US Army Corps
of Engineers
New York District

# Atlantic Coast of New York, East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

## Draft Integrated Hurricane Sandy General Reevaluation Report And Environmental Impact Statement

**August 2016**

# Executive Summary:
# Atlantic Coast of New York
# East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

# Draft Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

**Description of the Report**

This report is a Draft Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement (HSGRR/EIS) examining coastal storm risk management (CSRM) problems and opportunities for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay project area, which was devastated by the impacts of Hurricane Sandy in 2012. This report is a General Reevaluation Report (GRR) because there is an existing, authorized project for the area that was constructed in 1977 and renourished through 2004, based upon the 1965 construction authorization. A Reformulation effort was initiated in 2003 to revisit the authorized plan, and make recommendations for a long-term solution.

Consistent with current U.S. Army Corps of Engineers (USACE) planning guidance, the study team identified and screened alternatives to address CSRM, and is presenting a tentatively selected plan (TSP). The TSP identifies the overall project features, with the acknowledgement that the specific dimensions of the plan have not been finalized. These final design components will be undertaken after review of this report. This Draft HSGRR/EIS will undergo concurrent public review, policy review, Agency Technical Review (ATR), and Independent External Peer Review (IEPR). The USACE study team will respond to review comments, then present a recommended plan and develop a Final HSGRR/EIS.

This report and its recommendations are a component of the USACE response to the unprecedented destruction and economic damage to communities within the project area caused by Hurricane Sandy. The recommendations herein include a systems-based approach for CSRM that provides a plan for the entire area. The State of New York through the Department of Environmental Conservation (NYSDEC) is the non-Federal sponsor, and the City of New York through the New York City Mayor's Office of Recovery and Resiliency is the local sponsor to the NYSDEC. Project partners include the NYC Department of Parks and Recreation, the NYC Department of Environmental Protection, and the National Park Service, Gateway National Recreation Area (NPS).

The project area (Figure 1) consists of the Atlantic Coast of NYC between East Rockaway Inlet and Rockaway Inlet, and the water and lands within and surrounding Jamaica Bay, New York. The project area also includes the low lying Coney Island section of Brooklyn, which can be overtopped by floodwaters that flood the Brooklyn neighborhoods surrounding Jamaica Bay. The area is located within the Federal Emergency Management Agency (FEMA) regulated 100-year floodplain. The Atlantic Ocean shoreline, which is a peninsula approximately 10 miles in length, generally referred to as Rockaway, separates the Atlantic Ocean from Jamaica Bay immediately to the north. The greater portion of Jamaica Bay lies in the Boroughs of Brooklyn and Queens, NYC, and a section at the eastern end, known as Head-of-Bay, lies in Nassau County. More than 850,000 residents, 48,000 residential and commercial structures, and scores of critical infrastructure features such as hospitals, nursing homes, wastewater treatment facilities, subway, railroad, and schools are within the study area (Figure 2).

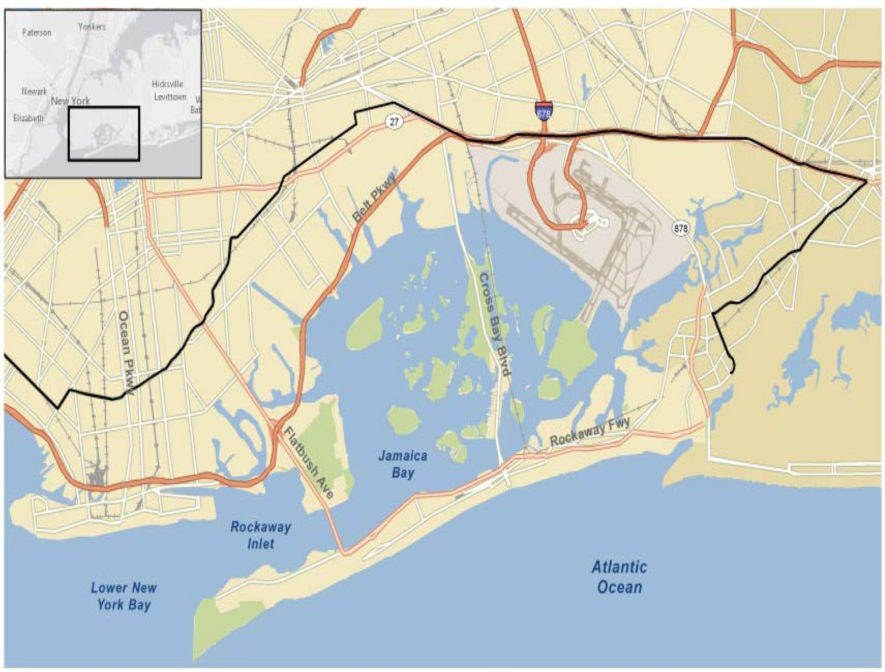



**Figure 1: East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Study Area**

During Hurricane Sandy, tidal waters and waves directly impacted the Atlantic Ocean shoreline. Tidal waters amassed in Jamaica Bay by entering through Rockaway Inlet and by overtopping and flowing across the Rockaway peninsula. Effective CSRM for communities within the study area requires reductions in risk from two sources of coastal storm damages: inundation, erosion, wave attack with overtopping along the Atlantic Ocean shorefront of the Rockaway peninsula and flood waters amassing within Jamaica Bay via the Rockaway Inlet.

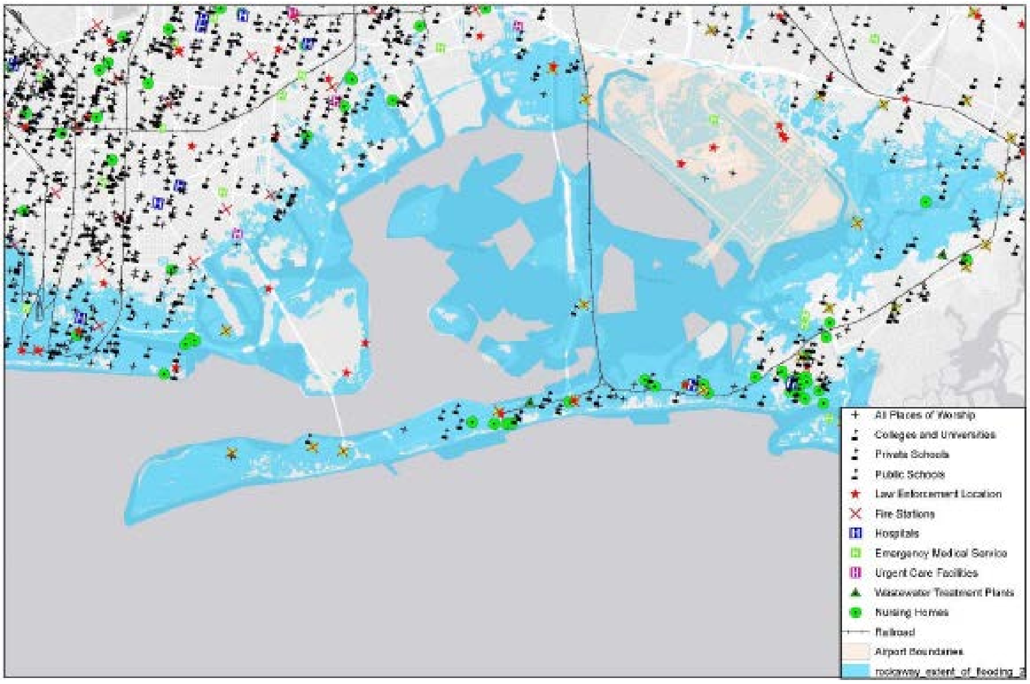



**Figure 2: Critical Infrastructure**

## Project Area Problems

The project area was one of the areas most devastated by Hurricane Sandy. Within the study area, there were 10 fatalities, and more than 1,000 structures were either sufficiently damaged to restrict re-entry or were destroyed by Hurricane Sandy. The NYC Department of Buildings post-Sandy damage assessment indicates the disproportionate vulnerability of the project area to storm surge damage. Of all buildings city-wide that were identified as unsafe or structurally damaged, 37% were located in the southern Queens portion of the project area, which is far greater than the percentage of all buildings in the Hurricane Sandy inundation zone that are located in southern Queens portion of the study area (24%). In addition to the structural impacts caused by waves and inundation, fires ignited by the storm surge inundation of electrical systems destroyed 175 homes along the Rockaway Peninsula portion of the project area.

Hurricane Sandy hit the project area at almost exactly high tide. Waves eroded beaches, breached boardwalks and seawalls, and broke against buildings in the oceanfront communities. Storm surge inundation reached as much as 10 feet above ground in some portions of the study area. In addition more than 1.5 million cubic yards of sand was torn from Rockaway Beach and deposited on oceanfront communities or washed out to sea.

Floodwaters funneled through Rockaway Inlet amassing a storm surge that inundated all the neighborhoods surrounding Jamaica Bay. The low-lying neighborhoods in the central and northern portions of the Bay, where the narrow creeks and basins provide the marine aesthetic of the neighborhood, were especially devastated by flood waters. Damage to the elevated portion of the subway system in Jamaica Bay and Rockaway (A line) disrupted service for months affecting about 35,000 riders daily. In the southern Queens portion of the study area 37 schools were closed for up to two months.

Habitats important to waterfowl and coastal water birds, including shorebirds, wading birds, and seabirds, were also impacted by Sandy. High winds and storm-driven water moved masses of coastal sediments, changed barrier landscapes, and blew out dikes on impoundments managed specifically for migratory birds.

Historically, CSRM-related problems in the project area have been addressed through construction of Atlantic Ocean Shoreline features. Although a Hurricane Barrier was recommended and authorized in the 1970's, that feature was never constructed. The devastation wrought by Hurricane Sandy reinforced the need for a holistic approach to CSRM for the entire project area.

**Project Area Opportunities**

Prior to Hurricane Sandy, the Corps was undertaking a Reformulation effort to identify a long-term solution for the Project Area. These CSRM efforts focused on Atlantic Ocean Shoreline features with the State of New York as the local sponsor. Awareness of the need for an integrated approach to CSRM opportunities in Jamaica Bay and surrounding communities has increased since Hurricane Sandy impacted the area in 2012. As a result of the devastation associated with Hurricane Sandy, the USACE has been tasked to address "coastal resiliency" and "long-term sustainability" in addition to the traditional USACE planning report categories of "economics, risk, and environmental compliance" (USACE 2013) The goal of the Draft HSGRR/EIS is to identify solutions that will reduce Atlantic Ocean Shoreline and Jamaica Bay vulnerability to storm damage over time, in a way that is sustainable over the long-term, both for the natural coastal ecosystem and for communities.

**Study Objectives**

Five principal planning objectives have been identified for the study, based upon a collaborative planning approach. These planning objectives are intended to be achieved throughout the study period, which is from 2020 – 2070:

1. Reduce vulnerability to storm water impacts;
2. Reduce future flood risk in ways that will support the long-term sustainability of the coastal ecosystem and communities;
3. Reduce the economic costs and risks associated with large-scale flood and storm events;
4. Improve community resiliency, including infrastructure and service recovery from storm effects; and
5. Enhance natural storm surge buffers, also known as natural and nature-based features (NNBFs), and improve coastal resilience.

**Project Constraints**

The project area falls within the boundary of Gateway National Recreation Area, Jamaica Bay. The enabling legislation for the NPS Gateway National Recreation Area requires that any plan for CSRM within the park boundaries must be mutually acceptable to the Secretary of the Army and the Secretary of the Interior. This report includes project features that are located within the park boundaries, but at this phase of the planning process, plans have not been eliminated based upon this constraint. USACE and the NPS intend to use the public and agency review of this report, and the subsequent design efforts in order to establish a plan that meets the requirement as a mutually acceptable plan.

**Without Project Conditions**

The future without project condition (FWOP) is the projection of the likely future conditions in the Project Area in the absence of any action resulting from the current Reformulation effort. The FWOP is the baseline for the analysis and comparison of alternatives for this study. The FWOP for this study recognizes that includes the following assumptions.

- Maintenance dredging of the existing Federal navigation channels at East Rockaway Inlet and Rockaway Inlet (Jamaica Bay Channel) are expected to continue as authorized.
- The existing, authorized, and constructed project from Beach 19$^{th}$ street to beach 149$^{th}$, which was repaired to design conditions following Hurricane Sandy, will not be renourished in the future as a Federal Project.
- In the absence of a Federal Project, it is expected that New York City will undertake small-scale sand placement projects if the beach erodes to a point that the existing infrastructure is imminently threatened.

The FWOP was evaluated to identify the expected damages that are likely to occur in the absence of a project. This analysis was undertaken considering an intermediate rate of relative sea level rise in the future (approximately 1 ft. over 50 years, from 2020 to 2070). This analysis shows that there is a potential for significant damages along the shorefront and in Jamaica Bay. A summary of these damages is provided below.

| **Without-Project Condition Annual Damages** | |
|---|---|
| Jamaica Bay Planning Reach | $444,218,000 |
| Atlantic Ocean Shorefront Planning Reach | $32,017,000 |
| Total Damages | $476,235,000 |

**Alternative Plan Development**

An array of structural and non-structural management measures, including NNBFs, were developed to address one or more of the planning objectives. Management measures were developed in consultation with the non-federal sponsor (NYSDEC), state and local agencies, and non-governmental entities. Measures were evaluated for compatibility with local conditions and relative effectiveness in meeting planning objectives.

Since the problems and opportunities vary across the project area, the alternatives have been formulated considering two planning reaches, to identify the most efficient solution for each reach. The two planning reaches are the Atlantic Ocean Shoreline Reach, and the Jamaica Bay Reach. Integrating CSRM alternatives for the two reaches provides the most economically efficient system-wide solution for the vulnerable communities within the study area. A comprehensive approach to CSRM in the study area must include an Atlantic Ocean shorefront component because overtopping of the Rockaway peninsula is a source of flood waters into Jamaica Bay. Efficient CSRM solutions were formulated specifically to address conditions at the Atlantic Ocean Shorefront Planning Reach. The best solution for the Atlantic Ocean Shorefront Planning Reach was then included as a component of the alternative plans for the Jamaica Bay Planning Reach.

**Atlantic Ocean Shorefront Planning Reach**

The Atlantic Ocean Shorefront Planning Reach is subject to inundation, erosion, wave attack, and overtopping along the Rockaway peninsula. Several iterations of planning were undertaken for the shorefront reach. The initial screening of measures was undertaken to identify the subset of measures that should be considered in developing alternatives for the planning reach. The approach to developing alternatives, based upon this initial screening, was to evaluate features that optimize life-cycle costs in combination with a single beach and dune template to select the most cost effective renourishment approach. Once the most efficient lifecycle management plan was selected, different combinations of beach, dune and reinforced dune cross-sections were evaluated to identify the most economically efficient plan for the planning reach, considering both the level of risk reduction afforded and the lifecycle costs.

The most cost effective alternative life-cycle management approach is beach restoration with renourishment, groin extensions and the addition of new groins (Figure 3). This alternative had the lowest annualized costs over the 50-year project life and the lowest renourishment costs over the project life. Renourishment costs are identified in Table 3: Alternative Plan Annual Costs. Renourishment also provides recreation benefits to beach users, which are included in the evaluation of CSRM alternatives and identified in Table 4: Alternative Plan Annual Benefits. Renourishment material would be sourced from a borrow area approximately two miles offshore (south) of the Rockaway peninsula (see inset in Figure 8).


**Figure 3: Beachfill, and Groin Improvements**

After the most cost-effective life-cycle approach was identified, the dimensions of this plan were optimized to evaluate the level of CSRM provided by a range of dune and berm dimensions and by reinforced dunes. A composite seawall in combination with beachfill and the groin features described in Figure 3 was selected as the most efficient CSRM alternative. This plan reduces risks for erosion and wave attack and also limits storm surge inundation and cross-peninsula flooding (Figures 4 and 5). The structure crest elevation is +17 feet (NAVD88), the dune elevation is +18 feet (NAVD88), and the design berm width is 60 feet. The armor stone in horizontally composite structures significantly reduces wave breaking pressure, which allows smaller steel sheet pile walls to be used in the design since the face of the wall is completely protected by armor stone. The composite seawall may be adapted in the future to rising sea levels by adding 1-layer of armor stone and extending the concrete cap up to the elevation of the armor stone.

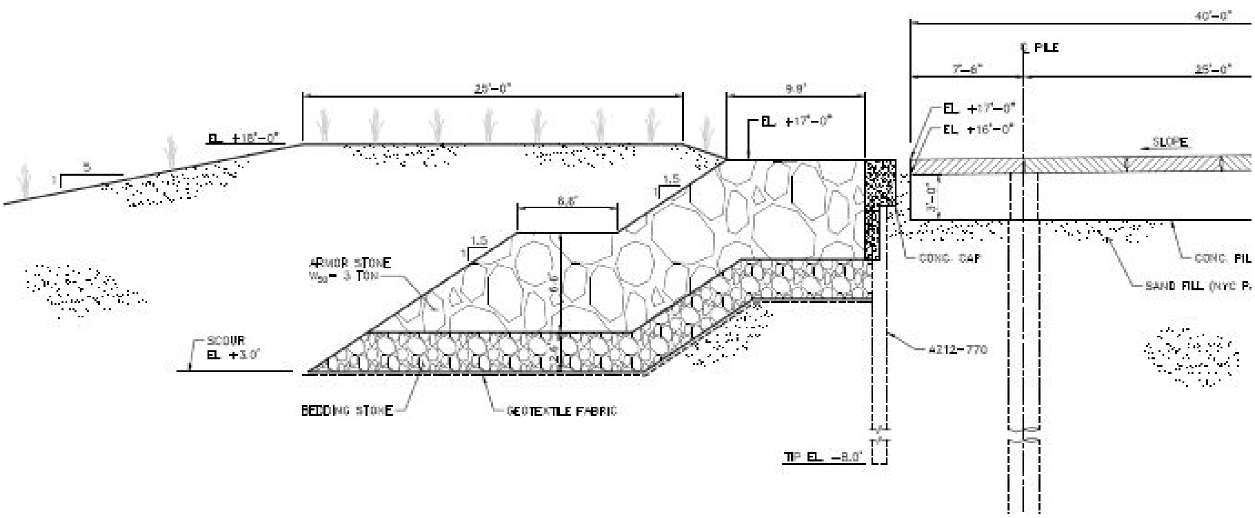



**Figure 4: Composite Seawall Beach 19th St. to Beach 126th St.**

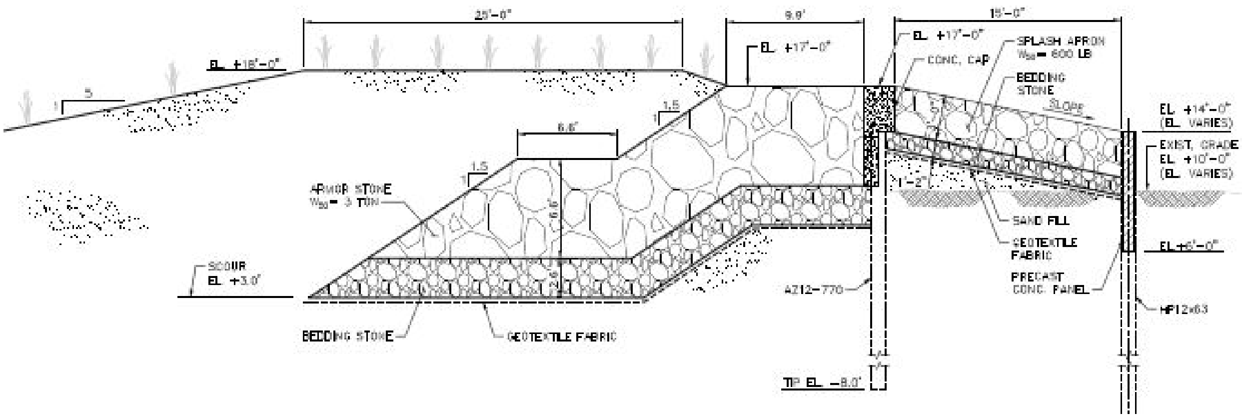



**Figure 5: Composite Seawall Beach 126th St. to Beach 149th St.**

## Jamaica Bay Planning Reach

The communities surrounding and within Jamaica Bay are subject to storm surges that amass in Jamaica Bay by entering through Rockaway Inlet and by overtopping and flowing across the Rockaway Peninsula (the Atlantic Ocean Shorefront Planning Reach) and across Coney Island. Preliminary screening of alternative plans for the Jamaica Bay Planning Reach resulted in a final array of two alternatives: a Jamaica Bay Perimeter Plan and a Storm Surge Barrier Plan. As described previously, both plans include the plan features for the Atlantic Ocean Shoreline Planning Reach.

The Jamaica Bay Perimeter Plan includes CSRM at the Atlantic Ocean Shorefront Planning Reach and creates a nearly 44-mile contiguous barrier along the Jamaica Bay interior, with the exception of JFK Airport (JFK Airport already has infrastructure providing CSRM). The community at Broad Channel, which is effectively within Jamaica Bay - as opposed to being a community on the fringe of Jamaica Bay- would not benefit from the Perimeter Plan, as site-specific features for

Broad Channel were not cost-effective and eliminated from consideration in the screening. (Figure 6).


**Figure 6: Jamaica Bay Perimeter Plan**

The Jamaica Bay Perimeter Plan (Plan D) would require 13 tributary flood gates (Sheepshead Bay, Gerritsen Inlet, Mill Basin, Paerdegat Basin, Fresh Creek, Hendrix Basin, Spring Creek, Shellbank Creek, Hawtree Basin, Head-of-Bay, Negro Bar Channel, Norton Basin and Barbados Basin) and five roadway flood gates across Rockaway Parkway at Canarsie Pier, Pennsylvania Avenue, Hendrix Street, Fountain Avenue, and the Edgemere landfill service road. Additionally a railroad floodgate would be required at 104$^{th}$ Street for the Long Island Railroad.

The Storm Surge Barrier Plan (Plan C) would require a hurricane barrier across Rockaway Inlet and includes CSRM at the Atlantic Ocean Shorefront Planning Reach. Three alternative alignments of the Storm Surge Barrier Plan (C-1, C-2, and C-3) were assessed. The C-3 alignment was screened out from the more detailed analysis based on relatively higher construction costs and Operation, Maintenance, Repair, Reconstruction, & Replacement (OMRR&R) costs due to its longer in-water footprint, while providing the same level of benefits as alignments C-1 and C-2. Each alternative alignment advanced for more detailed analysis (Figure 7) includes a continuous CSRM plan along the entire Atlantic Ocean Shorefront Planning Reach. CSRM at the Atlantic Ocean Shorefront Planning Reach is required for full functionality of the Storm Surge Barrier Plan.

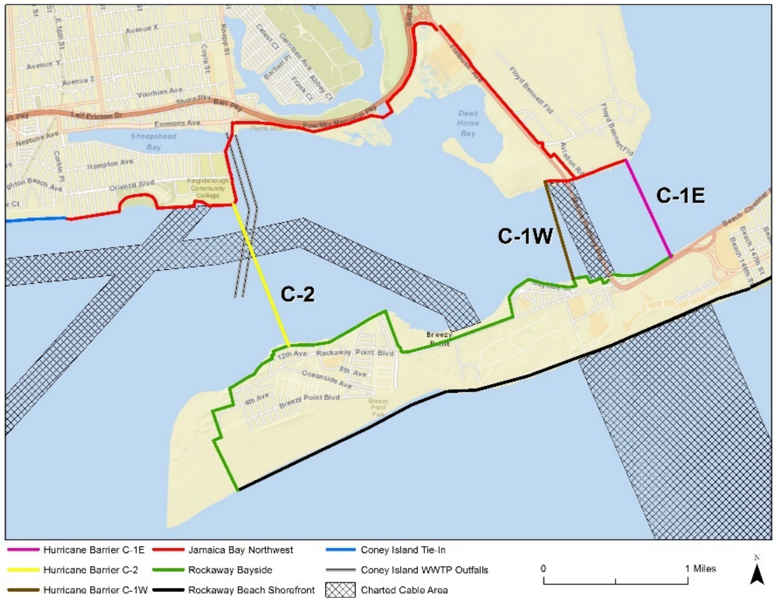



**Figure 7: Storm Surge Barrier Plan**

A simplified, hydrodynamic modeling effort to assess tidal amplitude and velocities as a proxy for water quality impacts evaluated Alignment C-2 and two alternative alignments for C-1 (C-1E and C-1W) for various tide gate configurations and Storm Surge Barrier alignments. The initial modeling was undertaken to aid in the design of the structures and assess whether potential impacts made a storm surge barrier infeasible. Alignment C-1E with 1,100 linear feet of gate opening and alignment C-2 with 1,700 linear feet of gate opening were identified as having the least hydrodynamic impacts to the bay. Both alignments resulted in a change in tidal amplitude of less than 0.2 feet for a portion of the tide cycle. Limited changes to the water column indicate that the natural environment driven by water circulation would be undisturbed and water chemistry would be consistent with and without a Storm Surge Barrier. In addition, flow speeds and directions for both alignments are similar to without-project conditions, which imply that circulation within Jamaica Bay would be minimally impacted.

To further support the evaluation of the proposed storm surge barrier alternatives, additional modeling was conducted by the New York City Department of Environmental Protection (NYC DEP) to assess the impacts of the installation and operation of the storm surge barrier on water quality in Jamaica Bay under varying wet-weather and barrier operating conditions. Preliminary results of the modeling (NYCDEP 2016, draft, in prep.) indicate the installation and operation of the storm surge barrier with the conceptual design presented in this report, could potentially impact the tidal range, water quality (e.g. dissolved oxygen), and habitat in the interior tidal tributaries and shallow areas of the Bay. Consequently, additional modeling and analysis will be conducted by the USACE prior to the Final HSGRR/EIS and/or prior to design of the storm surge barrier to identify, quantify and conclusively address any possible impacts to water quality and fish and wildlife species and their habitats in the Bay.

Prior to the comparison of the Jamaica Bay Perimeter Plan to the Storm Surge Barrier Plan, alignment C-1W was eliminated from consideration because it was determined that alignment C-1E would be preferred over alignment C-1W. Alignment C-1W was eliminated from consideration because C-1E would:

- result in less scour at the Gil Hodges Memorial Bridge;
- result in less real estate and aesthetic impacts to the Roxbury Community where alignment C-1W would tie in;
- be located in a more stable channel location; and
- avoid potential impacts to submerged cables.

During the plan selection process, the Jamaica Bay Perimeter Plan (Plan D) and the Storm Surge Barrier (Plan C: alignments C-1E and C-2) were evaluated for habitat impacts, real estate impacts, costs (construction, mitigation, real estate, and OMRR&R), and net benefits (Table 1). Note that CSRM at the Atlantic Ocean Shorefront Planning Reach is a component of both Plan C and Plan D and the impacts, costs, and benefits of CSRM at the Atlantic Ocean Shorefront Planning Reach are included in the evaluations of Plans C and D.

Plans C and D each require a western tie-in to either high ground or to a CSRM feature at Coney Island. The high ground alternative would provide a CSRM feature terminus at Flatbush Avenue, which does not address CSRM in Sheepshead Bay and adjoining neighborhoods. The evaluations of Plans C and D were based on the assumption that each plan would tie in to a CSRM feature at Coney Island. The tie-in location would be at or near Corbin Place. The estimated costs of the Coney Island CSRM feature are included in the costs for Plans C and D, but the CSRM benefits to Coney Island are not included in the evaluation of Plans C and D.

**Table 1: Alternative Plan Comparison – AAEQ Costs and Benefits ($000's)**

| | Storm Surge Barrier Plan Alternative Alignments | | Interior Plan D |
|---|---|---|---|
| | C-1E | C-2 | |
| Costs | $163,638 | $163,710 | $227,416 |
| Benefits | $509,233 | $509,233 | $497,582 |
| Net Benefits | $345,595 | $345,523 | $270,166 |
| BCR | 3.1 | 3.1 | 2.2 |

**Plan Recommendation**

Based on the planning objectives and USACE policy, the Storm Surge Barrier alignment C-1E is the TSP and is likely to be considered the Recommended Plan (Figure 8). Analyses performed to identify and assess CSRM alternatives for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay study area support the recommendation for comprehensive storm risk management. This does not preclude a decision to refine or alter the TSP at the Agency Decision Milestone (ADM) based on responses from public, policy, and technical reviews of this Draft HGRR/EIS, specifically for the alignment of the Storm Surge Barrier, the project features on lands under the jurisdiction of NPS and residual risk features. A final decision will be made at the ADM following the reviews and higher-level coordination within USACE to select a plan for feasibility-level design and recommendation for implementation. Coordination with the NPS to identify a plan that is mutually acceptable, and coordination with the natural resource agencies will continue throughout the study process.

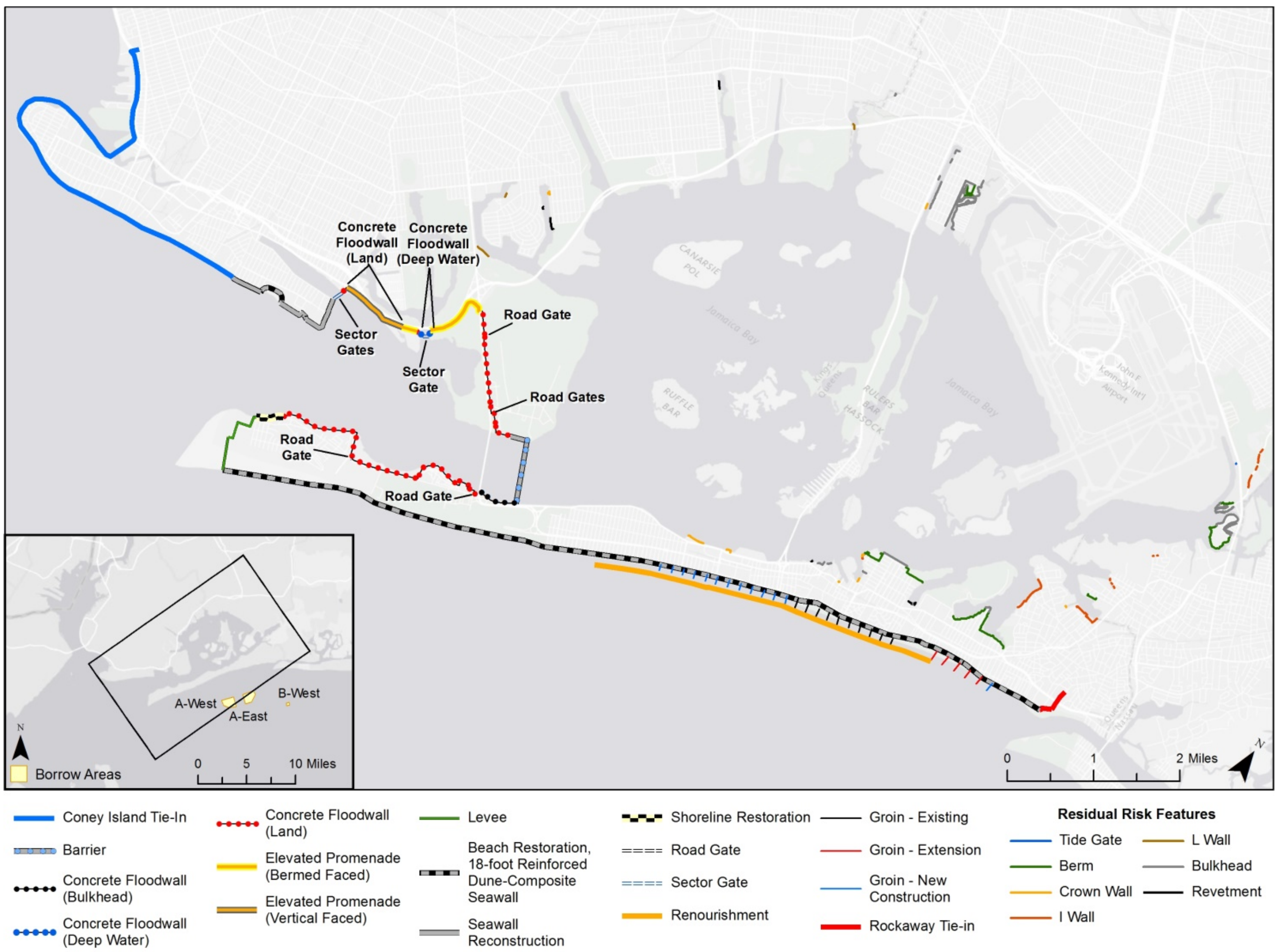



**Figure 8: Tentatively Selected Plan**

Analyses conducted to date support the recommendation for a composite seawall and associated beach restoration with increased renourishment at the Atlantic Ocean shorefront along the

Rockaway peninsula (shown in black in Figure 8). The structure crest elevation is +17 feet (NAVD88), the dune elevation is +18 feet (NAVD88), and the design berm width is 60 feet.

Multiple Storm Surge Barrier alignments and tie-in scenarios are available for the recommended Storm Surge Barrier Plan. Final design and selection of the Storm Surge Barrier alignment and associated tie-ins are deferred until additional analyses and design refinements can be conducted. Final Storm Surge Barrier design will be made in the future based on responses from public, policy, and technical reviews of this Draft HSGRR/EIS and additional investigations conducted for that purpose.

**Residual Risk Measures**

With a storm surge barrier plan, there are portions of Jamaica Bay that would remain vulnerable to flooding due to very frequent storm events. The TSP includes solutions to address this remaining, residual risk during design and construction of the Storm Surge Barrier and for those communities vulnerable to high frequency events, during which the Storm Surge Barrier gates would be open. A wide range of residual risk features were evaluated, and are included in the project costs, with 5 features specifically identified for the TSP:

- Brookville Blvd. – road raising and construction of an I-wall at the edge of the urban area;
- Mott Basin – construction of a berm and bulkhead;
- Edgemere – construction of a berm and bulkhead;
- Norton Basin – construction of an I-wall and bulkhead; and
- Canarsie – construction of a new revetment.

**Major Findings and Conclusions**

Thorough coordination and collaboration was conducted with Federal, State and local agencies, non-governmental organizations and interested stakeholders throughout the study process and public meetings. The recommendations contained herein reflect the information available at this time. This report presents an overview of CSRM problems and opportunities in the Rockaway Inlet to East Rockaway Inlet & Jamaica Bay Project Area, evaluated and selected CSRM for the entire area including the most economically efficient plan for the Atlantic Ocean Planning Reach, and for the Jamaica Bay Planning Reach. This approach considers both of these planning reaches as a single, complete system in this Draft HSGRR/EIS. Based on based on responses from public, policy, and technical reviews of this Draft HSGRR/EIS, USACE may consider a phased decision process. While planned as a system, phased decision making may allow USACE to move forward with implementation of discreet component first, while finalizing the details associated with more technically complex features, acknowledging that the full benefits wouldn't be realized until all components are complete.

**Tentatively Selected Plan Summary**

The TSP extends along approximately 152,000 linear feet of project area extending from the eastern end of the Rockaway peninsula at Inwood, Nassau County to the western end of the Rockaway peninsula, at Breezy Point, Queens, where the plan wraps around the existing shoreline past the Gil Hodges Memorial Bridge. Near Jacob Riis Park a storm surge barrier crosses Rockaway Inlet landing at Floyd Bennet Field, Brooklyn. The plan continues up Flatbush Avenue before turning west along the existing shoreline and continuing west until Norton Point. From Norton Point, the line of protection continues on the north side of Coney Island, crossing Coney Island Creek. From Coney Island Creek it continues north along the shoreline to high ground.

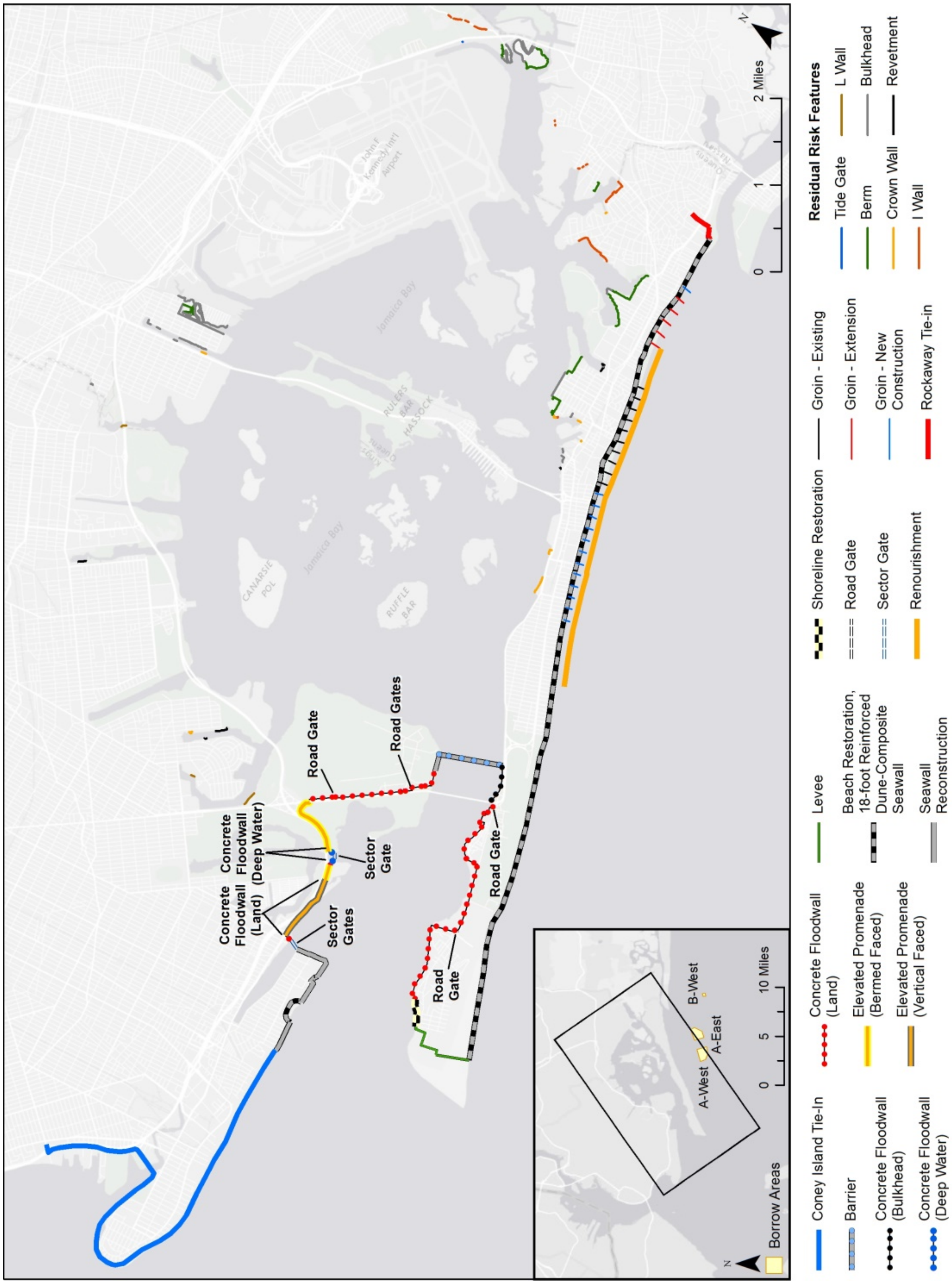
The plan along the Atlantic Ocean Shorefront consists of:

- A reinforced dune (composite seawall) with a structure crest elevation of +17 feet (NAVD88) and dune elevation of +18 feet (NAVD88), and a design berm width of 60 feet extending approximately 35,000 LF from Beach 9th to Beach 149th. The bottom of dune reinforcement extends up to 15 feet below the dune crest.
- A beach berm elevation of +8 ft. NAVD and a depth of closure of -25 ft. NAVD;
- A total beach fill quantity of approximately 804,000 cy for the initial placement, including tolerance, overfill and advanced nourishment with a 4-year renourishment cycle of approximately 1,021,000 cy, resulting in an advance berm width of 60 feet;
- Obtaining sand from borrow area located approximately 2 miles south of the Rockaway Peninsula and about 6 miles east of the Rockaway Inlet. It is about 2.6 miles long, and 1.1 miles wide, with depths of 36 to 58 feet and contains approximately 17 million cy of suitable beach fill material, which exceeds the required initial fill and all periodic renourishment fill operations.
- Extension of 5 existing groins; and Construction of 13 new groins.

The alignment along Jamaica Bay and Rockaway Inlet consists of:

- Reinforced Dune along the shoreline in Reaches 1 and 2 of the Atlantic Coast Planning Reach, from Beach 149th to Breezy Point.
- Levee and from approximately B227th St. north overland across Breezy Point, thence eastward from B222nd St. to B201st St. Approximately 450,000 cy of sediment required for levee construction.
- Concrete floodwall south along B201st St. extending east along north side of Rockaway Blvd to B184th St., thence north to existing shoreline. Concrete floodwall continues east to storm surge barrier approximately 2300 ft. east of the Gil Hodges Memorial Bridge/Marine Parkway Bridge.
- A 3,970-foot storm surge barrier across Rockaway Inlet from near Jacob Riis Park to Floyd Bennet Field;
- A concrete floodwall on land running north along Flatbush Avenue towards the Belt Parkway;
- A berm-faced elevated promenade running west along the waterside of the Belt Parkway to a concrete floodwall at Gerritsen Inlet;
- A sector gate across Gerritsen Inlet, which ties in to a concrete floodwall;

- Elevated promenades (berm faced and vertical faced) extend from Gerritsen Inlet around Plumb Beach westward to the inlet at Sheepshead Bay;
- A sector gate across Sheepshead Bay
- Seawall reconstruction around the eastern end of Coney island at Kingsborough Community College;
- A reinforced dune across sandy beach at Kingsborough Community College/Oriental and Manhattan Beach, and
- Seawall reconstruction from Manhattan Beach to approximately Corbin Place,
- The Coney Island tie-in, where the line of protection continues west until Norton Point. From Norton Point, the line of protection continues on the north side of Coney Island, crossing Coney Island Creek. From Coney Island Creek it continues north along the shoreline to high ground.


Road Gate
Road Gates
Concrete Floodwall (Land)
Concrete Floodwall (Deep Water)
Sector Gate
Sector Gates
Road Gate
Road Gate
Jamaica Bay
0
1
2 Miles
0
5
10 Miles
A-West
A-East
B-West
Borrow Areas
Coney Island Tie-In
Barrier
Concrete Floodwall (Bulkhead)
Concrete Floodwall (Deep Water)
Concrete Floodwall (Land)
Elevated Promenade (Bermed Faced)
Elevated Promenade (Vertical Faced)
Levee
Beach Restoration, 18-foot Reinforced Dune-Composite Seawall
Seawall Reconstruction
Shoreline Restoration
Road Gate
Sector Gate
Renourishment
Groin - Existing
Groin - Extension
Groin - New Construction
Rockaway Tie-in
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Tide Gate
Berm
Crown Wall
I Wall
L Wall
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Revetment

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# East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study

# Draft Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

# 1 STUDY INFORMATION

## 1.1 Introduction

This report is a Draft Integrated Hurricane Sandy General Reevaluation Report/Environmental Impact Statement (HSGRR/EIS) examining coastal storm risk management (CSRM) problems and opportunities for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay project area which was devastated by the impacts of Hurricane Sandy in 2012. Consistent with current U.S. Army Corps of Engineers (USACE) planning guidance, this reformulation identified and screened alternatives to address CSRM, and is presenting a tentatively selected plan (TSP). This Draft HSGRR/EIS will undergo public review, policy review, Agency Technical Review (ATR), and Independent External Peer Review (IEPR). The USACE study team will respond to review comments, then present a recommended plan and develop a Final HSGRR/EIS.

## 1.2 Construction Authority & Reformulation Authority

There is a long history of sediment placement in the study area (see Section 1.10 Prior Reports and Existing Projects). After initial construction in 1977 and subsequent beachfill placement along the Rockaway peninsula, a Reformulation was authorized by Congress in 1997 to ensure that the appropriate long-term solution was recommended.

The Reformulation Effort for East Rockaway Inlet to Rockaway Inlet and Jamaica Bay was authorized by the House of Representatives, dated 27 September 1997, as stated within the Congressional Record for the US House of Representatives. It states, in part:

> *"With the funds provided for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, New York project, the conferees direct the Corps of Engineers to initiate a reevaluation report to identify more cost-effective measures of providing storm damage protection for the project. In conducting the reevaluation, the Corps should include consideration of using dredged material from maintenance dredging of East Rockaway Inlet and should also investigate the potential for ecosystem restoration within the project area."*

Public Law 113-2 (29 Jan 13), The Disaster Relief Appropriations Act of 2013 (the Act), was enacted in part to "improve and streamline disaster assistance for Hurricane Sandy, and for other purposes". The Act directed the Corps of Engineers to:

> "…reduce future flood risk in ways that will support the long-term sustainability of the coastal ecosystem and communities and reduce the economic costs and risks associated with large-scale flood and storm events in areas along the Atlantic Coast within the boundaries of the North Atlantic Division of the Corps that were affected by Hurricane Sandy" (PL 113-2).

In partial fulfillment of the requirements detailed within the Act, USACE produced a report assessing "authorized Corps projects for reducing flooding and storm risks in the affected area that have been constructed or are under construction". The East Rockaway Inlet to Rockaway Inlet, NY project met the definition in the Act as a constructed project. In accordance with the Act, USACE is proceeding with this HSGRR to address resiliency, efficiency, risks, environmental compliance, and long-term sustainability within the study area (USACE, 2013a). The HSGRR reformulation effort is 100% federally funded, and the initial constriction of project features is 100% federally funded subject to availability of funds.

## 1.3 Reformulation Purpose and Scope*

Prior to Hurricane Sandy, CSRM efforts focused on Atlantic Ocean Shoreline features with the State of New York through the New York State Department of Environmental Conservation as the non-Federal sponsor. Awareness of the need for an integrated approach to CSRM opportunities for the entire project area including the shorefront, Jamaica Bay and surrounding communities has increased since Hurricane Sandy impacted the area in 2012. As a result of the devastation associated with Hurricane Sandy, the USACE has been tasked to address coastal resiliency and long-term sustainability when undertaking this reformulation effort, in addition to the traditional USACE planning report categories of "economics, risk, and environmental compliance (USACE, 2013a)." The goal of the Draft HSGRR/EIS is to identify solutions that will reduce Atlantic Ocean Shoreline and Jamaica Bay vulnerability to storm damage over time, in a way that is sustainable over the long-term, both for the natural coastal ecosystem and for communities.

The relationships and interactions among the natural and built features (e.g., floodwalls, flood gates, etc.) comprising a coastal risk reduction system are important variables determining coastal vulnerability, reliability, risk, and resilience (USACE, 2013b). Improving resilience, which is a key factor in reducing risk, includes improving the ability to anticipate, prepare for, respond to, and adapt to changing conditions and to recover rapidly from disruptions (USACE, 2013c).

Atlantic Ocean Shoreline CSRM alternatives include traditional structural and non-structural solutions with an emphasis on reducing vulnerability to inundation, wave attack and erosion. Jamaica Bay CSRM alternatives include traditional structural and non-structural solutions with an emphasis on incorporating natural and nature-based features (NNBFs) to complement or enhance the functionality of structural measures.

Natural Features (NF) are defined as features that are created and/or evolve over time through the actions of physical, biological, geologic, and chemical processes operating in nature. NF in a coastal ecosystem take a variety of forms, including reefs (e.g., coral and oyster), barrier islands, marsh islands, dunes, beaches, wetlands, and maritime forests. Nature-based features (NBF) are defined as those features that may mimic characteristics of natural features but are created by human design, engineering, and construction to provide specific services such as coastal risk reduction. Examples of NBF include constructed wetlands, or a beach and dune system engineered for coastal storm risk management. Consistent with the North Atlantic Coast Comprehensive Study (USACE, 2013b), these features are referred to jointly throughout this study. NNBFs (natural and nature-based features) are commonly combined to implement the concept of a "living shoreline".

## 1.4 Non-Federal Sponsor

New York State, through the New York State Department of Environmental Conservation, is the non-Federal partner. New York City (NYC), through the NYC Mayor's Office of Recovery and Resiliency, is the local sponsor to New York State. The non-Federal sponsor and the local sponsor support the TSP and moving forward with Plans & Specifications and Construction. Other project partners include the NYC Department of Parks and Recreation, NYC Department of Environmental Protection, and the National Park Service.

## 1.5 Study Area

The study area consists of the Atlantic Coast of NYC between East Rockaway Inlet and Rockaway Inlet, and the water and lands within and surrounding Jamaica Bay, New York (Figure 1-1). The study area also includes the low lying Coney Island section of Brooklyn, which can be overtopped by floodwaters that flood the Brooklyn neighborhoods surrounding Jamaica Bay. The coastal area, which is approximately 10 miles in length, is a peninsula located entirely within the Borough of Queens, NYC. This peninsula, generally referred to as the Rockaways, separates the Atlantic Ocean from Jamaica Bay immediately to the north. The greater portion of Jamaica Bay lies in the Boroughs of Brooklyn and Queens, NYC, and a section at the eastern end, known as Head of Bay, lies in Nassau County (Figure 2). More than 48,000 residential and commercial structures in the study area fall within the Federal Emergency Management Agency (FEMA) regulated 100-year floodplain.

Effective CSRM requires that risk management measures reduce flood risk from inundation at Jamaica Bay and the Rockaway peninsula and also reduce flood risk and the effects of erosion and wave attack along the Atlantic shorefront of the Rockaway peninsula. Reducing flood risk from inundation at Jamaica Bay cannot be fully effective without also reducing flood risk at the Atlantic shorefront on the Rockaway peninsula because flood waters would be able to inundate low lying areas of the Jamaica Bay side of the Rockaway peninsula, if the Atlantic shorefront risk reduction component were not in place. Similarly, risk management measures in Jamaica Bay also require that risk reduction measures address the flood water crossing the Coney Island beach, and flanking the Jamaica Bay risk reduction measures from as far west as Coney Island Creek.

Since the problems and opportunities vary across the project area, the alternatives have been formulated considering two planning reaches, to identify the most efficient solution for each reach. The two planning reaches are the Atlantic Ocean Shoreline Reach (Rockaway Peninsula), and the Jamaica Bay Reach. Integrating CSRM alternatives for the two reaches provides the most economically efficient system-wide solution for the vulnerable communities within the study area.

### 1.5.1 Rockaway Peninsula

The communities located on the Rockaway peninsula from west to east include Breezy Point, Roxbury, Neponsit, Belle Harbor, Rockaway Park, Seaside, Hammel, Arverne, Edgemere and Far Rockaway. The former Fort Tilden Military Reservation and the Jacob Riis Park (part of the Gateway National Recreation Area) are located in the western half of the peninsula between Breezy Point and Neponsit. The characteristics of nearly all of the communities on the Rockaway peninsula are similar. Ground elevations rarely exceed 10 feet, except within the existing dune field. Elevations along the Jamaica Bay shoreline side of the peninsula generally range from 5 feet, increasing to 10 feet further south toward the Atlantic coast. An estimated 7,900 residential and commercial structures on the peninsula fall within the FEMA regulated 100-year floodplain. Nearly the entire peninsula falls within the regulated 100-yr floodplain.

### 1.5.2 Jamaica Bay

Jamaica Bay is the largest estuarine waterbody in the NYC metropolitan area covering an approximately 20,000 acres (17,200 of open water and 2,700 acres of upland islands and salt marsh). Jamaica Bay measures approximately 10 miles at its widest point east to west and four miles at the widest point north to south, including approximately 26 square miles in total. The mean depth of the bay is approximately 13 feet with maximum depths of 60 feet in the deepest historical borrow pits. Federal navigation channels within the bay are authorized to a depth of 20 feet. Jamaica Bay has a typical tidal range of five to six feet. The portions of NYC and Nassau County surrounding the waters of Jamaica Bay are urbanized, densely populated, and very susceptible to flooding. An estimated 41,000 residential and commercial structures within the FEMA regulated 100-year Jamaica Bay floodplain.


**Figure 1-1: Map of Rockaway Peninsula and Jamaica Bay**

## 1.6 Project Area

The project area includes locations of potential alternative plans proposed by other agencies or the area that may be directly and indirectly impacted by construction or operations, which is typically a smaller footprint than the study area.

The project area includes:

- Jamaica Bay and the surrounding neighborhoods exposed to coastal storm risk;
- Atlantic Ocean shorefront along the Rockaway Peninsula, which is exposed to coastal storm risk and which conveys flood waters into Jamaica bay when overtopped;
- Coney Island, which also conveys flood waters into Jamaica bay when overtopped; and
- Atlantic Ocean borrow areas for construction material.

Much of the project area is located within portions of the Gateway National Recreation Area (GNRA), which includes the Jamaica Bay Wildlife Refuge. Both GNRA and the wildlife refuge are operated by the National Park Service (NPS). The GNRA extends from the estuaries and beaches in New York City to Sandy Hook, New Jersey; it encompasses 26,000 acres, 9,155 of which are part of the wildlife refuge. Any CSRM plan developed for the project area must be mutually acceptable to NPS (U. S. Department of the Interior) and USACE.

### 1.6.1 Atlantic Ocean Shorefront Planning Reach

The Atlantic Ocean Shorefront Planning Reach along the Rockaway Peninsula is subdivided into six reaches for the purpose of this analysis. Each reach is developed based upon site-specific physical, economic, and institutional differences. Considerations include hydrodynamic differences, coastal features, sediment transport boundaries, shoreline stability, existing projects, and development patterns. Reach designations help characterize the problems, needs, and opportunities and to identify alternatives viable for each reach. Division of the Atlantic Ocean Shorefront Planning Reach into reaches does not imply separable projects or construction areas.

The six Atlantic Ocean shorefront reaches (Figure 1-2) include:

- Reach 1: Rockaway Point to Beach 193$^{rd}$ Street;
- Reach 2: Beach 193$^{rd}$ Street to Beach 149$^{th}$ Street;
- Reach 3: Beach 149$^{th}$ Street to Beach 109$^{th}$ Street;
- Reach 4: Beach 109$^{th}$ Street to Beach 86$^{th}$ Street;
- Reach 5: Beach 86$^{th}$ Street to Beach 42$^{nd}$ Street; and
- Reach 6: Beach 42$^{nd}$ Street to Beach 9$^{th}$ Street.

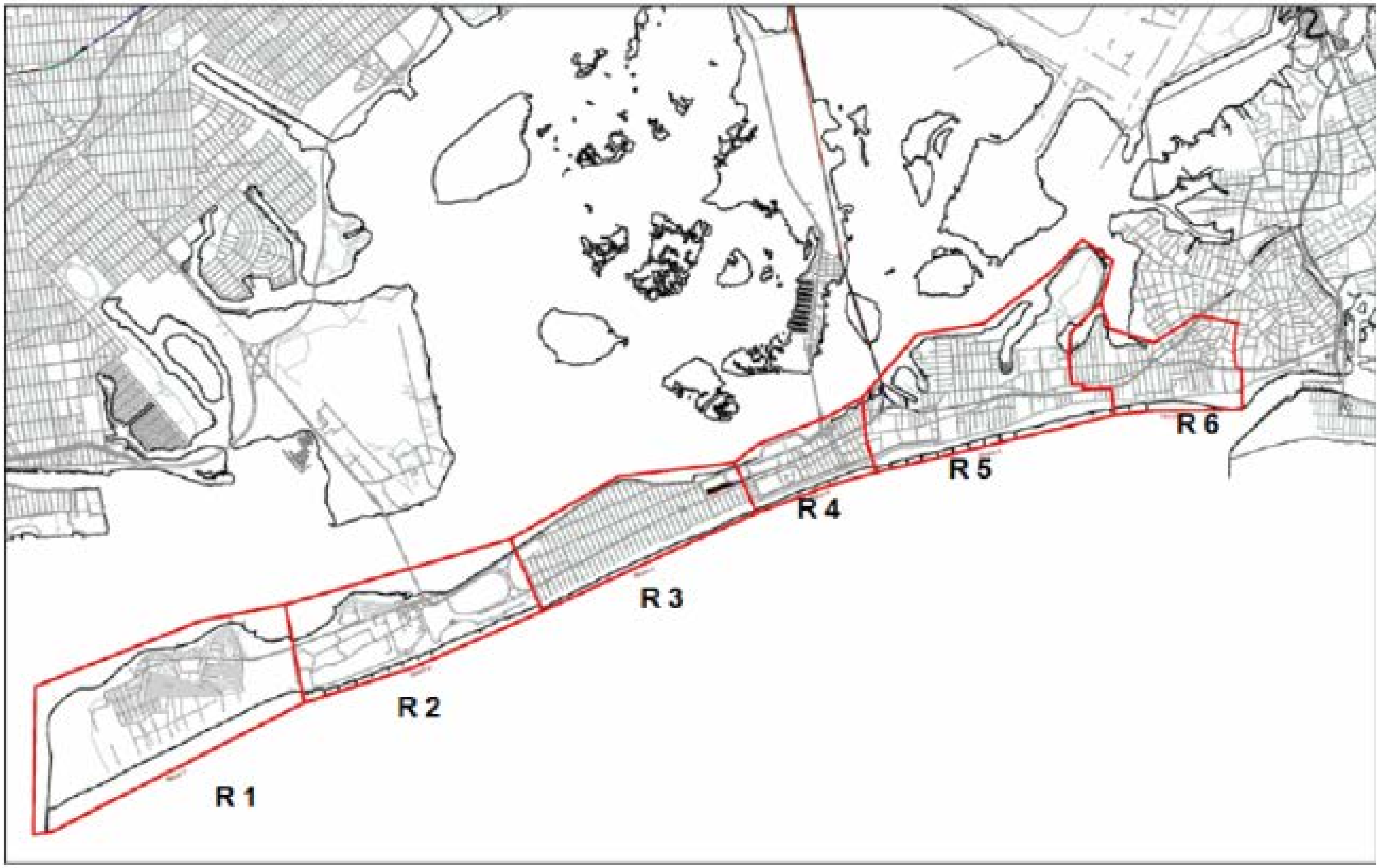


**Figure 1-2: Atlantic Shorefront Reaches**

### 1.6.2 Jamaica Bay Planning Reach

In order to develop alternative plans and to evaluate the risk reduction provided by those plans, Jamaica Bay was configured into six economic reaches that are defined by a common inundation elevation and existing community designations (Figure 1-3). For the development and preliminary screening of alternatives, each economic reach was defined as an area (*i.e.,* a GIS polygon) which would be inundated at a stillwater elevation of +11 feet (NAVD88). Eleven feet is generally equivalent to the stillwater elevation for a storm event with 1% probability of annual occurrence in 2070 including mid-range sea level rise.

Six reaches sufficiently define the project area because much of the shoreline and adjacent uplands that surround Jamaica Bay are low-elevation permeated with numerous basins, tidal creeks, and inlets, which provide little proximate access to areas of high ground. Configuring the reaches defined by a common inundation elevation resulted in six separable reaches. Individual plans were developed for each of the six reaches. Structures within low-lying areas shoreward of the adjacent uplands were assigned to these distinct reaches so that coastal storm damages may be estimated for each reach.

JFK Airport was not included within any of the economic reaches for which stand-alone alternatives were developed. Federal Aviation Administration regulations preclude the construction of barriers (e.g., floodwalls and levees) on airport property, which renders any alternative to directly protect the airport infeasible on an institutional basis. In addition, the airport is on relatively high ground, and nonstructural solutions may be a more appropriate solution for any flooding problems. Nevertheless, the Port Authority of New York and New Jersey has been and will continue to be consulted throughout the plan formulation process.

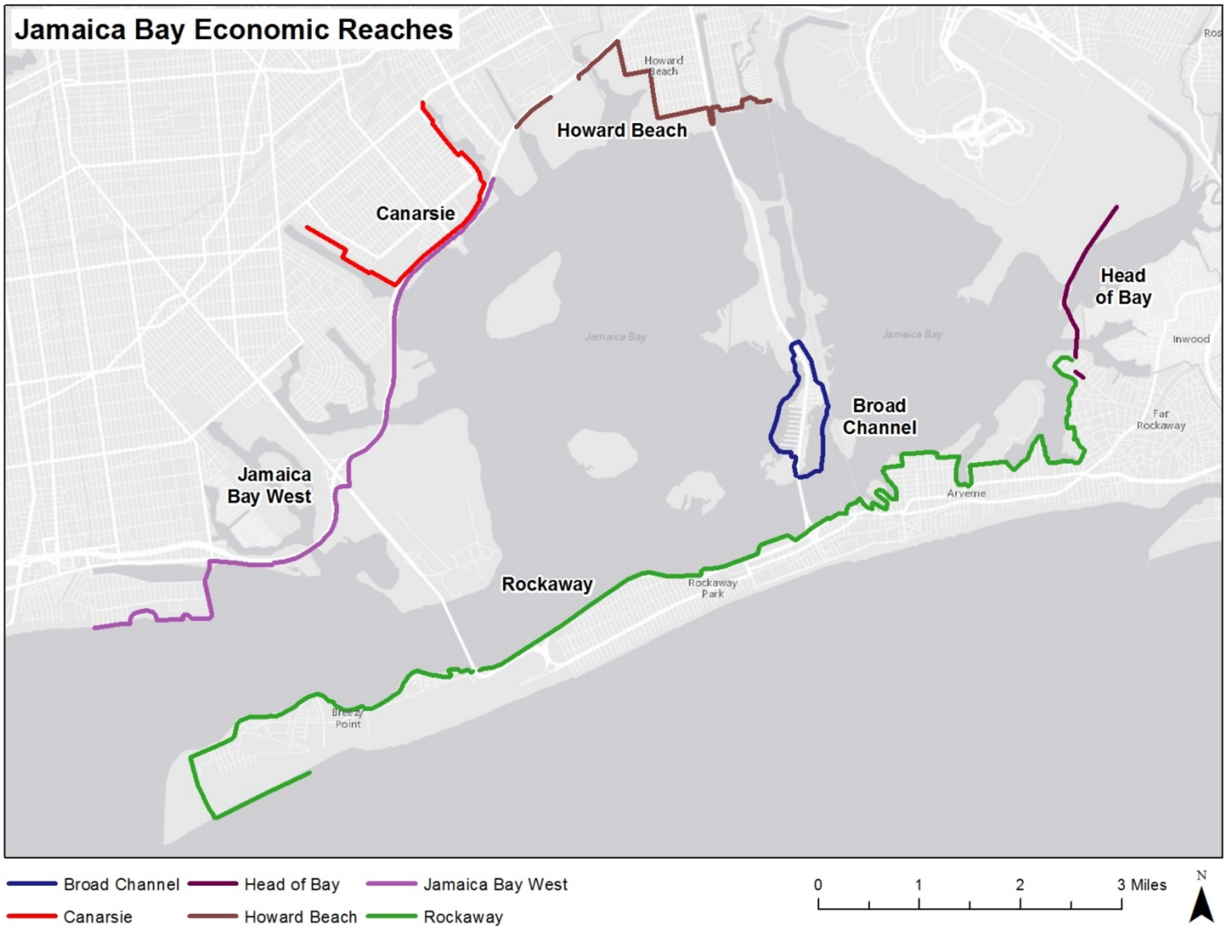


**Figure 1-3: Economic Reaches – Jamaica Bay**

## 1.7 Project Datum

All elevations referred to in this report, unless specifically noted otherwise, are based on the North American Vertical Datum of 1988 (NAVD 88). All depths used in this report are at Mean Lower Low Water (MLLW) datum unless otherwise specified. The difference between MLLW and NAVD88 in Jamaica Bay is approximately 3.0 ft.

## 1.8 Major Historical Surge Events in the Study Area

Frequent and severe damage from tidal inundation, erosion, and wave attack at the Atlantic Ocean Shorefront Planning Reach and inundation at the Jamaica Bay Planning Reach has long been identified as a problem for the study area (USACE, 1964). Historical flood impacts include evacuations during times of flood and extensive property damage in communities along the low-lying areas throughout the project area (USACE, 1993). The entire project area, with the exception of JFK Airport, is designated as either Evacuation Zone 1 or Evacuation Zone 2, the most at-risk zones, by the NYC Office of Emergency Management (NYCOEM, 2014). In response to the long history of storm damage in the study area and a particularly severe storm in 1962, a USACE

Cooperative Beach Erosion Control and Hurricane Study recommended construction of a Hurricane Barrier and associated floodwalls and closures to be constructed at Rockaway Inlet (USACE, 1964). Although the Hurricane Barrier was never constructed, erosion control recommendations, consisting of beachfill along the Atlantic Ocean Shorefront Reach were implemented.

Coastal storm surges in the study area occur from hurricanes, tropical storms, and extratropical storms known as "nor'easters". High tide combined with storm surge and wind speed increases flooding (NPS, 2014). There are no long-term historical tide gauge data for the project area, however; 23 major storms have been identified as impacting the NYC region since 1815 with impacts including fatalities, widespread structural damage, and the obliteration and removal of Hog Island from offshore of the Rockaway coast (Weather2000, 2014).

Figure 14 presents historical extreme tide gauge readings for the Battery off of Manhattan Island in New York Harbor. Although there are no data identifying the areas of inundation in the project area associated with most of the storm events identified in Figure 1-4, one reference point is the inundation that occurred during Hurricane Sandy (October 2012), which is associated with a tide gauge reading of 13.986 feet above MLLW at the Battery. Acknowledging that associating tide gauge readings at the Battery with inundation at project area is an approximation at best, Figure 15 presents approximate project area inundation based on two foot increments in tide gauge height at the Battery from 6 feet above MLLW (3 ft above NAVD) to 14 feet above MLLW (11 ft above NAVD). Although a rough approximation, Figure 1-5 nevertheless demonstrates the susceptibility of the study area to tidal inundation.

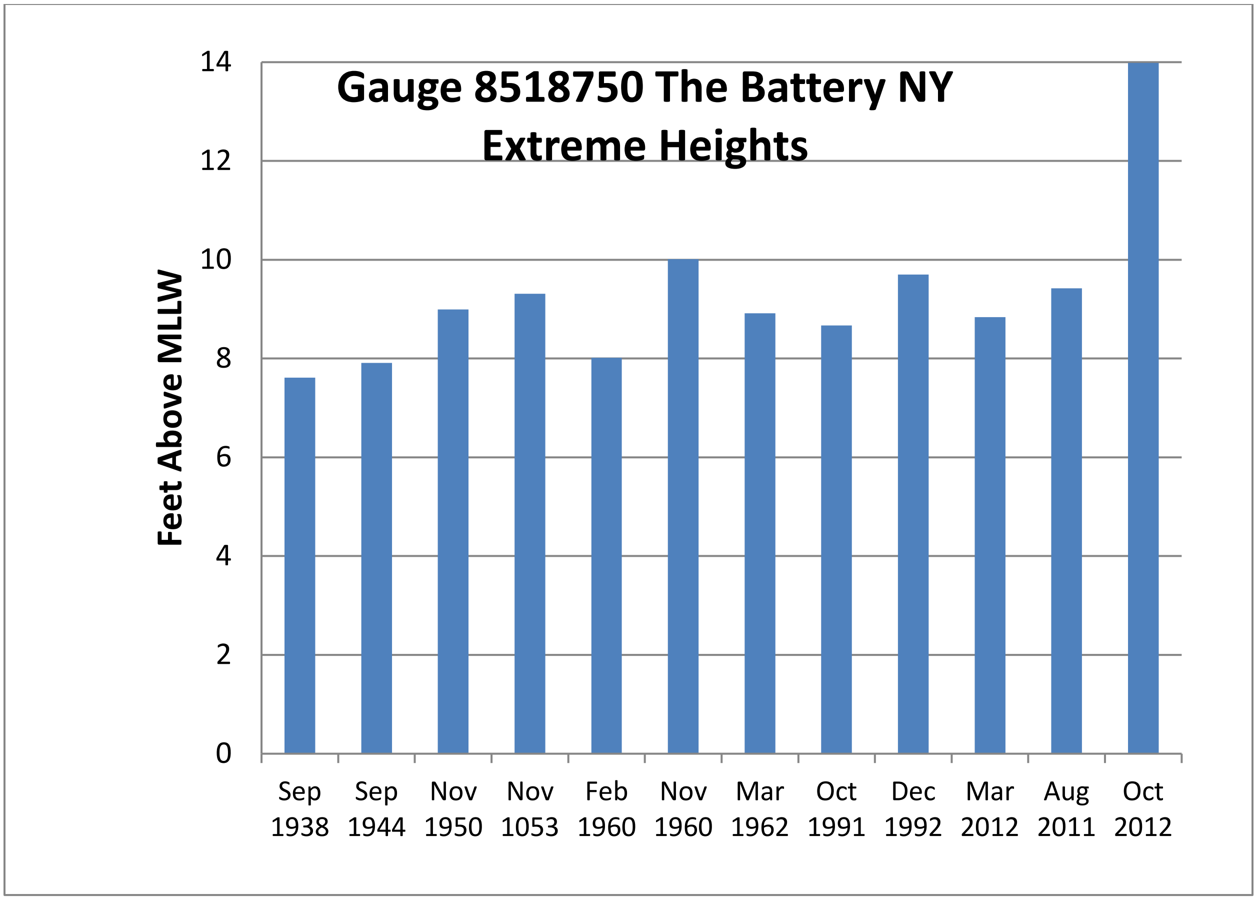


**Figure 1-4: Battery New York Extreme Tide Gauge Heights**

Source: http://tidesandcurrents.noaa.gov/est/est_station.shtml?stnid=8518750

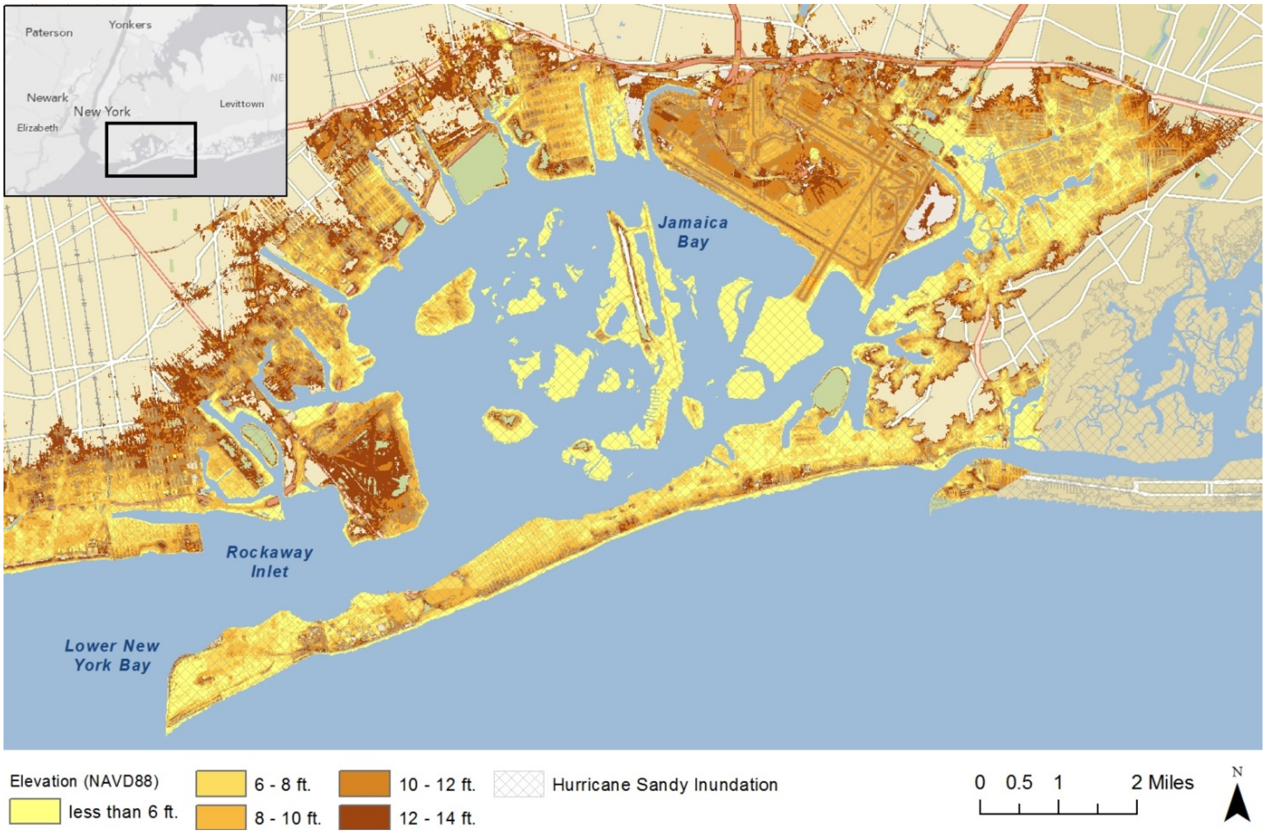


**Figure 1-5: Approximate Historical Study Area Inundation at Various Water Elevations**

## 1.9 Prior Reports and Existing Water Projects

### 1.9.1 1965 Authorization

The Beach Erosion Control and Hurricane Protection Project, recommended by the State of New York and USACE, was authorized by the Flood Control Act of 1965, as prescribed by House Document No. 215, 89th Congress, First Session. The project included a hurricane barrier across the entrance to Jamaica Bay and 4,000,000 cubic yards of beach fill along the ocean front as initial construction, with 10 years of periodic renourishment.

