APPENDIX H

BACKGROUND AND APPROACH TO ENVIRONMENTAL ANALYSIS

H.1 STORMS AND COASTAL PROCESS

This section discusses the anticipated future conditions related to storms and coastal processes under the Future Without Project (FWOP) scenario. In particular, this section addresses storms, sea level rise, longshore sediment transport, cross-island sediment transport, dune development and evolution, bayside shoreline processes, and estuarine processes. To a great extent, these processes are interconnected and changes in one can alter aspects of another process. The myriad of elements that influence sediment transport result in a constantly changing shoreline habitat profile, where habitats and landforms are alternately being formed, altered, or removed as a result of natural events.

H.1.1 Storms

The history of storm activity and response in the Study Area can be used as a basis for predicting what is likely to happen in the future, regardless of whether the project is implemented. The long history of storm activity, documented impact, and the human response in the Study Area is relevant for estimating and evaluating the conditions under the FWOP for all resources addressed in this section, including natural and socio-cultural. Under the FWOP, the following are anticipated to continue:

- Storms will likely occur in a frequency, duration, and intensity similar to those that have historically occurred.
- Human response to these storms will be similar to what has historically occurred, with a concerted effort to recover and rebuild.
- There will be a continuation of local measures to proactively protect homes and businesses, particularly in high risk areas.
- Storm impact will likely worsen as sea levels rise.
- Future development will be undertaken consistent with existing regulations and will not be subject to frequent storm damage.
- After storm events, beaches will tend to recover when long-period waves move sand from the nearshore back onto the beach.

H.1.2 Sea Level Rise

Sea level rise is a factor that is critical for consideration in evaluating the FWOP. Historical water level data recorded by National Oceanic Atmospheric Administration (NOAA) indicates that sea level rise varies by geographic location. Historical water levels recorded by NOAA at monitoring stations near the Study Area showed a sea level rise of 11.4 in (28.96 cm) (or 3.90 mm/yr) during the 74-year period between 1932 and 2006 at Sandy Hook, NJ; sea level rise of 6.5 in (16.51 cm) (or 2.78 mm/yr) during the 59-year period between 1947 and 2006 at Montauk, NY, and sea level rise of 16.4 in (41.66 cm) (or 2.77 mm/yr) during the 150-year period between 1856 and 2006, at the Battery Park, NY (NOAA 2008b). Under current trends, it is estimated that sea levels will rise 14.4 in (36.58 cm) at Sandy Hook, NJ, 10.3 in (26.16 cm) at Montauk, NY, and 10.3 in (26.16 cm) at the Battery Park, NY by the year 2100.

The Intergovernmental Panel on Climate Change (IPCC) released its Fourth Assessment Report (AR4) summarizing climate change in 2007 (IPCC 2007). The report predicts the average global sea level rise at the end of the 21^{st} century for a total of six model scenarios. A comparison summary of the IPCC global sea level predictions and the projected local sea level rise from NOAA historical trend data is shown below in Table H-1. The reader should note that the IPCC projections do not represent an upper bound for sea level rise due to limited understanding of important variables that drive global water levels.

Table H-1. Projected Sea Level Rise

Projected Local Sea Level Rise[1] (m at 2100 relative to 2006)			**IPCC Global Sea Level Predictions[2] (m at 2090-2099 relative to 1980-1999)**
Sandy Hook, NJ	**Montauk, NY**	**Battery Park, NY**	
0.37 m	0.26 m	0.26 m	0.18 m – 0.59 m

[1] NOAA sea level predictions are linearly extrapolated from the historic sea level trends published for each station.
[2] The range of predictions are compiled for the six Special Report Emission Scenarios outline in the AR4.
Note: 0.37m=14.4 in; 0.26 m = 10.3 in; 0.26 m = 10.3 in; .018m = 7.1 in; 59m = 23.2in.

H.1.3 Longshore Sediment Transport

Longshore sediment transport refers to the daily movement of sediment along the ocean coast. Longshore sediment transport can intensify during storms and hurricanes by transporting greater quantities of sediment during the time of the storm. In the Study Area the longshore sediment transport is generally from east to west, with localized as well as temporary reversals in direction. Sediment erodes from the cliffs and bluffs of Montauk and contributes to the longshore sediment transport to the west. Onshore and offshore sediments, as well as human actions such as beach nourishment, also provide a source for longshore transport. Longshore sediment transport contributes to the establishment and maintenance of protective features along the oceanfront.

