ENVIRONMENTAL APPENDIX
TIER 1 WILD AND SCENIC RIVERS
SECTION 7(a) EVALUATION

NEW JERSEY BACK BAYS
COASTAL STORM RISK MANAGEMENT
FEASIBILITY STUDY

PHILADELPHIA, PENNSYLVANIA

APPENDIX F.11

August 2021

NJBB
NEW JERSEY BACK BAYS STUDY

U.S. Army Corps of Engineers
Philadelphia District

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1.0 INTRODUCTION

The proposed Tentatively Selected Plan (TSP) and other alternatives identified in the New Jersey Back Bays (NJBB) Feasibility Study require compliance with the Wild and Scenic Rivers Act (WSRA) of 1968 (Public Law 90-542; 16 U.S.C. 1271, et seq. The Great Egg Harbor River (GEHR) is located within the NJBB study area and was designated in October 27, 1992. In the NJBB study area, Wild and Scenic River (WSR) status of the Great Egg Harbor River and tributaries occur in the Central Region of the study area and are generally west of the Garden State Parkway. Key drainages that are part of the system include Patcong Creek and the Tuckahoe River at near the Great Egg Harbor confluence west of the Garden State Parkway. The TSP includes two structural alternatives within 5 miles of the designated portion of the Great Egg Harbor River (Figure 1). One is a Bay Closure at 52nd Street in Southern Ocean City. The other is a storm surge barrier at the Great Egg Harbor Inlet. Both locations are outside and downstream of the designated mainstem and tributaries. However, both have potential indirect impacts on the Great Egg Harbor River. Therefore, USACE will undertake coordination with the National Park Service for review under Section 7(a) of the Wild and Scenic Rivers Act.

2.0 GREAT EGG HARBOR WILD AND SCENIC RIVER DESCRIPTION

The following is taken directly from the Comprehensive Management Plan and Environmental Impact Statement (National Park Service, 2000):

"The Great Harbor River begins in suburban towns and meanders for 59 miles on its way to the Atlantic Ocean, draining 304 square miles of wetlands in the lower half of the New Jersey Pinelands National Reserve. Dissolved iron and tannin, a product of fallen leaves and cedar roots, produce the river's tea colored "cedar water" along much of its length. The freshwater and tidal wetlands serve as resting, feeding, and breeding areas for waterfowl throughout the year amid undisturbed forests and swamp areas. The watershed has been occupied since pre-historic times, lived upon traditionally by the Lenape Indians before occupations by Europeans in the early 1700s. The lands contained all the necessary materials for shipbuilding, and in the Revolutionary War its "bog iron" made cannon balls while its hidden coves sheltered privateers. Blast furnaces, sawmills, glass factories, and brick and tile works followed until the Industrial Revolution drew its people away. Over 99 percent of the eligible waterways and adjacent lands are within the boundary of the Pinelands National Reserve, which was established by the United States Congress in 1978. Much of the land within the National Reserve is also within the state-designated Pinelands Area and falls under the jurisdiction of the New Jersey Pinelands Commission. Uses of the lands and waters within the Pinelands Area are governed by a Comprehensive Management Plan that is administered by the Pinelands Commission. Eligible waterways and adjacent lands outside of the Pinelands Area, but within the boundaries of the Pinelands National Reserve, are subject to New Jersey's Coastal Area Facilities Review Act (CAFRA), which must be consistent with the Pinelands Comprehensive Management Plan (and is ensured through joint review).

Remaining acreage outside of the National Reserve but within the designated river corridor is predominantly wetlands and is either publicly owned or regulated by state and federal agencies. The Great Egg Harbor National Scenic and Recreational River passes through, or along, twelve communities located in four counties in the State of New Jersey. The following communities are within the 129- mile designated section of the River: Buena Vista Township, Corbin City, Egg Harbor Township, City of Estell Manor, Borough of Folsom, Hamilton Township, Town of Hammonton, Monroe Township, City of Somers Point, Upper Township, Weymouth Township, and Winslow Township. The four counties are: Atlantic, Gloucester, Camden, and Cape May."

Figure 1. Great Egg Harbor Wild and Scenic River and TSP Features

"The Great Egg Harbor River flows within and is representative of rivers in the Pinelands ecosystem and the Embayed Coastal Plain physiographic province of New Jersey. The Pinelands National Reserve, which encompasses a major part of the river area, is recognized as a nationally significant resource because of its vast pine-oak forest, extensive surface and groundwater resources of high quality, and a wide diversity of rare plant and animal species. The Pinelands National Reserve is also internationally recognized as a unit of the South Atlantic Coastal Plain Biosphere Reserve under the United Nations Man and the Biosphere Program."

2.1 Designated Reach:

October 27, 1992. From the mouth of Patcong Creek to the Mill Street Bridge. From Lake Lenape to the Atlantic City Expressway. From the Williamstown-New Freedom Road to the Pennsylvania Railroad right-of-way.

The following tributaries from their confluence with the GEHR: Squankum Branch to Malaga Road; Big Bridge Branch to its headwaters; Penny Pot Stream Branch to 14th Street; Deep Run to Pancoast Mill Road; Mare Run to Weymouth Avenue; Babcock Creek to its headwaters; Gravelly Run to the Pennsylvania Railroad right-of-way; Miry Run to Asbury Road; South River to Main Avenue; Stephen Creek to New Jersey Route 50; Gibson Creek to First Avenue; English Creek to Zion Road; Lakes Creek to the dam; Middle River to the levee; Patcong Creek to the Garden State Parkway; Tuckahoe River to the Route 49 Bridge; Cedar Swamp Creek from its confluence with the Tuckahoe River to its headwaters.

3.0 Wild and Scenic River Classification/Mileage

There are three designations for wild and scenic rivers as defined below:

Wild River Areas – Those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive America.

Scenic River Areas – Those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads.

Recreational River Areas – Those rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past.

In the GEHR basin designations, there are 30.6 miles of scenic river and 98.4 miles of recreational river that make up a total of 129.0 miles. There are no wild river areas designated in the GEHR and Tributaries. Table 1 and Figure 2 provides classifications of river segments and tributaries.

The scenic and recreational classifications are based on five outstanding resource values (ORV's), that are:

- Historic,
- Recreation,
- Wildlife,
- Hydrology
- Traditional Use

On the GEHR Mainstem, the river is tidally influenced up to the dam at Lake Lenape. A number of the tributaries that feed the GEHR below Lake Lenape are also tidally influenced Table 1 and Figure 2.

Table 1. Great Egg Harbor River (GEHR) Mainstem and Tributaries Wild and Scenic River Classifications.

	Reach (upstream to downstream)	Classification	Tidal Regime
GEHR Mainstem	Atlantic City Expwy. to Big Ditch	Recreational	Non-tidal
	Deep Run to Big Ditch	Recreational	Non-tidal
	Big Ditch to Lake Lenape	Recreational	Non-tidal
	Lake Lenape to Perch Cove Run	Recreational	Tidal

	Perch Cove Run to Patcong Creek	Scenic	Tidal
GEHR TRIBUTARIES	Squankum Branch	Recreational	Non-tidal
	Big Bridge Branch	Recreational	Non-tidal
	Penny Pot Stream	Recreational	Non-tidal
	Big Ditch	Recreational	Non-tidal
	Deep Run	Recreational	Non-tidal
	Mare Run	Recreational	Non-tidal
	Babcock Creek	Recreational	Tidal + Non-tidal
	Miry Run	Recreational	Tidal + Non-tidal
	South River	Recreational	Tidal + Non-tidal
	Stephen Creek	Recreational	Tidal + Non-tidal
	Gibson Creek	Recreational	Tidal + Non-tidal
	English Creek	Recreational	Tidal + Non-tidal
	Lakes Creek	Recreational	Tidal + Non-tidal
	Middle River	Scenic	Tidal + Non-tidal
	Cedar Swamp Creek	Scenic	Tidal + Non-tidal
	Tuckahoe River	Recreational/Scenic	Tidal
	Patcong Creek	Recreational	Tidal

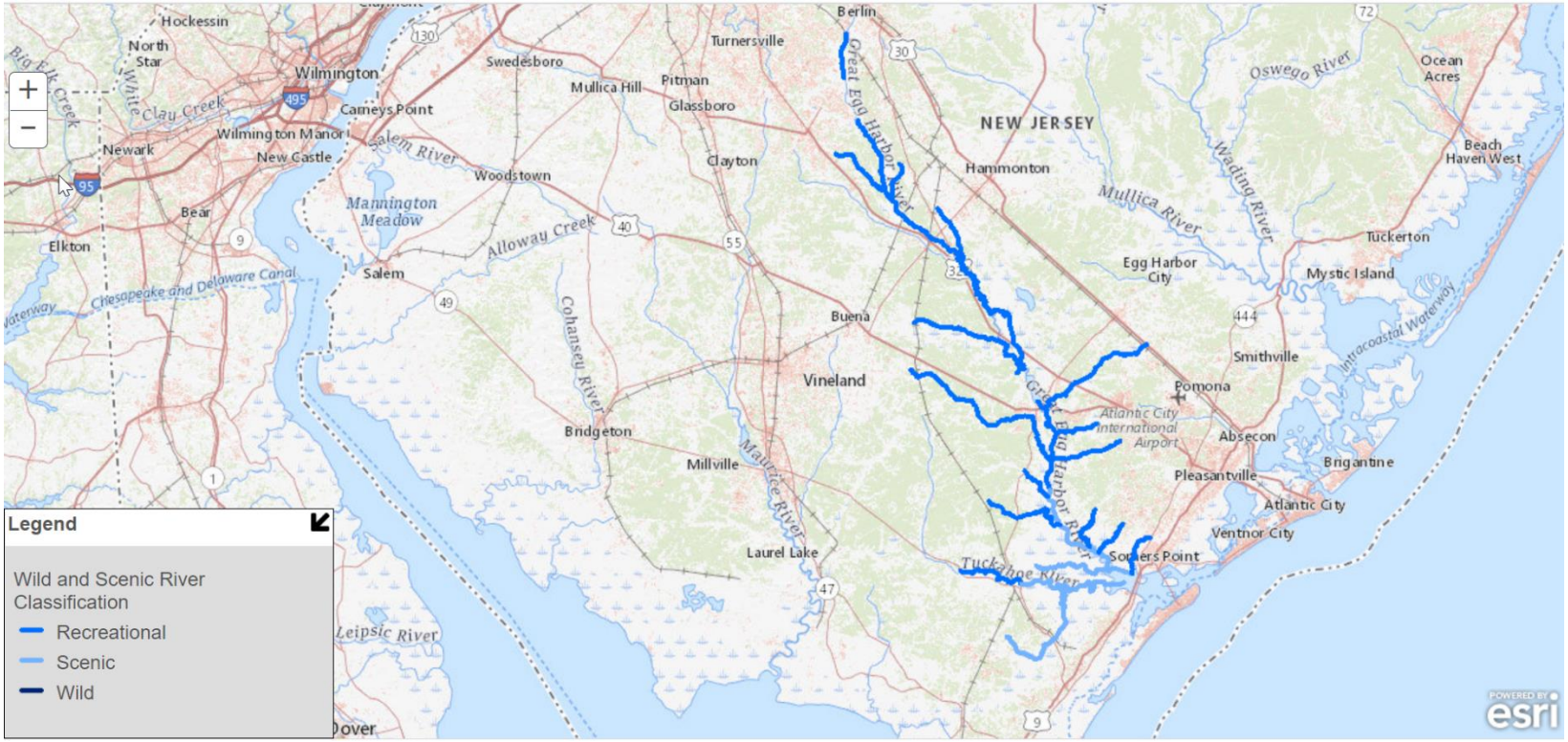


Figure 2. Great Egg Harbor Wild and Scenic River Classifications (mapping accessed from https://www.rivers.gov/river-app/index.html?river=145).

3.0 GREAT EGG HARBOR RIVER AFFECTED ENVIRONMENT

The following descriptions of important affected resources are taken directly from the "Great Egg Harbor Comprehensive Management Plan and Environmental Impact Statement" (NPS, 2000) and from the "Significant Habitats and Habitat Complexes of the New York Bight Watershed -Great Egg Harbor Estuary Complex #3" (USFWS,1997) as whole sections or excerpts, and are incorporated by reference.

3.1 General Environment

In NPS (2000),*"The Great Egg Harbor River flows within and is representative of rivers in the Pinelands ecosystem and the Embayed Coastal Plain physiographic province of New Jersey. The Pinelands National Reserve, which encompasses a major part of the river area, is recognized as a nationally significant resource because of its vast pine-oak forest, extensive surface and groundwater resources of high quality, and a wide diversity of rare plant and animal species. The Pinelands National Reserve is also internationally recognized as a unit of the South Atlantic Coastal Plain Biosphere Reserve under the United Nations Man and the Biosphere Program"* (NPS, 2000).

3.2 Resources

In NPS (2000),*"The Great Egg Harbor River is home to a wide array of natural, cultural, scenic, and recreational resources. The presence of these resources is what made the Great Egg Harbor River a candidate for designation into the National Wild and Scenic River System. A number of "outstandingly remarkable" and "priority" resources were identified in the river corridor during the study process.*

3.2.1 Outstandingly Remarkable Resources

3.2.1.1 Cultural Resources

NPS (2000) states*: "The adjacent lands along the lower Great Egg Harbor River and its tributaries contain a number of historically significant sites that were important in the early maritime industry in southern New Jersey. Sites that were crucial to the development of the bog iron industry also exist on the Great Egg Harbor River and its tributaries. A number of these sites are on, or are eligible for, the National Register of Historic Places and are recognized by the Office of Historic Preservation and the Pinelands Commission. In addition, significant American Indian and archeological sites exist along the river corridor.*

American Indian sites have been documented. The Pinelands Commission, the NJ Historic Preservation Office and the State Museum possess information regarding known archaeological and historic site and historic district locations" (NPS, 2000).

3.2.1.2 Fauna

NPS (2000) states*: "The lower Great Egg Harbor River and its tributaries provide breeding habitat for the peregrine falcon. Hardwood swamps and wetlands adjacent to the lower, middle and upper*

Great Egg Harbor River and its tributaries provide habitat for rare and endangered species such as the northern harrier and Pine Barrens tree frog. All of these areas are documented by the New Jersey Natural Heritage Program.

As a National Scenic and Recreational River, the Great Egg Harbor River provides a means of preserving wildlife habitat, protecting water quality and supply, managing land use, and affording the public with recreational opportunities to observe fish and wildlife resources within a densely populated area.

The Great Egg Harbor River complex provides aquatic and wetlands habitats for numerous wildlife species currently listed as rare, threatened, or endangered by the NJ Department

of Environmental Protection (NJ DEP) and the Pinelands Commission. Wildlife habitats contained within the Great Egg River corridor are characterized as "exceptional" by the NJ DEP. Wetland cover types within and adjacent to the Great Egg Harbor River, such as riverine, tidal and nontidal emergent wetlands, provide habitat for migratory waterfowl and passerine birds" (NPS, 2000).