Within the House Document 215 (1965), the District Engineer found that the Rockaway Peninsula and low-lying areas surrounding Jamaica Bay, particularly Howard Beach, were subject to frequent and severe damages from tidal inundation (flooding), and that the ocean front between East Rockaway Inlet and Rockaway Inlet was subject to considerable damage from wave attack. Improvement of the shore and provision of flood control works were needed to provide adequate beach erosion control and hurricane protection.

The problem in the study area, as identified in 1965, was a combination of shore erosion and wave attack along the Atlantic coast of the Rockaways, and inundation from storm tides from both the ocean and Jamaica Bay. The inundation problem was further complicated by an inadequate storm sewer system in the Rockaways and an incomplete system in the residential areas on the north side of the bay. This resulted in severe hardship to hundreds of families requiring evacuation during times of flood, and extensive property damage. The most severe damages occurred in the Rockaway Peninsula, the Howard Beach area, Broad Channel, and Rosedale sections of Queens.

### 1.9.2 1974 Authorization

Section 72 of WRDA of 1974 authorized construction of beach erosion control portion of the project separately from the construction of hurricane protection. The beach erosion control aspect of the project provided for the restoration of a protective beach along 6.2 miles of Rockaway Beach, between Beach 149th Street on the west at the boundary with Jacob Riis Park and Beach 19th Street on the east at East Rockaway Inlet. The project authorization also provided for Federal participation in the cost of periodic beach nourishment to stabilize the restored beach for a period not to exceed 10 years after the completion of the initial beach fill.

The initial nourishment construction was completed from 1975 to 1977. The first phase of the initial construction (1975) consisted of placing 3,669,000 cubic yards of sand between Beach 110th Street and Beach 46th Street. In the second phase of construction (1976), 1,490,000 cubic yards of fill were pumped onto the beach between Beach 46th Street and Beach 19th Street. The third phase of initial construction (1977) had 1,205,000 cubic yards placed between Beach 110th Street and Beach 149th Street.

The beach erosion control features of the authorized project on the Rockaway Peninsula consisted only of a 100-foot berm width at an elevation of +10 ft. NGVD (8.9 feet NAVD88) over the peninsula's entire project length (from Beach 19th Street to Beach 149th Street). Additional width sections of 150 feet and 200 feet of the authorized project provided for separable recreation benefits.

Severe storms in 1977 and 1978 eroded areas of the beach. A Post Authorization Change recommending a modification to the authorized Beach Erosion Control Project was approved on 8 June 1979. The modification provided for the construction of a 380-foot long quarry stone groin at the western limit of the project in the vicinity of Beach 149th street. The groin design provided for a structure which would hold the project beach fill and allow for maximum bypassing to the downdrift shore. The construction of the groin was completed in September 1982 and included placement of 163,300 cubic yards of beach fill on both sides of the groin.

Nourishment operations occurred at two-year intervals during the ten years following the completion of the initial fill, with the last operation being in 1988. The authorized hurricane protection aspect of the project was never constructed, and was de-authorized by WRDA of 1986.

### 1.9.3 Section 934 and Reformulation Study

In response to the authority of Section 934 of WRDA 1986, the State of New York requested a reevaluation of the period of renourishment. This resulted in a 1993 report that approved three additional beach nourishments in 1996, 2000, and 2004. The project design was limited to a 100-foot berm, which was determined to be sufficient for hurricane and storm damage protection. The 1993 report also recommended a "reformulation study" to account for the changes to the project in the interest of storm damage reduction, and to identify a more cost-effective approach for addressing renourishment needs, and determine whether Federal participation is needed for the project for an additional 50 years. Due to funding limitations, the Reformulation Study started in 2003 when NYSDEC and USACE signed a cost-share agreement.

Historically, maintenance material from the navigation channel at East Rockaway Inlet has been beneficially used periodically along the Rockaway Beach shoreline both between Beach 27th Street and Beach 38th Streets, and in some instances in the areas of Beach 92$^{nd}$ street. This has occurred intermittently over the years with the last placement occurring in 2010.

At the time hurricane sandy impacted the area, the project was in an eroded condition. Following hurricane Sandy the Corps was authorized to repair the project to pre-storm conditions and under P. L. 113-2 was also authorized to restore the project to its original design conditions. Emergency repair and restoration in response to Hurricane Sandy was performed in 2014. Sand placement on Rockaway Beach from Beach 19$^{th}$ Street to Beach 149$^{th}$ Street consisted of 3.5 million cubic yards of material. In conjunction with this repair and restore operation, the City of New York, and State of New York provided additional funds to also establish a project dune at elevation +16 ft. NAVD.

### 1.9.4 Federal Navigation Channels

There are two Federal navigation channels in the Project Area. The Federal Navigation at Jamaica Bay was authorized by the Rivers and Harbors Act of 1910 and subsequently modified by the Rivers and Harbors Acts of 1945 and 1950, and includes an entrance channel at Rockaway Inlet with a controlling depth of -20 feet MLLW. The channel continues to Barren Island at a depth of -18 feet MLLW. Branch channel depths range from -12 feet to -18 feet MLLW (USACE, WCSC 2014). The Project also includes the rock jetty constructed on the east side of the entrance channel.

Dredging records for the Rockaway channel show initial construction in 1930. No maintenance dredging of the entrance channel occurred until 1976, after which records show regular maintenance of the channel. The lack of maintenance dredging until the 1976 is likely due to the impoundment capacity of the jetty at Rockaway Inlet. Once maintenance dredging began in 1976, dredging intervals varied from 1 year to 5 years. Maintenance dredge volumes have gradually increased over time and is likely due to the growth of the fillet and increasing bypassing around east jetty at Breezy Point.

According to the Waterborne Commerce of the United States, domestic commercial vessels made approximately 1,002 upbound (entered Jamaica Bay) and downbound (exited Jamaica Bay) trips in 2013 (USACE, 2013). Based on this report, no trips were made by non-domestic vessels into Jamaica Bay.

Commercial vessels primarily transport bulk fuel to several privately operated bulk fuel storage terminals located in basins at the eastern end of Jamaica Bay. Commercial vessels also transport sand and gravel to several aggregate facilities at the eastern end of Jamaica Bay and north of Coney Island. A list of Wharf and Dock Facilities is presented in the Affected Environment section of the Environmental Appendix.

The Federal Navigation Channel at East Rockaway Inlet was authorized by the Rivers and Harbors Act of 1930. The project allows navigation to proceed from the Atlantic Ocean into Reynolds Channel and the bays north of the Long Beach. The inlet provides for a channel 12 ft. deep and approximately 250 ft. wide; one jetty constructed on the east side of the channel; one jetty (authorized but not constructed) on the west side of the channel.

Dredging records for East Rockaway channel show initial construction in 1935, maintenance dredging from 1938-1985, a channel realignment in 1988, and regular maintenance dredging from 1989 to present.

### 1.9.5 Jamaica Bay Study

A 1990 Study resolution for Jamaica Bay, Marine Park, and Plumb Beach New York resulted in the completion of a Reconnaissance Study by USACE New York District. The study recommended feasibility investigations for storm damage reduction in areas of areas of Arverne, Plumb Beach, Howard Beach and Broad Channel. The storm damage reduction study never advanced past the reconnaissance phase due to lack of local support at the time. The report also recommended a feasibility study for environmental restoration in Jamaica Bay, which moved forward. Some of the features recommended in the Jamaica Bay Study (now incorporated into the Hudson-Raritan Ecosystem Restoration Feasibility Study) are considered in this reevaluation study for CSRM as NNBFs and as potential mitigation.

## 1.10 History of the Investigation

As described above, this General Reevaluation is a result of the Section 934 analysis, which recommended project reformulation to identify the appropriate long-term solution for the Project Area. The Reformulation effort was initiated in 2003, and had focused on developing plans for risk reduction along the Atlantic Ocean Shoreline when Hurricane Sandy impacted the study area.

The size and energy of Hurricane Sandy caused damage not previously experienced along the Atlantic coast and left in its wake degraded coastal features, which increased risks and vulnerability from future storm events.

The Disaster Relief Appropriations Act of 2013 was passed by Congress and signed into law by the President on January 29, 2013 as Public Law 113-2 (P.L. 113-2). The legislation provides supplemental appropriations to address damages caused by Hurricane Sandy and to reduce future flood risk in ways that will support the long-term sustainability of the coastal ecosystem and communities and reduce the economic costs and risks associated with large-scale flood and storm events.

In addition to repairing the authorized project to the original design, USACE was also directed to undertake a broad, conceptual examination of the best ideas and approaches to reducing the vulnerability to major storms over time, in a way that accounts for current science and engineering, is sustainable over the long-term, both for the natural coastal ecosystem and for communities. Evaluations of project specific measures would addresses resiliency, economics, risks, environmental compliance, and long-term sustainability. Recognizing the vulnerability of the entire project area from Rockaway Inlet to East Rockaway Inlet and Jamaica Bay, the Reformulation effort was re-scoped to consider a greater suite of alternatives along the shorefront, and plans to address Jamaica Bay and its communities following the devastation caused by Hurricane Sandy.

This Hurricane Sandy General Reevaluation is being conducted under the current, SMART planning guidelines developed under the recent USACE planning modernization. Under these guidelines, planning studies are limited to a 3 years duration and cost of $3 million dollars, and are managed through a 3-tier vertical team (VT). These planning guidelines were revised to emphasize risk-based decision-making and early vertical team engagement while further developing and enhancing USACE planning capability.

The Alternatives Milestone was held in October 2014, which recommended a final array of alternatives that included 1) a Perimeter Plan for CSRM structures along the shoreline within Jamaica Bay and along the Atlantic Ocean shorefront and a Storm Surge Barrier Plan at Rockaway Inlet, which also included CSRM features along the Atlantic Ocean shorefront.  The TSP Milestone was held in March of 2016, which approved the release of this Draft HSGRR/EIS.

As described previously, under the current planning guidance, the TSP that was approved for public release is conceptual in nature, additional feature details will be developed between the draft report and final report, and some specific features may be deferred until the design phase, after approval of the GRR and finalization of the EIS

# 2 EXISTING CONDITIONS*

## 2.1 General

The project area is categorized by two distinct planning reaches: the Atlantic Ocean Shorefront Planning Reach and the Jamaica Bay Planning Reach. Where appropriate, project area descriptions are categorized by reach to identify the different conditions occurring along the ocean shoreline and in the bay.

The 11-mile long coastline of the Rockaway peninsula is the only unobstructed coastline of all of NYC (NYC, 2013 South Queens) and is a major recreational resource hosting millions of visitors each year (https://www.nycgovparks.org/parks/rockaway-beach-and-boardwalk). The Rockaway peninsula is home to more than 110,000 residents spread across neighborhoods all along the peninsula. The Rockaway peninsula also acts as a barrier protecting Jamaica Bay communities. Jamaica Bay includes NYC's largest remaining natural marshland and 10,000 acres of parkland under the coordinated management of NYC and the National Park Service. Jamaica Bay communities cross three New York State counties, including Kings (Brooklyn), Queens, and Nassau counties with a population of more than 160,000 (NYC 2014 South Queens and Brooklyn). Many of the residences in Jamaica Bay communities were built in the 1920's in low lying areas, which are very susceptible to flooding.

## 2.2 Physical Description of the Existing Area

### 2.2.1 Tides

The mean tidal range along the Atlantic Shorefront project area is 4.5 ft. and the spring tidal range reaches 5.4 ft. The Mean High Water (MHW) level and Mean Low Water (MLW) level relative to NAVD88 are +1.5 ft. and - 3.0 ft., respectively for the Atlantic Coast of the Island. With respect to the Bay, the MHW level and MLW level relative to NAVD88 within the Bay are +2.4 and -3.07 respectively.

### 2.2.2 Tidal Currents

With respect to the Atlantic Ocean Shoreline, tidal currents are generally weak. Currents at Rockaway Inlet and East Rockaway Inlet have respective average maximum velocities of 3.1 and 2.3 knots at flood tide, and 2.6 and 2.2 knots at ebb tides.

Rockaway Inlet is the only tidal inlet into Jamaica Bay with high currents at its narrowest point which is 0.63 miles with an average depth of 23 feet (USFWS 1997). At the entrance to Rockaway Inlet, the prevailing currents slow as they enter the mouth of the Bay and turn to the east and again slow which significantly reducing tidal exchange. Tides in Jamaica Bay are semi-diurnal and average 5 feet. Dredging has deepened the mean depth of the bay from approximately 3 feet in the past to 13 feet now, which has increased the residence time of water from 11 days to an average of 33 days but varying by depth and location (USFWS 1997). The maximum tidal current speeds in North Channel at Canarsie Pier are 0.5 knots (0.84 ft./s) flood and 0.7 knots (0.84 ft./s) ebb (USACE 2005). USGS observations of flow speeds at the USGS Rockaway Inlet gauge are generally 1.0 knots or less during neap tide periods and 1.7 knots or less during spring tide periods (Arcadis 2016b).

### 2.2.3 Wind and Wave Climate

Wind speed/direction data for the Jamaica Bay Planning Reach were available from recorded wind data at the National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC) for JFK Airport. Data is available beginning in the early half of the 20th century to the present. Based on the wind speed-direction occurrence, normal winds are predominantly from south clockwise to northwest quadrant, with stronger winds predominantly from west and northwest. Average monthly wind speeds range from 10 to 14 miles per hour (mph) and the maximum wind gust reached 71 mph and peak wind gusts from 47 to 71 mph with a prevailing direction from south.

The direction of wave approach to the Atlantic Ocean Shoreline project area is primarily from the south and southeast. For the Atlantic Coast of Long Island Jones Inlet to East Rockaway Inlet Long Beach Island Project, a wave height-frequency curve was developed to obtain storm wave conditions (USACE 1995). Breaking wave heights were calculated for the 10, 25, 50, 100 and 500-year return periods. The results of these calculations indicate that the deep-water wave height for a storm having a 100-year return period would be 21 ft. (USACE 2015).

Due to the length and orientation of Rockaway Inlet, the Bay project area is largely sheltered from ocean waves. The majority of waves in the bay are locally generated due to wind/water surface interaction or produced by vessels navigating the interior channels. The wind climate varies from calm and light to potentially dangerous winds of a winter nor'easter or a late summer hurricane. The wind, waves, and currents have significant bearing on the sustainability of the marsh within the bay. To varying degrees, the stability of the vegetative cover and the conservation of sediment depend on these coastal processes. The wave climate may be considerably different from year to year, resulting in very different erosion rates from year to year.

### 2.2.4 Sea Level Change

Local relative sea level change (SLC) was considered in selection of the TSP based on the guidance contained in the most recent Engineering Regulation (ER) 1100-2-8162 (USACE 2013e), which is the successor to the Engineering Circular (EC) 1165-2-212 (USACE 2011). This guidance requires the consideration of a range of relative SLC including the historic rate of SLC, and projections of increased rates of SLC. The current rate of local SLC, including subsidence, at the Sandy Hook, NJ gauge is 3.99 millimeters/year (.013 feet/year) (http://marine.rutgers.edu/geomorph/geomorph/pages/slr.html). A more detailed discussion of the range of SLC and the effects of SLC is discussed in Section 3.6 Sea Level Change.

## 2.3 Environmental and Historic Resources

### 2.3.1 Description of the Ecological Region

Jamaica Bay, formed by the barrier created by the Rockaway Peninsula, and its saltmarsh islands form one of the most recognizable and striking natural features within the urban landscape of NYC. Prior to the extensive urban development occurring over the past 150 years, tidewater grasslands colonized postglacial outwash plains at the ends of many creeks and streams in Jamaica Bay creating fringing salt marshes which encircled the bay. Figure 5, which reproduces a survey map from 1889, depicts the extensive saltmarsh islands and many more thousands of acres of fringing marshes and transitional uplands that once adjoined the mainland. The Rockaway peninsula did not extend much past what is now Jacob Riis Park. Figure 6, the current NOAA navigation chart, depicts current conditions in which nearly all fringing marshes are now gone because of filling for development, dredging, and pollution-related degradation (NPS, 2014). The Rockaway peninsula now extends much farther to the west creating a more funnel shaped Rockaway Inlet.

The contrast of Figures 2-1 and 2-2 illustrate the extent of the modifications of the project area in the last 130 years. The Rockaway peninsula has been substantially extended; islands have been removed by dredging or extended to the nearby mainland by fill; shorelines have been altered by dredge and fill activities; bulkheads have been installed to stabilize and protect shorelines; channels and borrow areas been dredged, altered bottom contours affect flows; and natural tributaries have essentially disappeared causing sediment input from these tributaries to be mainly silts and particulates from urban runoff (DEP, 2007).

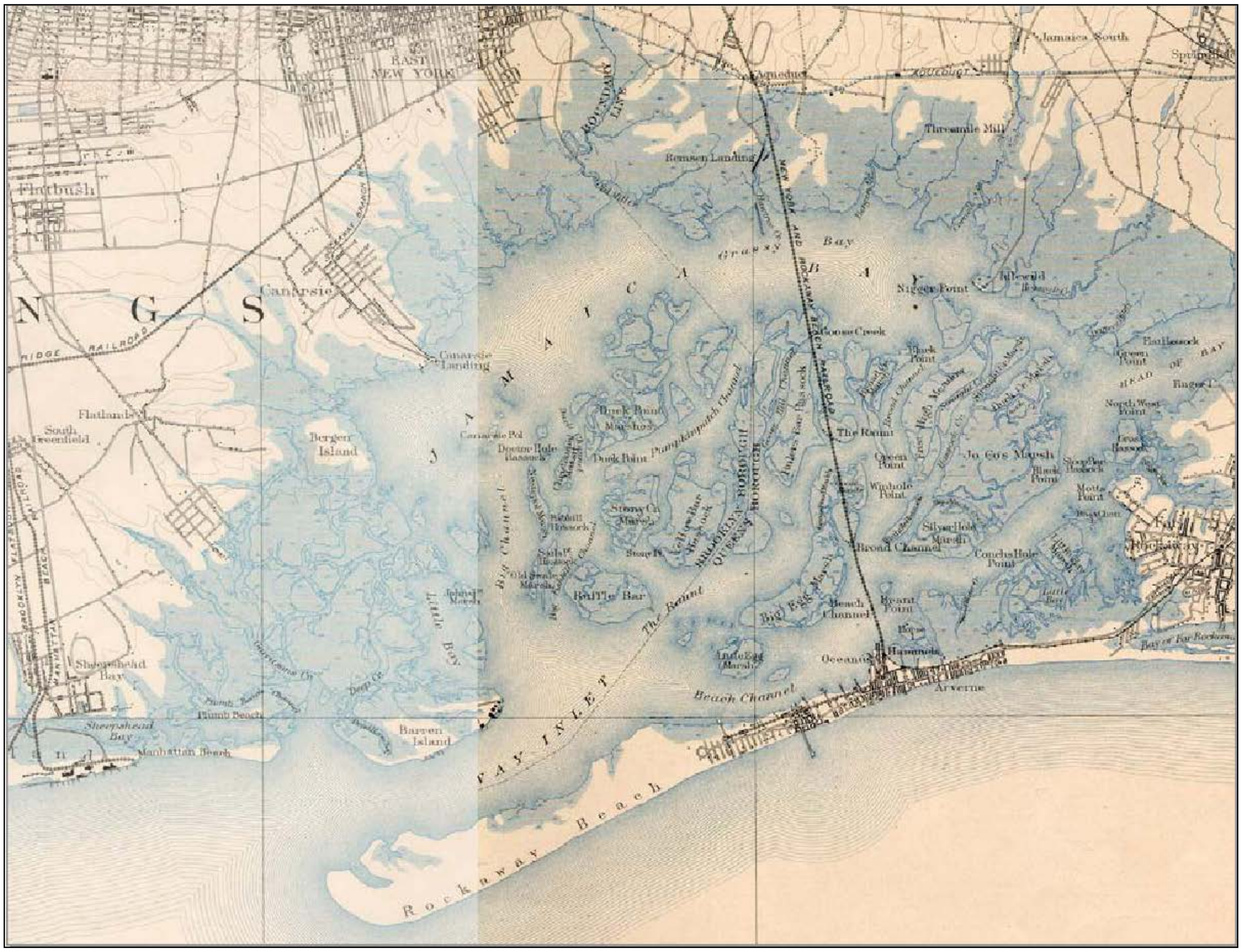


**Figure 2-1: Jamaica Bay circa. 1889**

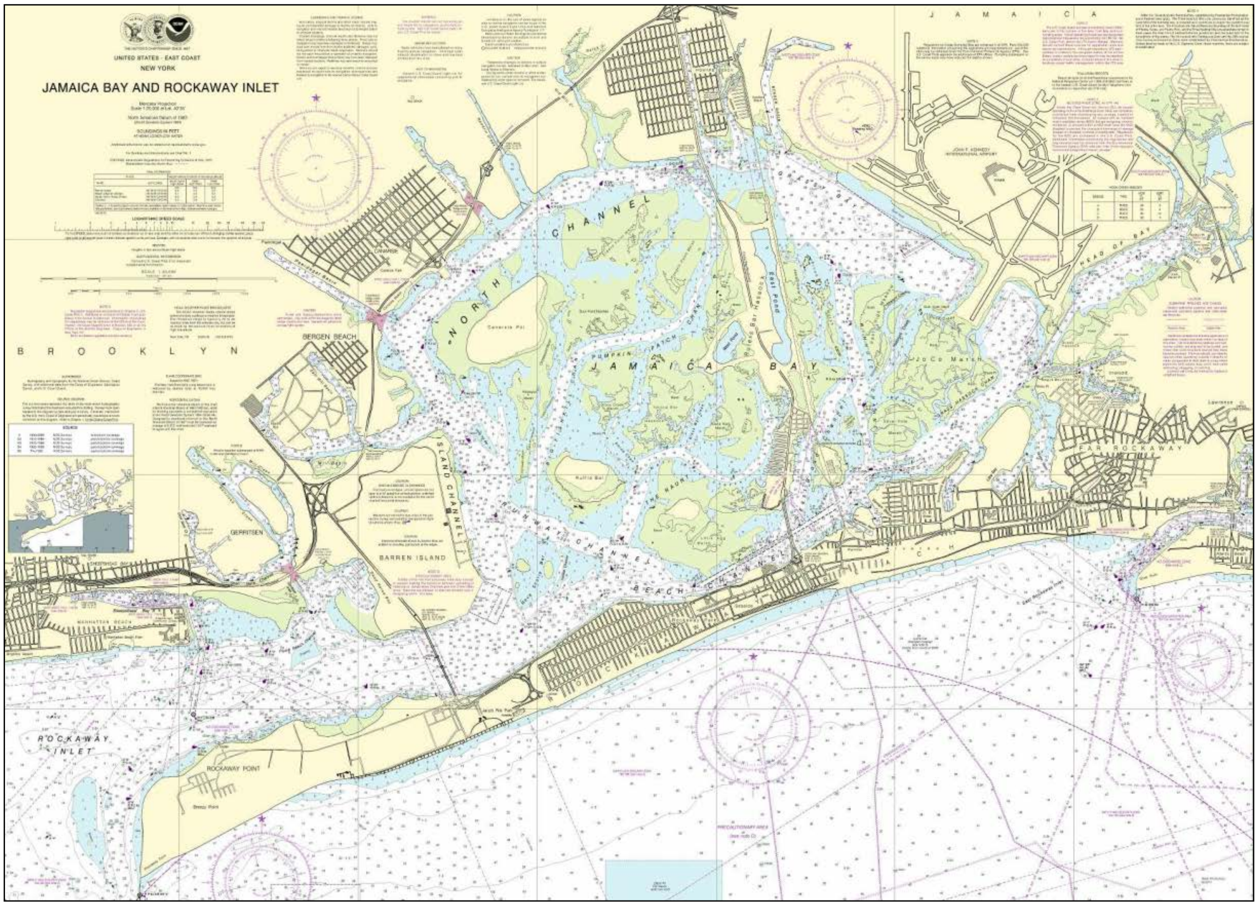


**Figure 2-2: Jamaica Bay circa. 2014**

## 2.3.2 Urban Development Impact on Natural Processes

The 71,000 acre Jamaica Bay watershed is comprised of the highly urban communities of Brooklyn and Queens as well as a small portion of Nassau County. Three hundred years ago, the area north of Jamaica Bay was host to numerous freshwater wetlands and uplands with grassland, shrubland, and forest plant communities. Creeks would have meandered through large wetlands on their way to Jamaica Bay. Most of the precipitation reaching the ground surface infiltrated into the soil or collected into natural stream channels and the nutrients entering the Bay from the watershed would have been easily assimilated into the Bay. Today's project area landscape is an urban environment with residential, commercial, industrial, and transportation infrastructure having replaced the natural vegetation (DEP, 2007). The upland areas adjacent to the marsh are largely underlain by urban fill or dredged materials (NPS, 2014).

The natural surface water tributaries to Jamaica Bay have been mostly filled, routed through pipes, or diverted (NPS, 2014). The remaining tributaries are now either substantially engineered, such as Sheepshead Bay and Paerdegat Basin, or are remnant creeks, such as Spring Creek and Brookville Creek. Major tributaries have been altered by channelization and tend to have little freshwater flow other than that conveyed during storm events (NPS, 2014). As a result, the primary sources of freshwater into the bay are wastewater treatment facility discharges (240-340 million gallons per day) and stormwater drainage (i.e., episodic urban runoff) through numerous combined storm water and sewer overflow (CSO) pipes (NPS, 2014).

A sediment budget is the exchange of sediment input, deposition, and transport out of the system. Usually, the sediment budget is expressed in terms of the volume of sediment gained or lost per year for a given area. Hardened shorelines around the perimeter of Jamaica Bay and the replacement of natural features with expanses of impervious surfaces throughout the watershed reduce the input of upland sediment. Filling of inlet connections to the ocean in the southeastern portion of the Rockaway Peninsula (Sommerville Basin, Norton Bay, and Little Bay as examples) and extension of the peninsula to the west by nearly 16,000 feet (3 miles) over the last 125 years has reduced sediment input to Jamaica Bay from the ocean side of the Rockaway Peninsula.

Historically, the average depth of Jamaica Bay has been estimated to be approximately three (3) feet. Dredging of Jamaica Bay sediments as a source for fill material and for navigation began in the 1800's (Rhoads, et al, 2001). Currently, the average depth is approximately 13 feet, with navigation channel depths in excess of 20 feet, and numerous borrow pits with depths in excess of 50 to 60 feet (NOAA, 2014). The westward extension of the Atlantic Ocean Shoreline, which has reduced sediment input from the ocean, combined with reduced sediment inputs from the watershed and historical removal of large volumes of sediment have caused most locations within Jamaica Bay to experience a long-term negative sediment budget (NPS, 2014), which has severely impacted the natural inland migration and stability of Jamaica Bay's marshes.

These large scale historical changes to the physical environment have substantially reduced the presence of natural shorelines ecosystems. Figure 2-3 presents Jamaica Bay profile approximations for pre-development and current conditions (DEP, 2007). The loss of these natural shorelines within Jamaica Bay has substantially reduced ecosystem resiliency by removing the natural substrate that would have provided areas for wetland migration and transitional habitats.

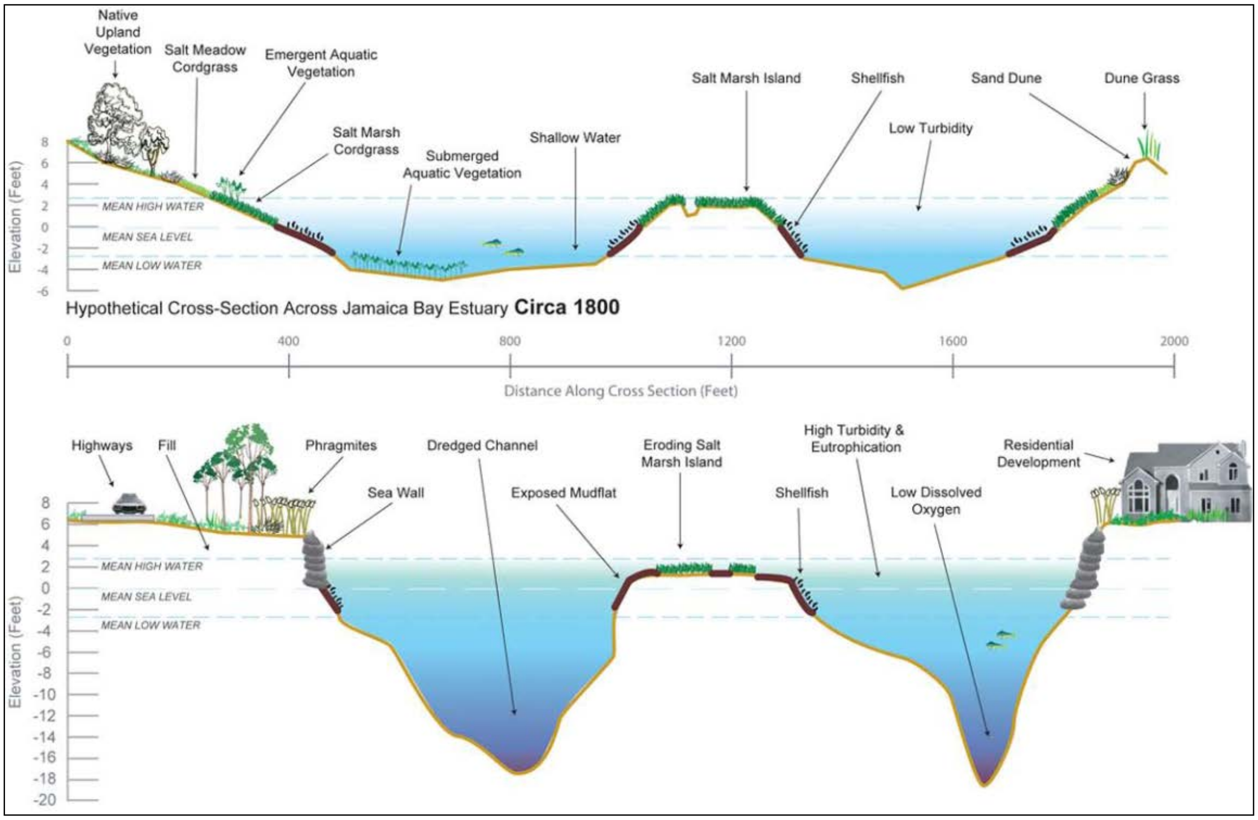


**Figure 2-3: Jamaica Bay Profiles - Pre-Development and Current**

The Rockaway peninsula also has been impacted by urban development. Prior to the stabilization of Rockaway and East Rockaway Inlets the shoreline experienced large morphological changes including the growth of the Rockaway Peninsula to the southwest by more than 4 miles (Figure 2-4), and westward migration of East Rockaway Inlet (not shown). This time period is also characterized by construction of numerous bulkheads and groins (constructed between 1914 and 1930) and placement of fill for land development purposes.

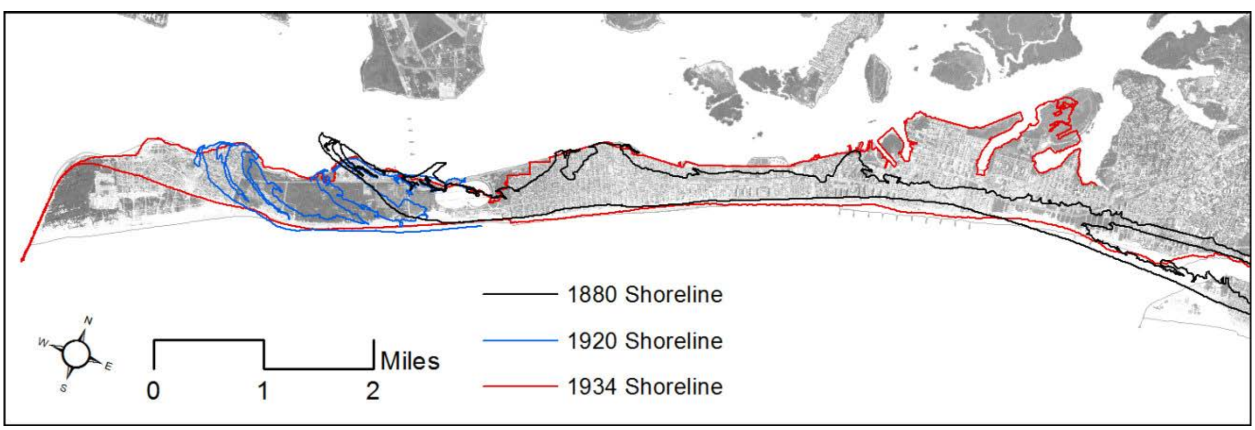


**Figure 2-4: Atlantic Ocean Shoreline Evolution 1880 – 1934**

In 1933 an 8,400 ft. long stone jetty was constructed on the updrift (eastern) side of Rockaway Inlet to stabilize the inlet. One year later, 1934, a 4,500 foot long stone jetty was constructed on the updrift (eastern) side of East Rockaway Inlet to stabilize the inlet. A second jetty was authorized for construction on the downdrift (eastern) side of East Rockaway Inlet but was never constructed. The construction of the jetties halted the westward migration of the inlets stabilized their position. Shortly after the construction of the Rockaway Inlet jetty (1936) approximately 5 million cubic yards of fill was placed at the western end of Rockaway for land development. The fillet updrift of Rockaway Inlet continued to grow over this time period (Figure 2-5) creating the area now called Breezy Point.

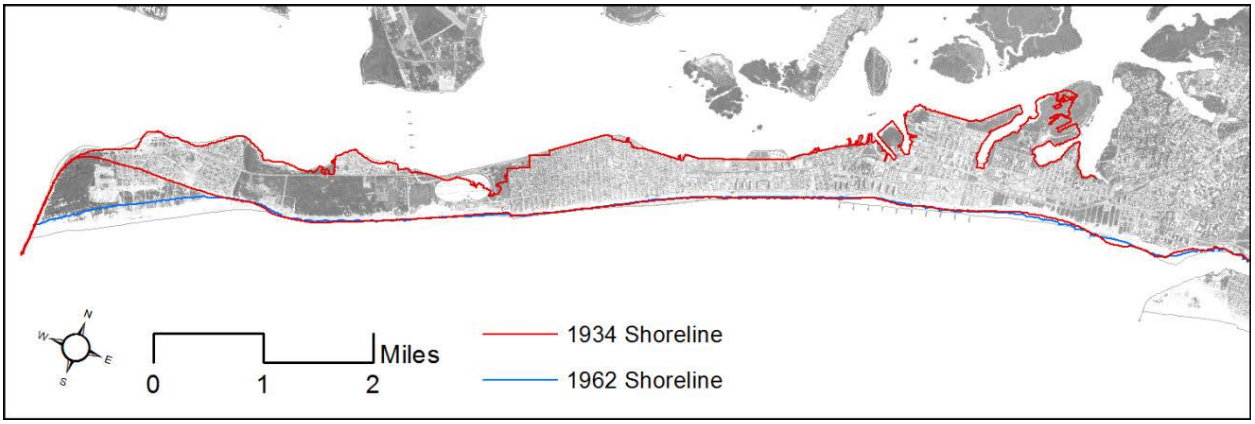


**Figure 2-5: Atlantic Ocean Shoreline Evolution 1934 – 1962**

From 1930-1976 no maintenance dredging was required at Rockaway Inlet as nearly all of the sediment was impounded updrift of the jetty. This time period is also characterized by construction of additional stone and timber groins and sporadic beachfill projects. No major beachfill operations occurred between 1961 and 1973 and all the shore stabilization groins were complete except the Beach 149th St. terminal groin, which was built in 1982. The only fill placement during this time period, 175,000 cubic yards. Over this time period the shoreline was relatively stable, with shoreline change rates between +7.9 ft/yr and – 5.4 ft/yr. It is noted that in 1962 a very strong Nor'easter known as the "Ash Wednesday Storm of 1962" caused extensive coastal erosion as the storm persisted over 5 high tides.

Since 1975, there have been two major beach nourishment projects (WRDA 1974 and section 934 of WRDA 1986) with intermittent renourishment and routine maintenance dredging of East Rockaway Inlet. An estimated 18.7 million cubic yards of beach fill was placed at Rockaway Beach during this time period. The shoreline positions fluctuated over this period in concert with the beach nourishment activities (Figure 2-6).

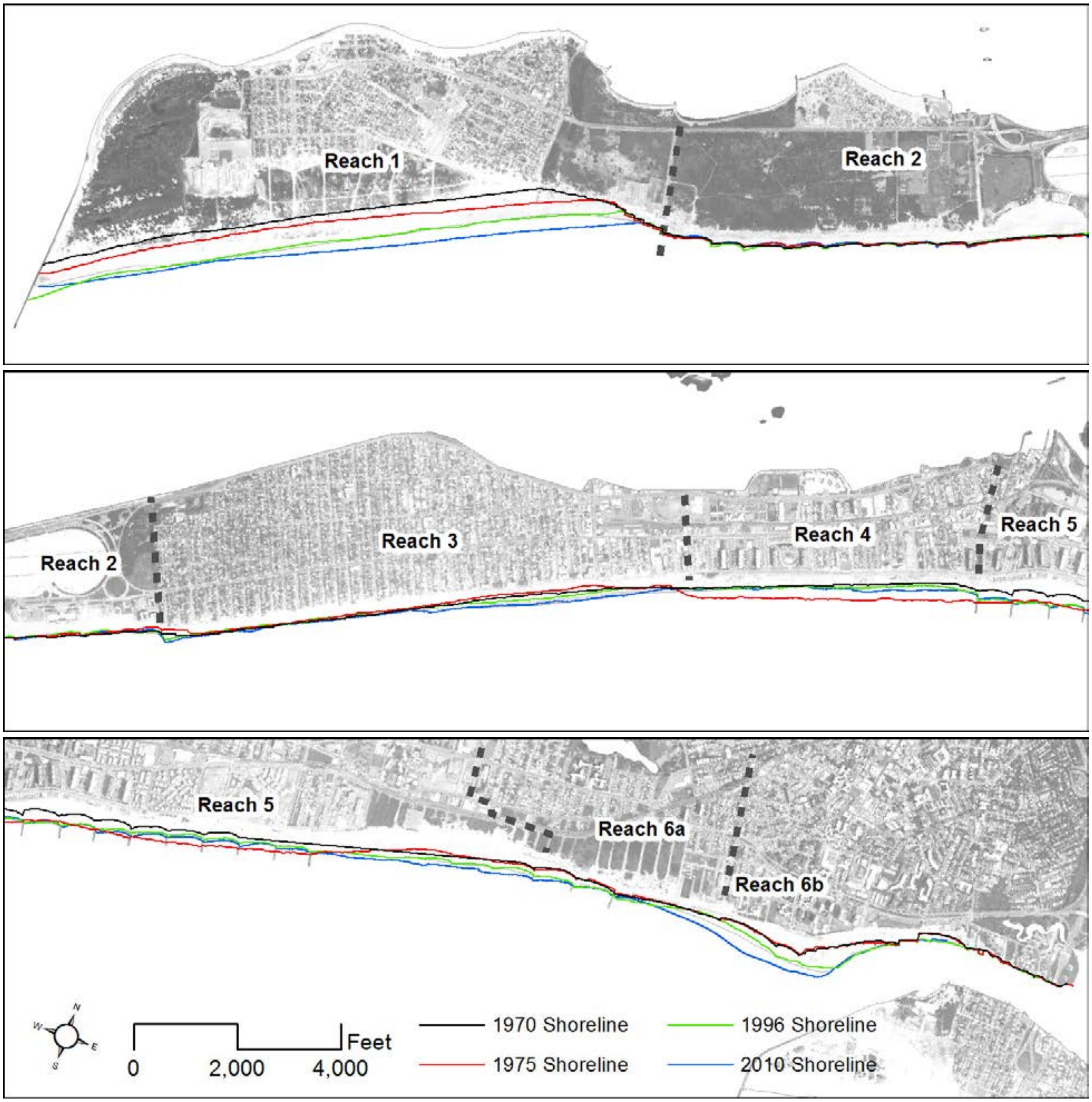


**Figure 2-6: Atlantic Ocean Shoreline Evolution 1970 - 2010**

### 2.3.3 Coastal Storm Hazards

For the purposes of the preliminary screening described in this document, major storms are identified to be those which produce surge tide and wave conditions similar to the 100-year base flood elevation (BFE), as defined by Federal Emergency Management Agency (FEMA), with additional consideration of projected sea-level change (SLC). FEMA recently released Preliminary Flood Insurance Rate Maps (FIRMs) in the NYC portion of the study area, which include consideration of stillwater elevations and wave conditions, which illustrate current flood risks in the study area. Though these maps are not yet the effective FIRMs in NYC, they are believed to be the best available information for defining 100-year flood elevations. The portions of the study area in Nassau County are assessed using the Nassau County 2009 Flood Insurance Study (FIS) 100-year effective Base Flood Elevation (BFE) data. These data were released in 2009 by FEMA (FEMA 2009) and include consideration of still water levels and wave action throughout Nassau County. Figure 2-7 shows the preliminary FIRMs for NYC and the effective BFEs in Nassau County.

Water levels used in the more detailed alternative evaluations were selected from the available USACE North Atlantic Coast Comprehensive Study (NACCS) data (NACCS-Simulation BasePlus96Tides). The NACCS analysis included numerical model simulations of several storms under various tidal conditions to estimate the 100-year water level in the bay (Cialone et al. 2015). This study did not report wave conditions for the 100-year event. Instead, this study used wave conditions from the Federal Emergency Management Agency (FEMA) flood insurance rate map study from 2013 (FEMA 2013). This was deemed reasonable because the water levels from both studies at the 100-year recurrence interval are comparable. This conclusion is corroborated by a USACE study in Raritan Bay (USACE 2015a).


**Figure 2-7: Preliminary FEMA Map Elevations (NAVD88) for the Study Area**

### 2.3.4 Impacts of Hurricane Sandy

The study area was one of the areas most devastated by Hurricane Sandy. Within the study area, 10 fatalities and more than 1,000 structures were sufficiently damaged to restrict re-entry or were destroyed by Hurricane Sandy (NYCOEM, 2016). The NYC Department of Buildings post-Sandy damage assessment indicates the disproportionate vulnerability of the study area to storm surge damage (Figures 2-8 and 2-9). Of all buildings city-wide that were identified as unsafe or structurally damaged, 37% were located in the southern Queens portion of the study area, which is far greater than the percentage of all buildings in the Hurricane Sandy inundation zone that are located in southern Queens portion of the study area (24%). In addition to the structural impacts caused by waves and inundation, fires ignited by the storm surge inundation of electrical systems destroyed 175 homes at the Rockaway Peninsula portion of the study area (SIRR).

Hurricane Sandy hit the study area at almost exactly high tide. Waves eroded beaches, breached boardwalks and seawalls, and broke against buildings in the oceanfront communities. Storm water inundation reached as much as 10 feet above ground in some portions of the study area. In addition more than 1.5 million cubic yards of sand was torn from Rockaway Beach and deposited on oceanfront communities or washed out to sea.

Floodwaters funneled through Rockaway Inlet amassing a storm surge that inundated all the neighborhoods surrounding Jamaica Bay. The low-lying neighborhoods in the central and northern portions of the Bay, where the narrow creeks and basins provide the marine aesthetic of the neighborhood, were especially devastated by flood waters. Damage to the elevated portion of the subway system in Jamaica Bay and Rockaway (A line) disrupted service for months affecting about 35,000 riders daily. In the southern Queens portion of the study area 37 schools were closed for up to two months.

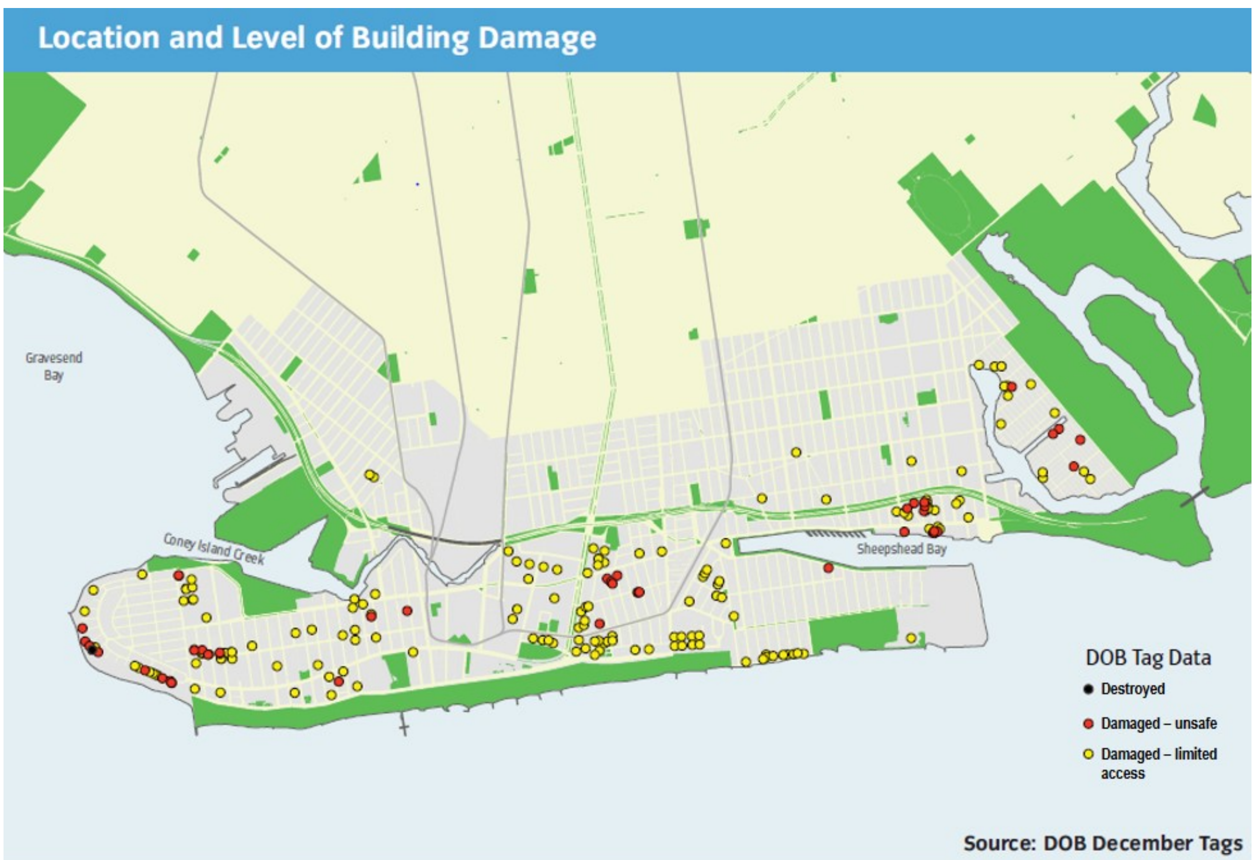


**Figure 2-8: Hurricane Sandy Building Damage (re-entry limitations) - Brooklyn**

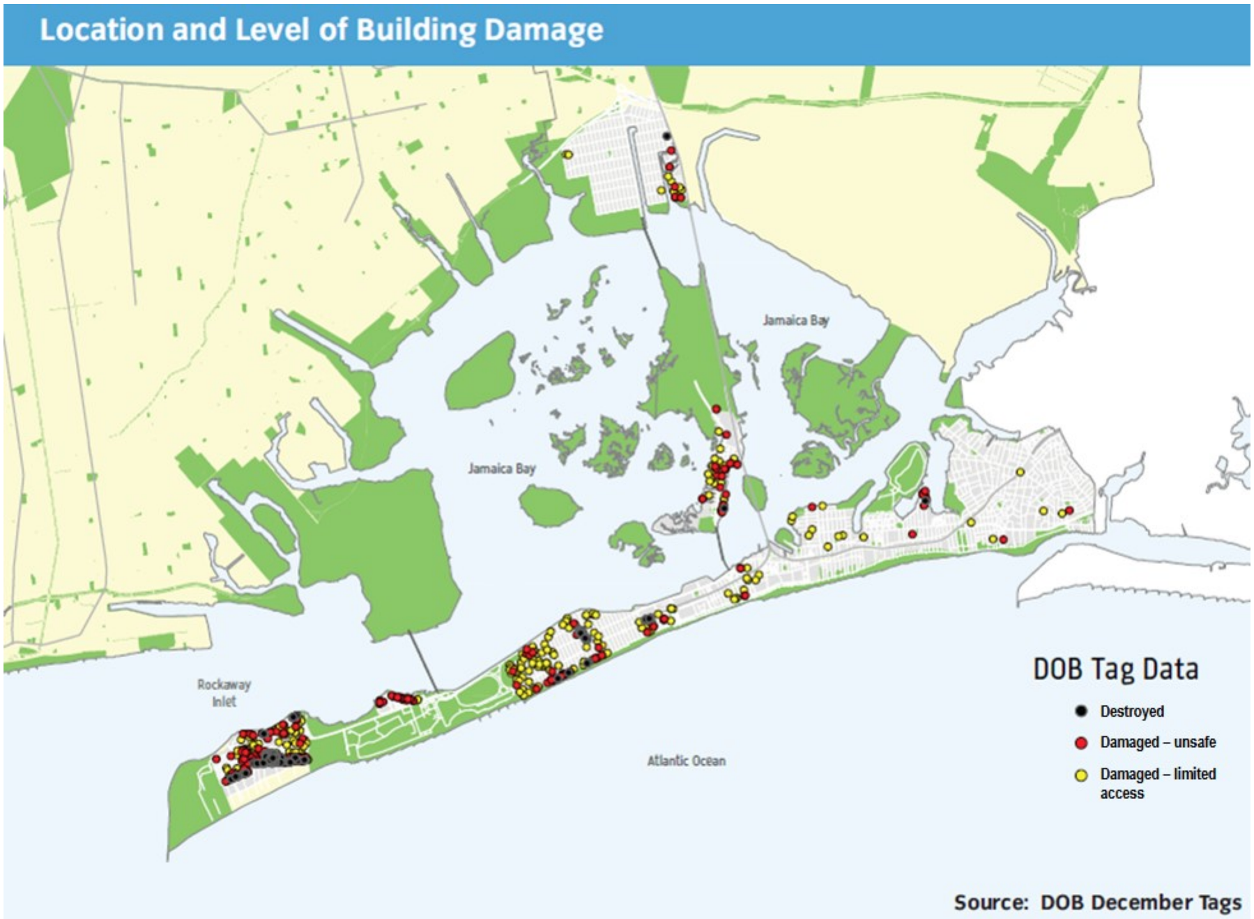


**Figure 2-9: Hurricane Sandy Building Damage (re-entry limitations) - Queens**

In the NACCS, The project area was identified as being within the Area of Extreme Exposure during Hurricane Sandy, which is defined as an area exposed to wave heights greater than +9 feet MHHW onshore and greater than 30 feet offshore (USACE, 2013d). The height of the beach and dunes on the Rockaway Peninsula at the time Hurricane Sandy hit is unknown, but project height was below design dimensions (USACE, 2013d). Although the beach berm on the Rockaway Peninsula had been overtopped, widespread flooding, inundation, and damages were also due to back-bay flooding, which had not been addressed through implementation of coastal flood risk management measures in project construction authorization (USACE, 2013d). Additional information concerning high-water marks with photos is available on the Hurricane Sandy Storm Tide Mapper website, at http://water.usgs.gov/floods/events/2012/sandy/sandymapper.

The HRE CRP (June 2916) identified that the Jamaica Bay Planning Region experienced extensive natural resource damages resulting from the storm surge associated with Hurricane Sandy.

> *"Within the interior of Jamaica Bay, coastal wetlands were littered with debris following the storm and wrack deposits were visible in many marsh areas. Initial reports and damage assessments may have underestimated the amount of wrack deposited, especially where*

*obscured by dense reed stands or maritime woody vegetation (ALS 2012). The Jamaica Bay marsh islands, restored prior to Hurricane Sandy by the USACE in partnership with NYSDEC, NYCDEP, PANYNJ, and National Park Service (NPS), accumulated significant amounts of debris, but experienced relatively little damage to existing plantings; repairs to vegetation originally planted at Yellow Bar Island in the summer of 2012 were required in the spring of 2014. The sand placed on Rulers Bar and Black Wall islands did not experience any damage as a result of the storm. Black Wall and Rulers Bar were subsequently vegetated through a community based planting effort led by ALS, Jamaica Bay Ecowatchers, and the Jamaica Bay Guardian funded by NYCDEP in July 2013.*

*The freshwater East and West Ponds of the Jamaica Bay Wildlife Refuge were breached by the storm surge during Hurricane Sandy and were inundated with saltwater. Storm waves washed away portions of the berm that separated the ponds from Jamaica Bay, transforming them into saltwater inlets. The ponds were well known for their abundance of waterfowl and shorebirds, including snow geese (Chen caerulescens), lesser and greater scaup (Aythya affinis and A. marila), ruddy duck (Oxyura jamaicensis), ring-necked duck (Aythya collaris), green winged teal (Anas carolinensis), northern pintail (Anas acuta), American wigeon (Anas americana), and gadwall (Anas strepera). The sudden rise in salinity created an unsuitable environment for brackish water species, which may ultimately alter foraging habitats (ALS 2012). Proposed repairs to the primary and secondary breaches include replacement of the wetlands water control structure and installation of a groundwater well to provide freshwater, which will allow NPS to return West Pond to a more freshwater and resilient condition that supports a diversity of Jamaica Bay habitats and wildlife (NPS 2016).”*

### 2.3.5 Protected Lands in the Study Area

#### 2.3.5.1 Gateway National Recreation Area

The following sections identify the individual Gateway National Recreation Area parks that fall within either the Jamaica Bay Planning Reach or the Atlantic Ocean Shorefront Planning Reach.

*Atlantic Ocean Shorefront Planning Reach*

The Gateway National Recreation Area parks located within the Rockaway Atlantic Ocean Shorefront Planning Reach include Fort Tilden, Jacob Riis Park, and Breezy Point Tip (Figure 2-10).


**Figure 2-10: Gateway National Recreation Area - Special Management Areas**

Source: http://www.ciesin.org/jamaicabay/photogallery/jb_resources2.jpg

*Jamaica Bay Planning Reach*

The Gateway National Recreation Area parks located within the Jamaica Bay Planning Reach include Jamaica Bay Wildlife Refuge, Floyd Bennett Field, Plumb Beach, Bergen Beach, Canarsie Pier, and the Frank Charles Memorial Park (Figure 2-7).

In addition to these specific park lands, Figure 2-10 also shows (with a brown line) that the northern perimeter of Jamaica Bay and the majority of the waters of Jamaica Bay fall within the jurisdictional boundaries of Gateway.

### 2.3.5.2 NYC WATERFRONT REVITALIZATION PROGRAM (WRP)

This Discussion incorporates both Planning Reaches. The NYC Waterfront Revitalization Program (WRP) is the city's principal coastal zone management tool. It establishes the City's policies for development and use of the waterfront. Most City, State and Federal discretionary actions in the Coastal Zone must be reviewed for consistency with these policies.

On February 3, 2016, the NYS Secretary of State approved the revisions to the NYC Waterfront Revitalization Program. This set of policies and maps should be used for consistency review of all local and state actions. However, until the revisions to the Waterfront Revitalization Program (WRP) are approved by the US Secretary of Commerce, the 2002 WRP should be used for all federal actions that require consistency review.

Although the NYC WRP policies are intended to be used to evaluate proposed actions to promote activities appropriate to various waterfront locations, evaluating the consistency of existing land use with those policies can be used to anticipate future waterfront conditions. Ten policies are included in the Program: (1) residential and commercial redevelopment; (2) water-dependent and industrial uses; (3) commercial and recreational boating; (4) coastal ecological systems; (5) water quality; (6) flooding and erosion; (7) solid waste and hazardous substances; (8) public access; (9) scenic resources; and (10) historical and cultural resources.

As originally mapped and adopted in 1982, the coastal zone boundary defines the geographic scope of the WRP (Figure 2-11).

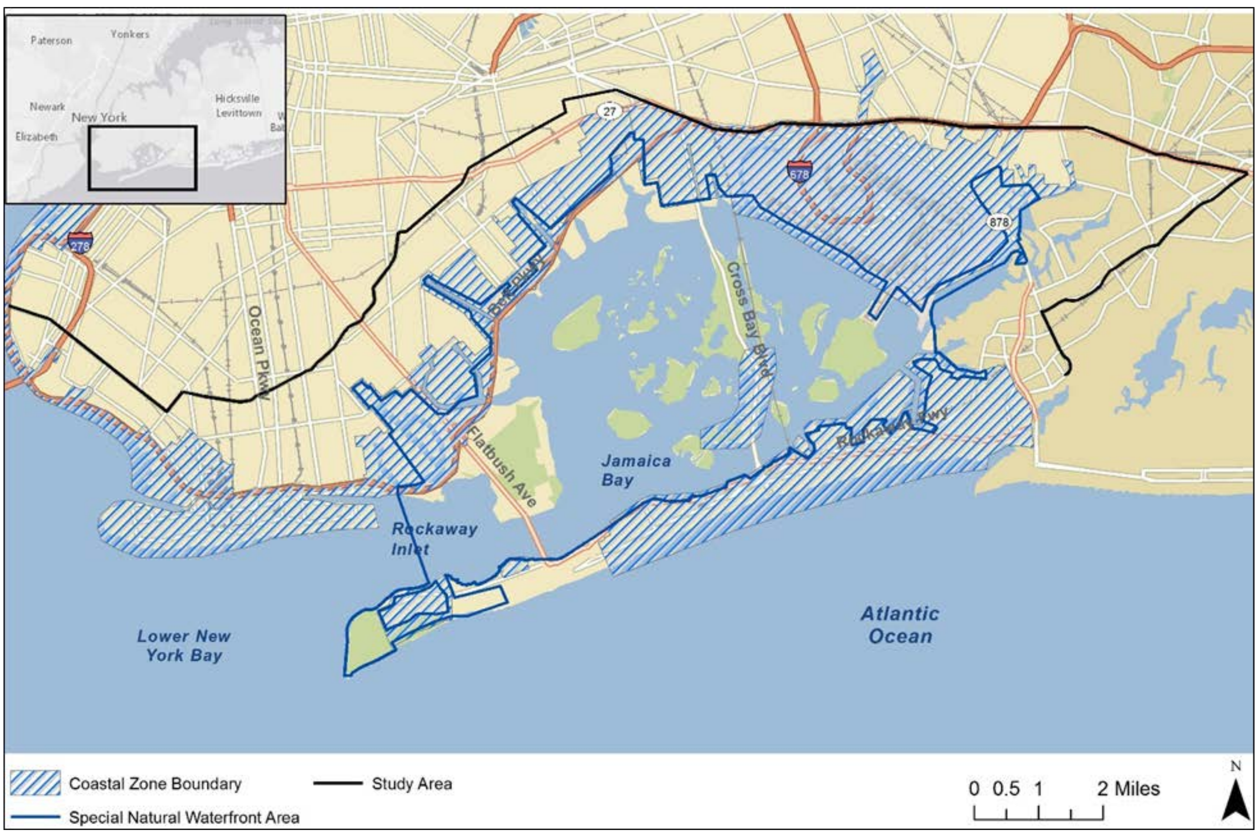


**Figure: 2-11. NYC Waterfront Revitalization Program, Coastal Zone Boundary, and Special Natural Waterfront Areas**

### 2.3.5.3 COASTAL ZONE BOUNDARY

This discussion incorporates both Planning Reaches. As originally mapped and adopted in 1982, the coastal zone boundary defines the geographic scope of the WRP. Pursuant to federal statute, the boundary encompasses all land and water of direct and significant impact on coastal waters.

The coastal zone boundary extends from the Westchester and Nassau County and New Jersey boundaries seaward to the three-mile territorial limit in the Atlantic. The boundary extends landward to encompass the following coastal features:

- Significant Maritime and Industrial Areas
- Significant Coastal Fish and Wildlife Habitats
- Special Natural Waterfront Areas (e.g. Jamaica Bay)
- Staten Island Bluebelts
- Tidal and Freshwater Wetlands
- Coastal Floodplains and Flood Hazard Areas
- Erosion Hazard Areas
- Coastal Barrier Resources Act Areas
- Steep Slopes
- Parks and Beaches
- Visual Access and Views of Coastal Waters and the Harbor
- Historic, Archaeological, and Cultural Sites Closely Associated with the Coast
- Special Zoning Districts.

In developed areas devoid of these features, the coastal zone boundary is generally defined as the nearest legally mapped street at least 300 feet landward of the Mean High Tide Line. In undeveloped areas devoid of these features, the landward boundary is delineated at the legally mapped street nearest to the first major man-made physical barrier. Exceptions to these guidelines include City Island, Broad Channel Island, and the Rockaway Peninsula which are included within the coastal zone in their entirety. Federal lands and facilities are excluded from the coastal zone and consistency review in accordance with federal legislation. However, should the federal government dispose of any coastal property, it would be included in the coastal zone.

### 2.3.5.4 NYC SPECIAL NATURAL WATERFRONT AREA

This discussion incorporates both Planning Reaches. Jamaica Bay, including the Rockaway peninsula, is a NYC-designated Special Natural Waterfront Area (SNWA). A SNWA is a large area with concentrations of important coastal ecosystem features such as wetlands, habitats and buffer areas, many of which are regulated under other programs. The New Waterfront Revitalization Program (NYC Department of City Planning [NYCDCP] 1999b) defines SNWAs as coastal areas with special characteristics identified in NYC's Comprehensive Waterfront Plan that "have particular natural habitat features that should be considered in connection with any waterfront activity." It further directs that "activities that protect and restore these features would be consistent with waterfront policy for these areas." Accordingly, the WRP encourages public investment within the SNWA to focus on habitat protection and improvement and discourages activities that interfere with the habitat functions of the area. Acquisition of sites for habitat protection is presumed consistent with the goals of this policy. Similarly, fragmentation or loss of habitat areas within an SNWA should be avoided.

#### 2.3.5.5 COASTAL BARRIER RESOURCES ACT AREAS

This discussion incorporates both Planning Reaches. In the 1970s and 1980s, Congress recognized that certain actions and programs of the Federal Government have historically subsidized and encouraged development on coastal barriers, resulting in the loss of natural resources; threats to human life, health, and property; and the expenditure of millions of tax dollars each year (USFWS, 2016). To remove the federal incentive to develop these areas, the Coastal Barrier Resources Act (CBRA) of 1982 designated relatively undeveloped coastal barriers along the Atlantic and Gulf coasts as part of the John H. Chafee Coastal Barrier Resources System (CBRS), and made these areas ineligible for most new federal expenditures and financial assistance. CBRA encourages the conservation of hurricane prone, biologically rich coastal barriers by restricting federal expenditures that encourage development, such as federal flood insurance. Areas within the CBRS can be developed provided that private developers or other non-federal parties bear the full cost.

The CBRA was amended by the Coastal Barrier Improvement Act of 1990 which added a new category of coastal barriers called Otherwise Protected Areas (OPAs). OPAs are undeveloped coastal barriers that are within the boundaries of an area established under Federal, State, or local law, or held by a qualified organization, primarily for wildlife refuge, sanctuary, recreational, or natural resource conservation purposes.

Section 6 of the Coastal Barrier Resources Act (CBRA; 16 U.S.C. § 3505) prohibits new Federal expenditures or financial assistance within System units of the CBRS and identifies exemptions to these restrictions. The project area meets with exemptions identified below. Federal expenditures are allowable within the CBRS if the project meets any one of the exceptions listed below (from 16 U.S.C. § 3505(a)(1)-(5)):

- Any use or facility necessary for the exploration, extraction, or transportation of energy resources which can be carried out only on, in, or adjacent to a coastal water area because the use or facility requires access to the coastal water body.
- The maintenance or construction of improvements of existing federal navigation channels (including the Intracoastal Waterway) and related structures (such as jetties), including the disposal of dredge materials related to such maintenance or construction. A federal navigation channel or a related structure is an existing channel or structure, respectively, if it was authorized before the date on which the relevant System unit or portion of the System unit was included within the CBRS.

- The maintenance, replacement, reconstruction, or repair, but not the expansion, of publicly owned or publicly operated roads, structures, or facilities that are essential links in a larger network or system.
- Military activities essential to national security.
- The construction, operation, maintenance, and rehabilitation of Coast Guard facilities and access thereto.

Additionally, a federal expenditure is allowable within the CBRS, if it meets any of the following exceptions (16 U.S.C. § 3505(a)(6)) and is also consistent with the three purposes of the CBRA (e.g. to minimize [1] the loss of human life, [2] wasteful expenditure of Federal revenues, and [3] the damage to fish, wildlife, and other natural resources associated with coastal barriers).:

- Projects for the study, management, protection, and enhancement of fish and wildlife resources and habitats, including acquisition of fish and wildlife habitats, and related lands, stabilization projects for fish and wildlife habitats, and recreational projects.
- Establishment, operation, and maintenance of air and water navigation aids and devices, and for access thereto.
- Projects under the Land and Water Conservation Fund Act of 1965 (16 U.S.C. § 460l-4 through 11) and the Coastal Zone Management Act of 1972 (16 U.S.C. § 1451 et seq.).
- Scientific research, including aeronautical, atmospheric, space, geologic, marine, fish and wildlife, and other research, development, and applications.
- Assistance for emergency actions essential to the saving of lives and the protection of property and the public health and safety, if such actions are performed pursuant to sections 5170a, 5170b, and 5192 of title 42 and section 1362 of the National Flood Insurance Act of 1968 (42 U.S.C. § 4103) and are limited to actions that are necessary to alleviate the emergency.
- Maintenance, replacement, reconstruction, or repair, but not the expansion (except with respect to U.S. route 1 in the Florida Keys), of publicly owned or publicly operated roads, structures, and facilities.
- Nonstructural projects for shoreline stabilization that are designed to mimic, enhance, or restore a natural stabilization system.

The western portion of the Rockaway peninsula and all of Jamaica Bay are located within the designated CBRA (Unit NY-60P) (Figure 2-12 and Figure 2-13). The "P" designation indicates an OPA designation because it is located within the Gateway National Recreation Area. http://www.fws.gov/ecological-services/habitat-conservation/cbra/Determinations.html).