Longshore sediment transport is important for larval distribution in the marine offshore, marine nearshore, and marine intertidal habitats. Longshore transport helps to maintain the marine beach habitat, which sustains organisms that depend upon this habitat and provides recreational areas for humans. In addition, longshore transport contributes sediment that subsequently is a source for cross-island sediment transport.

Natural occurrences and human activities can affect longshore sediment transport. The inlets in the Study Area are naturally occurring interruptions in the longshore sediment transport process; as the inlets are dredged and stabilized for navigation, the volume and direction of longshore sediment transport is further altered. Groin fields and jetties also interrupt, block, and redirect longshore flows, resulting in the accumulation of material on the updrift side of these structures. The long-term impacts associated with dredging and coastal structures varies based upon localized sediment transport regimes, and the size, effectiveness, and integrity of the structure. These impacts on longshore sediment transport can be both localized and regional in effect.

The existing conditions and trends for longshore sediment transport are discussed in more detail in Section 3.2.4.3. The FWOP assumes these conditions and trends will continue.

H.1.4 Cross-Island Sediment Transport

Cross-island sediment transport refers to the movement of sand back and forth across the barrier island, between the offshore bar, beach face, berm, dune, island core, bayshore, and bay. The movement of sand through the inlets also significantly contributes to this process. It is particularly important in areas of historic overwash such as Old Inlet or Smith Point County Park. Daily processes and seasonal conditions, such as storms, changes in sea level, and aeolian processes (i.e., wind erosion and deposition) support cross-island sediment transport.

During storms due to the surge of ocean waves, sand is deposited as “washover fans” behind dunes. This process contributes to the growth of the backbay side of the barrier island by the continuing accumulation of washover sediment or sand. Rollover occurs when this buildup of sand leads to the landward migration of the barrier island.

Cross-island sediment transport is observable in the following processes:

- Beach erosion/scarping and beach recovery;
- Dune erosion/scarping and dune rebuilding (through littoral and aeolian transport);
- Dune/island overwash (movement of sand and water across dunes and islands); and
- Barrier island breaching (cutting of a new channel across spit or island), inlet formation, and shoal evolution at inlets.

Cross-island sediment transport is complex and varies in amount and location year to year, and is strongly influenced by the longshore transport processes, as well as human activities occurring in an area. Cross-island sediment transport is critical in supporting the development of natural communities and biodiversity. Cross-island sediment transport, or lack thereof, has a dramatic effect on the barrier island habitats and the long-term geomorphic response of the barrier islands. Human activities that can directly and indirectly affect the scale and location of cross-island transport include: groin construction, breach closures, inlet stabilization, beach and dune nourishment, dune enhancement and construction – through trucking of sand, beach scraping, and sand fencing, dune removal to enhance water views, structures, and cuts in dunes for vehicles and access paths. Disruptions to cross-island sediment processes have local and immediate impacts, as well as regional and long-term impacts that effect the ongoing creation of barrier island and backbay habitats.

The existing conditions and trends for cross-island sediment transport are also discussed in the FIMP Environmental Impact Statement (EIS) and the Final General Reevaluation Report (GRR; USACE 2019). The FWOP assumes these conditions and trends will continue.

H.1.5 Dune Development and Evolution

Coastal dunes play an important role for the marine beach, and are particularly integral to the sand sharing system. Dunes accumulate sand at the upper margin of the beach. Dune growth is largely a product of wind transport, although water may also contribute to the accumulation during storms. Dune development and evolution is related to the condition of the shoreline and occurs when sand is transported inland across the bare sand beach to gather in areas of vegetation that trap sediment and stabilize the dune form. During a storm, the sand may be removed due to wave erosion, but these areas quickly recover and collect new sand.

Dunes serve an important ecological function by providing habitat in the transition zone between exposed beach and the sheltered landward portion of the barrier island. Dunes act as a storage area for sand, which helps to reduce the effects of erosion during severe storms and conditions that add significantly to sediment transport along the barrier island. Dunes also act as a barrier to protect against storm surge and wave penetration.

Past human activities have affected dune development. Some activities focus on trapping sand and fostering sand accumulation and dune growth, such as erection of sand fencing and planting of beach grass. The development or presence of houses within the foredune or primary dune interferes with vegetation cover, the opportunity for sand accumulation, and the creation of associated wildlife habitat. Access paths and dune cuts also breach the natural dune system, and buildings and other structures alter wind flow and the pattern of wind transport. Currently, many local zoning laws restrict activities that could affect dune development. These laws are expected to endure into the future and limit future development that negatively affects dunes.

The FWOP assumes these conditions and trends will continue.