USFWS (1997) provides a thorough discussion of fauna in the Great Egg Harbor Estuary and the following is taken from that publication: "*Significant concentrations of migrating and wintering waterfowl occur in the Great Egg Harbor estuary, with an average of over 12,000 waterfowl counted on midwinter aerial surveys. The most abundant species observed in the estuary, in descending order, are: American black duck (Anas rubripes), greater and lesser scaup (Aythra marila and A. affinis), brant (Branta bernicla), and mallard (Anas platyrhynchos), with lesser numbers of Canada goose (Branta canadensis), bufflehead (Bucephala albeola), northern pintail (Anas acuta), long-tailed duck (Clangula hyemalis), scoters (Melanitta spp.), green-winged teal (Anas crecca), American wigeon (Anas americana), red-breasted, common, and hooded mergansers (Mergus serrator, M. merganser, and Lophodytes cucullatus), tundra swan (Cygnus colombianus), canvasback (Aythra valisneria), and common goldeneye (Bucephala clangula). Dabbling ducks and bufflehead are fairly evenly distributed along the shorelines and tidal creeks of the estuary; diving ducks occur mostly in the more open water areas of Great Egg Harbor, and sea ducks occur near the inlet. Small flocks of tundra swan, averaging around 50 birds, are consistently found in or near the impoundments at MacNamara Wildlife Management Area (Tuckahoe Corbin Salt Marsh) before freeze-up. American black duck and northern pintail are common in the marshes at MacNamara. Scaup are found in the deeper open water of Great Egg Harbor Bay, while brant generally occupy the shallower water areas. Breeding waterfowl in the estuary include American black duck, gadwall (Anas strepera), mallard, and Canada goose.*

Waterbird colonies occur on most of the salt marsh and dredged material islands in the bay, including a sizable heronry at Cowpens Island with snowy egret (Egretta thula), glossy ibis (Plegadis falcinellus), great egret (Casmerodius albus), black-crowned night-heron (Nycticorax nycticorax), tricolored heron (Egretta tricolor), little blue heron, yellow-crowned night-heron, and cattle egret (Bubulcus ibis). Common terns (over 190 terns in 1995) and gulls (over 870 gulls in 1995) occur on several islands. Nesting gulls are predominantly laughing gull (Larus atricilla), with lesser numbers of herring gull (L. argentatus) and a few great black-backed gull (L. marinus). The sandy shoreline along the inlet and ocean beach of Ocean City (Waverly Beach) supports nesting by small numbers of piping plover and least tern and this beach, as well as the Longport beach on the other side of the inlet, supports occurrences of seaside evening primrose (Oenothera humifusa). Longport Sodbanks Island, just to the north of Great Egg Harbor Bay, has also supported nesting by piping plover, least tern, and Forster's tern (Sterna forsteri). Northern

diamondback terrapin feed throughout the estuary and nest on appropriate sandy shoreline habitat.

The entire New Jersey barrier beach/backbarrier lagoon system is extremely important for shorebirds during spring and, especially, fall migration. Great Egg Harbor is considered one of the top 20 sites for spring and fall migration in the eastern United States. Willet (Catoptrophorus semipalmatus) and spotted sandpiper (Actitis macularia) breed in the area. Nearby Delaware Bay is one of the top spring migratory sites in the hemisphere for semipalmated sandpiper (Calidris pusila), ruddy turnstone (Arenaria interpres), red knot (Calidris canutus), and sanderling (Calidris alba), with lesser numbers of dunlin (Calidris alpina) and dowitchers (Limnodromus spp.). These birds utilize the marshes on the Atlantic coast, including those within this complex, for roosting and feeding.

The rich food resources of the tidal marshes and creeks support several rare raptor species. There are numerous osprey nests on platforms within the MacNamara Wildlife Management Area; this area is one of the more important sites in the state for the recovery of the osprey. The marshes are an important bald eagle wintering site and pairs of eagles have also been observed during nesting season, though none have yet nested here. This is an important breeding area for northern harriers who nest and forage in the salt and brackish marshes. Barred owl also nest in the swamps adjoining the marshes. Clapper rail (Rallus longirostrus) nest in the salt marsh area and black rail (Latterallus jamiacensis) may also nest here. Nearly 100 species of birds were recorded as probable or confirmed breeders in or adjacent to the Great Egg Harbor River (tidal river and estuary) in the first two years of the state's Breeding Bird Atlas. These breeding birds include marsh nesters mentioned above, as well as passerines typical of pine barrens such as gray catbird (Dumetella carolinensis) and pine warbler (Dendroica pinus)" (USFWS, 1997)*.*

3.2.1.3 Fisheries

NPS (2000) states: *"The US Fish and Wildlife Service views the Great Egg Harbor River, its tributaries and associated wetland systems, as having high value to fish and wildlife resources. Estuaries and wetlands associated with the Great Egg Harbor River produce food and provide spawning and nursery habitats for anadromous fish, including: alewife (Alosa pseudoharengus),*

striped bass (Morone saxatilis), and American shad (Alosa sapidissima). Migratory birds and anadromous fish are a federal trust resource responsibility.

The US Fish and Wildlife Service has designated over 8,000 acres encompassing the upper reaches of Cedar Swamp Creek (a tributary to the Tuckahoe and Great Egg Harbor Rivers) as

a unit of the Cape May National Wildlife Refuge. The State of New Jersey owns in excess of 30,000 acres of land in five state Wildlife Management Areas that adjoin both the tidal and freshwater reaches of the Great Egg Harbor River and its tributaries.

The lower tidal portions of the Great Egg Harbor River (below Mays Landing) and its tributaries serve as critical nursery habitat and spawning grounds for anadromous, resident estuarine and transient marine fish, including alewife herring and striped bass. The lower Great Egg Harbor River is also one of only four areas in the State of New Jersey where commercially important quantities of seed oyster still exist (NPS, 2000)."

Fisheries of the Great Egg Harbor Estuary are described in USFWS (1997), and the following was taken directly from USFWS (1997): *"A total of 67 species of fish were caught in a one-year fisheries inventory of the Great Egg Harbor estuary. The most abundant species were Atlantic silversides (Menidia menidia), Atlantic menhaden (Brevoortia tyrannus), bay anchovy (Anchoa mitchilli), banded killifish (Fundulus diaphanus), alewife (Alosa psuedoharengus), hogchoker (Trinectes maculatus), white perch (Morone americanus), white catfish (Ameirus catus), and winter flounder (Plueronectes americanus). Great Egg Harbor Bay, with 32 species, had the highest diversity of fish taken. Great Egg Harbor Bay is an important commercial hard clam fishery, and the upper (western) bay inland of the Garden State Parkway is one of the few remaining oyster seed production areas in the state. The 1985 New Jersey Department of Environmental Protection survey indicates that there are over 40 hectares (100 acres) of oyster beds in the Great Egg Harbor River and nearly 16 hectares (40 acres) in the Tuckahoe River. Anadromous fish, including blueback herring (Alosa aestivalis), alewife, and striped bass (Morone saxatilis), spawn in streams of the Pinelands; this estuary serves as the major thoroughfare in the spring to the upriver sections and as the nursery area for newly-hatched fish. Other anadromous species present are hickory shad (Alosa mediocris), Atlantic menhaden, and the catadromous species American eel (Anguilla rostrata). Fish passage, especially upstream migrations, is impeded by obstructions, usually dams, which generally restrict activity to the lower reaches of these rivers* (USFWS, 1997)*."*

3.2.1.4 Flora

NPS (2000) states*: "The lower Great Egg Harbor River and its tributaries contain large expanses of ecologically significant tidal marshland and hardwood swamp. The middle and upper segments of the Great Egg Harbor River and its tributaries contain significant areas of hardwood swamp. Both areas have sites with rare plants or plant communities recognized by federal and state agencies and the Pinelands Commission. These rare plants and plant communities include Pine Barrens Boneset, Parker's Pipewort, Barratt's Sedge, and others. These areas are documented by the New Jersey Natural Heritage Program.*

The following two species have been recognized by the US Fish and Wildlife Service as federally listed threatened plants:

***Swamp pink**: Numerous known occurrences of swamp pink (Helonias bullata) exist within the Great Egg Harbor River watershed. Swamp pink is an obligate wetland species that occurs in a variety of palustrine forested wetlands in NJ, including forested wetlands bordering meandering streams, headwater wetlands, Atlantic white-cedar (chamaecyparis thyoides) swamps, and spring seepage areas. Swamp pink typically occurs in forested wet- lands, although occurrence in scrub/shrub wetlands is known.*

***Knieskern's beaked rush:** Numerous known occurrences of knieskern's beaked- rush (Rhynchospora knieskernii) have been documented within the Great Egg Harbor River drainage basin. Knieskern's beaked-rush typically occurs in early successional wetland habitats, often on bog-iron substrate or mud deposits adjacent to slow-moving streams in southern New Jersey. This species is also found in man-disturbed wet areas including abandoned borrow pits, clay pits, ditches, rights-of-way, and unimproved roads"* (NPS, 2000).

USFWS (1997) provides a vegetative description within the Great Egg Harbor River estuary and the following is taken directly from USFWS (1997): "*Small areas of submerged aquatic vegetation (SAV) may occur in the brackish waters of the mainstem of the Great Egg Harbor River, as well as the Tuckahoe River and Patcong Creek. Typical submerged aquatic vegetation plant species include horned pondweed (Zannichellia palustris), water celery (Vallisneria americana), slender pondweed (Potamogeton pusillus), redhead grass (P. perfoliatus), widgeon grass (Ruppia maritima), and naiad (Najas flexilis). In the freshwater tidal reaches, submerged aquatics intersperse with the floating-leaved and emergent plants of the lower tidal marsh that are more characteristic of freshwater communities in the Pinelands; these include ribbonleaf pondweed (Potamogeton epihydrus), arrowheads (Saggitaria latifolia, S. englemannia and S. spatulata), American mannagrass (Glyceria grandis), and bulrush (Scirpus spp.).*

There are 7,662 hectares (18,932 acres) of tidal marsh in the Great Egg Harbor estuary, predominantly high marsh dominated by salt-meadow cordgrass (Spartina patens) interspersed by numerous intertidal creeks and ditches with smooth cordgrass (Spartina alternifora). The salt marshes in the estuary are extensively ditched. Smaller areas of brackish tidal marsh complex occur adjacent to the Tuckahoe River, Cedar Swamp Creek, Patcong Creek and along the mainstem, with dominance by narrow-leaved cattail (Typha angustifolia), big cordgrass (Spartina cyosuroides), common reed (Phragmites australis), and Olney three-square bulrush (Scirpus americanus). Freshwater intertidal wetlands are found in a few locations in the upper reaches of tidal influence in the Great Egg Harbor and Tuckahoe Rivers as well as in small areas on other tributaries. These freshwater tidal wetlands can be divided into different zones depending on the degree of tidal inundation: the lower tidal zone, exposed only at low tide, consisting of sparsely vegetated intertidal flats with riverbank quillwort (Isoetes riparia), bluntscale bulrush (Scirpus smithii var. smithii), the regionally rare Parker's pipewort (Eriocaulon parkeri), stiff arrowhead (Sagittaria rigida), grass-leaved arrowhead (S. graminea), and Hudson arrowhead (S. subulata); a mid-tidal zone with wild rice (Zinzania aquatica), spatterdock (Nuphar advena), pickerel-weed Pontedariacordata), three-square bulrush (Scirpus pungens), arrow arum (Peltandra virginica), water hemp (Amaranthus cannabinus), and dotted smartweed (Polygonum punctatum); and an upper tidal marsh zone dominated by cattails (Typha angustifolia and T. glauca) and a diversity of other species, including sensitive fern (Onaclea sensibilis), halberd-leaved tearthumb (Polygonum arifolium), arrowheads, river bulrush (Scirpus fluviatalis), sweet flag (Acorus calamus), smooth bur-marigold (Bidens laevis), orange jewelweed (Impatiens capensis), rose-mallow (Hibiscus moscheutos var. moscheutos), as well as the invasive common reed and exotic purple loosestrife (Lythrum salicaria). Shrubs include knob-styled dogwood (Cornus amomum), buttonbush (Cepahalanthus occidentalis), and swamp rose (Rosa palustris).

The emergent marshes along the tidal mainstem and tributaries grade into seasonally-flooded hardwood and Atlantic white cedar swamps further from the creeks. The hardwood swamps are dominated by red maple (Acer rubrum), black gum (Nyssa sylvatica), sweet bay (Magnolia virginiana), sweet gum (Liquidambar styraciflua), and ash (Fraxinus spp.)" (USFWS, 1997). Figure 3. provides a general distribution of freshwater and saline wetland habitats in the Central Region of the study area, which includes the Great Egg Harbor River.

3.2.1.5 Rare and/or Special Status Species

Threatened and endangered flora and fauna are known to occur in and adjacent to areas within the Great Egg Harbor River and its tributaries. Table 2. provides a list of potential special status species entering into the GEHR WSR portion of the project area.

USFWS (1997) describes rare flora and fauna in the Great Egg Harbor Estuary as: "*Rare plants within the salt marsh include red goosefoot, and within the brackish marsh include Koehn's toothcup, clustered bluets (Oldenlandia uniflora), and small-headed beaked-rush. Brackish marsh habitat also supports rare skipper. A population of eastern mud salamander occurs in the freshwater/brackish marshes along South Creek. Rare freshwater tidal marsh communities occur at the upper reaches of tidal influence, supporting rare plants that include Parker's pipewort and golden club (Orontium aquaticum). Adjacent palustrine wetlands include forested swamps and bogs containing rare species typical of Pinelands wetlands. Rare plants include swamp pink,*

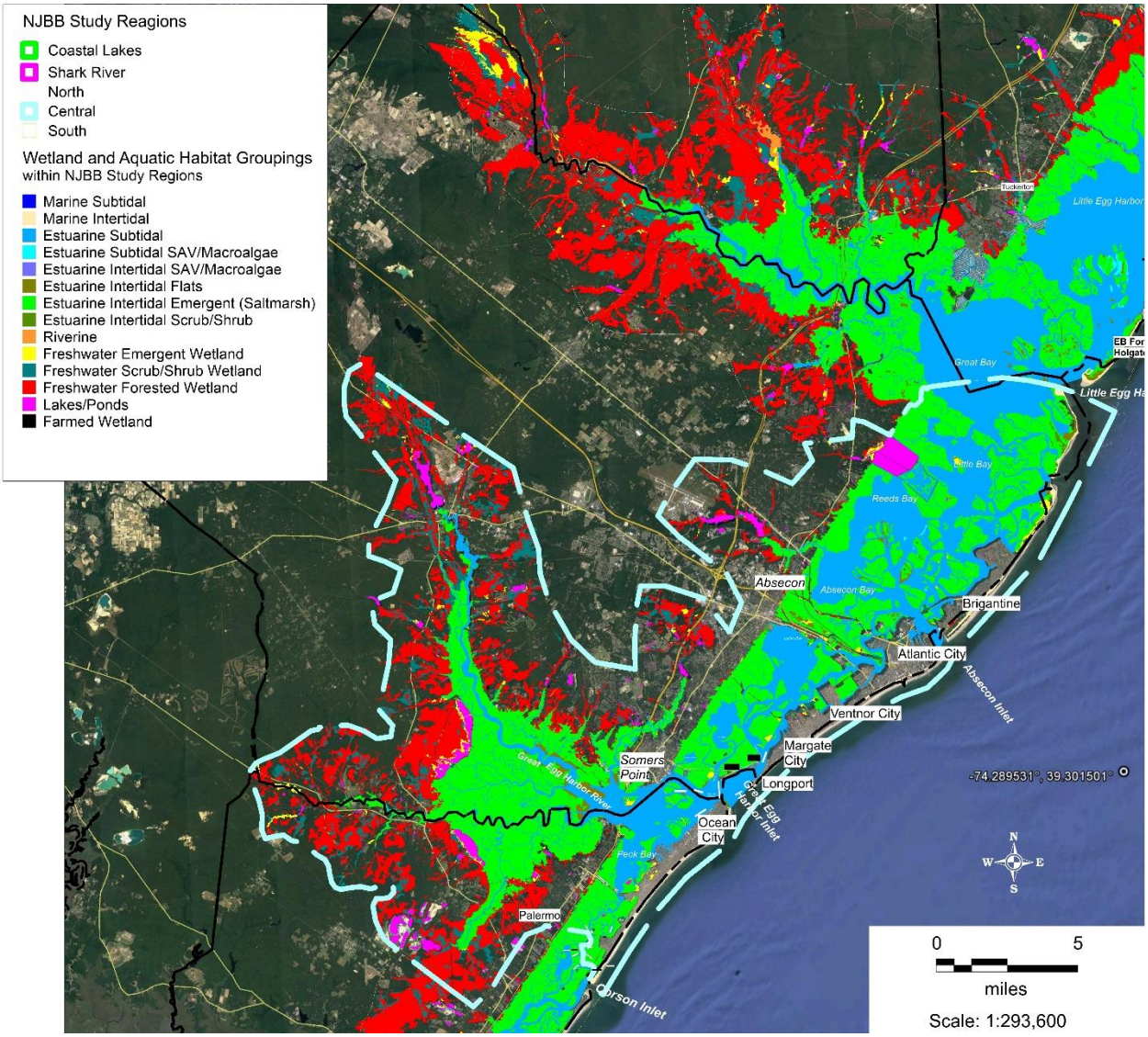


Figure 3. Fresh and Saline Wetlands within the Central Region of the NJBB Study Area

Table 2. Special Status Species Potentially Occurring within the NJBB Affected Area of the GEHWSR.