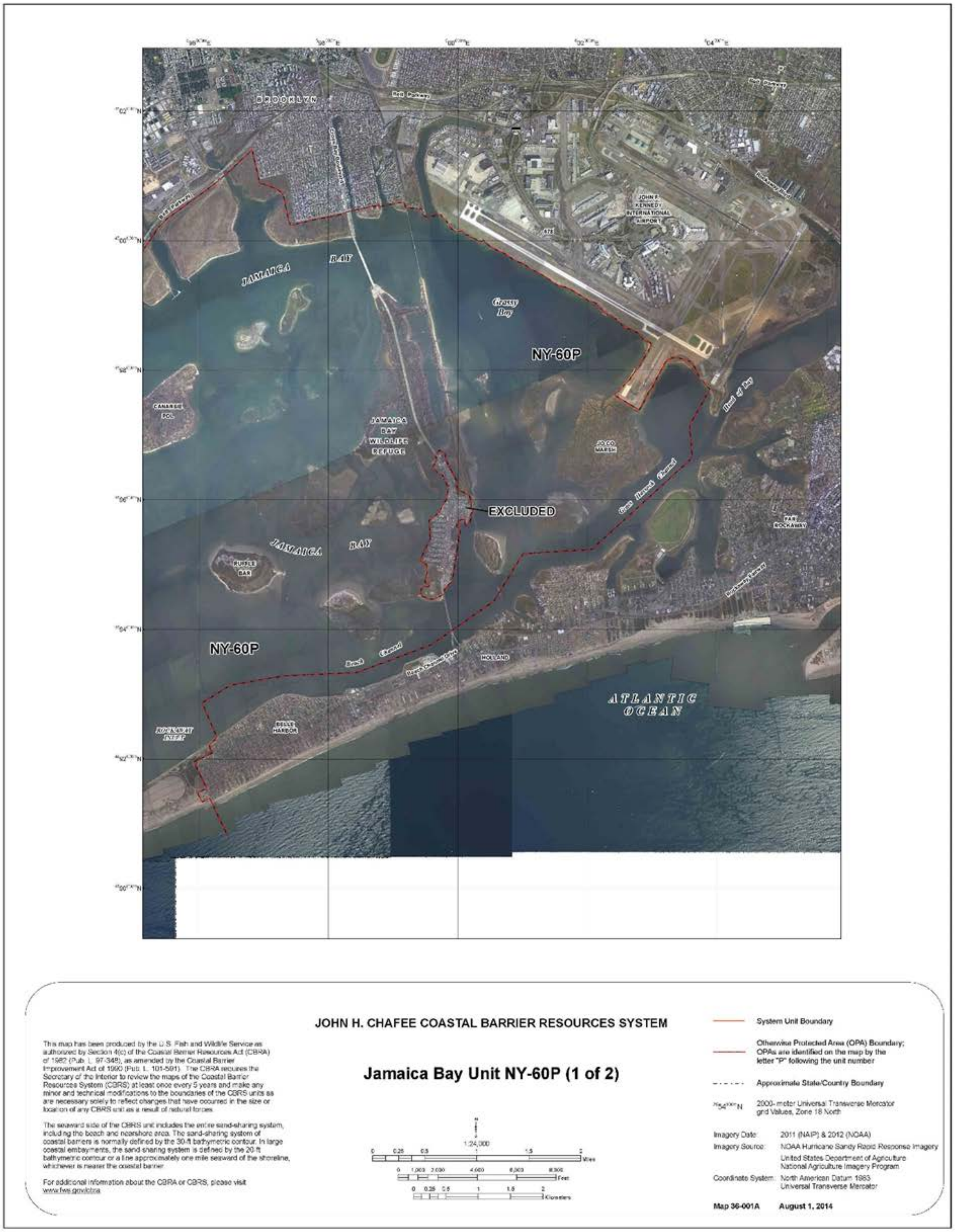


**Figure 2-12. Coastal Barrier Resource System Area (1 of 2)**

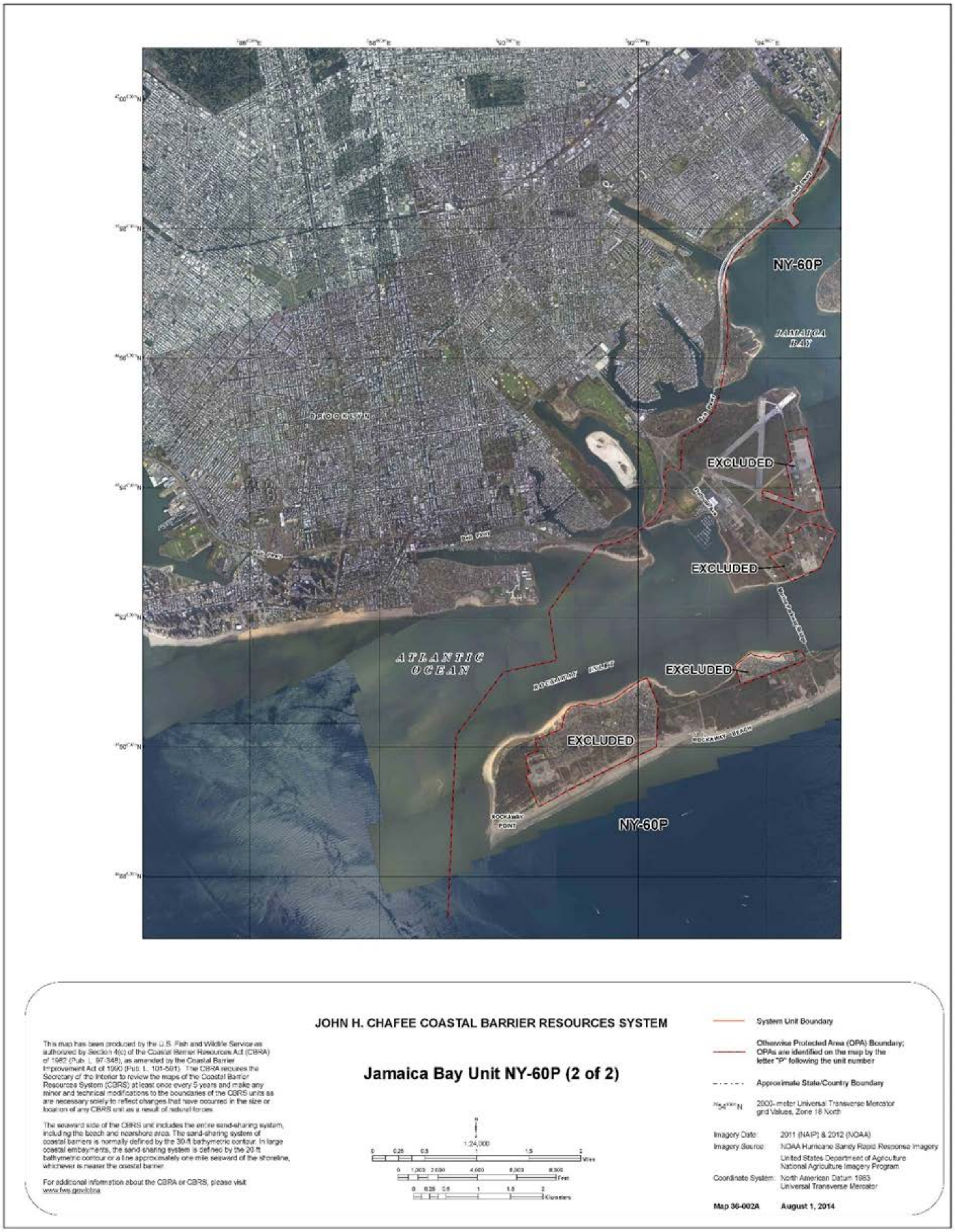


**Figure 2-13. Coastal Barrier Resources System Area (2 of 2)**

#### 2.3.5.6 New York State Natural Heritage Program

This discussion incorporates both Planning Reaches. The New York State Natural Heritage Program, in conjunction with The Nature Conservancy, recognizes two Priority Sites for Biodiversity within the Jamaica Bay and Breezy Point habitat complex: Breezy Point Tip (B2 - very high biodiversity significance) and Fountain Avenue Landfill (B3 - high biodiversity significance). The Breezy Point Tip is located in the Atlantic Ocean Shorefront Planning reach and the Fountain Avenue Landfill is located in the Jamaica Bay Planning Reach.

#### 2.3.5.7 New York State Department of State Significant Coastal Fish and Wildlife Habitats

This discussion incorporates both Planning Reaches. Jamaica Bay and Breezy Point Tip have been designated as Significant Coastal Fish and Wildlife Habitats by the New York State Department of State (NY Department of State, Planning and Development, 2016) (Figure 2-14).


**Figure: 2-14. NYS Dept. State Significant Coastal Fish and Wildlife Habitats**

Notes: Green shaded area indicates Significant Coastal Fish and Wildlife Habitats

Source: NY Department of State, Planning and Development, 2016.

#### 2.3.5.8 NYC Planning Special Purpose Districts

In additional to standard zoning, the NYC Planning Commission has designating special zoning districts (Figure 2-11) to achieve specific planning and urban design objectives in defined areas with unique characteristics (NYC Planning, 2016, http://www1.nyc.gov/site/planning/zoning/districts-tools/special-purpose-districts.page). Special districts respond to specific conditions; each special district designated by the Commission stipulates zoning requirements and/or zoning incentives tailored to distinctive qualities that may not lend themselves to generalized zoning and standard development.

*Atlantic Ocean Shorefront Planning Reach*

No NYC-designated special purpose districts were identified within the Rockaway Area of Potential Effect (APE) (NYC Planning, 2016).

*Jamaica Bay Planning Reach*

Within the Jamaica Bay APE, the NYC Planning-designated special purpose districts are located to the west of Marine Parkway Bridge and include the following areas (Figure 2-15):

- Sheepshead Bay District (the Sheepshead Bay district was identified to protect and strengthen that neighborhood's waterfront recreation and commercial character. New commercial projects and residential development must meet conditions that will support the tourist-related activities along the waterfront. Provision for widened sidewalks, landscaping, useable open space, height limitations, and additional parking.)
- Ocean Parkway District (the Ocean Parkway Special District encompasses a band of streets east and west of the parkway extending from Prospect Park in the north to Brighton Beach on the south. The purpose of the Special District is to enhance the character and quality of this broad landscaped parkway, a designated Scenic Landmark.)
- Coney Island District (the Special Coney Island District (CI) was created as part of a comprehensive, long-range plan to re-establish famed Coney Island as a year-round, open entertainment and amusement destination. Outside of the entertainment area, the district fosters neighborhood amenities and new housing opportunities, including affordable housing through the Inclusionary Housing designated areas Program.)
- Coney Island Mixed Use District (the Special Coney Island Mixed Use District (CO) was established to stabilize existing residential development and protect the industries within an area, zoned M1-2, north of Neptune Avenue. The district allows existing residential buildings to be improved and enlarged, and new residential infill housing to be developed if adjacent to an existing residence or community facility. Certain manufacturing uses and most commercial uses are allowed as-of-right on lots adjacent to existing commercial and manufacturing uses, and along certain streets that allow commercial uses.)
- Bay Ridge District (the Special Bay Ridge District (BR) maintains the neighborhood's existing scale in conjunction with contextual and lower-density zoning districts mapped throughout the district. Beyond the underlying district controls, the neighborhood streetscape is preserved by limitations on the maximum permitted floor area ratio (FAR) and the height of community facilities, which is limited to 32 feet in contextual zoning districts.)
- Development in the special use districts requires consultation with the NYC Planning Commission.


**Figure 2-15. NYC Planning Special Use Districts**

Source: NYC Planning, 2016.

### 2.3.5.9 NYSDEC Critical Environmental Area

This discussion incorporates both Planning Reaches. Jamaica Bay, including the Rockaway peninsula, is recognized by the NYSDEC under the State Environmental Quality Review Act as a Critical Environmental Area (CEA) (NYSDEC, 1990) (Figure 2-16). The NYSDEC states that Jamaica Bay and its tributaries, tidal wetlands, and regulated adjacent areas are considered to be a CEA. The tributaries leading into Jamaica Bay (e.g., Gerritsen Creek) and their tidal wetlands and regulated adjacent areas are considered as part of this CEA. The NYSDEC defines a CEA as having "exceptional or unique character." The distinct characteristics associated with Jamaica Bay are: 1) a natural setting (e.g., fish and wildlife habitat, forest and vegetation, open space and areas of important aesthetic or scenic quality) and 2) an inherent ecological, geological or hydrological sensitivity to change that may be adversely affected by any change."

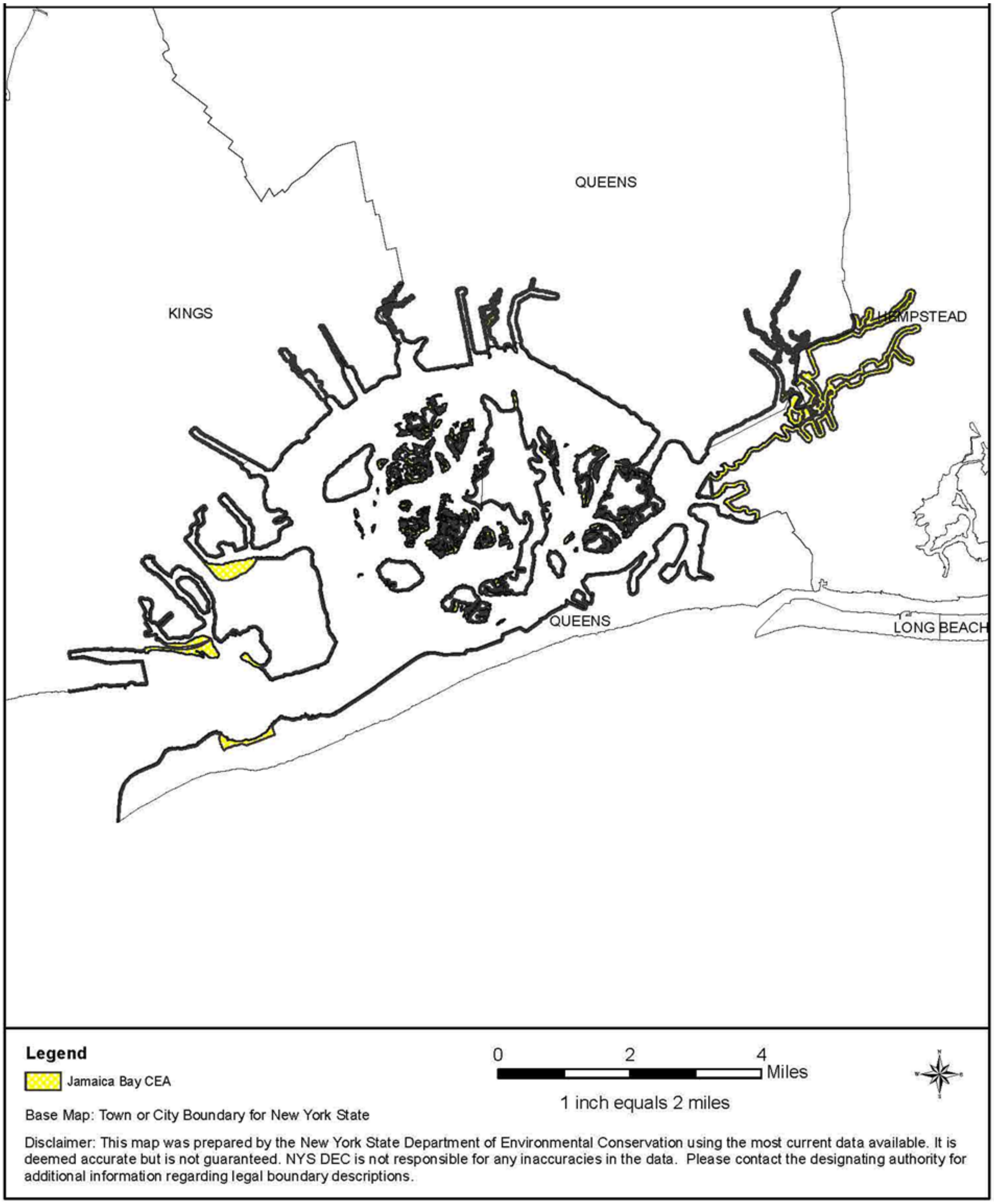


**Figure 2-16. NYSDEC Critical Environmental Area**

Source: NYSDEC, 1990.

#### 2.3.5.10 New York/New Jersey Harbor Estuary Program

This discussion incorporates both Planning Reaches. The New York/New Jersey Harbor Estuary Program (HEP) has also recognized the importance of the Jamaica Bay watershed, which includes the Rockaway Peninsula as one of the three watershed areas "of primary concern and ecological importance". HEP has adopted the HRECRP as the restoration strategy for the Program with the Jamaica Bay identified as one of the eight Planning Regions within the HRECRP study area.

### 2.3.6 Physical and Hydrological Characteristics of the Area

Both the Atlantic Ocean Shorefront Planning Reach and the Jamaica Bay Planning Reach are located at the western end of Long Island, which lies within the Atlantic Coastal Plain Physiographic Province of the U.S. and includes geological deposits and regional aquifers that are bounded to the south by the Atlantic Ocean and the north by Long Island Sound.

Long Island was formed primarily by Pleistocene-age glaciations including the Wisconsin Ice Age and Laurentide Ice Sheet, which retreated approximately 10,000 years ago. Two advances of the Wisconsin ice sheet during the Upper Pleistocene Epoch of the Quaternary Period caused the island to be blanketed with glacial till, ice-contact stratified drift, outwash deposits, and other deposits composed of clay, silt, sand, gravel, and boulders. The terminal moraines and the north shore of Long Island are composed primarily of stratified glacial drift with some till. The area between the moraines and the south shore of Long Island is primarily covered by outwash deposits. Central and South Long Island are of glaciofluvial origin. These Pleistocene deposits lie atop gently dipping, metamorphic, Paleozoic or Precambrian-age rocks (Misut and Monti 1999; US Dept Interior, NPS, October 2015).

The soils on the Rockaway peninsula are formed in a mantle of eolian and marine washed sand (USDA, 2001). These landforms are highly dynamic and can change readily with each coastal storm. Some areas have also been affected by human activities such as hydraulic filling or dredging to control erosion from hurricanes and nor'easters, and to maintain depth in nearby shipping channels. Soils found on the eolian and marine deposits within these portions of the park include Hooksan and Jamaica. On less stable landscapes the miscellaneous land units, Dune land and Beaches, are common. Soils formed in dredge filled areas include Bigapple, Fortress, and Barren. Verrazano soils are found where loamy fill has been placed over sandy materials. Soils within the Atlantic Ocean Shorefront Planning Reach are predominantly classified as Urban land-Verrazano and Urban land-Flatbush complexes, with 0-3% slopes and a sandy substratum, Hooksan-Dune land complex, and beaches. Soils along the perimeter of the Atlantic Ocean Shorefront Planning Reach are typically mucky peats susceptible to subsidence (USDA, 2016a).

Jamaica Bay has a long history of alterations by extensive dredging, filling, and development in and around the bay (USFWS, 1997; USDA, 2001). Over sixty years ago, West Pond and East Pond and other islands within Jamaica Bay were created on the filled lands from Rulers Bar Hassock

(USDA, 2001). The area was covered with fill material that consisted of natural and human materials, including rubble, fly ash, etc. (NPS, 2014a). For example, Floyd Bennett Field in the Jamaica Bay Unit was constructed on saltmarsh now covered by dredged materials, rubble, fly ash, and wastes and in some cases paved to create space for runways, hangars, and historically for the railroad across Jamaica Bay. The Fountain Avenue and Pennsylvania Avenue former landfills occupy space on the northern edge of Jamaica Bay. Each is about 80 feet high and covers 100 acres of former saltmarsh habitat (NPS, 2013).

Soils and sediments in Jamaica Bay are underlain by poorly drained glacial outwash soils in the Ipswich series, including organic materials that have accumulated since the retreat of the glaciers (USDA, 2001; US Dept Interior, 2015). Benthic soils in western Jamaica Bay are more likely fine to medium sands while sediment of the eastern and northern portions of the bay are silty and muddy, fine sand (USFWS 1997; NYCDEP 2011; US Dept Interior, 2015). The remainder of soils within the Jamaica Bay Planning Reach is predominantly classified as Urban land-Flatbush, -Verrazano, and -Riverhead complexes with 0-3% slopes and a tidal marsh or outwash substratum, Bigapple fine sand with 0-3% slope (USDA, 2016b).

The last erosional period, which may have been during late Pliocene time, generated many of the topographic features of Long Island, including the ancestral Long Island Sound and erosional scouring of a deep north-south channel in Queens County as having been incised by an ancestral Hudson River system (Cartwright, 2002). During the Quaternary, Pleistocene glacial episodes and the resulting changes in sea level caused alternating periods of deposition and erosion that reworked the surficial sediments. The last major features to be formed on Long Island are the glacial moraines, which were emplaced during the Wisconsinan glacial stage, and outwash that was deposited south of the moraines by glacial meltwater.

In 1835, Rockaway Point was located near the present east boundary of Jacob Riis Park (FEMA, 2013). East Rockaway Inlet was located 20,000 feet east of its present position, near Long Beach, New York. South of Rockaway Point, a large shoal had formed which was to provide the material for extending this point nearly four miles to the east during the next 100 years. The shoreline generally receded between 1835 and 1878 while, at the same time, Rockaway Point extended two miles westward. Jacob Riis Park acquired its present shoreline during this period. Between 1878 and 1927, the shoreline of the Rockaways advanced a small amount. Rockaway Point grew rapidly until 1902, but from 1902 to 1927, its westward expansion was only half its previous rate. Since 1975, more than 18 million cubic yards of beach fill has been placed on Rockaway Beach (see Engineering Appendix).

The characteristics of nearly all of the communities on the Rockaway peninsula are similar. Ground elevations rarely exceed 10 feet above mean sea level (msl), except within the existing dune field. Elevations along the Jamaica Bay shoreline side of the peninsula generally range from 5 feet above msl, increasing to 10 feet above msl further south toward the Atlantic coast (USGS, 2016, based on topographic maps dated 2013).

Within Jamaica Bay, it has been estimated that 150 million cubic yards of material have been dredged (FEMA, 2013). The most common use for dredged material has been for fill purposes in land reclamation projects. Originally, almost all of the area surrounding Jamaica Bay, except the barrier beach to the south, was marshland (FEMA, 2013)

The topography of the Jamaica Bay varies among the natural and man-made physiographic features within the APE, including the numerous basins and creeks that fringe the interior periphery of the bay; several man-made landfills and residential/commercial infilled developments along the interior periphery of the bay; and numerous salt marsh islands and island bars located within the interior of the bay (Figure 4.1.3 8). Accordingly, elevations vary on account of these features. The grades of the salt marsh islands and island bars vary from sea level to as high as 22 feet above msl at Ruffle Bar and Little Egg Marsh. Inland landfills rise rapidly from the shoreline to approximately 40 feet above msl, while residential/commercial areas are lower than the landfills, ranging from sea level at their shoreline to approximately 20 feet msl inland (USGS, 2016, topographic maps dated 2013).

### 2.3.7 Biological Communities in the Study Area

Coastal communities within both reaches generally occur along an ecological continuum dependent upon tidal influence. The critical tidal elevations that help define these habitats include MLLW, MHW, and mean higher high water (MHHW).

Biological communities were classified into twelve distinct habitat types that were identified and mapped throughout the project area. They represent the range of conditions and habitat quality observed throughout the Atlantic Ocean Shoreline and Jamaica Bay, including both native habitats and those resulting from long-term anthropogenic disturbances. Specifically, the Atlantic Ocean Shorefront Planning Reach consists of oceanfront beach habitat with isolated dune habitats. Most of the project area is devoid of vegetation and is significantly impacted from human use of the area for recreational activities and significant development that abuts the upper beach zone in most of the Project area. The Jamaica Bay Planning Reach consists of all twelve habitat types, and is one of the most diverse estuaries remaining in the Hudson-Raritan Estuary System (HRE). While many native communities can be found throughout Jamaica Bay, it is also characterized by dense urban development that has altered and/or created new habitats indicative of the historic anthropogenic disturbance.

A brief habitat summary for each habitat type is provided below, and additional habitat and plant community descriptions can be referenced in the Affected Environment section of the Environmental Appendix. In addition, the USFWS National Wetland Inventory (NWI) map for the entire Jamaica Bay watershed is included in the Affected Environment section of the Environmental Appendix.

#### 2.3.7.1 Subtidal Bottom

Subtidal bottom are all open water areas below the MLLW line (i.e., -3.1' North American Vertical Datum of 1998 [NAVD 88]). This habitat type represents a significant area throughout Jamaica Bay, as well as a significant variation of water depths (both naturally occurring and anthropogenic). Specific to this habitat type, historic anthropogenic disturbances have commonly altered this habitat and its connection to adjacent intertidal and upland habitats. In addition, managed navigation channels occur throughout the bay to support commerce within the bay.

#### 2.3.7.2 Oyster Reefs

As noted in the HRECRP, no known oyster reefs exist in the HRE study area presently. However, scattered live oysters can be found in certain areas, indicating the presence of isolated populations. NYCDEP, in collaboration with Cornell University's Cooperative Extension Service, constructed pilot oyster reef sites in Jamaica Bay in late 2010, by establishing a spat-on shell reef at Dubos Point and placed spat-covered reef balls in Gerritsen Creek. Both sites were monitored through 2012 and exhibited healthy oyster growth and survival, as well as a high degree of utilization by natant macrofauna.

Oyster reefs provide vertical and horizontal complexity to the subtidal bottom habitats to promote habitat use by diverse communities of fish and other aquatic organisms. The structural complexity of an oyster reef provides habitat and refuge to many small aquatic organisms. In turn, these reefs provide feeding, as well as breeding and nursery habitats, for finfish as well as larger crustaceans. In addition, oysters are an important prey source for gastropods, whelks, sea stars, crabs, and boring sponges. Finally, they also provide foraging habitats for many shorebirds throughout the bay.

Oyster reefs also provide ecological enhancement through their ability to filter significant particulates within the water column. By filtering particulate material from the water column, oysters are able to lower excess nutrients in an urban watershed, as well as improving water clarity. In turn, these water quality improvements can directly influence other species such as eelgrass beds (Cerco and Noel 2007).

The habitat complexity that reefs provide also is important acting as an NNBF relating to wave attenuation, such that the loss of oyster reefs has led to significant loss of intertidal wetlands throughout Jamaica Bay. Structurally, USACE encourages the use of NNBF to enhance coastal resilience. Beaches are natural features that can provide coastal storm risk reduction where their sloping nearshore bottom causes waves to break dissipating wave energy over the surf zone (NACCS, 2015).

#### 2.3.7.3 Hardened Shoreline

Throughout both reaches of the project area, many natural shorelines have been replaced with hardened structures such as groins, bulkheads, revetments, or rip rap. These hardened structures have interrupted the naturally occurring ecological continuum, and caused an unnatural transition from upland areas (i.e., usually impervious surfaces associated with urban areas) immediately into deep subtidal area. These shorelines provide limited habitats and services to a suite of resources identified as critical to the Jamaica Bay ecosystem.

#### 2.3.7.4 Mudflats

Mudflats are broad, shallow areas which are un-vegetated and exposed twice daily (i.e., diurnal) at or near low tide. This habitat provides a crucial ecological transition between intertidal wetlands and subtidal bottom areas, as well as provides services related to shoreline protection, water quality improvement, fisheries resources, and habitat and food sources for migratory and resident animals. Tidal mudflats support a wide diversity of both terrestrial and aquatic life.

#### 2.3.7.5 Intertidal Wetlands

Intertidal wetlands are vegetated areas tidally influenced and connected to open waters that are inundated or saturated by surface- or ground-water frequently enough to support vegetation that thrives in wet soil conditions. Intertidal wetlands for purposes of this Draft HSGRR/EIS include both low and native high salt marsh communities. The low salt marsh community generally occurs between mean low and mean high water, and is inundated twice daily by normal high tides. Low marsh communities are typically dominated by saltmarsh cordgrass *(Spartina alterniflora*). The native high marsh community occurs between MHW and the MHHW, which is only occasionally flooded during major storms or during extreme (i.e., spring) high tides. High marsh vegetation is dominated by salt marsh hay (*Spartina patens*) with saltgrass (*Distichlis spicata*) and/or marsh elder (*Iva frutescens*) occasionally mixed throughout.

Unfortunately, much of the native high marsh salt marsh community has been invaded by common reed throughout Jamaica Bay. Given the expansive monotypical stands of common reed, as well as the reduced level of services and functions that this community affords to the Jamaica Bay ecosystem, non-native intertidal wetlands have been defined as a separate habitat type. Common reed can cover many acres, and effectively outcompete native species that historically occurred throughout the high marsh. Through development of these expansive monotypical communities, this species also significantly reduce hydrologic complexity by altering and/or limiting intertidal channels and pools. Finally, these large monotypical stands also raise the elevation of these historic marsh communities by trapping sediment as well as the annual decomposition of the significant above ground biomass produced by this species.

#### 2.3.7.6 Marsh Islands

Given their complex role within Jamaica Bay, marsh islands are also identified as a distinct habitat type. While these marsh islands are primarily composed of intertidal wetlands, they also include relatively smaller patches of upland maritime forest and scrubland. Ecologically, these marsh islands are at the heart of the Jamaica Bay ecosystem. It is their ecological habitat complexity that differentiates them from perimeter wetlands. The assemblage of marsh islands in the center of Jamaica Bay provides the most significant habitat to the majority of wildlife resources within the

Back Bay and for all trophic levels of the bay food web. They are protected from a comparable level of anthropogenic disturbances impacting perimeter wetlands due to their remote location. In turn, significant ecological diversity can be found throughout the year utilizing these marsh islands.

#### 2.3.7.7 Beaches and Dunes

Beach and dune habitats are the most dynamic of the upland communities found within both project area reaches. They are continually modified by wind and waves, and stabilized by plant communities. Beaches are the narrow strip of shoreline in immediate contact with water and consisting of unconsolidated sediments (i.e., sand), and characteristically unvegetated. The Atlantic Ocean Shoreline reach is almost exclusively beaches. Within the Jamaica Bay Planning Reach, the largest beaches are primarily found near the inlet due to sediment dynamics found within the bay. However, there are a number of natural beaches, as well as beaches that formed in absence of degraded wetlands, throughout the inland perimeter of the bay.

Dunes are typically sand mounds located along the back edge of a beach which break waves and keep floodwaters from inundating. In many cases, dunes provide a sediment source for beach recovery after a storm passes. Characteristic species include beachgrass (*Ammophila breviligulata*), dusty miller (*Artemisia stelleriana*), beach pea (*Lathyrus japonicus*), sedge (*Carex spp*.), seaside goldenrod (*Solidago sempervirens*), and sand-rose. Stabilized dunes include beach heather (*Hudsonia tomentosa*), bearberry (*Arctostaphylos uva-ursi*), beach pinweed (*Lechea maritime*), jointweed (*Polygonella articulate*), bayberry (*Myrica pensylvanica*), and beach-plum (*Prunus maritima*).

#### 2.3.7.8 Maritime and Coastal Forest and Shrubland

Historically, a mosaic of the maritime forests/shrubland/grassland habitats was a large component of the undisturbed Jamaica Bay complex. They supported and therefore increased the value of the wetland and aquatic habitats by providing cover, alternate food sources and breeding habitats to many of the species that characteristically inhabit adjacent salt marshes, mudflats and shallow water habitats. They additionally act as a buffer area for the salt marsh communities. This benefit is integral to a full functioning integrated estuarine system, adding to the benefits of the adjacent habitats and increasing overall connectivity between and among similar habitats and multiple habitats used by the same species. Unfortunately, these maritime forests and grasslands, with beach and dune complexes, are now the rarest habitat type and often the subject of long-term restoration goals throughout the bay. They provide a critical resource for migratory passerine bird species, as well as other resident and migratory birds, mammals, and sensitive insect species. The Affected Environment section of the Environmental Appendix provides a summary of many of the different plant community types of upland habitats.

#### 2.3.7.9 Ruderal Uplands

As Jamaica Bay remains one of the most urban estuaries throughout North America, many upland habitats (which are not yet impervious surfaces) have been modified by historic and current anthropogenic disturbances. Ruderal upland habitats found extensively throughout both project area reaches represent upland areas that are (1) dominated by invasive species, (2) managed as lawns or landscape features, and/or (3) disturbed soil and/or rock and gravel.

#### 2.3.7.10 Urban

A great deal of area within both project area reaches has been paved with impervious surface due to urban development. This urban habitat type is inclusive of the following, and not necessarily limited to: roads; paved trails; recreational courts; commercial and residential buildings; parking lots; and laydown yards. This habitat type is assumed to provide little to no services or functions to the Jamaica Bay ecosystem.

### 2.3.8 Aquatic and Terrestrial Wildlife

#### 2.3.8.1 Invertebrate and Benthic Resources

Terrestrial and marine invertebrates have many important functions as key lower food web components in coastal and marine ecosystems. Terrestrial and benthic invertebrates serve as food resources for birds, mammals, and fish (Waldman 2008). Blue crab (*Callinectes sapidus*) and American lobster (*Homarus americanus*) are food resources for predatory fish and birds (Bain et al 2007; Waldman 2008; USACE 2009), and commonly found in subtidal bottom and oyster reef habitats. Horseshoe crab (*Limulus polyphemus*), and specifically the large quantities of horseshoe crab eggs produced during spawning, are key food resources for fish, reptiles, and migrating shorebirds like the red knot (Botton et al 2006). Horseshoe crabs utilize multiple habitats along the shoreline from subtidal bottoms, into intertidal mudflats, and along sandy beaches.

Clams (for example softshell, *Mya arenaria*, and quahog, *Mercenaria mercenaria*) are important food resources for other food web components and also perform water quality functions (USFWS 1997a). Blue mussels (*Mytilus edulis*) are found in intertidal shallows along the shorelines attached to hard substrates, while ribbed mussels (*Geukensia demissa*) are found in soft sediments and have an important mutualism with cordgrass species. Both mussel species are important food resources for fish and birds and as filter-feeders they improve water quality (Bain et al. 2007; Waldman 2008; USACE 2009; NYC Department of Environmental Protection 2014). Oysters (*Crassostrea virginica*) filter particulate matter from the water column, enhance subtidal habitats like eelgrass beds, and function as food resources for fish and birds. In addition, oyster reefs provide spatially complex substrate that facilitates the presence and functioning of other coastal ecosystems (Rodney et al. 2007, Bain et al. 2007; Waldman 2008; USACE 2009).

With respect to the Atlantic Ocean shoreline reach, the primary shellfish with important commercial or recreational value in the near shore portion of the Project area are the, hardshell clam [Quahog], softshell clam, bay scallop (*Argopencten irradiens*), American lobster, and blue crab (MacKenzie 1990). Surf clam (*Spisula solidissima*), razor clam (*Ensis directus*) and tellin (*Tellina agillis*) occur in the vicinity of the offshore borrow area. Surveys conducted by the USACE in 2003 and by the NYSDEC in 2012 indicate that the borrow area itself contains very small, to no, localized populations of surf clam. It is the intent of the USACE to conduct another survey in the borrow area prior to the utilization of the borrow area.

### 2.3.8.2 Finfish

Primary fish species of the Atlantic Ocean Shorefront Planning Reach and borrow area include black sea bass (*Centropristis striata*), summer flounder (*Paralichthys dentatus*), winter flounder (*Pseudopleuronectes americanus*), weakfish (*Cynosion regalis*), bluefish (*Pomatomus saltatrix*), scup (*Stenotomus chrysops*), striped bass (*Morone saxatillis*), and Atlantic mackerel (*Scomber scombrus*). In addition, other common species in near shore waters include tautog (*Tautoga onitis*), northern puffer (*Sphoeroides maculates*), windowpane (*Scophthalmus aquosus*) and American eel (*Anguilla rostrata*). A number of migrant anadromous and catadromous species are found throughout both project area reaches. Common migrant species include the Atlantic sturgeon (*Acipenser oxyhinchus*), blueback herring (*Alosa aestivalis*), alewife (*Alosa pseudoharengus*), American shad (*Alosa sapidissima*), Atlantic silverside (*Menidia menidia*), striped bass, and American eel (Woodhead 1992).

Jamaica Bay habitats are highly productive and support a large number of fish species that serve as key resources for other Jamaica Bay ecosystem components. Forage fish (*Fundulus sp*.) are important middle food web components and function as food resources for birds and predatory fish including resident (e.g., flounder sp.) and anadromous (e.g., shad, herring, Atlantic sturgeon, striped bass) species (USFWS 1997b; Waldman 2008; USACE 2009).

Winter flounder was the most important commercial and recreational fish to use Jamaica Bay in great numbers during all life stages; the bay is also believed to be a significant breeding area for this species. Forage fish species with high abundances, including Atlantic silverside (*Menidia menidia*), bay anchovy (*Anchoa mitchilli*), mummichog (*Fundulus heteroclitus*), Atlantic menhaden (*Brevoortia tyrannus*), and striped killifish (*Fundulus majalis*), form a prey base for other fish and birds that use the area. Both the nearshore and offshore waters of the project area support seasonally abundant populations of many recreational and commercial finfish (USFWS 1989, 1995, USACE 1995). Some of the other common species found in surveys and recreational landings include scup, bluefish, windowpane, tautog, weakfish, black sea bass, summer flounder, American eel, and searobin (*Prionotus spp*.). Anadromous species that use the area include blueback herring, Atlantic sturgeon, alewife, American shad, striped bass, and Atlantic mackerel (*Scomber scombrus*).

Numbers of Atlantic sturgeon in the New York Bight distinct population segment are extremely low compared to historical levels and have remained so for the past 100 years. Currently, the existing spawning population in the Hudson River is estimated to have 870 adults spawning each year (600 males and 270 females). The spawning population of this distinct population segment is thought to be one to two orders of magnitude below historical levels. This federally endangered species is vulnerable to various impacts because of their wide-ranging use of rivers, estuaries, bays and the ocean throughout the phases of their life. In addition, they have been commercial overharvesting for years and which likely has contributed to population declines. Further information is discussed in the Protected Species section below.

### 2.3.8.3 Reptiles and Amphibians

The diamondback terrapin (*Malaclemys terrapin*) are medium sized turtle species that inhabits brackish waters of estuaries, tidal creeks, and salt marshes along the northeastern coast of North America. Unfortunately, and its populations are declining throughout their range (Waldman 2008; USACE 2009). Diamondback terrapin use habitats within Jamaica Bay for nesting and feeding.

Other amphibians and reptiles species that may potentially be present in the project are include Fowler's toad (*Bufo woodhousii fowleri*), spring peeper (*Pseudacris crucifer*), gray treefrog (*Hyla versicolor*), green frog (*Rana clamitans*), spotted salamander, redback salamander (*Plethodon cinereus*), northern brown snake (*Storeria d. dekayi*), smooth green snake (*Opheodrys vernalis*), eastern hognose snake (*Heterodon platirhinos*), eastern milk snake (*Lampropeltis triangulum triangulum*), northern black racer (*Coluber c. constrictor*), snapping turtle (*Chelydra serpentina*), eastern painted turtle (*Chrysemys p. picta*), and eastern box turtle (*Terrapene c. carolina*).

Five species of threatened and endangered marine turtles have habitat ranges that overlap with the near shore coastal waters of the Project area during summer and early fall. Species include the Federally-listed Kemp’s ridley (*Lepidochelys kempii*, endangered), leatherback (*Dermochelys coriacea*, endangered), green (*Chelonia mydas*, threatened), loggerhead (*Caretta caretta*, threatened), and hawksbill (*Eretmochelys imbricata*, endangered). The most common are Kemps ridley that prefer coastal areas, and leatherbacks, which commonly found nearby in offshore Long Island waters (NYS DEC 2016a), while the hawksbill is considered to be the rarest encountered in NY waters (NYS DEC 2016b). Sea turtles may utilize coastal resources in the project area for foraging. However, nesting is unlikely to occur along beaches in the Atlantic Ocean Shorefront Planning Reach, as breeding grounds for all species are located in warmer waters to the south.

### 2.3.8.4 Birds

Several different groups of bird species use both the Atlantic Ocean Shorefront Planning Reach and the Jamaica Bay Planning Reach. Wading birds (herons, stilts), seabirds (terns, cormorants), waterfowl (ducks, geese), shorebirds (plovers, sandpipers), passerines (terrestrial songbirds) and raptors are dependent upon the different types of coastal and upland habitats found in these areas (Waldman 2008, USACE 2009, NYC Audubon 2015). Both resident and migratory bird species use Jamaica Bay (including Floyd Bennet Field, Gateway National Wildlife Refuge), Rockaway Beaches and Breezy Point.

A wide diversity of bird species is likely to occur within, and in the vicinity of, the Project area. The most common species in the project area are habitat generalists that are tolerant of development and that utilize beach habitat along the shoreline and deepwater habitats. Common species include herring gull (*Larus argentatus*), greater black-backed gull (*Larus marinus*), American crow (*Corvus brachyrhynchos*), American robin (*Turdus migratorius*), barn swallow

(*Hirundo rustica*), black-bellied plover (*Pluvialis squatarola*), black scoter (*Melanitta nigra*), bufflehead (*Bucephala albeola*), common grackle (*Quiscalus quiscula*), common yellowthroat (*Geothlypis trichas*), double-crested cormorant (*Phalacrocorax auritus*), European starling (*Sturnus vulgaris*), gray catbird (*Dumetella carolinensis*), mourning dove (*Zenaida macroura*), rock dove/pigeon (*Columba livia*), sanderling (*Calidris alba*), song sparrow (*Milospiza melodia*), house sparrow (*Passer domesticus*), house finch (*Carpodacus mexicanus*), and tree swallow (*Iridoprocne bicolor* [USACE 1998, 2003, USFWS 1992]). Permanent avian residents of the surrounding area include various species of gulls, crows, pigeons, and sparrows, which are commonly associated with developed areas and areas of high human activity (USFWS 1992, USACE 1998, 2003). Numerous migratory bird species of conservation concern are likely to be found breeding, foraging or migrating through the project area and are listed in the Affected Environment section of the Environmental Appendix.

#### 2.3.8.5 Mammals

Although mammals are a less visible component of project area ecosystems, the project area serves as important habitat for many species. Bat species like hoary bat (*Lasiurus cinereus*), red bat (*Lasiurus borealis*), little brown bat, (*Myotis lucifugus*), and silver-haired bat (*Lasionycteris noctivagans*) may be present (Waldman 2008) in upland habitats adjacent to Jamaica Bay. Other terrestrial mammals in the Atlantic Ocean Shorefront Planning Reach and the Jamaica Bay Planning Reach include opossum (*Didelphis virginiana*), black-tailed jackrabbit (*Lepus californicus*) escaped from JFK Airport cargo, eastern cottontail rabbit (*Sylvilagus floridanus*), eastern chipmunk (*Tamias striatus* - introduced), gray squirrel (*Sciurus carolinensis*), white-footed mouse (*Peromyscus leucopus*), meadow vole (*Microtus pennsylvanicus*), muskrat (*Ondatra zibethicus*), and house mouse (*Mus musculus*).

Nearshore coastal and the borrow areas serve as habitat for several marine mammals. Federally listed cetaceans that may occur in the Project area include the endangered North Atlantic right whale (*Eubalaena glacialis*); the endangered humpback whale (*Megaptera novaeangliae*); and the endangered fin whale (*Balaenoptera physalus*) (USACE 2015). Non-listed cetacean species with nearshore coastal New York water habitats include finback (*Balaenoptera physalus*), minke (*B. acutorostrata*), and pilot (*Globicephala melaena*) whales as well as several dolphin species, including common (*Delphinus delphis*), bottle-nosed (*Tursiops truncatus*), white-sided (*Lagenorhynchus acutus*), and striped (*Stenella coerulealba*), and harbor porpoise (*Phocoena phocoena*) (Edinger et. al. 2014). Other marine mammals that are found in coastal waters include seals. Harbor seals, the most abundant seal species found within New York State waters, frequently winter in nearshore waters of the project area and can be found basking on sand bars, rocks, or remote beaches (NYS DEC 2016c). Although not as frequent, grey seal (*Halichoerus grypus*) habitat also overlaps with the project area.

### 2.3.9 Threatened and Endangered Species

#### 2.3.9.1 Federal Species

The federally-listed Atlantic sturgeon (*Acipenser oxyrhynchus oxyrhynchus*, endangered), piping plover (*Charadrius melodus*, threatened), red knot (*Calidris canutus rufa*, threatened), roseate tern (*Sterna douglallii dougallii*, endangered), northern long-eared bat (*Myotis septentrionalis*), sandplain gerardia (*Agalinis acuta*, engendered), and seabeach amaranth (*Amaranthus pumilus*, threatened) have been identified within the project areas. Atlantic sturgeon is listed as endangered in the New York Bight. Numbers of Atlantic sturgeon in the New York Bight distinct-population segment are extremely low compared to historical levels and have remained so for the past 100 years. Currently, the existing spawning population in the Hudson River is estimated to have 870 adults spawning each year (600 males and 270 females). There is no population estimate for the Delaware River, but it is believed to have less than 300 spawning adults per year. The spawning population of this distinct population segment is thought to be one to two orders of magnitude below historical levels.

Seasonal avian surveys are conducted by NYC Parks and Recreation at the Atlantic Ocean Shorefront Planning Reach. In 2014 piping plovers used approximately 2 miles of beach. There are three continuous management zones: Far Rockaway (B9-B35 Street), Arverne (B35-B73 Street) and Rockaway (B73- B149 Street). In most years, including 2014, plovers bred between Beach 56th to Beach 19th Streets. 2014 breeding season netted 12 pairs. 54 eggs, 44 chicks and 25 fledglings (Productivity Rate of 2.08 fledglings/pairs),

Migrating red knot (*Calidris canutus*) populations use the beach habitat within the Atlantic Ocean Shorefront Planning Reach to forage on horseshoe crab eggs laid on beaches in Jamaica Bay, Breezy Point, and Rockaway Beaches. The red knot is only present in the project area during migration and does not breed there.

More than 90 percent of New York State's population of roseate terns is made up by a single colony on Great Gull Island, off Long Island's eastern end. The remainder occurs in small groups of often just one or two breeding pairs in variable locations along the south shore of eastern Long Island (Mitra 2008). Roseate terns have sporadically nested within the Jamaica Bay estuary in the past (e.g., 2 pairs in 1996; Wells 1996), but during the most recent Breeding Bird Atlas, they were not documented anywhere west of Suffolk County (Mitra 2008). Roseate terns are not among the beach-nesting bird species that nest on Rockaway Beach (Boretti et al. 2007). The Jamaica Bay estuary provides feeding and nesting habitat. The potential for roseate terns to occur in the project area is considered low and limited to migrants moving through the area en route to nesting sites elsewhere in the region or to wintering grounds in the southern hemisphere.

The northern long-eared bat is a forest interior species that inhabits upland and riparian forest within heavily forested landscapes and hibernates in caves or mines during winter (Ford et al. 2005, Broders et al. 2006, Henderson et al. 2008). The urbanized project area does not contain any habitat that would be suitable for northern long-eared bats for either breeding or winter hibernation.

The NYNHP and NYSDEC have no records of the northern long-eared bat occurring in any of the five boroughs of New York City, and no nuisance bats ever collected from the city and submitted to the New York State Department of Health for rabies testing have included a northern long-eared bat. The northern long-eared bat is not considered to have the potential to occur in the project area. Because the project site is relatively urban shoreline habitat, with no large woodlands nearby, northern long-eared bats are not likely to occur in the project area.

The Atlantic Ocean Shorefront Planning Reach supports one of the largest seabeach amaranth populations in New York State (Young 2000). During field surveys conducted by NYSDEC biologists in 2000, 26 sea beach amaranth plants were identified on the beach between Beach 22nd and Beach 39th Streets (Young 2000). A larger population of approximately 2,000 plants was also identified further west, between Beach 44th and Beach 66th streets. Seabeach amaranth is an annual plant that prefers beach habitats, and is subject to competitive exclusion by beach grass and other vegetation.

Sandplain gerardia is found along coastal plains in dry sandy soils. It requires periodic disturbance (e.g., fire, grazing) to maintain its dry, sandy, open habitat. Only a few populations of sandplain gerardia are located in Long Island and none are found west of Nassau County.

Some federally-listed endangered whales, sea turtles and Atlantic sturgeon may occur in the project area, periodically and seasonally. Informal coordination with NOAA National Marine Fisheries Service (NMFS) is currently on-going to determine the appropriate formal consultation process to pursue. Final coordination will be documented in the final version of the HSGRR/EIS.

#### 2.3.9.2 Critical Habitat

No federally designated critical habitat is found within or near the proposed project area.

Jamaica Bay and Breezy Point have been designated Significant Coastal Fish and Wildlife Habitat by the New York State Department of State (NYSDOS), Division of Coastal Resources. Jamaica Bay, Breezy Point, and Rockaway Beaches have also been designated globally Important Bird Areas by Audubon New York.

#### 2.3.9.1 Migratory Birds

Migratory birds are protected by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act. Any activity that results in the take of migratory birds or eagles is prohibited unless authorized by USFWS.

An IPaC search identified the following species of migratory birds which could potentially be affected by activities in this location: America bittern (*Botaurus lentiginosus*, breeding), American oystercatcher (*Haematopus palliates*, year round), bald eagle (*Halianeetus leucocephalus*, year round), black skimmer (*Rynchops niger*, breeding), black-billed cuckoo (*Coccyzus erythropthalmus*, breeding), blue-winged warbler (*Vermivora pinus*, breeding), Canada warbler

(*Wilsonia canadensis,* breeding), Cerulean warbler (*Dendroica cerulean*, breeding), fox sparrow (*Passerella illiaca*, wintering), gull-billed tern (*Gelochelidon nilotica*, breeding), horned grebe (*Podiceps auritus*, wintering), Hudsonian godwit (*Limosa haemastica*, migrating), least bittern (*Ixobrychus exilis*, breeding), least tern (*Sterna antillarum*, breeding), loggerhead shrike (*Lanius ludovicianus*, year round), marbled godwit (*Limosa fedoa*, wintering), peregrine falcon (*Falco peregrinus*, wintering), pied-billed grebe (*Podilymbus podiceps*, year round), prairie warbler (*Dendroica discolor*, breeding), purple sandpiper (*Calidris maritima*, wintering), red knot (wintering), rusty blackbird (*Euphagus carolinus*, wintering), saltmarsh sparrow (*Ammodramus caudacutus*, breeding), seaside sparrow (*Ammodramus maritimus*, year round), short-eared owl (*Asio flammeus*, wintering), snowy egret (*Egretta thula*, breeding), upland sandpiper (*Bartramia longicauda*, breeding), willow flycatcher (*Empidonax traillii*, breeding), wood thrush (*Hylocichla mustelina*, breeding), worm eating warbler (*Helmitheros vermivorum*, breeding).

#### 2.3.9.2 State Species of Concern

A review of New York State listed threatened, endangered, and rare species and species of concern in Nassau, Queens, and Kings Counties was conducted using the NYDEC website (http://www.dec.ny.gov/animals/7494.html, accessed April 6, 2016). These species are listed in the Affected Environment section of the Environmental Appendix.

The state-listed endangered least tern (*Sterna antillerum*) is known to occur in the same type of habitat as the piping plover and roseate tern (see Section 2.3.9 Threatened and Endangered Species) (USACE 1993). Least terns are known to nest in areas in the vicinity of Beach 45th Street and westward along the beach (USFWS 1999). Other state-listed threatened species that occur in the general area include the northern harrier (*Circus cyaneus*), osprey (*Pandion haliaetus*), and common tern (*Sterna hirundo*).

In addition, the piping plover (state endangered), peregrine falcon (state endangered), roseate tern (state endangered), and the bald eagle (state threatened) are present in the project area.

Two species of state-listed plants are known to occur in the vicinity of the Project Area (Young 2000). Seabeach knotweed (*Polygonum glaucum*, state status: rare) and dune sandspur (*Cenchrus tribuliodes*, state status: threatened) have been observed by NYSDEC biologists in the same type of habitat along the East Rockaway beaches as the federally-listed sea beach amaranth (Young 2000).

### 2.3.10 Water Quality

For the Atlantic Ocean Shorefront Planning Reach, water quality is influenced by ebbing waters from East Rockaway Inlet to the east and from semi-diurnal tidal fluctuations characteristic of the Atlantic coast. The project area is outside of and to the east of the three miles of the Atlantic coastline along New York State that are subject to shellfish water quality impairments from CFOs (NYSDEC 1998).

Recent water quality data collected from coastal stations at Far Rockaway and Atlantic Beach, as part of the USEPA helicopter-monitoring program, show that overall bacteriological water quality is very good. Geometric mean densities (1989 through 1998) of fecal coliform and enterococci are well below acceptable federal guidelines for primary contact recreational uses (USEPA 1999b). In addition, the NYC and Nassau County Public Health Departments report good overall water quality in the Atlantic Ocean Shorefront Planning Reach (Jacobs 1999, Luke 1999).

With respect to the Jamaica Bay Planning Reach, the bay continues to be threatened by poor water quality. Almost the entire watershed is urbanized such that the bay receives pollution from point and non-point sources around the bay, such as the CSOs, runoff from the roads and the airport, leachate from landfills, windblown trash, and other sources. Specifically, 240–340 million gallons per day of treated sewage effluent flow into Jamaica Bay from four Wastewater Treatment Plants (WWTP) (GNRA 2013). This continues to be a major source of pollution, including treatment byproducts such as chlorine, and heavy metals and other contaminants that are not eliminated by water treatment facilities (NPCA 2007a). In addition, large rain events can overwhelm the sewer system capacity, resulting in untreated wastewater and raw sewage. Other sources within the Jamaica Bay Planning Reach include landfill leaching, runoff from JFK Airport, as well as atmospheric deposition (NPCA 2007, USACE and PA 2009).

The water quality in Jamaica Bay has been extensively studied and characterized, as it is a critical component to the Jamaica Bay Watershed Protection Plan (NYCDEP 2007). While nitrogen and phosphorus are characteristically limiting nutrients in estuarine ecosystems, their quantities within Jamaica Bay are exaggerated by WWTP inputs. As such, nutrient loading can lead to eutrophication. High nitrogen levels can also decrease root production in salt marsh plants, and in turn decrease their ability to accumulate organic material and hold sediments within tidal marshes. High nitrogen levels also increase microbial decomposition, reducing the accumulation of organic matter and limiting the ability of saltmarshes to maintain an elevation that keeps pace with relative sea level change (SLC) (Rafferty, Castagna, and Adamo 2010).

High nutrient levels are also a major contributor to low DO levels in Jamaica Bay. DO ranges from 3.5 to 18.5 milligrams per liter (mg/L), sometimes falling below the 5.0 mg/L threshold specified by state water quality standards for waters suitable for recreation and fishing. Long periods of low DO can harm or kill larval fish and shellfish, and lead to odor problems from production of H2S gas in oxygen-deficient sediments. High concentrations of DO in the water column can also indicate poor water quality, and typically occur when algal blooms near the surface create very high to supersaturated DO concentrations as a byproduct of photosynthesis. While there is high year-to-year variability in measured DO concentrations, long-term monitoring suggests DO levels are trending toward improvement (NYCDEP 2007).

The NYSDEC assigns classifications to all of the waterbodies within its jurisdiction. These classifications are assigned such that "the discharge of sewage, industrial waste or other wastes shall not cause impairment of the best usages of the receiving water as specified by the water classification at the location of the discharge and at other locations that may be affected by such discharge." Three of the classifications developed by NYSDEC apply to waters within Jamaica Bay: Class SB, Class SC and Class 1.

- Class SB – includes the open waters of Jamaica Bay, Shellbank Creek, Gerritsen Creek, Mills Basin, and East Basin (NYSDEC 2011). The best usages of Class SB waters are primary and secondary contact recreation and fishing. These waters shall be suitable for fish, shellfish and wildlife propagation and survival.
- Class SC – Motts Basin (NYSDEC 2011). The best usage of Class SC waters is fishing. These waters shall be suitable for fish, shellfish and wildlife propagation and survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes.
- Class 1 - Hendrix Street Canal, Fresh Creek, Hendrix Creek, Spring Creek, Paerdegat Basin, Bergen Basin, Sheepshead Basin, and Thurston Basin (NYCDEC 2011). Impairment is due to nitrogen levels, oxygen demand, and presence of pathogens. The best usages of Class I waters are secondary contact recreation and fishing. These waters shall be suitable for fish, shellfish, and wildlife propagation and survival. In addition, the water quality shall be suitable for primary contact recreation, although other factors may limit the use for this purpose.

### 2.3.11 Sediment Quality

With respect to sediments within the Atlantic Ocean Shoreline project area, sediment modelling was completed to support the Optimal Life-Cycle Alternative Analysis (USACE 2015). A seven-cell sediment budget was completed for without project condition based upon historical data and anticipated SLC. The net annual longshore sediment transport rates are similar to historical conditions, and increase from east to west along Rockaway Beach peaking in Reach 3. The steady increase in net annual longshore transport rate creates a sediment deficit in Reaches 3, 4, 5, and 6a. The overall trend in longshore sediment transport is driven by the alongshore variability in the wave conditions. The primary difference between the without project condition and historical conditions sediment budgets is that there is no beach fill in the without project condition to offset the sediment deficit created by the overarching trend longshore sediment transport. Note that a total 15.6 million cubic yards of beachfill were placed along Rockaway Beach from 1975-2010. Table 3-4 FWOP Shoreline Changes shows the corresponding shoreline change rates based on the seven-cell without project condition sediment budget. The most striking cell is Reach 4, which is predicted to erode by 17.5 ft/yr. This erosion hotspot is caused by 1) overarching trend in longshore sediment transport along eastern Rockaway Beach, 2) sediment impoundment of updrift groin field in Reach 5.

With respect to sediments within the Jamaica Bay Planning Reach, movement is restricted due to the narrow restriction of Rockaway Inlet and little to no sediment input from the watershed (due to the urbanized land uses). At the entrance to Rockaway Inlet, the prevailing currents slow as they enter the mouth of the Bay and turn to the east to again slow. This continual slowing of water movement reduces sediment transport throughout the Jamaica Bay Planning Reach. Consequently, sediments at the mouth of the Bay are primarily coarse sands and the remainder of the Bay is finer silt sediments.

Historically, prior to pollution regulations, large quantities of chemicals, including heavy metals, pesticides, polychlorinated biphenyl (PCB), dichlorodiphenyltrichloroethane (DDT), and dioxin, were discharged into waters of Jamaica Bay. Contaminations adhere to organic compounds and settle into sediments; now found to exceed acceptable levels throughout the Bay (Steinberg et al. 2004). In addition to these "legacy" chemicals, chemicals from modern sources (i.e., WWTP discharges, CSOs, non-point source discharges, chemical and oil spills) are also known to adversely affect Bay sediments.

Many of these chemicals, which are readily absorbed in the fat cells of animals, can accumulate to dangerous levels. Currently, all regions of the Hudson-Raritan Estuary, including Jamaica Bay, have consumption advisories in some fish and shellfish species (NYSDOH 2016, NJDEP 2013). Moreover, the recent rates of decline in contaminants will be difficult to match in the future since current non-point sources of these chemicals and metals (e.g., overland runoff, atmospheric deposition) will not be as easy to control as point sources (Steinberg et al. 2004).

### 2.3.12 Air Quality

Based on the National Ambient Air Quality Standards (NAAQS), Queens, Kings, and Nassau Counties located in the New York, Northern New Jersey, Long Island, ozone nonattainment area are currently classified as 'moderate ' nonattainment for the 2008 8-hour ozone standard and 'maintenance' of the 2006 particulate matter less than 2.5 microns ($PM_{2.5}$) standard and 1971 carbon monoxide standard (40CFR§81.333). These counties are part of the Ozone Transport Region. Ozone is controlled through the regulation of its precursor emissions, which include oxides of nitrogen ($NO_x$) and volatile organic compounds (VOC). Sulfur dioxide ($SO_2$) is a precursor for $PM_{2.5}$. The project is anticipated to emit emissions associated with diesel-powered construction activities and these emissions will be temporary in nature, spanning only the construction period.

### 2.3.13 Greenhouse Gases

The generation of greenhouse gas (GHG) emissions associated with the project's construction activities will be temporary in nature, spanning only the construction period. The primary GHG emitted from diesel-fueled equipment is carbon dioxide ($CO_2$). Although nitrous oxides ($N_2O$) and methane ($CH_4$) have significantly higher global warming potentials (298 times $CO_2$ for $N_2O$

and 25 times $CO_2$ for $CH_4$)[1], they are emitted at significantly lower rates, resulting in minimal fractional increases in carbon dioxide equivalents ($CO_2e$) when compared with $CO_2$ alone.

In addition to the applicable regulated pollutants (Section 2.3.12), each Federal Agency project's National Environmental Policy Act (NEPA) assessments will consider and evaluate GHGs consistent with Council on Environmental Quality (CEQ) revised draft guidance on the consideration of GHGs emissions and the effects of climate change (CEQ 2014)[2].

### 2.3.14 Hazardous, Toxic, and Radioactive Wastes (HTRW)

A review was conducted of publically available databases for selected federal- and state-regulated sites with hazardous, toxic, and radioactive waste (HTRW) for both Planning Reaches. The federal USEPA Superfund Information System contains several databases with information on existing Superfund sites, including the Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS), the National Priorities List (NPL), Resource Conservation and Recovery Act Information (RCRAinfo), and the Brownfields Management System. In addition, the NYSDEC has records of RCRA sites. In summary, RCRA sites were investigated with the EPA Clip N Ship Application. The NYSDEC Remediation Site Boundary layer was used to investigate Superfund, Brownfields and Voluntary Cleanup sites within the project area. The Department of Energy database was reviewed for radioactive waste sites (http://energy.gov/em/cleanup-sites).

The following sections describe the summary findings of the review. Figures showing the locations of regulated HTRW sites and more detailed tables with a discussion of individual landfills are provided in the Affected Environment section of the Environmental Appendix. Preliminary analysis indicates that the TSP may cross into or be adjacent to HTRW sites. A more detailed analysis, including potential avoidance of HTRW site impacts, would be conducted prior to the Final HSGRR/EIS.

The following entries were found for the Atlantic Ocean Shorefront Planning Reach:

- 47 inactive RCRA sites and 49 active sites (EPA, 2016). The generation and disposal of hazardous waste should not have an effect on the environment if in compliance with RCRA.
- 3 Brownfield Cleanup Sites (NYSDEC, 2016). Of those sites, two sites are active, none are closed and one is No Further Action Taken.

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[1] EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2013*, April 2015.

[2] See *https://www.whitehouse.gov/administration/eop/ceq/initiatives/nepa/ghg-guidance*

- 5 State Superfund Sites (NYSDEC, 2016). Three of those sites are "Registry" Sites and the remaining two are Non-Registry Sites.
- Three Voluntary Cleanup Sites (NYSDEC, 2016). One is active and the remaining two are closed.
- No radioactive waste sites were identified.

The following entries were found for the Jamaica Bay Planning Reach:

- Nearly 1,000 inactive RCRA sites and nearly 700 active sites were found (EPA, 2016). The generation and disposal of hazardous waste should not have an effect on the environment if in compliance with RCRA.
- Ten Brownfield Cleanup Sites (NYSDEC, 2016). Of those sites, six sites are active, three are closed and one is no further action taken.
- Twenty four State Superfund Sites (NYSDEC, 2016). Nine of those sites are "Registry" Sites and the remaining 15 are Non-Registry Sites.
- Twelve Voluntary Cleanup Sites **Error! Reference source not found.** (NYSDEC, 2016). Just one site is no further action at this time, six are active and the remaining five are closed.
- No radioactive waste sites were identified.

Additionally, during preparation of the Federal Energy Regulatory Commission (FERC) EIS for the M&R facility, FERC received a comment from the NPS that a tar-like substance associated with an "old factory site" was located on the south shore of Floyd Bennet Field east of the Marine Parkway Bridge (FERC, 2013). No additional information about this site or actions taken was available in the file material.

### 2.3.15 Cultural Resources

"Cultural resources" is an umbrella term for many heritage-related resources, including prehistoric and historic archaeological sites, buildings, structures, districts, or certain objects. Cultural resources are discussed in terms of archaeological resources, architectural resources, or resources of traditional cultural significance.

Federal cultural resources laws applicable to this project include the National Historic Preservation Act (NHPA), the Archaeological and Historic Preservation Act (1974), the American Indian Religious Freedom Act (1978), the Archaeological Resources Protection Act (1979), and the Native American Graves Protection and Repatriation Act (1990).

The National Register of Historic Places (NRHP) is the official list of the properties in the United States that are significant in terms of prehistory, history, architecture, or engineering. The NRHP is administered by the National Park Service.

Section 106 of the NHPA requires a Federal agency official to take into account the effects of its undertaking on historic properties, and afford the Advisory Council on Historic Preservation (ACHP), an independent Federal agency, an opportunity to comment. This is done in accordance with the regulations of the ACHP implementing Section 106 process, 36 CFR Part 800. The Section 106 review requires an assessment of the potential impact of an undertaking on historic properties that are within the proposed project's Area of Potential Effect (APE) (see Figure 8 Executive Summary above). The APE is defined as the geographic area(s) "within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist." Consultation with the State Historic Preservation Office (SHPO) and consulting parties including local governments is required regarding the identification and evaluation of potentially affected historic properties, determination of potential effects of an undertaking on historic properties, and resolution of any adverse effects. Under the Section 106 process, the City of New York would be a consulting party for the proposed project.

There are numerous cultural resources within both reaches of the project area including landmark structures, Historic Districts, and shipwrecks. Consultation with the NYSHPO, interested parties and Native American Tribal consultation are ongoing. The APE includes a number of historic districts:

- Jacob Riis Park Historic District: A Works Progress Administration (WPA) constructed park that includes the original bathing pavilion, arcade and mall, walkway/promenade and parking area. The beach and shoreline is included in the historic district cultural landscape.
- Fort Tilden Historic District: Significant for its role in the New York City's harbor defense, the district consists of the Taft-era gun emplacements, World War I and II structures, and features associated with the Nike-Ajax and Nike-Hercules missile programs. Associated operational, administrative, housing, wharf and transportation components also survive as contributing elements. The wharf (Riis Landing), located on the bay side of the peninsula, contains warehouses and other buildings that are eligible as part of the historic district. The US Coast Guard Station, also a historic property, is located adjacent to the east of the wharf (see below). The Silver Gulf Beach Club, also a historic district, is adjacent to the Fort Tilden historic district to the west (see below).
- Far Rockaway Bungalow Historic District: Located along Beach 24$^{th}$, 25$^{th}$ and 26$^{th}$ Streets in Far Rockaway, the Far Rockaway Bungalow Historic District consist of summer beach bungalows built along the oceanfront in the 1920s.
- Silver Gull Beach Club: Adjacent to the Fort Tilden Historic District on the west, the district includes a cabana complex consisting of a clubhouse, court buildings, pool court, activity buildings and recreational facilities. The beach and shoreline are also included in the historic district as are the vistas to the east and west.
- Breezy Point Surf Club: Situated between Breezy Point Tip and the western end of the Breezy Point Community, the Breezy Point Surf Club consists of cabana courts, several pools, and athletic courts.

- Far Rockaway Coast Guard Station Historic District: Located just east of the Fort Tilden Wharf at Riis Landing and consists of WPA constructed boat basin, piers, breakwaters, and other features.
- Floyd Bennett Field Historic District: Located on a portion of Barren Island in Jamaica Bay, this historic district consists of the hangars and support buildings associated with the early airfield.

In addition to the historic districts, the Gil Hodges Bridge. There are other National Register-eligible and listed properties as well as New York City Landmark properties that are located inland and would not be affected by the proposed project elements. A portion of the borrow area has been surveyed and three potentially significant targets were identified. The APE is also sensitive for the recovery of archaeological resources, particularly areas that have buried deeply buried elements (see Appendix I for additional details).

### 2.3.16 Socioeconomic Considerations

The NYSDEC identifies "Potential Environmental Justice Areas (PEJAs)" as census block groups meeting one or more of the following NYSDEC criteria in the 2000 U.S. Census (NYSDEC, 2016):

- 51.1% or more of the population are members of minority groups in an urban area;
- 33.8% or more of the population are members of minority groups in a rural area, or;
- 23.59% or more of the population in an urban or rural area have incomes below the federal poverty level.

The NYSDEC publishes county maps identifying PEJAs, including Kings, Queens, and Nassau counties (NYSDEC, 2016). The following section discusses the NYSDEC PEJAs for the Atlantic Ocean Shorefront Planning Reach and the Jamaica Bay Planning Reach. Figure 2-17 identifies the proportion of persons below the poverty level for census blocks within project area communities.

The Atlantic Ocean Shorefront Planning Reach contains several PEJAs identified by the NYSDEC (NYSDEC, 2016). Almost the entire area between the eastern end of the project and Beach 116th Street near the central portion of the peninsula is identified as a PEJA (see the Affected Environment section of the Environmental Appendix for figures and additional details). There are no communities identified as a PEJA by the NYSDEC to the west of Beach 116th Street.

The Jamaica Bay Planning Reach located in portions of Kings, Queens, and Nassau Counties contains several PEJAs identified by the NYSDEC (NYSDEC, 2016). In Nassau County, a small PEJA is present the municipality of Hempstead, west of the Valley Stream neighborhood; however, the area south of Route 27 within the Jamaica Bay Planning Reach appears to contain few if any residences. In Queens County, the majority of the Jamaica Bay Planning Reach north and east of JFK airport is identified as a PEJA, while the neighborhoods west of JFK airport are not (Howard Beach, Lindenwood, Hamilton Beach). Likewise, the majority of the Jamaica Bay

Planning Reach within Kings County is identified as a PEJA, including the communities surrounding the Gateway National Recreation Area, a large portion of Coney Island, and in and around the Fort Hamilton municipality.


