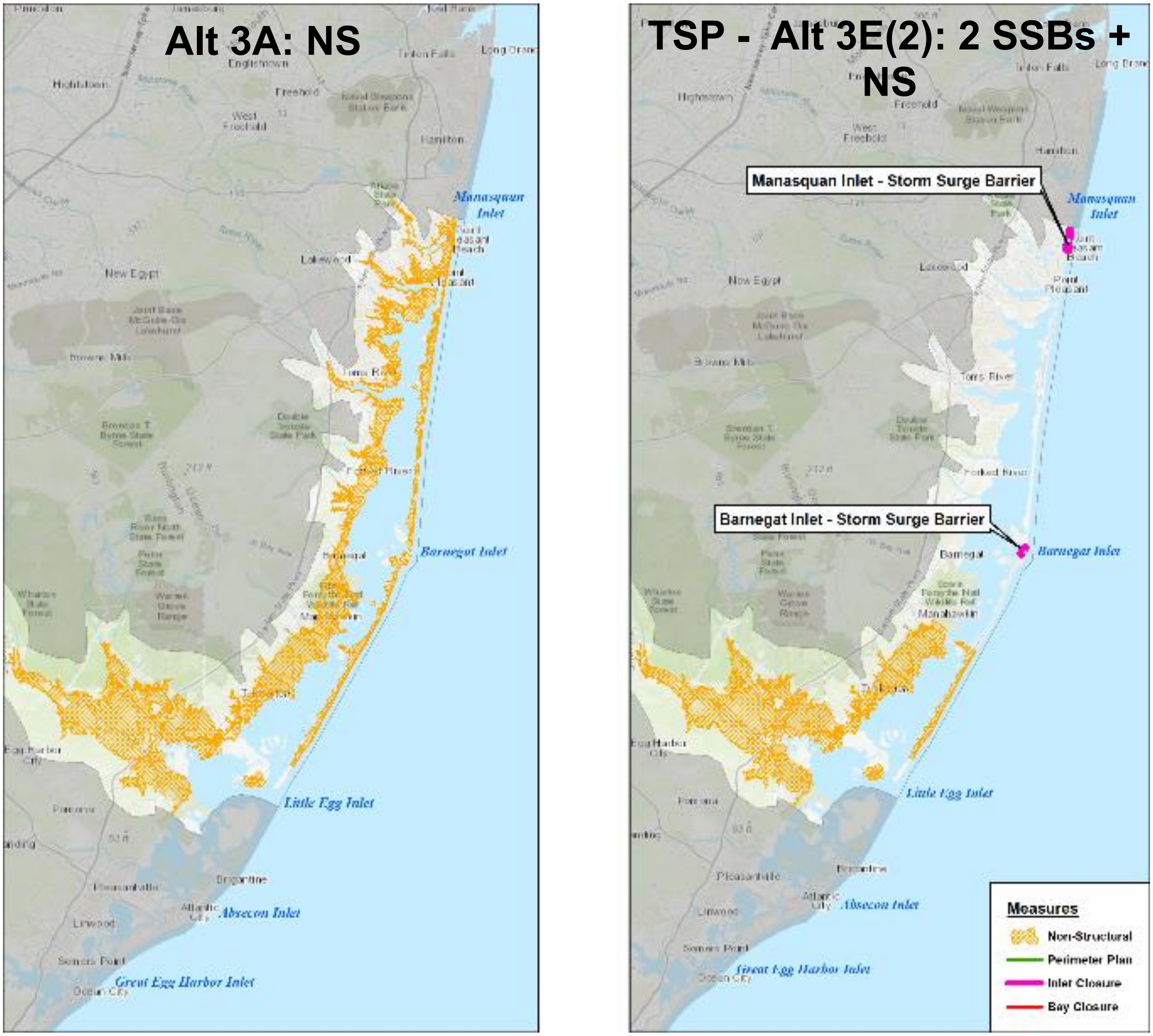
REGION	**ALT**	**NONSTRUCTURAL** Building Raising for structures with first floor w/in 20-yr floodplain	**PERIMETER** Floodwalls, Levees and Miter Gates	**STORM SURGE BARRIER** Inlet Navigable Sector Gates, Auxiliary Lift Gates, Impermeable Barriers, Levees	**BAY CLOSURE** Navigable Sector Gates, Auxiliary Lift Gates, Miter Gates, Sluice Gates, Impermeable Barriers, Levees	**Natural and Nature-Based Features (NNBF)** **Note: The measures presented here are proof of concept measures that have not been modeled for CSRM flood reduction and economic benefits. Further evaluation of these conceptual measures will be conducted in subsequent planning phases.**

*Tentatively Selected Plan (TSP)

▲ Apparent National Economic (NED) Plan

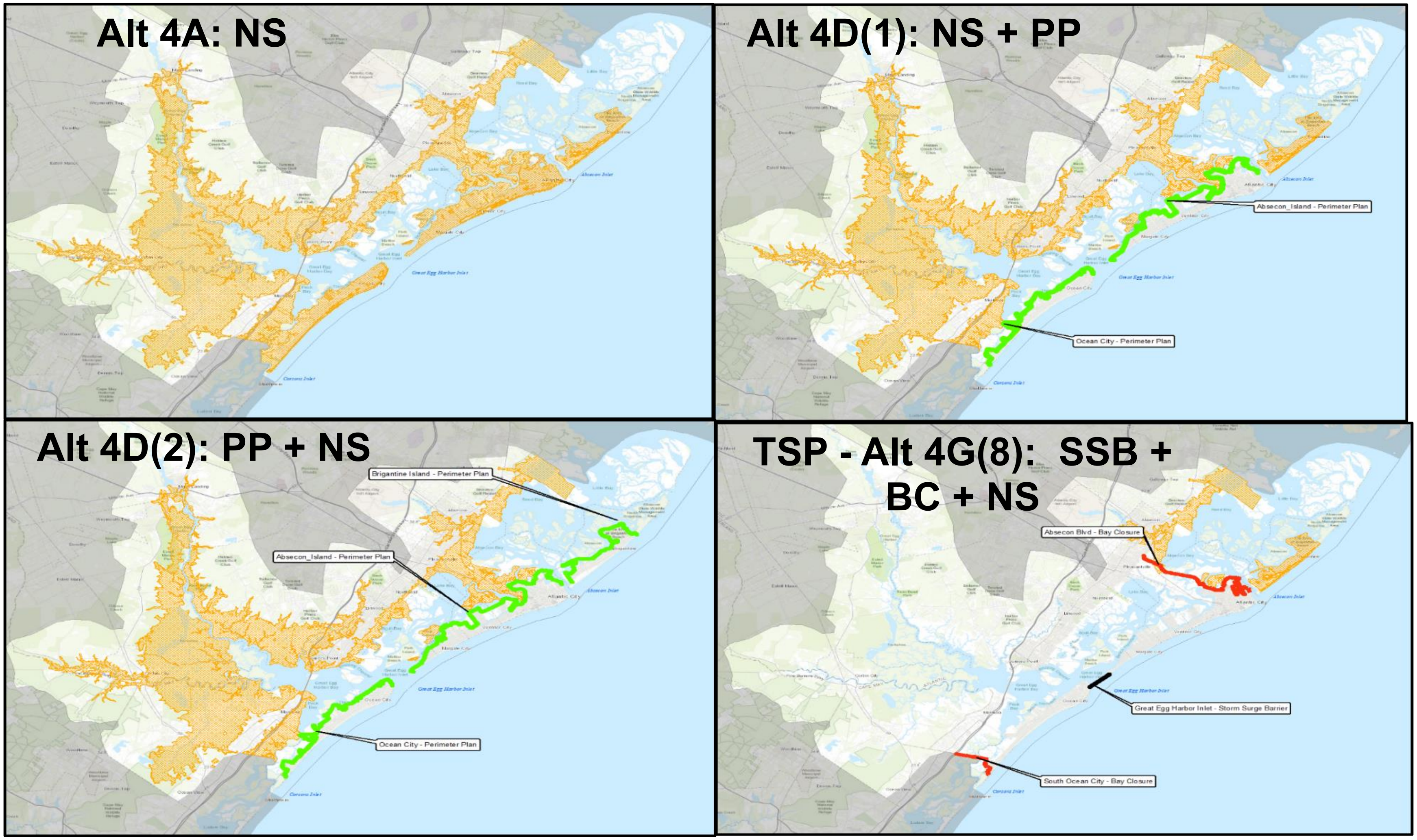
ᵻFurther Economic Analysis Warranted – Alternative or components of the alternative could be included later upon further evaluation

~~Strikethrough~~ = Alternative eliminated from consideration subsequent to Interim Report



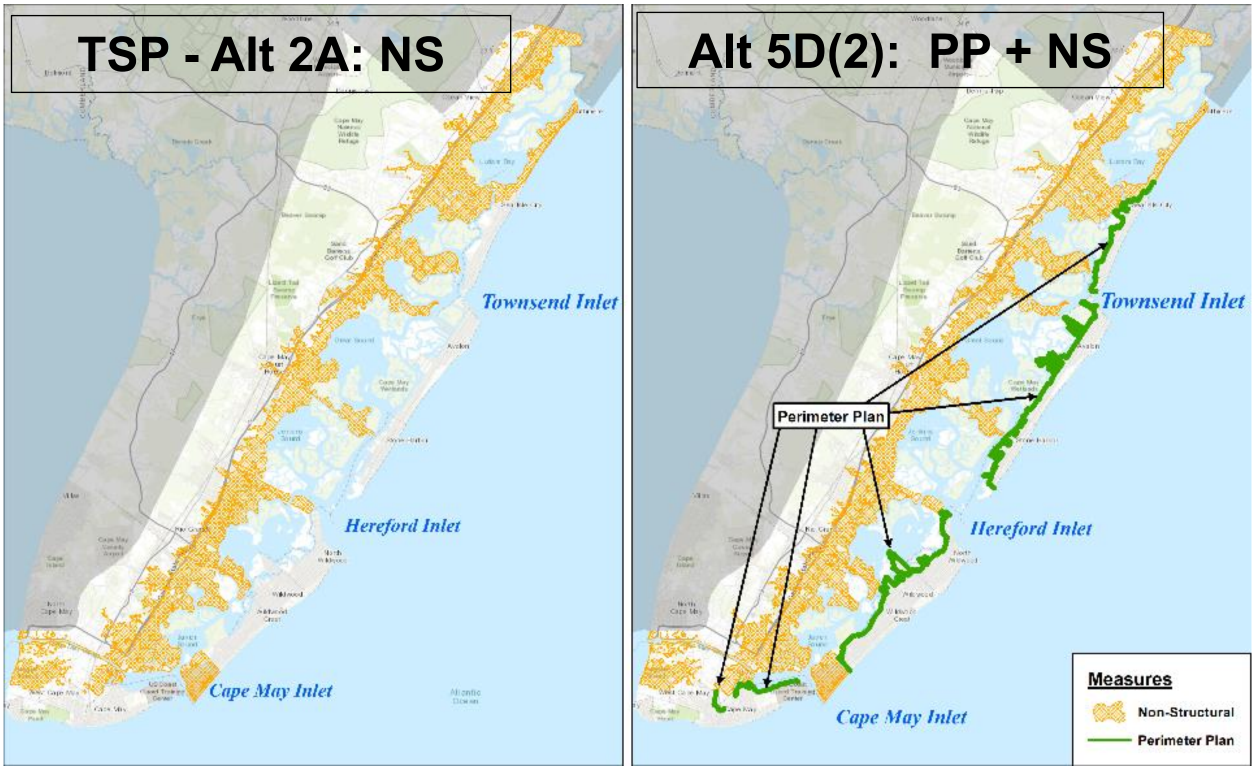
Notes: TSP = Tentatively Selected Plan; Alt = Alternative, NS = Nonstructural; SSB = Storm Surge Barrier

Figure 2. 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 3. 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 4. Comparison of the TSP and the Perimeter Plan and Nonstructural Alternative in the South Region

5.0 PROJECT DESCRIPTION

5.1 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 **Error! Reference source not found.**. Detailed engineering drawings, layouts and cross-sections, f or 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.