Species	Status	Habitat in NJBB
American Bittern (*Botaurus lentiginosos*) BR	SE	Brackish marshes
Bald Eagle (*Haliaeetus leucocephalus*) BR/NB	SE/ ST	Forest edges, open water
Northern Harrier (*Circus cyaneus*) BR	SE	Tidal marshes

Species	Status	Habitat in NJBB
Peregrine Falcon	SE	Widespread habitats in NJBB. Nest on man-made towers, bridges, buildings, nesting platforms, etc.
Red knot (*Calidris canutus rufa*) NB	FT, SE	Sandy beaches, spits, marsh islands, tidal flats
Short-Eared Owl (*Asio flammeus*) BR	SE	Coastal marshes
Black-Crowned Night-Heron (*Nycticorax nycticorax*) BR	ST	Maritime forests, scrub-shrub, mixed *Phragmites* marshes
Yellow-Crowned Night-Heron (Nyctanassa violacea)	ST	Maritime forests, scrub-shrub on barrier and bay islands
Osprey (*Pandion haliaetus*) BR	ST	Coastal rivers, marshes, bays & inlets. Nest on dead trees, platforms, poles
Piping plover(*Charadrius melodus*)	FT, SE	Ocean beaches, inlets, washover areas, tidal flats
Eastern Black Rail (*Laterallus jamaicensis*) BR/NB	FT, SE/ST	High marshes
Black Skimmer (*Rynchops niger*)	SE	Sandy beaches, inlets, sandbars, offshore islands
Least Tern (*Sternula antillarum*)	SE	Sandy beaches, bay islands
Roseate Tern (*Sterna dougallii*)	FE/SE	Beaches w/ vegetated dunes
Sedge Wren (*Cistothorus platensis*)	SE	High marshes
Atlantic Loggerhead (*Caretta caretta*)	FT/SE	Marine/Estuarine Pelagic
Kemp's Ridley (*Lepidochelys kempii*)	FE/SE	Marine/Estuarine Pelagic
Atlantic Green Sea Turtle *(Chelonia mydas*)	FT/ST	Marine/Estuarine Pelagic
Pine barrens treefrog *(Hyla andersonii*)	ST	Acidic freshwater Atlantic white cedar swamps and pitch pine lowlands in seeps or isolated or temporary woodland ponds.
Northern Long-Eared Bat (*Myotis septentrionalis*)	FT	Summertime roosts beneath the bark of live and dead trees.
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*)	FE/SE	Marine/estuarine; Demersal/pelagic
Bronze Copper (butterfly) (*Lycaena hyllus*)	SE	Brackish marshes
Swamp pink (*Helonias bullata*)	FT/SE	Freshwater forested wetlands bordering small streams

Species	Status	Habitat in NJBB
Knieskern's beakrush (*Rhynchospora knieskernii*)	FT/SE	Early successional freshwater wetlands adjacent to slow moving streams

FT= Federally Threatened *Note: There are over 800 species of Special Status Plants in NJ.

FE= Federally Endangered

ST=State Threatened

SE= State Endangered

BR= Breeding Population Only

NB= Non-Breeding Population Only

southern twayblade (Listera australis), pine barren boneset (Eupatorium resinosum), hornedbeaked rush (Rhynchospora inundata), federally listed threatened Knieskern's beaked-rush (Rhynchospora knieskernii), and Barratt's sedge (Carex barratii). Rare animal species in these adjacent wetlands include pine barrens tree frog (Hyla andersonii), Cope's gray tree frog (Hyla chyrsoscelis), barred owl, red-headed woodpecker (Melanerpes erythrocephalus), and northern pine snake (Pituophis m. melanoleucus)" (USFWS, 1997).

3.2.1.6 Recreation

NPS (2000) states*: "The Great Egg Harbor River is the longest navigable river in the New Jersey Pinelands. Its upper and middle reaches are toured by canoeists, while the lower tidal reaches provide sailors and power boaters with access to the intracoastal waterway and the ocean. The river and its tributaries, together with related adjacent lands, provide excellent recreational opportunities in close proximity to the major urban centers of Philadelphia, Trenton, Camden, and Wilmington.*

The US Fish and Wildlife Service has designated over 8,000 acres encompassing the upper reaches of Cedar Swamp Creek (a tributary to the Tuckahoe and Great Egg Harbor Rivers) as a unit of the Cape May National Wildlife Refuge. The State of New Jersey owns in excess of 30,000 acres of land in five state Wildlife Management Areas that adjoin both the tidal and freshwater reaches of the Great Egg and its tributaries" (NPS, 2000).

3.2.1.7 Physiographic/Geologic Setting

NPS (2000) states: *"The Cohansey formation, underlying the Pinelands and the Great Egg Harbor River, is the largest freshwater aquifer in the Mid-Atlantic region of the United States. The water in this shallow aquifer frequently lies near the surface, producing bogs, marshes and swamps"* (NPS, 2000).

3.2.1.8 Scenic Resources

NPS (2000) states: "*The US Department of the Interior, in cooperation with the Pinelands Commission and the New Jersey Department of Environmental Protection, published a report in 1980 entitled the Pinelands Scenic Study to define and assess the relative value of the scenic resources of the Pinelands. As part of the study, residents and users of the Pinelands were surveyed to evaluate scenic preferences. The most preferred scenic landscape in the Pinelands was surface water in lakes and streams. The next most preferred landscape was undisturbed forest, including cedar and hardwood swamp areas. The Great Egg Harbor River and its tributaries contain an abundance of both of these scenic landscapes.*

The Comprehensive Management Plan for the Pinelands National Reserve and the Pinelands Area designates the lower and middle reaches of the Great Egg Harbor River and its tributaries as scenic corridors of special significance to the Pinelands. The Great Egg Harbor National Scenic and Recreational River designation legislation also classifies 24.6 miles of the lower reaches of the river system as scenic" (NPS, 2000).

3.2.1.9 Surface Hydrology and Salinity

NPS (2000) states: "*The Great Egg Harbor River is one of two major river systems in the Pinelands National Reserve and drains about 20 percent of the area's 1.1 million acres. All waters in the Pinelands, including the Great Egg Harbor River and its tributaries, have been designated by the U. S. Environmental Protection Agency as Outstanding National Resource Waters that are to be protected from any change in water quality. Streams of the Pinelands and the coast are typically slow moving and shallow due to the flat topography. About 45% of the flow results from the outcropping of the Cohansey Aquifer.*

Twenty-five major impounded lakes are located in the Great Egg Harbor River basin. Impoundments on the mainstem of the Great Egg Harbor River are located at Mays Landing (forming Lake Lenape) in Atlantic County and at New Brooklyn in Camden County (forming New Brooklyn Lake). A series of breached small dams exist on the Tuckahoe River above Head of River which are maintained by the NJ Division of Fish, Game and Wildlife as wildlife impoundments. Hospitality Branch and its tributaries, Little Mill Creek, Big Ditch, Watering Race Branch, and Dry Run all exhibit alterations due to dams or impoundments. These alterations have significantly affected the free-flowing riverine characteristics of these tributaries.

The mainstem of the lower Great Egg Harbor River is tidally influenced up to Mays Landing while the lower Tuckahoe River is tidal up to Head of River" (NPS, 2000).

The following description is taken directly from USFWS (1997): *"The estuary of the Great Egg Harbor River receives surface water from two major river sources, the Great Egg Harbor River and the Tuckahoe River (including Cedar Swamp Creek). The Great Egg Harbor River is a 95-kilometer (59-mile) long river that is tidal for its lower 22.5 river kilometers (14 river miles) from the impoundment at May's Landing to its mouth where it joins the Middle and Tuckahoe Rivers at the head of Great Egg Harbor Bay. Smaller tributaries directly entering the estuary include the South River, Stephen Creek, Gibson Creek, and Middle River from the south, and Babcock Creek, Gravelly Run, English Creek, Lakes Creek, and Patcong Creek from the north. The Tuckahoe River is tidal for a distance of 22 river kilometers (13.5 river miles) upriver from the main stem of*

the Great Egg Harbor River; Patcong Creek is tidal for 9.4 river kilometers (5.8 river miles) from the bay; Cedar Swamp Creek is tidal for about 9.3 river kilometers (5.8 river miles) from its junction with the Tuckahoe; the lower portions of several other tributaries are tidal as well. Salinities in the Great Egg Harbor River vary with the diurnal (twice-daily) tides and the degree of rainfall, evapotranspiration, and consequent freshwater input. Salinities in the main stem of the Great Egg Harbor River range from less than 1 to 30 parts per thousand (ppt), with saltwater extending up the mainstem about 18.5 river kilometers (11.5 river miles) to just above Gravelly Run. Salinities above this point are generally less than 1 ppt. Salinities in the Tuckahoe River range from less than 1 to 21.3 ppt, with saltwater extending upriver about 22 river kilometers (13.5 river miles). Great Egg Harbor Bay itself is a polyhaline (high salinity), well-mixed estuary with salinities ranging from 17 to 32 ppt."

3.2.2 Priority Resources

NPS (2000) identified priority resources as part of the comprehensive management plan and EIS, and states: *"In addition to the Outstandingly Remarkable Resources identified above, the following river-related resources of state and local significance were also identified in the protection strategies for the Great Egg Harbor River".*

3.2.2.1 Wetlands

NPS (2000) states: *"Soils associated with wetlands adjacent to the Great Egg Harbor River and its tributaries are classified as having severe limitations for development purposes were recommended for protection. These areas are considered important in light of strong state legislation protecting freshwater wetlands."*

3.2.2.2 Flood Hazard Areas

NPS (2000) states: *"Flood Insurance Rate Maps for each community in the watershed were used to map the 100-year flood hazard areas. These areas surrounding the Great Egg Harbor River and its tributaries are important since the State Flood Hazard Area Control Act currently authorizes municipalities to regulate stream encroachment activities in the flood hazard areas and to develop conservation-oriented land use ordinances."*

3.2.2.3 Areas of Archaeological Significance and Sensitivity

NPS (2000) states: *"These areas are corridors along intermittent, permanent, and navigable streams where known American Indian sites have been documented and/or the probability of finding new sites is very high. These areas have been identified as corridors directly adjacent to wetlands, both tidal and freshwater, in the Great Egg Harbor River watershed."*

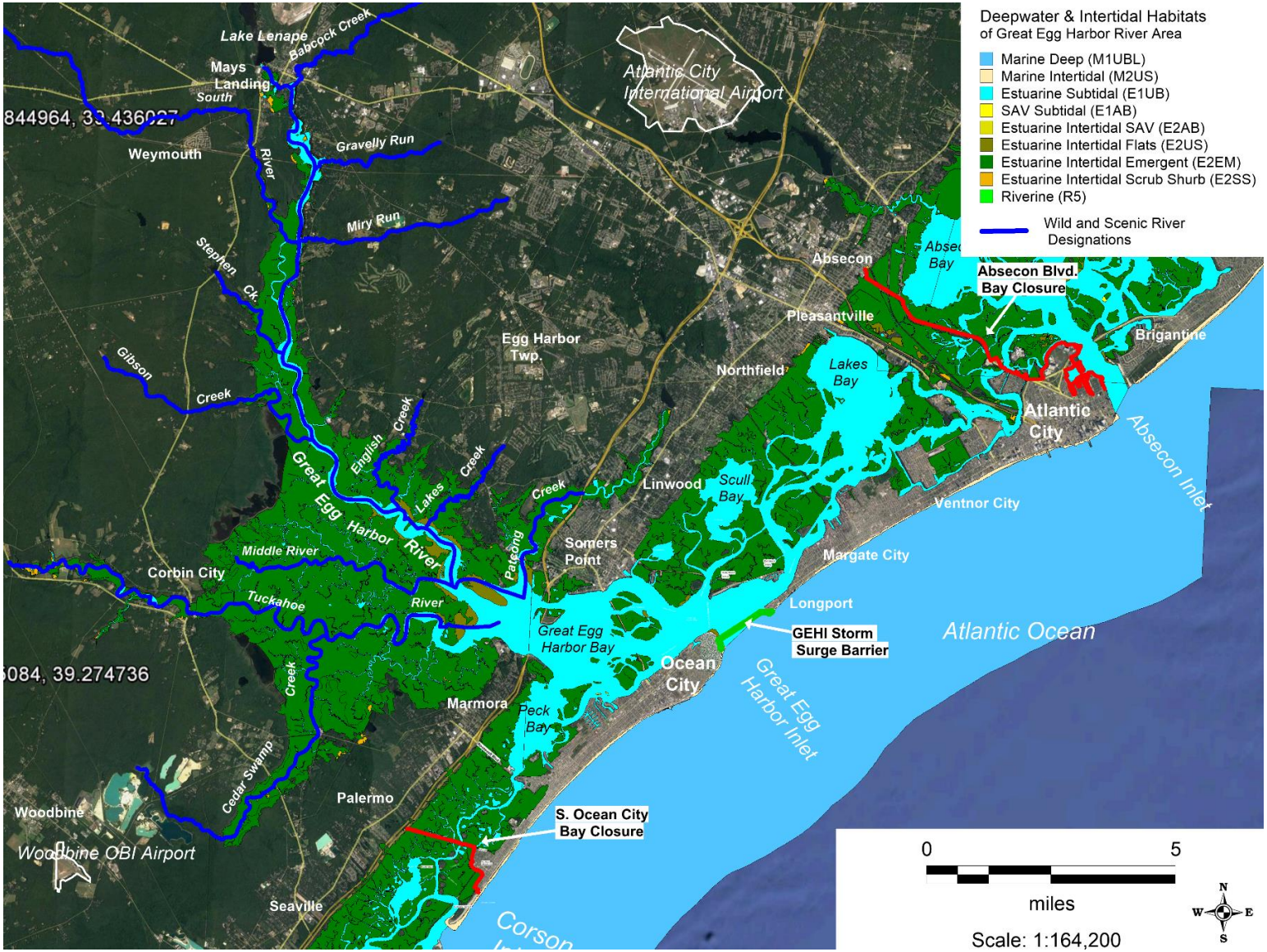


Figure 4. Tidally Influenced Habitats in Great Egg Harbor Area (from National Wetlands Inventory Mapping)

4.0 ACTION AREA

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

For the NJBB Study, the action area is all areas directly and indirect affected by the tentatively selected plan (TSP), presented **Error! Reference source not found.**. Since the affected Wild and Scenic River Area occurs within the Central Region, only alternatives involving the Central Region are presented here, which includes TSP alternative 4G(8). The TSP – 4G(8) includes the following project components:

- One inlet closure or storm surge barrier (SSB)
    - Great Egg Harbor Inlet
- Two cross bay barriers (CBB)
    - Absecon Blvd
    - South Ocean City
- Non-structural measures
    - structures eligible for elevation and floodproofing