H.1.6 Bayside Shoreline Processes

Bayside shorelines are composed of narrow bayside beaches, sand shoals, mud flats, tidal creeks, and salt marshes. The bayside shoreline contributes to barrier island integrity, acts to buffer the upland from bay wave action, and is integral in maintaining the diversity of the natural system in the face of rising sea level. The interaction of waves, winds, and wave- and tidally-conveyed longshore currents shape the bayside shorelines. The areas of higher energy tend to establish beaches, while more sheltered areas tend to establish salt marshes and beds of submerged aquatic vegetation (SAV). Beaches are more susceptible to erosion and would be affected by changes in sea level. Slower currents allow for the deposition of fine-grained sediment and the creation of salt marshes and mud flats. The cross-island sediment transport processes of breaching and overwash inject significant amounts of sediment into the gradual and ongoing sedimentation process for the bayside shoreline, contributing to the creation and expansion of these bayside areas and habitats. In addition to semi-diurnal high tides, tidal marshes are highly vulnerable to flooding during storm events. Natural bayside features reduce the risk of breaching and flooding along the barrier island.

Human activities have directly and indirectly impacted the bayside shoreline processes and habitats, and have impaired the ability of beaches, salt marshes, bay intertidal and subtidal, mud flats, and SAV beds to function as natural and protective features. These changes are primarily a result of inlet dredging and placement of material (e.g., sand bypass and beach nourishment), and through stabilization of the bay shorelines (e.g., bulkheads, sea walls, and marinas). Shoreline hardening can increase the amount of scour in adjacent areas and result in the redistribution of material into the bay; can trap material and alter the alongshore distribution of material; and can prevent sediment landward of the structures from entering the bayside littoral system, resulting in the direct loss or alteration of bayside beaches, mud flats, and salt marshes. In addition, as sea level increases within the bays, these shore stabilization structures prevent the landward and upward migration of these natural features, thus resulting in their long-term loss or impairment.

The functionality of the overall system relies on bayside shoreline processes that establish essential habitats. These habitats support the feeding, spawning, and growth of fish, crustaceans, shorebirds, and other invertebrates. Bayside shoreline also acts as a natural filtration system by absorbing nutrients and trapping pollutants transported from uplands. The FWOP assumes these conditions and trends will continue.

H.1.7 Estuarine Processes

Estuaries are areas of transition from which fresh water meets and mixes with salt water. Estuaries allow an exchange of water from land to the ocean, distribute sediments, and circulate water to support estuarine habitats. Estuaries are driven by the amount of freshwater input, bathymetry (bottom topography), water exchange through inlets, and wind. The exchange of water within the estuaries helps to maintain water quality by clearing the system of pollutants and discharge of materials or nutrients into the system.

Circulation patterns and sediment movement support the essential estuarine habitats and species, and associated shoreline habitats. These habitats include bay subtidal, sand shoals and mud flats, and submerged aquatic vegetation (SAV) beds. These habitats are vital to support the complex ecosystem within the estuary. Open bay subtidal habitats allow for circulation and mixing to occur, which aids in the distribution of plankton and larvae. Bay bottom provides habitat for shellfish and finfish. Sand shoals, bare sand, mud flats, and SAV (e.g., eelgrass beds) are important breeding, spawning, and feeding habitats for crustaceans, shellfish, finfish, and other species. These shallow areas also provide an important feeding habitat for shorebirds.

Salinity and temperature are characteristics of estuarine water quality that are affected by circulation. Water quality is also influenced by surface and ground water, point and non-point sources, variability in precipitation events, and regional changes in ocean circulation patterns. Storms can alter estuarine circulation through surges into the bay and breaches of the barrier islands. These breaches of the barrier islands can alter circulation patterns and salinity distribution by changing the location and amount of ocean water entering the bay.

As human population density increases, land clearing, application of fertilizers, discharge of sewage and cesspool systems, and other activities also increase the delivery of nutrients (such as nitrogen and phosphorus) to the estuary. The introduction of these materials alters the composition of the sediment on the surface of the bay bottom. Excessive nutrient loading into the bays can create “brown tides” or algal blooms, which can limit the growth of SAV beds.

The dredging of inlets to provide reliable navigation and to increase the exchange of water between the ocean and bays has altered the bottom composition, the bathymetry (through both dredging and placement), and the salinity distribution in the bays by increasing the amount of ocean water entering the bay. The dredging of inlets has also moderated the amount and distribution of flow that comes through the inlets.

The FWOP assumes these conditions and trends will continue.