Map created by the Science and Resilience Institute

**Figure 2-17: Persons Below Poverty Level**

# 3 FUTURE WITHOUT-PROJECT CONDITIONS*

The USACE is required to consider the Future Without-Project (FWOP) alternative (called the "No Action" alternative) during the planning process and assessment of impacts to comply with USACE regulation and guidance for planning as well as NEPA. With the FWOP, it is assumed that no project would be implemented by the Federal Government or by local interests to achieve the planning objective. The FWOP forms the basis against which all other alternative plans are measured.

The FWOP condition assumes the continuation of existing conditions for the resources listed above; no comprehensive intervention to reduce the impacts of storm surge on vulnerable populations (such as the elderly, low income, and public transportation dependent populations) and infrastructure of the study area; and no large-scale ecosystem restoration efforts to improve the sustainability of fragile coastal systems and attenuate storm surge. It should be noted though that planned wetland restoration efforts conducted under other authorities in in Jamaica Bay, such as the restoration at Spring Creek, are projected to be implemented in the FWOP. Along the Atlantic Ocean Reach, it is assumed that maintenance dredging of the existing Federal navigation channels at East Rockaway Inlet and Rockaway Inlet (Jamaica Bay Channel) continue as authorized. The existing, authorized, and constructed project from Beach 19$^{th}$ street to beach 149$^{th}$ will not be renourished in the future as a Federal Project. In the absence of Federal renourishment, it is expected that New York City will undertake small-scale emergency sand placement projects if the beach erodes to a point that the existing infrastructure along the shorefront is imminently threatened.

## 3.1 Project Area

Projected population growth (2010 – 2040) for the project area is based on projections for the boroughs of Brooklyn and Queens (Kings County and Queens County, respectively) developed by the NYC Department of Planning. The total resident population of Brooklyn is projected to increase by 11.3% and the population of Queens is projected to increase by 7.2%. The school age population for each of the two boroughs is project to increase by 7.1%. The population 65 years and older is projected to increase by 45.6% in Brooklyn and by 30.8% in Queens (NYC, 2013)

## 3.2 Economic Conditions

The FWOP economic conditions are based on the assumption that system wide CSRM will not be implemented in the project area. Comprehensive measures to provide CSRM to vulnerable communities and populations with the project area are not included in the FWOP economic conditions. Because these CSRM measures are not in place, projected FWOP damages create a baseline against which alternative plans can be evaluated. The number and type of structures in the project area (Table 3-1) is projected to be the same under FWOP conditions and with alternative plans in place. Table 3-2 presents the expected annual damages for the 1% storm in the project area.

| Table 3-1: Structures Within FEMA 1% Annual Chance Flood Area | | | |
|---|---|---|---|
| Structure Type | Atlantic Ocean Shorefront Planning Reach | Jamaica Bay Planning Reach | Total |
| Banks | 3 | 18 | 21 |
| Church/Non-Profit | 54 | 108 | 162 |
| Colleges/Universities | 54 | 1 | 55 |
| Entertainment & Recreation (Restaurants/Bars) | 3 | 35 | 38 |
| Government Emergency Response (Police/Fire/EOC) | 7 | 10 | 17 |
| Government General Services (Office) | 4 | 1 | 5 |
| Grade Schools | 25 | 60 | 85 |
| Heavy Industrial | 2 | 1 | 3 |
| Hospital | 3 | 1 | 4 |
| Institutional Dormitories (Group Housing/Jails) | 3 | 5 | 8 |
| Light Industrial | 25 | 107 | 132 |
| Medical Office/Clinics | 2 | 11 | 13 |
| Multi-Family Dwellings (10-19 Units) | 25 | 24 | 49 |
| Multi-Family Dwellings (20-49 Units) | 17 | 29 | 46 |
| Multi-Family Dwellings (3-4 Units) | 729 | 2,470 | 3,199 |
| Multi-Family Dwellings (5-9 Units) | 83 | 75 | 158 |
| Multi-Family Dwellings (Duplex) | 3,364 | 11,931 | 15,295 |
| Multi-Family Dwellings (over 50 Units) | 44 | 123 | 167 |
| Nursing Homes | 13 | 10 | 23 |
| Parking (Garages) | 9 | 19 | 28 |
| Personal/Repair Services (Service Station/Shop) | 9 | 46 | 55 |
| Professional/Technical Services (Offices) | 36 | 213 | 249 |
| Retail Trade (Stores) | 168 | 790 | 958 |
| Single Family Dwellings | 3,307 | 22,106 | 25,413 |
| Temporary Lodging (Hotel/Motel) | 1 | 5 | 6 |
| Theaters | 1 | 1 | 2 |
| Wholesale Trade (Warehouses) | 6 | 85 | 91 |
| Grand Total | 7,942 | 38,285 | 46,227 |

| **Table 3-2: Without-Project Condition Damages (AAEQ)** | |
|---|---|
| Jamaica Bay Planning Reach | $444,218,000 |
| Atlantic Ocean Shorefront Planning Reach | $32,017,000 |
| Total Damages | $476,235,000 |

## 3.3 Physical Conditions

Under without-project conditions natural processes will continue to be impacted by anthropomorphic conditions, which will result in net loss of beach at the Atlantic Ocean Shorefront Planning Reach and net loss of wetlands in the Jamaica Bay Planning Reach, as discussed below.

Identifying the FWOP at the Atlantic Ocean Shorefront Planning Reach is particularly challenging because the historical conditions include a Federal project with a history of renourishment. Therefore, historical data alone may not be used to describe the shoreline and beach conditions if no actions are taken in the project area. Instead, a shoreline change model (GENESIS-T) is used to simulate longshore sediment transport and shoreline changes that are likely to occur in the FWOP.

In defining the FWOP, the following assumptions are made to establish the framework of what is likely to occur:

- Beachfill Placement (P): As defined by existing Federal/State navigation authorities, the existing inlets (Rockaway Inlet and East Rockaway Inlet) and their corresponding approach and back-bay navigation channels will be maintained near the present widths depths, and locations. Approximately 230,000 cubic yards of material will be dredged from East Rockaway Inlet every 2 years and placed in Reach 6a.
- Natural Inlet Bypassing (BP) A natural inlet bypassing rate of 100,000 cy/year at East Rockaway Inlet is used to characterize the FWOP. This bypassing rate provided the best calibration in GENESIS-T and is within the range of previous estimates (OCTI, 2011 and USACE NYD, 2012).

GENESIS-T is designed to simulate long-term shoreline change based on spatial and temporal differences in longshore sediment transport induced primarily by wave action while accounting for coastal structures and beach fills. The GENESIS-T model was calibrated to historical conditions from 1996-2010. A detailed description of the GENESIS-T model development is provided in the GENESIS-T Modeling Report (Moffatt & Nichol, September 2014).

A 16-year GENESIS-T simulation was performed to characterize the FWOP. The wave conditions for the 16-year period are based on the wave conditions from 1996 to 2012. The predicted net annual longshore sediment transport from GENESIS-T is used in the FWOP sediment budget. The FWOP simulations include both natural inlet bypassing and inlet maintenance dredging, both of which reduce the shoreline erosion in Reach 6a. The GENESIS-T simulations do not include the impact of relative sea level change or any other cross-shore coastal processes.

The FWOP sediment budget was developed based on modeled shoreline changes, modeled net annual longshore sediment transport rates, relative sea level rise, and inlet bypassing and inlet maintenance dredging assumptions.

Cross-shore sediment losses due to relative sea level rise (RSLR) are incorporated in the sediment budget after Bruun (1962). The FWOP sediment budget uses the historic rate of RSLR at the NOAA Tide Gage at Sandy Hook, NJ. The sensitivity of the FWOP to higher rates of sea level rise is shown based on current USACE guidance (ER 1100-2-8162). Future RSLR rates were evaluated for a 50-year period from 2018-2068. Table 3-3 provides an overview of the impact sea level rise.

**Table 3-3: Relative Sea Level Rise Impacts on Shoreline Changes and Sediment Budget**

| RSLR Scenario | RSLR over 50 years (ft) | Shoreline Change (ft/yr) | Volumetric Loss (cy/yr) |
|---|---|---|---|
| USACE Low (Historical) | .064 | -0.78 | 53,000 |
| USACE Intermediate | 1.09 | -1.32 | 90,000 |
| USACE High | 2.8 | -3.07 | 209,000 |

The seven-cell FWOP sediment budget provides a detailed look at the sediment budget and identifies erosional hotspots along the Atlantic Ocean Shorefront Planning Reach. The net annual longshore sediment transport rates are similar to the Historical Conditions, and increase from east to west along Rockaway Beach peaking in Reach 3. The steady increase in net annual longshore transport rate creates a sediment deficit in Reaches 3, 4, 5, and 6a. The overall trend in longshore sediment transport is driven by the alongshore variability in the wave conditions. Figure 3-1 shows the alongshore variability in the net annual longshore sediment transport problems.

The primary difference between the FWOP and Historical Conditions sediment budgets is that there is no beachfill in the FWOP to offset the sediment deficit created by the overarching trend longshore sediment transport. Table 3-4 shows the corresponding shoreline change rates based on the FWOP sediment budget. The most striking cell is sub-reach 4, which is predicted to erode by 17.5 ft/yr. This erosion hotspot is caused by 1) overarching trend in longshore sediment transport along eastern Rockaway Beach, and 2) sediment impoundment of updrift groin field in sub-reach 5. Note also that shoreline change in sub-reach 6a would be much greater without beachfill from inlet maintenance dredging.

**Table 3-4: FWOP Shoreline Changes**

| Sub-reach | Shoreline change (ft/yr) |
|---|---|

| Table 3-4: FWOP Shoreline Changes | |
|---|---|
| 1 | +9 |
| 2 | +4.4 |
| 3 | -3.2 |
| 4 | -17.5 |
| 5 | -3.8 |
| 6a | -5.3 |
| 6b | +9.4 |

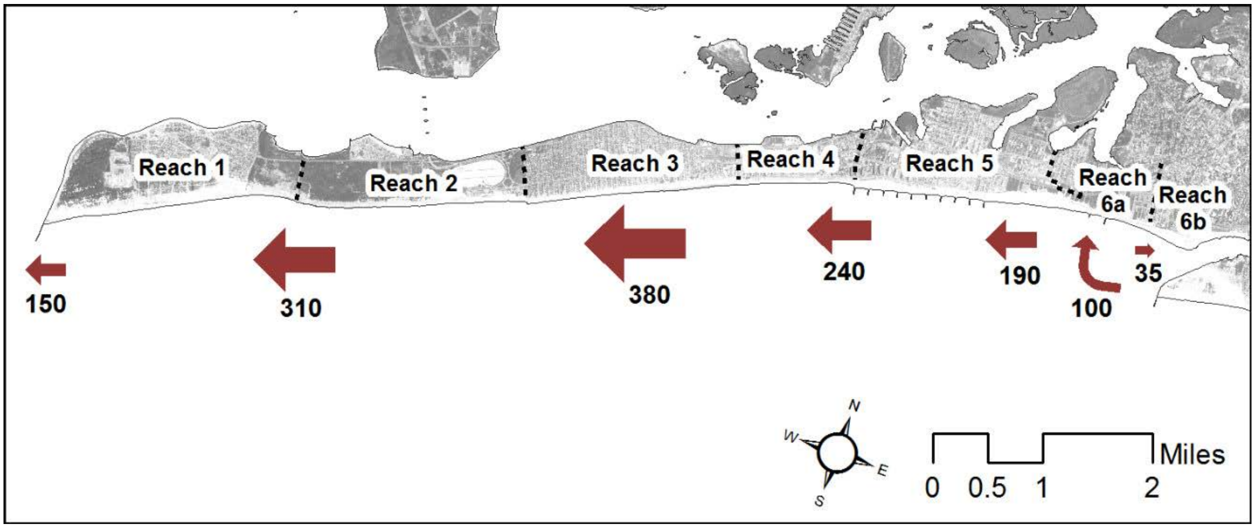


**Figure 3-1: FWOP Sediment Transport Pathways at the Atlantic Ocean Shorefront Planning Reach**

Wetland loss at Jamaica Bay has been occurring for decades, with a measured loss of vegetated marsh islands of 63% (1,471 acres) from 1951 to 2003 (2,347 acres to 876 acres). During this time of wetland loss, the rate of marsh loss has increased from 17 acres lost per year from 1951 - 1974 to 33 acres lost per year from 1989 – 2003 (NPS 2007). An alternative measure of marsh island loss indicates that during the five years from 1994 to 1999, an estimated 220 acres of marsh were lost at a rate of 47 acres per year (USACE 2016). At that rate of loss USACE projects that marsh islands would vanish from the Jamaica Bay Planning Reach by 2025.

Numerous initiatives, including beneficial use of dredged material from the NYNJ Harbor Deepening Project have been implemented to restore Jamaica Bay's marsh islands. To date more than 155 acres of marsh island have been restored (USACE 2016), however the potential for long term net loss vegetated wetlands in the Jamaica Bay Planning Reach remains a likely outcome of the FWOP.

## 3.4 Life Safety

Hurricane Sandy caused 10 fatalities in the study area. The overall resident population at risk in the project area is 850,000 based on the 2010 census blocks that intersect the damageable properties in the project area. Among the most vulnerable of the population at risk include the population over age 65 (Table 3-5). This population was based on the 2010 census blocks that intersect NYC Community Board boundaries in the project areas and on the 2010 census population for Inwood, Census-Designated Place (CDP) (Figure 3-2). This demonstration of those at risk does not include transportation routes for population evacuating or those at work in commercial or industrial areas.

**Table 3-5: At Risk Population Over Age 65**

| | |
|---|---|
| *Atlantic Ocean Shorefront Planning Reach* | |
| Community Board | Population |
| QC 14 | 15,319 |
| Atlantic Ocean Shorefront Planning Reach Total | 15,319 |
| | |
| *Jamaica Bay Planning Reach* | |
| Community Board | Population |
| QC 10 | 15,044 |
| BK 13 | 22,547 |
| BK 15 | 26,319 |
| BK 18 | 22,908 |
| Inwood CDP | 1,155 |
| Jamaica Bay Planning Reach Total | 87,973 |
| Project Area Total | 103,292 |


**Figure 3-2: Persons 65 Years of Age and Older**

Other considerations include high-risk areas that have populations/residents with special needs, hospitals, nursing homes, and schools. These types of populations were not fully defined in this study; however, the existing structures (hospitals, nursing homes, and schools) were inventoried in the project area. These structures are listed in Table 3-1 Structures Within FEMA 1% Annual Chance Flood Area. Additional information on the location of these structures is included in the Economics Appendix.

## 3.5 Critical Infrastructure

Figure 3-3 presents critical infrastructure within the study area and critical infrastructure within the Hurricane Sandy area of impact.

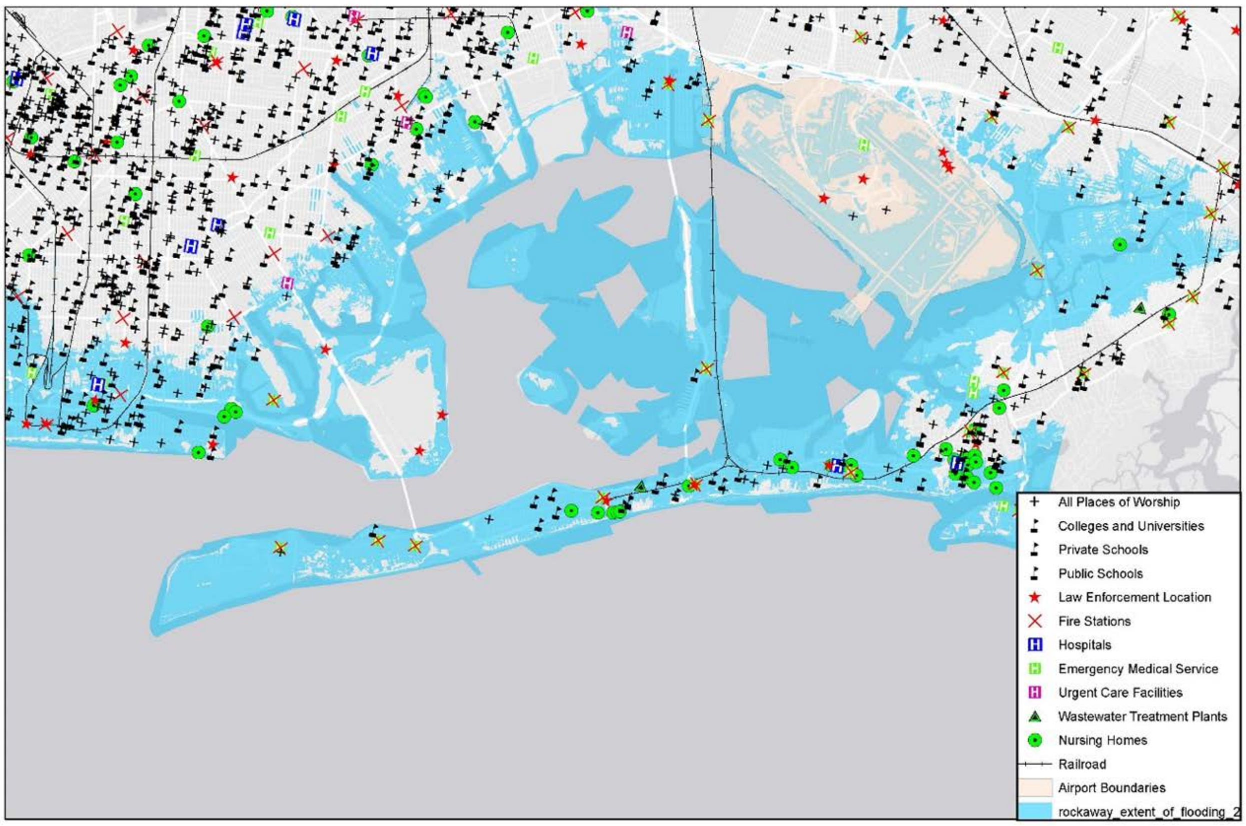


**Figure 3-3: Study Area Critical Infrastructure and Hurricane Sandy Impact Area**

## 3.6 Sea Level Change

Local relative sea level change (SLC) was considered in the preliminary screening of measures based on the guidance contained in the most recent Engineering Regulation (ER) 1100-2-8162 (USACE 2013e), which is the successor to the Engineering Circular (EC) 1165-2-212 (USACE 2011). Per ER 1100-2-8162:

> Planning studies and engineering designs over the project life cycle, for both existing and proposed projects, will consider alternatives that are formulated and evaluated for the entire range of possible future rates of SLC, represented here by three scenarios of “low,” “intermediate,” and “high” SLC. These alternatives will include structural, nonstructural, nature based or natural solutions, or combinations of these solutions. Alternatives should be evaluated using “low,” “intermediate,” and “high” rates of future SLC for both “with” and “without” project conditions.

ER 1100-2-8162 considers the historic rate of SLC as the low rate. The intermediate and high rates are computed from the modified National Research Council (NRC) Curve I and III respectively, considering both the most recent Intergovernmental Panel on Climate Change (IPCC) projections and modified NRC projections with the local rate of vertical land movement added.

For the purposes of the Reformulation Study, the year of construction is assumed to be 2020, with a design life of 50 years. Table 3-6 and Figure3-4 show the USACE SLC data and curves for 2010 to 2100 at The Battery, NY based on ER 1100-2-8162. The intermediate SLC rate is used to calculate equivalent annual flood damages. The sensitivity of the project to the historic rate of RSLC and the high rate of RSLC will be developed at a future phase of study. Hence, a SLC of 1.3 feet in 2070, as compared to the 1992 sea level values, or slightly greater than one foot as compared to the 2014 sea level value, is added to the 1% storm (100-year return period) elevations to identify future risk levels.

**Table 3-6: USACE SLC Projections (feet) at The Battery, NY (Gauge: 8518750)**

| Year | Low | Intermediate | High |
|---|---|---|---|
| 2010 | 0.17 | 0.20 | 0.29 |
| 2015 | 0.22 | 0.27 | 0.42 |
| 2020 | 0.27 | 0.34 | 0.56 |
| 2025 | 0.32 | 0.41 | 0.72 |
| 2030 | 0.36 | 0.49 | 0.90 |
| 2035 | 0.41 | 0.58 | 1.10 |
| 2040 | 0.46 | 0.66 | 1.31 |
| 2045 | 0.51 | 0.76 | 1.55 |
| 2050 | 0.56 | 0.85 | 1.80 |
| 2055 | 0.60 | 0.96 | 2.07 |
| 2060 | 0.65 | 1.06 | 2.37 |
| 2065 | 0.70 | 1.17 | 2.67 |
| 2070 | 0.75 | 1.29 | 3.00 |
| 2075 | 0.80 | 1.41 | 3.35 |
| 2080 | 0.84 | 1.53 | 3.71 |
| 2085 | 0.89 | 1.66 | 4.10 |

| Table 3-6: USACE SLC Projections (feet) at The Battery, NY (Gauge: 8518750) | | | |
|---|---|---|---|
| 2090 | 0.94 | 1.79 | 4.50 |
| 2095 | 0.99 | 1.93 | 4.92 |
| 2100 | 1.03 | 2.07 | 5.36 |
| Values shown to hundredth of foot per direct calculations from EC 1165-2-212, Equation 2: $E(t) = 0.0017t + bt^2$ and illustrate the incremental increase of sea level change over time. | | | |

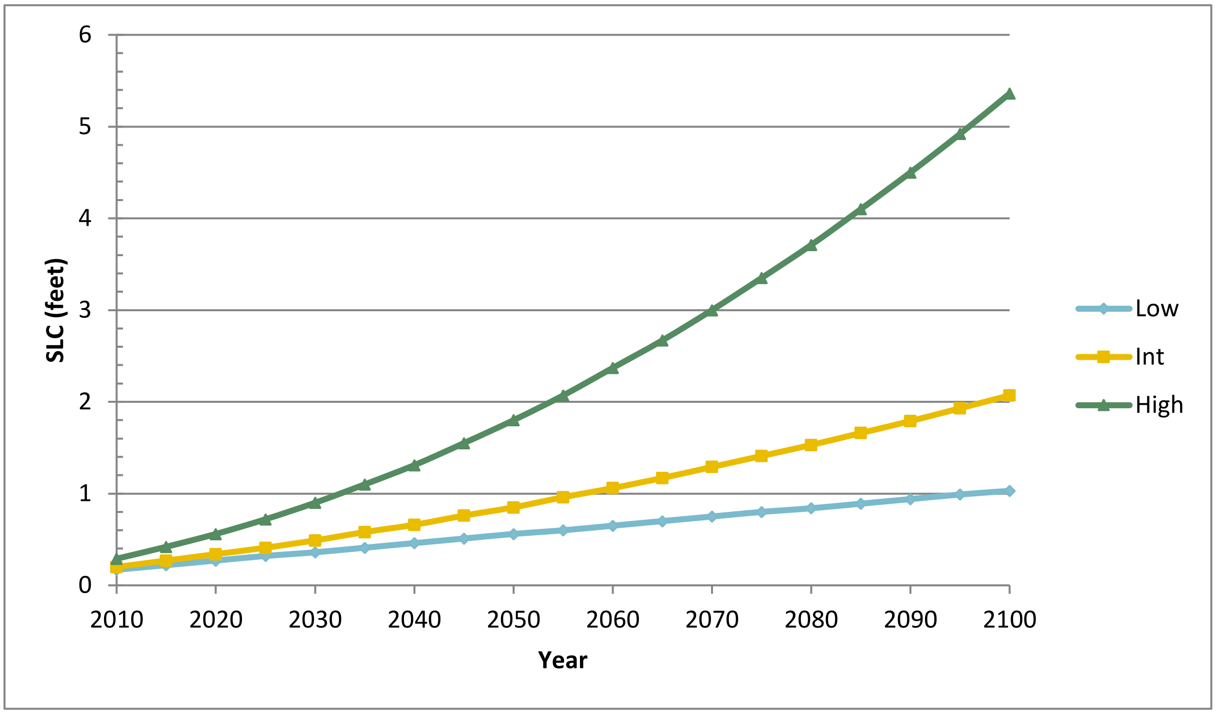


**Figure 3-4: USACE SLC Projections (feet) at The Battery, NY (Gauge: 8518750)**

With the addition of SLC to the current floodplain, the floodplain for the region expands in area and depth. Regions currently in the floodplain are at risk of higher flood depths during storm events. Similarly, the floodplain will extend further inland, increasing the number of assets at risk of flooding. Figure 3-5 depicts the current and projected future area of inundation, which would occur during a 100-year event (also referred to as the 1% annual chance flood hazard event) in the study area.

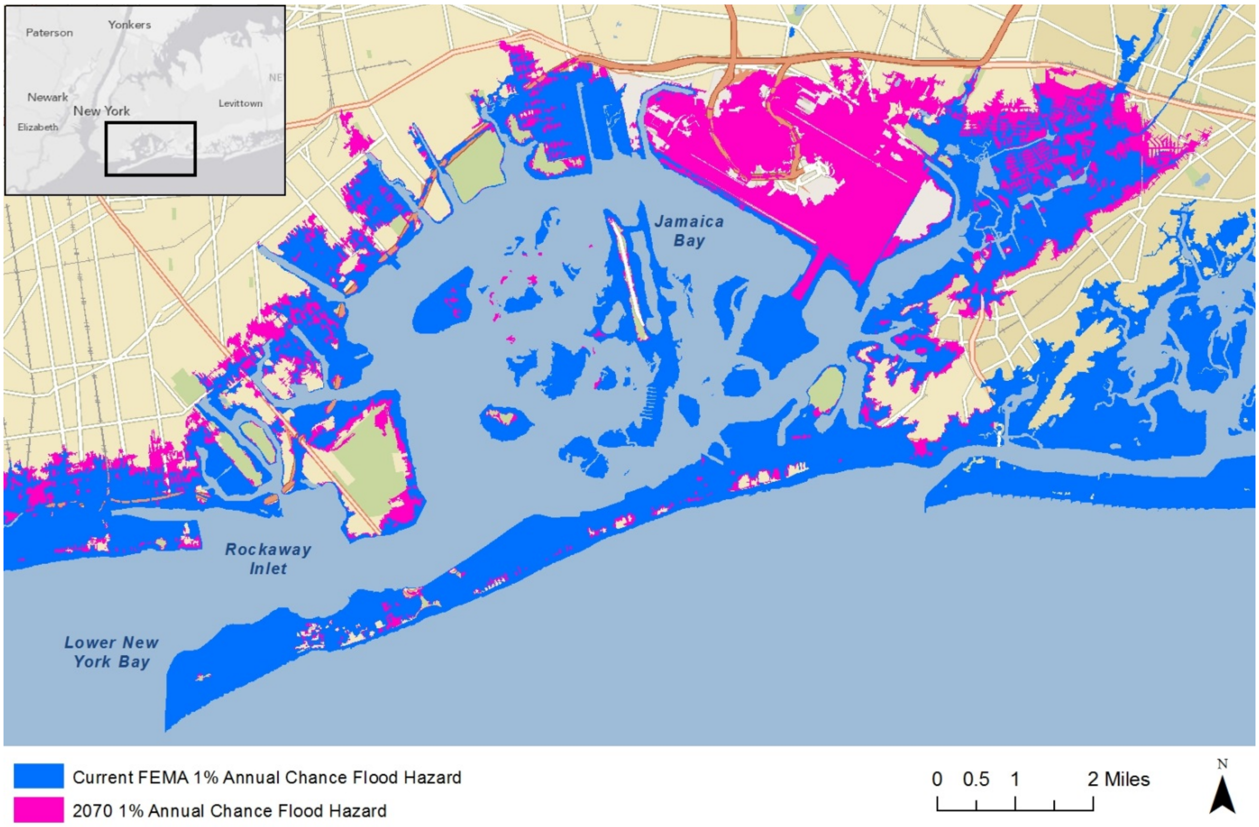


**Figure 3-5: 1% Annual Chance (100-year) Flood Hazard with Mid-Range SLC**

While Figure 3-5 illustrates the 1% annual chance (100-year return period) flood hazard in the study area, it is important to note that no design elevation has been decided upon for any of the Jamaica Bay Planning Reaches or measures that are being considered. Future efforts for the Reformulation Study, including economic and cost considerations, will be necessary to determine the most appropriate design elevation to protect each reach.

Research supported by the City of New York projected future increases in sea level rise are expected to substantially affect future flood heights in and around Jamaica Bay (Orton, *et al.*, 2014). Table 3-7 presents projected flood heights (NAVD88) at Howard Beach, Queens for baseline sea level (1983-2001) and future decades with sea level rise as presented in Orton, *et al*. The projected flood heights are based on hydrodynamic modeling conducted by Orton, *et al.*, which includes the effects of factors such as winds, friction, and other factors. At Howard Beach the flood heights generated by Orton, *et al* 's hydrodynamic modeling are within inches of flood heights predicted by static models. Based on the modeling results presented in Table 7, projected flood heights for similar chance events will increase by 2.9 feet from the baseline (1983 – 2001) to the 2050's. Note that the Orton, *et al*. research conducted for NYC includes SLC estimates, which are higher than the USACE SLC estimates presented in Table 3-6 and Figure 3-5.

| Table 3-7: Projected Flood Heights at Howard Beach | | |
|---|---|---|
| | 1% Annual Chance Flood Hazard (feet) | 0.2% Annual Chance Flood Hazard (feet) |
| Baseline (1983 - 2001) | 9.7 | 11.7 |
| 2020s | 10.8 | 12.7 |
| 2050s | 12.6 | 15.0 |
| 2080s | 15.0 | 16.6 |
| Source: Philip Orton, Sergey Vinogradov, Alan Blumberg and Nickitas Georgas, Hydrodynamic Mapping of Future Coastal Flood Hazards for New York City, 27 February 2014, Table 5.1, page 13. | | |

Figure 3-6 depicts the current and projected future (2050) area of inundation occurring with a 1% annual chance flood hazard in the study area based on higher SLC estimates than presented in Figure 3-5 (Orton *et al.*, 2014 for NYC and LiDAR data analysis for Nassau County).

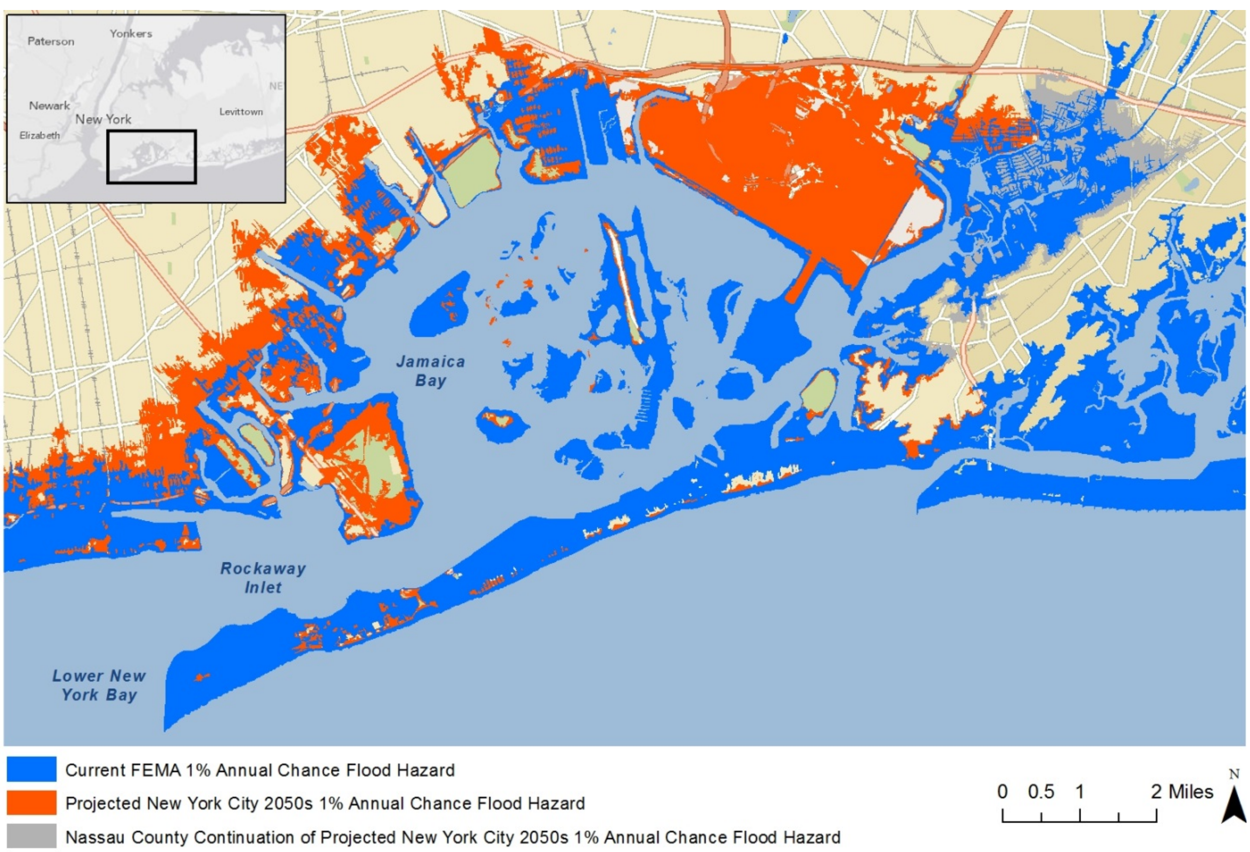


**Figure 3-6: Current and Projected Future 1% Annual Chance (100-year) Inundation Area**

## 3.7 Future Without-Project Conditions Summary

Based on the evaluation of the FWOP conditions, there is the potential for significant economic damages in the Atlantic Ocean shorefront and Jamaica Bay Planning Reaches. There are also concerns for life-safety, damages to critical infrastructure, sea level changes, and impacts on significant environmental resources. These can be further characterized as problems and opportunities for the Federal Government or local interests to implement projects. The FWOP forms the basis against which all potential projects are measured.

The FWOP conditions in the project area do not provide system-wide CSRM to communities devastated by Hurricane Sandy. Within the study area, 10 fatalities and more than 1,000 structures were sufficiently damaged to restrict re-entry or were destroyed by Hurricane Sandy. The NYC Department of Buildings post-Sandy damage assessment indicates the disproportionate vulnerability of the study area to storm surge damage. In addition to the structural impacts caused by waves and inundation, fires ignited by the storm surge inundation of electrical systems destroyed 175 homes at the Atlantic Ocean Shorefront Planning Reach. Damage to the elevated portion of the subway system which connects the Atlantic Ocean Shorefront Planning Reach with the Jamaica Bay Planning Reach (A line) disrupted service for months affecting about 35,000 riders daily. In the Atlantic Ocean Shorefront Planning Reach and in part of the Jamaica Bay Planning Reach 37 schools were closed for up to two months. Nothing in the FWOP condition prevents this level of devastation from recurring.

# 4 PROBLEMS AND OPPORTUNITIES

This chapter presents the results of the first step of the planning process: the specification of water and related land resources problems and opportunities in the study area. Problems are the undesirable conditions that effective plans avoid, reduce/minimize, or mitigate. Opportunities are occasions to beneficially influence future conditions.

## 4.1 Problems and Opportunities

Viewing from a systems context, the general problem within the project area is that the combination of naturally low-lying topography, densely populated areas, extensive low-lying infrastructure, and degraded coastal ecosystems have resulted in communities that are vulnerable to extensive inundation during storm surges. In addition, projected future climate changes are expected to exacerbate existing problems. Projected future climate changes, including sea level rise, will increase coastal storm flooding, erosion and wetland loss (NPS, 2014).

In this analysis, opportunities exist to avoid, reduce/minimize, or mitigate coastal storm impacts in and around the Atlantic Ocean shorefront and Jamaica Bay planning reaches of the project area. Coastal storm impacts include flooding, wave attack, overtopping, and erosion. In addition, there is an overall opportunity to complement ongoing system recovery, ecosystem restoration, and CSRM efforts being conducted by state and local agencies. For the purposes of this study, ecosystem restoration is inclusive of creation, restoration, and enhancement measures.

Specific problems and opportunities include:

- Problem 1 - Projected future coastal storm impacts:
    - The Sandy storm surge (as much as 10 feet above ground) and waves resulted in extensive shorefront damages and inundation of neighborhoods in Brooklyn and Queens, and hamlets in Nassau County (SIRR, 2013);
    - Future storms may be more severe with higher storm surges and waves, and more extensive inundation (Orton, *et al*., 2014); and
    - The frequency of intense storms, such as Sandy, may increase in the future (Orton, *et al*., 2014); and
    - Storm-related flooding and wave damages also occur with more frequent storms of less intensity than Sandy.
- Opportunity to Address Problem 1: Prevent or reduce future coastal storm impacts and related damages. Reduce the risk of coastal storm damage to buildings and infrastructure, which are subject to damages due to storm surge, waves and erosion from the ocean and storm surge in the bay.

- Problem 2 - Insufficient resiliency in natural and man-made systems:
  - Recovery from the damage caused by the Sandy storm surge and inundation was inconsistent across the region, with some systems taking an unacceptable time to recover (SIRR, 2013); and
  - Long lasting service disruptions (healthcare, transportation, telecommunications, electricity, liquid fuels, water supply, wastewater treatment) due to the Sandy storm surge impacted communities within and outside of the storm surge inundation area (SIRR, 2013).
- Opportunity to Address Problem 2: Improve the community's ability to recover from damages caused by storm surges by reducing the duration of interruption in services provided by man-made and natural systems.

- Problem 3 - Environmental degradation:
  - Jamaica Bay has lost 63-percent of its vegetated wetlands between 1951 and 2003 (USACE, 2009), inclusive of salt marshes that continue to diminish at a high rate and which their long term stability is threatened (DOI, 2013);
  - Remaining freshwater marshes and high saltmarshes in Jamaica Bay typically have been severely degraded by the nonnative common reed (*Phragmites australis)*, which forms dense monocultures that competitively exclude naturally occurring, native plant species (DOI, 2013);
  - Maritime and coastal forests within Jamaica Bay, which provide a natural storm surge buffer while also protecting adjacent coastal wetland habitats (DOI, 2013) have become increasingly rare;
  - Historical borrow pits and channelization have increased the average depth of Jamaica Bay from 11 feet to 16 feet (DOI, 2013); and
  - Projected FWOP erosion will substantially impact communities along the Atlantic Ocean Shorefront Planning Reach.
- Opportunity to Address Problem 3: Restore natural coastal features including, but not limited to, wetlands, reefs, and/or dunes and beaches. In addition, restore transitional upland natural features such as maritime or coastal forests and dunes that provide a storm surge buffer while also protecting adjacent natural aquatic features.

- Problem 4 – Impacts to human health and safety:
  - Multiple deaths by drowning, many victims perished within their homes during the Sandy storm surge (NY Times, 17 November 2012);
  - Service disruptions, some lasting for weeks, due to the Sandy storm surge and inundation, included critical electricity, water, heat, transportation, and health services (SIRR, 2013); and

    - Coney Island Hospital was evacuated due to the Sandy storm surge and inundation (SIRR, 2013).
- Opportunity to Address Problem 4: Enhance human health and safety by improving the performance of critical infrastructure and natural features during and after storm surge events.

## 4.2 Planning Goals, Objectives, and Constraints

### 4.2.1 Planning Goals

The main goals of this project are to reduce the risk to lives and property associated with coastal storms within the project area. Achievement of these goals includes the formulation of alternative plans for water resource problems to maximize contributions to National Economic Development (NED). Contributions to NED are increases in the net value of the national output of goods and services expressed in monetary units. Contributions to NED are the direct net economic benefits that accrue in the planning area and in the rest of the nation. NED benefits for CSRM projects are the reduction in projected future coastal flooding-related damages (USACE, 2000). Because it may not be possible to express all project benefits and costs in monetary units, the most efficient alternative may not be the plan with the greatest monetary net benefits. The plan formulation analysis must identify and include the relative importance of non-monetized benefits and costs in the evaluation of alternative plans (USACE, 2013e). Planning objectives; therefore, are not limited to monetary contributions to NED.

### 4.2.2 Public Concerns

Public scoping meetings were held following the Alternatives milestone, to obtain feedback on the alternatives under consideration. Common concerns expressed during public scoping meetings included the sense of urgency to move forward to construction of a risk management feature. Some expressed concerns about the coordination among multiple agencies addressing CSRM issues. Other concerns included maintaining access to the water, preserving views, and balancing CSRM with environmental impacts.

### 4.2.3 Planning Objectives

Objectives are the measurable outcomes of effective plans to avoid, reduce, or mitigate the problems; planning objectives must address the identified problems. In addition, planning objectives must be measurable so that alternative plans may be evaluated on their effectiveness and efficiency in meeting planning objectives.

In the aftermath of Hurricane Sandy, many potential actions have been proposed to reduce storm-related effects to the region. After a thorough review of the published literature as well as meetings with communities and other stakeholders, five principal planning objectives have been identified. These planning objectives are intended to be achieved throughout the study period, which is from

2020 – 2070. The planning objectives for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study include:

- Reduce vulnerability to coastal storm impacts;
- Reduce future coastal storm risk in ways that will support the long-term sustainability of the coastal ecosystem and communities;
- Reduce the economic costs and risks associated with large-scale flood and storm events;
- Improve community resiliency, including infrastructure and service recovery from storm effects; and
- Enhance natural storm surge buffers (NNBFs) and improve coastal resilience

Each of these objectives has the potential to address at least two of the identified problems. All of the problems may be addressed if multiple objectives are achieved. Table 4-1 depicts the problems addressed by each objective.

**Table 4-1: Problems and Objectives Matrix**

| Objectives | Problem 1: Storm Damages | Problem 2: Insufficient Resiliency | Problem 3: Environmental Degradation | Problem 4: Human Health & Safety Impacts |
|---|---|---|---|---|
| Reduce Vulnerability | X | - | - | X |
| Reduce Flood Risk while Supporting Sustainability | X | - | X | X |
| Reduce Economic Costs and Risks | X | - | - | - |
| Improve Community Resiliency | - | X | X | X |
| Enhance Natural Buffers and Ecosystem Resiliency | X | X | X | - |

In order for USACE to support the long-term sustainability of the coastal ecosystem and communities and reduce the economic costs and risks associated with large-scale flood and storm events (as directed in the Disaster Relief Appropriations Act of 2013), planning for CSRM requires an integrated strategy for reducing coastal risks and increasing human and ecosystem community resilience. Integration occurs through formulating alternatives using a combination of the full array of measures, which includes natural, nature-based, nonstructural, and structural measures. These measures are fully defined in Section 5.1 Management Measures. The full range of environmental and social benefits produced by the component features of an alternative plan must be evaluated to meet the National Objective. Integration of natural and nature-based features requires improved quantification of the value and performance of NNBFs for coastal risk reduction. In order to fulfill the National Objective and the directives of the Disaster Relief Appropriations Act of 2013, this analysis will:

- Evaluate NNBFs, not as stand-alone features, but as part of an integrated system and in combination with other measures; and
- Develop a consistent approach to valuing the benefits of NNBFs that contribute to coastal storm risk reduction and improved resilience.

Alternative plans are developed to achieve the identified planning objectives. Metrics are developed to measure the effectiveness and efficiency with which alternative plans achieve these objectives. Reductions in vulnerability are evaluated by measuring projected reductions in coastal storm risk and associated reductions in projected monetary damages.

Improvements to resiliency also are evaluated, in part, by measuring projected reductions in coastal storm risk and associated reductions in projected monetary damages. Improvements to resiliency are likely to be a function of reducing the time-to-recovery and may also be influenced by bringing the more important systems back on-line before other services. The prioritization of infrastructure and systems is likely to be informed by the effects on human health and safety.

The enhancement of natural buffers and ecosystem resiliency also are evaluated, in part, by measuring projected reductions in coastal storm risk and associated reductions in projected monetary damages. The enhancement of natural buffers and ecosystem resiliency also is likely to be evaluated in terms of the acreage of habitat provided and the cost effectiveness of providing that habitat.

### 4.2.4 Planning Constraints

Unlike planning objectives that represent desired positive changes, planning constraints represent restrictions that limit what could be done and are recognized as constraints because they should not be violated in the planning process. The planning constraints identified in this study are as follows:

- Do not negatively impact ongoing recovery, ecosystem restoration, and risk management efforts by others;
  - There are multiple agencies, which are planning and constructing infrastructure, ecosystem, and risk management improvements within the project area. Some of this work is in response to Hurricane Sandy, other efforts are part of other ongoing programs (e.g., National Park Service's Gateway National Recreation Area General Management Plan (NPS, 2014), NYC Department of Environmental Protection's Jamaica Bay Watershed Protection Plan (NYCDEP, 2007);

- CSRM plans affecting the Gateway National Recreation Area must be mutually acceptable to the Department of the Interior and the Department of the Army;
- Do not negatively impact navigation access through Rockaway Inlet;
  - The Federal navigation channel serves navigation interests including commercial cargo transport, charter fishing fleets, and recreational boaters, which use marinas within Jamaica Bay as their homeport;
- Do not induce flooding in areas not currently vulnerable to flooding and do not induce additional flooding in flood-prone areas;
- Do not reduce community access and egress during emergencies;
  - Island and peninsular communities within the study area currently have limited access, egress, and emergency evacuation routes;
- Do not impact operations at John F. Kennedy International Airport.
- Do not negatively affect plants, animals, or critical habitat of species that are listed under the Federal Endangered Species Act or a New York State Endangered Species Act.

## 4.3 Decision To Be Made

The decision to be made is to select a plan as the TSP from a final array to meet the objectives of the study. The planning objectives align with the Federal objective and the four accounts. The plan that best meets the objectives is identified as the TSP. This does not preclude a decision to refine or alter the TSP based on inputs for public, policy, and technical reviews of this Draft HSGRR/EIS.

# 5 FORMULATION AND EVALUATION OF ALTERNATIVE PLANS*

Plan formulation for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Reformulation Study has been conducted in accordance with the six-step planning process described in *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (1983) and the *Planning Guidance Notebook* (ER 1105-2-100, dated April 2000). A synopsis of the plan formulation process is presented below. A detailed description of plan formulation is contained in the Plan Formulation Appendix.

Structural and non-structural management measures, including NNBFs, were developed to address one or more of the planning objectives. Management measures were developed in consultation with the non-federal sponsor (NYSDEC), state and local agencies, and non-governmental entities. Measures were evaluated for compatibility with local conditions and relative effectiveness in meeting planning objectives (see Plan Formulation Appendix for details on measure evaluation).

Effective measures were combined to create CSRM alternatives for two distinct planning reaches: the Atlantic Ocean shorefront and Jamaica Bay. Integrating CSRM alternatives for the two reaches provides the most economically efficient system-wide solution for the vulnerable communities within the project area. Any comprehensive approach to CSRM in the study area must include an Atlantic Ocean shorefront component because overtopping of the Rockaway peninsula is a source of flood waters into Jamaica Bay. Efficient CSRM solutions were formulated specifically to address conditions at the Atlantic Ocean shorefront. The most economically efficient solution for the Atlantic Ocean Shorefront Planning Reach was included as a component of the alternative plans for the Jamaica Bay Planning Reach.

Overtopping of Coney Island also is a source of flood waters into Jamaica Bay. NYCEDC is currently evaluating CSRM features at Coney Island that could serve as a tie-in to high ground located west of Coney Island. This analysis includes the construction of plan features similar to the NYCEDC Coney Island project as necessary. The effort within this report more specifically identifies the necessary Coney Island tie-in near Corbin Place. The costs for the NYCEDC Coney Island CSRM feature are included in the costs of alternatives evaluated in this analysis, but the benefits to Coney Island are not included in this analysis.

The final array of alternative plans, which resulted from the Alternatives Milestone Meeting, includes alternative alignments for the Storm Surge Barrier Plan and a Jamaica Bay Perimeter Plan. Design details for the final array of alternative plans were refined to address key uncertainties (see the Plan Formulation Appendix for additional information on alternative milestone uncertainties and actions taken prior to the TSP) prior to plan evaluation. Evaluation of the final array of alternative plans was based on criteria developed for the Alternatives Milestone, including CSRM effectiveness and efficiency, environmental impacts, and real estate impacts

.

## 5.1 Management Measures

**Atlantic Ocean Shorefront Planning Reach**

The following is a list of measures that have been identified for consideration as CSRM features along the Atlantic Ocean Shorefront Planning Reach. The measures evaluated in this analysis are discussed in greater detail in the Plan Formulation Appendix.

1. No Action (FWOP)
2. Sand bypassing / Inlet Management
3. Beach and Dune fill
4. Breakwaters
5. Groins
6. Removal or Modification of Groins
7. Bulkhead under/near the boardwalk
8. Seawalls / Reinforced dunes
9. Non-Structural Measures
10. Boardwalk Relocation

A preliminary screening was undertaken based upon the specific problems and opportunities in each reach, to identify those measures that are applicable to the specific needs. The following provides a summary of the measures that were identified for consideration in each reach. Each measure marked with an "X" is recommended for further consideration within that Reach. The details supporting this screening of measures is described further in the Plan Formulation Appendix.

| Measures for consideration | Reach 1 | Reach 2 | Reach 3 | Reach 4 | Reach 5 | Reach 6 |
|---|---|---|---|---|---|---|
| Shorefront measures | | | | | | |
| No Action | X | X | X | X | X | X |
| Inlet Management | X | | | | | X |
| Beach and Dune fill | X | X | X | X | X | X |
| Breakwaters | | | | | | |
| Groins | | X | | X | | X |
| Groin Modification | | X | X | X | X | X |
| Bulkhead under/near the boardwalk | | | X | X | X | X |
| Seawalls / Reinforced dunes | | | X | X | X | X |
| Non-Structural (Boardwalk Relocation) | | | | | | X |

**Jamaica Bay Planning Reach**

The USACE Project Delivery Team used previous USACE investigations, Rockefeller Foundation analyses supporting the Science and Resiliency Institute at Jamaica Bay's "Towards a Master Plan for Jamaica Bay" initiative, and meetings with local stakeholders to identify the universe of potential measures that may be applicable to the Jamaica Bay planning reach. A comprehensive inventory of proposals compiled as part of the stakeholder outreach facilitated by the Science and Resiliency Institute at Jamaica Bay was reviewed to identify the breadth of measures to be considered for the reformulation effort. The measures evaluated in this analysis are listed in Table 5-1 and discussed in greater detail in the Plan Formulation Appendix.

**Table 5-1: Comprehensive Inventory of Measures**

| | |
|---|---|
| **Nonstructural Measures** | NNBF Measures |
| Acquisition | Living shoreline |
| Managed Retreat | Wetland |
| Floodplain zoning | Maritime forest |
| Floodproofing | Reef |
| Flood warning system | Dunes[1] and Beaches |
| **Structural Measures** | Swale/Channel |
| Flood gate | Other Measures |
| Hurricane barrier | Bay shallowing |
| Levee | Storm water improvement |
| Floodwall | Wastewater treatment |
| Bulkhead/Seawall | Park access and recreation |
| Breakwater | Evacuation routes |
| Sediment management | No action |
| Groins | |
| Beach nourishment | |
| [1]Includes reinforced dunes | |

Preliminary screening criteria were developed from the planning objectives, including:

- Can the measure provide CSRM benefits in accordance with USACE Civil Works missions and authorities;
- Is the measure effective in providing CSRM benefits (reduce vulnerability, flood risk, and economic costs associated with coastal storms) either as a stand-alone measure or as a part of a larger system when joined with other measures;
- Can the measure provide improvements in resiliency sustainability which include reductions of the time-to-recovery for the natural coastal ecosystem and for communities; and

- Can the measure also provide improvements in habitat quantity and quality for restoration, mitigation or other regulatory purposes?

Figure 5-1 presents a summary of the measures screened for the Jamaica Bay Planning Reach. For measures that achieved the particular screening criterion, a solid, blue marker was been placed in the appropriate row and column and that measure is retained for further evaluation. If a measure likely achieves the particular screening criterion only during high frequency storm events, a blue and yellow marker used to indicate this detail and the measure also is retained for further evaluation. Measures identified by a grey box are not carried forward for further evaluation, including swale/channel, bay shallowing, storm water improvement, wastewater treatment, park access and recreation, and evacuation routes.

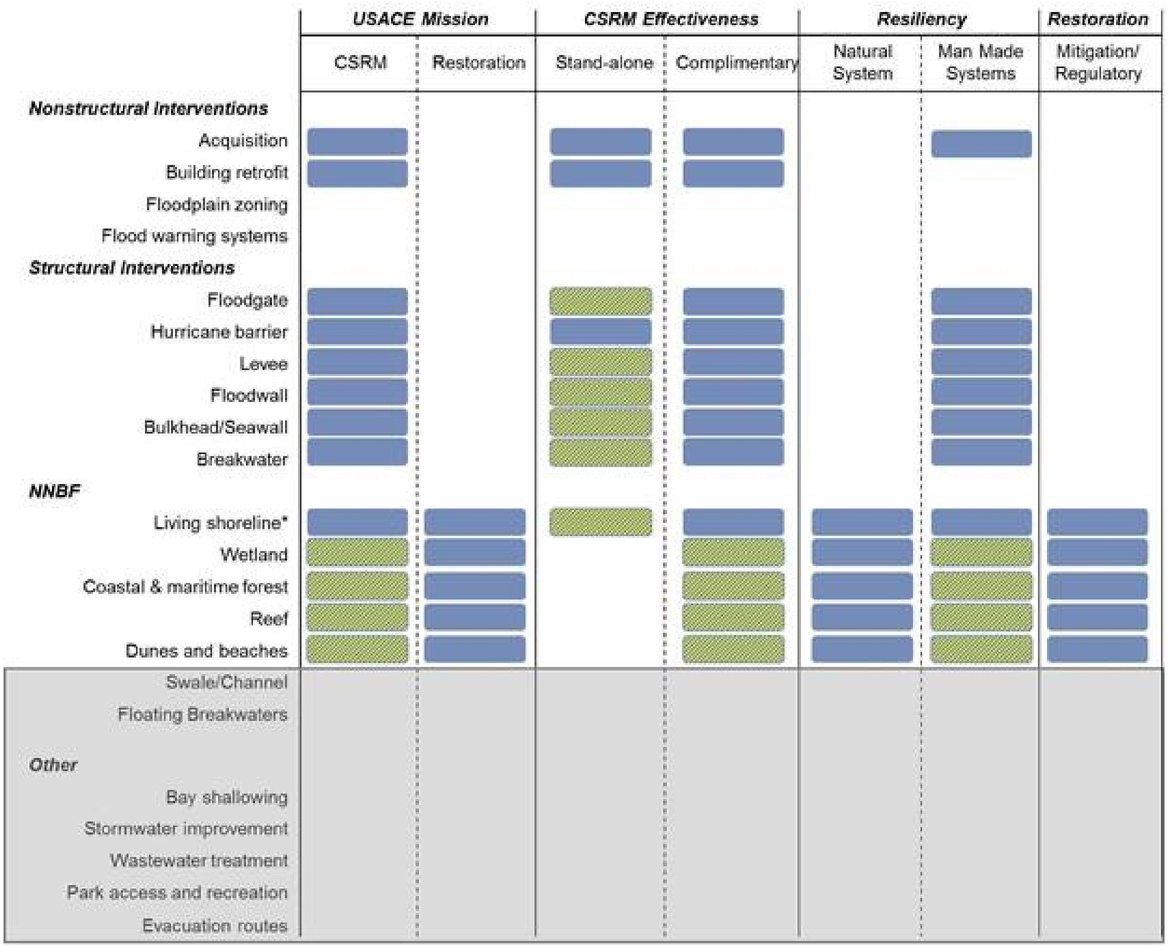


**Figure 5-1: Summary of Preliminary Screening of Jamaica Bay Measures**

## 5.2 Alternative Plan Formulation

This section describes the development of alternative plans based on combinations and refinements of screened measures. Measures were combined to create CSRM alternatives for two distinct reaches: the Atlantic Ocean shorefront and Jamaica Bay. A comprehensive approach to CSRM in the study area must include an Atlantic Ocean shorefront component because overtopping of the Rockaway peninsula is a source of flood waters into Jamaica Bay; therefore, the first step was to formulate efficient CSRM solutions specifically to address conditions at the Atlantic Ocean Shorefront Planning Reach. The best solution for the Atlantic Ocean Shorefront Planning Reach was then included as a component of the alternative plans for the Jamaica Bay Planning Reach.

### 5.2.1 Atlantic Ocean Shorefront Planning Reach

The general approach to developing CSRM alternatives along this reach was to evaluate features that optimize life-cycle costs in combination with a single beach and dune template to select the most cost effective renourishment approach. From the measures described above, this includes beachfill, groins, groin modifications, and boardwalk relocation. Once the most efficient lifecycle management plan was selected, different combinations of beach, dune and reinforced dune cross-sections were evaluated to identify the most economically efficient plan for the planning reach, considering both the level of risk reduction afforded and the lifecycle costs.

#### 5.2.1.1 Life-Cycle Cost Optimization: Beach Fill

Three lifecycle management alternatives were short-listed by the PDT and selected to be evaluated in detail. These alternatives included the following:

- Alternative 1: Beach Restoration; consisting of a beach and dune with renourishment.
- Alternative 2: Beach Restoration & Groin Modifications; consisting of a beach and dune with renourishment, shortening of existing groins, and relocation of the boardwalk
- Alternative 3: Beach Restoration & Groins; consisting of a beach and dune with renourishment, extension of existing groins, and construction of new groins.

The screening level design was used to optimize life-cycle costs, which consisted of developing layouts, cross-sections, quantities, and costs. The objective of the design was to develop enough detail regarding the designs to be able to reliably estimate the life-cycle costs. The life-cycle cost optimization (Figure 5-2) does not consider storm damage reduction benefits since all of the alternatives are based on the same design profile, and all provide a comparable level of risk reduction.

Based upon this comparison of costs, the optimal life-cycle cost feature is Alternative 3, which includes beach restoration with renourishment, extension of existing groins, and new groins (Figure 5-3). This feature had the lowest annualized costs over the 50-year project life and the lowest renourishment costs over the project life (Alternative 3 in Figure 5-2). Renourishment material would be sourced from a borrow area approximately two miles offshore (south) of the Rockaway peninsula.

| Rockaway Beach Formulation Summary | | Low SLR | | |
|---|---|---|---|---|
| | | Alternative 1 | Alternative 2 | Alternative 3 |
| Initial Cost | Initial Construction | $ 24,016,000 | $ 128,177,000 | $ 60,801,000 |
| | IDC | $ 125,000 | $ 2,204,000 | $ 1,273,000 |
| | **Investment Cost** | **$ 24,141,000** | **$ 130,381,000** | **$ 62,074,000** |
| | | | | |
| Annualized Cost | Investment Cost | $ 1,006,000 | $ 5,434,000 | $ 2,587,000 |
| | Renourishment (Planned/Emergency) | $ 7,708,000 | $ 5,936,000 | $ 5,740,000 |
| | O&M | $ 403,000 | $ 403,000 | $ 573,000 |
| | Major Rehab | $ 332,000 | $ 332,000 | $ 332,000 |
| | SLR Adaption | $ - | $ - | $ - |
| | **Total Annual Cost** | **$ 9,449,000** | **$ 12,105,000** | **$ 9,232,000** |

**Figure 5-2: Optimal Life-Cycle Cost Screening**

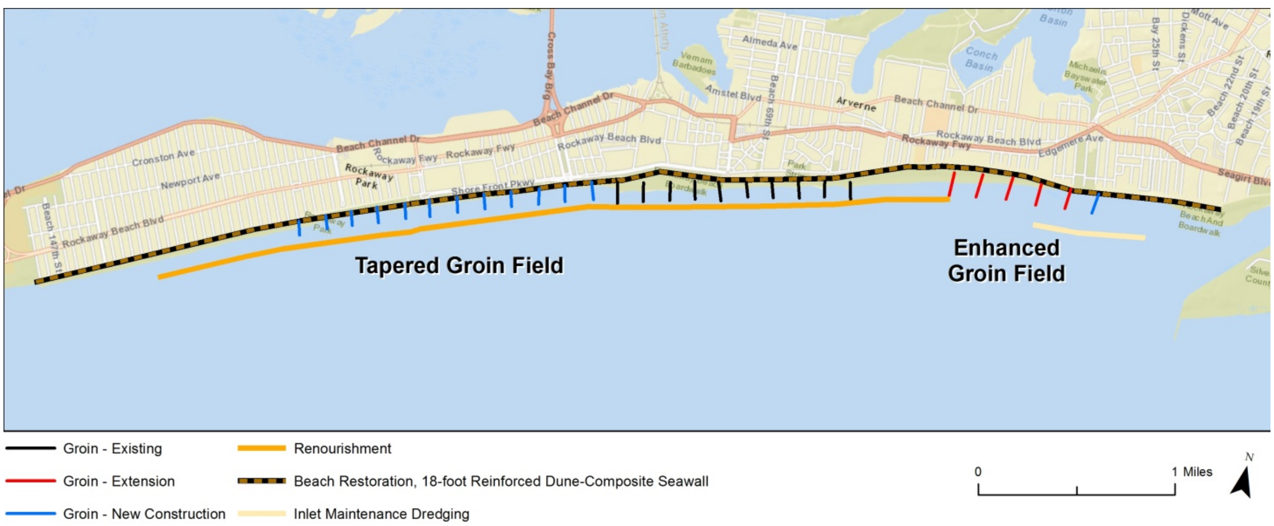


**Figure 5-3: Beach Restoration with Beachfill, Groin Extensions, and New Groins**

Beachfill quantities required for initial construction of the selected alternative is estimated based on the expected shoreline position in June of 2018. It is impossible to predict the exact shoreline position in June 2018 since the wave conditions vary from year to year and affect shoreline change rates. The shoreline position in June of 2018 was estimated based on a 2.5 year GENESIS-T simulation representative of typical wave conditions. Beachfill quantities are based on the difference in the design shoreline position (including advance fill) and the June 2018 shoreline. For every foot that the June 2018 shoreline needs to be translated seaward requires 1.22 cy/ft of fill, based on berm elevation of +8 ft NAVD and a depth of closure of -25 ft NAVD. Beachfill quantities (Tables 5-2) include an overfill factor of 11% based on the compatibility analysis for the borrow areas.

A renourishment interval of 4 years was developed, which is projected to result in advance berm widths of approximately 60 feet along the placement area. Renourishment in Reach 6a is not included as a part of the project because of annual East Rockaway Inlet dredging, which is projected to place 115,000 cubic yards of material on this reach annually.

**Table 5-2: Beachfill and Renourishment Quantities (cubic yards)**

| Reach | Beachfill | Renourishment per Cycle |
|---|---|---|
| Reach 3 | 279,000 | 444,000 |
| Reach 4 | 74,000 | 133,000 |
| Reach 5 | 227,000 | 444,000 |
| Reach 6a | 204,000 | 0 |
| Reach 6b | 20,000 | 0 |
| Totals | 804,000 | 1,021,000 |
| Note: Renourishment would occur on a four-year cycle | | |

#### 5.2.1.2 Life-Cycle Cost Optimization: Groins

Generally a groin is comprised of three sections: 1) horizontal shore section (HSS) extending along the design berm; (2) an intermediate sloping section (ISS) extending from the berm to the design shoreline, and (3) an outer sloping section (OS) that extends from the shoreline to offshore. The head section (HD) is part of the OS and is typically constructed at a flatter slope than the trunk of the groin and may require larger stone due to the exposure to breaking waves. Table 5-3 presents the location and length of groin sections depicted in Figure 5-2 (above).

**Table 5-3: Groin Locations and Lengths (feet)**

| Street | HSS | ISS | OS | Total | Description |
|---|---|---|---|---|---|
| 34th | 90 | 108 | 328 | 526 | New 526’ |
| 37th | 90 | 108 | 328 | 526 | Extension 175’ |
| 40th | 90 | 108 | 328 | 526 | Extension 200’ |
| 43rd | 90 | 108 | 228 | 426 | Extension 75’ |
| 46th | 90 | 108 | 228 | 426 | Extension 150’ |
| 49th | 90 | 108 | 228 | 426 | Extension 200’ |
| 92nd | 90 | 108 | 128 | 326 | New 326’ |
| 95th | 90 | 108 | 128 | 326 | New 326’ |
| 98th | 90 | 108 | 128 | 326 | New 326’ |
| 101st | 90 | 108 | 128 | 326 | New 326’ |
| 104th | 90 | 108 | 128 | 326 | New 326’ |
| 106th | 90 | 108 | 128 | 326 | New 326’ |

| Table 5-3: Groin Locations and Lengths (feet) | | | | | |
|---|---|---|---|---|---|
| 108th | 90 | 108 | 128 | 326 | New 326’ |
| 110th | 90 | 108 | 153 | 351 | New 351’ |
| 113th | 90 | 108 | 178 | 376 | New 376’ |
| 115th | 90 | 108 | 178 | 376 | New 376’ |
| 118th | 90 | 108 | 178 | 376 | New 376’ |
| 121st | 90 | 108 | 128 | 326 | New 326’ |

#### 5.2.1.3 Atlantic Ocean Reach Optimization

Optimization was performed by evaluating the level of overall CSRM provided by a range of dune and berm dimensions and by reinforced dunes, which would be combined with Beach Restoration with Groins to optimize CSRM at the Atlantic Ocean Shorefront Planning Reach. See the Plan Formulation Appendix for further details.

Five coastal storm risk management alternatives were considered:

1. Beach Restoration, +16 foot Dune, 60 foot Berm
2. Beach Restoration, +18 foot Dune, 80 foot Berm
3. Beach Restoration, +20 foot Dune, 100 foot Berm
4. Beach Restoration, +18 foot Reinforced Dune – Buried Seawall
5. Beach Restoration, +18 foot Reinforced Dune – Composite Seawall

All of the alternatives include the most cost effective beach fill and groin features described in Sections 5.1.2.1 and 5.1.2.2.

The smallest design beach fill profiles alternatives under consideration is slightly narrower than the Flood Control and Coastal Emergencies (FCCE) project but wider than the prior WRDA 1974 and Section 934 projects, with a dune height of +16 ft NAVD and a berm width of 60 feet. The two additional design beach fill profiles under consideration have wider berms and higher dunes (Figure 5-4). The dimensions of the three design beach profiles and associated level of protection is provided in Table 5-4.

**Table 5-4: Recommended Design and Beach Fill Profiles**

| Design | Dune Height (feet, NAVD) | Design Berm Width (feet) | LORR[1] (years) |
|---|---|---|---|
| Medium | +16 | 60 | 44 |
| Large | +18 | 80 | 70 |
| XL | +20 | 100 | 100 |

Notes: [1] Level of Risk Reduction (LORR) in return periods

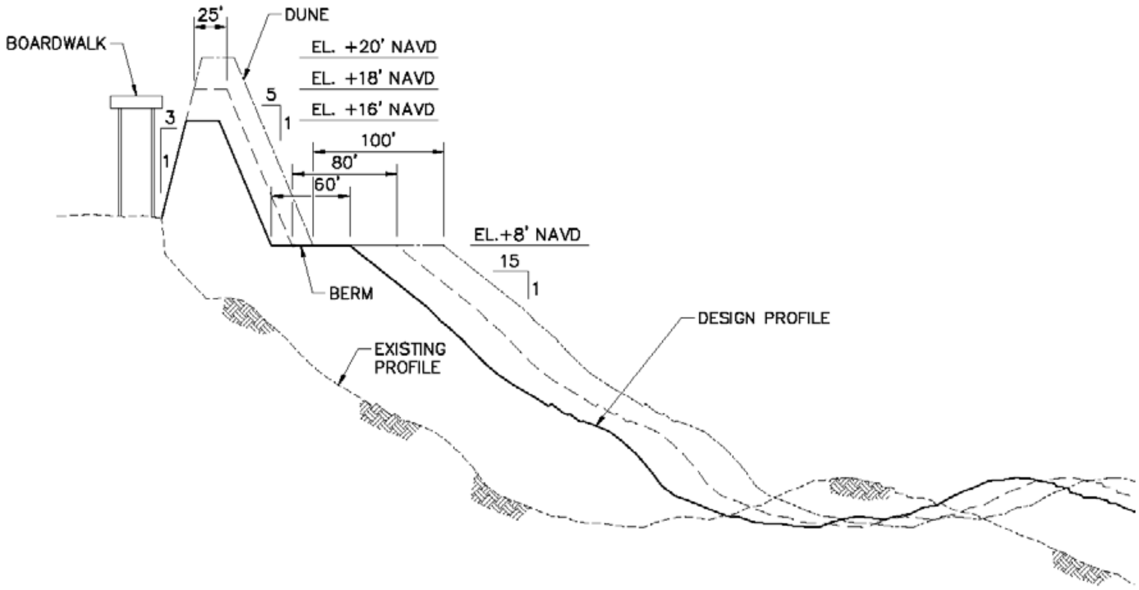


**Figure 5-4: Beach Restoration and Dune Alternatives**

Two reinforced dune concepts have been proposed for Rockaway Beach. The first type, buried seawall, is designed to protect inland areas from erosion and wave damages during severe storm events such as Hurricane Sandy. The second type, composite seawall, is designed to also limit storm surge inundation and cross-island flooding during severe storm events.

The first concept is a buried seawall. Buried seawalls are essentially dunes with a reinforced rubble mound core and were developed as an alternative to larger standalone seawalls. Buried seawalls are designed to function in conjunction with beach restoration projects and dunes. The primary advantage of buried seawalls over traditional dunes is the additional protection against erosion and wave attack provided by the stone core. Since the purpose of the buried seawall is wave protection, it may be constructed intermittingly along the shoreline in the most vulnerable areas.