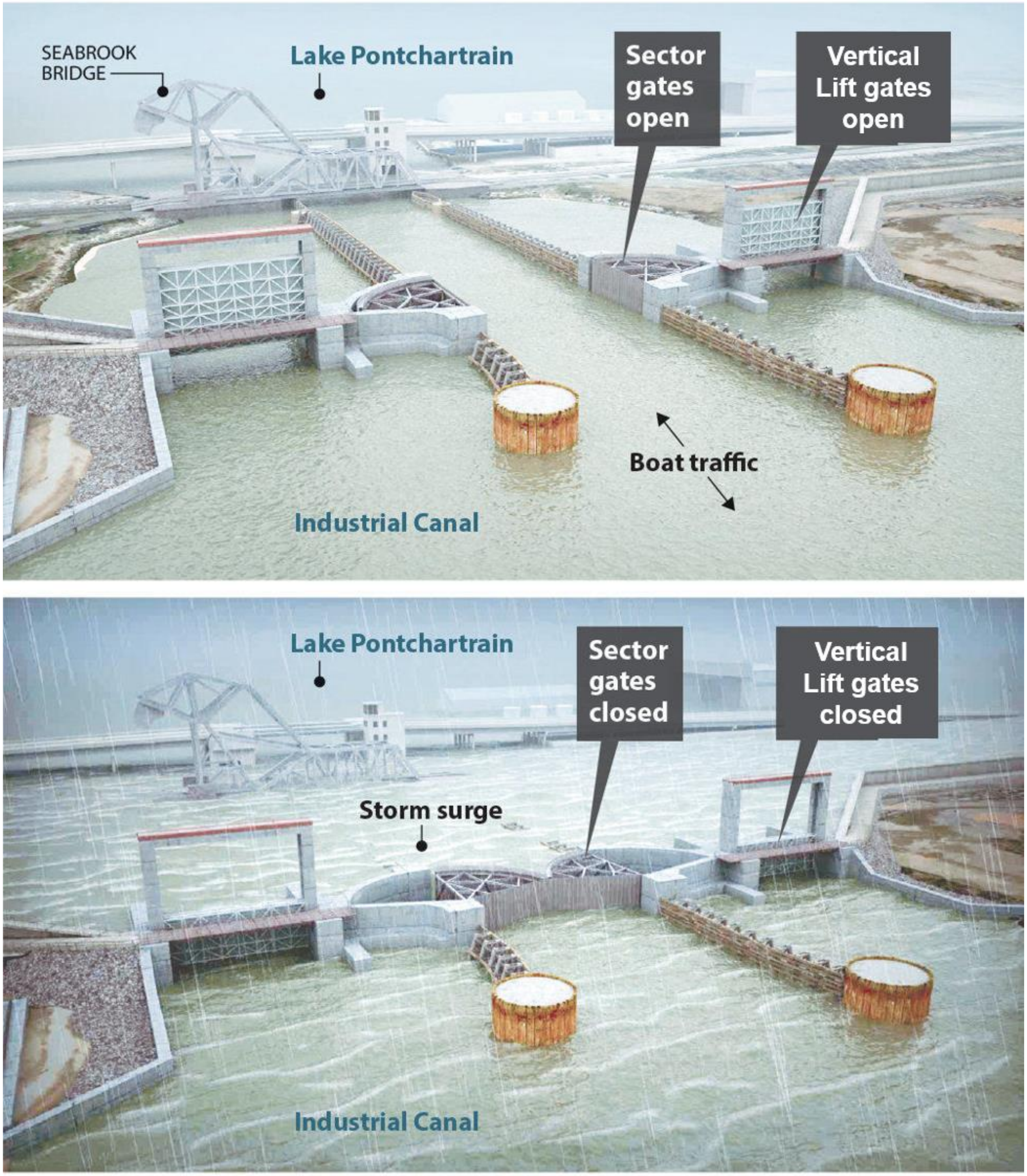
Navigable sector gates span the full width of the federal navigation channel with a 10-foot buffer on either side with opening spans ranging from 120 feet at the Bay Closures to 340 feet at Manasquan Inlet. Auxiliary flow gates have an opening span of 150 feet and are located along the storm surge barrier 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 is 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

HOW IT WORKS:



Illustrations coutesy of Army Corps of Engineers NOLA.com | The Times-Picayune

Figure 5. Example Storm Surge Barrier at Seabrook Flood Complex in New Orleans

5.1.1 Pre-construction

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

5.1.2 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.

5.1.3 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.

5.2 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.

5.2.1 Pre-construction

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

5.2.2 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.

5.2.3 Operations and Maintenance

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

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 6,

Figure 7, and Figure 8show 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**	**CONSTRUCTION**
		LENGTH (LF)	**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

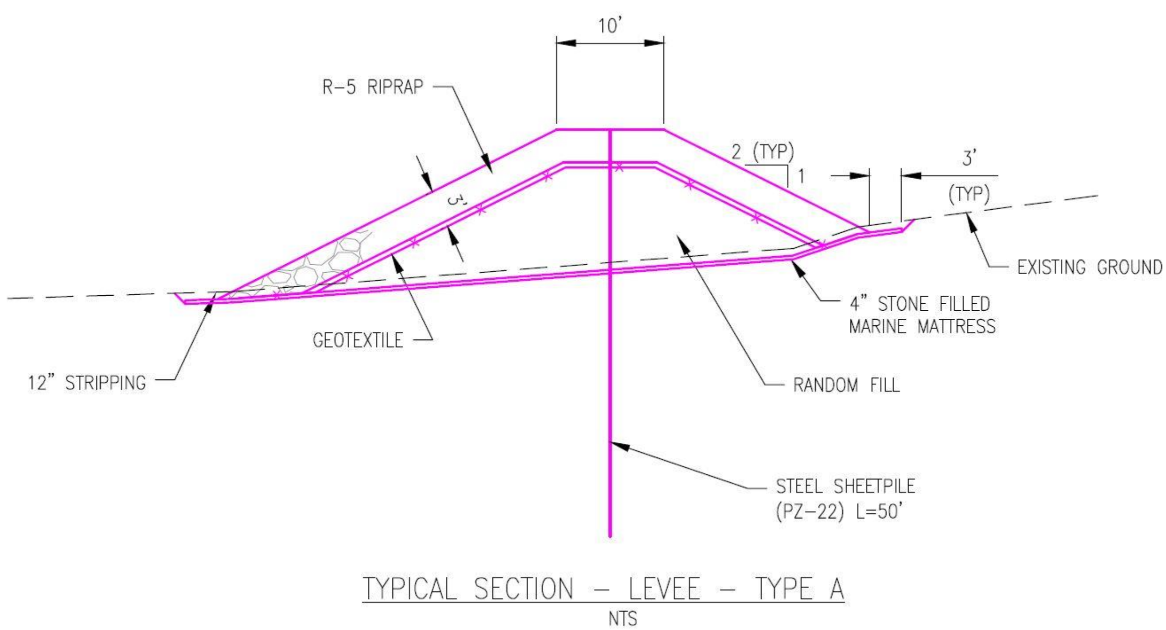


Figure 6. Typical Section – Levee – Type A

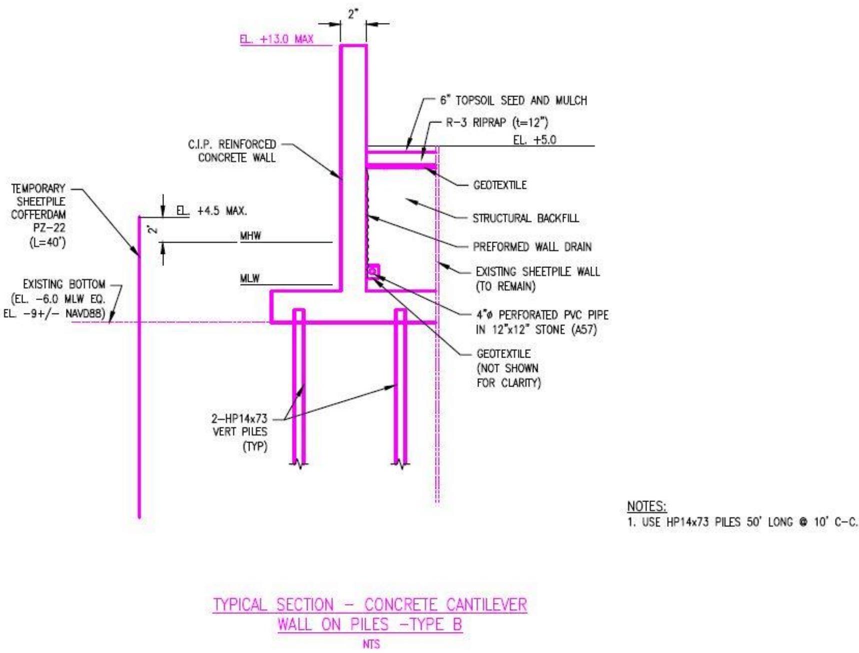


Figure 7. Typical Section – Concrete Cantilever Wall on Piles – Type B

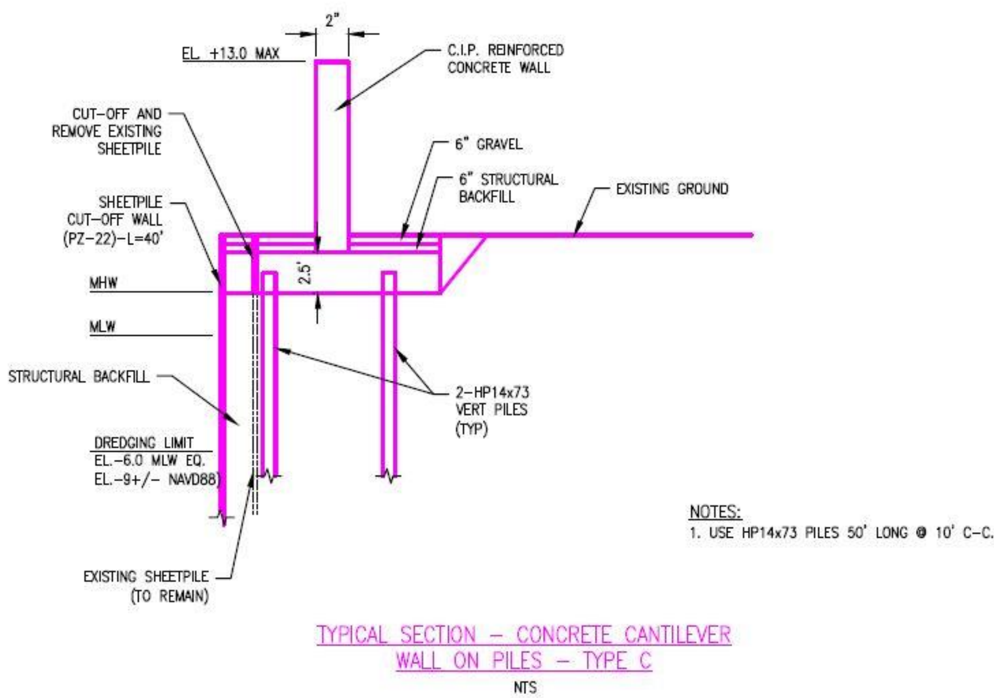


Figure 8. Typical Section – Concrete Cantilever Wall – Type C

5.2.4 Pre-construction

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

5.2.5 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.

5.2.6 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.

5.3 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.

5.3.1 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 9). 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.

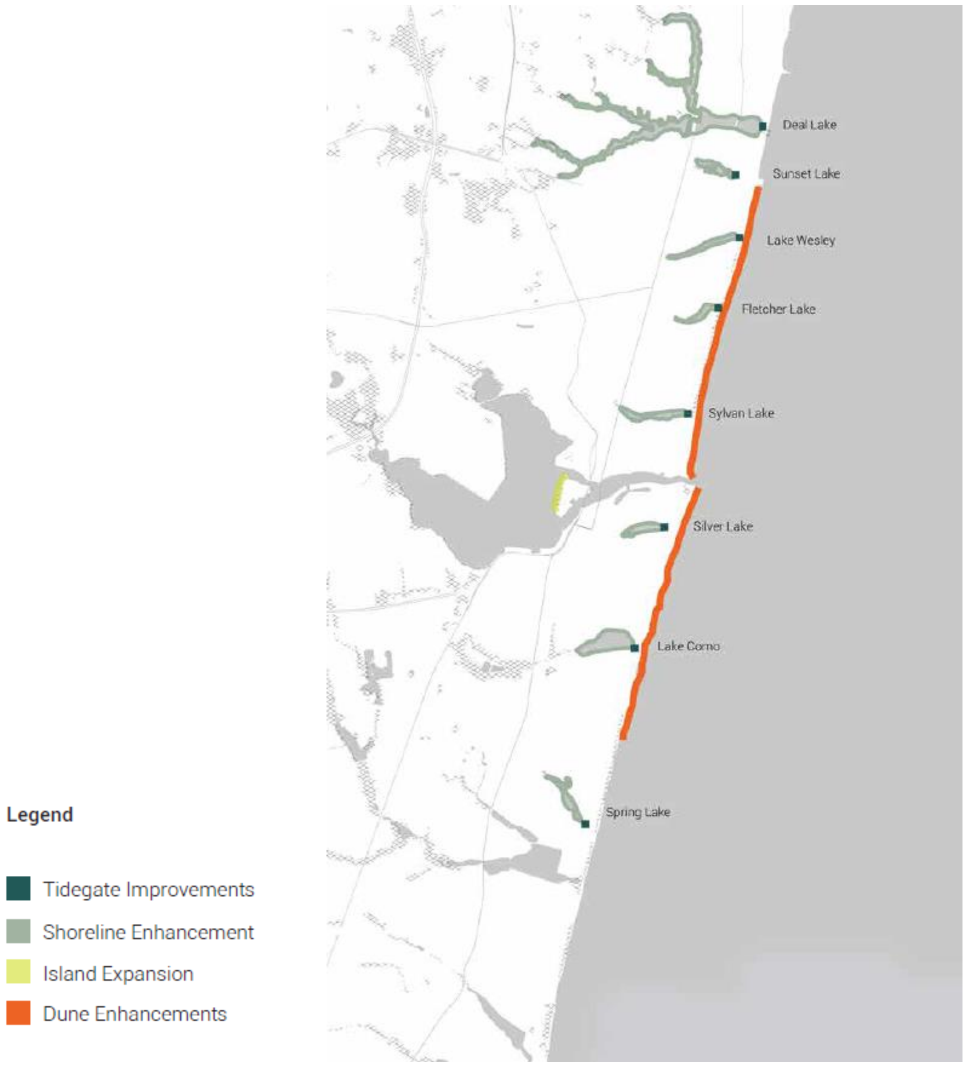


Figure 9. NNBFs within the Shark River/Coastal Lakes Region

5.3.2 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.