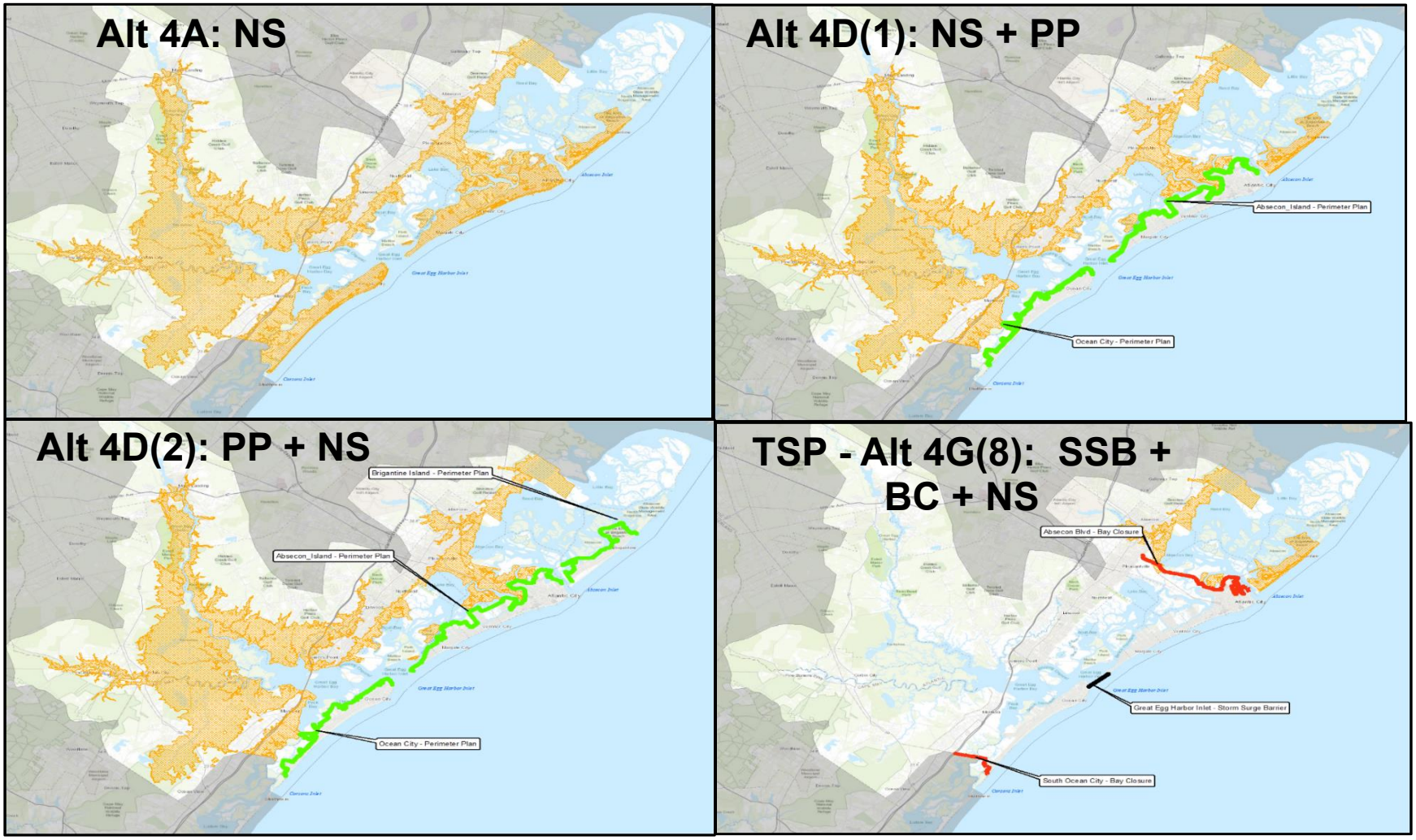
Additionally, the action area considers the effects of the following options, which have not yet been eliminated.

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

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

Table 3. Central Region Alternatives and TSP (4G(8))

Central Region Alternatives					
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.**
4A†	Brigantine, Absecon, Pleasantville, West A.C., A.C., Ventnor, Margate, Longport, Northfield, Linwood, Estell Manor, Mays Landing, Somers Point, Marmora, Ocean City, Palermo				• Horizontal or ecotone levee(s) • Island Creation/Expansion – Great Bay • Dune Enhancements • Wetland Creation or Restoration Great Bay, Reeds Bay, Absecon Bay, Lakes 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)†	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			
4G(8)*	**Brigantine, Absecon, Pleasantville, West A.C.,**		**1. Great Egg Harbor Inlet**	**1. Absecon Blvd.** **2. Southern Ocean City (52nd St.)**	



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

Figure 5. Comparison of the Non-Structural and Perimeter Plan Alternatives and the TSP in the Central Region.

5.0 PROJECT DESCRIPTION

5.1 Storm Surge Barriers and Cross Bay Barriers

In the Central Region, one storm surge barrier (SSB) at Great Egg Harbor Inlet) and two interior cross bay barriers (CBBs) across the bay (Absecon Blvd and Southern Ocean City) are included in the TSP. The selected SSB reduces storm surge from propagating into the bays from the ocean during storm events lowering flood elevations. The storm surge barriers across the bay (Cross Bay Barriers) 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. The SSB spans the inlet opening with a combination of static impermeable barriers and dynamic gates that are only closed during storm events. The SSB includes a navigable gate (sector gate) to provide a navigable opening with unlimited vertical clearance and a series of 19 auxiliary flow gates, vertical lift gates, to maintain tidal flow during non-storm conditions. An example of an SSB at the Seabrook Flood Complex in New Orleans, LA which is constructed with a sector gate and vertical lift gates and a rendering of a potential design across the GEHI is shown in **Error! Reference source not found.** and 9. Detailed engineering drawings, layouts and cross-sections, for the storm surge barriers are included in Appendix B. Storm surge barrier gate types and alignments are considered tentative and may change in future phases of the study with more detailed engineer analyses and designs.

Navigable sector gates span the full width of the federal navigation channel with a 10-foot buffer on either side with an opening span of 340 feet at Great Egg Harbor Inlet. Each auxiliary flow gate has an opening span of 150 feet and are located along the storm surge barrier in water depths that are deemed constructible and practical. 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 cross bay barriers, 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 4.

Table 4. TSP – Storm Surge Barrier Components

Storm Surge Barrier	Navigable Gate	Auxiliary Flow Gates	Impermeable Barrier	Perimeter Barrier
Great Egg Harbor Inlet Closure	1 Sector Gate Length = 320 feet 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. Bay Closure	1 Sector Gate Length= 120 FT Crest Elev.=13 FT Sill Elev.=-20FT	4 Shallow Water Gates Length=24 FT Each Crest Elev.=13 FT Sill Elev.=-2FT	Length=869 FT Area= 14,772 SF	Levee = 27,524 FT Floodwall = 28,890 FT 4 Road Closure Gates 5 Mitre Gates
Southern Ocean City Bay Closure	1 Sector Gate Length= 120 FT Crest Elev.=13 FT Sill Elev.=-10FT	None	None	Levee = 9,467 FT Floodwall = 4,124 FT 1 Mitre Gate 1 Sluice Gate

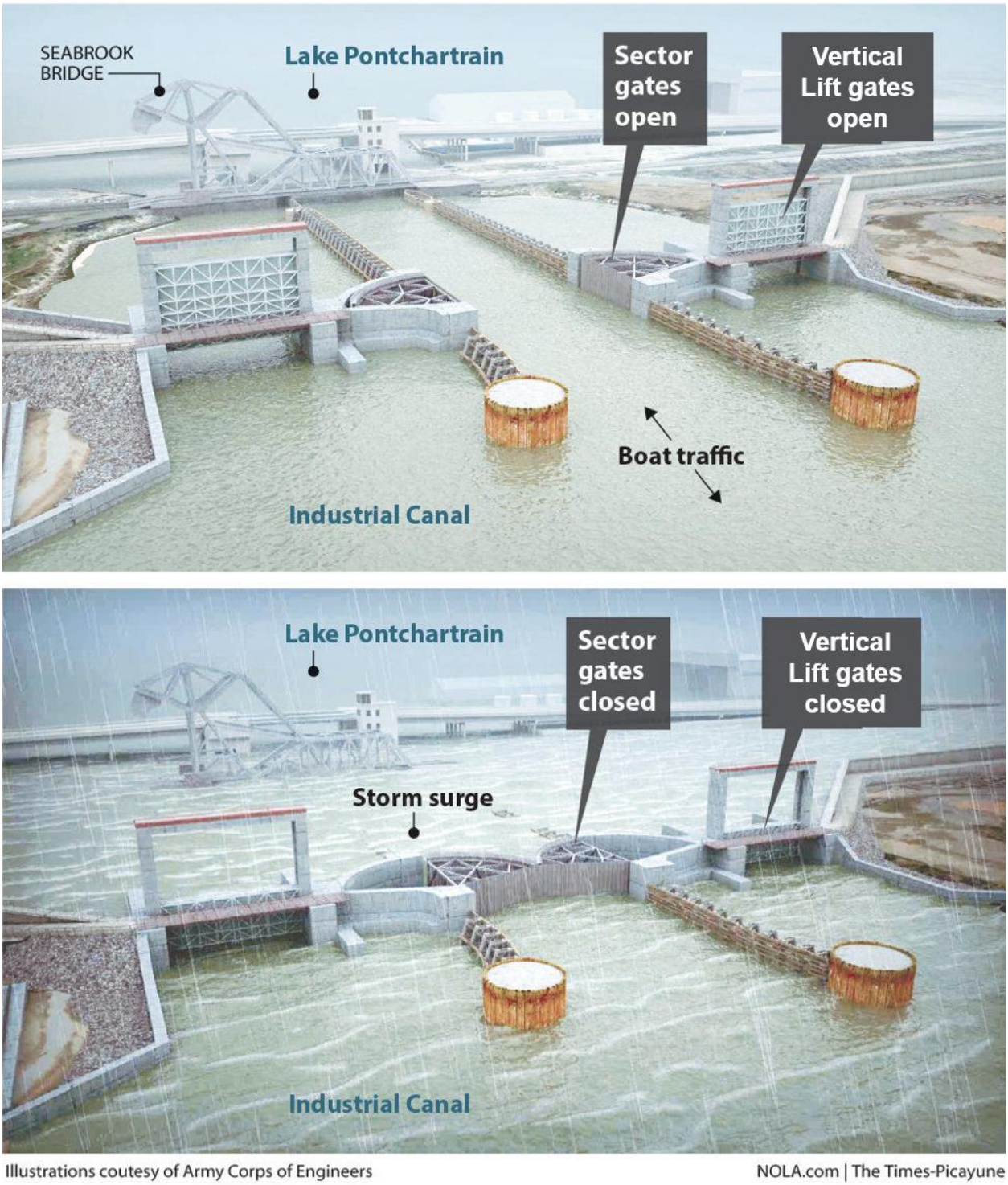


Figure 6. Example of Storm Surge Barrier at Seabrook Flood Complex in New Orleans,