The second reinforced dune concept is a composite seawall with an impermeable core (i.e. steel sheet pile). The purpose of the composite seawall is to not only protect against erosion and wave attack but also to limit storm surge inundation and cross-island flooding. The composite seawall provides a high level of protection that may not be practical to achieve with a dune because of the necessary height and footprint of such a dune. In addition, the composite seawall is compatible with a comprehensive storm surge barrier for Jamaica Bay (Table 5-5).

**Table 5-5: Recommended Seawall Design Alternatives**

| Structure Type | Structure Crest Elevation (feet, NAVD) | Dune Elevation | Design Berm Width (feet) | LORR[1] (years) |
|---|---|---|---|---|
| Buried Seawall | +16 | +18 | 60 | 70[2] |
| Composite Seawall | +17 | +18 | 60 | 150[2] |

The cost and benefits for each of the alternatives were evaluated. The results of the comparison, presented in Figure 5-4, indicate that all of the alternative plans are cost effective and that the highest net benefits are provided by the composite seawall. Among the beach restoration and dune alternatives, the highest net benefits are provided by the largest alternative considered.

| Rockaway Beach Formulation Summary | | Low SLR | | | | | |
|---|---|---|---|---|---|---|---|
| | | Without Project | 16 Foot Dune | 18 Foot Dune | 20 Foot Dune | Buried Seawall | Composite Seawall |
| Initial Cost | Initial Construction | $0 | $60,801,000 | $84,535,000 | $134,540,000 | $142,487,000 | $205,872,000 |
| | IDC | $0 | $1,273,000 | $2,088,000 | $3,637,000 | $4,205,000 | $7,707,000 |
| | Investment Cost | $0 | $62,074,000 | $86,623,000 | $138,177,000 | $146,692,000 | $213,579,000 |
| Annualized Cost | Initial Construction | $0 | $2,587,000 | $3,610,000 | $5,759,000 | $6,114,000 | $8,901,000 |
| | Renourishment (Planned/Emergency) | $812,000 | $5,740,000 | $6,167,000 | $6,589,000 | $5,740,000 | $5,740,000 |
| | O&M | $0 | $573,000 | $592,000 | $614,000 | $718,000 | $822,000 |
| | Major Rehab | $0 | $332,000 | $332,000 | $332,000 | $332,000 | $332,000 |
| | SLR Adaptation | $0 | $0 | $0 | $0 | $0 | $0 |
| | Total Annual Cost | $812,000 | $9,232,000 | $10,701,000 | $13,294,000 | $12,904,000 | $15,795,000 |
| Damages | Damages - Shore Front | $15,782,000 | $7,886,000 | $4,909,000 | $2,617,000 | $4,831,000 | $1,886,000 |
| | Damages - Cross Shore Flood Damages | $28,705,000 | $26,491,000 | $19,422,000 | $15,467,000 | $19,422,000 | $11,396,000 |
| | Back Bay Damages | $65,163,000 | $65,163,000 | $65,163,000 | $65,163,000 | $65,163,000 | $65,163,000 |
| | Total Damages | $109,650,000 | $99,540,000 | $89,494,000 | $83,247,000 | $89,416,000 | $78,445,000 |
| Benefits | Total Benefits (Reduced Damages) | - | $7,896,000 | $10,873,000 | $13,165,000 | $10,951,000 | $13,896,000 |
| | Cost Avoided (Emergency Nourishment) | - | $812,000 | $812,000 | $812,000 | $812,000 | $812,000 |
| | Shorefront Benefit (Reduced Damage Plus Cost Avoided) | - | $8,708,000 | $11,685,000 | $13,977,000 | $11,763,000 | $14,708,000 |
| | Cross Shore Flood Damage Reduced | - | $2,214,000 | $9,283,000 | $13,238,000 | $9,283,000 | $17,309,000 |
| | Total Storm Damage Reduction Benefits | - | $10,922,000 | $20,968,000 | $27,215,000 | $21,046,000 | $32,017,000 |
| | Recreation Benefits | - | Pending | Pending | Pending | Pending | Pending |
| | Total Benefits | - | $10,922,000 | $20,968,000 | $27,215,000 | $21,046,000 | $32,017,000 |
| | Net Benefits (Damage Reduction Only) | - | $1,690,000 | $10,267,000 | $13,921,000 | $8,142,000 | $16,222,000 |
| BCR | | - | 1.18 | 1.96 | 2.05 | 1.63 | 2.03 |

**Figure 5-5: Dune and Berm Screening**

CSRM at the Atlantic Ocean Shorefront Planning Reach consists of optimized beach fill with groins plus a composite seawall, which provides the highest net benefits of all Atlantic Ocean shorefront alternatives considered (Figure 5-5). The armor stone in horizontally composite structures significantly reduces wave breaking pressure, which allows smaller steel sheet pile walls to be used in the design if the face of the wall is completely protected by armor stone. The composite seawall may be adapted in the future to rising sea levels by adding 1-layer of armor stone and extending the concrete cap up to the elevation of the armor stone.

The composite seawall (Figures 5-6 and 5-7) protects against erosion and wave attack and also limits storm surge inundation and cross-island flooding. The structure crest elevation is +17 feet (NAVD88), the dune elevation is +18 feet (NAVD88), and the design berm width is 60 feet. The composite seawall alternative provides effective and efficient CSRM at the Atlantic Ocean Shorefront Planning Reach and is a necessary component of comprehensive CSRM in the project area.

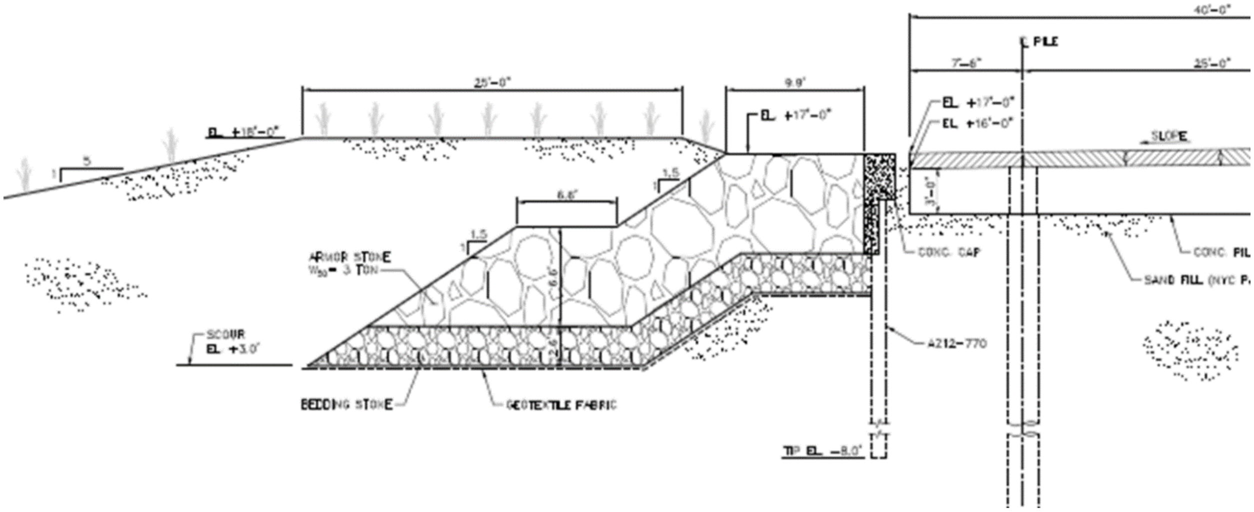


**Figure 5-6: Atlantic Shorefront Composite Seawall Beach 19th St. to Beach 126th St**

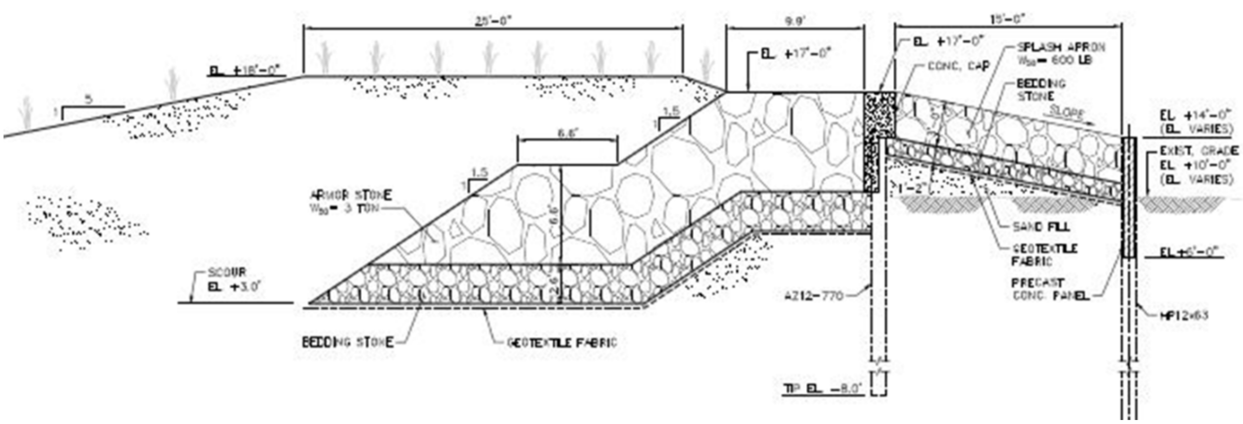


**Figure 5-7: Atlantic Shorefront Composite Seawall Beach 126th St. to Beach 149th St.**

### 5.2.2 Jamaica Bay Planning Reach

The alternative plans for the Jamaica Bay Planning Reach include the best solution for the Atlantic Ocean Shorefront Planning Reach, which would substantially reduce overtopping of the Rockaway peninsula as a source of flood waters into Jamaica Bay. Alternative plans for the Jamaica Bay

Planning Reach also include necessary tie-ins at Coney Island and at the eastern end and western end of the Rockaway peninsula (see section 5.2.2.3 Tie-ins). Four plans were initially developed (A – D). Plan A is the no Action Alternative. Plan B consists of non-structural alternatives such as buy-out, flood-proofing, etc. Plan C is a storm surge barrier at Rockaway Inlet. Plan D is a perimeter barrier along the Jamaica Bay shoreline. The final array of alternatives for the Jamaica Bay Planning Reach, which resulted from the Alternatives Milestone, includes the Jamaica Bay Perimeter Plan (Plan D) and the Storm Surge Barrier Plan (Plan C).

#### 5.2.2.1 Storm Surge Barrier Alternative (Plan C)

Two alternative alignments of the Storm Surge Barrier Plan (C-1, and C-2) were assessed for the TSP Milestone. Each alternative alignment consists of the optimized plan for the Atlantic Ocean Shorefront Planning Reach, two tie-ins (Coney Island tie-in and the Rockaway shorefront eastern and western tie-in) and alignment-specific variations of the Jamaica Bay Northwest CSRM unit (CSRMU) and the Rockaway Bayside CSRM unit.

The C-3 alignment was screened out from the more detailed analysis conducted for alignments C-1 and C-2 because alignment C-3 proved to have higher construction costs and OMRR&R costs due to its longer in-water footprint, while providing the same level of benefits as alignments C-1 and C-2. In addition, alignment C-3 did not prove to have the advantage of a less complicated tie-in to Breezy Point that was initially envisioned at the Alternatives Milestone.

Alignment C-2 and two alternative alignments for C-1 (C-1E and C-1W) were analyzed using the ADCIRC numerical model to aid in the design of the storm surge barriers and consider the number of openings, evaluate changes in tidal amplitude and velocities in Jamaica Bay for various gate configurations and Storm Surge Barrier alignments (Figure 5-8). Storm Surge Barrier alignment C-1E is preferred over alignment C-1W because alignment C-1E:

- would likely result in less impact to the Gil Hodges Memorial Bridge;
- would result in less real estate and aesthetic impacts to the Roxbury Community where alignment C-1W would tie in;
- is located in a more stable channel location; and
- avoids potential impacts to submerged cables.

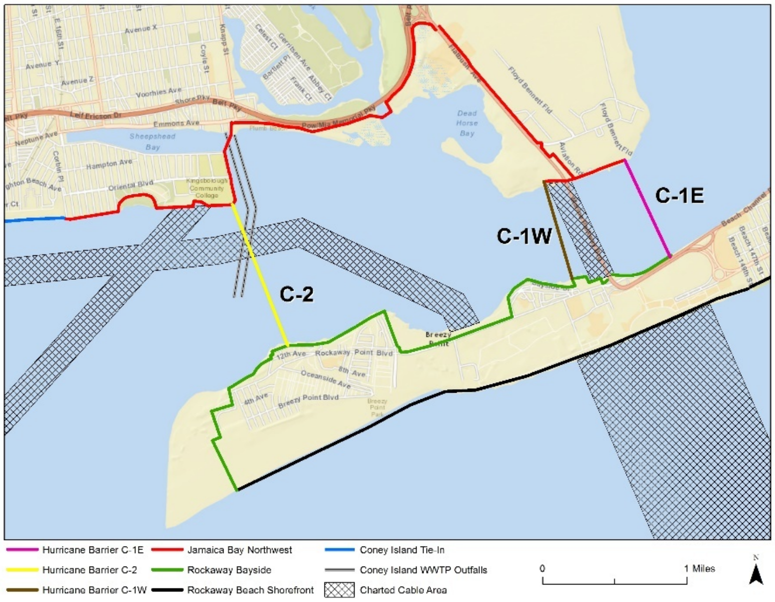


**Figure 5-8: Alignments C-1 and C-2**

Hydrodynamic modeling was conducted on multiple alignment and opening configurations to determine the alignment configuration pairs with the least impacts to tidal amplitude. The ADCIRC hydrodynamic modeling identified alignment C-1E with 1,100 linear feet of gate opening and alignment C-2 with 1,700 linear feet of gate opening as having the least hydrodynamic impacts to the bay as compared to all other potential alignment and opening configurations (Table 5-5). Both alignments C-1E and C-2 result in a maximum tidal amplitude change of 0.2 feet, which occurs only during the highest tides of a tidal cycle. This small impact to tidal amplitude indicates that there would not be any major changes in the water column throughout the bay. Limited changes to the water column indicates that the natural environment driven by water circulation would be undisturbed and water chemistry, including the benthic layer, would be consistent with and without a Storm Surge Barrier. In addition, flow speeds and directions for both alignments are similar to without-project conditions, which imply that circulation within the bay would be minimally impacted. This modeling effort was consistent with SMART planning guidelines as an initial step to identify and mitigate risks, and was intended to identify any significant impacts of a barrier before it was further refined and considered at the TSP Milestone. Additional water quality modeling has been undertaken since the TSP Milestone (NYCDEP, 2016, in prep) and more will be undertaken to ensure that barrier design avoids water quality impacts while the barrier is open or closed.

**Table 5-5: Storm Surge Barrier Alternative Alignment Gate Opening Aggregate Length**

| Alignment | Total Opening (ft) | Number of 100-foot Vertical Lift Gates | Number of 200-foot Sector Gates |
|---|---|---|---|
| C-1E | 1,100 | 7 | 2 |
| C-2 | 1,700 | 11 | 3 |

Storm Surge Barrier alignment C-1E includes a Storm Surge Barrier (design elevation = 16.0 feet NAVD88) with seven 100-foot wide vertical lift gates and two 200-foot wide sector gates (Figure 5-9). Alignment C-1E runs in a northwesterly direction from Jacob Riis Park on the Rockaway peninsula to Barren Island at Floyd Bennet Field, Gateway National Recreation Area (HB-01). On the Rockaway peninsula, alignment C-1E ties in to the Rockaway Bayside CSRM unit, which continues west along the Rockaway peninsula and around Breezy Point prior to tying into the Atlantic Ocean Shorefront Planning Reach (RPV-16). Note that an alternative alignment for the Rockaway Bayside CSRM unit would include a southwestern terminus at Beach 169$^{th}$ Street, which avoids alignments around Breezy Point. This alternative alignment would tie-in to high ground at the Marine Parkway Bridge ramps to the north (RPV-13) and to the south at the Atlantic Ocean Shorefront Planning Reach (RPV-16). At the eastern end of the Rockaway peninsula alignment C-1E ties in to high ground at the Rockaway shorefront eastern tie-in.

On Barren Island, alignment C-1E ties in to a modification of the Jamaica Bay Northwest CSRM unit (HB-01), which runs from the U.S. Marine Corps Reserve Center at Floyd Bennett Field north along Flatbush Avenue. At the Belt Parkway, the Jamaica Bay Northwest CSRM unit continues west along the same alignment identified for the Jamaica Bay Perimeter Plan (JBV-00 through JBV-04) with the western terminus of the unit tying in Coney island. This modified version of the Jamaica Bay Northwest CSRM unit includes floodgates at Sheepshead Bay (JBV-01) and Gerritsen Inlet (JBY-03).


**Figure 5-9: Storm Surge Barrier Plan C-1E**

<u>Storm Surge Barrier alignment C-2</u> includes a Storm Surge Barrier (design elevation = 16.0 feet NAVD88) with eleven 100-foot wide vertical lift gates and three 200-foot wide sector gates (Figure 5-10). Alignment C-2 runs in a northwesterly direction from approximately Beach $218^{th}$ Street on the Rockaway peninsula to Seawall Avenue at Kingsborough Community College (HB-02). On the Rockaway peninsula, alignment C-2 ties in to the Rockaway Bayside CSRM unit. For this alignment the Rockaway Bayside CSRM unit continues west along the Rockaway peninsula, circles around the tip of the peninsula around Breezy Point, then turns east prior to tying into the Atlantic Ocean Shorefront Planning Reach (RPV-16).

At Kingsborough Community College, alignment C-2 ties in to a modification of the Jamaica Bay Northwest CSRM unit (HB-01), which runs from Kingsborough Community College west to the terminus at Manhattan Beach. This modified version of the Jamaica Bay Northwest CSRM unit does not include tributary floodgates. Storm Surge Barrier alignment C-2 also includes the Coney Island tie-in and the Rockaway shorefront eastern tie-in CSRM units.


**Figure 5-10: Storm Surge Barrier Plan C-2**

### 5.2.2.2 Jamaica Bay Perimeter Plan Alternative (Plan D)

The Jamaica Bay Perimeter Plan consists of the optimized plan for the Atlantic Ocean Shorefront Planning Reach, two tie-ins (Coney Island tie-in and the Rockaway shorefront eastern and western tie-in) and three distinct CSRM units (Jamaica Bay Northwest, Head of Bay, and Rockaway Bayside).

The Jamaica Bay Perimeter Plan (Figure 5-11) creates a contiguous barrier along the Jamaica Bay interior, with the exception of JFK Airport. The Jamaica Bay Perimeter Plan would avert inundation at a stillwater elevation of 11 feet for communities surrounding the Bay. Eleven feet is generally equivalent to the stillwater elevation for a storm event with 1% probability of annual occurrence in 2070 including mid-range sea level rise. The community at Broad Channel, which is effectively within Jamaica Bay - as opposed to being a community on the fringe of Jamaica Bay- would not benefit from the Jamaica Bay Perimeter Plan.

After the Alternatives Milestone, additional analyses were conducted to reduced uncertainties associated with the final array of alternatives. A major objective of the additional analyses was to refine alignments to minimize costs, impacts to private property, and habitat disturbances associated with the Jamaica Bay Perimeter Plan.


**Figure 5-11: Plan D Jamaica Bay Perimeter Plan**

The following describes the three distinct CSRM units (Jamaica Bay Northwest, Head of Bay, and Rockaway Bayside) that comprise the Jamaica Bay Perimeter Plan (including references to the appropriate design sheets found in the Engineering Appendix: Plan Sheets).

<u>The Jamaica Bay Northwest CSRM unit</u> runs from Manhattan Beach on Coney Island to Hamilton Beach at Bergen Basin (Plan Sheets JBV-00 through JBV16). The western terminus of the unit ties in at Manhattan Beach (see section 6.7 Risk and Uncertainty). The eastern terminus of the unit ties in at high ground at Bergen Basin. Floodgates are provided at Sheepshead Bay (JBV-01), Gerritsen Inlet (JBY-03), Mill Basin (JBV-05), Paerdegat Basin (JBV-07), Fresh Creek (JBV -09),

Hendrix Basin (JBV-11), Old Mill/Spring Creek (JBV-12), Shellbank Creek (JBV-14), and Hawtree Basin (JBV-16). The Jamaica Bay Northwest CSRM unit alignment generally follows the Belt Parkway and Jamaica Bay Greenway, which minimizes costs, impacts to private property, and disturbances to existing habitat. Roadway floodgates are provided at the Canarsie Pier (JBV-08), Pennsylvania Avenue (JBV-10.1), Hendrix Street (JBV 10.1), and Fountain Avenue (JBV-10.2). A railroad floodgate is positioned at 104$^{th}$ Street for the Long Island Railroad.

The Jamaica Bay Northwest CSRM unit also includes construction of vertical living shorelines at Bergen Beach (JBV-06), Charles Memorial Park (JBV 15.1), Spring Creek (JBV-12), and Hawtree Point (JBV-16). The vertical living shorelines were included in the CSRM unit to dissipate wave energy, reduce shoreline erosion, address anticipated sea level change within the bay, and to offset impacts resulting from other features of the CSRM unit. The vertical living shorelines proposed for Bergen Beach and Charles Memorial Park (Type "B") is specifically designed for locations where a bicycle path is adjacent to the roadway and the protected side does not have space for a levee. The design includes a vertical wall on the protected side that accommodates the space constraints present due to the existing bicycle path (i.e., Jamaica Bay Greenway) and roadway (i.e., Belt Parkway). The Type "B" living shoreline would be planted with high marsh and low marsh vegetation.

The vertical living shorelines proposed for Spring Creek and Hawtree Point (Type "D") have fill placed on top of the 3:1 levee core to accommodate a gentle slope from the middle of the bay side face of the levee to an extent of approximately 25 feet from the toe of the levee. This gentle slope facilitates restoration opportunities for shrubland and maritime forest and provides a functional transition to the existing upland habitats that maximizes ecological functions and/or services to Jamaica Bay.

The <u>Head-of-Bay CSRM unit</u> runs from the Perimeter Road at the eastern side of JFK Airport (RPV-00) to the tie-in at Bayswater Point State park (RPV-04). The northern terminus of the unit ties in to high ground along Perimeter Road at JFK Airport. The southern terminus of the unit ties in to the Rockaway Bayside CSRM unit at Bayswater Point State Park. Floodgates are provided at Head-of-Bay (RPV-01) and Negro Bar Channel (RPV-03). There are no roadway or railroad gates for this unit.

The <u>Rockaway Bayside CSRM unit</u> runs from the tie-in with the Negro Bar Channel floodgate at Bayswater Point State Park (RPV-04) to the Atlantic Ocean Shorefront Planning Reach (RPV-16). The northeastern terminus of the unit ties in to the Negro Bar Channel floodgate at Bayswater Point State Park (RPV-04). The southwestern terminus of the unit ties in to the Atlantic Ocean Shorefront Planning Reach at approximately Beach 149$^{th}$ Street (RPV-16; see section 6.7 Risk and Uncertainty). A land-based floodwall is proposed for the more than 3-mile stretch along the northern side of Beach Channel Drive. At the Edgemere Landfill, rip rap and a shallow foundation sheet pile or T-wall core are proposed for construction on top of the landfill cap to allow the alignment to tie in to the high ground provided at the landfill (RPV-07 and RPV-08).

Floodgates are provided at Norton Basin (RPV-07) and Barbados Basin (RPV-10). Roadway/beach access gates are provided at various locations along Breezy Point and at Riis landing. Roadway flood gates are provided at the Edgemere landfill Service Road (RPV-07 and RPV-08),

Note that an alternative alignment for the Rockaway Bayside CSRM unit would include a southwestern terminus at Beach 169$^{th}$ Street, which avoids alignments around Breezy Point. This alternative alignment would tie-in to high ground at the Marine Parkway Bridge ramps to the north (RPV-13) and to the south at the Atlantic Ocean Shorefront Planning Reach (RPV-16).

The Rockaway Bayside CSRM unit also includes construction of vertical living shorelines at Bayswater Point State Park (RPV-04), Somerville Basin (RPV-08), and Beach 86$^{th}$ Street (RPV-13). The living shorelines were included in the CSRM unit to dissipate wave energy, reduce shoreline erosion, address anticipated sea level change within the bay, and to offset impacts resulting from other features of the CSRM unit. The living shorelines proposed for the Rockaway Bayside CSRM unit (Type "D") have fill placed on top of the 3:1 levee core to accommodate a gentle slope from the middle of the bay side face of the levee to an extent of approximately 25 feet from the toe of the levee. This gentle slope facilitates restoration opportunities for shrubland and maritime forest and provides a functional transition to the existing upland habitats that maximizes ecological functions and/or services to Jamaica Bay.

#### 5.2.2.3 Jamaica Bay Planning Reach Tie-ins

<u>Rockaway Shorefront Western Tie-in</u>

The Rockaway shorefront CSRM unit optimization was conducted for reaches 3 – 6 along the Rockaway shorefront (beach 149$^{th}$ Street to Beach 19$^{th}$ Street). It is assumed that similar design features, elevations and costs are applicable for Rockaway shorefront reaches 1 and 2 up to the tie-in with the Rockaway bayside CSRM unit, including a composite seawall throughout, and beachfill as may be required in Reach 2.

<u>Rockaway Shorefront Eastern Tie-in</u>

The Rockaway Shorefront eastern tie-in consists of an eastward extension of the Rockaway shorefront CSRM unit running along the backside of the beach until it turns inland at Beach 17$^{th}$ Street. The alignment continues until termination near the north end of the Yeshiva Darchei Torah campus. The alignment includes concrete floodwalls and two roadway gates.

<u>Coney Island Tie-in</u>

At the Alternatives Milestone Meeting it was assumed that the Storm Surge Barrier alternative and the Jamaica Bay Perimeter Plan alternative would have their western terminus at an assumed tie-in at Corbin Place on Coney Island. For the TSP Milestone, this tie-in has been further defined as the CSRM feature identified by the Coney Island Creek Tidal Barrier and Wetland Feasibility Study (NYCEDC). The revised Coney Island tie-in alignment includes CSRM features developed by NYCEDC at Coney Island Beach, Sea Gate, Coney Island Creek, and Gravesend, tying into high ground at Bensonhurst Park. The alignments and feasibility level cost information have been provided for this analysis by NYCEDC. The costs of the NYCEDC Coney Island CSRM project have been included in the alternative costs for this project.

Jamaica Bay Northwest CSRM Unit

The full extent of the Jamaica Bay Northwest CSRM unit runs from Coney Island to Bergen Basin, which had previously been identified as alignment D-7 for the Alternatives Milestone. The full extent of the Jamaica Bay Northwest CSRM unit is a major component of the Jamaica Bay Perimeter Plan (Plan D). Shorter sections at the western end of the Jamaica Bay Northwest CSRM unit are required to achieve the full functionality of the Storm Surge Barrier Plan by providing a tie-in between the Storm Surge Barrier and the CSRM structure at Coney Island. The design and cost of the Manhattan Beach section of the Jamaica Bay CSRM unit is based on the Rockaway Shorefront CSRM unit composite seawall design and costs.

## 5.3 Alternative Plan Evaluation and Comparison

The Jamaica Bay Perimeter Plan (Plan D) and the Storm Surge Barrier (Plan C alignments C-1E and C-2) were evaluated for habitat impacts, real estate impacts, costs (construction, mitigation, real estate, and OMRR&R), and net benefits. Both plans include the same project features along the Atlantic Ocean shoreline Planning Reach.

### 5.3.1 Habitat Impacts and Mitigation Requirements

Environmental impacts associated with structural alternatives were addressed by complimentary evaluations:

1. Permanent and temporary impacts using an acreage metric. This provides a traditional measure of mitigation needs, and does not account for the level of ecological service and/or functions provided by the habitat types; and
2. Evaluation for Planned Wetlands (EPW) was paired with a Benthic Index of Biological Integrity (B-IBI) to evaluate impacts to ecological functioning within coastal wetlands in in-water habitats.

Table 5-6 presents permanent and temporary habitat impacts using an acreage metric. This metric provides a traditional measure of impacts and mitigation needs, but does not account for the level of ecological service and/or functions provided by the habitats.

| Table 5-6: Permanent and Temporary Habitat Impacts (acres) | | | | | | |
|---|---|---|---|---|---|---|
| | **Permanent** | | | **Temporary** | | |
| **Habitat Type** | **C-2** | **C-1E** | **D** | **C-2** | **C-1E** | **D** |
| Subtidal Bottom | 37.7 | 34.6 | 45.1 | 0.1 | 1.2 | 13 |
| Intertidal Mudflat | 3.3 | 7.5 | 25.1 | 3.8 | 8.8 | 24.2 |
| Intertidal Wetlands | 0 | 0 | 9.4 | 0 | 0.1 | 7 |
| Non-Native Wetlands | 0 | 0.4 | 3.5 | 0 | 0.4 | 0.3 |
| Beach | 0 | 13 | 17 | 61 | 69.9 | 69.6 |
| Dune | 3.1 | 4 | 6.8 | 10.4 | 11.3 | 10.3 |
| Maritime Forest/Shrub | 6.71 | 20.6 | 31.5 | 3.9 | 11.4 | 30.3 |
| Ruderal | 0.43 | 24.4 | 46.7 | 0.6 | 12.6 | 49.4 |
| Rip Rap/Bulkhead | 4.2 | 6.5 | 13.5 | 0.2 | 0.4 | 3.5 |
| Urban | 6.7 | 18.7 | 48.4 | 6.2 | 12.8 | 41.5 |
| Total | 62.14 | 129.7 | 247 | 86.2 | 128.9 | 249.1 |

Two mitigation projects, which have previously been identified as high priority restoration projects by the Hudson-Raritan Estuary Comprehensive Restoration Plan (HRECRP) have been selected as mitigation projects for the alternative CSRM plans. Dead Horse Bay represented both a high level of ecological benefit as well as one the most efficient for any of the selected projects. This project also has a significant level of past evaluation and design (i.e., USACE 2010), and considerable current momentum with local stakeholders to be moved forward. This project is recommended to be carried forward within the context of mitigation for all three evaluated alternative alignments. Constructing the Dead Horse Bay and Duck Point projects are recommended as mitigation for Alternative C-2. Proposed mitigation for Alternative C-2 would provide 202 acres of habitat (Table 5-6), which is an increase of 134 acres more than the existing condition.

The mitigation requirements for Alternative C-1E are satisfied by a combination of constructing the Floyd Bennett Field Wetlands Habitat Creation project and the Elders Island project. Proposed mitigation for Alternative C-1E would provide 247 acres of habitat (Table 5-7), which is an increase of 93 acres more than the existing condition.

The combination of the Dead Horse Bay project and the Floyd Bennett Field Wetlands Habitat Creation project satisfies the mitigation requirements for Alternative D. Proposed mitigation for Alternative D would provide 341 acres of habitat (Table 5-7), which is an increase of 227 acres more than the existing condition. Future modeling can facilitate refinement of these mitigation costs at a later date, but future refinement will not have an impact on the current TSP selection.

| Table 5-7: Proposed Mitigation Habitat Improvements (acres) | | | | | | |
|---|---|---|---|---|---|---|
| | **Alt. C-2** | | **Alt. C-1E** | | **Alt D** | |
| **Habitat Type** | **Existing** | **Post-Mitigation** | **Existing** | **Post-Mitigation** | **Existing** | **Post-Mitigation** |
| Subtidal Bottom | 3.4 | 3.4 | 0.0 | 0.0 | 3.4 | 3.4 |
| Intertidal Mudflat | 50.3 | 19.9 | 72.0 | 4.9 | 13.3 | 24.8 |
| Intertidal Wetlands | 0.1 | 66.0 | 2.1 | 147.6 | 2.3 | 104.7 |
| Non-Native Wetlands | 3.1 | 0.0 | 0.0 | 0.0 | 3.1 | 0.0 |
| Beach | 3.6 | 3.6 | 4.8 | 4.8 | 8.4 | 8.4 |
| Dune | 2.6 | 3.7 | 0.0 | 0.0 | 2.6 | 3.7 |
| Maritime Forest/Shrub | 5.7 | 105.9 | 75.5 | 90.0 | 81.2 | 195.9 |
| Ruderal | 133.7 | 0.0 | 94.0 | 0.0 | 227.7 | 0.0 |
| Rip Rap/Bulkhead | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.2 |
| Urban | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 | 0.0 |
| Total | 202.4 | 202.6 | 248.5 | 247.3 | 342.0 | 340.9 |
| Natural Habitat | 68.7 | 202.4 | 154.4 | 247.3 | 114.2 | 340.7 |
| Note: Natural Habitat excludes Ruderal, Rip Rap/Bulkhead and Urban habitat types | | | | | | |

### 5.3.2 Real Estate Impacts and Costs

Real estate impacts resulting from implementation of planning alternatives were assessed in GIS software by overlaying the completed structure footprints and associated right of way easements necessary for structure maintenance on the building footprints, tax lots, and public right-of-way. Those structures and easements intersecting private buildings are assumed to require the purchase of the building and the entirety of the associated tax lot. Those structures and easement intersecting tax lots, but not intersecting any structure on the tax lot, are assumed to require the purchase of only that portion of the parcel necessary for the footprint of the structure. Construction and maintenance right of way easements are to be obtained for those areas intersecting the structure easement, but no land acquisition is required.

The acreage assumed to be required for purchase and easement is presented for privately owned and publicly owned parcels based on the land use designation for the tax lot as identified in the MapPLUTO dataset (see the Real Estate Cost Attachment to the Economics Appendix for additional details). Publicly owned parcels are assumed to include the following land use categories: Open Space and Outdoor Recreation, Parking Facilities, Public Facilities and Institutions, Transportation and Utility (excludes gas stations), and Vacant Land. All other land use categories are assumed to be in private ownership (Table 5-8).

| Table 5-8: Real Estate Impact (acres) | | | | | |
|---|---|---|---|---|---|
| | Purchase Required | | Easement Required | | |
| Alternative | Public | Private | Public | Private | Total |
| C-1E | 31.3 | 2.2 | 42.4 | 0.8 | 76.6 |
| C-2 | 17.1 | 0.5 | 11.2 | 0.01 | 28.7 |
| D | 85.1 | 5.9 | 84.6 | 2.3 | 177.9 |

Estimated real estate costs (Table 5-9) are based on the "FULLVALUE16" field in the MapPLUTO dataset. If an alternative structure feature footprint intersects a building on a private tax lot, real estate costs are the entire tax lot, including the building. If an alternative structure feature footprint intersects a private tax lot, but no buildings are affected, real estate costs are that portion of the tax lot intersected by the structure footprint as calculated as a percentage of the 2016 market value.

If an alternative structure feature footprint intersects a building on a public tax lot, real estate costs are the assessed value of the building and that portion of the tax lot intersected by the structure footprint as calculated as a percentage of the 2016 market value. If an alternative structure feature footprint intersects a public tax lot, but no buildings are affected, real estate costs are that portion of the tax lot intersected by the structure footprint as calculated as a percentage of the 2016 market value.

| Table 5-9: Real Estate Costs (2016$'s) | | | | |
|---|---|---|---|---|
| | Entire Tax Lot | Partial Tax Lot | | |
| Alternative | Private | Private | Public | Total Costs |
| C-1E | | $1,868,000 | $27,568,400 | $29,436,400 |
| C-2 | | $414,300 | $16,971,500 | $17,385,800 |
| D | $4,851,000 | $3,233,800 | $171,870,200 | $179,955,000 |

The acreage and costs of intersecting private and public properties with CSRM structures does not indicate the full real estate impacts of the alternative plans. Additionally, CSRM structures near residential properties inhibit views and/or reduce access to the waterfront. The Rockaway Bayside CSRM unit has many instances where a series of multiple houses along the waterfront would have both water view and waterfront access severely impacted by CSRM structures. These costs would be captured in a more specific appraisal that would be undertaken in conjunction with the final selected plan.

There is a very large difference in water view impacts for the Rockaway peninsula terminus of the two alternative Storm Surge Barrier alignments, which will have 50-foot vertical gate elevations in the open position. Storm Surge Barrier alignment C-1E terminates at the Jacob Riis Park parking lot, which is nearly one-half mile from the nearest residential area. Storm Surge Barrier alignment C-2, on the other hand is immediately adjacent to a residential area at Breezy Point (Figure 5-12).

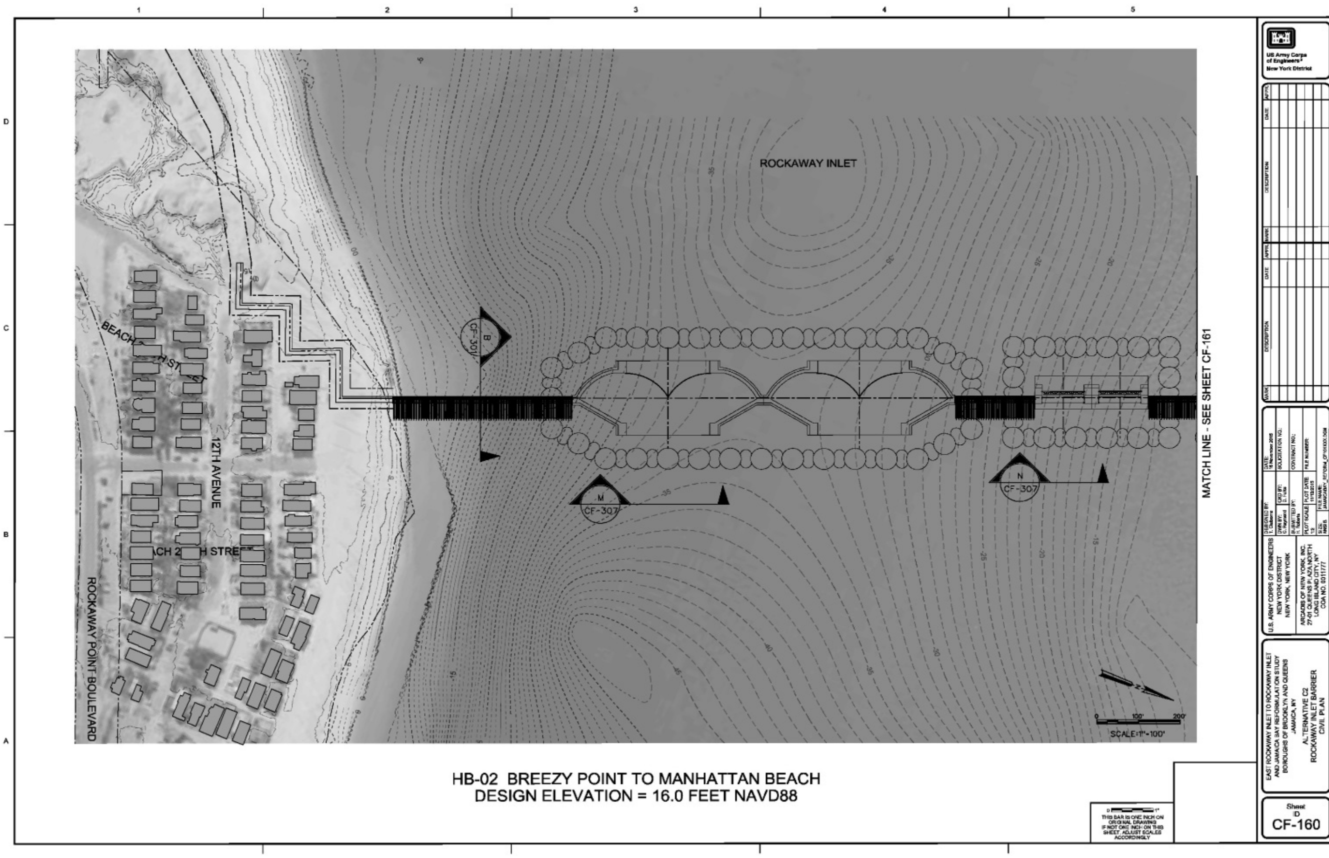


**Figure 5-12: Alt C-2 Proximity to Residential Area**

### 5.3.3 Operation and Maintenance Costs

Operation and Maintenance (OMRR&R) costs include maintenance for passive CSRM structures such as floodwalls and levees and for active CSRM structures such as floodgates and roadway gates. Maintenance activities for each CSRM structure were scheduled with weekly, bi-weekly, monthly, quarterly, annual, 5-year, or 15-year occurrence. Order-of-magnitude OMRR&R costs are based in information from the South Shore of Staten Island, New York Feasibility Study, a reconnaissance level study for the Mississippi Storm Surge Barrier, and information for the Stamford Hurricane Protection Barrier located in Stamford, Connecticut. Average annual equivalent values (AAEQ) were calculated using the FY16 federal discount rate of 3.125% and a 50-year time period (Table 5-12). OMRR&R costs are substantially higher for the Jamaica Bay Perimeter Plan because the Perimeter Plan has many more structures to operate and maintain than the Storm Surge Barrier Plan (Table 5-12).

### 5.3.4 Alternative Plan Costs

In accordance with the USACE's SMART Planning principles, the estimates prepared for this analysis were developed at the level of detail required during the Alternatives Formulation & Analysis Phase, i.e. Alternatives Milestone to Tentatively Selected Plan Milestone. According to

Engineering Record 1110-2-1302 (USACE 2008), the estimate classification for the Pre-Authorization Alternatives Study costing is required to be a Class 4 estimate as defined in American Society for Testing and Materials (ASTM) E 2516-06 (ASTM 2006). Cost estimate assumptions and details are provided in the Cost Estimate Sections of the Engineering Appendix.

The primary characteristic of a Class 4 estimate is that the level of project definition is between 1 and 15 percent. Class 4 estimates utilize a methodology that is primarily stochastic, i.e. unit rates are based on the probability distribution of historical rates. Estimating at a Class 4 level of detail is appropriate for concept/alternatives studies, and the expected accuracy ranges from +100 percent to –50 percent. Because they are based on a very limited project definition, areas of risk and uncertainty in the project should be identified to determine the amount of contingency that should be added to the estimate to reduce uncertainty to an acceptable level.

The construction cost for each alternative is based on the structures and associated quantities (or linear distances) identified in Table 5-10. Note that the costs for each alternative plan include the costs for optimal CSRM at the Atlantic Ocean Shorefront Planning Reach because CSRM at this reach is an integral component of comprehensive CSRM for the project area.

**Table 5-10: CSRM Structures and Associated Quantities**

| | **CSRM Structure Length (ft)** | | |
|---|---|---|---|
| **CSRM Structure** | **Alternative C-1E** | **Alternative C-2** | **Alternative D** |
| Inlet Barrier | 3,930 | 5,715 | |
| Buried Seawall | 55,062 | 55,062 | 55,062 |
| Concrete Floodwall (Bulkhead) | 2,356 | | 21,521 |
| Concrete Floodwall (Deep Water) | 742 | | 5,903 |
| Concrete Floodwall (Land) | 25,367 | 578 | 50,068 |
| Concrete Floodwall (Shallow Water) | | | 8,770 |
| Elevated Promenade (Berm-Face) | 5,041 | | 10,435 |
| Elevated Promenade (Vertical-Face) | 4,234 | | 8,268 |
| Elevated Promenade with Living Shoreline | | | 1,038 |
| Levee | 4,920 | 4,920 | 8,533 |
| Levee w/ Living Shoreline (Berm w/ Maritime Forest) | | | 12,631 |
| Levee w/ Living Shoreline (Tidal Marsh Rock Sill) | | | 1,134 |
| Raised Road | | | 137 |

| Table 5-10: CSRM Structures and Associated Quantities | | | |
|---|---|---|---|
| | CSRM Structure Length (ft) | | |
| **CSRM Structure** | **Alternative C-1E** | **Alternative C-2** | **Alternative D** |
| Road Gate | 180 | | 882 |
| Seawall Reconstruction | 7,599 | 3,967 | 6,554 |
| Sector Gate | 1,048 | | 4,282 |
| Shoreline Restoration | 1,702 | 1,702 | 1,702 |
| Vertical Lift Gate | | | 486 |
| Rockaway Shorefront East Tie-In | 2,135 | 2,135 | 2,135 |
| Coney Island Tie-In | 32,338 | 32,338 | 32,338 |
| New Groins | 4,613 | 4,613 | 4,613 |
| Extend Existing Groins | 800 | 800 | 800 |
| Total Linear Feet | 152,067 | 111,830 | 237,2928 |
| Total Miles | 27.8 | 21.2 | 44.9 |

Construction costs (Table 5-11) include nominal costs for utility relocations and rough order of magnitude costs for relocation of submerged cables that Storm Surge Barrier alignment C-2 crosses (see 6.3.2 Utility Relocations). Mitigation costs were previously discussed in section 5.3.1 Habitat Impacts and Mitigation Requirements. Real estate costs were previously discussed in Section 5.3.2 Real Estate Impacts and Costs. Interest during construction (IDC) for each alternative is calculated based on a five-year construction period, with an equal distribution of funds each year at the FY16 federal discount rate of 3.125%.

| Table 5-11: Construction, Mitigation, and Real Estate Costs | | | |
|---|---|---|---|
| | **Alternative C-1E** | **Alternative C-2** | **Alternative D** |
| Construction | $3,328,135,000 | $3,361,337,000 | $4,467,352,000 |
| Mitigation | $90,833,000 | $75,783,000 | $123,383,000 |
| Real Estate | $29,436,000 | $17,386,000 | $179,955,000 |
| First Cost Total | $3,448,404,000 | $3,454,506,000 | $4,770,690,000 |
| IDC | $333,029,000 | $336,274,000 | $424,262,000 |
| Total Construction Cost | $3,781,433,000 | $3,790,780,000 | $5,194,952,000 |

Operation and Maintenance (OMRR&R) costs include maintenance for passive CSRM structures such as floodwalls and levees and for active CSRM structures such as floodgates and roadway gates. Maintenance activities for each CSRM structure were scheduled with weekly, bi-weekly, monthly, quarterly, annual, 5-year, or 15-year occurrence. Order-of-magnitude OMRR&R costs are based in information from the South Shore of Staten Island, New York Feasibility Study, a reconnaissance level study for the Mississippi Storm Surge Barrier, and information for the Stamford Hurricane Protection Barrier located in Stamford, Connecticut. Average annual equivalent values (AAEQ) were calculated using the FY16 federal discount rate of 3.125% and a 50-year time period (Table 5-12).

Renourishment costs include dredging costs, which are estimated based on the USACE Dredging Software CEDEP and a MII cost estimate for the shore crew. A beachfill unit price of $12.01 per cubic yard and mob/demob of $3.3 million is used throughout the cost estimates. The unit prices for groin construction are based on an MII cost estimates using local labor rates.

**Table 5-12: Annual Costs**

| | Alternative C-1E | Alternative C-2 | Alternative D |
|---|---|---|---|
| Construction | $150,474,000 | $150,846,000 | $206,722,000 |
| Renourishment | $5,740,000 | $5,740,000 | $5,740,000 |
| OMRR&R | $7,424,000 | $7,124,000 | $14,954,000 |
| Total AAEQ | $163,638,000 | $163,710,000 | $227,416,000 |

## 5.4 Alternative Plan Benefits

There are three components to the NED benefits (Table 5-13) provided by the alternative plans: bayside coastal storm risk reduction, shorefront coastal storm risk reduction, and improved recreation. Bayside coastal storm risk reduction is based on reductions in the economic costs and risks associated with property inundation during storm and flood events. Shorefront coastal storm risk reduction includes reductions in the economic costs and risks associated with wave attack, wave run up, and inundation of shorefront properties. Recreation benefits are based on improved recreation opportunities at Rockaway Beach on the Atlantic Ocean Shorefront Planning Reach, which result in an increased value per visit and in an increase in total visits.

**Table 5-13: Alternative Plan Component Benefits (AAEQ)**

| | Alternative C-1E | Alternative C-2 | Alternative D |
|---|---|---|---|
| Inundation Bayside Damage Reduction | $444,218,000 | $444,218,000 | $432,567,000 |
| Atlantic Shorefront Damage Reduction | $32,017,000 | $32,017,000 | $32,017,000 |
| Total Damages Avoided | $476,235,000 | $476,235,000 | $464,584,000 |
| Atlantic Shorefront Recreation | $32,998,000 | $32,998,000 | $32,998,000 |
| Total Benefits | $509,233,000 | $509,233,000 | $497,582,000 |

### 5.4.1 Jamaica Bay Planning Reach

Reduction in economic costs and risks associated with large-scale flood and storm events is measured by estimating the economic damages avoided by each alternative. Equivalent annual flood damages (EAD) are defined as the monetary value of physical losses and non-physical damages that can occur in any given year based on the magnitude and probability of losses from all possible flood events. The typical basis for determining EAD are losses actually sustained as a result of historical floods, supplemented by appraisals, application of depth-damage curves, and an inventory of capital investment within the floodplain. EAD are computed using standard damage-frequency integration techniques and computer models that relate hydrologic and hydraulic flood variables such as discharge and stage to damages and to the probability of occurrence. Damages are computed by the application of depth-damage functions, which include application of generalized curves, or site-specific relationships between inundation depth and damage determined by field surveys. EAD can then be computed from the definition of stage-damage, stage-discharge, and discharge-frequency relationships. All of these relationships are developed using a risk-based analytical framework, in accordance with USACE regulations.

EAD calculations were performed using Version 1.2.5 of the Hydrologic Engineering Center's Flood Damage Analysis computer program (HEC-FDA, October 2010). This program applies Monte Carlo Simulation to calculate expected damage values while explicitly accounting for uncertainty in the input data. HEC-FDA models were prepared for existing without-project conditions and future without-project conditions, which incorporate an anticipated one-foot rise in water surface elevations over the 50-year period of analysis.

In the typical flood damage reduction study, every potentially damageable floodplain property is inventoried in order to establish structure type, physical characteristics, and approximate values and elevations. Surveys of all residential properties are conducted in many studies, and representative samples in most others. Industrial, public and unique commercial properties typically require 100% sampling and more detailed on-site inspections. Given the scope and scale of the preliminary formulation phase of the Rockaways study, on-site inspection of all, or a significant percentage of, floodplain properties at this stage of the analysis was not feasible. However, GIS-based structure location data and complete aerial imagery has provided much of the data gathered in a typical USACE flood damage reduction on-site survey.

Based on the type, usage and size of each structure included in the GIS data base (over 90,000 for this analysis) damages were calculated relative to the main floor elevation of the structure. Using structure and ground elevation data, the depth vs. damage relationships were converted to corresponding stage (NAVD88) vs. damage relationships. Generalized depth-percent damage functions for structure, structure content and other items were applied to structures for calculation of inundation damage. For this analysis, generalized depth-percent damage functions used for multi-family residential and all non-residential structures were taken from the HAZUS-MH MR4 Technical Manual. Depth-percent damage functions used for single family residential dwellings with basements were taken from Corps of Engineers' Economic Guidance Memoranda EGM 04-

01. Depth-percent damage functions used single family residential dwellings without basements were taken from *Depth-Damage Relationships For Structures, Contents, and Vehicles and Content-To-Structure Value Ratios in Support of the Donaldsonville to the Gulf, Louisiana, Feasibility Study – March, 2006* (USACE 2006). The damage curves represented in the Louisiana study were used in this analysis because they represent damages occurring from short-duration saltwater intrusion, which typifies coastal flooding experienced in the Jamaica Bay study area. Alternative depth-percent damage functions for single family residential dwellings without basements are available from Corps of Engineers' Economic Guidance Memoranda EGM 01-03, but these functions represent riverine flooding, not coast flooding, and therefore, were not used in this analysis.

For each structure, EADs were calculated for a range of protection levels (10, 25, 50, 100, 250, and 500-year). It is important to note that, the EAD for a structure's 50-year level of protection is not equal to damages incurred by a structure from a 50-year event. Rather, the EAD for a 50-year level of protection represents the average annual equivalent benefits of protecting a structure for storms up to and including the 50-year event, which also includes the 2, 5, 10, and 25-year events. The calculation incorporates the probabilities of various levels of flood events and the associated damages from those events

Table 5-14 presents EADs for the bayside component of each alternative plan for the 10-year, 50-year and 100-year events. The EADs for both Storm Surge Barrier plans are equivalent because each plan under Alternative C provides the same level of protection for all economic reaches.

**Table 5-14: Alternative Plan Jamaica Bay Planning Reach Equivalent Annual Damage Reduction ($000's)**

| Alternative Plan | 10-year event | 50-year event | 100-year event |
|---|---|---|---|
| C-1E | $149,828 | $382,393 | $444,218 |
| C-2 | $149,828 | $382,393 | $444,218 |
| D | $144,344 | $371,601 | $432,567 |

### 5.4.2 Atlantic Ocean Shorefront Planning Reach

The benefit estimates for Atlantic Ocean shorefront coastal storm risk reduction include reduced damages for the Atlantic Ocean shoreline, reduced damages from cross island flooding, and reduced future maintenance costs (Table 5-15). For the Atlantic Ocean shoreline areas the Beach-fx models incorporate each design profile and were adjusted for future profiles to reflect the planned renourishment, which maintains the design profile into the future. The reduced damage due to cross shore flooding was estimated by using the HEC-FDA levee function to truncate/eliminate damages for storm events that would not generate significant overtopping volumes (1.0 cfs). Because the project will maintain the design profile there will be no need for non-federal actions to repair the design profile after major storm events. These future costs avoided are estimated to add $812,000 in average annual benefits to each plan. The composite seawall was selected as a common element of each alternative plan because it provides the highest net benefits of the alternative shorefront elements.

**Table 5-15: Atlantic Ocean Shorefront Planning Reach Equivalent Annual Damage Reduction**

| | Composite Seawall |
|---|---|
| Total Benefits (Reduced Damages) | $13,896,000 |
| Cost Avoided (Emergency Nourishment) | $812,000 |
| Shorefront Benefit (Reduced Damage Plus Cost Avoided) | $14,708,000 |
| Cross Shore Flood Damage Reduced | $17,309,000 |
| Total Storm Damage Reduction Benefits | $32,017,000 |
| Net Benefits (Damage Reduction Only) | $16,222,000 |

### 5.4.3 Recreation Benefits

Implementation of the shorefront component of the project will maintain the beaches within the study area that were restored and renourished after Hurricane Sandy in 2012. Maintaining the width of existing beaches will create an enhanced recreation experience (relative to the future condition of the beach without maintenance) which is reflected in an increase in willingness to pay (WTP) for the recreation experience and an increase in visitation.

The future without-project condition is to not maintain the beaches at presently renourished beach widths. The beach will experience erosion and will eventually be half the width of the existing beach. The shorefront element of each alternative plan will maintain the beaches in the study area against erosion, to a width of approximately 200 feet of beach.

The Travel Cost Method (TCM) is used to estimate economic use values associated with sites that are used for recreation. The basic premise of the TCM is that the time and travel cost expenses that people incur to visit a site represent the 'price' of access to the site. An individual TCM approach was used, based on survey data from individual users at Rockaway Beach. Data was gathered on the location of the visitor's home ZIP Code, how far they traveled to the site, how many times they visited the site during the season, the length of the trip, travel expenses, the method of travel to the site, the person's income and other socioeconomic characteristics.

Beach attendance data was provided by the Department of Parks and Recreation (DPR), City of New York. Based on the total Rockaway Beach visitation provided by DPR, and information from the survey (corrected for trip bias), 2015 beach attendance was estimated by method of travel to the beach. The without project condition of not maintaining Rockaway Beach against erosion results in a substantial number of existing beach goers not willing to visit. Those willing to visit under the without project condition slightly reduce their number of beach visits compared with their existing beach visits. The number of visits not taking place under the without project condition at Rockaway Beach is 4,512,512. The average value per visit is estimated through the TCM as $6.23.

The without-project future condition assumes the lack of beach maintenance against erosion. Rockaway Beach would continue to experience erosion at a rate of about 10 feet per year. Based on responses to beach surveys completed in the summer of 2015, it is estimated that a 50 percent reduction in beach width would reduce the annual number of visits to Rockaway Beach by 4,512,512 visits. Beach visits per year were interpolated between these two points based on survey responses. The reduced beach width would, in turn, reduce the user willingness to pay for the remaining 3,225,988 visits to a substantially lower $3.24 per visit. The average annual equivalent value of the recreation component of NED benefits is $32,998,000 (see the Recreation Appendix for benefits estimation method and calculations).

## 5.5 Identification of the Tentatively Selected Plan

Table 5-16 presents the average annual costs, benefits, net benefits, and benefit-to-cost ratio for each of the alternative plans.

**Table 5-16: Alternative Plan Average Annual Net Benefits (AAEQ)**

| Plan Name | Total Cost | Benefits | Net Benefits | BCR |
|---|---|---|---|---|
| C-1E | $163,638,000 | $509,233,000 | $345,595,000 | 3.1 |
| C-2 | $163,710,000 | $509,233,000 | $345,523,000 | 3.1 |
| D | $227,416,000 | $497,582,000 | $270,166,000 | 2.2 |

Storm Surge Barrier Plan alignment C-1E provides the greatest net benefits of the final set of alternative plans, but is very close when compared to alignment C-2. There are three additional compelling factors that make Storm Surge Barrier Plan alignment C-1E the TSP:

- The costs for C-1E include far less uncertainty that the costs for C-2. There is no need for submerged cable relocations for alignment C-1E.
- Although the real estate costs for alignment C-2 are lower than real estate costs for C-1E (Table 11), real estate costs do not account for the severe impact to water views that are imposed on a Breezy Point neighborhood by alignment C-2 (Figure 5-11). Storm Surge Barrier Plan alignment C-1E is nearly one-half mile away from residential structures on the Rockaway peninsula.
- Alignment C-1E provides flexibility in the determination of whether to include and to what extent to include Breezy Point and Jacob Riis Park into the project. The Rockaway peninsula terminus of alignment C-2 cannot be removed from Breezy Point in a cost effective manner. In other words, alignment C-2 requires the inclusion of and impacts to Breezy Point. The Rockaway terminus of alignment C-1E is approximately one-half mile from Breezy Point. There are numerous potential configurations of the Rockaway Bayside and the Rockaway Shorefront CSRM units that can provide alternative levels of CSRM at Breezy Point.

Therefore the Storm Surge Barrier Alignment C-1E, which includes CSRM at the Atlantic Ocean Shorefront Planning Reach, is currently the TSP. Additionally, Storm Surge Barrier alignment C-1E may be constructed with alternative tie-in locations (listed in Table 5-17 and presented in Figures 5-12 to 5-15), which provide flexibility for the final design.

The Storm Surge Barrier Plan, regardless of alignment, provides substantially more net economic benefits, has less of an environmental impact, and has less of a real estate impact than the Jamaica Bay Perimeter Plan. In addition, the Storm Surge Barrier includes residual risk reduction opportunities that are not available for the Perimeter Plan (See section 6.7 Risk and Uncertainty). Note that the estimated costs for potential residual risk features (Table 6-3) are not substantial enough to impact plan selection. Therefore the TSP is selected from among the alternative Storm Surge Barrier alignments.

Table 5-17 presents a summary of comparisons among the three final alternatives, which supports selection of Storm Surge Barrier Plan C-1E as the TSP.

| Table 5-17: Alternative Plan Comparison Summary | | | | | | |
|---|---|---|---|---|---|---|
| **Category** | **Alternative C-1E (recommended)** | | **Alternative C2** | | **Alternative D** | |
| Construction Cost | $3,328,135,000 | | $3,361,337,000 | | $4,467,352,000 | |
| On-land structures (ln ft) | 44,000 | | 15,000 | | 125,000 | |
| In-water structures (ln ft) | 4,900 | | 7,900 | | 11,000 | |
| Number of tributary gates | 3 | | N/A | | 16 | |
| Number of barrier gates | 9 | | 14 | | N/A | |
| | **Pro** | **Con** | **Pro** | **Con** | **Pro** | **Con** |
| Geomorphology | Hardened shoreline makes longshore sedimentation a | | | Longshore sedimentation a greater risk than C-1E | | |

| Table 5-17: Alternative Plan Comparison Summary | | | | | | |
|---|---|---|---|---|---|---|
| **Category** | **Alternative C-1E (recommended)** | | **Alternative C2** | | **Alternative D** | |
| | smaller risk than C-2 | | | | | |
| | | Marine Parkway - Gil Hodges Memorial Bridge may require scour protection | Bridge foundation scour not likely | | | |
| Utilities | **No conflict with charted submarine cable area** | | | **Conflicts with charted submarine cable area** | **No conflict with charted submarine cable area** | |
| | | Potential Coney Island WWTP effluent line conflict near Sheepshead Bay – some realignment required | | **Current alignment, which has smallest in-water footprint, conflicts with Coney Island WWTP effluent line; substantial realignment** | | Potential Coney Island WWTP effluent line conflict near Sheepshead Bay – some realignment required |

| Table 5-17: Alternative Plan Comparison Summary | | | | | | |
|---|---|---|---|---|---|---|
| **Category** | **Alternative C-1E (recommended)** | | **Alternative C2** | | **Alternative D** | |
| | | | | **required to avoid conflict** | | |
| Environmental Impact (Permanent Impact to Habitat Acres) | | Moderate level of environmental impact<br>(130 acres) | | **Lowest level of environmental impact**<br>**(62 acres)** | **Facilitated incorporation of 8 living shoreline projects within alignment.** | Highest level of environmental impact<br>(247 acres) |
| Mitigation | Moderate Level Mitigation Costs. $90,833,000. (Includes carrying forward Floyd Bennett Field Wetlands Creation and Elders Island as examples.) | Unknown, potential impacts to water quality and tidal amplitude in most up-gradient reaches of tidal inlet channels. Excess mitigation recommended to account for this unknown. | Lowest required mitigation costs. $75,538,000. (Includes carrying forward Dead Horse Bay and Duck Point as examples.) | Unknown, potential impacts to water quality and tidal amplitude in most up-gradient reaches of tidal inlet channels. Excess mitigation recommended to account for this unknown. | | Highest required mitigation costs. $123,383,000. (Includes carrying forward Dead Horse Bay and Floyd Bennett Field Wetlands Creation as examples.) Unknown, potential impacts to water quality and tidal |

| Table 5-17: Alternative Plan Comparison Summary | | | | | | |
|---|---|---|---|---|---|---|
| **Category** | **Alternative C-1E (recommended)** | | **Alternative C2** | | **Alternative D** | |
| | | | | | | amplitude in most up-gradient reaches of tidal inlet channels. Excess mitigation recommended to account for this. unknown. |
| Annual OMRR&R Costs | $7,424,000 | | $7,124,000 | | $14,954,000 | |

## 5.6 Selection of the Recommended Plan

USACE guidance requires selection of the TSP as the Recommended Plan unless there are other Federal, state, local, or international concerns that make another alternative viable to recommend at full cost sharing. In addition, there is an opportunity for the local sponsor to request implementation of a locally preferred plan (LPP) in which they would fully fund the cost above the NED plan if it were higher, or the plan would be reduced in cost if they preferred a smaller plan. Any plan other than the NED Plan would require a waiver from the Assistant Secretary of the Army for Civil Works.

This draft report will undergo public, policy, ATR, and Independent External Peer Review (IEPR), and the study team will address all comments from these reviews. The ADM is the decision point where a Senior Leader Panel confirms the TSP and makes the decision on the Recommended Plan to carry forward for detailed feasibility-level design based on policy, public, ATR, and IEPR reviews of the draft report.

## 5.7 Potential Optimization Outcomes

Storm Surge Barrier alignment C-1E may be constructed with alternative tie-in locations (alignments BZ, 149, FB, and 149 & FB listed in Table 5-18 and shown in Figures 5-13 through 5-16), which provide flexibility for the final design. This flexibility is desirable, since the proposed work along the shorefront, located west of the C-1E Storm Surge Barrier is located on lands within the jurisdiction of the National Park Service. This flexibility allows for consideration of plan variations to minimize effects to the park resources in order to arrive at a plan that is mutually acceptable between the Secretary of the Army and Secretary of the Interior. Therefore, Storm Surge Barrier C-1E, which includes CSRM at the Atlantic Ocean Shorefront Planning Reach, is currently the TSP.

**Table 5-18: Alternative Plan Comparison – AAEQ Costs and Benefits ($000's)**

| | Storm Surge Barrier Plan Alternative Alignments | | | | | | Interior Plan D |
|---|---|---|---|---|---|---|---|
| | C-1E | C-1E BZ | C-1E 149 | C-1E FB | C-1E 149&FB | C-2 | |
| Costs | $163,638 | $153,549 | $114,715 | $113,759 | $94,882 | $163,710 | $227,416 |
| Benefits | $509,233 | $509,233 | $500,884 | $426,107 | $417,757 | $509,233 | $497,582 |
| Net Benefits | $345,595 | $355,684 | $386,169 | $312,348 | $322,875 | $345,523 | $270,166 |
| BCR | 3.1 | 3.3 | 4.4 | 3.7 | 4.4 | 3.1 | 2.2 |


**Figure 5-13: TSP Breezy Point Variation (C-1E BZ)**


**Figure 5-14: TSP Beach 149th Street Variation (C-1E 149)**


**Figure 5-15: TSP Flatbush Variation (C-1E FB)**

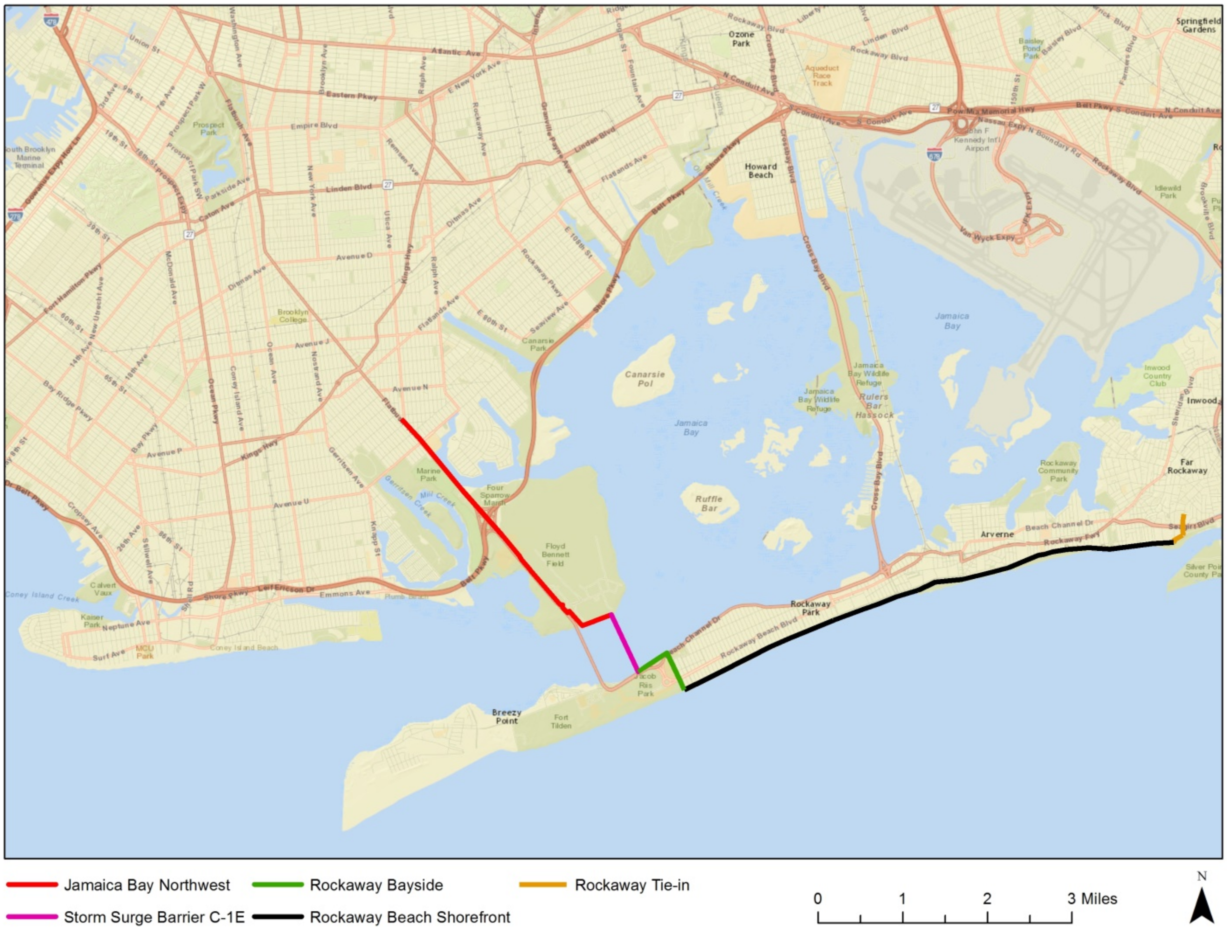


**Figure 5-16: Flatbush and Beach 149th Street Variation (C-1E 149 & FB)**

# 6 TENTATIVELY SELECTED PLAN

The Storm Surge Barrier alignment C-1E, the TSP, efficiently provides system-wide CSRM benefits to the study area, including the Jamaica Bay Planning Reach and the Atlantic Ocean Shorefront Planning Reach. This draft report will undergo public, policy, ATR, and IEPR, and the study team will address all comments from these reviews. Based particularly on input from public and agency reviews concerning public safety and infrastructure concerns, a final alignment for the Storm Surge Barrier and final selection of residual risk measures will be determined. Additional design of the Storm Surge Barrier and residual risk measures will be undertaken prior to the Final HSGRR/EIS.