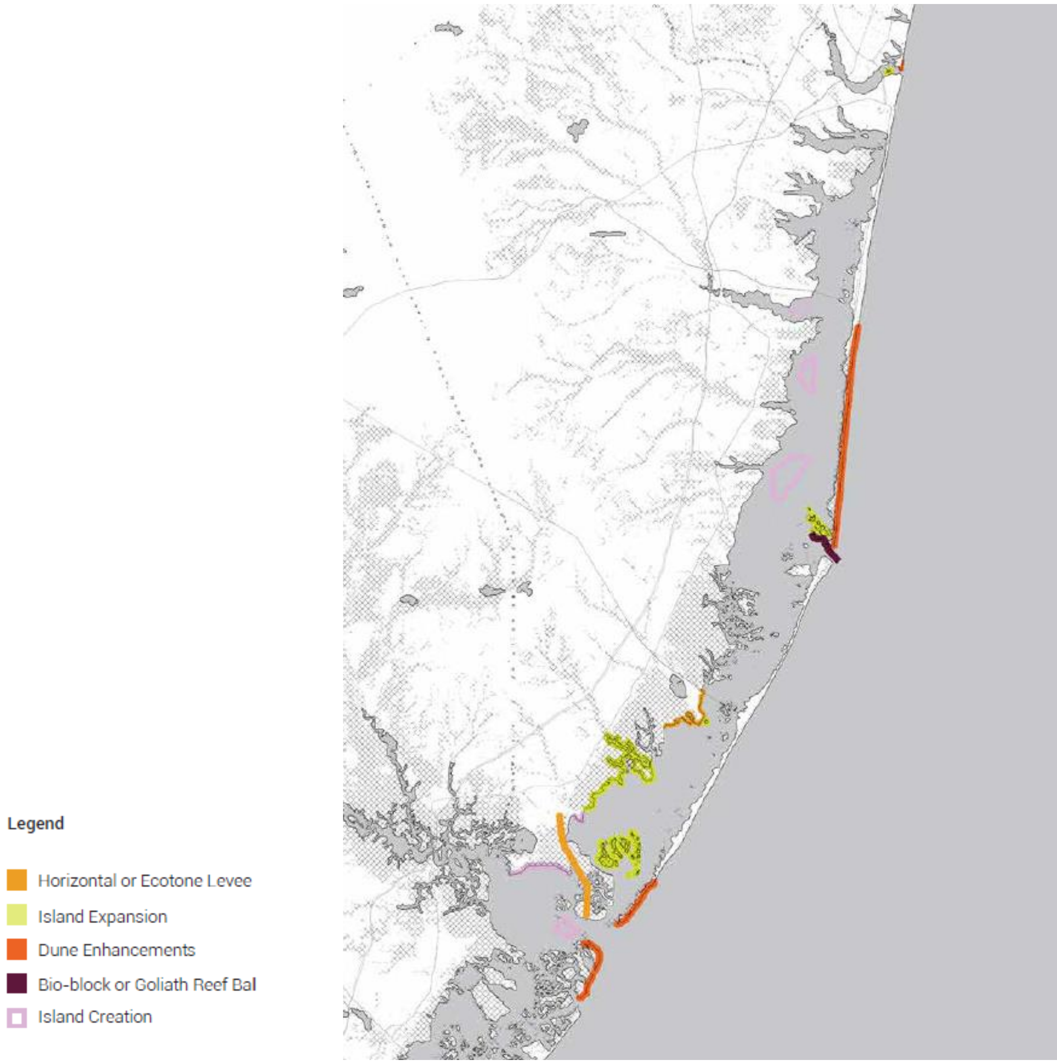


Figure 10. NNBFs within the North Region

5.3.3 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.

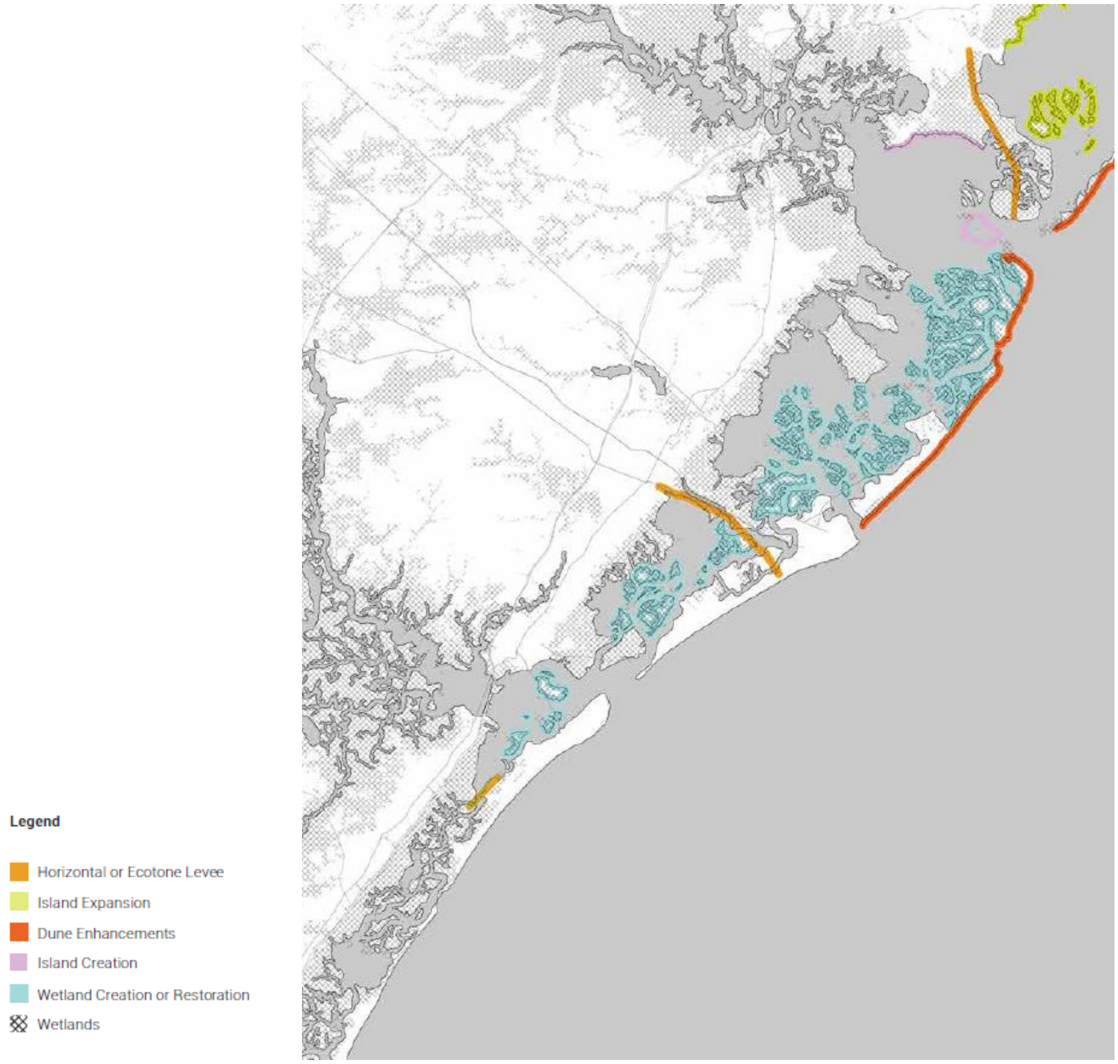


Figure 11. NNBFs within the Central Region

5.3.4 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 12. NNBFs within the South Region

5.3.5 Pre-construction

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

5.3.6 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.

5.3.7 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.

6.0 DIRECT HABITAT IMPACTS OF THE TSP

6.1 Structural

The direct impacts of the construction of SSBs, Bay Closures and Perimeters include the construction of sector gates, vertical lift gates (auxiliary gates), impermeable barriers, seawalls, floodwalls, levees, miter gates and sluice gate structures within coastal wetlands and shallow bay waters would be the loss of these habitats within the footprint alignment of the structures. 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 2012 wetland mapping and National Wetlands Inventory - NWI), the current (preliminary) alignments and an assumed width of the disturbance offset from the structure. The footprints of the various structural elements pass through subtidal, intertidal, and supratidal regimes, which include 14 different aquatic and wetland habitat types. The 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 5 provides preliminary estimates of permanent wetland impacts of the TSP components and the three perimeter plan alternatives that require additional economic evaluation. It should be noted that, to date, no jurisdictional wetland delineations have been conducted along any of the preliminary perimeter plans, storm surge barrier and bay closure alignments at this point. Alignments of these structures could affect a fairly wide range of impacts. For instance, perimeter alignments shifted landward or design innovations that minimize structural footprints could significantly reduce the overall impacts on adjacent aquatic resources. However, a shift in alignment into the waters or wetland feature could significantly increase the direct impacts on aquatic habitats. The current alignments assessed in the feasibility study are either at the water's edge or provide some overlap between aquatic and terrestrial areas. A range of direct impact values is provided in Table 6 to present a 20% shift from the median value (at current water's edge) of lower impacts (landward shift) to higher impacts (bayward/wetland shift). These impact estimates may be modified and refined in a Tier 2 analysis based on a higher level of design detail that would 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.

6.2 Non-Structural

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. However, existing structures would most likely be in upland urbanized settings where construction activities would not result in any direct wetland and aquatic habitat impacts. Therefore, the need for compensatory mitigation for wetland and aquatic impacts is not expected.

6.3 Natural and Nature-Based Features

NNBF's in the form of standalone features or as a complementary feature to a structural feature would include but not be limited to: horizontal (ecotone) levees, storm surge filters, island and marsh edge augmentation, living shorelines, reefs, wetland restoration, submerged aquatic vegetation (SAV), and Engineering With Nature (EWN) modifications to structural measures including habitat benches to restore more natural slope along shorelines and textured concrete to support colonization of algae and invertebrates.

NNBFs, similar to the other structural and nonstructural measures would involve construction impacts during the time of implementation. The degree of the impact is largely dependent on the feature and it's method of construction. For instance, some NNBFs like wetland restoration or reef construction may require the aquatic placement and/or redistribution of fill materials through dredge or fill placement that would disturb existing substrates of subtidal soft bottoms or intertidal mud or sand flats, and likewise generate localized, but temporary, turbidity in the water column. These effects are expected to be temporary after construction is completed and the areas become stabilized with vegetation and/or other biogenic processes. The installation of NNBFs would also result in conversions of habitat. For instance, a subtidal soft-bottomed subtidal habitat may be changed to an intertidal saltmarsh, mudflat, beach, or reef. However, the installation of NNBFs would have beneficial impacts, by providing overall ecological uplifts of wetland and aquatic habitats in the NJBB study area. Since NNBF's are intended to be provide ecological uplift through either providing creation, restoration, and/or enhancement of aquatic ecosystems with sea level change resilience built-in, compensatory mitigation is not planned for NNBF. Additionally, as NNBF features are further evaluated, the potential use of NNBF, if appropriate, could be used to offset the overall adverse impacts of other measures. This would have to be carefully measured based on the consistency of the "uplift" provided by a NNBF measure with the impacted habitats.

Table 5. Comparative Estimated Wetland Impacts (in acres) among TSP and Perimeter Plan (PP) Alternatives Considered in the Final Array of Alternatives

		Saline Low Marsh	Saline High Marsh	Scrub Shrub Deciduous	Scrub Shrub Coniferous	Forested Wetlands	Phragmites Dominated Wetland	Herbaceous Wetlands	Disturbed Wetlands	Managed Wetlands (Lawn)
ALTS	**NWI Class:**	E2EM1N, E2EM1Nd, E2EM1P	E2EM1N, E2EM1P	E2SS1P, E2EM5P, PSS1/4B	PEM1R, E2EM1P	PF01	E2EM1N, E2EM5P, E2EM1P	E2EM1N, PEM1A, PEM1E	PEM1R, E2EMP	PEM1R
		Impact Acres	Impact Acres	Impact Acres	Impact Acres		Impact Acres	Impact Acres	Impact Acres	Impact Acres
	Features									
3E-2	**Manasquan + Barnegat SSB**									
	Barnegat Inlet SSB (A1)	-	-	-	-	-	-	-	-	-
	Manasquan Inlet SSB (A1)	-	-	-	-	-	-	-	-	-
	TOTAL	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
	20% Impact Range*:	0	0	0	0	0	0	0	0	0
4D-2	**Central ALL PP**									
	Ocean City PP	37.9	2.9	2.7	3.4	-	18.6		4.8	4.7
	Absecon Island PP	15.7	5.1	4.3	-	-	0.6	0.3	-	-
	Brigantine PP	14.5	3.6	0.1	-	-	-	0.4	-	-
	TOTAL	**68.1**	**11.6**	**7.1**	**3.4**	**0.0**	**19.2**	**0.7**	**4.8**	**4.7**
	20% Impact Range*:	**54-82**	**9-14**	**6-8**	**2.7-4.0**	**0**	**15-23**	**0.6-0.9**	**4-6**	**4-6**
4D-1	**Central ALL PP**									
	Ocean City PP	37.9	2.9	2.7	3.4	-	18.6	-	4.8	4.7
	Absecon Island PP	15.7	5.1	4.3	-	-	0.6	0.3	-	-
	TOTAL	**53.6**	**8.0**	**6.9**	**3.4**	**0.0**	**19.2**	**0.3**	**4.8**	**4.7**
	20% Impact Range*:	**43-64**	**6-10**	**6-8**	**2.7-4.0**	**0**	**15-23**	**0-1**	**4-6**	**4-6**

Table 5. Comparative Estimated Wetland Impacts (in acres) among TSP and Perimeter Plan (PP) Alternatives Considered in the Final Array of Alternatives

		Saline Low Marsh	Saline High Marsh	Scrub Shrub Deciduous	Scrub Shrub Coniferous	Forested Wetlands	Phragmites Dominated Wetland	Herbaceous Wetlands	Disturbed Wetlands	Managed Wetlands (Lawn)
ALTS	**NWI Class:**	E2EM1N, E2EM1Nd, E2EM1P	E2EM1N, E2EM1P	E2SS1P, E2EM5P, PSS1/4B	PEM1R, E2EM1P	PF01	E2EM1N, E2EM5P, E2EM1P	E2EM1N, PEM1A, PEM1E	PEM1R, E2EMP	PEM1R
		Impact Acres	Impact Acres	Impact Acres	Impact Acres		Impact Acres	Impact Acres	Impact Acres	Impact Acres
4G-8	**GEHI SSB+Absecon BC+SOC BC**									
	Great Egg Harbor Inlet SSB (A1)	-	-	-	-	-	-	-	-	-
	Absecon Blvd. Bay Closure BC	38.9	10.8	1.5	-	1.3	2.6	0.3	1.0	-
	South Ocean City 52ND ST BC	20.6	2.9		1.8	-	0.3	-	-	-
	TOTAL	**59.5**	**13.7**	**1.5**	**1.8**	**1.3**	**2.9**	**0.3**	**1.0**	**0.0**
	20% Impact Range*:	**48-71**	**11-16**	**1.2-1.8**	**1.5-2.2**	**1.0-1.6**	**2.3-3.5**	**0-1**	**0.8-1.2**	**-**
5D-2	**All Perimeter**									
	Cape May PP	2.0	3.7	2.4	2.1	3.7	1.1	1.3	-	0.5
	Wildwood PP	22.4	10.7	7.6	-	-	1.4	-	-	-
	Stone Harbor/Avalon PP	16.9	7.3	0.3	4.1	-	0.9	-	-	-
	Sea Isle City PP	22.6	10.3	3.4	-	-	6.4	-	-	-
	TOTAL	**63.9**	**32.0**	**13.7**	**6.2**	**3.0-4.4**	**9.8**	**1.3**	**0.0**	**0.5**
	20% Impact Range*:	**51-77**	**26-38**	**11-16**	**5-7**	**3.7**	**8-12**	**1-2**	**-**	**0-1**

TSP Component **Alternative Requiring Further Evaluation** *Due to the uncertainty of impact and mitigation estimates at this level of design and evaluation at a Tier 1 level, a 20% variation of the current alignment is presented as a range of impacts.