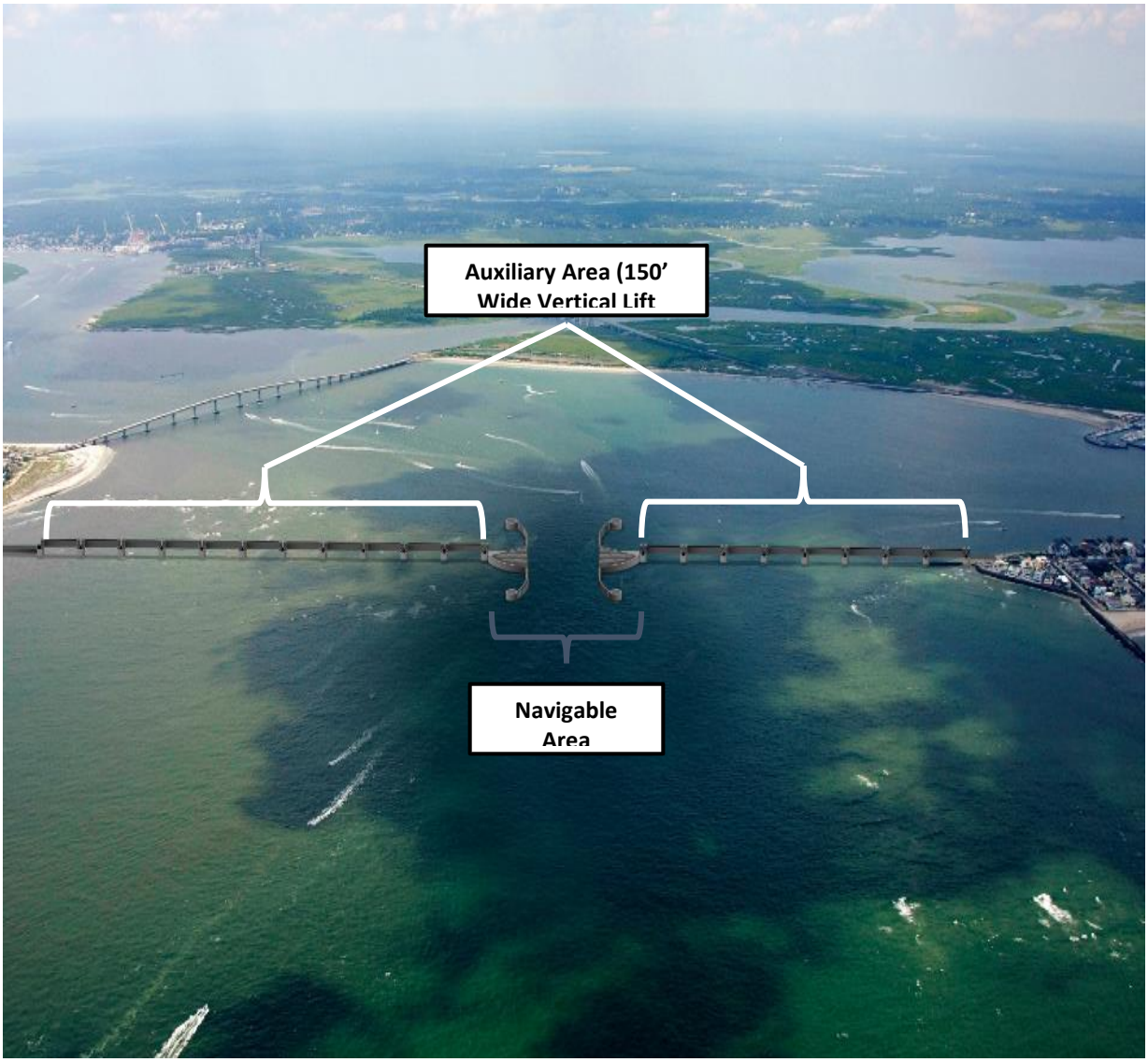


Figure 7. Rendering of an Inlet Storm Surge Barrier at Great Egg Harbor Inlet

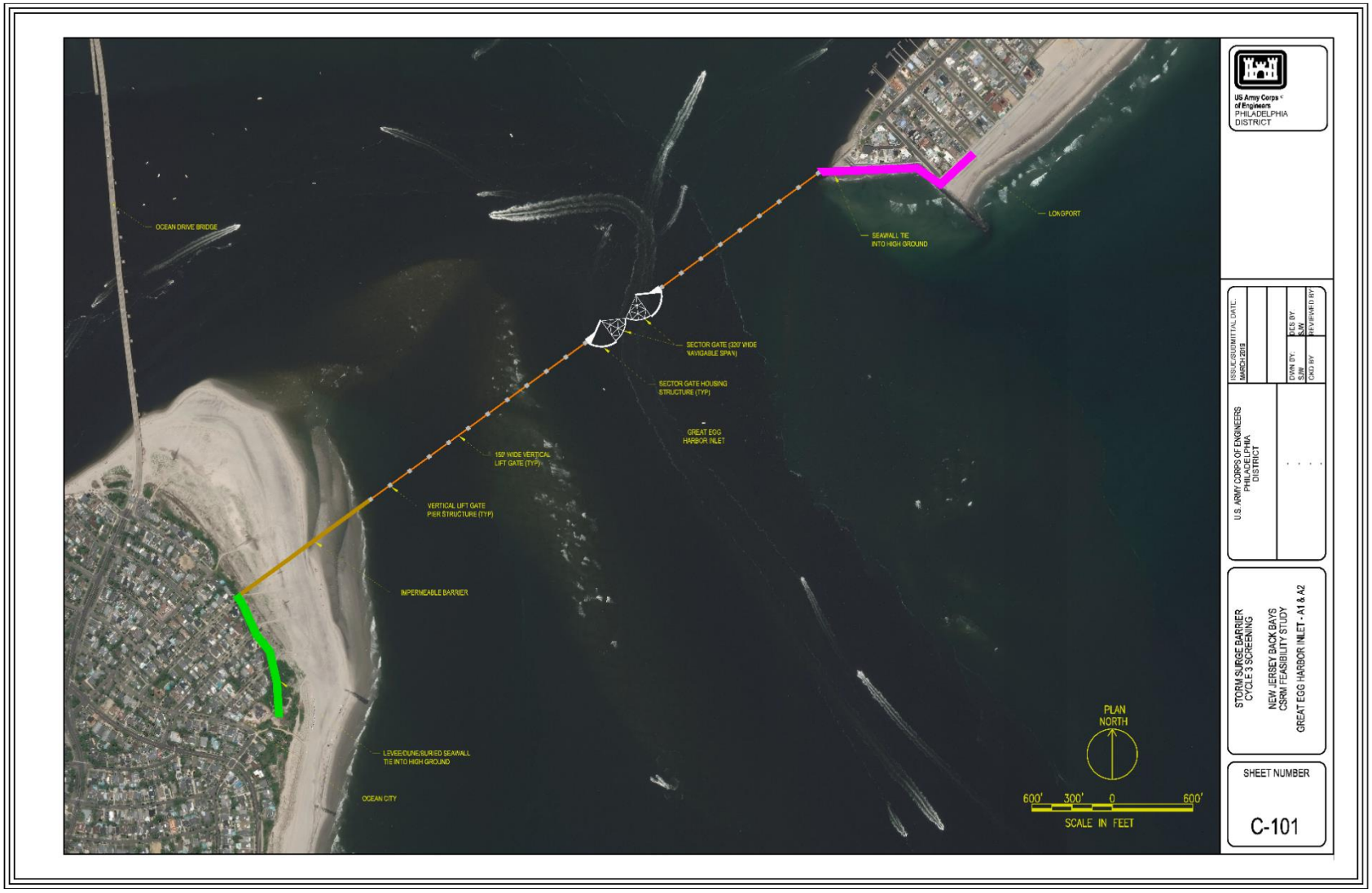


Figure 8. TSP GEHI SSB A1 & A2 Alignment

Figure 9. TSP Absecon Boulevard CBB Alignment

Figure 10. TSP S. Ocean City CBB Alignmen

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 cross bay barriers 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 cross bay barriers 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 in the Central Region includes Nonstructural measures such as, elevating structures and floodproofing, in areas where the storm surge barriers will not significantly reduce flood elevations. These areas are concentrated in the Absecon, Brigantine, and West Atlantic City areas, which include structures located within the 5% AEP floodplain (20-year return period).

In addition, to the TSP, two plans contain non-structural options (4D-1 and 4D-2) and one completely nonstructural options are still under consideration.

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

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.

5.3 Perimeter Plans

The perimeter plan options that are still being considered in the Central region includes 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 11,

Figure 12, and Figure 13 show 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).

The location, length, and construction duration for the perimeter plans for these options are presented in Table 5.

Table 5. Location, Length, and Construction Duration for Perimeter Plan Options in the Central Region

ALTERNATIVE	LOCATION	BARRIER LENGTH (LF)	CONSTRUCTION DURATION (MONTHS)
4D1	Ocean City	78,732	89
	Absecon Is.	111,111	126
4D2	Ocean City	78,732	89
	Absecon Is.	111,111	126
	Brigantine	48,699	55

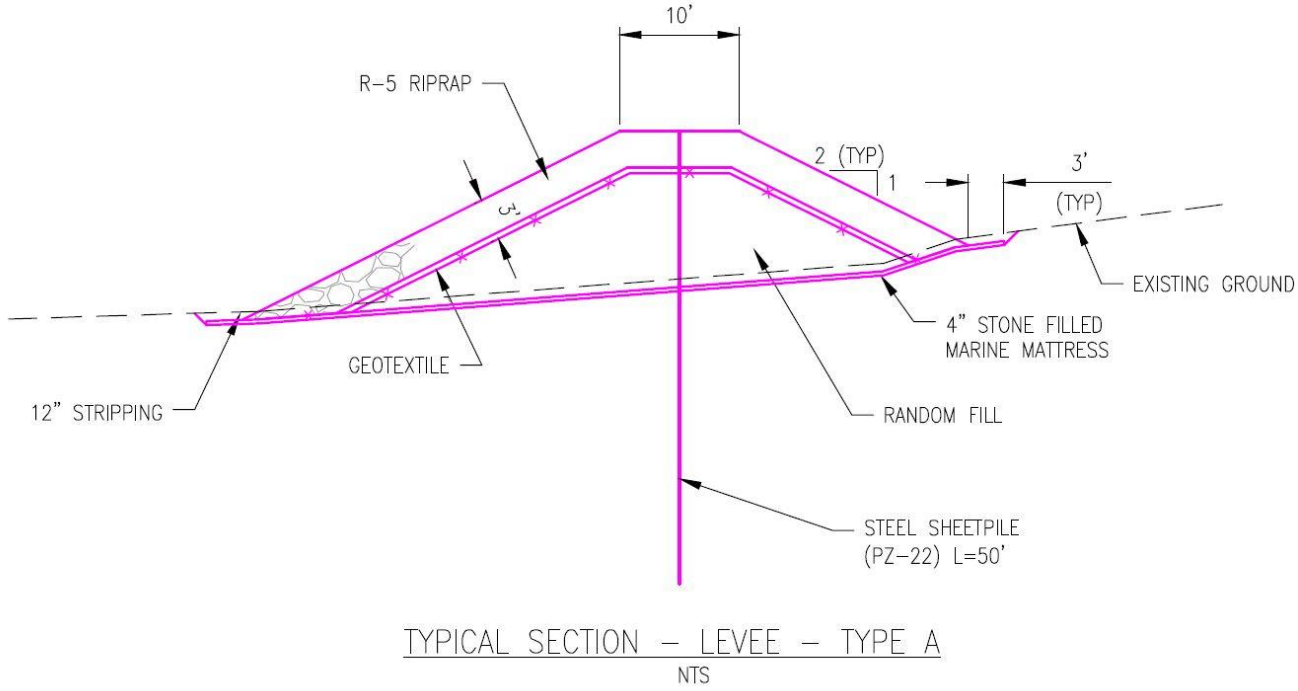


Figure 11. Typical Section – Levee – Type A

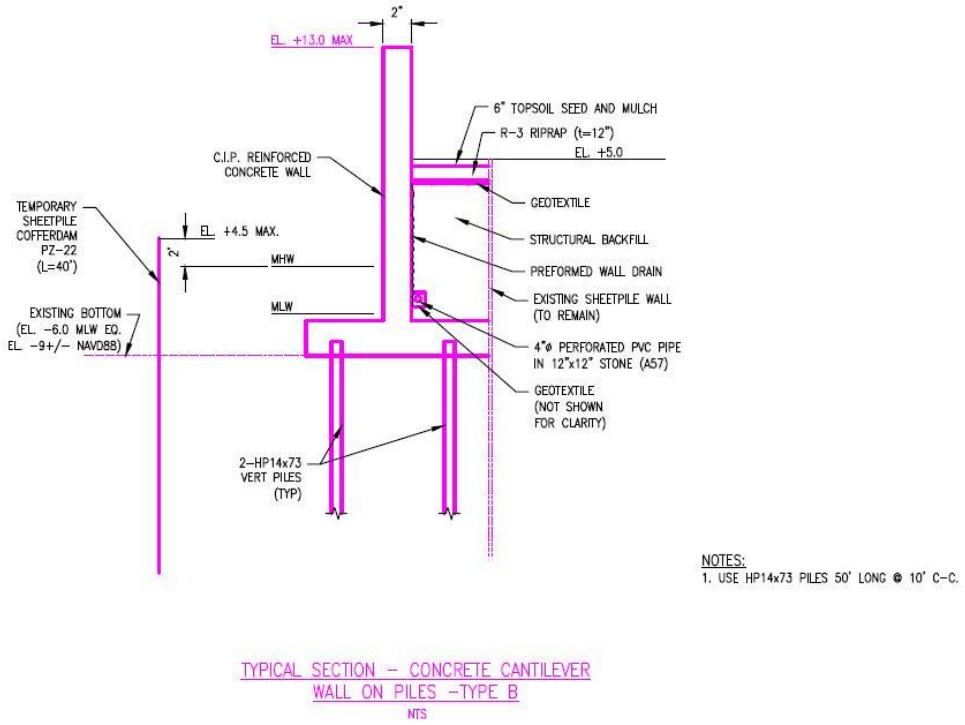


Figure 12. Typical Section – Concrete Cantilever Wall on Piles – Type B

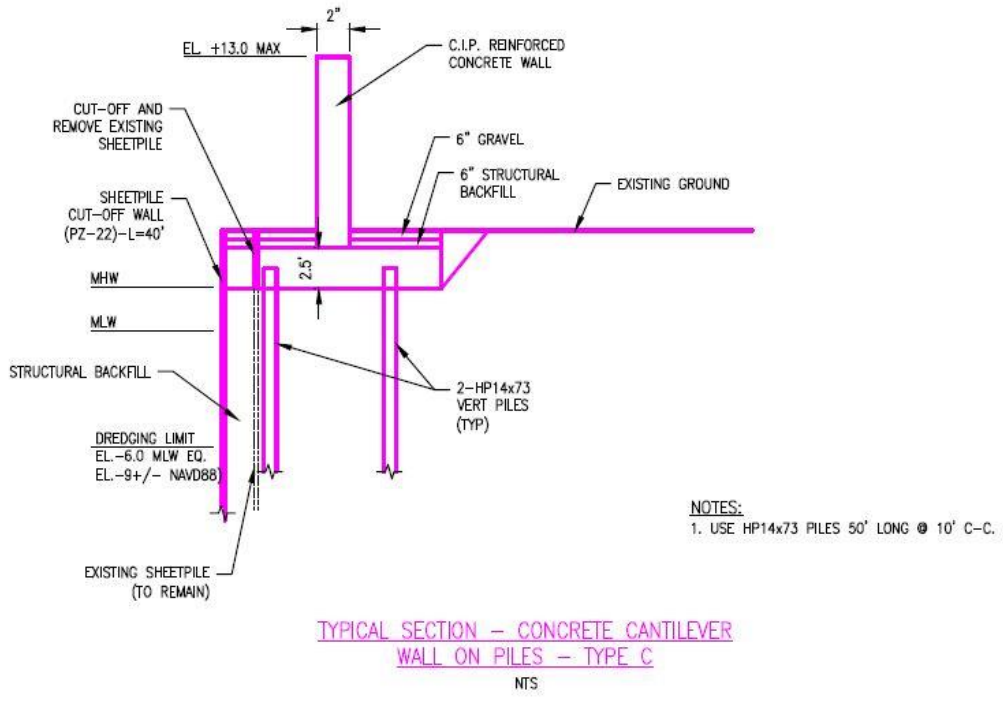


Figure 13. Typical Section – Concrete Cantilever Wall – Type C

5.3.1 Pre-construction

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

5.3.2 Construction

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

5.3.3 Operation and Maintenance

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

5.4 Natural and Nature Based Features (NNBF)

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

5.4.1 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 CBBs, 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.

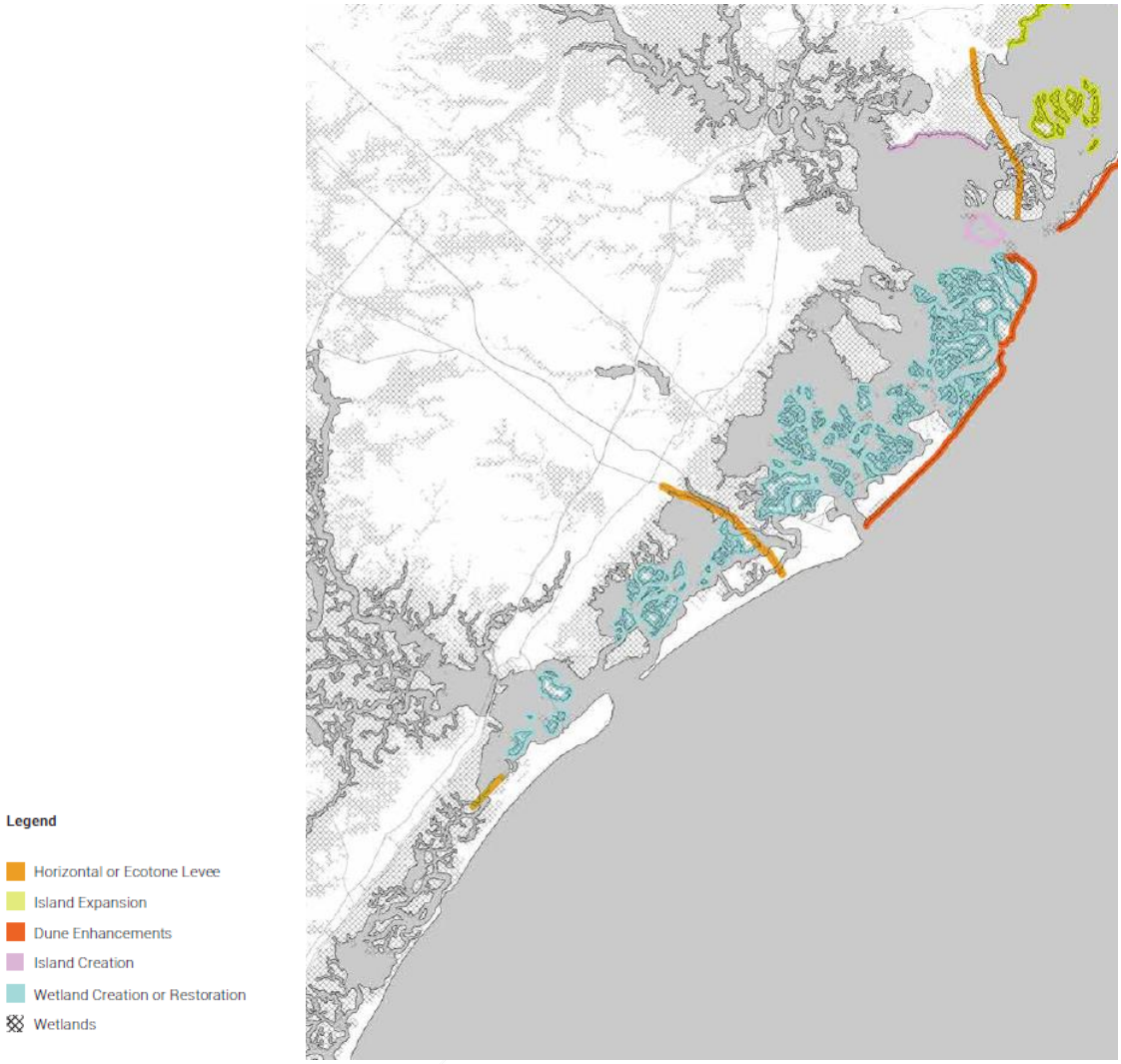


Figure 14. Potential NNBFs within the Central Region

5.4.2 Pre-construction

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

5.4.3 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.