## 6.1 Plan Components

The TSP integrates CSRM structures for two planning reaches that provide system-wide benefits to the vulnerable communities within the study area. The major components of the TSP include:

- Beach restoration with renourishment, groin extension, groins, and a composite seawall along the Atlantic Ocean Shorefront Planning Reach;
- A Storm Surge Barrier and associated tie-ins at the Jamaica Bay Planning Reach; and
- Residual risk CSRM features, which are small scale CSRM features to reduce residual risks for communities vulnerable to high frequency events and to provide CSRM in the short term prior to construction of the Storm Surge Barrier.

### 6.1.1 TSP Description

TSP plan components (Tables 6-1 to 6-3 and Figures 6-1 to 6-3) are described for Storm Surge Barrier alignment C-1E, which includes a tie-in to the Coney Island CSRM project and provision of CSRM to the Breezy Point community. The design and placement of TSP tie-ins and the extent of CSRM provided to Breezy Point by the TSP will be refined during analyses to be conducted prior to the Final HSGRR/EIS. Storm Surge Barrier alignment C-1E provides comprehensive CSRM for the Atlantic Ocean Shorefront Planning Reach, the Jamaica Bay Planning Reach, and includes opportunities for residual risk CSRM features, which would provide CSRM for communities vulnerable to high frequency events during which the barrier gates would likely be open and during construction of the Storm Surge Barrier.

| Table 6-1: TSP Plan CSRM Structures (length in linear feet) | | | |
|---|---|---|---|
| CSRM Structure | Length | CSRM Structure | Length |
| Inlet Barrier | 3,930 | Seawall Reconstruction | 7,599 |
| Buried Seawall | 55,062 | Sector Gate | 1,048 |
| Concrete Floodwall (Bulkhead) | 2,356 | Shoreline Restoration | 1,702 |
| Concrete Floodwall (Deep Water) | 742 | Rockaway Shorefront Tie-In | 2,135 |
| Concrete Floodwall (Land) | 25,367 | New Groins | 4,613 |
| Road Gate | 180 | Extend Existing Groins | 800 |
| Elevated Promenade (Berm-Face) | 5,041 | Coney Island Tie-In | 32,338 |
| Elevated Promenade (Vertical-Face) | 4,234 | Total Linear Feet | 152,067 |
| Levee | 4,920 | Total Miles | 28.8 |

| Table 6-2: Beachfill and Renourishment Quantities (cubic yards) | | |
|---|---|---|
| **Sub-Reach** | **Beachfill** | **Renourishment per Cycle** |
| Sub-Reach 3 | 279,000 | 444,000 |
| Sub-Reach 4 | 74,000 | 133,000 |
| Sub-Reach 5 | 227,000 | 444,000 |
| Sub-Reach 6a | 204,000 | 0 |
| Sub-Reach 6b | 20,000 | 0 |
| Totals | 804,000 | 1,021,000 |
| Note: Renourishment would occur on a four-year cycle | | |

The TSP includes solutions to address residual risk during design and construction of the Storm Surge Barrier and for those communities vulnerable to inundation during normal hydrometeorological conditions. The operation plan for the Barrier will seek a balance between the frequency of operation and associated impacts due to closure. Too frequent operation (a relatively low closure threshold) could result in a reduction of tidal circulation within Jamaica Bay, while infrequent operation (a relatively high closure threshold) does not reduce the exposure of low lying areas to smaller coastal flood events. The residual risk of the Storm Surge Barrier Plan is the risk that remains for Jamaica Bay as a result of storm surges of too small a magnitude to trigger closure of the Surge Barrier, but large enough to result in coastal flooding in Jamaica Bay's low lying areas.

A wide range of residual risk features were evaluated for low-lying areas around Jamaica Bay, as shown in Table 6-3. At this point in the formulation process, the costs shown in table 6-3 have been included to capture the upper boundary of the cost of these features. There are 5 features from this list that have been sufficiently identified at this point to describe the proposed construction:

- Brookville Blvd. – road raising and construction of an I-wall at the edge of the urban area;
- Mott Basin – construction of a berm and bulkhead;
- Edgemere – construction of a berm and bulkhead;

- Norton Basin – construction of an I-wall and bulkhead; and
- Canarsie – construction of a new revetment.

**Table 6-3: Potential Residual Risk CSRM Structures**

| Project Name | Project Cost | Project Name | Project Cost |
|---|---|---|---|
| Rockaway Park | $1,400,000 | Spring Creek | $800,000 |
| Seaside | $500,000 | Lindenwood | $1,100,000 |
| Hammels West | $1,500,000 | **Canarsie** | $5,900,000 |
| Hammels East | $5,500,000 | Bergen Beach South | $9,900,000 |
| Barbados Basin | $200,000 | Bergen Beach North | $1,600,000 |
| Somerville | $24,000,000 | Mill Basin East | $3,100,000 |
| **Edgemere** | $14,500,000 | Mill Basin West | $700,000 |
| **Norton Basin** | $10,600,000 | Arverne | $9,000,000 |
| **Mott Basin** | $8,900,000 | Mott Basin North | $1,400,000 |
| Meadowmere | $42,200,000 | Inwood | $1,300,000 |
| **Brookville Blvd** | $8,200,000 | Back of Inwood | $500,000 |
| Old Howard Beach | $180,000,000 | Norton Point Facility | $6,100,000 |
| | | Total | $381,300,000 |


**Figure 6-1 TSP Structures (1 of 3)**

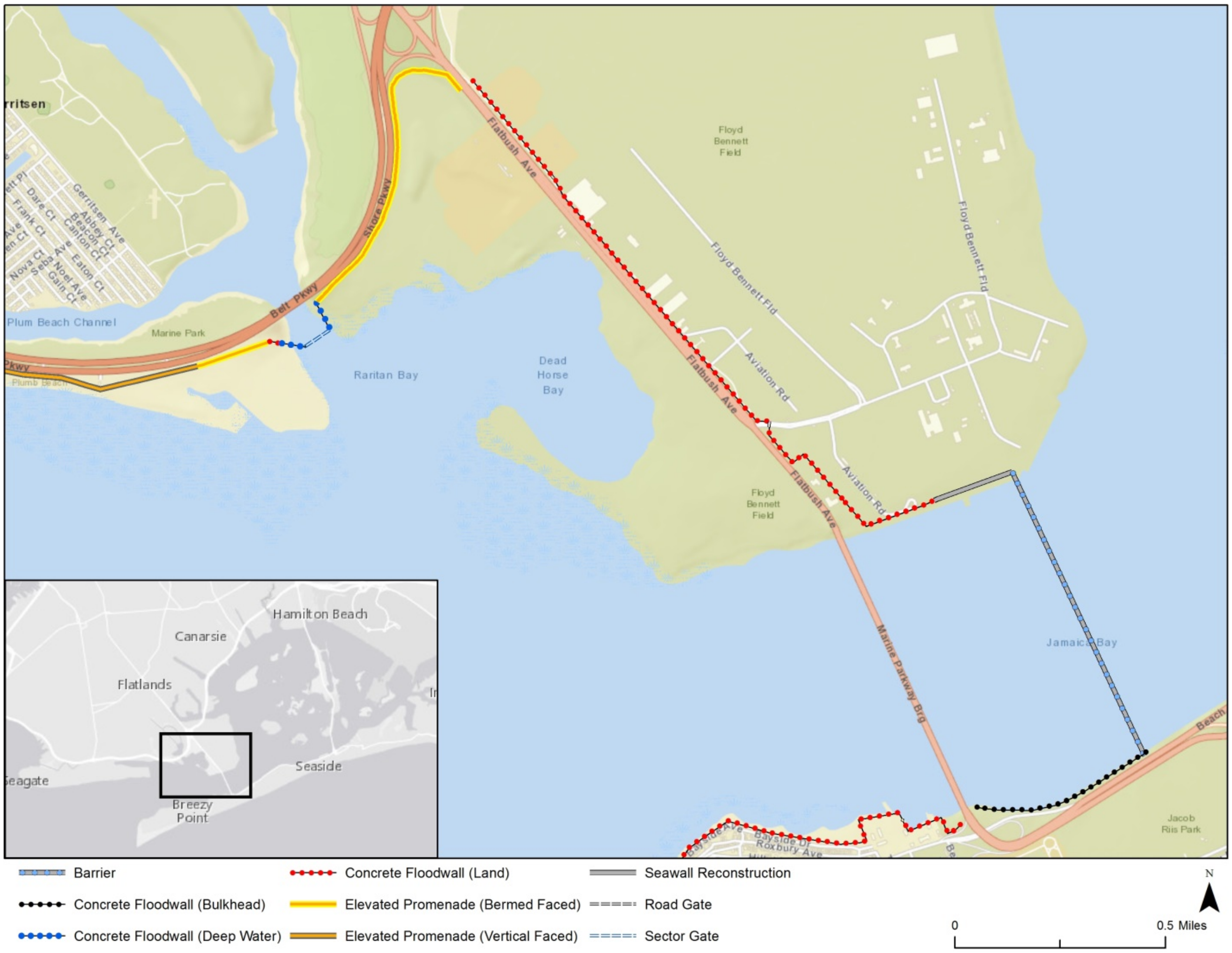


**Figure 6-2: TSP Structures (2 of 3)**

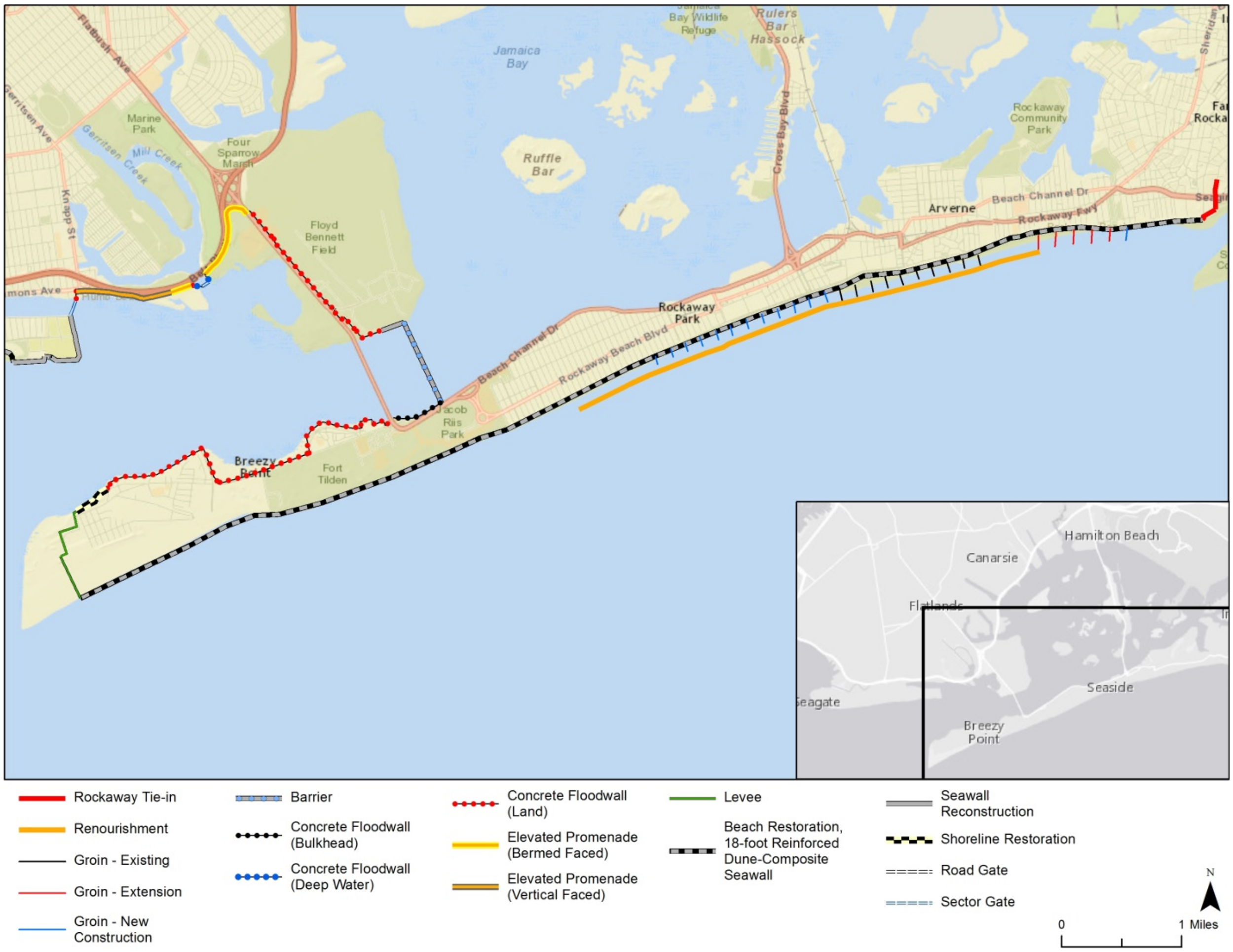


**Figure 6-3: TSP Structures (3 of 3)**

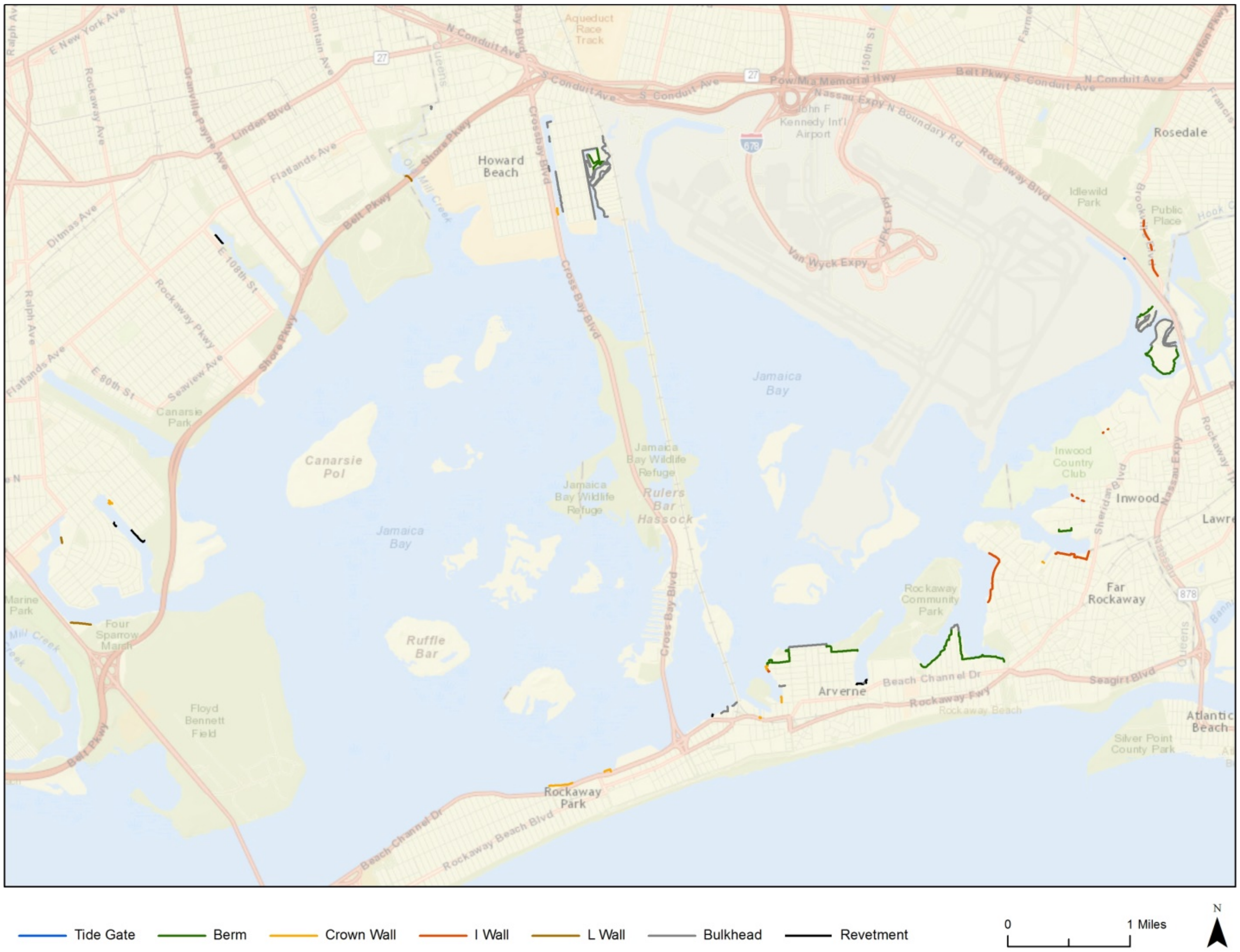


**Figure 6-4: Potential Residual Risk Features**

### 6.1.2 Separable Elements

A separable element is any part of a project which has separately assigned benefits and costs, and which can be implemented as a separate action (at a later date or as a separate project). There are two separable elements of the TSP. The CSRM Plan features for the Atlantic Ocean Shoreline along Reach 3 to 6 can function individually and is separable. The residual risk CSRM features, which would provide CSRM benefits to communities vulnerable to high frequency events and during the time prior to full TSP construction, are also separable elements.

The Storm Surge Barrier, on the other hand, would not be fully effective without the CSRM Plan for the Atlantic Ocean shoreline because storm waters could flood Jamaica Bay by overtopping the Rockaway peninsula. The Storm Surge Barrier also requires tie-ins to high ground to be fully effective and therefore is not separable from those components of the TSP.

Based on based on responses from public, policy, and technical reviews of this Draft HSGRR/EIS, USACE may consider a phased NEPA decision process. Phased NEPA decision making may allow USACE to move forward with implementation of the component measures that can be decided first, while making progress toward the overall goals incrementally, acknowledging that the full benefits wouldn't be realized until all components are complete.

The first phase of decision making may consider construction recommendations to address erosion, storm surge, and wave damage along the Atlantic Ocean shorefront and residual risk measures. A second phase decision might address the details of Storm Surge Barrier construction (specific alignment, operation needs, site-specific mitigation measures, etc.) and will provide the basis for the implementation of the Storm Surge Barrier and related decisions for the interior of Jamaica Bay.

### 6.1.3 Fish and Wildlife Mitigation

Mitigation is proposed for the TSP impacts on fish and wildlife habitats. The mitigation plan proposed in this report is a preliminary plan, which has been developed to indicate the potential for fish and wildlife habitat mitigation in the project area. This preliminary mitigation plan will update after public and agency review and comment.

#### 6.1.3.1 Summary of Environmental Impacts

A rapid assessment ecological tool was developed to provide a means to measure or evaluate the structure, composition, and function of the ecological habitats that characteristically occur in the study area. Evaluation for Planned Wetlands (EPW) was paired with a Benthic Index of Biological Integrity (B-IBI) to evaluate ecological impacts and mitigation requirements for structural alternatives. The combined EPW and B-IBI provides a means to comprehensively evaluate the loss of ecological functions and services across a wide range of habitats, which may not have equal value or provide equivalent levels of service to the ecosystem within the Jamaica Bay Planning Reach. A similar analysis would be conducted for the Atlantic Ocean Shorefront Planning Reach prior to the Finals HSGRR/EIS.

Table 6-4 presents permanent and temporary habitat impacts of the TSP using an acreage metric. This metric provides a traditional measure of impacts and mitigation needs, but does not account for the level of ecological service and/or functions provided by the habitats.

| Table 6-4: Permanent and Temporary Habitat Impacts (acres) | | |
|---|---|---|
| **Habitat Type** | **Permanent Impacts** | **Temporary Impacts** |
| Subtidal Bottom | 34.6 | 1.2 |
| Intertidal Mudflat | 7.5 | 8.8 |
| Intertidal Wetlands | 0 | 0.1 |
| Non-Native Wetlands | 0.4 | 0.4 |
| Beach | 13 | 69.9 |
| Dune | 4 | 11.3 |
| Maritime Forest/Shrub | 20.6 | 11.4 |
| Ruderal | 24.4 | 12.6 |
| Rip Rap/Bulkhead | 6.5 | 0.4 |
| Urban | 18.7 | 12.8 |
| Total | 129.7 | 128.9 |

#### 6.1.3.2 Summary of Conceptual Mitigation Plan

In accordance with the mitigation framework established by Section 906 of the Water Resources Development Act (WRDA) of 1986 (33 USC 2283), as amended by Section 2036 of WRDA 2007 and Section 1040 of the Water Resources Reform and Development Act (WRRDA) of 2014, the Council on Environmental Quality (CEQ)'s NEPA) regulations (40 CFR Sections 1502.14(f), 1502.16(h), and 1508.20), and Section C-3 of Engineer Regulation (ER) 1105-2-100, USACE will ensure that project-caused adverse impacts to ecological resources are avoided or minimized to the extent practicable, and that remaining, unavoidable impacts are compensated to the extent justified.

Mitigation would be required to compensate for a loss of 154 acres of natural habitat. Two mitigation projects, which have previously been identified as high priority restoration projects by the Hudson-Raritan Estuary Comprehensive Restoration Project have been selected as mitigation projects for the TSP. The mitigation requirements for the TSP are satisfied by a combination of constructing the Floyd Bennett Field Wetlands Habitat Creation project and the Elders Island project (Table 6-5). Proposed mitigation for Alternative C-1E would provide 247 acres of habitat, which is an increase of 93 acres more than the existing condition.

| Table 6-5: Mitigation Service Gains and Costs | | | | |
|---|---|---|---|---|
| **TSP** | **Habitat Loss (Acres)** | **Mitigation Habitat Gain (Acres)** | **Excess Habitat Gain (Acres)** | **Mitigation Construction Cost** |
| C-1E | -154 | +247 | +93 | $90,833,406 |

Final selection of potential mitigation sites and modeling of benefits will be conducted in coordination with resource agencies. Feasibility-level costs of selected mitigation measures will be developed, and the costs and benefits will be used to identify a best buy mitigation plan using Cost Effectiveness-Incremental Cost Analysis that will fully compensate for all impacts.

### 6.1.4 Cost Estimate

The TSP cost estimate was prepared using the MII software. The estimates were organized according to the Civil Works Work Breakdown Structure (CWWBS). To support parametric estimating, MII models were developed for each measure allowing for direct entry of geometric parameters, resulting in cost element quantities specific to those parameters. A model template was used to set up multiple project items for the same basic construct but with variations in geometry. The primary material requirements for the project include: ready-mix concrete, reinforcing steel, steel sheet piling, steel H-piles, steel pipe piles, riprap, certified clean fill sands, clean impervious fill, and topsoil. Where available, multiple local estimates were used to develop material prices. The TSP cost estimates is provided in Table 6-6.

**Table 6-6: TSP Total Cost Estimate**

| | Alternative C-1E |
|---|---:|
| Construction | $3,328,135,000 |
| Mitigation | $90,833,000 |
| Real Estate | $29,436,000 |
| First Cost Total | $3,448,404,000 |
| IDC | $333,029,000 |
| Total Construction Cost | $3,781,433,000 |

A more detailed cost estimate will be developed for the plan carried forward for feasibility-level design following the concurrent public, policy, ATR, and IEPR.

### 6.1.5 Project Schedule and Interest During Construction

A preliminary project schedule was prepared with a construction schedule of five years. A more refined schedule and calculation of interest during construction will be further developed for the plan carried forward for feasibility-level design following the concurrent public, policy, ATR, and IEPR review. For cost estimating purposes, construction schedules for each feature were estimated.

## 6.2 Design and Construction Considerations

After the TSP is affirmed as the recommended plan, plan optimization will be conducted. The planning level design used to identify the TSP gave significant consideration to existing infrastructure and habitats that are in close prominently to the work areas and CSRM structures. Construction activities would be closely monitored to ensure that there is not any damage to existing infrastructure and to minimize impacts to the adjacent Gateway National Recreation Area. Coordination with numerous different stakeholders along with the project local sponsors will be required.

### 6.2.1 Value Engineering

A Value Engineering Study will be performed on the plan carried forward for feasibility-level design following the concurrent public, policy, ATR, and IEPR.

### 6.2.2 Relative Sea Level Change

Design and construction considerations for future feasibility-level design will focus on addressing the potential impacts of relative rise of sea level change in the study area. Optimization would consider the costs and benefits of sea level change adaptions. For this analysis, relative sea level change (rise) has been accounted for in the optimization of life-cycle costs analysis conducted for the Atlantic Ocean Shorefront Planning Reach and in the projected performance of CSRM measures. The TSP may be augmented with sea level rise protection measures including adaptive retrofit measures (Figure 6-5).

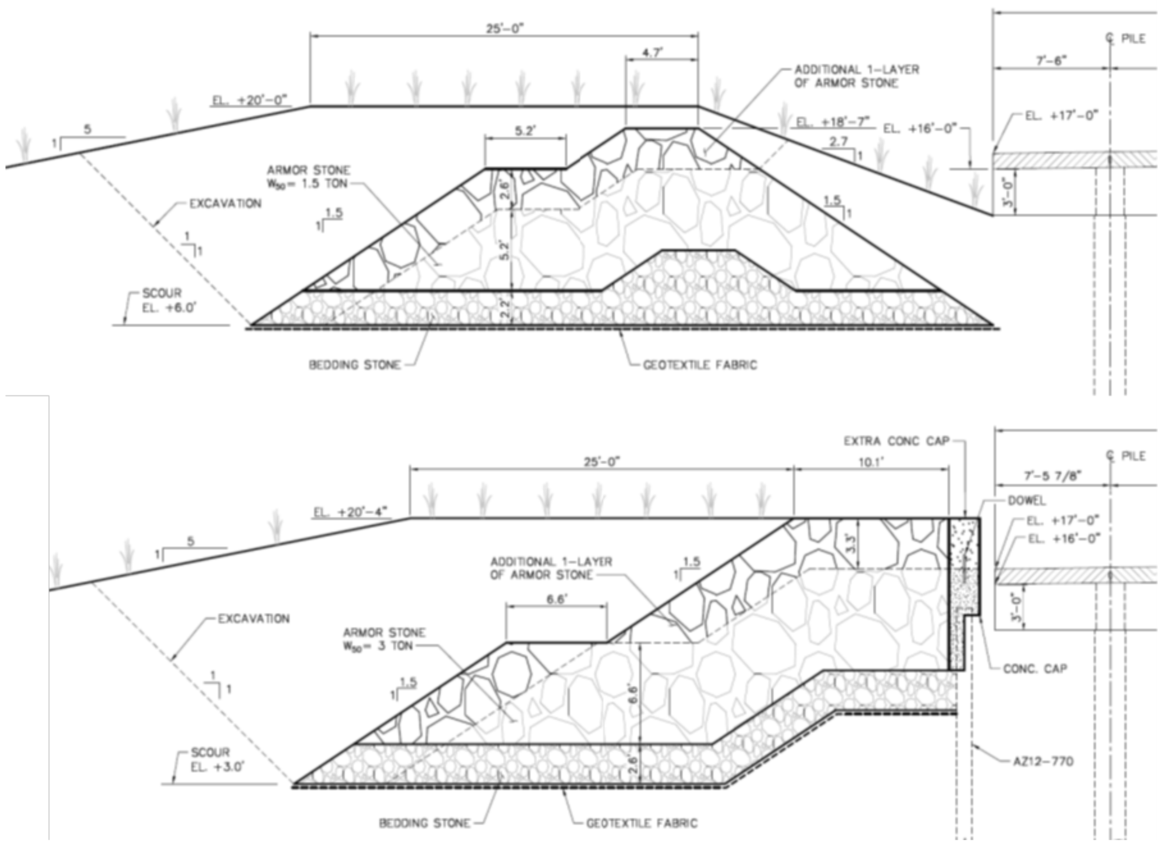


**Figure 6-5: RSLR Adaptability Measures**

## 6.3 Real Estate Considerations

The Non-Federal Sponsors will be responsible for acquiring and furnishing all lands, easements, rights-of-way, relocations (i.e., P.L. 91-646 relocations and utility/facility relocations), borrow material, and dredged or excavated material disposal areas (LERRD) for the project areas, as required. All lands needed for this project will be acquired in fee, with the exception of the land needed for the flood protection levee easements, staging areas, perpetual road easements, and borrow area easements. Avoiding residential property impacts, where possible, has been a criterion in the development of alternative plans. It is estimated that only 3 acres of private property and 74 acres of public property could be impacted by the TSP. .

### 6.3.1 Lands, Easements, and Rights-of-Way

Real estate impacts and costs are discussed and presented in Section 5.3.2 Real Estate Impacts and Costs. The following tables (6-7 and 6-8) present real estate impacts and costs respectively for only the TSP.

**Table 6-7: Real Estate Impact (acres)**

| | Purchase Required | | Easement Required | | |
|---|---|---|---|---|---|
| **TSP** | **Public** | **Private** | **Public** | **Private** | **Total** |
| C-1E | 31.3 | 2.2 | 42.4 | 0.8 | 76.6 |

**Table 6-8: Real Estate Costs (2015$'s)**

| | Entire Tax Lot | Partial Tax Lot | | |
|---|---|---|---|---|
| **Alternative** | **Private** | **Private** | **Public** | **Total Costs** |
| C-1E | | $1,868,000 | $27,568,400 | $29,436,400 |

The acreage and costs of intersecting private and public properties with CSRM structures does not indicate the full real estate impacts of the alternative plans. Additionally, CSRM structures near residential properties inhibit views and/or reduce access to the waterfront. The TSP has some instances where a series of multiple houses along the waterfront may have both water view and/or waterfront access impacted by CSRM structures.

### 6.3.2 Facility Removals/Utility Relocations

In an effort to minimize impacts to utilities through the proposed CSRM alignments, a due diligence effort was made to identify all major utility crossings. Online mapping resources were reviewed to gather information where available. For this analysis, an allowance of $100,000 was included for each utility crossing identified. This allowance accounts for the cost to provide a suitable penetration through the CSRM measure and to install check valves to prevent intrusion of flood waters through these conduits.

Although the current TSP alignment (C-1E) specifically avoids charted submarine cable areas, details of the submarine cables (e.g., depth and cable type) are unknown at this time; therefore, costs associated with potential cable conflicts, which are rough order of magnitude costs, need to be further investigated prior to final design. However, contingency costs reflect the cost risk of cable relocation. One barrier alignment crosses two large effluent sewer lines spanning between the Coney Island Wastewater Treatment Plant and the diffuser located in Rockaway Inlet. The cost associated with potential realignment of the 96-inch and 72-inch effluent lines is included in this phase of the study for the relevant alternatives.

## 6.4 Operations and Maintenance

Operation and maintenance (OMRR&R) of these facilities would be extensive. The TSP will be a complex system constructed in a marine environment. OMRR&R activities for each CSRM structure were scheduled with weekly, bi-weekly, monthly, quarterly, annual, 5-year, or 15-year occurrence.

Passive CSRM measures, such as floodwalls, elevated promenades, levees, and bulkheads, generally require minimal maintenance and preparation in advance of an approaching storm. Maintenance activities would include a survey crew checking settlement markers on the floodwalls every 5 years. Similarly, licensed professionals with expertise in dam safety and structural inspection would be recommended to inspect the concrete structures every 5 years. Apart from these requirements, a small maintenance crew would be employed to perform regular maintenance, such as mowing the grass around the wall, clearing of invasive vegetation, nesting of animals and birds, etc.

The active CSRM measures, including sector gates and their necessary passive components, generally require greater maintenance and preparation than passive CSRM measures in advance of an approaching storm. Navigable sector gates require mechanical operation for opening and closing the gates. It is anticipated that the sector gates will remain open for all normal channel operating conditions. Prior to a storm event, the gates need to be closed. Gate closing and opening is usually mechanized by electrical power, in which case a single person is adequate to serve as the operator. Sector gates are also equipped to operate during power failures. In such scenarios, the sector gate leafs can be closed by towing them using a barge. It is expected that such operation would require a crew of two to four members.

## 6.5 Economic Analysis for the Tentatively Selected Plan

The Economics Appendix presents the details of the economic analysis used to estimate project benefits.

### 6.5.1 Economic Optimization

The proposed TSP (Storm Surge Barrier Plan with alignment C-1E) includes the best plan for each planning reach. Final determination of the NED plan will be conducted when the Storm Surge Barrier alignments are optimized prior to the Final Draft HSGRR/EIS.

## 6.6 Summary of Accounts

### 6.6.1 National Economic Development (NED)

The average annual equivalent net benefits for the TSP are $390,929,000. The average annual equivalent net benefits for the Atlantic Ocean shorefront separable element are $16,222,000 excluding recreation benefits and $49,220,000 including recreation benefits.

### 6.6.2 Environmental Quality (EQ)

Potential impacts of the TSP on human and environmental resources have been identified and presented in this document. All factors that may be relevant to the TSP were considered, including direct and indirect impacts on wetlands, effects on essential fish habitat and listed species, air quality, water and sediment quality, hazardous materials, historic properties, socioeconomic, and environmental justice impacts. Environmental impacts on wetlands are the primary environmental effect. Potential effects are evaluated in Section 7: Environmental Consequences.

### 6.6.3 Regional Economic Development Benefits (RED)

The proposed TSP reduces probabilities of direct damage to property, but also decreases the occurrence of secondary impacts, such as potential disruptions to commercial, industrial, and retail productivity. It is expected that a quantitative (input/output) model will not be used to estimate these secondary impacts (benefits other than direct damages); however, this will be confirmed following the concurrent public, policy, and technical reviews.

### 6.6.4 Other Social Effects

Hurricane Sandy resulted in 10 fatalities in the project area. The TSP would substantially reduce the risk of damage caused by coastal storms and presumably would have a positive effect on life-safety risk. Although based on a purely qualitative assessment, the expectation is that by reducing the risk of physical damage the TSP would positively affect life-safety risk. A quantitative model was not used to determine performance of plans against life-safety risk reduction. It is expected that the TSP would have a positive effect and no increase in risk. This will be confirmed following the concurrent public, policy, and technical reviews.

## 6.7 Risk and Uncertainty

### 6.7.1 Engineering Data and Models

This section summarizes risk and uncertainty included in some key models and methods applied in this study and documented in the report appendices in more detail.

#### 6.7.1.1 Costs of Utility Crossings and Relocations

Utility crossings and relocations were avoided to the extent feasible. Costs for providing suitable penetration through the CSRM structure for unavoidable utility crossings are assumed to be

$100,000 for each crossing. These costs reflect the multiple intersections with various utilities around the perimeter of the bay and will be refined during the detailed design phase. The effluent lines running from the Coney Island WWTP to Rockaway Inlet are a more significant impediment and may need to be relocated for one potential alignment of the storm surge barrier and the Jamaica Bay Perimeter Plan Alternative; however, realignment of the alternative plans may be cost effective. The costs for relocating the effluent lines have been included in the cost estimate, and contingencies reflect the uncertain impacts on schedule and cost that relocation may entail.

The most significant uncertainty concerning relocations is that Storm Surge Barrier alignment C-2 crosses through a charted submerged cable area (NOAA Chart 13250). This alignment cannot be cost effectively modified to avoid crossing the submerged cable area. The number, type, and depth of cables in this area are unknown and the costs of relocating these submerged cables has been estimated, and the associated contingencies reflect the uncertain impacts on schedule and cost that relocation may entail. Note that the proposed TSP (Storm Surge Barrier alignment C-1E) does not impact submerged cables (Figure 6-6).

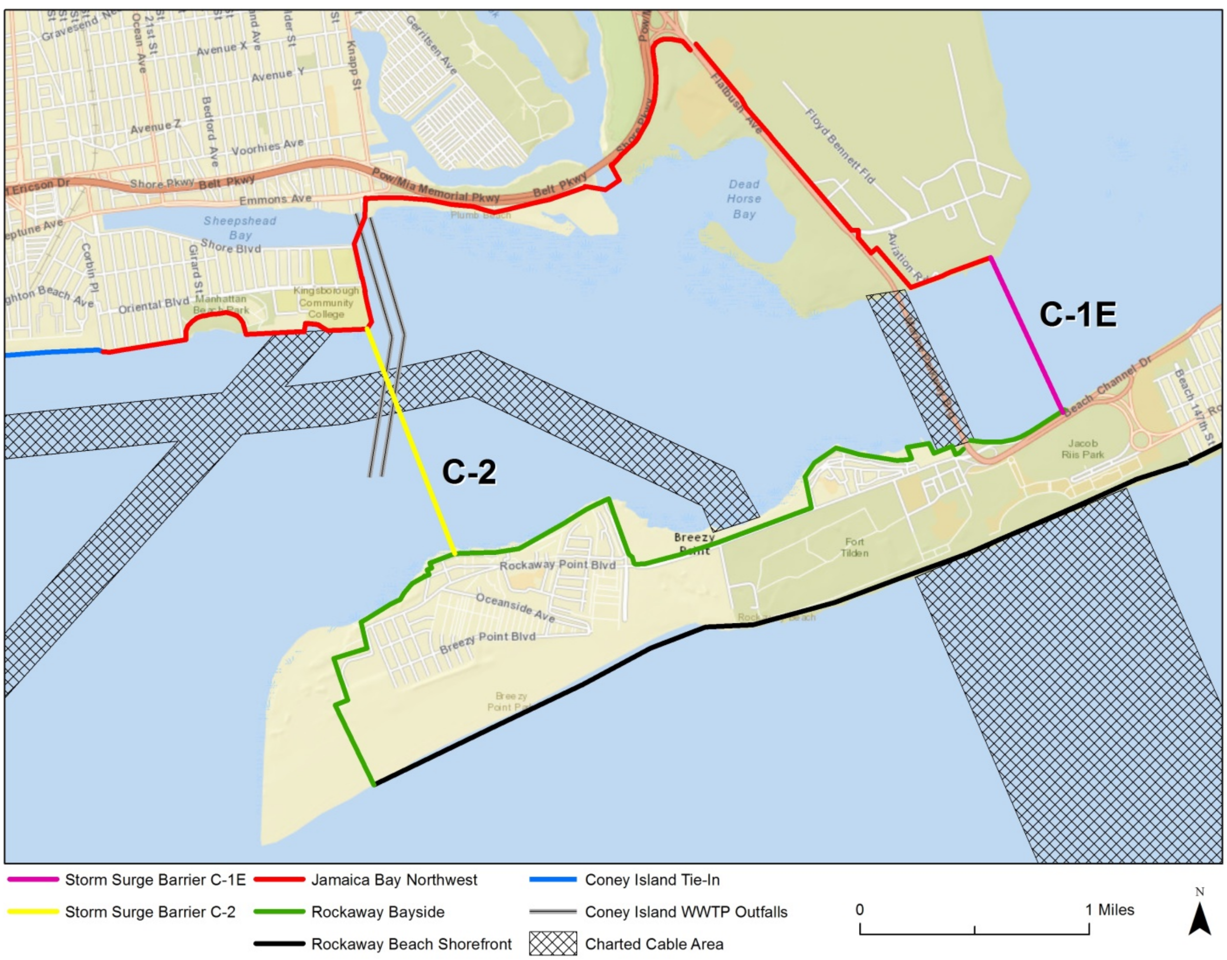


**Figure 6-6: Storm Surge Barrier Alignments and Submerged Cables**

#### 6.7.1.2 Barrier Design Changes

The conceptual design of the storm surge barriers evaluated in this plan will be refined in subsequent stages of the study as more specific area conditions are collected and in response to agency and public comment. The location and extent of the gate openings, and the operation of the gate over future storm conditions will be further refined as additional constraints are understood and as water quality modeling is completed.

#### 6.7.1.3 Impacts to Existing Structures

Potential scour impacts to the Gil Hodges Memorial Bridge were not evaluated. Potential scour impacts need to be evaluated and a revised gate configuration for the TSP or bridge pier protection may be required. However, additional engineering risk to other structures may need to be evaluated for the final design.

#### 6.7.1.4 Tie-ins

The Coney Island tie-in is based on a conceptual level of design for the proposed NYC Economic Development Corporation's Coney Island Creek Tidal Barrier. The Rockaway east tie-in is based on a simple extension of the proposed Rockaway Peninsula composite seawall along the shortest route to high ground. Additional analyses need to be conducted to identify the optimal design details for these tie-ins.

#### 6.7.1.5 Rockaway Shorefront Sub-reaches 1 and 2 and Manhattan Beach Seawalls

The composite seawall dimensions and costs developed for sub-reaches 3 – 6 along the Rockaway shorefront (see figure 3-1 for sub-reach locations) were assumed to be applicable for Rockaway shorefront sub- reaches 1 and 2 and for Manhattan Beach. Additional analyses need to be conducted to identify the optimal design details for these CSRM structures.

#### 6.7.1.6 Design Elevations

Hydraulic reaches were approximated in the calculation of design elevations for all CSRM measures. A design elevation of 16 feet was assumed for the Storm Surge Barrier based on stillwater elevation. Hydraulic reaches and design elevations will need to be refined during more detailed analyses, which would include the effects of backside scour due to wave over topping.

#### 6.7.1.7 Jamaica Bay Sediment Budget

Although a detailed sediment budget analysis had been conducted for the Atlantic Ocean Shorefront Planning Reach, a sediment budget for Jamaica Bay Planning Reach has not been developed. Potential impacts to Jamaica Bay wetlands due to the effects of alternatives on erosion and deposition in the bay are unknown.

#### 6.7.1.8 CSRM Features to Reduce Residual Risk

The TSP includes features to reduce inundation risk to communities vulnerable to high frequency storm events, during which the Storm Surge barrier would likely be open and reduce inundation risk to communities vulnerable in the interim time while the Storm Surge Barrier is in design and construction phases. A list of potential residual CSRM features is identified in Table 6-3 and depicted in Figure 6-4. The costs of constructing and implementing these features are not substantial enough to impact plan formulation or to advance Plan D, the Jamaica Bay Perimeter Plan, as the TSP. Additionally, because the residual CSRM features are smaller scale variations of CSRM structures used in the Jamaica Bay Perimeter Plan, they have been implicitly included in the assessment of environmental impacts (see Section 7: Environmental Consequences).

The assumption for the TSP is that residual risk CSRM features will be designed to address the .2 percent exceedance event; however, final design will be based in part on the final operating plans for the Storm Surge Barrier and on the projected length of time of construction for the Storm Surge Barrier. The number and scale of these residual CSRM features will evolve as detailed design progresses.

### 6.7.2 Relative Sea Level Change

Sea-level change (SLC) was considered in the preliminary screening of measures based on the guidance contained in the most recent Engineering Regulation (ER) 1100-2-8162 (USACE 2013e), which is the successor to the Engineering Circular (EC) 1165-2-212 (USACE 2011). Per ER 1100-2-8162:

> Planning studies and engineering designs over the project life cycle, for both existing and proposed projects, will consider alternatives that are formulated and evaluated for the entire range of possible future rates of SLC, represented here by three scenarios of “low,” “intermediate,” and “high” SLC. These alternatives will include structural, nonstructural, nature based or natural solutions, or combinations of these solutions. Alternatives should be evaluated using “low,” “intermediate,” and “high” rates of future SLC for both “with” and “without” project conditions.

ER 1100-2-8162 considers the historic rate of SLC as the low rate. The intermediate and high rates are computed from the modified National Research Council (NRC) Curve I and III respectively, considering both the most recent Intergovernmental Panel on Climate Change (IPCC) projections and modified NRC projections with the local rate of vertical land movement added.

For the purposes of the analysis, the year of construction is assumed to be 2020, with a design life of 50 years. Hence, a SLC of 1.3 feet in 2070, as compared to the 1992 sea level values, or slightly greater than one foot as compared to the 2014 sea level value, is added to the FEMA preliminary

FIRM 100-year elevations to identify future risk levels. Future consideration of cost and performance will refine the appropriate design elevation to protect each reach.

### 6.7.3 Economic Data and Models Analysis

Uncertainty related to economics can come from several sources. One source is the structure elevation, which has two components: the topographic ground elevation that a structure sits on, and the structure's estimated first floor elevation. Another source is the value of the structure and its contents. The structure inventory for this effort was derived from a combination of existing data sources and simplifying assumptions for the relevant structure characteristics. The final source of uncertainty is in the inundation depth/percent damage relationship (usually known as depth damage functions) used to estimate damages to a structure for a given level of flooding. Parameter settings in HEC-FDA account for these uncertainties. Additional information on the uncertainties is contained in Economics Appendix.

### 6.7.4 Project Cost and Schedule Risk Analysis

A Cost and Schedule Risk Analysis will be performed on the plan carried forward for feasibility-level design following the concurrent public, policy, ATR, and IEPR review.

### 6.7.5 Environmental Data and Analyses

The most current available data were used for environmental analyses of the study area, augmented by field visits to the study areas and reviews of habitat classification using the most recent aerial photographs. Ecological modeling was required to quantify impacts or mitigation, which included the following evaluations specific to habitat types:

- Benthic Index of Biotic Integrity (B-IBI) for sub-tidal and intertidal mudflat habitats – bulk sediment sampling at each site location for benthic community assessment.
- Evaluation of Planned Wetlands (EPW) for coastal wetlands – site surveys and data collection at each site, focused on completion each of the EPW data sheets.
- Upland Structure and Function Index for maritime and coastal forests and shrublands – site survey and data collection at each site, focused on completing data sheet.

Uncertainty is inherent in ecosystems, and therefore unavoidable when evaluating ecological processes and impacts. There is often a lack of extensive data sets for all parameters under study, and many of the physical and biological processes are not completely understood. Ecological analyses for the study utilized input from indices and surveys identified above.

Because of uncertainty associated with project performance, the monitoring and adaptive management plan should include evaluation of the performance of the Storm Surge Barrier in maintaining tidal flows. Impact assessments are also based upon assumptions regarding the impacts to tidal amplitude and flow. Impact assumptions should be reviewed when engineering design is sufficiently complete to determine if impacts have been captured appropriately.

There is risk that the location of the Storm Surge Barrier alignment will change because of technical, policy, and public comments on the draft report. Additionally, the alignments of structural residual risk measures have not been fully determined. Environmental impacts from Storm Surge Barrier realignment and non-structural residual risk measures will need to be fully evaluated prior to the Final Draft HSGRR/EIS

## 6.8 Consistency with State and Federal Laws

This Draft HSGRR/EIS has been prepared to satisfy the requirements of all applicable environmental laws and regulations and has been prepared using the Council on Environmental Quality (CEQ) NEPA regulations (40 CFR Part 1500–1508) and the USACE's regulation ER 200-2-2 -Environmental Quality: Policy and Procedures for Implementing NEPA, 33 CFR 230. In implementing the Recommended Plan, USACE would follow provisions of all applicable laws, regulations, and policies related to the proposed actions, including agreement from the NPS on plans affecting GNRA. The following sections present brief summaries of Federal environmental laws, regulations, and coordination requirements applicable to this Draft HSGRR/EIS.

### 6.8.1 Clean Air Act

Temporary air emission impacts resulting from construction of the TSP have been calculated; the analysis is presented in the Environmental Impacts section of the Environmental Appendix.

### 6.8.2 Clean Water Act

Clean Water Act Section 404 of the CWA regulates dredge-and/or-fill activities in waters of the U.S. In New York, Section 401 of the CWA (State Water Quality Certification Program) is regulated by the NYSDEC. Compliance will be achieved through coordination of the Draft HSGRR/EIS with NYSDEC to obtain water quality certification for the TSP. Coordination includes an evaluation of the TSP based on the Section 404(b)(1) Guidelines as presented in the Environmental Impacts section of the Environmental Appendix.

Submittal of this Draft HSGRR/EIS to NYSDEC initiates USACE's requested Section 401 State Water Quality Certification for the TSP. USACE has determined that construction and operation of the TSP will not violate water quality standards. The proposed alignment of the Rockaway Atlantic Ocean CSRM, Inlet Barrier, and borrow area has been located to minimize, to the greatest extent practicable, impacts on the Rockaway shoreline and to avoid and minimize impacts on the aquatic ecosystem in Jamaica Bay and Atlantic Ocean. The TSP is the least environmentally damaging practicable alternative; overall, the TSP provides protection from coastal storms that would otherwise damage the environment to a far greater degree than the No Action Alternative.

### 6.8.3 Endangered Species Act

USACE has prepared a draft Biological Assessment (BA) to describe the TSP study area, Federally-listed threatened and endangered species of potential occurrence in the study area as identified by USFWS, and to describe potential impacts of the TSP on these protected species—in particular: piping plover and red knot. The draft BA is presented in the Draft HSGRR/EIS in the Environmental Impacts section of the Environmental Appendix. Similarly, USACE is currently conducting informal consultation with NOAA-NMFS to determine the appropriate formal consultation (i.e. Biological Assessment or Not Likely to Adversely Affect Determination) to undertake for the phased or tiered TSP as pertains to protected marine resources.

Submittal of this Draft HSGRR/EIS to USFWS and NMFS initiates USACE's requested Section 7 consultation for the TSP. The Draft HSGRR/EIS will document the consultation process, USFWS's and NMFS determinations for protected species, and any mitigation of significant impacts required by USACE for the TSP.

### 6.8.4 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (PL 94-265), as amended, establishes procedures for identifying Essential Fish Habitat (EFH) and required interagency coordination to further the conservation of Federally-managed fisheries. Its implementing regulations specify that any Federal agency that authorizes, funds, or undertakes, or proposes to authorize, fund, or undertake, an activity that could adversely affect EFH is subject to the consultation provisions of the Act and identifies consultation requirements. EFH consists of those habitats necessary for spawning, breeding, feeding, or growth to maturity of species managed by Regional Fishery Management Councils in a series of Fishery Management Plans.

Submittal of this Draft HSGRR/EIS to National Marine Fisheries Service (NMFS) initiates EFH consultation between USACE and NMFS. It contains an assessment of impacts on EFH in section 6.8.4 Magnuson-Stevens Fishery Conservation and Management Act. Direct and indirect impacts associated with the Rockaway Atlantic Ocean reach CSRM Plan would result from dredging offshore in the borrow site; construction of groins, seawalls, and the Inlet Barrier; and beach fill placement in the intertidal zone and nearshore. As a result of sand removal (suction dredging) and placement of the material, the most immediate, indirect effect on EFH areas would be the loss of benthic invertebrate prey species. Small motile and sedentary epifaunal species (*e.g.*, small crabs, snails, tube- dwelling amphipods), and all infaunal species (*e.g.*, polychaetes), would be most vulnerable to suction dredging and burial. In total, the TSP would permanently impact approximately 110 acres of habitat including subtidal bottom, intertidal mudflats and wetlands, beach, and dune ecotypes.

USACE plans to conduct a biological monitoring program (BMP) to evaluate the effects of dredging clean sand for flood control/shoreline stabilization construction activities for five years, similar to the plan accepted for Long Beach Island Hurricane and Storm Damage Reduction project. The offshore area to be evaluated is the borrow area and it will be compared to the 1994 data collected as well as comparing the data to East Rockaway benthic data. The offshore and nearshore components will focus on benthic infauna, grain size, and water quality.

The District will notify NMFS prior to commencement of each dredging event prior to the solicitation of bids to ensure the EFH conservation recommendations remain valid. The District will also report annually to NMFS the areas of area dredged including volumes and depths removed. Surf clam surveys would be conducted prior to construction so that areas of high densities can be identified and avoided. Copies of the survey results will be provided to NMFS. Implementation of the selected plan will have an overall beneficial effect on existing shellfish and macroinvertebrate species, as well as some finfish species. Therefore, the TSP will not cause any significant adverse effects to EFH or EFH species.

### 6.8.5 Coastal Zone Management Act

Under the New York State Coastal Management Program (NYCMP), enacted under the Coastal Zone Management Act in 1972, the NY Department of State (NYDOS) reviews Federal activities to determine whether they are consistent with the policies of the NYCMP. The waterward boundary extends 3 miles into open ocean, to shared state lines in Long Island Sound and the New York Bight and to the International boundary in the Great Lakes, Niagara and St. Lawrence Rivers. Generally, the inland boundary is approximately 1,000 feet from the shoreline following well-defined features such as roads, railroads or shorelines. In urbanized and other developed locations along the coast, the landward boundary is approximately 500 feet from the shoreline or less than 500 feet at locations where a major roadway or railway line runs parallel to the shoreline. The seaward boundary of New York State's coastal area includes all coastal waters within its territorial jurisdiction.

USACE has prepared a Consistency Determination that evaluates the TSP for consistency with the NYCMP; it is provided in the Draft HSGRR/EIS Environmental Appendix. USACE has concluded that the TSP is consistent to the maximum extent practicable with the enforceable policies of the NYSDOS program.

### 6.8.6 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act provides for consultation with the USFWS and, in New York, with NYSDEC whenever the waters or channel of a body of water are modified by a department or agency of the U.S.

Submittal of this Draft HSGRR/EIS initiates coordination with both USFWS and NYSDEC. As previously described under the Endangered Species Act and the Clean Water Act headings, the Draft HSGRR/EIS contains information regarding impacts associated with implementing the

TSP on protected species and regulated waters. USACE anticipates receiving draft recommendations from USFWS through the Section 7 consultation process and NYSDEC through the Section 401 certification process. Additionally, NYSDEC may also provide recommendations regarding State-listed threatened, endangered, and special concern wildlife species identified under the NY Natural Heritage Program. USACE will incorporate these into the Final HSGRR/EIS impact evaluations and implementation recommendations.

### 6.8.7 Marine Mammal Protection Act of 1972

The Marine Mammal Protection Act was passed in 1972 and amended through 1997. It is intended to conserve and protect marine mammals and establish the Marine Mammal Commission, the International Dolphin Conservation Program, and a Marine Mammal Health and Stranding Response Program.

Section 2.3.9 Threatened and Endangered Species of this Draft HSGRR/EIS identifies minor short-term direct adverse impacts on threatened and endangered sea turtles and marine mammals during temporary construction activities for the TSP. Impacts are considered minor, given the given the temporary nature of the disturbance, the availability of suitable adjacent habitat, and the large extent of the Atlantic Ocean and Jamaica Bay compared to the project construction footprint. Implementation of BMPs to control sedimentation and erosion during construction would further minimize adverse impacts on sea turtles. In accordance with the latest NMFS recommendations, if hopper dredges are used in the inlets or offshore borrow area between mid-June and mid-November, NMFS-approved observers will be onboard the vessels to monitor the removal of the dredge material.

Additionally, USACE anticipates receiving draft recommendations from NMFS through the EFH consultation process as previously described. USACE will incorporate these into the Final HSGRR/EIS impact evaluations and implementation recommendations.

### 6.8.8 National Historic Preservation Act

Compliance with the National Historic Preservation Act of 1966, as amended (54 U.S.C. § 306108), requires the consideration of effects of the undertaking on all historic properties in the project area and development of mitigation measures for those adversely affected properties in coordination with the NY SHPO and the Advisory Council on Historic Preservation.

USACE has initiated Section 106 consultation with the NY SHPO and selected Native American Tribes. Copies of Section 106 consultation letters are provided in the Draft HSGRR/EIS Environmental Appendix. Additionally, USACE anticipates executing a Programmatic Agreement among USACE, the NY SHPO, and non-Federal implementation sponsors to address the identification and discovery of cultural resources that may occur during the construction and maintenance of proposed or existing facilities. USACE will also invite the ACHP and Native American Tribes to participate as signatories to the anticipated Programmatic Agreement.

### 6.8.9 Federal Water Project Recreation Act

This 1995 Act requires consideration of opportunities for outdoor recreation and fish and wildlife enhancement in planning water-resource projects. The TSP is not expected to have any long-term effects on outdoor recreation opportunities in the area.

### 6.8.10 Farmland Protection Policy Act of 1981 and the CEQ Memorandum Prime and Unique Farmlands

In 1980, the CEQ issued an Environmental Statement Memorandum “Prime and Unique Agricultural Lands” as a supplement to the NEPA procedures. Additionally, the Farmland Protection Policy Act, passed in 1981, requires Federal agencies to evaluate the impacts of Federally funded projects that may convert farmlands to nonagricultural uses and to consider alternative actions that would reduce adverse effects of the conversion. The TSP will not impact prime or unique farmlands identified by the Natural Resource Conservation Service or NYSDEC, as identified in Section 7: Environmental Consequences.

### 6.8.11 Executive Order 11988, Floodplain Management

This Executive Order (EO) directs Federal agencies to evaluate the potential effects of proposed actions on floodplains. Such actions should not be undertaken that directly or indirectly induce growth in the floodplain unless there is no practicable alternative. The Water Resources Council Floodplain Management Guidelines for implementation of EO 11988, as referenced in USACE ER 1165-2-26, require an eight-step process that agencies should carry out as part of their decision making on projects that have potential impacts on or within the floodplain. The eight step assessment, presented in the Environmental Impacts section of the Environmental Appendix, concludes that all practicable alternatives have been considered in developing the TSP, and that the main Federal objective of reducing coastal flood risk cannot be achieved by alternatives outside the floodplain. Additionally, USACE has determined that the TSP does not induce direct or indirect floodplain development within the base floodplain.

### 6.8.12 Executive Order 11990, Protection of Wetlands

This EO directs Federal agencies to avoid undertaking or assisting in new construction located in wetlands, unless no practicable alternative is available. Construction of the TSP would result in the conversion of approximately 7.5 acres of intertidal mudflats, 0.4 acres of non-native wetlands, and approximately 35 acres of subtidal bottom. All practicable measures have been taken to minimize the loss of wetlands. Alternatives to avoid the loss of wetlands were evaluated, and the CSRM elements were carefully located to minimize the loss. Additionally, the TSP will effectively protect existing wetlands from damage caused by coastal storms; this protection would not be afforded by the No Action Alternative. However, through consultation with other Federal, State and local agencies, as well as public comment, USACE will review the alignment of the TSP to determine if impacts may be minimized further, and a record of this communication will be presented in the Final HSGRR/EIS.

### 6.8.13 Coastal Barrier Improvement Act of 1990

This act is intended to protect fish and wildlife resources and habitat, prevent loss of human life, and preclude the expenditure of Federal funds that may induce development on coastal barrier islands and adjacent nearshore areas. The Coastal Barrier Improvement Act of 1990 expanded the CBRS and created a new category of lands known as otherwise protected areas (OPAs). The only Federal funding prohibition within OPAs is Federal flood insurance. Other restrictions to Federal funding that apply to CBRS units do not apply to OPA's. The western portion of Rockaway Peninsula and all of Jamaica Bay are located within the designated CBRA OPA (Unit NY-60P) and has determined that the National Park Service has local jurisdiction of the CBRA Unit. Accordingly, no further coordination under the CBIA or CBRA is necessary.

### 6.8.14 Executive Order 12898, Environmental Justice

This EO directs Federal agencies to determine whether the Preferred Alternative would have a disproportionate adverse impact on minority or low-income population groups within the project area. Based on a demographic analysis of the study area (presented in section 7: Environmental Consequences) and based on findings of an environmental justice review, the TSP would not have a disproportionately high and adverse impact on any low-income or minority population. USACE has determined that the TSP will provide short- and long-term benefits to disappropriated populations by protecting infrastructure resources (e.g. housing, transportation, commercial/retail/recreational facilities) from damage caused by coastal storms.

### 6.8.15 Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds and the Migratory Bird Treaty Act

The Migratory Birds and the Migratory Bird Treaty Act (MBTA) of 1918 (as amended) extends Federal protection to migratory bird species. Among other activities, nonregulated "take" of migratory birds is prohibited under this Act in a manner similar to the ESA prohibition of "take" of threatened and endangered species. Additionally, EO 13186 "Responsibilities of Federal Agencies to Protect Migratory Birds" requires Federal agencies to assess and consider potential effects of their actions on migratory birds (including, but not limited to, cranes, ducks, geese, shorebirds, hawks, and songbirds).

Under the USFWS Section 7 consultation process, USFWS will prepare a Draft Coordination Act Report (CAR); it will be included in the Final HSGRR/EIS (Environmental Appendix). The Draft CAR will provide draft conservation recommendations for specific species; USACE will incorporate these into the Final HSGRR/EIS impact evaluations and implementation recommendations for avoiding and minimizing impacts to migratory birds and their nests from construction and operation of the TSP.

### 6.8.16 Executive Order 13045, Protection of Children from Environmental and Safety Risks

This EO requires Federal agencies to make it a high priority to identify and assess environmental health and safety risks that may disproportionately affect children and to ensure that policies, programs, activities, and standards address these risks. This report has evaluated the potential for the TSP to increase these risks to children, and it has been determined that children in the project areas would not likely experience any adverse effects from the TSP.

# 7 ENVIRONMENTAL CONSEQUENCES*

In accordance with CEQ regulations (40 CFR 1502.16), direct and indirect impacts are described in this Section and cumulative impacts are described Section 7.25. The significance of potential impacts from implementation of the Proposed Action (the TSP), the Action Alternative (Jamaica Bay Perimeter Plan), or the No-action Alternative were analyzed for each resource area identified in Section 5.3.1 Habitat Impacts and Mitigation Requirements. Potential effects on environmental resources are described qualitatively rather than quantitatively; however, for some resource areas, preliminary qualitative analyses are provided. Note that the terms "effect" and "impact" are used synonymously in the CEQ regulations (40 CFR §1508.8) and those terms are used interchangeably in this Draft HSGRR/EIS.

*General Environmental Impacts for Proposed Storm Surge Barrier*

The construction and operation of a storm surge barrier across Jamaica Bay would have the potential to impact the estuarine environment in several different ways. A detailed discussion of each type of impact and the degree that each barrier option would have on the Jamaica Bay environment is beyond the scope given the level of the present design detail. An overview of the literature relative to the environmental impacts of similar storm surge barriers on tidal estuaries in other areas is provided below (taken from Fugo, 2016), and parallels are drawn to identify likely categories of impacts for Jamaica Bay. In general, a storm surge barrier would have the potential to affect tidal hydraulics (flows and water levels) and water quality parameters such as temperature, dissolved oxygen, nutrient concentrations, etc. Also, the proposed structure could impact bay bottom and areas along the shoreline area. This study has not identified potential environmental impacts that would preclude the implementation of the preferred option described in this study, however, further environmental assessment of the chosen alternative is recommended.

> “Storm surge barriers have been constructed or are in construction around the world, including in the United States. Sizes of tidal openings also vary among barrier systems. Venice’s MOSE (Modulo Sperimentale Elettromeccanico or Electromechanical Experimental Module) barrier represents one of the most open structures, but is also one of the most expensive to construct. When retracted, the MOSE barrier is below the seabed and does not constrict tidal flows.”

However, it is noted that the impacts for the Storm Surge Barrier will generalized within this document, but further analyses will be developed and finalized prior upon once the final alignment and design details are completed.”

## 7.1 Geologic Setting

If an alternative would result in an increased geologic hazard or a change in the availability of a geologic resource, it could have an adverse significant impact. Such geologic and soil hazards would include, but not be limited to, seismic vibration, land subsidence, slope instability, or a reduction in the productive agricultural use of soils.

### 7.1.1 Impacts Common to Both Actions

#### 7.1.1.1 Geology

In addition to the significance criteria identified in section 7.1 Geologic Setting, an adverse geologic impact could occur if CSRMU elements altered bedrock conditions such that bedrock aquifer quality was compromised; bedrock competency to support existing or future building foundations was decreased; or caused an increase in seismic activity at levels capable of damaging buildings and at a frequency above predicted levels.

Under both alternatives, no impacts on geology are anticipated from implementation of the common CSRMU elements. The CSRMU seawall, floodwall, roadway gate, and floodgate structural foundations would have a negligible impact on bedrock, and all other construction activities would occur above bedrock elevation.

Additionally, the project is located in an area with a low occurrence of seismic activity at frequencies damaging to buildings. Accordingly, naturally occurring seismic activity is not anticipated to have an adverse significant impact on the structural integrity of the constructed CSRMU elements. However, CSRMU elements will be designed by licensed engineers and incorporate industry-standard features to withstand current and projected future seismic activity for this area. Therefore, projected future seismic activity should not cause an adverse significant impact on the competency or function of the CSRMU elements.

#### 7.1.1.2 Topography

Adverse minor long-term direct impacts to topography in the proposed project areas are anticipated from construction or extension of temporary and permanent near-shore and on-shore groins, walkovers, and access roads. The minor impacts on topography would exist for as long as built structures remain in place. Minor short-term direct adverse impacts on topography are anticipated from beach fill placement along the Coney Island tie-in and the Rockaway Beach Shorefront CSRMUs. Following proposed project activities, the topography in beach fill areas would be characteristically similar to natural beach/dune communities found along the Atlantic coast near Jamaica Bay.

#### 7.1.1.3 Soils

Adverse minor direct short-term impacts to soils would occur due to such construction activities as clearing, grading, trench excavation, backfilling, and the movement of construction equipment within the project areas. Impacts include soil compaction and disturbance to and mixing of discrete soil strata. To reduce the impacts of construction on beach soils, BMPs would be implemented to control erosion and sedimentation during construction (e.g., installation of silt fences). Areas disturbed by construction activities (e.g., temporary access roads) would be restored at the end of project execution. Contamination from spills or leaks of fuels, lubricants, and coolant from construction equipment could adversely affect soils. The effects of contamination are typically minor because of the low frequency and volumes of spills and leaks. Spill prevention and countermeasures BMPs would be implemented to minimize the potential for impacts associated with an inadvertent spill of hazardous materials.

None of the soils within the Rockaway peninsula are classified as prime farmland. The Sudsbury sandy loam and Riverhead loamy coarse sand soils north of Jamaica Bay are classified as prime farmland; however, neither action would prevent these soils from potential agricultural use. Therefore, there would be no adverse significant impact on the agricultural use of soil.

Beneficial long-term direct impacts on soils would occur from built structures (e.g., groins, seawalls, floodwalls) that retain and capture littoral materials native to the beach communities and/or limit the effects of wave and storm surge erosion. Construction and extension of groins and construction of seawalls and floodwalls would result in continued protection of upland soils from wave action and erosion that are anticipated from significant storms along project area shorelines, and would reduce the amount of renourishment fill required in the future. The groin and seawall structures would help slow the long-term beach erosion rate in the Project Area. Beneficial long-term direct impacts on soils would also occur due to beach renourishment actions, where beach sands are replenished at prescribed intervals over the project life cycle. The texture of the nourishment material to be used would be compatible with native sand material.

### 7.1.2 Proposed Action Impacts

Additional adverse minor long-term direct impacts to topography and adverse minor short-term direct impacts to soils would occur along the Rockaway Bayside and the Jamaica Bay Northwest segments of the Proposed Action. Impacts in these areas would be similar to those described for the common actions across the additional construction areas.

Additional beneficial long-term direct impacts would occur from built structures and beach renourishment, as described for the common project elements. No short- or long-term direct or indirect impacts to geology would occur from implantation of the additional unique aspects of the Proposed Action. However, it is noted that the construction details for Storm Surge Barrier will be developed and finalized prior to the Final HSGRR/EIS. If the final design has the foundation secured to or directly on top of bedrock, potential impacts to bedrock, as well as from seismic activity, will be reevaluated as part of the analysis.

### 7.1.3 Action Alternative Impacts

Adverse minor long-term direct impacts to topography and minor short-term direct impacts to soils would occur along the Rockaway Bayside and the Jamaica Bay Northwest segments associated with the Action Alternative. Because the linear extent of construction activities would be substantially broader in the Jamaica Bay Northwest and Rockaway Bayside segments, impacts would be more extensive compared to those described for the common project elements. Soil compaction issues would be more extensive in areas where Type B and D vertical living shorelines would be constructed, including extensive temporary access roads. Additional, and more extensive, beneficial long-term direct impacts would occur from built structures and beach renourishment, as described for the common project elements, and from construction of vertical living shorelines which would enhance soil retention and natural development. No short- or long-term direct or indirect impacts to geology would occur from implantation of the additional unique aspects of the Action Alternative.

### 7.1.4 No-Action Alternative Impacts

Adverse significant long-term direct impacts to area topography and soils, but no short- or long-term direct or indirect impacts to geology are anticipated from implementation of the No-Action Alternative. Not implementing the proposed coastal protective measures would allow continued beach sand and upland soil erosion from continued costal wave action and future extreme weather events.

## 7.2 Bathymetry and Sediments

### 7.2.1 Impacts Common to Both Action Alternatives

#### 7.2.1.1 Bathymetry

Construction of groins in the Atlantic Ocean Shorefront Planning Reach will have a net long-term benefit on the shoreline by stabilizing erosion and minimizing the long-term requirements for beach renourishment. However, construction of groins could have minor long-term effects by causing enhanced erosion on the down current side due to the modified sand transport. In addition, some sand would be expected to be diverted offshore as longshore currents flow into deeper waters around the groins.

Construction of seawalls and/or bulkheads in portions of the Jamaica Bay Northwest segment shared by both alternatives would also have minor long-term adverse impacts on bathymetry, as they are generally recommended where a similar structure is already present. Additional scouring at the toe of the structural measures could result from amplified wave energy and increased erosion and sediment transport associated with these hardened structures.

Short-term direct adverse impacts to bathymetry in Jamaica Bay could occur due to construction activities where increased sediment generation could affect depth of the water column. These effects would be minor and short-term, limited to the period of construction. Implementation of BMPs to control sedimentation and erosion and the large extent of Jamaica Bay compared to the construction footprint would minimize adverse impacts on the overall bathymetry of Jamaica Bay.

#### 7.2.1.2 Sediments

The project would have a beneficial long-term direct impact on sediment budgets along the Atlantic Ocean Shorefront Planning Reach from implementation of the common project elements.

Sediment budgets with and without implementation of Atlantic Ocean shorefront and Jamaica Bay renourishment projects were analyzed quantitatively in Life-Cycle Costs Alternative Analysis (USACE 2015). With or without project implementation, east reaches along Rockaway Peninsula experience loss of sand and western reaches experience sand accretion. Based on results of the GENESIS-T modeling, sediment budgets calculated for Action Alternatives would result in a 29,000 cubic yards (cy) per year (yr) increase in renourishment quantities, not accounting for sea level rise. If the intermediate and high sea level change predictions are applied, renourishment quantities would increase by an additional 20,000 and 84,000 cy/yr respectively.