Table 6. Estimated Direct Impacts of Open Water, Shallow Subtidal, and Intertidal Mudflat/Sandy Beach

		Open Water Subtidal Soft Bottom	Open Water Subtidal Soft Bottom (shellfish)	SAV Beds (subtidal)	Subtidal Open Water Hardened Shoreline	Subtidal Open Water Hardened Shoreline (shellfish)	Intertidal Rocky SL (l.f.)	Intertidal Mudflat	Intertidal Mudflat (shellfish)	Intertidal Sandy Beach	Intertidal Sandy Beach (shellfish)
ALTS	**NWI Class:**	E1UBL, M1UBL E1UBLx,		E1AB3L, E1ABLx, E1ABL	E1UBL, E1UBL$_x$, E1UBL6		E2RS2, M2USN, RipRap	E2USM, E2USP, E2USN		E2USS, E2USM,E2USP,E2US2P,E2USN,M2US2N,M2US2P	
		Impact Acres	Impact Acres	Impact Acres	Impact Acres	Impact Acres	Impact l.f.	Impact Acres	Impact Acres	Impact Acres	Impact Acres
	Features										
3E-2	**Manasquan + Barnegat SSB**										
SSB.09	Barnegat Inlet SSB (A1)		12.2	2.6							0.8
SSB.10	Manasquan Inlet SSB (A1)	2.1					2279				0.0
	TOTAL	**2.1**	**12.2**	**2.6**	**0.0**	**0.0**	**2279**	**0.0**	**0.0**	**0.0**	**0.8**
	20% Impact Range*	**1.7-2.6**	**9.8-14.6**	**2.1-3.1**	**0**	**0**	**1824-2736**	**0**	**0**	**0**	**0.6-0.9**
4D-2	**Central ALL PP**										
G12	Ocean City PP		1.0		10.3	23.9		2.0	1.6		0.6
G18	Absecon Island PP	0.5	2.2		32.9	12.5	4196	6.2	6.6	9.0	1.7
G23	Brigantine PP		0.8		1.8	13.9		1.8	8.1	0.3	0.6
	TOTAL	**0.5**	**4.0**	**0.0**	**45.1**	**50.2**	**4196**	**10.0**	**16.2**	**9.2**	**2.9**
	20% Impact Range*	**0.4-0.6**	**3.2-4.8**	**0**	**36-54**	**40-60**	**3357-5036**	**8-12**	**13-19**	**7-11**	**2.3-3.5**
4D-1	**Central ALL PP**										
G12	Ocean City PP		1.0		10.3	23.9		2.0	1.6		0.6
G18	Absecon Island PP	0.5	2.2		32.9	12.5	4196	6.2	6.6	9.0	1.7
	TOTAL	**0.5**	**3.2**	**0.0**	**43.2**	**36.3**	**4196**	**8.2**	**8.1**	**9.0**	**2.3**
	20% Impact Range*	**0.4-0.6**	**2.6-3.8**	**0**	**35-52**	**29-44**	**3357-5036**	**7-10**	**6-10**	**7-11**	**1.8-2.8**

Table 6. Estimated Direct Impacts of Open Water, Shallow Subtidal, and Intertidal Mudflat/Sandy Beach

		Open Water Subtidal Soft Bottom	Open Water Subtidal Soft Bottom (shellfish)	SAV Beds (subtidal)	Subtidal Open Water Hardened Shoreline	Subtidal Open Water Hardened Shoreline (shellfish)	Intertidal Rocky SL (l.f.)	Intertidal Mudflat	Intertidal Mudflat (shellfish)	Intertidal Sandy Beach	Intertidal Sandy Beach (shellfish)
ALTS	**NWI Class:**	E1UBL, M1UBL	E1UBLx,	E1AB3L, E1ABLx, E1ABL	E1UBL, $E1UBL_{x,}$ E1UBL6		E2RS2, M2USN, RipRap	E2USM, E2USP, E2USN		E2USS, E2USM,E2USP,E2US2P,E2USN,M2US2N,M2US2P	
		Impact Acres	Impact Acres	Impact Acres	Impact Acres	Impact Acres	Impact l.f.	Impact Acres	Impact Acres	Impact Acres	Impact Acres
4G-8	**GEHI SSB+Absecon BC+SOC BC**										
SSB.06	Great Egg Harbor Inlet SSB (A1)	20.0								5.6	
BC.01	Absecon Blvd. Bay Closure BC	0.7	2.4		4.5	13.4	1831	2.3	1.0	1.1	1.6
BC.08	South Ocean City 52ND ST BC		1.6								
	TOTAL	**20.7**	**4.0**	**0.0**	**4.5**	**13.4**	**1831**	**2.3**	**1.0**	**6.6**	**1.6**
	20% Impact Range*	**17-25**	**3-5**	**0**	**4-5**	**11-16**	**1465-2197**	**1.9-2.8**	**0.8-1.2**	**5-8**	**1.3-2.0**
5D-2	**All Perimeter**										
G1	Cape May PP	0.1				6.4	2324		0.5		7.3
G2	Wildwood PP		0.5			19.2			21.5		2.0
G5	Stone Harbor/Avalon PP		0.4		3.5	63.2	79	1.0	8.7	1.0	
G10	Sea Isle City PP		0.4			13.2			0.5		0.1
	TOTAL	**0.1**	**1.3**	**0.0**	**3.5**	**102.0**	**2404**	**1.0**	**31.2**	**1.0**	**9.4**
	20% Impact Range*	**-**	**1.1-1.6**	**0**	**2.8-4.2**	**82-122**	**1923-2885**	**0.8-1.2**	**25-37**	**0.8-1.2**	**7-11**

TSP Component **Alternative Requiring Further Evaluation** *Due to the uncertainty of impact and mitigation estimates at this level of design and evaluation at a Tier 1 level, a 20% variation of the current alignment is presented as a range of impacts.

Figure 13. Storm Surge Barrier Overlay with Wetland Habitats at Manasquan Inlet in TSP Alternative 3E(2)

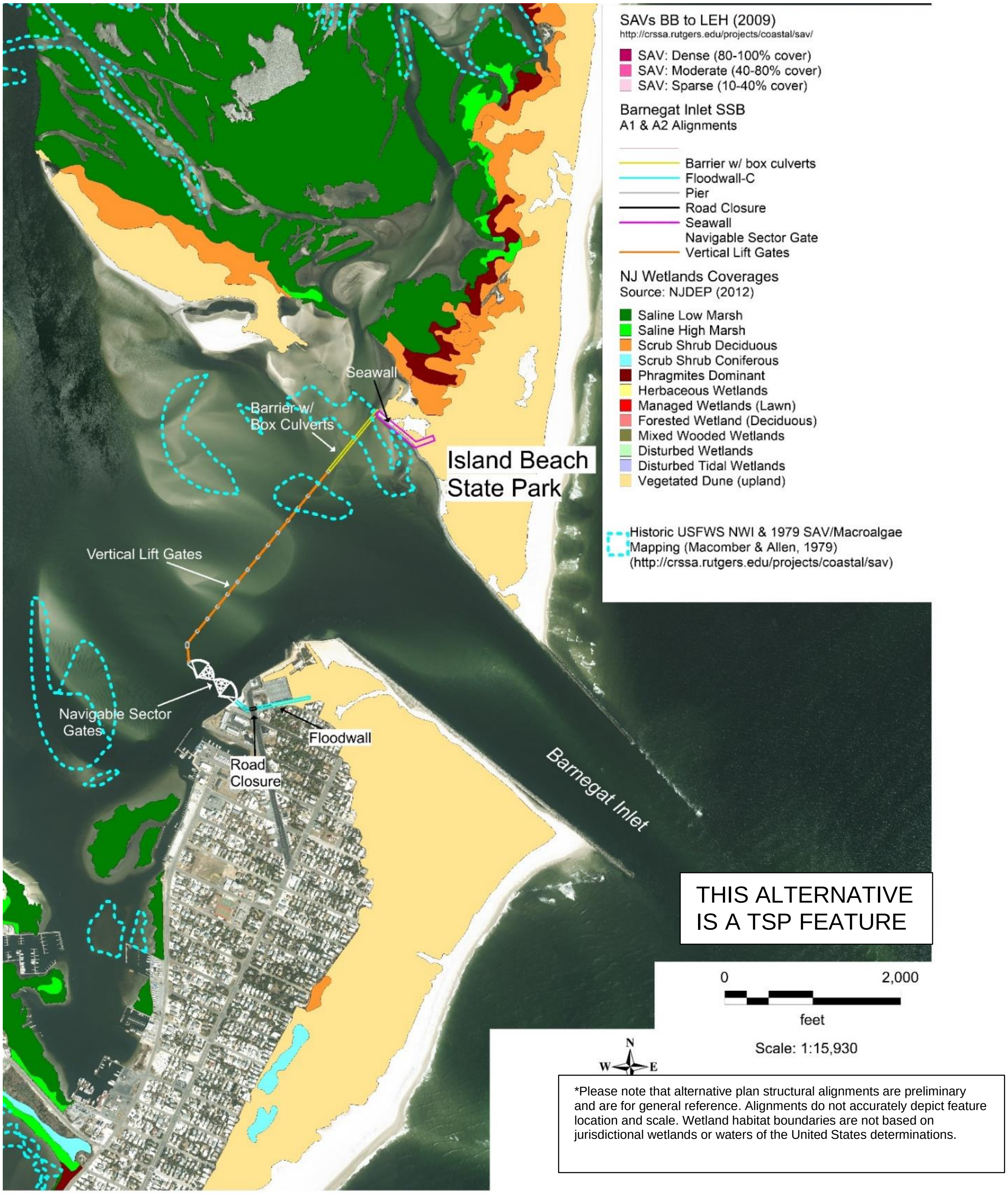


Figure 14. Storm Surge Barrier Overlay with Wetland Habitats at Barnegat Inlet in TSP Alternative 3E(2)

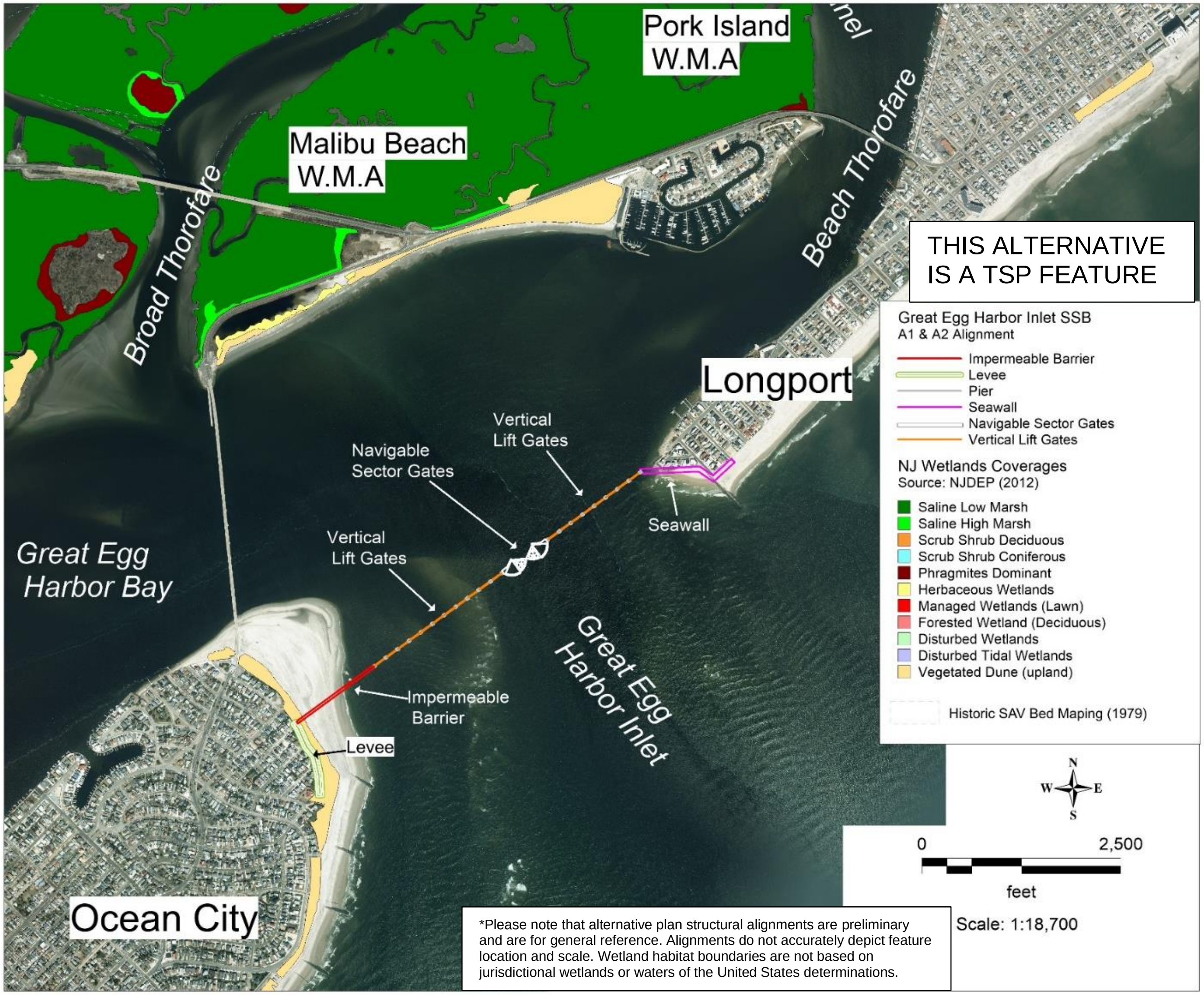


Figure 15. Storm Surge Barrier Overlay with Wetland Habitats at Great Egg Harbor Inlet in TSP Alternative 4G(8)