5.4.4 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 PROJECT EFFECTS ON GREAT EGG HARBOR SCENIC AND RECREATIONAL RIVER RESOURCES

6.1 Outstandingly Remarkable Resources

6.1.1 Cultural Resources

Although historic properties exist within the Great Egg Harbor River, the USACE does not see a high probability risk of adverse impact with any of the proposed New Jersey Back Bay alternatives. The structural and non-structural alternatives are largely outside of the boundaries of the Great Egg Harbor Wild and Scenic River limits; however, there is a minimal risk to archaeological sites or historic properties that may be impacted by repeated water level changes. Flooding of structures and erosion of archaeological sites is possible but will need to be assessed further in the study in order to properly identify those resources, and to make a determination of effects.

6.1.2 Fauna

Because the GEHI SSB and the two CBBs are more than 4.5 miles away from the Wild and Scenic River designation, temporary construction and long-term direct impacts to fauna would be considered non-existent or minimal within the WSR designated portion of the affected area.

Indirect effects on fauna are more complex stemming from potential tidal amplitude changes that may affect wetland habitats at the edges of the upper and lower tidal range and any indirect trophic effects that could potentially occur.

6.1.3 Fisheries

The TSP features and other measures are not expected to have significant direct impacts on fisheries and habitats in the Wild and Scenic River (WSR) portions since construction and O&M activities would occur outside of the WSR areas. However, the indirect impacts of SSBs and CBBs on finfish, shellfish are potentially significant. Under normal conditions, the gates of SSBs and CBBs would remain open and fish and other aquatic organisms should be able to transit through these structures. However, because SSBs require large in-water structural components such as the gate housing and abutments/piers, preliminary estimates indicate significant cross-sectional restrictions where 42% of the Great Egg Harbor Inlet would be blocked by these SSB structures in an open-gate scenario. These constrictions would produce changes in velocity as tidal flows have less area to push into and out of the inlets, thus flow velocities will increase significantly at the gate locations by to compensate for tidal forcing. It is not well understood if these velocities would change migratory fish patterns for fish traversing through the inlet areas. Migratory fish potentially affected include obligate migrators (diadromous fishes such as eels, alosines, and Atlantic sturgeon) and marine fishes and other facultative migrators (e.g. bluefish, flounders, and weakfish) and forage fishes (e.g. menhaden, bay anchovy, Atlantic silversides) (Orton et al. 2020). Anadromous fish such as river herrings seek higher velocities to ascend into their natal rivers, but there is little known on what the effects of these velocity changes would have on fish at the inlet areas, and if the fish would adapt to these changes. Observations in the UK noted that adult and juvenile salmon upstream and downstream migrations were delayed after a barrier was implemented (Orton et al. 2020). Additionally, fish larval transport is also likely to be affected by the changes where the gate structures may block or inhibit larvae from entering or exiting the inlet

or the increased velocities may have a “jettison” effect on them. Because these effects of SSBs are relatively unknown, there is a high risk for significant effects on fisheries. Additional modeling and fish census studies would need to be conducted to better understand these effects before proceeding with implementation. These actions can be implemented prior to the completion of the Final Tier 1 EIS and/or during the Tier 2 – Engineering and Design phase.

With the gates open, the small salinity changes could potentially result in minor to significant effects on the abundance and distribution of fisheries. For instance, adult hard clams cannot tolerate lowered salinities where they do not grow at ≤ 12 ppt salinity, and are intolerant of protracted salinities < 15 ppt, and interactions between temperature and salinity on hard clam larval development are stressed at lower salinities (Bricelj *et al*. 2012). The AdH modeling did not demonstrate large changes in the mean salinity (the highest mean salinity change was slightly above 1 ppt) with the TSP SSB/CBBs but even small changes on the margins may be enough to stress these organisms. Because of normal fluctuations of salinities within the estuarine mixing zones, the effects may not be severe, however, additional evaluations are required in subsequent phases to evaluate changes from the TSP structures on the extremes and salinity tolerances for the most affected EFH species.

Gate closures may have even more of an effect on fisheries, although temporary. Extreme storm and high tide events would trigger the closure of SSBs and CBBs, causing shifts in water quality and flow rates. During these closures, tidal fluxes in water would cease for a period of time, potentially reducing water quality and dissolved oxygen (DO), while increasing the number of harmful nutrients in the water. The changes in water quality, DO, and nutrients could have compound and/or cumulative interactions, causing increased stress levels to fish populations, which may lead to increased susceptibility to disease or even a mortality event (Tietze 2016; Bachman and Rand 2008). Additionally, periodic maintenance of the structures proposed would be necessary over time; the maintenance would likely result in localized disturbances caused by increased underwater noise and turbidity. The operation and maintenance of SSBs and CBBs could potentially result in temporary to permanent significant adverse impacts to fish and fisheries resources (USACE, 2017).

At this time, it is concluded that the indirect effects on fisheries in the WSR portion of the Great Egg Harbor River and tributaries would be considered a “diminution” based on that the effects are not fully known or could be far removed from the WSR portion. Although mitigation is proposed that could provide compensation for any of these effects, additional investigations such as modeling of gate closures and a study on changes in velocities at the SSB locations on migratory fish would be required in subsequent study phases.

6.1.4 Flora

The TSP features and other measures are not expected to have significant direct impacts on flora and wetland habitats in the Wild and Scenic River (WSR) portions since construction and O&M activities would occur outside of the WSR areas.

Indirect effects of the GEHI SSB on tidal flora could result in small changes in tidal amplitudes as the SSB structure would result in ebb and flood tidal flow constrictions. Based on AdH modeling, mean tidal amplitudes would be reduced at the Great Egg Harbor River location by about 1.4 cm where flora at the upper end of the tide range could become less inundated at high tide and flora at the lower tide range could be come more inundated. However, sea level rise is likely to produce

significant effects on floral distribution in the without project condition (no action) and the with-project condition (SSB gates open) as salinity is expected to push further into brackish and freshwater areas along with higher tides flooding resulting in salt marsh migrations into freshwater marshes or conversions of low-lying forested wetlands into “ghost forests”. SSB gate closures could have a moderating effect by limiting salinity “pulses” from significant storm events, but they would not prevent daily increases of tide levels and salinity.

At this time, it is concluded that the indirect effects on flora in the WSR portion of the Great Egg Harbor River and tributaries would be considered a “diminution” based on that the effects are not fully known or could be far removed from the WSR portion. Although mitigation is proposed that could provide compensation for any of these effects, additional investigations such as modeling of gate closures and a study on changes of tidal amplitudes and tidal elevations with sea level rise on wetland flora would be required in subsequent study phases.

6.1.5 Rare and/or Special Status Species

The TSP features and other measures are not expected to have significant direct impacts on flora/fauna and wetland habitats in the Wild and Scenic River (WSR) portions since construction and O&M activities would occur outside of the WSR areas.

Indirect effects of the GEHI SSB on tidal flora could result in small changes in tidal amplitudes as the SSB structure would result in ebb and flood tidal flow constrictions. Based on AdH modeling, mean tidal amplitudes would be reduced at the Great Egg Harbor River location by about 1.4 cm where flora at the upper end of the tide range could become less inundated at high tide and flora at the lower tide range could become more inundated. Effects on high saltmarshes may result in changes in hydrology along the upper edges that could have indirect effects on the Eastern black rail (*Laterallus jamaicensis*). However, sea level rise is likely to produce significant effects on floral/faunal distribution in the without project condition (no action) and the with-project condition (SSB gates open) as salinity is expected to push further into brackish and freshwater areas along with higher tides flooding resulting in salt marsh migrations into freshwater marshes or conversions of low-lying forested wetlands into “ghost forests”. These effects could modify important habitats for species inhabiting brackish marshes such as the state listed species, American bittern and bronze copper (butterfly) or forested wetlands such as the pine barrens tree frog. SSB gate closures could have a moderating effect by limiting salinity “pulses” from significant storm events, but they would not prevent daily increases of tide levels and salinity.

At this time, it is concluded that the indirect effects on flora/fauna with special status in the WSR portion of the Great Egg Harbor River and tributaries would be considered a “diminution” based on that the effects are not fully known or could be far removed from the WSR portion. Although mitigation is proposed that could provide compensation for any of these effects, additional investigations such as modeling of gate closures and a study on changes of tidal amplitudes and tidal elevations with sea level rise on wetland flora/fauna would be required in subsequent study phases.

6.1.6 Recreation

The TSP features and other measures are not expected to have significant impacts on recreation in the Wild and Scenic River (WSR) portions since construction and O&M activities would occur

outside of the WSR areas. The proposed project features are far removed from the WSR portions and will not limit access to or eliminate or degrade recreational activities that occurred at the time of designation.

6.1.7 Physiographic/Geologic Setting

The TSP features and other measures are not expected to have significant impacts on the physiographic/geologic setting of the Wild and Scenic River (WSR) portions since construction and O&M activities would occur outside of the WSR areas.

6.1.8 Scenic Resources

The TSP features and other measures are not expected to have significant impacts on the scenic resources of the Wild and Scenic River (WSR) portions since construction and O&M activities would occur outside of the WSR areas. The structural features would not be visible in the WSR portions, and occur more than 4 miles from the designated areas among other visual obstructions including bridges, highways, and urbanized areas.

6.1.9 Surface Hydrology and Salinity and Water Quality

The TSP features and other measures are not expected to have significant direct impacts in the Wild and Scenic River (WSR) portions since construction and O&M activities would occur outside of the WSR areas. However, many lagoonal estuaries with poor flushing and long residence times are more likely to retain nutrients longer in the system, which could lead to higher primary production rates, thus becoming more susceptible to eutrophication. Whereas, well-flushed estuaries demonstrate greater resilience to nutrient loading attributed to reduced residence time and greater exchange with less impacted coastal waters (Lancelot and Billen, 1984 as cited in Defne and Ganju, 2015). Barnegat Bay and Little Egg Harbor (BB-LEH) estuaries are the most studied concerning hydrodynamic modeling and residence times where Guo and Lordi (2000) estimated an average residence time at Barnegat Inlet based on velocity and salinity as occurring between 24 and 74 days (depending on season). Defne and Ganju (2015) performed systemic modeling using a combination of hydrodynamic and particle tracking modeling of the BB- LEH estuaries to determine a mean residence time of 13 days, but special variability was between 0 and 30 days depending on the initial particle location. This modeling also demonstrated that there is a pronounced northward subtidal flow from Little Egg Inlet in the south towards Point Pleasant Canal in the north attributed to frictional effects in the inlets. This effect resulted in better flushing of the southern half of the estuary and more particle retention (poor flushing) in the northern estuary.

The shallow lagoonal coastal bays in New Jersey are susceptible to potential changes caused by the placement of structures such as storm surge barriers across the affected inlets and cross bay barriers, which run across the bays in an east-west direction. Both of these types of structures can potentially modify tidal flows by reducing the cross section and free exchange of tidal flows through the inlets and bay systems. Thus, the implementation and operation of barriers and closures have the potential for significant impacts on water quality based on their potential for altering flow and circulation patterns. These impacts are inherently based on the design of the

barrier/closure such as the number of openings and widths of these openings, which could significantly alter the flow patterns through the inlets and bays by constricting flows and affecting current velocities. A number of design components make up these barriers/closures, which include navigable sector gates, auxiliary flow lift gates, impermeable barriers, levees and seawalls. For the inlet barriers, the navigable sector gates, auxiliary flow lift gates, and their support piers are the predominant in-water structures. The impermeable barrier structure is a hardened structure that is also an in-water structure that ties the gates into features on the adjacent land such as a levee, seawall or existing dune. The cross bay barriers have the same components as the inlet barriers, but the cross bay barriers also have other features such as levees, road closures and miter gates and sluice gates, which are for smaller channels and tidal guts. The navigable sector gate is open under normal conditions to allow for navigation traffic and tidal exchange. The auxiliary lift gates are vertical gates that are “up” during normal conditions to allow for tidal exchange. These gates would be designed to remain open during normal conditions. However, even with the gates in opened positions, there would be a net reduction in channel cross-sectional area that would act as a constriction to flood and ebb tidal flow through the inlets. Table 6 provides a preliminary estimate of cross- sectional areas of the A1 alignment affected by the combinations of the features of the SSB at Great Egg Harbor Inlet and shows significant changes in conveyance from baseline conditions(100% conveyance). The GEHI SSB alignment results in a net flow restriction of 42% of the current cross section.

Table 6. Inlet Cross Sectional Changes from TSP Storm Surge Barriers

SSB Location	Existing Wetted Cross Section Area (SF)	A1 Wetted Area (SF)	A1 Conveyance (%)	A1 Restriction (%)
Great Egg Harbor Inlet	70,618	40,682	58%	42%

Based on these restrictions, changes in tidal flow velocity are likely, which could increase susceptibility to scour and erosion in areas with increased velocity and sediment deposition in areas of lowered velocity. These flow pattern changes could potentially result in changes in circulation and increased residence times, which could have more profound effects in backwater areas that are already poorly flushed. Restrictions in tidal flows and increases in residence times could affect salinity levels, stratification, nutrients, chlorophyll *a* and dissolved oxygen concentrations. These effects could be exacerbated at times when the gates are closed during a significant storm event when increased freshwater inputs, nutrients, bacteria and other pollutants discharged from tributaries and point and non-point sources are held in the bays for a longer period. The frequencies and durations of gate closures may vary where closures at a minimum would be over two tide cycles (approximately 24 hours) to approximately 48 hours several times a year. These closures are unpredictable and would depend on the number and severity of the storms in the affected area.

Measuring these physical changes is important for understanding the potential for effects on water quality. Therefore, a two-dimensional (2D) Adaptive Hydraulics (AdH) model was developed and validated for simulation of hydrodynamics and salinity within the affected areas. The model was

validated to available field data for all parameters and then utilized to test project alternatives for present and future sea level rise conditions (McAlpin and Ross, 2020). Baseline field measurements and modeling occurred at 30 locations situated throughout the study area. The results of the AdH modeling include changes in salinity, velocity, and water levels throughout the model domain under the various alternative conditions. Additionally, particle tracking was conducted by Lackey et al. (2020) utilizing the Particle Tracking Model (PTM) (McDonald et al 2006, Gailani et al 2016, Lackey et al 2008) to determine any changes in residency times of the affected estuaries from the structures associated with the TSP. At this time, the AdH model and particle tracking model (PTM) was only applied for the open-gate condition, which would be the predominant condition for the with-project TSP. Subsequent analyses of AdH and PTM will be conducted to simulate conditions with the gates closed during storm events and maintenance activities.

Open-Gate Scenario

Results of the open-gate AdH modeling indicate localized increases in velocity surrounding the SSB structures, which would increase at Great Egg Harbor Inlet indicating significant localized changes; however, the impact of the velocity magnitudes away from the structures would be very little. Based on the restrictions imposed by the cross section of the SSB at Great Egg Harbor Inlet, the tidal prism (volume of water exchange) would be reduced by 4.8% following construction. The impacts to tidal amplitudes were found to not be evenly distributed throughout the bays with a mean individual reduction in tidal amplitude at the Great Egg Harbor River station near the mouth of English Creek by 2.3% or by 1.4 cm (Table 7)

Table 7. Mean Tidal Amplitude and With-Project (WP1/TSP) Modeled Changes Among the Central Region Locations in the AdH Model.