No short- or long-term direct or indirect adverse impacts to sediment quality would occur from implementation of the common project elements. Beach replenishment is not expected to have an adverse impact on sediment quality, as all imported sands will be brought from dredge areas that have been tested for grain size, compatibility, and potential toxicity.

In the Jamaica Bay Planning Reach reduced sediment deposition in Jamaica Bay has been studied as a possible cause of the documented disappearance of wetlands in the bay. Understanding the possible relationship between sediment transport and marsh losses informs an analysis of regional projects that may cumulatively affect Jamaica Bay. Hardening of the bay's perimeter and changing the bay's physical contours may reduce sediment deposition in the bay.

### 7.2.2 Proposed Action Impacts

#### 7.2.2.1 Bathymetry

Minor long-term indirect adverse impacts to bathymetry are anticipated from construction of gate structures across the inlet and potential scouring due to increased velocities. Modeling detailed in the Engineering Appendix with respect to the Storm Surge Barrier noted the increased flow speeds.

Based on engineering judgement, each of the modeled Storm Surge Barrier alignments has reasonable flow speeds through the gates, with the likely exception of 1E-400. Flow speeds and current patterns for any recommended storm surge barrier alternative should be studied in more detail using ship handling simulations with realistic flow fields to develop safe passing procedures, as well as appropriate classes of vessels, flow speeds and directions for safe passage.

Hydrodynamic modeling to date has assumed a fixed bottom elevation, which could change with increased velocities. Therefore, additional hydrodynamic and sediment modeling is required to further refine understanding of long-term effects on increased flows through the inlet gate structure and potential design considerations to address potential scouring. This additional modeling would be conducted prior to the Final HSGRR/EIS.

While additional modeling is necessary, the potential effect of scouring of sediment resulting in changes in bathymetry, which could affect the depth of the water column near the inlet gate, is expected to be negligible. Substrate size of bed material within proximity to the gate would be expected to change due to increased velocities. A further discussion of modeled tidal flushing and amplitude is discussed in the Engineering Appendix.

#### 7.2.2.2 Sediments

Based upon completed hydrodynamic modeling (Engineering Appendix), storm surge barrier is not expected at this time to have a long-term adverse effect on the sediment budget within Jamaica Bay. However, further refinement of the hydrodynamic models, and potential additional sediment modeling, is required to appropriately support engineering design and address potential scouring. Specifically, increased velocity through the gate could have an effect on sediment movement and bathymetry and will need to be evaluated further during engineering design to be conducted prior to the Final HSGRR/EIS.

Minor short-term adverse impacts could result from in-water construction activities as described above, and implementation of BMPs is expected to control sedimentation and erosion.

Minor short-term direct adverse impacts on sediment quality could result from disturbance of a tar-like substance associated with an old factory site located off the south shore of Floyd Bennett Field. This site would potentially be disturbed by construction of the Storm Surge barrier where it ties into Barren Island. Therefore, sediment testing will be required during a feasibility study to appropriately inform engineering design and develop appropriate methods for isolation and potential disposal of contaminated sediments. It is anticipated that the amount of disturbed sediment would be minimized by implementation of BMPs.

Minor short-term adverse impacts on sediment quality could also result from other areas of in-water construction where contaminated sediments occur but are currently not delineated. Short-term adverse impacts on flow patterns during or immediately following construction will have the potential to mobilize contaminated sediment. These adverse impacts would be short-term, as it is expected that sediments will quickly settle through use of BMPs (e.g., silt curtains, work at low tide out of the water) when water depths and velocities permit their use, but would have the potential to have adverse indirect effects on aquatic life discussed in Section 7.6 Aquatic and Terrestrial Habitats.

### 7.2.3 Action Alternative Impacts

#### 7.2.3.1 Bathymetry

Construction of gates across the tributaries of Jamaica Bay would have the potential to increase flow velocities and, therefore, increase the likelihood of scour. Given the sensitivity of the existing hydrodynamic model and uncertainties associated with tributaries, the potential long-term impacts associated with tributary gates are unknown at this time.

Minor short-term direct adverse impacts to bathymetry would occur in Jamaica Bay because the linear extent of construction activities would be substantially broader in the Jamaica Bay Northwest and Rockaway Bayside segments and include multiple areas of in-water construction. Construction of seawalls and/or bulkheads would also have minor long-term adverse impacts on bathymetry, as they are generally recommended where a similar structure is already present.

Scouring at toe of the structural measure may result from amplified wave energy and increased erosion and sediment transport associated with these hardened structures.

#### 7.2.3.2 Sediments

It is unknown at this time if the Action Alternative would have an adverse effect on the sediment budget within Jamaica Bay. Additional hydrodynamic modeling is required to address uncertainties associated with the tidal exchange in the tributaries. A constriction of flows in each tributary would have the potential to change water velocities and, therefore, sediment transport.

Minor short-term adverse impacts on sediment quality could result from areas of in-water construction where contaminated sediments have the potential to occur but are currently not delineated. It is anticipated future sediment sampling may be required, and that these construction impacts would be minimized by implementation of BMPs (e.g., silt curtains, work at low tide out of the water). A change in flow patterns during or following construction will also have the potential to mobilize contaminated sediment. These adverse impacts would be short-term as it is expected that sediments would quickly settle through use of BMPs.

Implementation of vertical living shorelines are not expected to substantially increase the benefits accrued from implementation of the common project elements.

### 7.2.4 No-Action Alternative Impacts

Within the Atlantic Ocean Shorefront Planning Reach, significant long-term direct adverse impacts to sediment budgets are anticipated from implementation of the No Action alternative. Beach-fill continues to be insufficient to offset the sediment deficit created by the overarching longshore sediment transport trend. The No-Action alternative would leave the coast vulnerable to the strong waves and storm surges associated with extreme weather events, resulting in flooding, overwash, and loss of sand from dunes and some upland areas. The resulting loss of sand would increase adverse impacts on bathymetry and sediment budgets.

Within the Jamaica Bay Northwest and Rockaway Bayside segment, implementation of the No-Action alternative would have a significant increase in shoreline erosion and, in turn, adversely effecting bathymetry and sediment budgets. The No-Action alternative would leave the bay shoreline vulnerable to the strong waves and storm surges associated with extreme weather events, resulting in flooding, overwash, and loss of wetlands and some upland areas. In turn, implementation of the No-Action alternative could have an adverse effect on sediment quality by erosion of potentially contaminated soils along the shoreline.

## 7.3 Surface Water

### 7.3.1 Impacts Common to Both Action Alternatives

#### 7.3.1.1 Water Levels

No short- or long-term direct or indirect adverse impacts on surface water levels would be realized from implementation of the common project elements. Overall, minor effects on water levels would be expected from implementation of the common project elements.

#### 7.3.1.2 Tidal Currents

Proposed activities in the Atlantic Ocean Shorefront Planning Reach would have a direct long-term benefit on near shore tidal currents. Consistent with discussion of sediment budgets in Section 7.2 Bathymetry and Sediments, common elements of both projects are expected to benefit the shoreline by reducing shoreline erosion and in turn reducing long-term need for beach renourishment.

#### 7.3.1.3 Wind and Wave Climate

Implementation of the common project elements will have a long term benefit by directly addressing anticipated wave climate, and preventing future shoreline erosion. Under implementation of the common project elements, tidal current flow speeds and directions within the Atlantic Ocean shorefront and Jamaica Bay planning reaches would not be measurably affected. Groins have the potential to alter wave climates, but would have a long-term benefit by reducing future beach renourishment requirements.

#### 7.3.1.4 Tributaries

No short- or long-term direct or indirect adverse impacts to the majority of Jamaica Bay tributaries are anticipated from implementation of the common elements of the Action Alternatives.

A gate across Sheepshead Bay and Shellbank Creek is a common element of the Action Alternatives. Additional hydrodynamic modeling would be required to understand the sensitivity of impacts to flushing and circulation within the tributaries as a result of tidal gates. This modeling would be conducted prior to the Final HSGRR/EIS.

#### 7.3.1.5 Water Quality

Minor short-term direct adverse impacts to ocean waters would occur from disturbance of subsurface sediments during construction of groins, walkovers, living shorelines, bulkheads, sea walls, and excavation of sand off shore. Water quality would quickly return to baseline conditions after construction activities are completed. It is anticipated that these adverse construction impacts would be minimized by implementation of BMPs.

Minor direct short-term impacts to surface water quality would occur due to common construction activities such as clearing, grading, trench excavation, backfilling, and the movement of construction equipment used during execution of the common project elements. Water quality impacts to surface water would primarily be related to increases in turbidity and suspended solids as a result of increased erosion and sedimentation, which would cause a short-term reduction in oxygen levels. These adverse construction impacts would be minimized by implementation of BMPs (e.g., silt curtains, work at low tide out of the water).

Spills or leaks of fuels, lubricants, or coolant from construction equipment could adversely affect water quality; however, the effects of contamination are typically negligible because of the low frequency and volumes of spills and the use of spill prevention standard construction BMPs. Leaks and spill effects would be minimized by immediate implementation of spill control and countermeasure BMPs (e.g. good housekeeping, adsorbents, storage containers).

Periodic renourishment activities over the project life-cycle would cause impacts similar to those generated during initial construction; however, because of tidal and current influences and the relatively quick settling velocity of subsurface sediments, turbidity is expected to dissipate rapidly, both spatially and temporally (Naqvi and Pullen 1982). Adherence to USACE and the New York State Section 404(b)(1) water-quality guidelines would further ensure minimal adverse water quality impacts.

The effect on water quality from a tide gate across both Sheepshead Bay and Shellbank Creek is unknown at this time. The USACE is working with the NYCDEP to refine existing water quality models to evaluate potential adverse effects.

## 7.3.2 Proposed Action Impacts

### 7.3.2.1 Water Levels

Hydrodynamic modeling (Arcadis 2016b) demonstrated that the two storm surge barrier alignments (C-1E & C-2) would only have a minor long-term impact on tidal levels throughout the bay. Specifically, all tide levels sampling locations are within 0.10 foot of the without project conditions tide levels, with the exception of an increase of 0.11 foot to MHW at Location 1 (Head of Bay) for both storm surge barrier scenarios.

### 7.3.2.2 Tidal Currents

Hydrodynamic modeling completed to date indicates that an inlet gate structure (as a component of the Storm Surge Barrier) would have limited minor long-term effect on tidal currents. Specifically, the gate is anticipated to slightly increase flow velocities within the Rockaway Inlet. Maximum flow speeds through the gates were assessed to identify potential concerns related to scour and vessel navigation. Based on engineering judgement, alternatives C-1E and C-2 each have reasonable flow speeds through the gates. An increase in flow velocities could have an effect on sediment transport within the bay. As indicated in the Engineering Appendix, flow patterns and speeds, and potential effect on sediment transport, are being studied in more detail prior to the Final HSGRR/EIS.

#### 7.3.2.3 Wind and Wave Climate

No long-term direct or indirect adverse impacts on wind and wave climate are anticipated from implementation of the additional actions associated with the Proposed Action. As noted above, flow patterns and speeds, and potential effect on localized wave climates, are being studied in more detail prior to the Final HSGRR/EIS.

#### 7.3.2.4 Water Quality

Hydrodynamic modeling was conducted on multiple alignment and opening configurations to determine the alignment configuration pairs with the least impacts to tidal amplitude. The ADCIRC hydrodynamic modeling identified alignment C-1E with 1,100 linear feet of gate opening and alignment C-2 with 1,700 linear feet of gate opening as having the least hydrodynamic impacts to the bay as compared to all other potential alignment and opening configurations (Table 5-5). Both alignments C-1E and C-2 result in a maximum tidal amplitude change of 0.2 feet, which occurs only during the highest tides. This small impact to tidal amplitude indicates that there would not be any major changes in the water column throughout the bay. Limited changes to the water column indicates that the natural environment driven by water circulation would be undisturbed and water chemistry, including the benthic layer, would be consistent with and without a Storm Surge Barrier. In addition, flow speeds and directions for both alignments are similar to without-project conditions, which imply that circulation within the bay would be minimally impacted.

In turn, impacts of an inlet gate at the Storm Surge Barrier are assumed to also have minor long-term adverse impacts on water quality. However, it is recognized that further analysis is required to better understand potential long-term effects on water quality. Specifically, water quality impacts for the interior basins need additional analyses to understand sensitivity of impacts to flushing and circulation, especially with respect to the tidal inlets that already exhibit poor water quality due to their limited flushing.

Since the initial hydrodynamic modeling was undertaken in a SMART planning context, to assess whether water quality impacts made the barrier alternative infeasible, further modeling was required. The New York City Department of Environmental Protection (NYCDEP) recently assessed the potential impact of a barrier on water quality within the bay using the Jamaica Bay Eutrophication Modeling system, known as JEM. JEM is comprised of a coupled hydrodynamic model and a water quality model and is calibrated to specific Jamaica Bay parameters. Additional detail of the modeling is available in a technical report prepared by New York City (NYCDEP 2016, draft, in prep.). Initial model runs of various durations of barrier closures suggest that minimal impacts occur during all scenarios beside long duration closure for extreme rain events.

Additional modeling will be undertaken to ensure that barrier design avoids water quality impacts while the barrier is open or closed.

The NYCDEP is implementing a multiyear plan to address water quality in Jamaica Bay that will improve future water quality under the Proposed Action Alternatives (see Section 7.17 Infrastructure).

## 7.3.3 Action Alternative Impacts

### 7.3.3.1 Water Levels

Hydrodynamic modeling (Arcadis 2016b) demonstrated that the two Storm Surge Barriers (C-1E & C-2) would only have a minor long-term impact on tidal levels throughout the bay. However, the effects of tide gates across individual tributaries have not been evaluated at this time. Additional modeling would be required to understand the potential effects of tributary gates on water levels in each of the affected tributaries. This modeling would be conducted prior to the Final HSGRR/EIS.

### 7.3.3.2 Tidal Currents

The effects of tide gates across individual tributaries have not been evaluated at this time. Additional modeling would be required to understand the potential effects of tributary gates on tidal currents in each of the affected tributaries. This modeling would be conducted prior to the Final HSGRR/EIS.

### 7.3.3.3 Wind and Wave Climate

The effects of tide gates across individual tributaries have not been evaluated at this time. Additional modeling would be required to understand the potential effects of tributary gates on wind and wave climate in each of the affected tributaries. This modeling would be conducted prior to the Final HSGRR/EIS.

### 7.3.3.4 Water Quality

Current hydrodynamic modeling indicates minor long-term adverse impacts to bay hydrodynamics. However, the effects of tributary tidal gates have not been evaluated at this time. To date, it has been recognized that water quality impacts to the interior tidal basins need additional analyses to understand the sensitivity of impacts to water quality from flushing and circulation. Currently, the USACE is working with the NYCDEP to refine existing water quality models to refine the evaluation of potential long-term effects on water quality within the bay. This modeling would be conducted prior to the Final HSGRR/EIS.

### 7.3.3.5 No-Action Alternative Impacts

No short- or long-term direct or indirect adverse impacts on tidal currents, wind and wave climate, tributaries, or water quality are anticipated from implementation of the No-Action Alternative.

Baseline conditions would remain as described in Section 2.2 Physical Description of the Existing Area. The NYCDEP is implementing a multiyear plan to address water quality in Jamaica Bay that will improve future water quality under the No Action Alternative (Section 7.17 Infrastructure).

## 7.4 Air Quality Impacts

### 7.4.1 No-Action Alternative (FWOP)

The FWOP scenario may result in greater pollutant emissions due to the repeated coastal management that would need to be conducted as individual projects or emergency actions (i.e., less efficient implementation). For example, additional mobilization and demobilization, emergency response conditions, and other elements associated with numerous individual projects would continue to be needed under the FWOP scenario, which could reduce the overall efficiency of protecting the coast, which may in turn lead to increases in pollutant emissions.

Further, from the pollutant perspective, there is the potential that not all of the individual projects would necessarily trigger General Conformity, resulting in no offsetting of construction emissions associated with 'de minimis' projects. In this scenario, the ongoing projects and activities associated with the FWOP would continue to be reviewed with respect to General Conformity applicability and there is the potential that individual projects might not be subject to the requirements of General Conformity and therefore not be fully offset. If this were the case, the FWOP could actually result in higher levels of emissions than implementing the TSP.

While the FWOP scenario may result in higher overall emissions from the individual projects compared to the TSP, as noted above, it is anticipated that it would not result in a significant change to air quality in the area.

### 7.4.2 Preferred Alternative (TSP)

The TSP will temporarily produce emissions associated with diesel-fueled equipment relating to dredging, beach sand placement, and related landside construction activities. The project is currently anticipated to be constructed from 2017 through 2022, or for a duration of five (5) years. The localized emission increases from the diesel-fueled equipment will last only during the project's construction period (and primarily only locally to where work is actually taking place at any point in time), and then end when the project is over. Therefore, any potential impacts will be temporary in nature. The TSP is anticipated to be the most efficient approach to coastal management for the study area, and thus is anticipated to generate the lowest pollutant emissions.

The TSP will take place in Queens, Kings, and Nassau Counties, New York and the General Conformity applicability trigger levels for 'moderate' ozone nonattainment areas are: 100 tons per year (any year of the project) for $NO_x$ and 50 tons per year for VOC (40 CFR§93.153(b)(1)). For areas designated as 'maintenance' for $PM_{2.5}$, the applicability trigger levels are: 100 tons for direct $PM_{2.5}$, $SO_2$, and CO per year (40 CFR§93.153(b)(2)).

The General Conformity-related emissions associated with the project are estimated as part of the General Conformity Review and are summarized below, by calendar year (assuming 5 year construction duration, regardless of start and end dates) below in Table 7-1. Emission calculations are provided in the Environmental Impacts section of the Environmental Appendix

**Table 7-1: TSP General Conformity-Related Emissions per Calendar Year, tons**

| Pollutant | Estimated Emissions, tons per year | | | | |
|---|---|---|---|---|---|
| | 2017 | 2018 | 2019 | 2020 | 2021 |
| $NO_x$ | 159.6 | 239.4 | 239.4 | 0.0 | 0.0 |
| VOC | 6.0 | 9.0 | 9.0 | 0.0 | 0.0 |
| $PM_{2.5}$ | 8.3 | 12.5 | 12.5 | 0.0 | 0.0 |
| $SO_2$ | 0.1 | 0.2 | 0.2 | 0.0 | 0.0 |
| CO | 20.8 | 31.2 | 31.2 | 0.0 | 0.0 |

The emission levels of $NO_x$ exceed the ozone 'de minimis' trigger levels for General Conformity; therefore, applicable $NO_x$ emissions will need to be fully offset as part of the project. Because $NO_x$ will be fully offset, by rule, the net $NO_x$ emissions increase will be zero and therefore will produce no significant impacts.

A Statement of Conformity (SOC) will be utilized to ensure that the project meets the General Conformity requirements. The associated mitigation and tracking over the life of the project will be coordinated through the Regional Air Team (RAT) that consists of: EPA Region 2, NYSDEC, NJDEP, USACE New York District, and other agencies associated with the mitigation efforts associated with the Harbor Deepening Project and the Hurricane Sandy-related Authorized -But-Unconstructed (ABU) projects. This approach was successfully used to fully offset emissions from the Harbor Deepening Project, which covered a construction period from 2005 through 2016.

The mitigation options for $NO_x$ include: use of available Surplus NOx Emission Offsets (SNEOs) generated by the Harbor Deepening Project, establishment of a Marine Vessel Engine Replacement Program (MVERP; see Environmental Appendix), the purchase of EPA Cross-State Air Pollution Rule (CSAPR) ozone season $NO_x$ allowances, statutory exemption, State Implementation Plan accommodation, or elongation of the construction schedule so as not to trigger GC. The final combination of the above options will be coordinated and tracked through the RAT. The draft SOC is provided in the Environmental Impacts section of the Environmental Appendix. In meeting the General Conformity requirements, the project, by definition will not incur significant impacts.

Project emissions of VOC, $PM_{2.5}$, $SO_2$, and CO are all significantly below their respective trigger levels and therefore, by rule, are considered 'de minimis' and will have only temporary impacts around the construction activities with no significant impacts.

## 7.5 Groundwater

If an alternative would result in a reduction in the quantity or quality of water resources for existing or potential future use, or if the demand exceeded the capacity of the potable water system, the action could have a significant impact.

### 7.5.1 Impacts Common to Both Action Alternatives

No short- or long-term direct or indirect impacts on groundwater are anticipated from implementation of the common project elements. No activities associated with the Proposed Action or the Alternatives would involve penetration of groundwater aquifers or result in contaminant release that could reasonably reach groundwater resources.

### 7.5.2 Proposed Action Impacts

No short- or long-term direct or indirect impacts on groundwater are anticipated from implementation of the additional unique elements associated with the Proposed Action.

### 7.5.3 Action Alternative Impacts

No short- or long-term direct or indirect impacts on groundwater are anticipated from implementation of the additional unique elements associated with the Action Alternative.

### 7.5.4 No-Action Alternative Impacts

No short- or long-term direct or indirect impacts on groundwater are anticipated from implementation of the No-Action Alternative. Baseline conditions would remain as described in Section 2.3.10 Water Quality.

## 7.6 Aquatic and Terrestrial Environments

Based upon aquatic and terrestrial habitat types defined in section 2.3.8 Aquatic and Terrestrial Habitats, Table 5-3 Permanent and Temporary Habitat Impacts summarizes the temporary and permanent impacts based upon an area metric (i.e., acres) associated with the two Storm Surge Barrier alignments associated with the Proposed Action (i.e., C-2 and C-1E) and the Action Alternative (i.e., D). In addition, habitat maps for all areas within the limits of disturbance boundaries associated with the selected TSP are included in Environmental Impacts section of the Environmental Appendix. Permanent impacts were assumed to be all areas within the Right-Of-Way, and all other areas within the limits of disturbance defined as temporary impacts. The following provides additional discussion of impacts to aquatic and terrestrial habitats. A greater level of detail is available in the Environmental Impacts section of the Environmental Appendix.

### 7.6.1 Impacts Common to Both Action Alternatives

Construction of buried sea walls and/or groins along the Atlantic Ocean Shorefront Planning Reach, as well as portions of the Jamaica Bay Northwest segments, shared by both Action

Alternatives, would have short-term minor adverse impacts on beach habitats, aquatic habitat, and potentially associated dune habitats at each nourishment area. These aquatic and terrestrial habitats are likely to be recolonized from nearby communities and benthic aquatic habitats are expected to-establish to a similar community within a 1 to 2-year period (USACE 1995, USACE 2001). No permanent impacts associated with habitat structure and/or vegetation are anticipated in this segment, as the seawall will be buried with sand in an effort to restore the existing habitat type. In fact, the project will have a net long-term benefit on these habitats by stabilizing the shoreline, increasing sediment the sediment budget, and minimizing future renourishment activities necessary to support a healthy North Atlantic Upper Ocean Beach community.

Construction of bulkheads or seawalls in both the Rockaway Bayside and Jamaica Bay Northwest reaches would have short-term minor adverse impacts to existing hardened shorelines as well as adjacent intertidal mudflat habitat. No long-term adverse impacts are anticipated given the previous hardening of the shoreline. Construction of floodwalls and/or levees associated with the Breezy Point portion of the Rockaway Bayside reach, as well as shared portions of the Jamaica Bay Northwest reach, would have a footprint and maintained easement area that would have both long-term minor adverse impacts to ruderal, urban, maritime forest, dune and beach habitats. In addition, areas within the limits of disturbance would have short-term minor adverse impacts to these habitats.

Impacts to both ruderal and urban habitats will be negligible given the limited ecological functions provided in current condition. The location of recommended CSRM measures were planned to minimize adverse impacts to these natural habitats (i.e., maritime forest, dune, beach), and were strategically placed along the outer edge of habitats that currently border urban (i.e., developed) habitats in an effort to reduce habitat fragmentation. However, both short- and long-term adverse impacts are unavoidable. Short-term adverse impacts to vegetation are anticipated to occur from clearing all areas within the defined construction limits of disturbance. In addition, impacts to soils discussed in Section 7.1 Geologic Setting would cause a minor short-term indirect impact on vegetation in the affected areas. Impacts to surface water quality from increases in near shore turbidity and suspended solids as described in Section 7.3 Surface Water could cause a minor short-term direct reduction in oxygen levels, resulting in a reduction in primary productivity and photosynthesis in freshwater plant communities in Jamaica Bay. Long-term adverse impacts are expected to those aquatic and terrestrial habitats that are lost within the permanent footprint of the proposed structures.

Mitigation discussed in Section 5.3.1 Habitat Impacts and Mitigation Requirements is intended to offset unavoidable long-term adverse impacts to natural habitats affected by the Proposed Action.

### 7.6.2 Proposed Action Impacts

Construction of an inlet gate structure as a component of the Storm Surge Barrier will have both short- and long-term minor adverse impacts on aquatic habitats – primarily deep water subtidal bottom. Long-term adverse impacts will be realized from the footprint of the gate structure. Short-term adverse impacts will result from construction and potential to increase flow velocities, and therefore increased likelihood of scour. Refined modeling necessary to inform engineering design will provide additional information with respect to potential impacts on aquatic habitats. This modeling would be conducted prior to the Final HSGRR/EIS.

It should be noted that the Proposed Action would have beneficial long-term direct impacts on native habitats throughout Jamaica Bay by protecting shorelines from future erosion associated with storm surges. Specifically, an inlet gate will protect and preserve marsh island habitats, which have been diminishing at an accelerated rate (see section 2.3.8 Aquatic and Terrestrial Habitats).

Mitigation discussed in Section 5.3.1 Habitat Impacts and Mitigation Requirements is intended to offset long-term adverse impacts to natural habitats affected by the Proposed Action.

### 7.6.3 Action Alternative Impacts

Given the large footprint of CSRM structures across Jamaica Bay associated with the Perimeter Plan, the Action Alternative would have both short-term and long-term adverse impacts to a range of habitat types, consistent with the Alternative elements discussed above.

Tidal gates across each tributary would have both short- and long-term minor adverse impacts to primarily deep water subtidal bottom habitat, as well as intertidal wetland habitats at a few locations. Long-term adverse impacts are anticipated to occur from the permanent footprint of the gate structures. However, as noted above, hydrodynamic modeling of individual tributary gates has not been performed to date. Therefore, it is unknown at this time if tidal gates across individual tributaries could have other direct long-term adverse impacts to terrestrial and aquatic habitats.

Construction of elevated promenades, floodwalls and/or levees would have a footprint and maintained easement area that would have a directly, long-term minor adverse impacts to ruderal, urban, intertidal wetlands, non-native wetlands, maritime forest, dune and beach habitats. In addition, the limits of disturbance associated with construction of each feature would also have a direct, short-term impact. Impacts to both ruderal and urban habitats will be negligible. The location of CSRM measures were planned to minimize adverse impacts to these natural habitats (i.e., maritime forest, wetlands, dune, beach), and strategically placed along the outer edge of habitats, where possible, in an effort to reduce habitat fragmentation. Clearing of vegetation is assumed to occur within the defined limits of disturbance. Impacts to soils are discussed in Section 7.1 Geologic Setting and would cause a minor short-term indirect impact on vegetation in the affected areas. Impacts to surface water quality from increases in near shore turbidity and suspended solids as described in Section 7.3 Surface Water could cause a minor short-term direct reduction in oxygen levels, resulting in a reduction in primary productivity and photosynthesis in freshwater plant communities in Jamaica Bay.

Construction of bulkheads and/or seawalls will have short-term minor adverse impacts to existing hardened shorelines as well as adjacent intertidal mudflat habitat and subtidal bottoms. No long-term adverse impacts are anticipated given the previous hardening of the shoreline.

Living shorelines will have a long-term beneficial impact on native shoreline habitats throughout the bay. Table 7-2 includes a summary of benefits from NNBFs within the Action Alternative based upon an area metric.

**Table 7-2: Summary Benefits of NNBFs in the Jamaica Bay Planning Reach**

| | Area (Acreage) | |
|---|---|---|
| **Habitat Types** | **Existing** | **Alternative Action** |
| Subtidal Bottom | 5.5 | 4.6 |
| Intertidal Mudflat | 13.2 | 12.1 |
| Intertidal Wetlands | 5.8 | 11.1 |
| Non-Native Wetlands | 0.6 | 0.0 |
| Oyster Reef | 0.0 | 2.1 |
| Beach | 2.8 | 2.2 |
| Dune | 0.9 | 2.6 |
| Maritime Forest/Shrubland | 2.4 | 42.2 |
| Ruderal | 62.3 | 14.6 |
| Rip Rap / Bulkhead | 0.0 | 0.1 |
| Urban | 8.9 | 8.2 |

### 7.6.4 No-Action Alternative Impacts

Significant long-term direct adverse impacts on both aquatic and terrestrial habitats are anticipated from a No-Action Alternative. Significant adverse impacts are anticipated from shoreline erosion and loss of natural habitats throughout the bay. Specifically, the marsh island habitats are eroding at an accelerated rate. In the absence of any human intervention, the marshes are projected to vanish by the year 2025 (USACE 2016). The loss of sensitive habitat would, in turn, have significant adverse impacts on aquatic and terrestrial wildlife.

## 7.7 Invertebrate and Benthic Resources

### 7.7.1 Impacts Common to Both Action Alternatives

Beneficial long-term direct impacts to benthic shellfish species would be realized from implementation of the common project elements. Constructed groins would create areas suitable for recruitment and protection for numerous shellfish species. Beneficial impacts to the benthic community include the increase in food source, spawning beds, and shelter in the project area (USACE, 2015, [Jones Inlet EA]). Construction and extension of groins would provide living spaces for the floral and faunal communities on which benthic species rely. In addition to creating living spaces and increasing food availability of the project area, the proposed Project would provide shelter from wave attacks for the existing and surrounding benthic communities. Some species, such as rockweeds (*Fucus spp*.), oysters, and barnacles (*Balanus spp*.) would flourish on the newly constructed groins (Carter 1989). Various floral species such as rockweed and spongomorpha (*Spongomorpha spp*.), and faunal species such as barnacle, oyster, and blue mussel, are expected to move into the area and colonize living space on groins (USACE 1995). Rockweeds are known to support numerous organisms, including both autotrophs and heterotrophs. In addition, rockweeds provide shelter, moisture at low tide, and food especially for the sessile epifaunal and epiphytic groups (Oswald et al. 1984). Gastropods, bivalves, and crustaceans are all common inhabitants of rockweeds.

Minor short-term direct adverse impacts to benthic communities are anticipated from construction activities associated with the common project elements, including future periodic renourishment. Construction would cause increased sedimentation, resulting in the smothering of existing sessile benthic communities in the vicinity of construction areas. Some mortality of shellfish, and polychaetes is expected for individuals that cannot escape during the construction process. Motile shellfish species would be able to relocate temporarily outside of the immediate project area.

A short-term impact to the existing benthic habitat is anticipated from burial of the benthic floral and faunal community. Benthic resources would begin to recolonize the project area immediately following Project completion. Infaunal organisms are likely to recolonize the area from nearby communities and re-establish to a similar community within a 2 - 6.5 month period (USACE 1995; USACE 2001). Short-term adverse impacts would occur because of short-term changes to water quality during construction, including resuspension of sediments in the water column and changes to the quality or quantity of soft bottom substrates, as discussed in Section 7.2 Bathymetry and Sediments. Construction related increases in turbidity and suspended solids cause a short-term reduction in oxygen levels (Reilley et al. 1978, Courtenay et al., 1980). Impacts are expected to be minor, given the temporary nature of the disturbance and the availability of suitable adjacent habitat and given the large extent of the Atlantic Ocean and Jamaica Bay compared to the project construction footprint. Implementation of BMPs to control sedimentation and erosion during construction would further minimize adverse impacts on benthic invertebrate species. It is possible that the species composition of the benthic community that reestablishes would be slightly different than the pre-construction composition given disturbance and potential change in substrate type.

Minor, but recurring, short-term, direct adverse impacts on nearshore benthic communities would occur as a result of dredging sand from the borrow areas and occur at each nourishment. According to the NPS environmental documents prepared for previous borrow efforts indicate the adverse impacts are not significant (GMP/EIS, 2014). Minor long-term direct impact on benthic invertebrates, particularly to the abundance and size structure of sand dollar (*Echinarachnius parma*) populations (USACE 2001), would be experienced due to displacement and/or mortality during dredging for borrow areas. Impacts to benthic communities in the borrow area are considered short-term and minor because benthic invertebrate species are expected to recolonize the borrow area within 2-2.5 years (USACE 2001).

### 7.7.2 Proposed Action Impacts

Construction of an inlet gate structure as a component of the Storm Surge barrier will have short- and long-term minor adverse impacts to primarily deep water subtidal bottom habitat that is used by some benthic species. Long-term adverse impacts will be realized from the footprint of the gate structure, which will permanently remove some benthic habitat; although the project site is already impacted because it is actively maintained as a navigation channel. In addition, most benthic species would recolonize nearby and the addition of new hardened in-water structures can function as habitat for some benthic species. Short-term adverse impacts will result from the potential to increase flow velocities, and therefore increase likelihood of scour in benthic habitat proximate to this permanent feature.

The Proposed Action would have a beneficial long-term direct impact on native habitats throughout Jamaica Bay by protecting shorelines from future erosion associated with storm surges. Specifically, an inlet gate will protect tidal marsh and intertidal wetland habitats, used by many benthic species, which have been diminishing at an accelerated rate.

Mitigation discussed in Section 5.3.1 Habitat Impacts and Mitigation Requirements is intended to offset long-term unavoidable adverse impacts to natural habitats affected by the Proposed Action.

### 7.7.3 Action Alternative Impacts

The Action Alternative would have beneficial and adverse short-term and long-term adverse impacts to habitats important for benthic populations, consistent with the common elements discussed above.

Tidal gates across each tributary would have adverse short- and long-term minor adverse impacts to primarily deep water subtidal bottom habitat and intertidal wetland habitats, which are important habitats for benthic species in the Bay. Long-term adverse impacts are anticipated from the footprint of the gate structure. However, as noted above, hydrodynamic modeling has not been performed at this time for individual tributary gates. Therefore, it is unknown at this time if tidal gates across individual tributaries could have other direct long-term impacts to terrestrial and aquatic habitats

Construction of elevated promenades, floodwalls and/or levees would have a footprint and maintained easement area that would have both short- and long-term minor adverse impacts to intertidal mudflats and wetlands, as well as non-native wetlands that are used by many benthic species. Impacts to surface water quality from increases in near shore turbidity and suspended solids as described in Section 7.3 Surface Water could cause a minor short-term direct reduction in oxygen levels which could impact benthic species.

Construction of bulkheads and/or seawalls will have short-term minor adverse impacts to existing hardened shorelines as well as adjacent intertidal mudflat habitat and subtidal bottoms. No long-term adverse impacts are anticipated, as benthic species can recolonize the structures after completion. No change is anticipated in the extent of hardened shorelines; therefore no long-term adverse impacts are expected for benthic resources.

Living shorelines will have a long-term beneficial impact on native shoreline habitats throughout the bay, including intertidal wetlands which are important for many benthic species.

Mitigation discussed in Section 5.3.1 Habitat Impacts and Mitigation Requirements is intended to offset long-term unavoidable adverse impacts to natural habitats affected by the Action Alternative.

### 7.7.4 No-Action Alternative Impacts

No short- or long-term direct impacts on benthic species are anticipated from implementation of the No-Action Alternative. Baseline conditions would remain as described in Section 2.3.8 Aquatic and Terrestrial Species.

The No-Action alternative will potentially have indirect adverse effects on the benthic species in the project area through the continued, on-going impacts to aquatic habitats from high energy storm events. Intertidal wetlands and mudflats that function as habitat for many invertebrate species would experience significant erosion. Storms will also temporary increase water turbidity and changes in water chemistry from high energy wave action caused by storms. These adverse impacts can reduce the quality and extent of subtidal bottom and oyster reef habitats that are important for benthic invertebrates. Climate change is expected in increase the frequency and intensity of storms that would continue to contribute to the damage and loss of these habitats over the long-term (reference).

## 7.8 Finfish

### 7.8.1 Impacts Common to Both Action Alternatives

Beneficial long-term direct impacts to fish species are also anticipated from implementation of the common project elements. Constructed groins would create areas suitable for recruitment and protection for numerous fish species. Beneficial impacts to the fish community include the increase in food source, spawning beds, and shelter in the project area (USACE, 2015, [Jones Inlet EA]). Construction and extension of groins would provide living spaces for the food resource on which fish species rely. In addition to creating living spaces and increasing food availability of the project area, the proposed Project would provide shelter from wave attacks for the existing and surrounding fish communities.

There would be minor short-term direct adverse impacts on adult and juvenile life stages of nearshore fish during construction, as mobile fish would be temporarily displaced from foraging habitat as they retreat from the area in response to construction activities. Construction related increases in turbidity and suspended solids will cause a short-term reduction in oxygen levels and reduce visibility for feeding (Reilley et al. 1978, Courtenay et al., 1980). Impacts are expected to be minor, given the temporary nature of the disturbance and the availability of suitable adjacent habitat. Adult and juvenile life stages and their prey species would quickly reestablish themselves after completion of construction.

Additional minor short-term direct adverse impacts on nearshore fish communities would occur as a result of dredging sand from the borrow areas. According to the NPS environmental documents prepared for borrow efforts indicate the adverse impacts are not significant (GMP/EIS, 2014). Additional minor short-term direct impact on benthic feeding fish species (e.g., windowpane, summer and winter flounder) would be experienced, due to temporary displacement during dredging for borrow areas. Impacts are considered minor because benthic feeding fish species are expected to avoid construction areas and feed in the surrounding area; therefore, would not be adversely affected by the temporary localized reduction in available benthic food sources. There are expected to be no impacts to fish assemblages of finfish foraging habits in offshore borrow areas (USACE 2001). Because adverse effects to essential fish habitat would be minor, the essential fish habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations would be satisfied.

Minor short-term direct adverse impacts on nearshore fish communities would be realized by less mobile life stages (eggs and larvae) of nearshore fish, e.g., Atlantic butterfish, red hake, windowpane flounder, winter flounder, summer flounder, and scup, if present at the time of construction activities. Impacts would occur because of short-term changes to water quality, including resuspension of sediments in the water column and changes to the quality or quantity of soft bottom substrates, as discussed in Section 7.3 Bathymetry and Sediments. Impacts to nearshore fish community assemblages are considered minor (USACE 2001), given the large extent of the Atlantic Ocean and Jamaica Bay compared to the project construction footprint, and there would be no impact to nearshore fish foraging habits (USACE 2001).. Implementation of BMPs to control sedimentation and erosion during construction would further minimize adverse impacts on eggs and larvae of nearshore fish species.

Mitigation discussed in Section 5.3.1 Habitat Impacts and Mitigation Requirements is intended to offset long-term unavoidable adverse impacts to natural habitats affected by the Proposed Action.

### 7.8.2 Proposed Action Impacts

Construction of an inlet gate structure as a component of a Storm Surge Barrier will have adverse short- and long-term minor impacts to finfish populations that use deep water subtidal bottom habitat in the immediate project area. Long-term adverse impacts are anticipated from the footprint of the gate structure that will eliminate a small portion of subtidal bottom habitat for fish; however impacts will be minor and fish species should easily re-establish in other, adjacent habitat. Short-term adverse impacts will result in slight changes to water conditions around the inlet gate because of the potential to increase flow velocities.

The Proposed Action would have a beneficial long-term direct impact on native habitats important to fish species throughout Jamaica Bay by protecting tidal marshes and intertidal wetlands from future erosion associated with storm surges. Tidal marshes and marsh islands are important nursery habitat for many fish species in the Bay. Tidal marshes have been diminishing at an accelerated rate.

### 7.8.3 Action Alternative Impacts

The Action Alternative would have beneficial and adverse short-term and long-term impacts to habitats important for fish populations, consistent with the common elements discussed above.

Tidal gates across each tributary would have adverse short- and long-term minor impacts to primarily deep water subtidal bottom habitat and intertidal wetland habitats, which are important habitats for different life stages of many fish species in the Bay. Long-term, but minor, adverse impacts will be realized from the footprint of the gate structure, which will permanently remove a small amount of habitat for fish. Short-term adverse impacts will result from the potential to increase flow velocities, and therefore increase likelihood of scour proximate to this permanent feature and potentially alter the environment for fish using these areas.

Construction of elevated promenades, floodwalls and/or levees would have a footprint and maintained easement area that would have both short- and long-term minor adverse impacts to intertidal wetlands and non-native wetlands that are used by many fish species. Construction impacts to surface water quality from increases in near shore turbidity and suspended solids as described in Section 7.3 Surface Water could cause a minor short-term direct reduction in oxygen levels, resulting in a reduction in primary productivity and photosynthesis in freshwater plant communities in Jamaica Bay. This could cause adverse impacts to herbivorous fish and indirectly impact carnivorous fish. Mitigation discussed in Section 5.3.1 Habitat Impacts and Mitigation Requirements is intended to offset long-term adverse impacts to natural habitats affected by the Proposed Action.

Construction of bulkheads and/or seawalls will have short-term minor adverse impacts to existing hardened shorelines as well as adjacent intertidal mudflat habitat and subtidal bottoms. No long-term adverse impacts are anticipated given that fish species can temporarily vacate the area during construction and recolonize after completion. No change is anticipated in the extent of hardened shorelines, therefore no long-term adverse impacts are expected for fish.

Living shorelines will have a long-term benefit on native shoreline habitats throughout the bay, including intertidal wetlands which are important for many fish species.

Mitigation discussed in Section 5.3.1 Habitat Impacts and Mitigation Requirements is intended to offset unavoidable adverse long-term impacts to natural habitats affected by the Action Alternative.

### 7.8.4 No-Action Alternative Impacts

No short- or long-term direct impacts on fish species are anticipated from implementation of the No-Action Alternative. Baseline conditions would remain as described in Section 2.3.8 Aquatic and Terrestrial Habitats.

The No-Action alternative will potentially have indirect adverse effects on the fish species in the project area through the continued, on-going impacts to aquatic habitats from high energy storm events. Intertidal wetlands along the main shorelines of Jamaica Bay and marsh islands that function as important nursery habitat for many fish species would experience significant erosion. These adverse impacts can also reduce the quality and extent of subtidal bottom and oyster reef habitats that are important for fish. Climate change is expected to increase the frequency and intensity of storms that would continue to contribute to the damage and loss of these habitats over the long-term.

## 7.9 Reptiles and Amphibians

### 7.9.1 Impacts Common to Both Action Alternatives

Beneficial long-term direct adverse impacts on herptiles (i.e., reptiles and amphibians) are anticipated from implementation of the common project elements. Construction of buried seawalls and floodwalls associated with the Atlantic Ocean Shorefront Planning Reach, the limited Rockaway Bayside CSRM segment, and the limited Jamaica Bay Northwest CSRM segment would protect shoreline vegetation from physical degradation, likewise preserving reptile and amphibian habitat. Overall habitat within the intertidal zone would increase as the beach is widened with beach fill, and groin structures would reduce the rate of beach loss. The physical characteristics of the intertidal habitat will not be altered, because the grain size of fill material will be the same as that of project footprint native sand.

Minor short-term direct adverse impacts on reptiles and amphibians are anticipated from construction associated with the common project elements. Shoreline intertidal, subtidal, upper beach, and dune wildlife habitats would be impacted from construction activities such as clearing and grading for temporary access road construction. Wetland habitats would be impacted by temporary changes in surface water quality from increases in near shore turbidity and suspended solids, as described in Section 7.6 Aquatic and Terrestrial Environments, affecting freshwater-dependent and saltmarsh-dependent reptile and amphibian species. There would be a permanent loss of some small areas of terrestrial upper beach zone and dune communities, dominated by sand and beachgrass, from construction of permanent pedestrian access ramps and walkways and placement of sand barriers. In addition, these habitats would experience minor short-term direct adverse impacts from construction activities. However, these adverse impacts are expected to occur in a small footprint and will be mitigated (see Section 5.3.1 Habitat Impacts and Mitigation Requirements) through implementation of BMPs and the addition of new habitat in other strategic locations within Jamaica Bay.

Construction of bulkheads in both the Rockaway Bayside and Jamaica Bay Northwest reaches will have short-term minor adverse impacts to existing hardened shorelines as well as adjacent intertidal mudflat habitat that may be used by turtle species. No long-term adverse impacts are anticipated given the previous hardening of the shoreline.

### 7.9.2 Proposed Action Impacts

Additional adverse and beneficial but minor impacts on herptiles would occur as a result of implementation of the additional unique elements of the Proposed Action. Impacts would be similar to those described for the common project elements based upon selected CSRM measure, but would extend across an expanded project footprint.

Construction of an inlet gate structure as a component of the Storm Surge Barrier will have adverse short- and long-term minor impacts to upland habitats in the immediate project area that may be used by reptile and amphibian species. Some habitat will be permanently removed, although additional habitat with more ecological functional value will be created in other areas. Passage through Rockaway Inlet is not expected to deter sea turtles from continuing to utilize Jamaica Bay.

The Proposed Action would have a beneficial long-term direct impact on native habitats important for reptiles and amphibians including wetlands, mudflats, and upland habitats throughout Jamaica Bay by protecting shorelines from future erosion associated with storm surges.

### 7.9.3 Action Alternative Impacts

Additional adverse and beneficial but minor impacts on herptiles would occur as a result of implementation of the additional unique elements of the Action Alternative. Impacts would be similar to those described for the common project elements, but would extend across an expanded project footprint. The Action Alternative would have both short-term and long-term adverse impacts to habitats important for reptile and amphibian populations, consistent with the common project elements.

Tidal gates across each tributary would have both short- and long-term minor adverse impacts to upland, mudflats, and intertidal wetland habitats, which are important habitats for some turtle species in the Bay. Long-term adverse impacts will be realized from the footprint of the gate structure, which will permanently remove a small amount of upland, wetland, mudflat, and shoreline habitat used by amphibians and reptiles. It is unknown at this time if the tidal gates would have additional adverse impacts to native habitats through modification of tributary hydrodynamics.

Construction of elevated promenades, floodwalls and/or levees would have a footprint and maintained easement area that would have both short- and long-term minor adverse impacts to intertidal wetlands and non-native wetlands that are potentially used by reptiles and amphibian species. Impacts to surface water quality from increases in near shore turbidity and suspended solids as described in Section 7.3 Surface Water could cause a minor short-term direct reduction in water quality which could impact reptile species.

Construction of bulkheads and/or seawalls will have short-term minor adverse impacts to existing hardened shorelines as well as adjacent intertidal mudflat habitat and subtidal bottoms. No change is anticipated in the extent of hardened shorelines, therefore no long-term impacts are expected for reptiles and amphibians.

Living shorelines will have a long-term benefit on native shoreline habitats throughout the bay, including intertidal wetlands, mudflats, and uplands, which are important for many reptile and amphibian species.

Mitigation discussed in Section 5.3.1 Habitat Impacts and Mitigation Requirements is intended to offset long-term adverse impacts to natural habitats affected by the Action Alternative.

### 7.9.4 No-Action Alternative Impacts

No short- or long-term direct impacts on amphibian and reptile species are anticipated from implementation of the No-Action Alternative. Baseline conditions would remain as described in Section 2.3.8 Aquatic and Terrestrial Habitats.

The No-Action alternative will potentially have indirect long-term adverse effects on the amphibian and reptile species through the continued, on-going impacts to their habitats from high energy storm events. Beach/dune systems, uplands, intertidal wetlands, mud flats, and marsh island habitats experience significant erosion, temporary increases in turbidity and changes in water levels and water chemistry from high energy wave action caused by storms. Erosion of buffer habitats like intertidal wetlands may also have indirect adverse impacts on maritime and coastal shrub and forest habitats. These adverse impacts can reduce the quality and extent of these habitats in Jamaica Bay, negatively impacting the reptiles and amphibian species that use them. Climate change is expected in increase the frequency and intensity of storms that would continue to contribute to the damage and loss of these habitats over the long-term.

## 7.10 Birds

### 7.10.1 Impacts Common to Both Action Alternatives

Beneficial long-term direct impacts on birds are anticipated from implementation of the common project elements. As discussed in Section 7.6 Aquatic and Terrestrial Environments, vegetation, stabilization and renourishment of Rockaway Beach would support healthy North Atlantic Upper Ocean Beach; benefiting bird species, particularly beach nesting birds like piping plover and least terns that use this habitat. These are known to nest within the Study Area at several locations. Stabilizing the eroding beaches under the TSP may have a positive effect on maintaining or increasing suitable shoreline nesting or feeding habitat in the long term. If an overwash area is formed the winter prior to the shorebird breeding season (April 1st - July 1st), piping plovers (in addition to other shorebirds) will immediately use the newly altered area for foraging. Gently sloping overwash fans that extend into the backbay marshes provide prime foraging habitat. Due to routine dynamic changes in washover areas, the vegetation typically remains sparse. This provides optimal nesting habitat. The insects associated with the sparse vegetation (i.e., common ants and flies) also provide a food source for the foraging shorebirds. However, shorebirds that utilize washover areas for nesting may also be subject to increased predation, and to nest failure due to subsequent washovers at the same location. In direct contrast to the benefits derived from overwash deposits, a barrier island breach and continued beach erosion could have negative impacts on piping plovers. A breach occurring during the nesting season could result in the direct loss of eggs, and mortality of chicks and/or adults. Flood tidal deltas resulting from a breach may provide additional foraging areas for piping plovers. However, this benefit must be weighed against the loss of beachfront nesting habitat. Continued erosion of the beach and fore-dune can create erosion scarps, thereby degrading existing or other potential plover habitat.

Potential short term impacts to piping plover habitat could result from proposed filling activities, placement may temporarily decrease the habitat quality of the piping plover's food source resulting in a decrease in the value of the foraging habitat until the beach is stabilized and itsfaunal community restored. Beach slope is also a critical factor for piping plover habitat selection and use. In order to maintain existing habitat conditions, the slope of the placement material will be consistent with adjacent existing beaches that contain successful brooding areas.

Conducting the beach fill operations outside of the piping plover nesting season is the easiest way to avoid adverse impacts. To minimize impacts to the species and habitat efforts would be made to artificially create and maintain high quality piping plover habitats, minimize direct disturbance to piping plover breeding on stabilized beaches, and reduce project induced effects of increased recreational disturbance.

Construction of seawalls and floodwalls associated with the Atlantic Ocean Shorefront Planning Reach, the limited Rockaway Bayside reach, and the limited Jamaica Bay Northwest CSRM reach would protect shoreline vegetation from physical degradation, likewise preserving bird habitat. Overall habitat within the intertidal zone would increase as the beach is widened with beach fill, and groin structures would reduce the rate of beach loss. The physical characteristics of the intertidal habitat will not be altered because the grain size of fill material will be the same as that of project footprint native sand.

Minor adverse short-term direct impacts on birds are anticipated from construction associated with the common project elements. Shoreline intertidal, subtidal, upper beach, and dune wildlife habitats would be impacted due to such construction activities as clearing and grading for temporary access road construction. Aquatic habitats would be impacted by temporary changes in surface water quality from increases in near shore turbidity and suspended solids as described in Section 7.3 Surface Water, affecting freshwater-dependent and saltmarsh-dependent bird species. There would be permanent loss of some small areas of terrestrial upper beach zone and dune communities, dominated by sand and beachgrass due to construction of permanent pedestrian access ramps and walkways and placement of sand barriers. In addition, these habitats would experience minor short-term direct adverse impacts from construction activities. However these adverse impacts are expected to be over a small footprint and will be mitigated for (see Section 5.3.1 Habitat Impacts and Mitigation Requirements) through BMPs (specifically construction planned for times of the year outside key breeding and migration periods) and the addition of new habitat in other locations in the project area.

Construction of bulkheads in both the Rockaway Bayside and Jamaica Bay Northwest reaches will have short-term minor adverse impacts to existing hardened shorelines as well as adjacent intertidal mudflat habitat that may be used by bird species. No long-term impacts are anticipated given that the extent of hardened shoreline will not change.

Placement of groins would result in small losses of intertidal beach and subtidal aquatic habitats used by birds that are located within groin footprints. However, these adverse impacts are expected to occur in a small footprint and will be mitigated (see Section 5.3.1 Habitat Impacts and Mitigation Requirements) through implementation of BMPs (specifically construction planned for times of the year outside key breeding and migration periods) and the addition of new habitat in other locations in the project area. The addition of groins could be beneficial for some bird species, as groins create habitat for many benthic and fish species that are prey for shorebirds and raptors.

### 7.10.2 Proposed Action Impacts

Additional minor adverse and beneficial impacts on birds would occur as a result of implementation of the additional unique elements of the Proposed Action. Construction of an inlet gate structure as a component of a Storm Surge Barrier will have adverse short- and long-term minor impacts to primarily some upland, intertidal wetland, beach, and mudflat habitat that could be utilized by birds directly adjacent to the construction area. These adverse impacts are expected to occur in a small footprint and will be mitigated (see Section 5.3.1 Habitat Impacts and Mitigation Requirements) through implementation of BMPs (specifically construction planned for times of the year outside key breeding and migration periods) and the addition of new habitat in other locations in the project area. Short-term adverse impacts to water quality and water conditions will result from the potential to increase flow velocities proximate to this permanent feature, although this is not expected to impact birds.

The Proposed Action would have a beneficial long-term direct impact on native habitats important for birds including wetland, marsh island, beach, mudflat, and upland habitats throughout Jamaica Bay by protecting shorelines from future erosion associated with storm surges. Specifically, an inlet gate will protect marsh island habitats, used by many bird species, which have been diminishing at an accelerated rate.

### 7.10.3 Action Alternative Impacts

Additional adverse and beneficial but minor impacts on birds would occur as a result of implementation of the additional unique elements of the Action Alternative. The Action Alternative would have short-term adverse and long-term beneficial impacts to habitats important for bird populations, consistent with the common elements discussed above.

Tidal gates across each tributary would have both short- and long-term minor adverse impacts to intertidal wetland habitats, which are important habitats for bird species and their food resources in the Bay.

Construction of elevated promenades, floodwalls and/or levees would have a footprint and maintained easement area that would have both short- and long-term minor adverse impacts to maritime forest, intertidal wetlands and mudflats, and non-native wetlands that are used by many bird species.

Construction of bulkheads and/or seawalls will have short-term minor adverse impacts to existing hardened shorelines as well as adjacent intertidal mudflat habitat and subtidal bottoms. No long-term impacts are anticipated, as bird species are not likely to use these areas. No change is anticipated in the extent of hardened shorelines, therefore no long-term adverse impacts are expected for birds.

Living shorelines will have a long-term benefit on native shoreline habitats throughout the bay, including intertidal wetlands which are important for many bird species.

Mitigation discussed in Section 5.3.1 Habitat Impacts and Mitigation Requirements is intended to offset long-term adverse impacts to natural habitats affected by the Action Alternative.

### 7.10.4 No-Action Alternative Impacts

No short- or long-term direct impacts on bird species are anticipated from implementation of the No-Action Alternative. Baseline conditions would remain as described in Section 2.3.8 Aquatic and Terrestrial Habitats.

The No-Action alternative will potentially have indirect adverse effects on bird species through the continued, on-going loss of their habitats from high energy storm events. Beach/dune systems, intertidal wetlands, mud flats, and marsh island habitats experience significant erosion, temporary increases in turbidity and changes in water levels and water chemistry from high energy wave action caused by storms. Erosion of buffer habitats, like intertidal wetlands, may also have indirect adverse impacts on maritime and coastal shrub and forest habitats. These adverse impacts can reduce the quality and extent of these habitats in Jamaica Bay, negatively impacting the bird species that use them. Climate change is expected in increase the frequency and intensity of storms that would continue to contribute to the damage and loss of these habitats over the long-term.

## 7.11 Mammals

### 7.11.1 Impacts Common to Both Action Alternatives

Beneficial long-term direct impacts on mammals are anticipated from implementation of the common project elements. As discussed in Section 7.6 Aquatic and Terrestrial Environments, vegetation stabilization and renourishment of Rockaway Beach would support healthy North Atlantic Upper Ocean Beach; benefiting mammal species that use this habitat. Construction of seawalls and floodwalls associated with the Atlantic Ocean Shorefront Planning Reach, the limited Rockaway Bayside reach, and the limited Jamaica Bay Northwest reach would protect shoreline vegetation from physical degradation, likewise preserving upland habitat used by mammals. Overall habitat within the intertidal zone would increase as the beach is widened with beach fill, and groin structures would reduce the rate of beach loss.

Minor short-term direct adverse impacts on mammals are anticipated from construction associated with the common project elements. Upper beach, and dune wildlife habitats would be impacted due to such construction activities as clearing and grading for temporary access road construction. Wetland habitats would be impacted by temporary changes in surface water quality from increases in near shore turbidity and suspended solids as described in Section 7.6 Aquatic and Terrestrial Environments, affecting freshwater-dependent and saltmarsh-dependent mammal species. There would be permanent loss of some small areas of terrestrial upper beach zone and dune communities, dominated by sand and beachgrass due to construction of permanent pedestrian access ramps and walkways and placement of sand barriers. In addition, these habitats would experience minor short-term direct adverse impacts from construction activities, however these impacts are expected to occur in a small footprint and will be mitigated (see Section 5.3.1 Habitat Impacts and Mitigation Requirements) through implementation of BMPs and the addition of new habitat in other locations in the project area.

Construction of bulkheads in both the Rockaway Bayside and Jamaica Bay Northwest reaches will have short-term minor adverse impacts to existing hardened shorelines as well as adjacent intertidal mudflat habitat that may be used by mammal species. No long-term impacts are anticipated given that the extent of hardened shoreline will not change.

### 7.11.2 Proposed Action Impacts

Construction of an inlet gate structure as a component of a Storm Surge Barrier will have short- and long-term minor adverse impacts to primarily some upland, intertidal wetland, beach, and mudflat habitat that could be utilized by mammals. These adverse impacts are expected to occur in a small footprint and will be mitigated (see Section 5.3.1 Habitat Impacts and Mitigation Requirements) through implementation of BMPs and the addition of new habitat in other locations in the project area. Short-term adverse impacts to water quality and water conditions will result from the potential to increase flow velocities proximate to this permanent feature, although this is not expected to impact mammals.

Additional beneficial and minor adverse impacts on wildlife would occur as a result of implementation of the additional unique elements of the Proposed Action. Impacts would be similar to those described for the common project elements, but would extend across an expanded project footprint.

The Proposed Action would have a beneficial long-term direct impact on native habitats important for mammals including wetland, marsh island, beach, mudflat, and upland habitats throughout Jamaica Bay by protecting shorelines from future erosion associated with storm surges.

### 7.11.3 Action Alternative Impacts

Additional beneficial and minor adverse impacts on wildlife would occur as a result of implementation of the additional unique elements of the Action Alternative. Impacts would be similar to those described for the common project elements, but would extend across an expanded project footprint.

Given the large footprint of structures for the Jamaica Bay Perimeter Plan, the Action Alternative would have both short-term and long-term adverse impacts to habitats important for mammal populations, consistent with the Alternative elements discussed above.

Construction of elevated promenades, floodwalls and/or levees would have a footprint and maintained easement area that would have both short- and long-term minor adverse impacts to some upland, intertidal wetlands and non-native wetlands that are used by mammal species.

Construction of bulkheads and/or seawalls will have short-term minor adverse impacts to existing hardened shorelines as well as adjacent intertidal mudflat habitat. No long-term impacts are anticipated given that mammal species are not likely to use these areas. No change is anticipated in the extent of hardened shorelines, therefore no long-term impacts are expected for birds.

Living shorelines will have a long-term benefit on native shoreline habitats throughout the bay, including intertidal wetlands, beach, and uplands which are important for many mammal species.

Mitigation discussed in Section 5.3.1 Habitat Impacts and Mitigation Requirements is intended to offset long-term adverse impacts to natural habitats affected by Action Alternative.

### 7.11.4 No-Action Alternative Impacts

No short- or long-term direct impacts on wildlife are anticipated from implementation of the No-Action Alternative. Baseline conditions would remain as described in Section 2.3.8 Aquatic and Terrestrial Environments.

The No-Action alternative will potentially have indirect adverse effects on the mammal species through the continued, on-going adverse impacts to their habitats from high energy storm events. Beach/dune systems, intertidal wetlands, mud flats, and marsh island habitats experience significant erosion from high energy wave action caused by storms. Erosion of buffer habitats like intertidal wetlands may also have indirect adverse impacts on maritime and coastal shrub and forest habitats. These adverse impacts can reduce the quality and extent of these habitats in Jamaica

Bay, negatively impacting the mammals that use them. Climate change is expected in increase the frequency and intensity of storms that would continue to contribute to the damage and loss of these habitats over the long-term.

## 7.12 Special Management Areas

A significant impact could occur if elements of an alternative were not in compliance with development and management requirements established for a regulated Special Management Area. Additionally, impacts could be significant if the project resulted in the degradation of characteristic natural or man-made features of Special Management Areas.

### 7.12.1 Impacts Common to Both Action Alternatives

Beneficial short- and long-term direct impacts on special management areas are anticipated from implementation of the common project elements. Construction of shoreline protective measures such as groins, seawalls, and floodwalls would protect special management areas from physical degradation and negative effects of flooding. Special management areas that would realize protection from the common project elements include:

- NPS Gateway National Recreation Area (Portions of Fort Tilden and Jacob Riis Park, Breezy Point, Plumb Beach);
- Special Natural Waterfront Area (Portions of Fort Tilden and Jacob Riis Park, Breezy Point, Plumb Beach);
- Coastal Zone Boundary (Coney Island, portions of Jamaica Bay Northwest, portions of Rockaway Peninsula, and Rockaway Bayside); and
- NYC Waterfront Revitalization Program (same areas as Coastal Zone Boundary).

Gateway National Recreational Area's shoreline needs protection in order to provide continued recreational opportunities and protect its significant natural and cultural resources. The erosion and subsequent shoreline retreat threatens Gateway's resources as well as the NPS' present level of use and operations. Continued erosion will likely result in damage to NPS physical and historical facilities and beaches, and severely restrict access by the public and tenants. Adverse minor short-term direct impacts on the special management areas listed above are anticipated from construction activities associated with the common project elements. These impacts to cultural and natural resources along the project area are to be minimized, and mitigation and monitoring measures will be established to insure compliance with the appropriate legislation and affected agency mission. Negligible short-term direct impacts during project construction are anticipated from disruption of access to the special management areas listed above. Negligible short-term indirect impacts are anticipated from construction noise and dust, slightly diminishing the visitor experience in the special management areas listed above. Construction BMPs would be implemented to reduce the severity of these impacts to negligible levels to the maximum extent possible. BMPs would include limiting construction hours to standard allowable hours, using noise suppressing mufflers on construction equipment, water tanker trucks for dust suppression, covering trucks with tarps to prevent airborne dust, etc.

### 7.12.2 Proposed Action Impacts

Beneficial short- and long-term direct impacts on special management areas are anticipated from implementation of the unique elements of the Proposed Action. Beneficial impacts associated with the unique Proposed Action elements would be similar to those described for the common project elements, but would be broader, particularly with construction of the Storm Surge Barrier, which when closed during storm surge conditions, would further protect special management areas throughout Jamaica Bay. Additional special management areas protected by the unique elements of the Proposed Action include:

- NPS Gateway National Recreation Area (Floyd Bennett Field);
- Special Natural Waterfront Area (all Rockaway Bayside portions and Jamaica Bay portions, e.g., Brooklyn Marine Park, Four Sparrow March, Grassy Bay, Broad Channel);
- Coastal Zone Boundary (all Rockaway Bayside portions, Jamaica Bay portions inside the Storm Surge Barrier, and JFK Airport);
- NYC Waterfront Revitalization Program (same areas as Coastal Zone Boundary);
- Vernam/Barbadoes Park;
- Brant Point Habitat Restoration Area;
- Dubos Point Habitat Restoration Area; and
- Bayswater State Park Habitat Restoration Area.

Minor short-term direct impacts on some special management areas are anticipated from construction activities associated with the Proposed Action. Negligible short-term direct impacts during project construction are anticipated from disruption of access to these additional special management areas potentially affected by the unique elements of the Proposed Action. Minor short-term indirect impacts are anticipated from construction noise and dust, slightly diminishing the visitor experience in the special management areas listed above.

### 7.12.3 Action Alternative Impacts

Beneficial short- and long-term direct impacts on special management areas are anticipated from implementation of the unique elements of the Action Alternative. Beneficial impacts associated with the unique Proposed Action elements would be similar to those described for the common project elements, but would be broader in scope and would further protect special management areas in Jamaica Bay. Additional special management areas protected by the unique elements of the Action Alternative are the same as those listed for the Proposed Action, with the exception of Floyd Bennett Field, Broad Channel, and JFK Airport. Implementation of the Action Alternative would leave these special management areas unprotected.

Adverse minor short-term direct impacts on some special management areas are anticipated from construction activities associated with the Action Alternative. Minor short-term direct impacts during project construction are anticipated from disruption of access to the additional special management areas potentially affected by the unique elements of the Action Alternative (see list under Section 7.12.2 Special Management Areas, Proposed Action Impacts). Minor short-term indirect impacts are anticipated from construction noise and dust, slightly diminishing the visitor experience in the special management areas listed in Section 7.12.2 Special Management Areas, Proposed Action Impacts.

### 7.12.4 No-Action Alternative Impacts

Adverse significant short- and long-term direct impacts on special management areas are anticipated from implementation of the No-Action Alternative. Not implementing the proposed coastal protective measures would leave all special management areas identified in Section 7.12.2 Special Management Areas, Proposed Action Impacts vulnerable to degradation and destruction by future coastal storm events.

## 7.13 Protected Species

### 7.13.1 Impacts Common to Both Action Alternatives

Beneficial long-term direct impacts on federally and state listed threatened and endangered species are anticipated from implementation of the common project elements. As discussed in Sections 7.6 and 7.10, vegetation stabilization and renourishment of Rockaway Beach would support healthy North Atlantic Upper Ocean Beach; therefore, habitats for sandplain gerardia, seabeach amaranth, piping plover, red knot, roseate tern and other species that use this habitat would benefit for the 50-year life of the project. Construction of seawalls and floodwalls associated with the Atlantic Ocean Shorefront Planning Reach, the limited Rockaway Bayside reach, and the limited Jamaica Bay Northwest reach would protect shoreline vegetation from physical degradation, likewise preserving habitat for these species. Overall habitat within the intertidal zone would increase as the beach is widened with beach fill and groin structures would reduce the rate of beach loss. The physical characteristics of the intertidal habitat will not be altered because the grain size of fill material will be the same as that of project footprint native sand. USACE is engaged with the USFWS to ensure the latest reasonable and prudent measures for piping plovers (USFWS 2014) and standard BMPs are incorporated into the projects' Plans and Specifications detailing specific conservation measures to be undertaken to minimize potential adverse effects to protected species under their jurisdiction.

Minor short-term direct impacts to threatened and endangered species are anticipated from construction associated with the common project elements. Shoreline intertidal, subtidal, upper beach, and dune wildlife habitats would be impacted due to such construction activities as clearing and grading for temporary access road construction. Wetland habitats would be impacted by changes in surface water quality from increases in near shore turbidity and suspended solids as described in Section 7.3 Surface Water, affecting freshwater-dependent and saltmarsh-dependent wildlife species. Terrestrial upper beach zone and dune communities, dominated by sand and beachgrass would experience minor short-term direct impacts due to construction of permanent pedestrian access ramps and walkways and placement of sand barriers. Placement of groins would result in small losses of intertidal beach and subtidal aquatic habitats located within groin footprints, although groins attract benthic invertebrates and fish species that are food resources for, roseate tern, red knot, bald eagle, and osprey.

These activities will likely have impacts on the beach foraging habitats of least tern, sandplain gerardia and seabeach amaranth and the nesting habitat of the piping plover and roseate tern at Breezy Point and Rockaway Beaches, and the beach foraging habitat for migrating red knots dependent on horseshoe crab reproduction on beaches in Jamaica Bay, Breezy Point, and Rockaway Beaches. Future surveys are necessary to better define habitat areas utilized by species of concern within the project study area. In addition, implementation of BMPs to limit construction activities during the breeding and migratory seasons and protect areas where seabeach amaranth populations are present should further minimize adverse impacts on these threatened and endangered species.

Minor short-term direct adverse impacts on threatened and endangered sea turtles and marine mammals are expected at the time of construction these mobile species would be able to retreat from the area in response to if these species are temporarily displaced; however, impacts are expected to be minor because construction activities would be constructed during “construction windows”. Impacts are considered minor, given the given the temporary nature of the disturbance, the availability of suitable adjacent habitat, and the large extent of the Atlantic Ocean and Jamaica Bay compared to the project construction footprint. Implementation of BMPs to control sedimentation and erosion during construction would further minimize adverse impacts. In accordance with the latest NMFS recommendations (NMFS 2014) , if hopper dredges are used in the inlets or offshore borrow area between mid-June and mid-November, NMFS-approved observers will be onboard the vessels to monitor the removal of the dredge material.

Dredging offshore areas has the potential to impact the Federally-listed species Atlantic Sturgeon habitat by removal/burial of benthic organisms and increased turbidity from dredging and construction activities. Hydraulic dredges can directly impact sturgeon and other fish by entrainment in the dredge. Dredging may also impact important habitat features of Atlantic sturgeon if these actions disturb benthic fauna. Alteration of rock substrate is not a concern as this does not occur in the project area. Indirect impacts to sturgeon from either mechanical or hydraulic dredging include the potential disturbance of benthic feeding areas, disruption of spawning migration, or detrimental physiological effects of re-suspension of sediments in spawning areas.