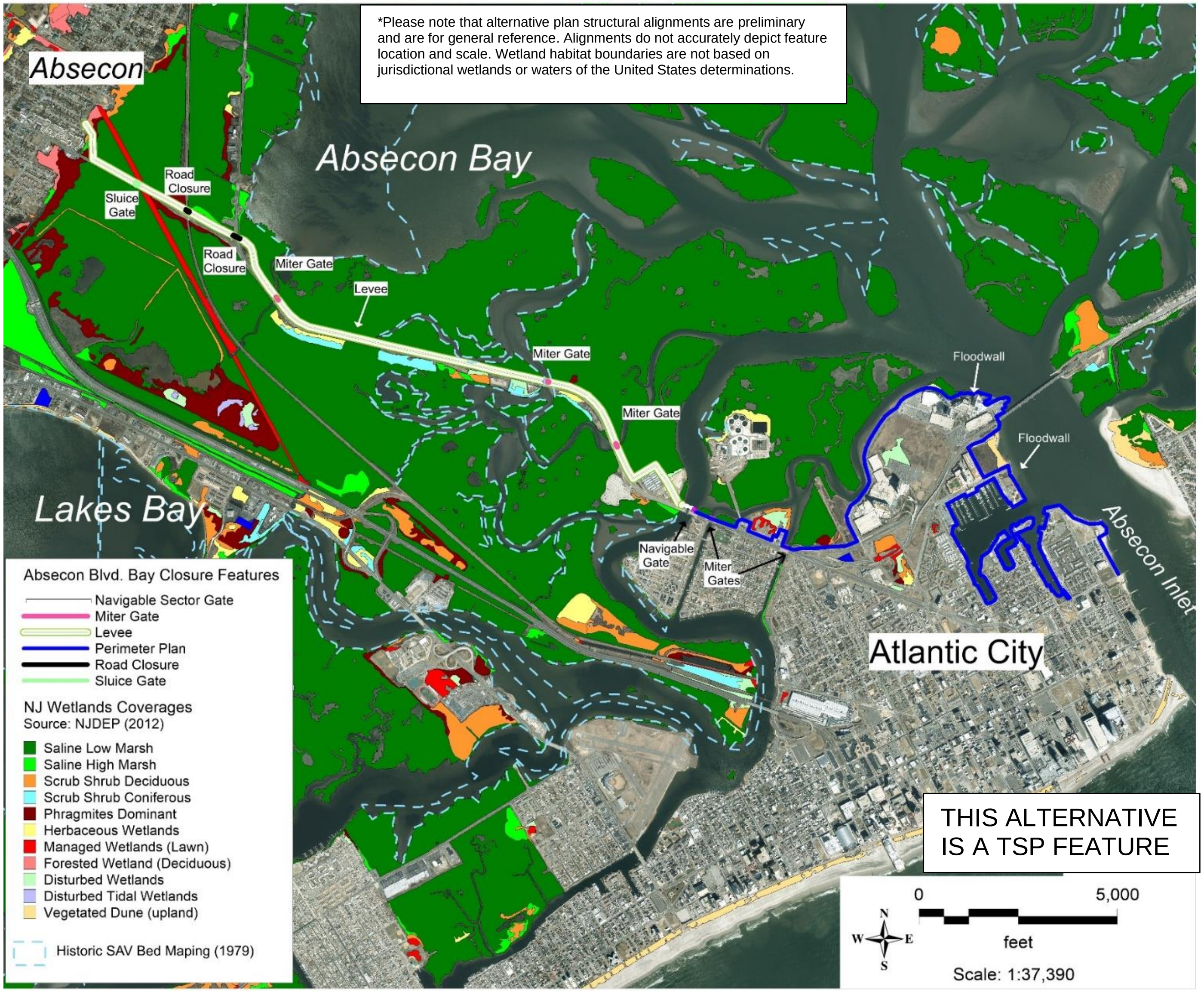


Figure 16. Interior Bay Closure Overlay with Wetland Habitats at Absecon Boulevard in TSP Alternative 4G(8)

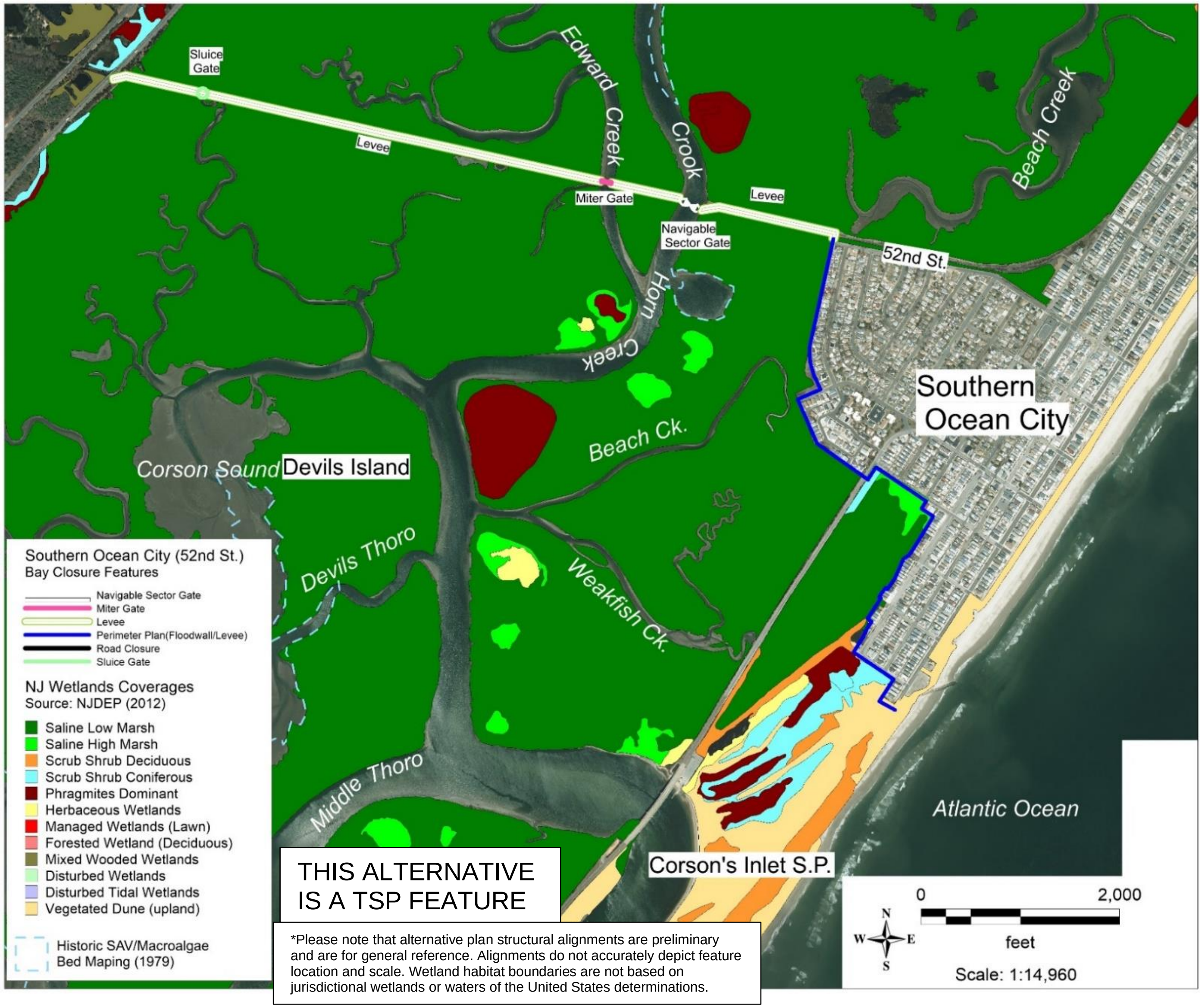


Figure 17. Interior Bay Closure Overlay with Wetland Habitats at Southern Ocean City in TSP Alternative 4G(8)

7.0 INDIRECT IMPACTS OF THE TSP

The short-term indirect impacts of SSB and BC structures on aquatic habitats and wetlands are expected to be minimal to significant and are related to temporary impacts such as sedimentation during construction and temporary access/staging in these areas. However, SSBs and BCs may pose long-term significant indirect effects on wetlands and other aquatic habitats. Depending on the design of an SSB or BC, the available openings to pass tidal flows when open during normal conditions would be more constricted than existing inlets and other waterways. A constriction would change the tidal prism by limiting incoming (flood) tides that could result in tidal amplitudes where a lowered high tide elevation and the outgoing (ebb) tides could result in higher low tides, thereby affecting wetland and aquatic habitats at each end of the tidal range on a bay-wide scale. In Orton et al. 2020, SSBs have the potential to change geomorphic processes that shape and maintain saltmarsh habitats and recommended that effects for SSBs should be evaluated for these possibilities: 1.) reductions in tidal amplitude will decrease sediment accretion through reduced biomass production and sediment deposition, 2.) reduction in high water levels will decrease inundation time and sediment deposition, 3.) reduction in water levels in severe storms will modify edge erosion process, and changes to estuary salinity or its extremes could cause an evolution of marsh species (eg. conversions of salt marsh species to *Phragmites*).

Modeling was conducted on the affected NJBB estuaries utilizing the AdH model open-gate scenario, which 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 for the TSP. Table 7. shows that with the exception of Watson Creek, a tributary to the Manasquan River, all locations showed slight reductions in amplitude. Table 7. presents the mean reductions per station. 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 these TSP 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.

Based on the results of the AdH modeling, it can be assumed that even small reductions in tidal amplitude that the TSP could result in initial significant conversions of transitional intertidal habitats such as high marshes to upland and some of the intertidal mudflats to open water. Over time with sea level rise, some of these transitional conversions may revert back to their original regime with higher amplitudes introduced by SLR, but become somewhat offset by the SSBs and BCs. To accurately measure this effect, these changes will require additional modeling that would account for sensitivities associated with tidal changes of a few centimeters over the existing and future spatial land/water interfaces.

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.

Table 7. AdH Model Comparing Mean Baseline Tidal Amplitudes with TSP (A1 Alignments) for Alternatives 3E(2) and 4G(8) Open-Gate Conditions and with Sea Level Rise (SLR) at Locations Throughout the NJBB Study Area (McAlpin and Ross, 2020)

Study Region	Waterway	Station	Existing Conditions				With SLR			
			Base (m)	TSP (m)	Change (m)	Change (cm)	Base (m)	TSP (m)	Change (m)	Change (cm)
NORTHERN REGION	Manasquan River	Watson Creek	0.941	0.955	+0.014	1.4	0.88	0.87	-0.01	-1.0
		Manasquan River	0.604	0.593	-0.011	-1.1	0.74	0.67	-0.07	-7.0
	Barnegat Bay- Little Egg Harbor	Brick	0.103	0.098	-0.005	-0.5	0.22	0.21	-0.01	-1.0
		Barnegat Bay at Mantoloking	0.162	0.154	-0.008	-0.8	0.23	0.22	-0.01	-1.0
		Barnegat Bay at Route 37 Bridge	0.17	0.16	-0.01	-1	0.25	0.23	-0.02	-2.0
		Berkeley	0.164	0.154	-0.01	-1	0.24	0.23	-0.01	-1.0
		Barnegat Light	0.168	0.157	-0.011	-1.1	0.20	0.19	-0.01	-1.0
		Barnegat Bay at Waretown	0.172	0.162	-0.01	-1	0.20	0.19	-0.01	-1.0
		Barnegat Bay at Barnegat Light	0.404	0.153	-0.251	-25.1	0.46	0.40	-0.06	-6.0
		Barnegat Light (Ocean)	0.708	0.692	-0.016	-1.6	1.02	1.02	0.00	0.0
		East Thorofare	0.472	0.463	-0.009	-0.9	0.38	0.37	-0.01	-1.0
		Westecunk	0.336	0.332	-0.004	-0.4	0.32	0.31	-0.01	-1.0
		Beach Haven	0.505	0.492	-0.013	-1.3	0.53	0.48	-0.05	-5.0
CE NT RAL	Mullica River	JACNEWQ (Mullica River)	0.428	0.414	-0.014	-1.4	0.39	0.38	-0.01	-1.0

Table 7. AdH Model Comparing Mean Baseline Tidal Amplitudes with TSP (A1 Alignments) for Alternatives 3E(2) and 4G(8) Open-Gate Conditions and with Sea Level Rise (SLR) at Locations Throughout the NJBB Study Area (McAlpin and Ross, 2020)

Study Region	Waterway	Station	Existing Conditions				With SLR			
			Base (m)	TSP (m)	Change (m)	Change (cm)	Base (m)	TSP (m)	Change (m)	Change (cm)
	Little Egg Inlet/Great Bay	Little Egg Inlet	0.57	0.558	-0.012	-1.2	0.75	0.68	-0.07	-7.0
	Absecon Bay	Absecon Creek	0.586	0.567	-0.019	-1.9	0.63	0.62	-0.01	-1.0
	Obes Thorofare	Brigantine	0.53	0.514	-0.016	-1.6	0.65	0.61	-0.04	-4.0
	Absecon Inlet	Absecon Channel	0.681	0.677	-0.004	-0.4	0.91	0.82	-0.09	-9.0
	Atlantic Ocean	Atlantic City (Ocean)	0.739	0.738	-0.001	-0.1	1.04	1.04	0.00	0.0
	Inside Thorofare	Inside Thorofare (Rt. 40)	0.686	0.67	-0.016	-1.6	0.70	0.66	-0.04	-4.0
	Beach Thorofare	Beach Thorofare (Margate Blvd.)	0.71	0.682	-0.028	-2.8	0.75	0.70	-0.05	-5.0
	Scull Bay	Scull Bay	0.56	0.543	-0.017	-1.7	0.75	0.60	-0.15	-15.0
	Great Egg Harbor River	Great Egg Harbor River	0.6	0.586	-0.014	-1.4	0.50	0.47	-0.03	-3.0
	Rainbow Channel	Great Egg Harbor Bay	0.713	0.689	-0.024	-2.4	0.95	0.78	-0.17	-17.0
	Crook Horn Creek	Ocean City 39th St	0.622	0.608	-0.014	-1.4	0.72	0.57	-0.15	-15.0
SOUTHERN REGION	Middle Thorofare	Corson Sound	0.566	0.554	-0.012	-1.2	0.49	0.48	-0.01	-1.0
	Ludlum Thorofare	Ludlum Thorofare (Sea Isle Blvd.)	0.573	0.563	-0.01	-1.0	0.47	0.47	0.00	0.0
	Ingram Thorofare	Ingram Thorofare (Old Avalon Blvd.)	0.641	0.635	-0.006	-0.6	0.74	0.68	-0.06	-6.0
	Cape May Canal	Cape May Ferry	1.022	1.018	-0.004	-0.4	1.28	1.28	0.00	0.0
	Cape May Harbor	Cape May Harbor	0.909	0.906	-0.003	-0.3	1.10	1.10	0.00	0.0

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.