Location	Base (m)	WP1 (TSP) (m)	% change	Change (m)	Change (cm)
JACNEWQ	0.428	0.414	-3.2%	-0.014	-1.4
Little Egg Inlet	0.57	0.558	-2.05%	-0.012	-1.2
Absecon Creek	0.586	0.567	-3.09%	-0.019	-1.9
Brigantine	0.53	0.514	-3.03%	-0.016	-1.6
Absecon Channel	0.681	0.677	-0.69%	-0.004	-0.4
Atlantic City (Ocean)	0.739	0.738	-0.11%	-0.001	-0.1
Inside Thorofare	0.686	0.67	-2.25%	-0.016	-1.6
Beach Thorofare	0.71	0.682	-4.02%	-0.028	-2.8
Scull Bay	0.56	0.543	-3.13%	-0.017	-1.7
Great Egg Harbor River	0.6	0.586	-2.30%	-0.014	-1.4
Great Egg Harbor Bay	0.713	0.689	-3.39%	-0.024	-2.4

Location	Base (m)	WP1 (TSP) (m)	% change	Change (m)	Change (cm)
Ocean City 39th St	0.622	0.608	-2.22%	-0.014	-1.4
Corson Sound	0.566	0.554	-2.07%	-0.012	-1.2

Tidal amplitudes were also modeled in AdH with sea level rise and showed significant changes among the baselines between current mean baseline amplitudes and future mean baseline amplitudes. The modeling demonstrates that for most bay stations, mean baseline tidal amplitudes increased with SLR whereas upstream stations in the rivers such as JACNEWQ (Mullica River) and Great Egg Harbor River decreased in amplitudes where the Great Egg Harbor River decreased by 0.1 m. This would indicate a future without project/no action decrease in amplitude of 10 cm with SLR in the Great Egg Harbor resulting in lower high tides and higher low tides compared to current conditions. The modeled with-project SSB at GEHI would decrease tidal amplitudes an additional 0.03 m (3 cm), thus, an overall reduction in mean tidal amplitude of 13 cm. However, these changes in amplitude would be well within a much larger significant shift in tidal elevations with SLR.

Table 8. Mean Tidal Amplitude and With-Project (WP1/TSP) Modeled Changes with Sea Level Rise (50 years) Among the Central Region Locations in the AdH Model.

Location	SLR Baseline (m)	Baseline Change w/ SLR (m) (FWOP)	WP1 (TSP) w/ SLR (m)	WP1 SLR change w/ Base SLR.	WP1 SLR change from Existing Base
JACNEWQ	0.39	-0.04	0.38	-0.01	-0.05
Little Egg Inlet	0.75	+0.18	0.68	-0.07	0.11
Absecon Creek	0.63	+0.04	0.62	-0.01	0.03
Brigantine	0.65	+0.12	0.61	-0.04	0.08
Absecon Channel	0.91	+0.23	0.82	-0.09	0.14
Atlantic City (Ocean)	1.04	+0.30	1.04	0.00	0.30
Inside Thorofare	0.70	+0.01	0.66	-0.04	-0.03
Beach Thorofare	0.75	+0.04	0.70	-0.05	-0.01
Scull Bay	0.75	+0.19	0.60	-0.15	0.04
Great Egg Harbor River	0.50	-0.10	0.47	-0.03	-0.13
Great Egg Harbor Bay	0.95	+0.24	0.78	-0.17	0.07

Ocean City 39th St	0.72	+0.10	0.57	-0.15	-0.05
Corson Sound	0.49	-0.08	0.48	-0.01	-0.09

Changes in salinity were also modeled in the AdH model for the open-gate conditions Table 9 presents the open-gate baseline salinities and the salinities of the with-project TSP- SSB and CBBs in place per location. 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.

Table 9. AdH Model Comparing Mean Baseline Salinities with TSP (A1 Alignments) for Alternative 4G(8) Open-Gate Conditions and with Sea Level Rise (SLR) at Locations Throughout the Central Region of the NJBB Study Area (McAlpin and Ross, 2020)

Study Region	Waterway	Station	Existing Conditions			With SLR		
			Base (ppt)	TSP (ppt)	Change (ppt)	Base (ppt)	TSP (ppt)	Change (ppt)
CENTRAL REGION	Mullica River	JACNEWQ (Mullica River)	4.8	5.14	+0.34	10.01	9.9	-0.11
	Little Egg Inlet/Great Bay	Little Egg Inlet	26.89	27.04	+0.15	27.31	27.29	-0.02
	Absecon Bay	Absecon Creek	27.52	27.6	+0.08	27.77	27.81	+0.04
	Obes Thorofare	Brigantine	27.67	27.71	+0.04	27.93	27.92	-0.01
	Absecon Inlet	Absecon Channel	28.44	28.5	+0.06	28.51	28.52	+0.01
	Atlantic Ocean	Atlantic City (Ocean)	28.65	28.7	+0.05	28.61	28.62	+0.01
	Inside Thorofare	Inside Thorofare (Rt. 40)	27.6	27.25	-0.35	27.89	27.57	-0.32
	Beach Thorofare	Beach Thorofare (Margate Blvd.)	28.25	28.18	-0.07	28.46	28.33	-0.13
	Scull Bay	Scull Bay	27.77	27.75	-0.02	27.81	27.68	-0.13
	Great Egg Harbor River*	Great Egg Harbor River (DS of English Creek)	18.99	18.73	-0.26	21.79	20.97	-0.82
	Rainbow Channel	Great Egg Harbor Bay	27.34	27.21	-0.13	27.43	27.06	-0.37

Table 9. AdH Model Comparing Mean Baseline Salinities with TSP (A1 Alignments) for Alternative 4G(8) Open-Gate Conditions and with Sea Level Rise (SLR) at Locations Throughout the Central Region of the NJBB Study Area (McAlpin and Ross, 2020)

Study Region	Waterway	Station	Existing Conditions			With SLR		
			Base (ppt)	TSP (ppt)	Change (ppt)	Base (ppt)	TSP (ppt)	Change (ppt)
	Crook Horn Creek	Ocean City 39th St	25.75	25.45	-0.3	25.79	25.18	-0.61
*Station is located along mainstem of Great Egg Harbor River								

McAlpin and Ross (2020) conclude that overall, the with-project TSP SSBs do not significantly impact the salinity in the back-bay region. The mean salinity does not vary by more than 0.35 ppt for the TSP. There is a slightly larger range in the salinity variation among the sea level rise alternatives, but this is still generally less than 2 ppt (SLR TSP showed a 1.1 ppt reduction at Barnegat Bay Rt. 37 Bridge area). The variation at specific times may be larger but overall, the impact is small. Given the well-mixed nature of the inlets, ocean salinity is pushed into the back-bay areas and allowed to move easily throughout the area. The restrictions created by the alternative structures and the reduction in tidal prism are not large enough to significantly impact the salinity at the analysis locations. However, the modeling suggests that in places like the Great Egg Harbor that the barriers may have a small moderating effect on salinity with SLR in 50 years as mean salinities are projected to increase by almost 3ppt without the gates, whereas with gates, the salinity would increase by almost 2 ppt from baseline. The effects of this further upstream into freshwater tidal areas would need to be further investigated.

Because of the potential for the SSBs and CBBs to increase residency time of the affected estuaries and the potential indirect effects of water quality issues, Lackey et. al (2020) applied the AdH hydrodynamic model results to the Particle Tracking Model (PTM) to evaluate the impact of the storm surge barriers (open gates conditions) have on residence time in the NJBB study area. Overall, the PTM results, Table 10**Error! Reference source not found.**, shows that the structures had little discernable changes to residence time with modeled differences generally within the uncertainty range from innate model randomness caused by diffusion. Model results show that the TSP in general increases in residence time in South and Central regions by 2 to 5 days and reduces residence time in North region by 1 to 2 days. Additionally, an investigation of sea level rise (SLR) with PTM, showed that flushing increases with SLR for all structural configurations.

Table 10. Baseline and TSP with Project Condition Average Residence Time (Days) for Affected NJBB Estuaries Utilizing Particle Tracking Model (PTM) (Lackey et al. 2020).

Location	Baseline Residency (Days)	TSP w/Project Residency (Days)	Change from Baseline (Days)
Cape May	10.88	9.85	-1.03
Hereford	24.96	26.95	+1.99
Townsends	35.97	39.89	+3.92
Corson	19.14	23.95	+4.81
Great Egg Harbor Bay	19.59	22.09	+2.50
Absecon Bay	26.2	27.92	+1.72
Great Bay	20.03	19.09	-0.94
Barnegat Bay	30.48	29.55	-0.93
Manasquan River	29.66	27.37	-2.29

Based on these model outputs, it is reasonable to conclude that the small changes in residence times would not contribute to large scale increases in stagnation and/or water quality degradation associated by nutrient loading in areas most affected by SSBs. However, subtle changes are more difficult to model, thus implementation of these structures still present a high risk for determining water quality impacts especially in estuarine systems stressed by nutrient enrichment. In order to mitigate this risk, additional modeling and refinements along with collecting long-term data sets on measured attributes would provide a better baseline to compare changes prior to any SSB implementation. Additionally, incorporating and budgeting for environmental mitigation through either subsequent refinements in design or adaptive management is an important part in assuring that this risk is minimized.

Closed Gate Scenario

Inlet SSB gate closures either being closed for maintenance/testing or during storm events would temporarily block all tidal flows from entering the estuaries from the ocean inlets. Gate closures for the CBBs would also temporarily inhibit tidal flows and circulation within the bay systems as well. As previously stated, AdH modeling and PTM have not been conducted for TSP closed gate scenarios. This type of modeling is expected to be completed prior to the conclusion of the Feasibility Study and/or for a Tier 2 level assessment during the Engineering and Design Phase. Nevertheless, the frequency and duration of closure operations are expected to have significant effects on water quality within the affected estuaries, which would be heavily dependent on the timing and duration of these closures. A current closure scenario is that the gates will be closed at a minimum of once per year for testing. The exact details of closure operations for storm events are still being determined and will be refined as the study progresses. At this point, a closing of the storm surge barrier gates for storm events about once every 5 years (20% Annual Exceedance Probability) is anticipated. Additionally, it is expected that adjustments to the water level threshold over time in response to RSLR so that the frequency of closure operations, about once every 5 years, remains constant over the life of the project.

Based on this and taking a conservative estimate of 3 days per closure, this would yield approximately 18 days of closures over a 5-year period (assuming 3 days/year for maintenance and 3 days per 5 years for a storm event). This results in about 1% of the time that closures would be conducted.

These closures are expected to increase retention times during the duration of each closure by closing off any tidal exchange of seawater entering through the inlets which would normally have the effect of flushing out non-point source pollutants such as nutrients (nitrogen and phosphorous), bacteria, and other organic/inorganic contaminants stemming from primarily non-point sources(urban areas, roadways, septic systems, marinas, leaking storage tanks, etc.) which may be exacerbated at a time of heavy rainfall and associated runoff. The seasonality of these closure events would be critical to the effects that these increased residence times would have on estuarine water quality. Closures during the growing season may have greater adverse effects on promoting algal blooms and associated dissolved oxygen depressions. While closures during the winter months may have a lesser effect. Additionally, gate closures would affect the distribution of salinity particularly at a time of a storm event where huge amounts of freshwater from precipitation may be entering the bay systems from the rivers and tributaries that discharge into these bays. A gate closure, though temporary, would prevent the mixing of saline seawater in these areas during the duration of such a closure and salinity levels would likely decrease. However, this may have some beneficial effects as it would prevent or minimize “pulses” of salinity from intruding into freshwater tidal and low-lying non-tidal wetlands as would occur during a significant storm event.

To understand these effects, additional AdH modeling is required that first measures the physical changes a gate closure would impose and then second how these physical changes affect water quality in these systems. As discussed in the open-gate discussion, a high risk for determining water quality impacts especially in estuarine systems stressed by nutrient enrichment exists. In order to mitigate this risk, additional modeling and refinements along with collecting long-term data sets on measured attributes would provide a better baseline to compare changes prior to any SSB implementation. Additionally, incorporating and budgeting for environmental mitigation through either subsequent refinements in design, operation or adaptive management is an important part in assuring that this risk is minimized.

The cumulative impacts during the construction of the inlet storm surge barriers and cross bay barriers on water quality are not expected to be significant because the generation of turbidity during construction would be of short duration and limited to within work segments. However, the cumulative effects of turbidity may be increased if there are other similar activities ongoing and nearby that generate turbidity such as dredging, earth disturbance, non-point storm water discharges, etc.

The cumulative impacts of the operation of storm surge barriers and cross bay barriers on water quality are not well known. Since these structures have the potential to affect bay-wide system water quality, there is a potential for cumulative effects on water quality when coupled with existing water quality trends and the effects of climate change/sea level rise. Results of the AdH modeling for the open gate scenario do not indicate significant effects on the tidal prism or residence times, which can be assumed that the amount of current seawater flushing of these bays would be maintained. However, the closed-gate conditions, although temporary, may result in cumulative effects on water quality. To better understand the effects of the various inlet barriers and cross bay barriers in the TSP, the next phase of the study will include additional hydrodynamic and

water quality modeling that would be applied to better assess the effects that these measures would have on these bay systems.

At this time, it is concluded that the indirect effects on surface hydrology, salinity and water quality in the WSR portion of the Great Egg Harbor River and tributaries would be considered a "diminution" based on that the effects are not fully known or could be far removed from the WSR portion. Although mitigation is proposed that could provide compensation for any of these effects, additional investigations such as modeling of gate closures and a study on changes of tidal amplitudes and tidal elevations, salinity, and residence times with sea level rise would be required in subsequent study phases.

6.2 Priority Resources

NPS (2000) identified priority resources as part of the comprehensive management plan and EIS, and states: *"In addition to the Outstandingly Remarkable Resources identified above, the following river-related resources of state and local significance were also identified in the protection strategies for the Great Egg Harbor River".*

6.2.1 Wetlands

The TSP features and other measures are not expected to have significant direct impacts on wetland habitats in the Wild and Scenic River (WSR) portions since construction and O&M activities would occur outside of the WSR areas.

Indirect effects of the GEHI SSB on tidal flora could result in small changes in tidal amplitudes as the SSB structure would result in ebb and flood tidal flow constrictions. Based on AdH modeling, mean tidal amplitudes would be reduced at the Great Egg Harbor River location by about 1.4 cm where flora at the upper end of the tide range could become less inundated at high tide and flora at the lower tide range could be come more inundated. However, sea level rise is likely to produce significant effects on floral distribution in the without project condition (no action) and the with-project condition (SSB gates open) as salinity is expected to push further into brackish and freshwater areas along with higher tides flooding resulting in salt marsh migrations into freshwater marshes or conversions of low-lying forested wetlands into "ghost forests". SSB gate closures could have a moderating effect by limiting salinity "pulses" from significant storm events, but they would not prevent daily increases of tide levels and salinity.

At this time, it is concluded that the indirect effects on wetlands in the WSR portion of the Great Egg Harbor River and tributaries would be considered a "diminution" based on that the effects are not fully known or could be far removed from the WSR portion. Although mitigation is proposed that could provide compensation for any of these effects, additional investigations such as modeling of gate closures and a study on changes of tidal amplitudes and tidal elevations with sea level rise on wetland flora would be required in subsequent study phases.

6.2.2 Flood Hazard Areas

The purpose of the TSP and other measures is to provide Coastal Storm Risk Management for areas within flood hazard areas. No structural TSP CSRM measures are being placed in the WSR

portions of the Great Egg Harbor River. The TSP SSB and CBBs would provide CSRM benefits from low frequency flood occurrences resulting from coastal storm surges.

6.2.3 Areas of Archaeological Significance and Sensitivity

Although historic properties exist within the Great Egg Harbor River, the USACE does not see a high probability risk of adverse impact with any of the proposed New Jersey Back Bay alternatives. The structural and non-structural alternatives are largely outside of the boundaries of the Great Egg Harbor Wild and Scenic River limits; however, there is a minimal risk to archaeological sites or historic properties that may be impacted by repeated water level changes. Flooding of structures and erosion of archaeological sites is possible but will need to be assessed further in the study in order to properly identify those resources, and to make a determination of effects.

7.0 SECTION 7 WILD AND SCENIC RIVERS ACT APPLICABILITY REVIEW

As discussed previously, the NJBB Feasibility is conducting a tiered approach to NEPA with regards to level of detail available, information on resources and effects upon, and phase of the actions under consideration. At this time, USACE has not identified any actionable items in the TSP or other alternatives still under consideration. However, based on a review of the TSP measures, and their potential for direct and indirect physical and biological effects on the Great Egg Harbor Wild and Scenic River and tributaries, a Section 7 review is warranted.

Section 7 is one of the most important and powerful parts of the Wild and Scenic Rivers Act (WSRA). This key provision directs Federal agencies to protect the free-flowing condition and other values of designated rivers and congressionally authorized study rivers (USFS, 2004). Section 7(a) of the WSRA states: "...no department or agency of the United States shall assist by loan, grant, license or otherwise in the construction of any water resource project that would have a direct or adverse effect on the values for which such river was established, as determined by the Secretary charged with its administration."

For the Great Egg Harbor WSR, the river-administering agency is the Great Egg Harbor River Council (Council) with oversight from the National Park Service (NPS). If a water resources project on a designated WSR would have a direct and adverse effect on the values for which the river was designated, and those impacts cannot be avoided or eliminated, then the National Park Service (NPS) cannot consent to the project (NPS, 2011).

NPS (2011) and USFS (2004) provide a decision framework to evaluate when a Section 7 determination is required.

Table 11. Section 7 Determination Decision Framework (from USFS, 2004)

A project is proposed in the bed or banks of a designated river or congressionally authorized study river	A project is proposed in the bed or banks of a river below, above or on a stream tributary to a designated river or congressionally authorized study river.
AND	**AND**
A project is proposed by a Federal agency or it requires some type of Federal assistance such as a permit, license, grant or loan	A project is proposed by a Federal agency or it requires some type of Federal assistance such as a permit, license, grant or loan
	AND
	A project is likely to result in effects within a designated river or congressionally authorized study river.
Only when both of the above conditions exist is a determination required under Section 7.	Only when all of the above conditions exist is a determination required under Section 7.
***Highlighted items represent applicability of the TSP measures to Section 7 WSRA**	

Based on the criteria in Table 5, a Section 7 evaluation is warranted for the TSP structural measures including the SSB at Great Egg Harbor Inlet and the two CBBs along Absecon Boulevard and Southern Ocean City. NNBF features in the Great Egg Harbor Bay or River would also require a Section 7 evaluation; however, no formal proposal is available at this time. Non-structural measures in alternatives 4D(1) and 4D(2) that have not been eliminated from consideration may also require a Section 7 evaluation, but details such as type of NS measure and specific locations are not available. For these measures, additional Section 7 evaluations may be forthcoming.

Because the TSP is a Federal action in an existing WSR, Section 7(a) applies. Section 7(a) of the Act provides a specific standard for review of developments below or above or on a stream tributary to a designated river. Such developments may occur as long as the project "will not invade the area or unreasonably diminish the scenic, recreational, and fish and wildlife values present in the areas as of the date of designation…". This standard applies to projects outside the river but on the same river or a tributary (USFS, 2004). Figure 15. provides a decision framework for a Section 7(a) evaluation. Table 12 also provides the decision rationale at each step with respect to the structural TSP measures.

The SSB and CBBs are not located within the designated corridor or tributaries; however, they are located downstream from the designated river in tidally connected waterbodies such as Great Egg Harbor Inlet (SSB), which has the most influence on the hydrology of the designated Wild and Scenic River tidal reaches and the CBBs at Crook Horn Creek (Southern Ocean City) and Inside Thorofare/Beach Thorofare (Absecon Blvd.), which have less influence on the Wild and Scenic River designation, but do have a hydrologic connection.

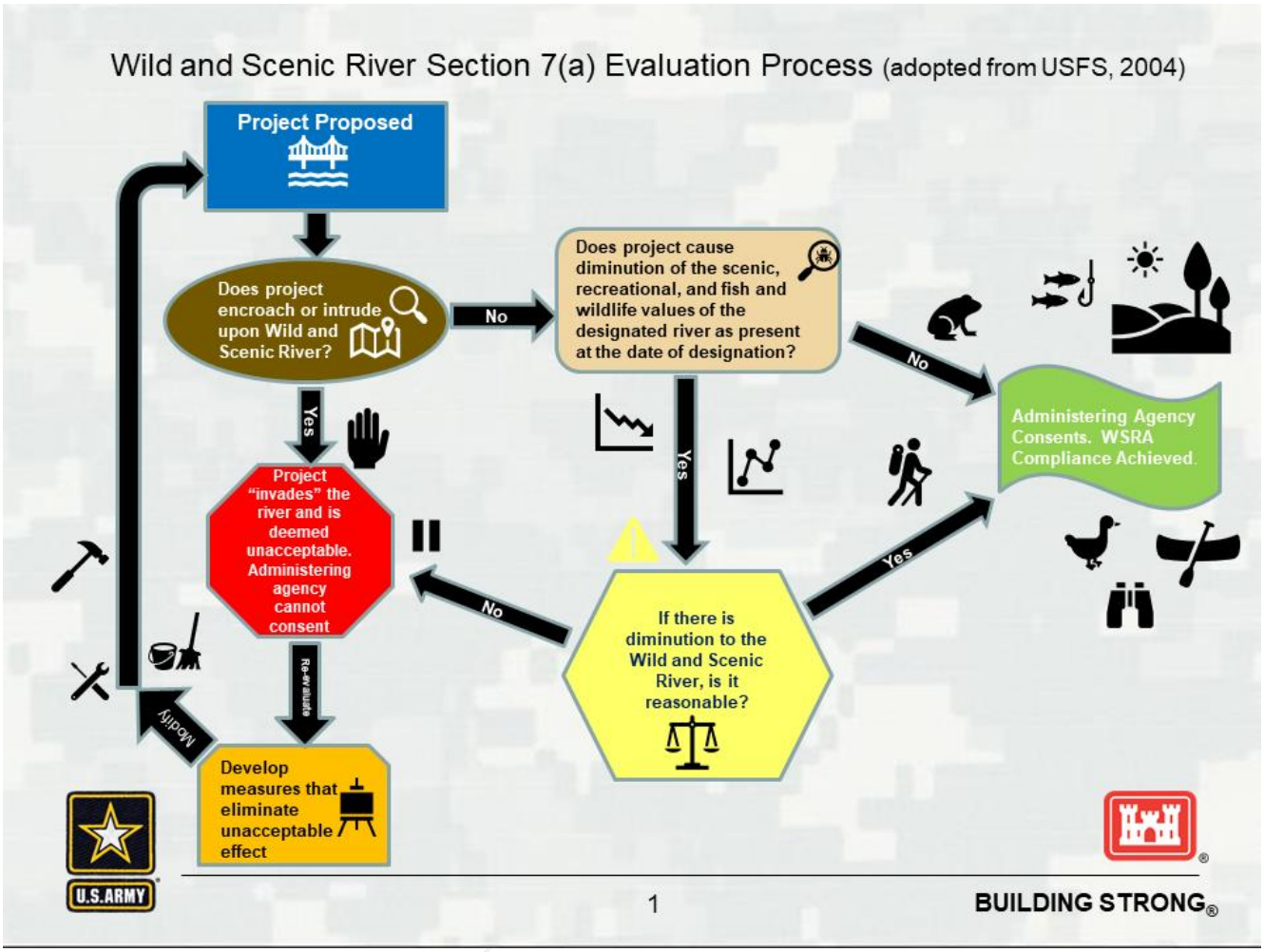


Figure 15. Section 7(a) Evaluation Process

Table 12. NJBB TSP and other Measures Section 7(a) Decision Matrix

CSRM Feature	Does project encroach or intrude upon Wild and Scenic River?	Does project cause diminution of the scenic, recreational, and fish and wildlife values of the designated river as present at the date of designation?	If there is diminution to the Wild and Scenic River, is it reasonable?
GEHI SSB	No	Yes	Unknown
	The proposed SSB is a large structure that would span the Great Egg Harbor Inlet. This structure would be about 4.6 miles downstream of the WSR designation at the confluence with Patcong Creek. There are two major bridges that would have visual obstructions along with extensive urbanized waterfronts at Somers Point and Ocean City. Tidal hydraulic flows would be maintained with navigable sector gates and vertical lift gates, which will also serve as migratory pathways for fish and wildlife. The SSB is not expected to have significant adverse effects on the GEHR ORV's.	AdH modeling conducted with a "gates open" scenario suggests that there would be minor upstream changes in tidal amplitudes and a small reduction in salinity. However, more significant affects on tidal elevations and salinity are expected with projected sea level rise in a "No Action" scenario. Increased velocities through the gates may have some effects on fish migration and larval transport. Closure of gates at time of storm may affect several tidal cycles. Additional modeling is required to better understand these potential effects on the GEHR ORV's.	Although early indications from AdH modeling do not suggest significant physical changes that could cause unreasonable diminution, the current available information is insufficient to make a "reasonable diminution" determination until further modeling is completed and a better assessment on the effects the SSB would have on the GEHR ORV's.
CBB at Southern Ocean City	No	Yes	Yes
	The CBB at Southern Ocean City would have no visual effects on GEHR. Several large visual obstructions occur between GEHR and the CBB including the urbanized areas of Marmora, Ocean City, the Roosevelt Blvd. Bridge, and the GS Parkway/Route 9. Tidal hydraulic flows would be maintained with miter gates and vertical lift gates, which will also serve as migratory pathways for fish and wildlife.	AdH modeling conducted with a "gates open" scenario suggests that there would be minor upstream changes in tidal amplitudes and a small reduction in salinity, when implemented with the GEHI SSB. However, the volumes of water affected at the SOC location would have minimal effects on the GEHR. Closure of gates at time of storm may affect several tidal cycles.	Because the SOC CBB is about 5.7 miles from the GEHR confluence w/ Patcong Creek, the direct and indirect effects on the hydrology and fish and wildlife values are far enough removed that they are considered "reasonable diminution".
CBB at Absecon Boulevard	No	Yes	Yes

CSRM Feature	Does project encroach or intrude upon Wild and Scenic River?	Does project cause diminution of the scenic, recreational, and fish and wildlife values of the designated river as present at the date of designation?	If there is diminution to the Wild and Scenic River, is it reasonable?
	The CBB at Absecon Boulevard (Atlantic City) would have no visual effects on GEHR and is over 10 miles away with numerous urbanized areas and bridges/highways. Tidal hydraulic flows would be maintained with miter gates and vertical lift gates, which will also serve as migratory pathways for fish and wildlife.	AdH modeling conducted with a "gates open" scenario suggests that there would be minor upstream changes in tidal amplitudes and a small reduction in salinity, when implemented with the GEHI SSB. However, the volumes of water affected at the Absecon Blvd. location would have minimal effects on the GEHR. Closure of gates at time of storm may affect several tidal cycles.	Because the Absecon Blvd. CBB is over 10 miles from the GEHR confluence w/ Patcong Creek, the direct and indirect effects on the hydrology and fish and wildlife values are far enough removed that they are considered "reasonable diminution".
Ocean City Perimeter Plans (4D-1 and 4D-2)	No	No	
	The Ocean City Perimeter Plans for alternatives 4D-1 and 4D-2 are situated along existing urbanized shorelines and are far enough away to not have any significant visual effects or adverse effects on the GEHR ORV's.	The Ocean City Perimeter Plans for alternatives 4D-1 and 4D-2 are situated along existing urbanized shorelines and are far enough away to not have any significant visual effects or adverse effects on the GEHR ORV's.	
Absecon Island Perimeter Plans (4D-1 and 4D-2)	No	No	
	The Absecon Island Perimeter Plan for alternatives 4D-1 and 4D-2 are situated along existing urbanized shorelines and are far enough away to not have any significant visual effects or adverse effects on the GEHR ORV's.	The Absecon Island Perimeter Plan for alternatives 4D-1 and 4D-2 are situated along existing urbanized shorelines and are far enough away to not have any significant visual effects or adverse effects on the GEHR ORV's.	

CSRM Feature	Does project encroach or intrude upon Wild and Scenic River?	Does project cause diminution of the scenic, recreational, and fish and wildlife values of the designated river as present at the date of designation?	If there is diminution to the Wild and Scenic River, is it reasonable?
Brigantine Perimeter Plan (4D-2)	No	No	
	The Brigantine Perimeter Plan for alternative 4D-2 is situated along existing urbanized shorelines and are far enough away to not have any significant visual effects or adverse effects on the GEHR ORV's.	The Brigantine Perimeter Plan for alternative 4D-2 is situated along existing urbanized shorelines and are far enough away to not have any significant visual effects or adverse effects on the GEHR ORV's.	
Non-Structural Measures	Unknown	Unknown	Unknown
	Alternatives 4D-1 and 4D-2 include non-structural components that may involve modifying buildings and infrastructure within the Wild and Scenic River corridor. At this time, there is insufficient detail on the types of NS measures proposed and the specific locations. A full Section 7(a) evaluation would be conducted prior to any implementation.	Alternatives 4D-1 and 4D-2 include non-structural components that may involve modifying buildings and infrastructure within the Wild and Scenic River corridor. At this time, there is insufficient detail on the types of NS measures proposed and the specific locations. A full Section 7(a) evaluation would be conducted prior to any implementation.	
Natural and Nature-Based Features	Unknown	Unknown	Unknown
	NNBFs may involve a number of measures, principally wetland and island creation, downstream of the Wild and Scenic River corridor. At this time, there is insufficient detail on the types of NNBF measures proposed and the specific locations. A full Section 7(a)	NNBFs may involve a number of measures, principally wetland and island creation, downstream of the Wild and Scenic River corridor. At this time, there is insufficient detail on the types of NNBF measures proposed and the specific locations. A full Section 7(a) evaluation would	

CSRM Feature	Does project encroach or intrude upon Wild and Scenic River?	Does project cause diminution of the scenic, recreational, and fish and wildlife values of the designated river as present at the date of designation?	If there is diminution to the Wild and Scenic River, is it reasonable?
	evaluation would be conducted prior to any implementation.	be conducted prior to any implementation.	

8.0 REFERENCES

Defne, Zafer and Ganju, Neil K. (2014) Quantifying the residence time and flushing characteristics of a shallow, back-barrier estuary: Application of hydrodynamic and particle tracking models. Estuaries and Coasts. Volume 38, Issue 5. Pages 1719-1734.

Guo, Q., and G.P. Lordi. 2000. Method for quantifying freshwater input and flushing time in estuaries. Journal of Environmental Engineering 126: 675–683.

Lackey, Tahirih, Nathan Mays, Jennifer McAlpin, and Sung-Chan Kim. 2020. Residence Time Analysis to Predict Impact of Proposed Storm Protection Structures in New Jersey Back Bays (NJBB Technical Report TR-20-xx. U.S. Army Engineer Research and Development Center, Vicksburg, MS. *Draft*.

McAlpin, Jennifer and Ross, C. 2020. Analysis of Proposed Storm Protection Structures on the Hydrodynamics and Salinity in New Jersey Back Bays (NJBB). Technical Report TR-20-xx. U.S. Army Engineer Research and Development Center, Vicksburg, MS. *Draft.*

National Park Service (NPS). 2000. Comprehensive Management Plan and Environmental Impact Statement for the Great Egg Harbor National Scenic and Recreational River - Final. National Park Service, Philadelphia Support Office In cooperation with the Great Egg Harbor River Planning Committee.

USFWS. (U.S. Fish and Wildlife Service). 1997. Significant Habitats and Habitat Complexes of the New York Bight Watershed. Great Egg Harbor Estuary Complex #3.

U.S. Forest Service (USFS). 2004. Wild and Scenic Rivers Act: Section 7. Technical Report of the Interagency Wild and Scenic Rivers Coordinating Council.