<u>Gates Closed Scenario</u>

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.

Because of the high potential risk for wetland and other aquatic habitat impacts and the uncertainty of identifying these impacts. It is assumed that compensatory mitigation will be required for the potential direct and indirect impacts on tidal wetlands. Indirect impacts will require additional evaluation using models such as the NYBEM (in development) and practicing additional avoidance and minimization as design details become better refined. It is expected that this information will be fully evaluated at the Tier 2 level.

8.0 COMPENSATORY WETLAND MITIGATION FUNCTIONAL ANALYSIS AND MITIGATION REQUIREMENTS

8.1 Application of New England Marsh Model

Compensatory mitigation quantity requirements are found in 33 CFR Part 332.3(f.)(1)(2). "When compensatory mitigation is necessary to offset unavoidable impacts to aquatic resources, the amount of required compensatory mitigation must be, to the extent practicable, sufficient to replace lost aquatic resource functions. In cases where appropriate functional or condition assessment methods or other suitable metrics are available, these methods should be used where practicable to determine how much compensatory mitigation is required. If a functional or condition assessment or other suitable metric is not used, a minimum one-to-one acreage or linear foot compensation ratio must be used." A preliminary evaluation of the estimated unavoidable direct impacts to wetland ecosystems resulting from the construction of CSRM measures in the TSP was performed. The New England Salt Marsh Model (McKinney et al. 2009) was used to assess the functional loss of wetlands within the footprint of the proposed CSRM structures. The New England Salt Marsh Model (NESMM) is a wetland community model that quantifies the heath and function of a salt marsh based on marsh characteristics and the presence of habitat types that contribute to use by terrestrial species. The model consists of eight wetland and landscape components that are used to assess and evaluate salt marsh wildlife habitat values. Several of the components are directly based on the different habitat types found in and around marshes or ecosystems that are linked to salt marshes. Other components reflect the anthropogenic alteration of these habitats. The remaining components take into account the size, morphology, and landscape positions of the marsh, which may be important to territorial species and those that require adjacent upland habitats. The eight components are (1) marsh habitat types, (2) marsh morphology, (3) marsh size, (4) degree of anthropogenic modification, (5) vegetative heterogeneity, (6) surrounding land use, (7) connectivity, and (8) vegetation types.

Model output is a numerical score with a maximum possible ranking score of 784. Individual desktop assessments were performed on desktop GIS-delineated salt marsh units along plan feature components. Among the TSP components, the Bay Closures along Absecon Boulevard and the Southern Ocean City (52^{nd} St. and abandoned railroad embankment) resulted in the highest impacts to saltmarsh habitats. The saltmarsh habitats (including adjacent supratidal wetlands) were delineated as NESMM marsh units that were bounded either by large water bodies or significant development or hydrologic restrictions. The marsh habitat types in Table 8. were then combined as part of the NESMM marsh unit. A number of different saltmarsh units were encountered along these alignments, and had variable ranking scores from 286 to 655. These scores were multiplied by the acres impacted to provide a quantified ranking of the impacted marsh. To determine the quantity of functional compensatory mitigation for these impacted areas, a mitigation site marsh relative ranking score was assigned as a proxy for a mitigation acres. The relative ranking score assigned was 328, which reflects the function of a constructed marsh after initial establishment but may not have developed all of the functions of an older established marsh. In order to provide a compensatory mitigation acreage estimate, the following formula was used:

$$\text{Estimated mitigation acres} = \frac{\text{Impact Site Relative Ranking Score X Acres of Impact}}{\text{Mitigation Site Marsh Relative Ranking}}$$

Table 8. provides the preliminary results of this formula along with a 20% variance in range of impacts and range of mitigation to account for uncertainty in structural footprints and actual jurisdictional lines.

8.2 Application of the New York Bight Ecological Model (NYBEM)

The NYBEM is currently in development and will be applied to assess the direct and indirect effects of implementing the TSP measures on all affected aquatic habitats, which include marine, estuarine, and freshwater salinity zones; and by tidal regimes as deep water, subtidal and intertidal. This covers a number of habitat types within these zones/regimes including subtidal soft-bottom areas, intertidal sandy beaches, intertidal mudflats, and saltmarshes. In NYBEM, the quantity and quality of each ecosystem type may be assessed separately. For instance, ecosystems could be rapidly delineated from empirical data for the existing condition (e.g., field or tide gauge) or modeled hydrodynamic data for future conditions or proposed management actions. These delineated ecosystems can be summarized as an overarching habitat quantity in acres. Ecosystem quality may then be assessed based on patch-specific data and known thresholds in ecological response (e.g., on a normalized 0 to 1 scale indicating ecological quality or function). The product of habitat quality and quantity provides a consistent metric across ecosystem types (i.e., “habitat units”). Here, the terms “habitat” and “ecosystem” are used synonymously to indicate a given patch.

8.3 Compensatory Mudflat, Intertidal Beach, Submerged Aquatic Vegetation, And Open-Water Mitigation Functional Analysis and Mitigation Requirements

Because the NYBEM model is currently in development, the New England Salt Marsh Model is being utilized to provide impact and mitigation estimates as a rough order of magnitude for salt marsh habitats. Additionally, in the interim (and until NYBEM is available), direct impacts to discreet intertidal mudflats, intertidal sandy beaches, and soft-bottom subtidal habitats are being assessed and weighted based on their presence within areas historically identified as shellfish waters or SAV beds. This weighting assumed that aquatic habitats in shellfish waters would have a higher resource value than areas that were impacted by hardened shorelines or within other areas of lesser resource value like marinas or wharves with periodic anthropogenic effects. For cost-estimating purposes, mitigation estimates are based on parametric costs for the replacement as either salt marshes for intertidal habitats or as SAVs for subtidal habitats. These estimates may be refined based on the application of the NYBEM in addition to continued coordination with the resource agencies. Table 8. provides the preliminary estimates of mitigation for habitats not evaluated in the NESMM along with a 20% variance in range of impacts and range of mitigation to account for uncertainty in structural footprints and actual jurisdictional lines.

8.4 Compensatory Mitigation for Indirect Effects

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 COMPENSATORY MITIGATION METHODS

In the State of New Jersey, mitigation for wetlands may take the following forms: creation, restoration, enhancement, mitigation bank credit purchase, monetary contribution, preservation, or a land donation (NJAC).

Table 8. Compensatory Wetland Mitigation Estimates from New England Salt Marsh Modell (NESMM)

	NESMM Marsh Unit ID	Marsh Impact Acres	NESMM Ranking Score	NESMM Value	NESMM Relative Mitigation Site Ranking Score	Proposed Mitigation Acres
		(Acres)		= NESMM Ranking Score X Impact Acres	Estimated Assigned Value	Acres= NESMM Value/328
Alternative 4G(8) – Bay Closures						
Absecon Boulevard Bay Closure	Small Fringe Marsh	1.4	395	565	328	1.7
	G1801	1.0	286	283	328	0.9
	G1802	4.4	429	1892	328	5.8
	G1803	1.4	419	578	328	1.8
	G1804	1.0	321	308	328	0.9
	G1805	1.3	422	549	328	1.7
	ABSECBC01	35.0	603	21093	328	64.3
	ABSECBC02	1.2	442	544	328	1.7
	ABSECBC03	8.5	441	3744	328	11.4
	SUBTOTAL	**55** **(44-66)***				**90** **(72-108)***
South Ocean City (52nd St.) Bay Closure	G1203 Marsh	11.0	557	6149	328	18.7
	G1204 Marsh	14.6	655	9576	328	29.2
	SUBTOTAL	**26** **(21-31)***				**48** **(38-58)***
	TOTAL Estimated	**81**		**1.7:1**		**138**
	Total Range*	**65-97**				**110-166**

Table 8. Compensatory Wetland Mitigation Estimates from New England Salt Marsh Modell (NESMM)

	NESMM Marsh Unit ID	Marsh Impact Acres	NESMM Ranking Score	NESMM Value	NESMM Relative Mitigation Site Ranking Score	Proposed Mitigation Acres
		(Acres)		= NESMM Ranking Score X Impact Acres	Estimated Assigned Value	Acres= NESMM Value/328
	(20% Difference)					
4D(1) CENTRAL PERIMETER PLAN						
Ocean City Perimeter Plan	G1201	19.1	508	9718	328	29.6
	G1202	6.1	465	2846	328	8.7
	G1203	46.6	557	25934	328	79.1
	Small Fringes	2.9	395	1161	328	3.5
	SUBTOTAL	**75** **(60-90)***				**121** **(97-145)***
Absecon Island Perimeter Plan	G1801	1.0	286	283	328	0.9
	G1802	4.1	421	1718	328	5.2
	G1803	0.9	419	373	328	1.1
	G1804	0.9	321	289	328	0.9
	G1805	1.3	422	557	328	1.7
	G1806	6.7	515	3456	328	10.5
	G1807	4.4	624	2714	328	8.3
	Small Fringes	7.5	395	2966	328	9.0
	SUBTOTAL	**27** **(21-32)***				**38** **(30-45)***

Table 8. Compensatory Wetland Mitigation Estimates from New England Salt Marsh Modell (NESMM)

	NESMM Marsh Unit ID	Marsh Impact Acres	NESMM Ranking Score	NESMM Value	NESMM Relative Mitigation Site Ranking Score	Proposed Mitigation Acres
		(Acres)		= NESMM Ranking Score X Impact Acres	Estimated Assigned Value	Acres= NESMM Value/328
	TOTAL Estimated	**102**		**1.6:1**		**159**
	Total Range* **(20% Difference)**	**81-122**				**110-190**
4D(2) CENTRAL PERIMETER PLAN						
Ocean City Perimeter Plan	G1201	19.1	508	9718	328	29.6
	G1202	6.1	465	2846	328	8.7
	G1203	46.6	557	25934	328	79.1
	Small Fringes	2.9	395	1161	328	3.5
	SUBTOTAL	**75** **(60-90)***				**121** **(97-145)***
Absecon Island Perimeter Plan	G1801	1.0	286	283	328	0.9
	G1802	4.1	421	1718	328	5.2
	G1803	0.9	419	373	328	1.1
	G1804	0.9	321	289	328	0.9
	G1805	1.3	422	557	328	1.7
	G1806	6.7	515	3456	328	10.5
	G1807	4.4	624	2714	328	8.3
	Small Fringes	7.5	395	2966	328	9.0

Table 8. Compensatory Wetland Mitigation Estimates from New England Salt Marsh Modell (NESMM)

	NESMM Marsh Unit ID	Marsh Impact Acres	NESMM Ranking Score	NESMM Value	NESMM Relative Mitigation Site Ranking Score	Proposed Mitigation Acres
		(Acres)		= NESMM Ranking Score X Impact Acres	Estimated Assigned Value	Acres= NESMM Value/328
	SUBTOTAL	**27** **(21-32)***				**38** **(30-45)***
Brigantine Perimeter Plan	G2301	0.2	744	126	328	0.4
	G2302	1.2	591	680	328	2.1
	G2303	6.0	577	3462	328	10.6
	G2304	2.6	607	1566	328	4.8
	Small Fringes	8.3	395	3294	328	10.0
	SUBTOTAL	**18** **(15-22)***				**28** **(22-33)***
	TOTAL Estimated	**120**		**1.6:1**		**187**
	Total Range* **(20% Difference)**	**96-144**				**132-223**
5D(2) SOUTHERN PERIMETER PLAN						
Cape May Perimeter Plan	G1CM01	0.26	314	81	328	0.2
	G1CM02	0.31	396	121	328	0.4
	G1CM03	11.86	597	7080	328	21.6
	Small Fringes	2.2	395	852	328	2.6
	SUBTOTAL	**15** **(12-17)***				**25** **(20-30)***

Table 8. Compensatory Wetland Mitigation Estimates from New England Salt Marsh Modell (NESMM)

	NESMM Marsh Unit ID	Marsh Impact Acres	NESMM Ranking Score	NESMM Value	NESMM Relative Mitigation Site Ranking Score	Proposed Mitigation Acres
		(Acres)		= NESMM Ranking Score X Impact Acres	Estimated Assigned Value	Acres= NESMM Value/328
Wildwood Perimeter Plan	G2WW01	2.5	491	1220	328	3.7
	G2WW02	1.7	477	814	328	2.5
	G2WW03	1.5	479	719	328	2.2
	G2WW04	8.7	509	4445	328	13.6
	G2WW05	4.7	634	3003	328	9.2
	G2WW06	4.3	486	2098	328	6.4
	G2WW07	16.3	573	9320	328	28.4
	G2WW08	1.6	655	1025	328	3.1
	Small Fringes	3.0	395	1184	328	3.6
	SUBTOTAL	**44 (35-53)***				**73 (58-87)***
Stone Harbor/Avalon Perimeter Plan	G5SHAV01	5.6	563	3160	328	9.6
	G5SHAV02	1.0	682	694	328	2.1
	G5SHAV03	4.6	690	3208	328	9.8
	G5SHAV04	3.1	690	2133	328	6.5
	Small Fringes	20.3	395	8013	328	24.4
	SUBTOTAL	**38 (30-45)***				**52 (42-63)***
Sea Isle City PP	G10SIC01	12.6	575	7271	328	22.2
	G10SIC02	9.3	454	4218	328	12.9

Table 8. Compensatory Wetland Mitigation Estimates from New England Salt Marsh Modell (NESMM)

	NESMM Marsh Unit ID	Marsh Impact Acres	NESMM Ranking Score	NESMM Value	NESMM Relative Mitigation Site Ranking Score	Proposed Mitigation Acres
		(Acres)		= NESMM Ranking Score X Impact Acres	Estimated Assigned Value	Acres= NESMM Value/328
	G10SIC03	15.4	459	7086	328	21.6
	Small Fringes	5.3	395	2112	328	6.4
	SUBTOTAL	**45** **(36-54)***				**63** **(50-76)***
	TOTAL Estimated	**142**		**1.5:1**		**213**
	Total Range* **(20% Difference)**	**113-169**				**170-256**

TSP Component   **Alternative Requiring Further Evaluation**

*Due to the uncertainty of impact and mitigation estimates at this level of design and evaluation at a Tier 1 level, a 20% variation of the current alignment is presented as a range of impacts and compensatory mitigation.

Table 9. Compensatory Aquatic Habitat Mitigation Estimates

		Open Water Subtidal Soft Bottom		Open Water Subtidal Soft Bottom (shellfish)		SAV Beds (subtidal)		Subtidal Open Water Hardened Shoreline		Subtidal Open Water Hardened Shoreline (shellfish)		Intertidal Rocky SL (l.f.)		Intertidal Mudflat		Intertidal Mudflat (shellfish)		Intertidal Sandy Beach		Intertidal Sandy Beach (shellfish)	
	NWI Class:	E1UBL, E1UBLx, M1UBL		E1UBL, E1UBLx, M1UBL		E1AB3L, E1ABLx, E1ABL		E1UBL, E1UBLx, E1UBL6		E1UBL, E1UBLx, E1UBL6		E2RS2, M2USN, RipRap		E2USM, E2USP, E2USN		E2USM, E2USP, E2USN		E2USS, E2USM,E2USP,E2US2P,E2USN,M2US2N,M2US2P		E2USS, E2USM,E2USP,E2US2P,E2USN,M2US2N,M2US2P	
	Features	Impact Acres	Mit. Acres	Impact Acres	Mit. Acres	Impact Acres	Mit. Acres	Impact Acres	Mit. Acres	Impact Acres	Mit. Acres	Impact l.f.	Mit. l.f.	Impact Acres	Mit. Acres	Impact Acres	Mit. Acres	Impact Acres	Mit. Acres	Impact Acres	Mit. Acres
3E-2	**Manasquan + Barnegat SSB**																				
SSB.09	Barnegat Inlet SSB (A1)		0.0	12.2	16.3	2.6	5.2		0.0		0.0		0.0		0.0		0.0		0.0	0.8	1.1
SSB.10	Manasquan Inlet SSB (A1)	2.1	1.7		0.0		0.0		0.0		0.0	2280	1140		0.0		0.0		0.0	0.0	0.0
	TOTAL	**2.1**	**1.7**	**12.2**	**16.3**	**2.6**	**5.2**	**0.0**	**0.0**	**0.0**	**0.0**	**2280**	**1140**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.8**	**1.1**
	Total Range* **(20% Difference)**	**1.7-2.6**	**1.4-2.0**	**9.8-14.6**	**13.0-19.5**	**2.1-3.1**	**4.2-6.3**					**1824-2736**	**912-1368**							**0.6-0.9**	**0.8-1.3**
4D-2	**Central ALL PP**																				
12	Ocean City PP		0.0	1.0	1.3		0.0	10.3	8.2	23.9	31.8		0.0	2.0	1.6	1.6	2.1		0.0	0.6	0.8
18	Absecon Island PP	0.5	0.4	2.2	2.9		0.0	32.9	26.3	12.5	16.6	4196	2098	6.2	5.0	6.6	8.7	9.0	7.2	1.7	2.2
23	Brigantine PP		0.0	0.8	1.1		0.0	1.8	1.5	13.9	18.5		0.0	1.8	1.4	8.1	10.8	0.3	0.2	0.6	0.8
	TOTAL	**0.5**	**0.4**	**4.0**	**5.3**	**0.0**	**0.0**	**45.1**	**36.1**	**50.2**	**67.0**	**4196**	**2098**	**10.0**	**8.0**	**16.2**	**21.6**	**9.2**	**7.4**	**2.9**	**3.9**
	Total Range* **(20% Difference)**	**0.4-0.6**	**0.3-0.5**	**3.2-4.8**	**4.3-6.4**			**36.1-54.1**	**28.9-43.3**	**40.2-60.3**	**53.6-80.4**	**3357-5036**	**1679-2518**	**8.0-12.0**	**6.4-9.6**	**13.0-19.5**	**17.3-26.0**	**7.4-11.1**	**5.9-8.8**	**2.3-3.5**	**3.1-4.7**
4D-1	**Central ALL PP**																				
12	Ocean City PP		0.0	1.0	1.3		0.0	10.3	8.2	23.9	31.8		0.0	2.0	1.6	1.6	2.1		0.0	0.6	0.8
18	Absecon Island PP	0.5	0.4	2.2	2.9		0.0	32.9	26.3	12.5	16.6	4196	2098	6.2	5.0	6.6	8.7	9.0	7.2	1.7	2.2
	TOTAL	**0.5**	**0.4**	**3.2**	**4.3**	**0.0**	**0.0**	**43.2**	**34.6**	**36.3**	**48.4**	**4196**	**2098**	**8.2**	**6.6**	**8.1**	**10.8**	**9.0**	**7.2**	**2.3**	**3.1**
	Total Range* **(20% Difference)**	**0.4-0.6**	**0.3-0.5**	**2.6-3.8**	**3.4-5.1**			**34.6-52.0**	**28.0-42.0**	**29.1-43.6**	**39-58**	**3357-5036**	**1679-2518**	**6.6-9.8**	**5.2-7.9**	**6.5-9.7**	**8.7-13.0**	**7.2-10.8**	**5.7-8.6**	**1.8-2.8**	**2.5-3.7**
4G-8	**GEHI SSB+Absecon BC+SOC BC**																				
SSB.06	Great Egg Harbor Inlet SSB (A1)	20.0	16.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0	5.6	4.4		0.0
BC.01	Absecon Blvd. Bay Closure BC	0.7	0.5	2.4	3.2		0.0	4.5	3.6	13.4	17.9	1831	916	2.3	1.9	1.0	1.4	1.1	0.9	1.6	2.2
BC.08	South Ocean City 52ND ST BC		0.0	1.6	2.1		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
	TOTAL	**20.7**	**16.6**	**4.0**	**5.3**	**0.0**	**0.0**	**4.5**	**3.6**	**13.4**	**17.9**	**1831**	**916**	**2.3**	**1.9**	**1.0**	**1.4**	**6.6**	**5.3**	**1.6**	**2.2**
	Total Range* **(20% Difference)**	**16.6-25.0**	**13.3-20.0**	**3.2-4.8**	**4.2-6.4**			**3.6-5.3**	**2.8-4.3**	**10.7-16.1**	**14.3-21.5**	**1465-2197**	**732-1098**	**1.9-2.8**	**1.5-2.2**	**0.8-1.2**	**1.1-1.6**	**5.3-8.0**	**4.3-6.4**	**1.3-2.0**	**1.7-2.6**
5D-2	**All Perimeter**																				
1	Cape May PP	0.1	0.1		0.0		0.0		0.0	6.4	8.5	2324	1162		0.0	0.5	0.6		0.0	7.3	9.7
2	Wildwood PP		0.0	0.5	0.7		0.0		0.0	19.2	25.7		0.0		0.0	21.5	28.7		0.0	2.0	2.7
5	Stone Harbor/Avalon PP		0.0	0.4	0.6		0.0	3.5	2.8	63.2	84.3	80	40	1.0	0.8	8.7	11.6	1.0	0.8		0.0
10	Sea Isle City PP			0.4	0.6					13.2	17.6					0.5	0.7			0.1	0.1

Table 9. Compensatory Aquatic Habitat Mitigation Estimates

		Open Water Subtidal Soft Bottom		Open Water Subtidal Soft Bottom (shellfish)		SAV Beds (subtidal)		Subtidal Open Water Hardened Shoreline		Subtidal Open Water Hardened Shoreline (shellfish)		Intertidal Rocky SL (l.f.)		Intertidal Mudflat		Intertidal Mudflat (shellfish)		Intertidal Sandy Beach		Intertidal Sandy Beach (shellfish)	
	NWI Class:	E1UBL, E1UBLx, M1UBL		E1UBL, E1UBLx, M1UBL		E1AB3L, E1ABLx, E1ABL		E1UBL, E1UBLx, E1UBL6		E1UBL, E1UBLx, E1UBL6		E2RS2, M2USN, RipRap		E2USM, E2USP, E2USN		E2USM, E2USP, E2USN		E2USS, E2USM,E2USP,E2US2P,E2USN,M2US2N,M2US2P		E2USS, E2USM,E2USP,E2US2P,E2USN,M2US2N,M2US2P	
	Features	Impact Acres	Mit. Acres	Impact Acres	Mit. Acres	Impact Acres	Mit. Acres	Impact Acres	Mit. Acres	Impact Acres	Mit. Acres	Impact l.f.	Mit. l.f.	Impact Acres	Mit. Acres	Impact Acres	Mit. Acres	Impact Acres	Mit. Acres	Impact Acres	Mit. Acres
	TOTAL	**0.1**	**0.1**	**1.3**	**1.8**	**0.0**	**0.0**	**3.5**	**2.8**	**102.0**	**136.0**	**2404**	**1202**	**1.0**	**0.8**	**31.2**	**41.6**	**1.0**	**0.8**	**9.4**	**12.5**
	Total Range* **(20% Difference)**	**0.1-0.1**	**0.1-0.1**	**1.1-1.6**	**1.4-2.1**			**2.8-4.2**	**2.2-3.4**	**81.6-122.4**	**109-163**	**1923-2885**	**962-1443**	**0.8-1.2**	**0.6-0.9**	**25.0-37.5**	**33.3-50.0**	**0.8-1.2**	**0.7-1.0**	**7.5-11.2**	**10.0-15.0**

TSP Component **Alternative Requiring Further Evaluation**

*Due to the uncertainty of impact and mitigation estimates at this level of design and evaluation at a Tier 1 level, a 20% variation of the current alignment is presented as a range of impacts and compensatory mitigation.

9.1 Permittee-Responsible Mitigation

In the State of New Jersey, a "permit applicant" may implement compensatory measures at the impact site (i.e., on-site mitigation) or at another location usually within the same watershed as the permitted impact (i.e., off-site mitigation). In this case, USACE would not be applying for state permits, but would retain responsibility for the implementation and success of the mitigation. Creation, restoration, and enhancement typically fall within "permitee"-responsible mitigation. In addition, USACE does not utilize ratios for Federal project mitigation. USACE utilizes ecological models to provide quantitative and qualitative measures of habitat features considering that the mitigation at least compensates for the impact. In accordance with USACE mitigation policy, these mitigation estimates would undergo an incremental cost analysis to determine best-buy mitigation alternatives and to determine the most cost-efficient measures.

9.1.1 Creation and Restoration

Creation means the establishment of wetlands or waters characteristics and functions in a non-wetland area where there is no evidence or documentation that the area has ever been wetlands.

Restoration means the reestablishment of wetland or waters characteristics and functions in an area that was once a wetland and/or State open water but is no longer; or the reversal of a temporary disturbance and the reestablishment of the functions and values of the wetlands and/or water that was temporarily disturbed.

9.1.2 Enhancement

Enhancement means the improvement of the ability of an existing, degraded wetland or water to support natural aquatic life, through substantial alterations to the soils, vegetation and/or hydrology. Improvement of a wetland or water that is not degraded does not constitute enhancement. Conversion of a water to a wetland does not by itself constitute enhancement, although the NJDEP may approve a mitigation proposal that includes this in some cases as part of a larger mitigation project.

In general, the State of New Jersey requires enhancement ratios for wetlands that range from 3:1 to 10:1 or more, depending upon the ecological benefit (uplift) provided by the proposal resulting from the enhancement activities. That means for everyone acre of impacts for which mitigation is needed, an applicant will have to enhance as little as 3 or as many as 10 or more acres of wetlands. USACE does not utilize ratios for Federal project mitigation. Instead, USACE utilizes ecological models to provide quantitative and qualitative measures of habitat features considering that the mitigation at least compensates for the impact.

9.1.3 Mitigation Banking

A permit applicant may purchase credits from a mitigation bank. A mitigation bank is a wetland, stream or other aquatic resource area that has been restored, created, enhanced, or, in certain circumstances, preserved. This resource area is then set aside to compensate for future conversions of aquatic resources for development activities. The value of a bank is determined by quantifying the aquatic resource functions restored or created in terms of "credits." Permittees, upon approval of regulatory agencies, can acquire these credits to meet their requirements for compensatory mitigation.

33 CFR Part 323.3(b) describes mitigation banking as “When permitted impacts are located within the service area of an approved mitigation bank, and the bank has the appropriate number and resource type of credits available, the permittee's compensatory mitigation requirements may be met by securing those credits from the sponsor. Since an approved instrument (including an approved mitigation plan and appropriate real estate and financial assurances) for a mitigation bank is required to be in place before its credits can begin to be used to compensate for authorized impacts, use of a mitigation bank can help reduce risk and uncertainty, as well as temporal loss of resource functions and services.” According to the New Jersey Mitigation Council, there are currently 24 mitigation banks established around the State. However, only one of the mitigation banks occurs within the NJBB study area that could potentially accommodate some of the compensatory mitigation needs. This bank is located in the Great Bay/Mullica River watershed, and it consists of 124 acres palustrine forested, palustrine scrub shrub, tidal wetlands, mudflats and open waters; however, it is uncertain if whether the intertidal and open water habitats are saline, which would be required for the directly affected NJBB wetland habitats.

9.1.4 In-Lieu Fee Mitigation

A permit applicant may make a payment to an in-lieu fee program. In-lieu fee programs are generally administered by public agencies or non-profit organizations who have established an agreement with regulatory agencies to use in-lieu fee payments collected from permit applicants to conduct wetland, stream or other aquatic resource restoration, creation, enhancement or preservation activities.

9.2 Compensatory Mitigation Site Selection

9.2.1 Coastal Resilience Marsh Explorer Tool

The study is in the early phases of selecting habitat mitigation locations and methods, which would be similar to a “permitee-responsible mitigation” that could potentially involve creation, restoration, enhancement, and combinations, thereof. As a preliminary screening measure, the Nature Conservancy Coastal Resilience Marsh Explorer Tool (https://maps.coastalresilience.org/newjersey/#) was utilized to identify potential coastal estuarine marsh habitat locations that need tidal marsh restoration across New Jersey’s ocean coast. The Marsh Explorer Tool utilizes criteria developed by the Stockton University Coastal Research Center (Ferencz, A. et al., 2017) to conduct a reconnaissance-level mapping project, and to evaluate the current condition of New Jersey’s coastal marshes with the intent of identifying the potential for marsh restoration focusing on the beneficial reuse of dredged materials. In the Marsh Explorer Tool, there are four major criteria or metrics that were used in these evaluations to produce a ranking of restoration need. These criteria were the amount and size of linear ditches (miles of ditching), marsh edge erosion (wetlands lost in acres), unvegetated marsh (non-vegetated in acres), and unused dredged lagoons (lagoons), and were supported by GIS data overlays on the presence of Federal navigation channels, sediment cores, and sediment distribution. Sites identified as needing restoration were identified on a 1-mile square grid covering the entire study area. Sites could be evaluated either as individual criteria selected rankings or as combined criteria rankings. For either individual criteria or combined criteria, the degree of rankings (of Restoration Need) were: N/A, Lowest, Low, Moderate, High, and Highest. For the purpose of screening potential mitigation sites, only locations identified by combined criteria as either “High” or “Highest” are being considered for further future evaluation. The sites matching these criteria are presented in Figures 18 and 19. These sites will be further investigated and ranked in subsequent phases in coordination with resource agencies to determine suitability for meeting mitigation criteria.

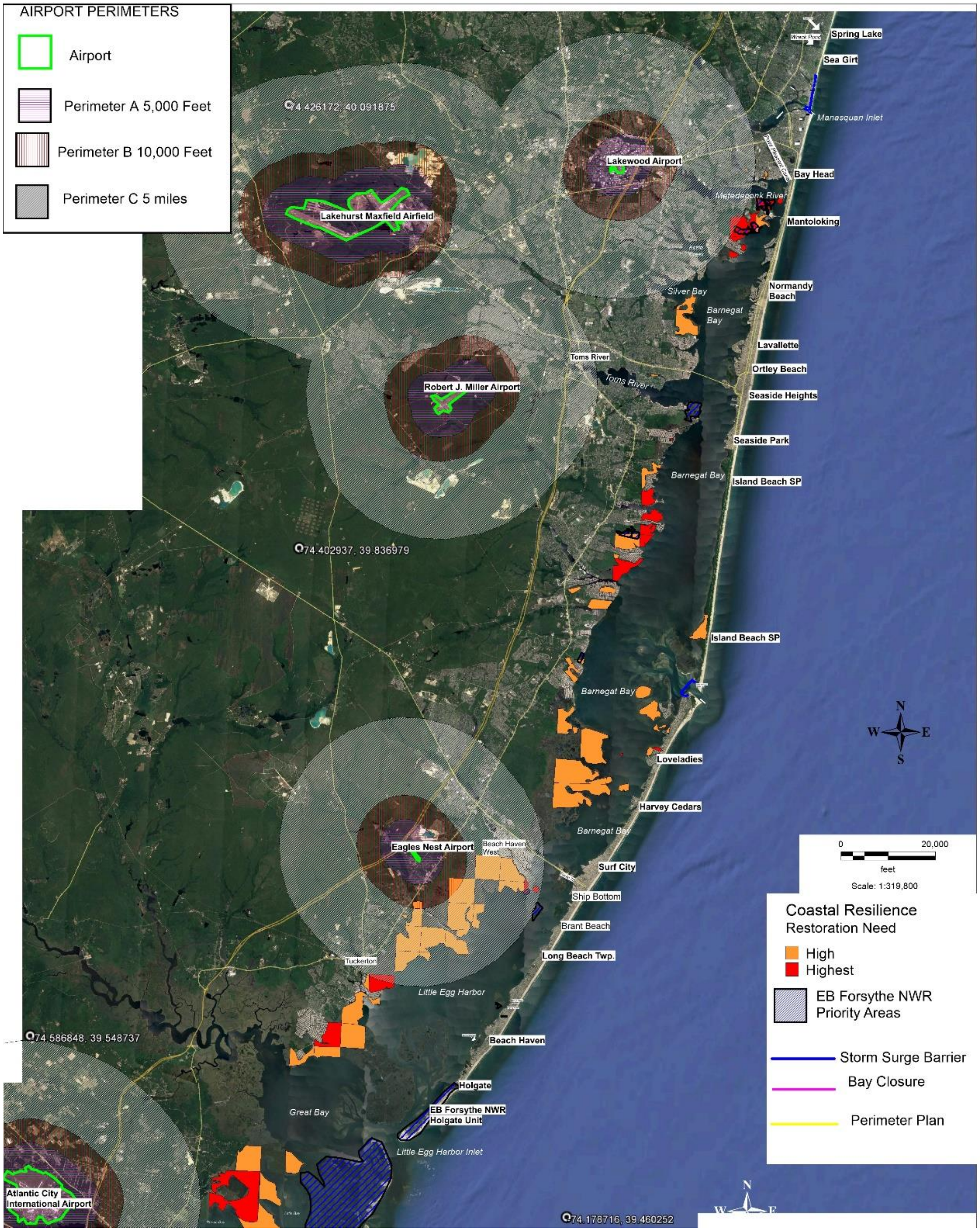


Figure 18. Coastal Resilience Restoration Need and EBFNWR Identified Sites in Northern Region

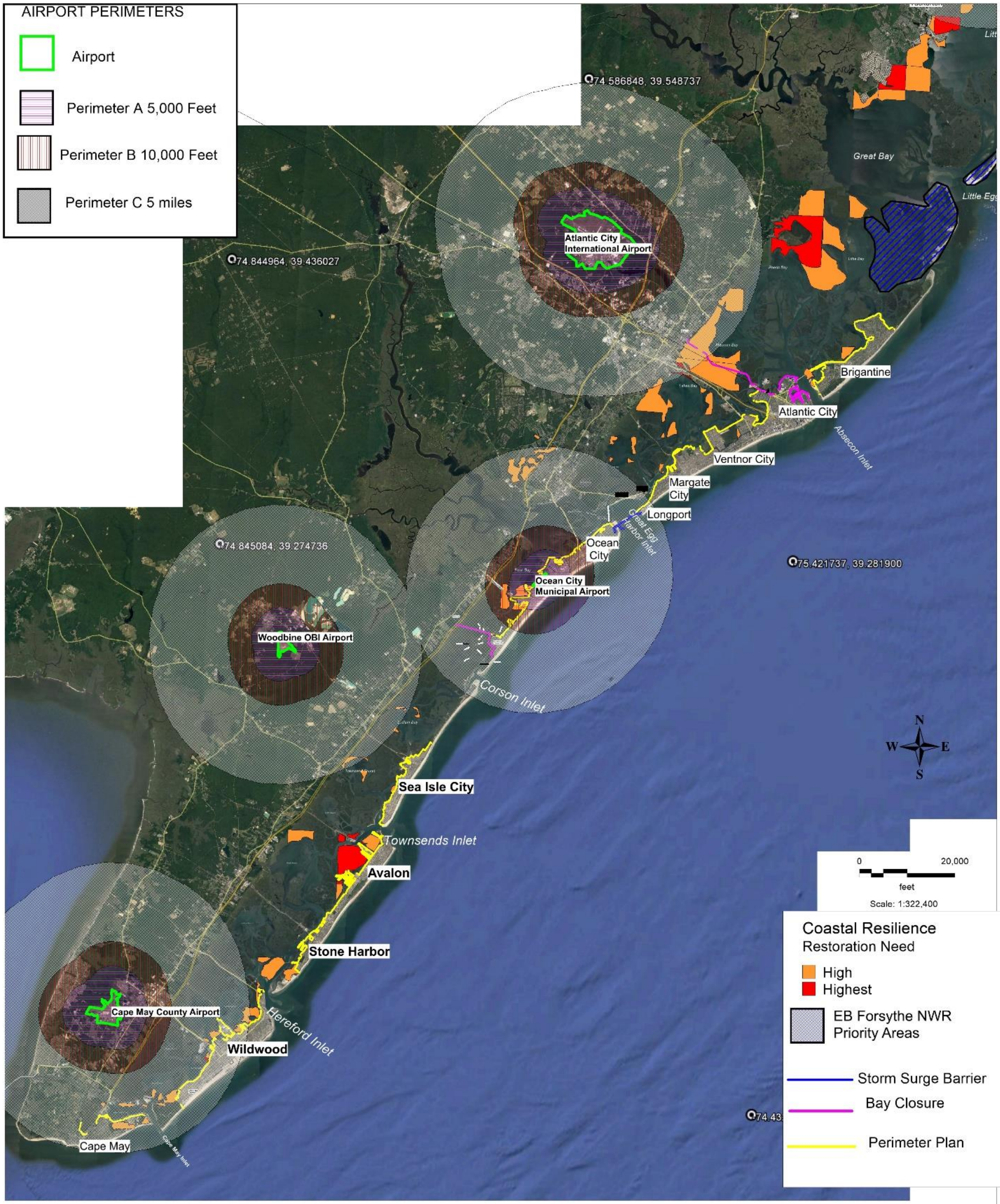


Figure 19. Coastal Resilience Restoration Need and EBFNWR Identified Sites in Central and Southern Regions

9.2.2 E.B. Forsythe National Wildlife Refuge Priority Areas

The U.S. Fish and Wildlife Service, Edwin B. Forsythe National Wildlife Refuge (EFBNWR) has identified a number of saltmarsh locations within the refuge's purview that require improved tidal flows into the saltmarshes, sediment enrichment of open water areas of the marshes, drainage improvements due to deteriorating culverts and ditches, and restoration of marsh shorelines/islands lost to erosion (Figures 18 and 19).

The EBFNWR received funding in 2013 from the Disaster Relief Appropriations Act (Public Law-113-2), which were used to develop three sediment placement projects on the refuge to improve the marshes. Two locations are in Brick Township (Metedeconk and Reedy Creek) and one in Berkeley Township, Ocean County. These projects were permitted to receive sediment from the NJDOT, but to date, no funding has been allocated to implement these projects.

Staff from EBFNWF have worked with the Ocean County Mosquito Commission at Stouts Creek (Lacey Township, Ocean County) to restore tidal flow to several water-impounded areas on the refuge, but these areas have remained primarily as open water habitat, and would require sediment enrichment and marsh plantings to improve saltmarsh functions.

A number of locations along the western side of Barnegat Bay have experienced significant losses of marsh edge habitat due to wave action from winds, storms, and boat wakes. These areas are throughout the bay regions, but specific examples cited by EBFNWR were at Ocean Township (Waretown) and Popular Point (Stafford Twp.).

There are numerous islands throughout Barnegat Bay and Little Egg Harbor that have experienced significant erosion or even disappeared due to the same wave factors as the marsh edge erosion on the western side of the bay. Specific examples provided by EBFNWR are located at Egg Island and Marshelder Island.

Additionally, EBFNWR have indicated that they have concerns with natural effects and anthropogenic effects on the Holgate and Little Beach areas of the refuge. Although, no specific actions are recommended, these areas are being closely monitored for any potential detrimental effects that could require some type of future intervention to prevent loss and/or maintain critical nesting habitat for the piping plover.

These sites will be further investigated and ranked in subsequent phases in coordination with the U.S. Fish and Wildlife Service and other resource agencies to determine site suitability for meeting mitigation criteria.

9.2.3 Hazardous Wildlife Attractants Near Airports

Due to the increasing concern about aircraft-wildlife strikes, the Federal Aviation Administration has implemented standards, practices, and recommendations for holders of Airport Operating Certificates issued under Title 14, CFR Part 139, Certification of Airports, Subpart D (Part 139), to comply with the wildlife hazard management requirements of Part 139. Airports that have received Federal grant-in-aid assistance must use these standards.

When considering proposed dredged spoil, beneficial use features, and mitigation areas, developers must take into account whether the proposed action will increase wildlife hazards. Figures 18 and 19 provide airport locations within the study area. The Federal Aviation Administration recommends minimum separation criteria for land-use practices that attract hazardous wildlife to the vicinity of airports. These criteria include land uses that cause movement of hazardous wildlife onto, into, or across the airport's approach or departure airspace or air operations area.

These separation criteria include:

• Perimeter A: For airports serving piston-powered aircraft, hazardous wildlife attractants must be 5,000

feet from the nearest air operations area (includes one airport within the study area);

• Perimeter B: For airports serving turbine-powered aircraft, hazardous wildlife attractants must be 10,000

feet from the nearest air operations area (includes two airports within the study area); and

• Perimeter C: 5-mile range to protect approach, departure, and circling airspace (includes five airports within the study area).

Although no mitigation sites are currently proposed or selected at this time, subsequent mitigation site screening will utilize FAA-recommended separation criteria as a basis for site selections in subsequent study phases.

References

https://maps.coastalresilience.org/newjersey/#

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