USACE is currently coordinating with NMFS to determine the formal consultation process that is appropriate for the known elements of the TSP, specifically the Atlantic Shoreline CSRM element and will defer formal consultation on the Jamaica Bay barrier plan until such time the TSP for that element of the project has been identified and sufficient detail is available to conduct an appropriate analyses in accordance with Section 7 regulations and procedures. As part of this consultation, minimally, the latest protective BMPs will be incorporated into the projects’ Plans and Specifications detailing specific conservation measures to be undertaken to minimize potential adverse effects to protected aquatic species under their jurisdiction. The planned construction methods will incorporate BMPs, thereby reducing the temporary water quality impacts and general disturbances resulting from in-water construction activities. Additionally, transient listed species are expected to avoid the project area during construction activities.

### 7.13.2 Proposed Action Impacts

Additional minor impacts on threatened and endangered species would occur as a result of implementation of the additional unique elements of the Proposed Action. Impacts would be similar to those described for the common project elements, but would extend across an expanded project footprint.

Construction of an inlet gate structure as a component of a Storm Surge Barrier will have short- and long-term minor impacts to primarily some upland, intertidal wetland, beach, and mudflat habitat that could be utilized by threatened and endangered species listed in the Affected Environment section of the Environmental Appendix directly adjacent to the construction area. These impacts are expected to be over a small footprint and will be mitigated for (see Section 7.12.2 Special Management Areas, Proposed Action Impacts) through BMPs and the addition of new habitat in other locations in the project area. Short-term impacts to water quality and water conditions will result from the potential to increase flow velocities proximate to this permanent feature although this is not expected to impact threatened and endangered plant and bird species.

The Proposed Action would have a beneficial long-term direct impact on native habitats important for threatened and endangered species, specifically beach and dune shoreline habitat important for piping plover, roseate tern, red knot, and seabeach amaranth in Jamaica Bay by protecting shorelines from future erosion associated with storm surges.

### 7.13.3 Action Alternative Impacts

Additional minor impacts on federal and state listed threatened and endangered species would occur as a result of implementation of the additional unique elements of the Action Alternative. Impacts would be similar to those described for the common project elements, but would extend across an expanded project footprint. The Action Alternative would have both short-term and long-term adverse impacts to habitats important for threatened and endangered species populations, consistent with the common elements discussed above.

Construction of elevated promenades, floodwalls and/or levees would have a footprint and maintained easement area that would have both short- and long-term minor impacts to intertidal wetlands and non-native wetlands. No long-term impacts are anticipated given that the threatened and endangered species listed in the Affected Environment section of the Environmental Appendix are not likely to use these areas.

Construction of bulkheads and/or seawalls will have short-term minor impacts to existing hardened shorelines as well as adjacent intertidal mudflat habitat and subtidal bottoms. No long-term impacts are anticipated, as the threatened and endangered species listed in the Affected Environment section of the Environmental Appendix are not likely to use these areas. No change is anticipated in the extent of hardened shorelines, therefore no long-term impacts are expected for birds.

Living shorelines will have a long-term benefit on native shoreline habitats throughout the bay that may be used by some threatened and endangered species.

Mitigation discussed in Section 5.3.1 Habitat Impacts and Required Mitigation is intended to offset long-term impacts to natural habitats affected by the Action Alternative.

### 7.13.4 No-Action Alternative Impacts

No short- or long-term direct or indirect impacts on federal and state listed threatened and endangered species are anticipated from implementation of the No-Action Alternative. Baseline conditions would remain as described in Section 2.3.9 Threatened and Endangered Species.

The No-Action Alternative will potentially have indirect adverse effects on threatened or endangered terrestrial and aquatic species through the continued, on-going impacts to their habitats from coastal storm events as discussed in Section 2.3.1 Description of the Ecological Region. These impacts can reduce the quality and extent of these habitats in Jamaica Bay, negatively impacting the aquatic and terrestrial species that use them. In particular beach/dune habitat important to seabeach amaranth and nesting and foraging piping plover, roseate tern, and red knot would be under increased threat of erosion. Climate change is expected in increase the frequency and intensity of storms that would continue to contribute to the damage and loss of these habitats over the long-term.

## 7.14 Land Use

An alternative could have a significant effect if it was not consistent with existing and documented future land use policies, and/or result in the loss of property value or use of existing or projected future development, including economic losses. Note that real estate impacts are also discussed in Section 5.3.2 Real Estate Impacts and Costs and in the Real Estate Cost Attachment to the Economics Appendix.

### 7.14.1 Impacts Common to Both Action Alternatives

Beneficial long-term direct impacts on land use would be realized by implementation of the common project elements. Construction of seawalls, groins, and floodwalls along with beach renourishment actions would serve to stabilize coastal land, protecting the land from the influence of winds, waves, currents, and sea-level changes. Stabilizing the land and protecting land resources from coastal storm events promotes current residential, recreational, and transportation land uses. Negligible long-term direct and indirect impacts on project area privately held real estate are anticipated from implementation of the Proposed Action or the Action Alternative, relative to completed structure footprints and associated rights-of-way easements necessary for structure maintenance. Slightly larger impacts are projected for publicly held land (see Section 5.3.2 Real Estate Impacts and Costs and in the Real Estate Costs Attachment to the Economics Appendix for greater detail).

### 7.14.2 Proposed Action Impacts

Additional beneficial short- and long-term direct impacts on land use would be realized from implementation of the additional shore protection actions unique to the Proposed Action. Beneficial impacts associated with the unique Proposed Action elements would be similar to those described for the common project elements, but would be broader, particularly with construction of the Storm Surge Barrier, which when closed during storm surge conditions, would further protect lands along the Jamaica Bay shoreline from physical degradation and negative effects of flooding. The Proposed Action would provide CSRM benefits to more than 40,000 properties in the project area.

Additional long-term direct and indirect impacts on project area real estate are anticipated from implementation of the Proposed Action, as described for the common project elements. Tables 5-5 and 6-4 present the real estate impact to public and private lands. Note that out of the total impact to 76.6 acres, the purchase of only 2.2 privately held acres and easements for 0.8 privately held acres are required for the Proposed Action. The purchase of 31.3 publically held acres and easements for 42.4 publically held acres are required for the Proposed Action.

### 7.14.3 Action Alternative Impacts

Additional beneficial short- and long-term direct impacts on land use would be realized from implementation of the additional shore protection actions unique to the Action alternative. Additional long-term direct and indirect impacts on project area real estate are anticipated from implementation of the Action Alternative, as described for the common project elements. Land use protections afforded by the unique elements of the Action Alternative are the same as those listed for the Proposed Action, with the exception of Floyd Bennett Field and the community at Broad Channel, which is not protected under implementation of the Action Alternative, resulting in potential adverse short- and long-term coastal storm risk for those areas.

### 7.14.4 No-Action Alternative Impacts

Significant long-term direct impacts on land use are anticipated from implementation of the No-Action Alternative. The No-Action alternative would leave land and communities along the Atlantic Ocean Shorefront Planning Reach and the Jamaica Bay Planning Reach vulnerable to coastal storm risks from waves, storm surge, and inundation. Historically, extreme storms have devastated communities and associated transportation, commercial, industrial, health-related, and educational activities. Under the No-Action Alternative, beaches would experience erosion and eventually be as much as half the width of existing beaches, limiting recreational land use (NED Recreation Benefit for Rockaway Beach, NY, Undated).

## 7.15 Recreation

An alternative could have a significant impact on recreation resources if it reduced or prevented use of designated recreational areas. Additionally, an impact could be significant if actions associated with an alternative permanently degraded the characteristics of a recreation resource that make the resource appealing to the public.

### 7.15.1 Impacts Common to Both Action Alternatives

Beneficial long-term direct impacts on recreation would be realized by implementation of the common project elements. Construction of seawalls, groins, and floodwalls along with beach renourishment actions would stabilize areas currently used for recreation, protecting recreational resources from the detrimental influence of winds, waves, currents, and sea-level changes. Long-term benefits to recreational resources described in Section 2.3.15 Cultural Resources generally result from:

- Additional areas available for sport fishing (i.e., additional groins);
- An increase in the size of recreational beach area (Rockaway);
- Improved access to comfort stations and lifeguard headquarters (Rockaway);
- Protection of beaches (Rockaway and Coney Island);
- Protection of the newly constructed Rockaway Boardwalk (NYC Parks EA, 2014);
- Protection of Coney Island recreational facilities; and
- Protection of parks (NPS, NYC, NYSDEC) throughout the study area.

CSRM at the Atlantic Ocean Shorefront Planning Reach is designed to maintain the beaches in the study area against erosion, to a width of approximately 200 feet of beach (NED Recreation Benefit for Rockaway Beach, NY, Undated). Maintaining the width of existing beaches would create an enhanced recreation experience relative to the future condition of the beach without maintenance, which would be reflected in an increase in visitation. The Rockaway Beach Attendance Study demonstrated that people would be more willing to visit Rockaway Beach if the beach restoration projects were implemented. Based on responses to beach surveys completed in the summer of 2015, it was estimated that a 50 percent reduction in beach width would reduce the annual number of visits to Rockaway Beach by 4,512,512 visits (NED Recreation Benefit for Rockaway Beach, NY, Undated). For example, the total annual Rockaway Beach project recreation benefits are $38.6 million dollars (NED Recreation Benefit Document, Undated). CSRM provided by both action alternatives would also support future planning and implementation efforts for NYC's Rockaway Parks Conceptual Plan.

Negligible short-term direct impacts are anticipated from disruption of access to recreation resources during project construction (e.g., beaches, parks, historic sites). Additionally, negligible short-term indirect impacts are anticipated from construction noise and dust, slightly diminishing the recreational experience of visitors who visit recreation areas during active construction. BMPs would include limiting construction hours to standard allowable hours, using noise suppressing mufflers on construction equipment, water tanker trucks for dust suppression, and covering trucks with tarps to prevent airborne dust.

### 7.15.2 Proposed Action Impacts

Additional beneficial short- and long-term direct impacts on recreation would be realized from implementation of the additional shore protection actions unique to the Proposed Action. Beneficial impacts associated with the unique Proposed Action elements would be similar to those described for the common project elements, but would be broader, particularly with construction of the Storm Surge Barrier, which when closed during storm surge conditions, would further protect recreation resources throughout Jamaica Bay from physical degradation and negative effects of flooding. In particular, the portions of Gateway National Recreation Area on Floyd Bennett Field would be protected by the Storm Surge Barrier alternative, but not protected by implementation of the Action Alternative.

Additional negligible short-term direct and indirect impacts on recreation are anticipated from implementation of the Proposed Action, as described for the common project elements.

### 7.15.3 Action Alternative Impacts

Additional beneficial short- and long-term direct impacts on recreation would be realized from implementation of the additional shore protection actions unique to the Action Alternative. Additional negligible short-term direct and indirect impacts on recreation are anticipated from implementation of the Action Alternative, as described for the common project elements. Recreation area protections afforded by the unique elements of the Action Alternative are the same as those listed for the Proposed Action, with the exception of Floyd Bennett Field, which is not protected under implementation of the Action Alternative, resulting in potential minor short- and long-term adverse effects. Living shorelines and associated walk and bike paths would provide recreation opportunities at some areas along the Jamaica Bay Perimeter Plan.

### 7.15.4 No-Action Alternative Impacts

Significant long-term direct impacts on recreation are anticipated from implementation of the No-Action Alternative. The No-Action alternative would leave Atlantic Ocean Shorefront Planning Reach and Jamaica Bay Planning Reach communities vulnerable to coastal storm risks from waves, storm surge, and inundation. Extreme storms would be detrimental to recreational resources. Under the No-Action Alternative, beaches would experience erosion and eventually be as much as half the width of existing beaches, limiting recreational land use. Implementation of the No-Action Alternative would result in Rockaway Beach continuing to experience erosion at a rate of about 10 feet per year. Based on responses to beach surveys completed in the summer of 2015, it is estimated that a 50 percent reduction in beach width would reduce the annual number of visits to Rockaway Beach by 4,512,512 visits. Beach visits per year were interpolated between these two points based on survey responses (NED Recreation Benefit for Rockaway Beach, NY, Undated).

Additionally, the No-Action Alternative could result in similar significant adverse impacts on recreational resources as occurred during Hurricane Sandy in October 2012, which devastated the area, sweeping away the majority of the Rockaway boardwalk, and many of the adjacent recreational areas on Rockaway, Following Hurricane Sandy, more than $140 million was invested to repair and restore Rockaway Beach. As part of this work, intact sections of the boardwalk were repaired, damaged beach buildings were renovated with new boardwalk islands constructed around them, public restrooms and lifeguard stations were installed to replace destroyed facilities and interim shoreline protection measures were created. The No-Action Alternative will offer no CSRM for the recently constructed Rockaway Boardwalk (i.e. NYP Rockaway Boardwalk EA 2014) and no CSRM for recreational resources within Jamaica Bay Unit of the Gateway National Recreation Area (see Section 2.3.5 Protected Lands within the Study Area).

## 7.16 Navigation

An alternative could have a significant impact if it significantly reduced, impeded, or prevented the overwater navigation of commercial and recreational vessels.

### 7.16.1 Impacts Common to Both Action Alternatives

No short- or long-term direct or indirect impacts on navigation are anticipated from implementation of the common project elements. With or without implementation of the Proposed Project or the Action Alternative, commercial or recreational vessel usage of Jamaica Bay, including the Federal Navigation Channel, would be maintained to support baseline conditions or future projected conditions.

### 7.16.2 Proposed Action Impacts

No short- or long-term direct or indirect impacts on navigation are anticipated from implementation of the Proposed Action. The constructed Storm Surge Barrier would be closed during a storm event; however, no adverse impact on navigation is anticipated from the closed barrier, as navigation during a storm is unlikely. After construction of the Storm Surge Barrier, the Rockaway Inlet channel would be narrower than under existing conditions; however, adverse impacts from this narrowing are considered negligible on navigation of both commercial and recreational vessels. Vessels would have to become familiar with the new restricted opening and be more careful regarding safe passage through the barrier opening.

### 7.16.3 Action Alternative Impacts

No short- or long-term direct or indirect impacts on navigation are anticipated from implementation of the Action Alternative.

### 7.16.4 No-Action Alternative Impacts

No short- or long-term direct or indirect impacts on navigation are anticipated from implementation of the No-Action Alternative.

## 7.17 Infrastructure

An alternative could have a significant effect on infrastructure if it would increase demand on a given infrastructure beyond the infrastructure's capacity, requiring a substantial system expansion or upgrade. Additionally, an impact could be significant if it would result in substantial system deterioration over current infrastructure condition beyond normal "wear and tear."

### 7.17.1 Impacts Common to Both Action Alternatives

Minor short-term direct impacts on airports and wharf and dock facilities are anticipated from implementation of the common project elements. The common elements of the action alternatives do not protect these infrastructure components in Jamaica Bay, including JFK International Airport and commercial and recreational wharf and dock facilities.

No short- or long-term direct or indirect impacts on rail roads; wastewater treatment; and bridge, pipeline, and cable crossings are anticipated. None of these infrastructure components are in the construction foot print of the common project elements. The borrow areas are specifically designed to avoid the pipeline and cable structures buried offshore.

Negligible short-term direct impacts on roads and traffic are anticipated from implementation of the common project elements. Roadways used by construction crews and equipment to access project construction sites would experience negligible short-term direct impacts from increased traffic congestion and wear. Temporary disruption of traffic on local roadways and thoroughfares in the area may occur during delivery of stone rubble and other construction-related materials and equipment. The primary roads affected by construction in the common project elements include those that access Rockaway Peninsula:

- Flatbush Avenue;
- Marine Parkway Bridge (aka Gil Hodges Memorial Bridge);
- Cross Bay Boulevard;
- Cross Bay Veterans Memorial Bridge;
- Rockaway Beach Boulevard;
- Beach Channel Drive; and
- Shore Front Parkway.

Minor impacts to navigation traffic may occur due to in-water construction and transportation of construction materials.

### 7.17.2 Proposed Action Impacts

Additional negligible and minor impacts on infrastructure would occur as a result of implementation of the additional unique elements of the Proposed Action. Impacts would be similar to those described for the common project elements, but would extend across an expanded project footprint. In particular, construction of the Storm Surge barrier at Rockaway Inlet would increase road and traffic impacts; however, because impacts would be limited to the construction period, impacts are still considered to be negligible. Additional roads that would be impacted by construction activity include:

- 90-7C/Shore Parkway;
- NY27;
- Cropsey Avenue; and
- 908H/Ocean Parkway.

Beneficial long-term direct impacts on infrastructure would occur as a result of implementation of the additional unique elements of the Proposed Action. Specifically, beneficial long-term direct impacts on airports and wharf and dock facilities are anticipated from implementation of the unique elements of the Proposed Action, in particular, construction and use of the Storm Surge Barrier would provide CSRM to commercial and recreational wharf and dock facilities from degradation by coastal storm events, and may allow them to be operational during such events and allow them to become operational more quickly after such events.

### 7.17.3 Action Alternative Impacts

Additional negligible and minor impacts on infrastructure would occur as a result of implementation of the additional unique elements of the Action Alternative. Impacts would be similar to those described for the common project elements and the Proposed Action, but would extend across an expanded project footprint. In particular, construction of the extensive seawalls and floodgates along the perimeter of Jamaica Bay would increase road and traffic impacts; however, because impacts would be limited to the construction period, impacts are still considered to be negligible.

Beneficial long-term direct impacts on infrastructure would occur as a result of implementation of the additional unique elements of the Action Alternative. Specifically, beneficial long-term direct impacts on some wharf and dock facilities are anticipated from implementation of the unique elements of the Proposed Action, in particular, commercial dock facilities in the Head-of-Bay portion of the Jamaica Bay Planning Reach and recreational dock facilities along the tributaries to Jamaica Bay would benefit from CSRM provided by the tributary gates.

### 7.17.4 No-Action Alternative Impacts

No short- or long-term direct or indirect impacts on infrastructure are anticipated from implementation of the No-Action Alternative.

However, the No Action Alternative would not prevent similar adverse significant impacts on waterfront infrastructure as occurred during Hurricane Sandy in October 2012. Although barges and other “floating” infrastructure played a key role in the city’s recovery from Sandy, damage to “fixed” waterfront infrastructure was extensive. The storm damaged boardwalks, landings, and terminals (NYC, Sandy and Its Impacts, 2013 [Chapter 1 in NYC Special Initiative for Rebuilding and Resiliency (SIRR), download here: http://www.nyc.gov/html/sirr/downloads/pdf/final_report/Ch_1_SandyImpacts_FINAL_singles.pdf and the entire report here http://www.nyc.gov/html/sirr/html/report/report.shtml)

Additionally, the No Action Alternative would not prevent adverse significant impacts on transportation infrastructure as occurred during Hurricane Sandy in 2012. For example, the storm tide destroyed rail tracks and crucial subway service to the Rockaways, provided by the A line, was suspended for six months as crews performed cleanup and emergency repairs.

## 7.18 Wastewater Treatment

An alternative could have a significant effect if it would result in a substantial increase if it influenced the functioning of known water treatment within the project area. The location of WWTPs as well as associated CSOs are detailed in the Affected Environment Section of the Environmental Appendix.

### 7.18.1 Impacts Common to Both Action Alternatives

Common project elements cross two large effluent sewer lines spanning between the Coney Island Wastewater Treatment Plant and the diffuser located in Rockaway Inlet. Alternatives D and C-1 cross these effluent sewer lines near the entrance of Sheepshead Bay, while C-2 crosses these effluent sewer lines in Rockaway Inlet. An analysis to assess whether the effluent lines can be realigned or built over requires further evaluation as part of a future, and would influence a determination of effect.

The indirect impacts of wastewater treatment on water quality from a tide gate across both Sheepshead Bay and Shellbank Creek is unknown at this time. USACE is working with NYCDEP to refine existing water quality models to evaluate potential adverse effects.

### 7.18.2 Proposed Action Impacts

No short term or long term direct impacts on wastewater treatment are expected. Current hydrodynamic modeling indicates minor long-term impacts to bay hydrodynamics. In turn, impacts of an inlet gate are assumed to also have minor long-term impacts on water quality and the contribution of wastewater treatment. However, it is recognized that further analysis is required to better understand potential long-term effects on water quality. Specifically, water quality impacts for the interior basins need additional analyses to understand sensitivity of impacts to flushing and circulation. With respect to these tidal inlets that already are challenged by poor water quality, their current condition is that of limited flushing. Therefore, refinement of existing model is anticipated to address these uncertainties. Currently USACE is working with NYCDEP to utilize existing water quality models to refine evaluation of potential long-term effect on water quality within the bay.

### 7.18.3 Action Alternative Impacts

Current hydrodynamic modeling indicates minor long-term impacts to bay hydrodynamics. However, the effects of tributary tidal gates has not been evaluated at this time. To date it has been recognized that water quality impacts and the contribution of wastewater treatment for the interior basins need additional analyses to understand sensitivity of impacts to flushing and circulation. Currently USACE is working with NYCDEP to refine existing water quality models to refine evaluation of potential long-term effect on water quality within the bay.

### 7.18.4 No-Action Alternative Impacts

Significant long-term direct impacts to area wastewater treatment would result from implementation of the No-Action Alternative. The No-Action alternative would leave the WWTPs along the coast and surrounding Jamaica Bay vulnerable to strong waves and storm surge. Extreme storms have proven detrimental to WWTPs, particularly due to inundation which renders them inoperable and damages equipment.

## 7.19 Bridge, Pipeline, and Cable Crossing

An alternative could have a significant effect if it would result in altering the location of a pipline or cable crossing. The location of WWTPs as well as associated CSOs are detailed in Affected Environment Section of the Environmental Appendix.

### 7.19.1 Impacts Common to Both Action Alternatives

Common project elements could potentially affect cross charted submarine cable areas that are known to occur within the Rockaway Inlet. Details of the submarine cables (e.g., depth and cable type) are unknown at this time and will require further investigation in future design phases.

No pipelines or fiber optic lines are known within the project area.

### 7.19.2 Proposed Action Impacts

With the exception of potential impacts to chartered submarine cable areas, there are no other short- or long-term direct or indirect impacts related to bridges, pipelines, and cable crossings from implementation of the additional unique elements associated with the Proposed Action Alternative.

### 7.19.3 Action Alternative Impacts

**T**here are no other short- or long-term direct or indirect impacts related to bridges, pipelines, and cable crossings from implementation of the additional unique elements associated with the Action Alternative.

### 7.19.4 No-Action Alternative Impacts

There are no other short- or long-term direct or indirect impacts related to bridges, pipelines, and cable crossings from implementation of the additional unique elements associated with the No-Action Alternative.

## 7.20 Hazardous, Toxic, and Radioactive Waste

An alternative could have a significant effect if it would result in a substantial increase in the generation of hazardous substances, increase the exposure of persons to hazardous or toxic substances, increase the presence of hazardous or toxic materials in the environment, or place substantial restrictions on property use due to hazardous waste, materials, or site remediation.

### 7.20.1 Impacts Common to Both Action Alternatives

Adverse minor short term direct impacts could occur during construction of the common project elements. Operation of the construction vehicles would increase the likelihood for release of vehicle operating fluids (e.g., oil, diesel, gasoline, anti-freeze, etc.) in the work zones. However, releases are expected be immediately addressed by site safety spill prevention and control measures to minimize potential impacts.

### 7.20.2 Proposed Action Impacts

Adverse minor short-term direct impacts could result from disturbance of a tar-like substance associated with an old factory site located off the south shore of Floyd Bennett Field. This site would potentially be disturbed by construction of the Storm Surge Barrier where it ties in to Floyd Bennett Field, and hazardous sediments would potentially be generated, depending on results of sediment testing during excavation in this area.

Any hazardous materials needed to operate the Storm Surge Barrier (lubricating oils, paints, etc.) would be managed in accordance with USACE solid and hazardous materials SOPs and applicable Federal, State, and NYC laws.

### 7.20.3 Action Alternative Impacts

No short- or long-term direct or indirect impacts related to HTRW are anticipated from implementation of the additional unique elements associated with the Action Alternative.

### 7.20.4 No-Action Alternative Impacts

No short- or long-term direct or indirect impacts related to HTRW are anticipated from implementation of the No-Action Alternative. Following Hurricane Sandy, New York DEP undertook a study to understand the impact of the storm on sites that store hazardous substances, in accordance with Local Law 26 of 1988, more commonly known as the NYC Right-to-Know Law. Of 367 facilities that had filed reports under Local Law 26, 46 facilities were severely affected by Sandy, but reported no spills and showed no evidence of spills. Only 11 facilities reported spills related to Hurricane Sandy, but the spills had been cleaned up by the facility prior to DEP inspection or spills were completely washed out by the storm. The DEP study concluded that though the lack of evidence of contamination may indicate that the impacted businesses had secured these chemicals sufficiently prior to Sandy or adequately remediated their sites post-storm, it also may reflect the particular reality of Sandy, as the high volume of water may have diluted and washed away any spills that occurred (http://www.nyc.gov/html/sirr/downloads/pdf/final_report/Ch11.5_EnvironProtection_FINAL_singles.pdf).

## 7.21 Landfills

An alternative could have a significant impact on landfills if the action compromised the integrity of the landfill's engineered barrier, resulting in the potential exposure of wastes or leaching of waste material into the environment.

### 7.21.1 Impacts Common to Both Action Alternatives

No short- or long-term direct or indirect impacts on landfills are anticipated from implementation of the common project elements. No landfills were identified in areas that could be affected by project activities in the Atlantic Ocean Shorefront Planning Reach, the Coney Island tie-in, the Jamaica Bay Northwest reach (the short segment on the western side of Gil Hodges Bridge), or the Rockaway Bayside reach.

### 7.21.2 Proposed Action Impacts

Beneficial long-term direct impacts on landfills are anticipated from implementation of the additional unique elements associated with the Proposed Action. Construction of the Storm Surge barrier at Rockaway Inlet would provide CSRM to the closed landfills in Jamaica Bay, including the former Edgemere, Fountain Avenue, Pennsylvania Avenue, and Barren Island Landfills. The Proposed Action would provide CSRM during coastal storm events that could lead to the exposure of landfill contents, such as the event that occurred at the Barren Island landfill in the 1950s, when the east shore of the cap burst, exposing the buried waste.

### 7.21.3 Action Alternative Impacts

Adverse minor long-term direct impacts on landfills are anticipated from implementation of the additional unique elements associated with the Action Alternative. Construction of unique Action Alternative elements, such as vertical living shorelines along the Jamaica Bay Northwest reach would not provide protection for the former Fountain Avenue, Pennsylvania Avenue, and Barren Island Landfills. These landfills would be vulnerable to future landfill cap degradation, as described for the common project elements.

Beneficial long-term direct impacts on landfills are anticipated from construction of floodwalls along the Rockaway Bayside reach, which would protect the former Edgemere landfill from future landfill cap degradation, as described for the common project elements.

### 7.21.4 No-Action Alternative Impacts

Adverse minor long-term direct impacts on landfills are anticipated from implementation of the No-Action Alternative. The former Edgemere, Fountain Avenue, Pennsylvania Avenue, and Barren Island Landfills would remain vulnerable to future landfill cap degradation, as described for the common project elements.

## 7.22 Cultural Resources

A Programmatic Agreement will be executed to take provide a process for continuing to identify historic properties and address effects to these historic properties caused by project elements as they are developed. The Programmatic Agreement will be developed and implemented in coordination and consultation with the NYSHPO, the Shinnecock Indian Nation and other Tribes, the NPS and other interested parties. The following sections analyze the potential for construction and operation of the individual CSRMU elements to adversely impact the historic properties within the APE.

### 7.22.1 Impacts Common to Both Action Alternatives

Beneficial short- and long-term direct impacts on cultural resources are anticipated from implementation of the common project elements, which will protect the historic districts and other properties from coastal storms.

Several CSRMU elements are common to both action alternatives. These elements are located along the Atlantic Ocean-facing side of Rockaway peninsula. The impact from these elements within this APE is described in the following subsections.

**1. Groin construction and extensions**

These elements require excavating potentially undisturbed sediments up to 10 feet below the seafloor. Based on previous investigations, the potential for buried/submerged cultural resources in this area is low. Accordingly, the potential for this element to adversely impact cultural resources is low. However, USACE will consider additional investigations, to include utilizing a cultural monitor during excavation for the groin footings to document the discovery of potential cultural resources.

**2. Renourishment**

USACE has previously determined that sand placement should not have an adverse effect as long as it does not interfere with any features in the historic districts. The renourishment element does not intersect with any historic districts or landmarks. Accordingly, renourishment will not have an adverse effect within the Rockaway APE.

### 3. Borrow Area Dredging

Panamerican conducted a remote sensing survey at Borrow Area A-West and A-East in 2005 (Panamerican, 2005). Sixty-seven magnetic anomalies were recorded within the project area. Based on signal characteristics, three anomalies have the potential to represent significant cultural resources. Panamerican recommended avoidance of all three targets. If avoidance is not an option, additional archaeological investigations are recommended to identify the source of the magnetic anomalies. Additional work should consist of remote-sensing target refinement and diver assessment of the refined target location. Diver assessment should consist of a visual and tactile investigation of the ocean bed at the center of highest gamma deviation for each. In the event that there is no source of magnetic deflection located directly on the ocean bed, sub-ocean bed investigations should be conducted with a probe or hydroprobe to a depth sufficient to either meet proposed project requirements or to locate and delineate the anomaly source. All targets should be assessed as to historical significance, relative to NRHP criteria. The remaining anomalies represent debris deposited for fish havens along and in the western edge of the project area, as well as a pipeline that parallels the southern project area boundary (Panamerican, 2005).

A remote sensing survey has not been conducted at Borrow Area B-West. If USACE plans to use this borrow area, a remote sensing survey will be conducted prior to dredging any material. USACE will share the results with the NYSHPO and provide recommendations for avoidance or additional investigation, as warranted.

### 4. Buried seawall, beach and dune restoration

The on-land portion of this element overlaps the southern boundaries of the historic districts at Jacob Riis Park, Fort Tilden, Silver Gulf Beach Club, and the Breezy Point Surf Club. The shoreline is a part of the historic district for Jacob Riis Park, Fort Tilden and the Silver Gulf Beach Club. Construction of elements along the beach has the potential to adversely affect the historic districts. The proposed alignment for this element passes through the existing footprint of the Silver Gulf Beach Club pavilion. As such, alternative alignments for this element should be considered to avoid this impact.

Additionally, the CSRMU element requires installation of pilings up to 8 feet below NAVD88. Although the presence of buried cultural resources in the piling footprint is unknown, USACE will consider additional investigations, to include utilizing a cultural monitor during construction activities.

Furthermore, the CSRMU element is designed to reach an elevation of approximately 17-18 feet NAVD88, which is several feet higher than the current ground elevation. Therefore, this element has the potential to adversely impact the viewshed when looking out at the Atlantic Ocean from within the historic district.

As a BMP to prevent potential impacts to undiscovered resources, all construction personnel would be instructed on procedures to follow in case previously unidentified archeological resources were uncovered during construction. The procedure would include:

- Cease work in the area of a discovery immediately.
- Contact the assigned USACE project cultural resources specialist.
- Consult with the New York State Historic Preservation Officer, in accordance with 36 CFR§ 800.13.
- Follow provisions outlined in the Native American Graves Protection and Repatriation Act (1990) in the unlikely event that human remains are discovered.

### 7.22.2 Proposed Action Impacts

This section continues the analysis of potential impacts within the Rockaway and Jamaica Bay APEs relative to the remaining CSRMU elements that are unique to the Proposed Action. Only CSRMUs that are likely to have the potential to adversely impact an identified cultural resource are included in the following sections.

**1. Levee**

This CSMRU element is proposed to be constructed around the western border of the Breezy Point neighborhood. The element surrounds the Breezy Point Surf Club historic district. However, the element does not intersect with any of the key/individual elements comprising the historic district. However, the levee requires installation of pilings up to -6 feet NAVD88. Although the presence of buried cultural resources in the piling footprint is unknown, USACE will consider additional investigations, to include utilizing a cultural monitor during construction activities.

The top of the levee will be at an elevation of approximately 14 feet NAVD88, which is higher than the current ground surface. Views of the Atlantic Ocean, Breezy Point Tip, and the New York Harbor would be obscured within the land side of the levee. This would also obscure the view of the historic district from outside of the levee. This would result in a long-term adverse impact. This impact is unavoidable because the levee height needs to extend above the anticipated 2070 high water level in order to provide coastal storm protection.

**2. Concrete Floodwall (Land)**

This CSRMU element would be constructed on the Jamaica Bay-side of the Rockaway peninsula. This element intersects the dock areas at the Riis Landing and U.S Coast Guard Far Rockaway historic district boundaries. This element would have long-term adverse impact on the historic district, though not directly on any of the contributing structures. USACE should consider an alternative alignment to avoid this impact.

**3. Hurricane Barrier**

The Hurricane Barrier is designed to span Rockaway Inlet on the eastern side of Gil Hodges Bridge. No impact to Gil Hodges Bridge is anticipated, as the barrier would be located approximately 2,200 feet east. Views of the Atlantic Ocean and Jamaica Bay from Gil Hodges Bridge would not be obstructed but the hurricane barrier. However, views of the bridge from points in the Bay would be obstructed.

Construction of the hurricane barrier will require installation of pilings several feet below the seafloor. Although the presence of buried cultural resources in the piling footprint is unknown, USACE will consider additional investigation, including utilizing a cultural monitor during construction activities.

**4. Seawall Reconstruction, Concrete Floodwall (land), Elevated Promenade**

These CSRMU elements will be constructed on the southern and western portions of Barren Island and within the Floyd Bennett Field historic district. The elements will roughly align with Flatbush Avenue. The heights of these elements range from 14.5-18 feet NAVD88, obstructing views of the entirety of the historic district on either side of the element, including obstruction of views of contributing structures from the western side of the elements. The footings will be advanced to approximately -10 feet NAVD88. Although the presence of buried cultural resources in the piling footprints is unknown, USACE will consider additional investigations, to include utilizing a cultural monitor during construction activities.

The elevated promenade will be constructed within or in very close proximity to the right of way for Belt Parkway. The right of way is anticipated to be heavily disturbed and with a very low potential for encountering cultural resources. Accordingly, USACE will consider using a cultural monitor to observe the construction of the elevated promenade in areas outside of the Belt Parkway right of way, where the potential to encounter cultural resources would be relatively higher.

**5. Sector Gates**

The Sector Gates will span the inlets to Sheepshead Bay and Plumb Beach Channel. The foundation of the sector gates will be placed on top of the seafloor. Additionally, footings will be advanced below the seafloor. Although the potential for the presence of buried cultural resources in the piling footprints is low, USACE will consider utilizing a cultural monitor during construction activities. However, if these channels are routinely dredged, the potential for cultural resources is further decreased, and the USACE would not provide a cultural monitor. Additional consultation with other stakeholders regarding dredging frequency and depth of these channels will be used to inform USACE's decision.

**6. Dune Restoration**

Dune restoration would occur along the concave on-land portion of Manhattan Beach on Coney Island. The element would be constructed using buried rubble to a height of approximately 18 feet NAVD88. Although the potential for the presence of buried cultural resources in the dune footprint is low, USACE will consider utilizing a cultural monitor during construction activities. However, if this area has been previously excavated and renourished, the potential for cultural resources is further decreased, and the USACE would not provide a cultural monitor. Additional consultation with other stakeholders regarding the history of subsurface excavation within Manhattan Beach will be used to inform USACE's decision.

**7. Residual Risk Features**

The residual risk features surrounding Jamaica Bay vary in the elements proposed and the affected environment. Jamaica Bay has been used extensively and has been continually recontoured. Based on previous documentary research and pedestrian survey, areas around Jamaica Bay are sensitive for potentially significant cultural resources. In particular, at Dead Horse Bay, Fresh Creek, Spring Creek and Motts Point, there are remains of historic period cultural landscapes embedded in the existing environment (Panamerican 2003). These and other areas have the potential for the discovery of prehistoric and historic period deposits. Additional investigations may be required depending upon the location and element recommended.

### 7.22.3 Action Alternative Impacts

Beneficial short- and long-term direct impacts on cultural resources are anticipated from implementation of additional protective measures associated with the unique elements of the Action Alternative. Long-term benefits are anticipated from protection of additional cultural resources from degradation or destruction by severe weather events. Cultural resource protections afforded by the unique elements of the Action Alternative are the same as those listed for the Proposed Action, with the exception of Floyd Bennett Field, which is not protected under implementation of the Action Alternative, resulting in potential adverse minor short- and long-term effects.

### 7.22.4 No-Action Alternative Impacts

Adverse significant short- and long-term direct impacts on cultural resources are anticipated from implementation of the No-Action Alternative. Not implementing the proposed coastal protective measures would leave cultural resources vulnerable to degradation by future coastal storm events.

## 7.23 Socioeconomics and Environmental Justice

Environmental justice issues would arise if activities associated with an alternative caused a disproportionate impact to low-income or minority populations. Disproportionate impacts could be related to human health effects or environmental effects.

### 7.23.1 Impacts Common to Both Action Alternatives

Beneficial long-term direct impacts on Potential Environmental Justice Areas (PEJAs) would be realized by implementation of the common project elements. Construction of seawalls, groins, and floodwalls along with beach renourishment actions as part of the Atlantic Ocean Shorefront Planning Reach, the Coney Island tie-in, the Jamaica Bay Northwest reach, and the Rockaway Bayside reach would stabilize residential areas defined as PEJAs. These PEJAs would be protected from the detrimental effects of winds, waves, currents, and sea-level changes. Adverse impacts from storm damage are felt more deeply by communities with high levels of poverty, because community residents have limited financial resources available for rebuilding structures and replacing damaged possessions. Conversely, benefits of property protection realized from the common project elements would be more beneficial to areas with higher levels of poverty (e.g., PEJAs).

### 7.23.2 Proposed Action Impacts

Beneficial short- and long-term direct impacts on PEJAs, in addition to those realized by implementation of the common project elements, would be realized from implementation of the additional shore protection actions unique to the Proposed Action.

### 7.23.3 Action Alternative Impacts

Beneficial short- and long-term direct impacts on PEJAs, in addition to those realized by implementation of the common project elements, would be realized from implementation of the additional shore protection actions unique to the Action Alternative.

### 7.23.4 No-Action Alternative Impacts

Adverse significant long-term direct impacts on PEJAs are anticipated from implementation of the No-Action Alternative. The No-Action alternative would leave the Atlantic Ocean Shorefront Planning Reach and Jamaica Bay Planning Reach PEJAs vulnerable to property damage from strong waves and storm surges associated with extreme weather events. Adverse impacts, as discussed in Section 2.3.16 Socioeconomic Considerations, from extreme storm damage are felt more deeply by communities with high levels of poverty.

## 7.24 Aesthetics

An alternative could significantly affect visual resources if it resulted in abrupt changes to the complexity of the landscape and skyline (i.e., in terms of vegetation, topography, or structures) when viewed from points readily accessible by the public.

### 7.24.1 Impacts Common to Both Action Alternatives

Beneficial long-term direct impacts on aesthetics would be realized by implementation of the common project elements. Construction of seawalls, groins, and floodwalls along with beach renourishment actions would stabilize areas currently frequented by residents and visitors seeking to connect with significant natural or built features, including area beaches, parks, and landmark structures and districts. Implementation of protective features and beach renourishment common to both action alternatives would protect the project area’s natural and culturally significant resources from the detrimental influence of winds, waves, currents, and sea-level changes. As discussed under impacts to recreation, based on responses to beach surveys completed in the summer of 2015, it was estimated that a 50 percent reduction in beach width would reduce the annual number of visits to Rockaway Beach by 4,512,512 visits (NED Recreation Benefit for Rockaway Beach, NY, Undated).

Negligible short-term direct impacts to area aesthetics are anticipated from the presence in the viewshed of heavy equipment during project construction and from temporary increases in dust and exhaust from construction activities. Construction BMPs would be implemented to reduce the severity of these impacts to negligible levels to the maximum extent possible. BMPs would include limiting construction hours to standard allowable hours, using noise suppressing mufflers on construction equipment, water tanker trucks for dust suppression, and covering trucks with tarps to prevent airborne dust.

Long-term direct impacts would include viewshed disruption for some key observation points, which would be impacted by the presence of lift gates, sector gates, floodwalls and berms.

### 7.24.2 Proposed Action Impacts

Additional beneficial short- and long-term direct impacts on aesthetics would be realized from implementation of the additional shore protection actions unique to the Proposed Action. Additional negligible short-term direct and indirect impacts on aesthetics are anticipated from implementation of the Proposed Action, as described for the common project elements, because of the greater extent of the Proposed Action project footprint.

Long-term direct impacts would include viewshed disruption for some key observation points, which would be impacted by the presence of lift gates, sector gates, floodwalls and berms, although these impacts would be far less extensive than the impacts associated with the Alternative Action..

### 7.24.3 Action Alternative Impacts

Additional beneficial short- and long-term direct impacts on aesthetics would be realized from implementation of the additional shore protection actions unique to the Action Alternative. Construction of unique Action Alternative elements, such as vertical living shorelines along the Jamaica Bay Northwest reach would increase the aesthetics along stretches of shoreline, particularly where paths and trails make shoreline vistas accessible to the public. As a BMP, landscape vegetation used in living shorelines should not grow to heights that would impair views of water features from key near-shore observation points.

Additional negligible short-term direct and indirect impacts are anticipated from implementation of the Action Alternative, as described for the common project elements, because of the greater extent of the Action Alternative project footprint.

Long-term direct impacts would include viewshed disruption for some key observation points, which would be impacted by the presence of lift gates, sector gates, floodwalls and berms. Some impacts would be localized affecting numerous homes in a single block or neighborhood at different areas throughout the Jamaica Bay Planning Reach. These impacts are far greater for the Action Alternative than they are for the Proposed Action.

### 7.24.4 No-Action Alternative Impacts

Adverse significant long-term direct impacts on aesthetics are anticipated from implementation of the No-Action Alternative. The No-Action alternative would leave land along the coast and surrounding Jamaica Bay vulnerable to change and instability from strong waves and storm surge. Coastal storms would negatively alter the aesthetic landscape, including beaches, parks, and landmark structures and districts. Negative impacts to aesthetics would contribute to the loss in recreational beach visits, as described in Section 7.15 Recreation.

## 7.25 Cumulative Impacts

As defined by CEQ Regulations at 40 CFR Part 1508.7, cumulative impacts are those that "result from the incremental impact of the Proposed Action when added to other past, present, and reasonably foreseeable future actions, without regard to the agency (Federal or non-Federal) or individual who undertakes such other actions." Cumulative impact analysis captures the effects that result from the Proposed Action in combination with the effects of other actions in the Proposed Action's region of influence (ROI). A cumulative impacts analysis is intended to give a better picture of the additive or total impacts a given resource may experience when the impacts of unrelated actions or events are added to the predicted impacts of the alternative being evaluated. Analysis of cumulative impacts considers how the Proposed Action affects sensitive resources directly or indirectly, and also what other effects have occurred, are occurring, or might occur to these resources from other, related or unrelated activities within the Proposed Action's ROI. The analysis of cumulative effects is an extension of the impacts analysis performed to determine the significance of direct and indirect, project-specific effects.

The TSP and the cumulative impacts of the proposed Action maybe revised at the Agency Decision Milestone (ADM) based on responses from public, policy, and technical reviews of this Draft HGRR/EIS, specifically for the alignment of the Storm Surge Barrier and residual risk features.

The first step in cumulative impacts analysis is identification of resources that could be impacted by the Proposed Action, as presented in Section 7.1 through 7.24 (Environmental Consequences). Resources deemed to have no impacts from the Proposed Action were eliminated from the cumulative impacts analysis; resource areas that would not experience impacts could not contribute cumulatively to regional effects. Based on the impacts analysis, resources with minor adverse impacts from the Proposed Action were considered for inclusion in the cumulative impacts analysis. The following resources were included in the cumulative impacts analysis, based on the conclusion that the Proposed Action would have a minor adverse impact on the resource and could contribute to cumulative regional impacts.

- Soils
- Sediments (bathymetry and sediment budgets)
- Water Quality (surface and ocean)
- Vegetation (including invasive species and terrestrial habitat)
- Wetlands (including aquatic habitat)

- Fish
- Benthic Community
- Wildlife
- Protected Species and Critical Habitat

Secondly, the ROI for each resource under each alternative scenario was defined in order to evaluate cumulative impacts resulting from projects that are proposed or anticipated within the foreseeable future. The ROI for all resources considered for the cumulative impacts analysis is defined as the "greater New York Metropolitan area" coastal and estuarine regions.

Thirdly, the relevant past, present, and reasonably foreseeable future actions in the ROI were researched. Regional projects were evaluated for inclusion in the analysis that could cumulatively affect each identified resource, considering both the magnitude and significance of the potential cumulative effects.

Representative projects were researched and considered in broad categories of regional projects. Dozens of regional projects were identified, and those with a potential to introduce cumulative impacts in conjunction with potential effects of the Proposed Action were included in the analysis.

Recent, on-going, and proposed actions planned over the next several years with a potential interaction with effects of the Proposed Action are described below. The project sub-headings are broad project classifications. Cumulative impacts for the resource areas identified in Table 7.3 are summarized in Section 7.25.8 Summary of Cumulative Impacts; the analysis concludes that all adverse cumulative impacts are less than significant. Beneficial cumulative impacts are also summarized in Section 7.25.8 Summary of Cumulative Impacts.

**Table 7-3 Region of Influence for Cumulative Impact Analysis**

| Resource Area | Region of Influence (ROI) |
|---|---|
| Aquatic and Terrestrial Habitat | The Atlantic Coast in Rhode Island, Connecticut, New York, and New Jersey |
| Threatened and Endangered Species and Critical Habitat | The extent of each species' known range of critical habitat |
| Erosion and Larger Scale Coastal Zone Management | The Atlantic Coast in Rhode Island, Connecticut, New York, and New Jersey |
| Water Quality | The greater New York metropolitan area |

## 7.25.1 Special Aquatic Habitat Programs Including Wetlands

Regional programs are being implemented to restore degraded or diminished aquatic habitat, including wetlands. Regional projects are described in the following subsections.

### 7.25.1.1 Yellow Bar, Black Wall and Rulers Bar Marsh Island Restoration 2012

The Marsh Islands Complex is an integral part of Jamaica Bay, targeted for restoration by the USACE, PANYNJ, National Park Service (Gateway), NYSDEC, NYCDEP, the National

Resources Conservation Service and the New York/New Jersey Harbor Estuary Program. Restoring salt marshes and coastal wetlands in Jamaica Bay are a critical component of the Comprehensive Restoration Plan for the Hudson Raritan Estuary. Since 2007, more than 160 acres (0.68 kilometers2) of marsh island habitat have been restored at Elders Point East and West, Yellow Bar Hassock, Black Wall, and Rulers Bar. Additional marsh islands, including Pumpkin Patch, Duck Point, Elders East/West, and Stoney Point are being designed as part of the HRE Ecosystem Restoration Feasibility Study.

The NYSDEC, NYCDEP with the local non-profit organizations EcoWatchers, Jamaica Bay Guardian and the American Littoral Society, completed a community-based planting effort to vegetate 30 new acres created at Black Wall and Rulers Bar. Plantings in June 2013 included a mixture of smooth cord grass or salt marsh cord grass (Spartina alterniflora), salt marsh cord grass, salt meadow cord grass or salt hay (Spartina patens), and spike grass (Distichis spicata).

The marsh island restoration efforts are being monitored by a project team that is providing valuable data on the cause of problems and assisting to identify optimum effective future restoration options. This program also has significant implications for the future success of restoration activities from beneficially using sand from the Operations and Maintenance (OMRR&R) Program

#### 7.25.1.2 Broad Channel's Sunset Cove Salt Marsh Restoration Project

In 2009, NYCDPR acquired a former marina at Sunset Cove located in the center of Jamaica Bay. The site is adjacent to Big Egg Marsh, a large wetland complex owned and managed by the NPS. The restoration plan for Sunset Cove Park was created by a partnership of NYCDPR, NPS, NY-HEP, New England Interstate Water Pollution Control Commission (NEIWPCC), Jamaica Bay EcoWatchers, Broad Channel Civic Association, and the American Littoral Society. The plan incorporates approximately 4 acres (0.02 kilometers2) of salt marsh restoration and preservation, 500 feet (152.4 meters) of shoreline restoration, and approximately 7 acres (0.03 kilometers2) of upland habitat restoration. Together, these restoration efforts will establish a sustainable salt marsh, remove concrete tailings, debris, and construction fill, expand the existing wetland complex at Big Egg Marsh, and create an upland walking path through a coastal shrubland. In addition, Phase 2 of the plan, in partnership with the Governor’s Office of Storm Recovery, proposes enhancements to amenities for public waterfront access, including a boardwalk and access to the water for educational programs. The plan also includes berms along the upland perimeter to provide shoreline protection, enhancing resiliency to climate change and laying the foundation for regional economic growth. The proposed plan for Sunset Cove Park was released in spring 2014 as part of NYCDPR’s Rockaway Parks Conceptual Plan. The design project for the saltwater marsh and coastal upland construction is currently under review by the community board and external agencies.

#### 7.25.1.3 Oyster Reef Restoration Project for Thurston Basin

Oyster restoration has been proposed by NYCDEP for Thurston Basin, but is not yet funded. The head of Thurston Basin is three feet deep which is suitable for restoration of oyster reefs. Shallow parts of the Basin along Idlewild Park Preserve have the potential to offer opportunities for other aquatic habitat restoration. Oyster restoration in Thurston Basin can lead to a series of protective oyster reefs that can dissipate wave energy and slow tidal flows. Oyster restoration would also improve the habitat and health of both Thurston Basin, known as a top location for bird watching in New York State, as well as adjacent Idlewild Park Preserve. Oyster restoration in Thurston Basin is an effective and resilient project complimentary to the ongoing Hudson-Raritan Estuary projects such as the Jamaica Bay Oyster Bed Pilot project and the New York Harbor Schools Billion Oysters Project in addition to other projects initiated by NY/NJ Baykeeper.

### 7.25.2 Measures that Change Sediment Input to Jamaica Bay

Changes in sediment deposition to Jamaica Bay have been studied as a possible cause of the documented disappearance of wetlands in the bay. Understanding the possible relationship between sediment transport and marsh losses informs an analysis of regional projects that may cumulatively affect Jamaica Bay. Changes in sediment input result from the following types of human undertakings (Gateway National Recreation Area, National Park Service, Jamaica Bay Watershed Protection Plan Advisory Committee, August 2, 2007):

- Hardening of the bay's perimeter from increased residential and commercial development, which reduce the overall sediment load to the bay.
- Channeling of overland flow through storm sewers and CFOs, which redistributed the sediment load to the bay.
- Changing the bay's physical contours by westward progression of the Rockaway Peninsula, which alters sediment transport and affects water circulation.
- Dredging of navigational channels may be acting as sediment sinks and the increased wave energy and sediment flushing time caused by a deeper average depth may affect sediment accretion.
- Altering Jamaica Bay's tributaries, basins, creeks, and canals until there is little or no freshwater flow other than that conveyed by the sewage treatment, water pollution control plants, and storm sewers.

Regional projects that lead to any of the above outcomes potentially disrupt sediment transport in Jamaica Bay, including the Proposed Action. CSO projects are discussed in Section 7.25.6, Long Term Combined CSO Projects below. The following projects may cumulatively adversely affect sediment transport in Jamaica Bay.

### 7.25.3 Beach Front Measures

Regional projects affecting beach fronts include the beach renourishment and replenishment projects identified in Section 7.25.5 USACE Overall Program. Additional regional projects are described in the following subsections.

#### 7.25.3.1 Rockaway Boardwalk Reconstruction Project

The NYC Department of Parks and Recreation and the NYC Economic Development Corporation have funded this project, which is designed to reconstruct the boardwalk between Beach 20th and Beach 126th Streets in a similar footprint.

Existing concrete foundations in the way of new construction are to be removed and new steel foundations would be spaced approximately 30 feet apart. The reconstructed boardwalk will not intrude on the seaward side of the mean high water spring elevation. The typical boardwalk surface would be designed to be 3.0 feet above the 100-year storm surge elevation. This new elevation would result in raising the new boardwalk sections from approximately 1.4 feet at the eastern portion of the site to approximately 8.0 feet to the west. The reconstruction would also incorporate a sand-retaining wall underneath the boardwalk that would prevent sand migration and help to protect the adjacent beach vegetation community. Between Beach 126th and Beach 149th Streets, the project includes providing structured access to the beach with stairs and ramps across the new dunes currently being constructed as part of the USACE beach renourishment project. In addition, the project would maintain the five existing at-grade crossings through the existing dunes between Beach 9th and Beach 20th Streets.

### 7.25.4 Borrow Area Usage

Regional projects affecting beach fronts include the beach renourishment and replenishment projects identified in Section 7.25.5, USACE Overall Program and Coastal Zone Habitat Modifications. Each of these projects includes dredging borrow materials from off-shore sources. Regional projects requiring borrow material are discussed in this section. Some projects may have completed initial construction activities, but are considered for cumulative impacts because of plans for future, periodic replenishment.

#### 7.25.4.1 Coney Island

The project includes approximately 3 miles of public beachfront from Corbin Place to West 37th Street. The constructed beach has a minimum design berm elevation of +13 feet NGVD, with a width of 100 feet measured from the Coney Island boardwalk seaward and an additional 50 feet of advanced nourishment fill. Approximately 2.3 million cubic yards were dredged from the borrow area offshore, south of the project shoreline within the East Bank Shoal and there is more available for future nourishments if necessary.

#### 7.25.4.2 Long Beach

This USACE project entails the construction of a beach berm, dune and groin system to reduce the potential for storm damage along approximately 35,000 linear feet of shoreline, including the creation or rehabilitation of at least 22 groins and the addition of more than 4.7 million cubic yards of sand. Work is scheduled to begin spring 2016 and is the first of two contracts. Contract one includes 4 new groins and 18 groin rehabilitations. Contract two, including a dune, sand replenishment and construction of crossovers, is scheduled for late 2017.

#### 7.25.4.3 The Westhampton Beach Project

The project is designed to provide beach fill, taper an existing groin field, and fill the compartments of the groins in the villages of Westhampton Dunes, Westhampton Beach, and Southampton. Including re-nourishments, approximately 6.5 million cubic yards of sand were placed along 21,460 linear feet of beach. The project is reportedly performing better than expected.

#### 7.25.4.4 West of Shinnecock Project

Starting in 2004, this project placed approximately 450,000 cubic yards of sand from the inlet channel on adjacent beaches. Approximately 40,000 to 60,000 cubic yards were placed just west of the inlet jetties to address severe erosion problems in front of the fishing cooperative. The remainder were placed further downdrift to accomplish sand bypassing around the inlet. The timing of future fill to address erosion west of the jetties is still uncertain.

#### 7.25.4.5 Fire Island Inlet to Moriches Inlet Stabilization Project (FIMI)

The Fire Island to Moriches Inlet (FIMI) project includes one reach within the overall FIMP Project area. The USACE is currently constructing a project to reinforce the existing dune and berm system along the island. The stabilization effort was developed as a one-time, stand-alone construction project to repair damages caused by Hurricane Sandy and to stabilize the island. The offshore borrow areas used for construction is approximately 5,000,000 cy of sand to be removed from one borrow area and placed in the fill areas between Fire Island Inlet and Davis Park. Approximately 700,000 cy to be removed from another borrow area, and approximately 1,300,000 cy to be removed from a third borrow area for fill areas between Smith Point County Park and Moriches Inlet.

### 7.25.5 USACE Overall Program and Coastal Zone Habitat Modifications

The USACE New York District plans and executes an overall ecosystem restoration program to provide a comprehensive approach for addressing problems associated with disturbed and degraded ecological resources. Restoration techniques include wetland creation and restoration, streambank stabilization, reclamation and treatment of contaminated waterways, flood damage prevention, shoreline and coastal protection, and coastal zone habitat modification projects also involving beach renourishment and replenishment (similar to the Proposed Action). Projects in USACE's overall program that were considered for potential cumulative impacts are described in the following subsections.

#### 7.25.5.1 Hurricane Sandy Coastal Restoration in New York

USACE is carrying out near-term coastal restoration work at previously completed coastal storm risk reduction projects throughout the northeast that were impacted by Hurricane Sandy in October 2012. This involves the placement of millions of cubic yards of sand along beaches impacted by Hurricane Sandy in order to restore them. The USACE New York District manages projects in New York and in New Jersey north of Manasquan Inlet. (Work south of Manasquan Inlet is managed by the USACE Philadelphia District.) Near-term coastal restoration work includes the following five projects in New York.

- Rockaway Beach – Placed approximately 3.5 million cubic yards of sand through two contracts to repair and restore this CSRM beach project.
- Coney Island - Placed approximately 600,000 cubic yards of sand to repair and restore this CSRM beach project.
- Gilgo Beach - Placed approximately 1.5 million cubic yards of sand to complete the repair of this CSRM beach that is part of dual-purpose navigation (Fire Island Inlet) and CSRM project and to bolster nearby municipal beaches using additional funds provided by the state of New York.
- West of Shinnecock Inlet - Placed approximately 450,000 cubic yards of sand to repair and restore this CSRM beach project.
- Westhampton – USACE awarded a construction contract for this work and expects to oversee the placement of roughly 1 million cubic yards of sand by the end of this year to repair and restore this CSRM beach project.

#### 7.25.5.2 North Atlantic Coast Comprehensive Study

The North Atlantic Coast Comprehensive Study (NACCS) provides a step-by-step approach, with advancements in the state of the science and tools to conduct three levels of analysis (available at http://www.nad.usace.army.mil/CompStudy). Tier 1 is a regional scale analysis (completed as part of this study), Tier 2 would be conducted at a State or watershed scale (conceptual Tier 2 evaluations were completed in each State and the District of Columbia and can be found in State and District of Columbia Analyses Appendix), and Tier 3 would be a local-scale analysis that incorporates benefit-cost evaluations of CSRM plans.

Using the tiered analyses will enable communities to understand and manage their short-term and long-term coastal risk in a systems context. The NACCS addresses the coastal areas defined by the extent of Hurricane Sandy's storm surge in the District of Columbia and the States of New Hampshire, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, Pennsylvania, Delaware, Maryland, and Virginia. Maine was not included in the study because minimal impacts from storm surge were documented as part of the Federal Emergency Management Agency's (FEMA's) Modeling Task Force (MOTF) Hurricane Sandy Impact Analysis. Additionally, the USACE Hurricane Sandy Coastal Projects Performance Evaluation Study included an assessment of 13 USACE CSRM projects in northern Massachusetts and Maine, and noted that Hurricane Sandy was generally less than a 20 percent flood with negligible damages to project features. Based on minimal impacts and the authorization language that defined the study area as areas affected by Hurricane Sandy, Maine was not included as part of the NACCS study area. Regardless, as the Maine coastline is primarily affected by nor'easters and periodically by tropical storms and hurricanes, stakeholders and communities could apply the study results to address coastal storm risk as well as utilize the various products generated as part of the NACCS.

#### 7.25.5.3 NY & NJ Harbor Deepening Contract Areas and Future OMRR&R Projections

The project area is the main navigation channels in the Port of New York and New Jersey that support the container terminals. The non-federal sponsor is The Port Authority of New York & New Jersey. The authorized project provides 50-foot water access to the four container terminals by deepening Ambrose Channel from deep water in the Atlantic Ocean to the Verrazano-Narrows Bridge, the Anchorage Channel (from the Verrazano-Narrows Bridge to its confluence with the Port Jersey Channel), the Kill Van Kull Channel, the main Newark Bay Channel to Pt. Elizabeth and the Port Elizabeth and South Elizabeth tributary channels, the Arthur Kill Channel adjacent to the New York Container Terminal), and the Port Jersey. Also authorized but deferred is the deepening of the Bay Ridge channel to 50 ft to the South Brooklyn Marine Terminal. The project also facilitated the beneficial use of nearly all dredged material from the channel deepening project. Some of the beneficial uses include creating fishing reefs from blasted rock, creating marshes, capping the Historic Area Remediation Site (HARS), and capping existing impacted landfills and brownfields.

The project includes 21 dredging contracts and construction of four marsh restoration projects. Two marsh restoration projects at Woodbridge, NJ and Elders Point East, Jamaica Bay, NY (2006-2007, 40 acres of wetlands) were constructed as mitigation for the channel deepening. In 2009 through 2012, the project was modified to include the restoration of two additional Jamaica Bay marsh islands (Elders West and Yellow Bar Hassock) through the beneficial reuse of dredged material. In 2010 with 100 percent non-federal sponsor funding, 339,235 cubic yards of sand was beneficially used for the restoration of Lincoln Park, New Jersey. Twenty dredging contracts have been awarded with 19 physically complete and one underway. Two of the last three contracts removed accumulated shoals and debris (partially due to Hurricane Sandy) in previously deepened channel areas inside the Narrows to facilitate transition of the project from construction to operation. The last contract, which involves the removal of material in utility corridors and other shoals in the Anchorage and Port Jersey Channels, is underway and will be completed shortly following the abandonment of two existing water supply siphons within Anchorage Channel. This water siphon relocation construction work by the Port Authority of NY and NJ and the NYC Economic Development Corporation was severely impacted and delayed by Hurricane Sandy such that the utility corridor deepening contract is not expected to be completed until summer of 2016.

#### 7.25.5.4 Hudson-Raritan Estuary (HRE) Comprehensive Restoration Plan

The Hudson Raritan Estuary (HRE) is within the boundaries of the Port District of New York and New Jersey, and is situated within a 25-mile radius of the Statue of Liberty National Monument. The HRE study area includes 8 Planning Regions: 1) Jamaica Bay; 2) Lower Bay; 3) Lower Raritan River; 4) Arthur Kill/Kill Van Kull; 5) Newark Bay, Hackensack River and Passaic River; 6) Lower Hudson River; 7) Harlem River, East River, and Western Long Island Sound; and 8) Upper Bay.

The study purpose is to identify the water resources problems, existing conditions and factors contributing to environmental degradation within the estuary in order to develop potential solutions aimed at ecosystem restoration, while building upon existing restoration efforts and management plans (e.g., Harbor Estuary Program's Comprehensive Conservation Management Plan).

The HRE Ecosystem Restoration Program will enable USACE, its non-Federal cost-sharing sponsors, and other regional stakeholders to restore and protect lost or degraded aquatic, wetland and terrestrial habitats within the HRE study area. These activities will be accomplished by implementing various site-specific ecosystem restoration projects formulated within the context of an overall strategic plan.

As a first step, the USACE, with participation of the regional stakeholders, developed a Comprehensive Restoration Plan (CRP) that serves as a master plan and blueprint for future restoration in the HRE region. The CRP provides the framework for an estuary-wide ecological restoration program by utilizing restoration targets - Target Ecosystem Characteristics (TECs) developed by the region's stakeholders. The CRP Program goal is to develop a mosaic of habitats that provide society with renewed and increased benefits from the estuary environment. Each TEC is an important ecosystem property or feature that is of ecological and/or societal value including restoration of coastal wetlands, shellfish/oyster reefs, eelgrass beds, water bird islands, public access, maritime forest, tributary connections, shorelines and shallow habitat, fish crab and lobster habitat, reduction of contaminated sediments and improvement of enclosed and confined waters. The CRP provides a strategic plan to achieve the TEC goals, identify potential restoration opportunities and mechanisms for implementation.

The HRE Feasibility Study will recommend specific restoration projects throughout the HRE Study Area that advance the CRP goals and provide solutions for water resource problems. Projects will be recommended for near-term construction and future feasibility study spin-offs (per Civil Works Transformation). Recommendations from the HRE- Lower Passaic River, HRE-Hackensack Meadowlands, Flushing Creek and Bay, Bronx River Basin, and Jamaica Bay, Marine Park, Plumb Beach Feasibility Studies will be incorporated into the HRE Feasibility Report and Environmental Assessment. These recommendations may include benthic habitat restoration, tidal wetland restoration, vegetative buffer creation, shoreline stabilization, and aquatic habitat improvement.

#### 7.25.5.5 Spring Creek North Restoration Project and Spring Creek South Hazard Mitigation Grant Program

The USACE), NYSDEC, NYCDPR, NYCDEP, NPS, the Federal Emergency Management Agency (FEMA), the Governor's Office of Storm Recovery (GOSR), and the U.S. Department of Housing and Urban Development (HUD), among others, have partnered to restore the Spring Creek area located along the north shore of Jamaica Bay. The site consists of two separately funded projects referred to as Spring Creek North and Spring Creek South. Spring Creek North is owned by NYCDPR and the restoration project is being funded by the USACE and NYCDPR pursuant to the Continuing Authorities Program (CAP). Spring Creek South is owned by NPS and the restoration project is funded by a grant provided to NYSDEC under the FEMA Hazard Mitigation Grant Program (HMGP). These projects are also being coordinated with the Governor's Office of Storm Recovery's Howard Beach New York Rising Community Reconstruction Plan (March 2014).

Spring Creek North is a tidal creek that has retained its meandering pattern and has several smaller side channels with exposed mudflats at low tide. The proposed ecosystem restoration project at this site consists of excavating and recontouring uplands to achieve intertidal elevation, as well as removing invasive plant species and replanting the area with native plants. A total of approximately 8 acres (0.03 kilometers2) of low marsh, 5.5 acres (0.02 kilometers2) of high marsh, and almost 25 acres (0.1 kilometers2) of maritime upland habitat would be restored.

In addition, NYCDPR received a National Fish and Wildlife Foundation (NFWF) Grant to conduct complementary actions to provide coastal storm risk management (CSRM) features and improve resiliency at the site.

Spring Creek South was originally recommended as a potential restoration opportunity for the USACE's Jamaica Bay, Marine Park, and Plumb Beach Ecosystem Restoration Feasibility Study. As part of FEMA's HMGP, NYSDEC, USACE (as a planning and construction management contractor), and NPS have reevaluated the restoration plans to include Natural/Nature Based Features (NNBFs) providing CSRM benefits and enhanced coastal resiliency to the Howard Beach Community. A protective berm, in conjunction with up to 178 acres (0.72 kilometers2) of maritime upland habitat and 51 acres (0.21 kilometers2) of wetlands, could be restored at Spring Creek South.

### 7.25.6 Long-Term Combined Sewer Overflow (CSO) Projects

Municipalities are concerned about CSOs because of their effect on water quality and recreational uses in local waterways. Water treatment plants are affected by heavy rain and snow storms when combined sewers receive higher than normal flows. Treatment plants are unable to handle flows that are more than twice design capacity and when this occurs, a mix of excess stormwater and untreated wastewater discharge directly into waterways at certain outfalls. The following subsections describe CSO projects evaluated for cumulative impacts.

#### 7.25.6.1 Jamaica Bay CSO Upgrade Projects

NYC Department of Environmental Protection (DEP) prepared a 2014 update to the Jamaica Bay Watershed Protection Plan. The plan, first issued in 2007, focuses on water quality improvements, ecological restoration and enhancing valuable natural resources. The update outlines the numerous initiatives DEP has undertaken, along with state and federal partner agencies, environmental advocates, leading educational institutions and community groups, to protect one of the most bountiful wildlife habitats in the Northeastern Unites States.

Ongoing initiatives include wastewater treatment plant upgrades, oyster and ribbed mussel pilot restoration projects, wetlands restoration, green infrastructure projects and mapping.

#### 7.25.6.2 NYC CSO Control Plan

Recent NYCDEP construction projects have included upgrades in key wastewater treatment facilities, storm sewer expansions and the construction of several large CSO retention tanks to further mitigate this chronic source of pollution. Existing infrastructure developments have increased NYCDEP's standardized CSO capture rate from about 30% in 1980 to over 80% today. Some of the most recent increases can be attributed to the implementation of additional CSO control measures such as the Spring Creek and Flushing Bay CSO Retention Facilities that came online in 2007, and the Paerdegat Basin and Alley Creek CSO Retention Facilities, which came online in 2010.

### 7.25.7 Community Development Plans

Community development plans in the ROI can have direct cumulative effects, but such projects are also known to induce associated development. For example, improved recreational opportunities at area beaches often bring commercial development designed to serve increased visitor traffic. Regional projects are described in the following subsections.

#### 7.25.7.1 Replacement or Repair of the Gil Hodges Bridge

The Metropolitan Transportation Authority (MTA) includes a feasibility study repair or replacement of the Gil Hodges Bridge in the 2015 – 2019 Capital Program budget. The feasibility study is programed for 2018. Repair or replacement of the bridge is not included in this cumulative impacts analysis because the outcome of the feasibility study is speculative at this point in time. The 2015 – 2019 Capital Program budget includes rehabilitation/repair of the bridge's underwater structure, which is programmed for major construction in 2018. This 2018 action is considered in the cumulative impact analysis.

#### 7.25.7.2 The Arverne Urban Renewal Area

The 308-acre Arverne Urban Renewal Area is bounded by Beach 32nd Street, Beach 81st Street, Rockaway Freeway, and the Rockaway Boardwalk. The project is to be developed in phases. Phase I, Water's Edge, was completed in the Spring of 2001 and consisted of the construction of 40 two-family homes on four infill sites between Beach 59th Street and Beach 62nd Street, south of Rockaway Beach Boulevard. In 2006, construction began on Phase II, which consists of 130 condominiums in the same area as Phase I. The area also contains two other projects. Arverne by the Sea is intended to produce 2,300 units, half of which will be affordable to households making no more than $92,170 for a family of four. An area adjacent to Arverne by the Sea, Arverne East, has the goal of building 1,600 units of middle-income units. Forty-three percent of the units will be reserved for households with incomes no greater than $92,170 for a family of four.

### 7.25.8 Summary of Cumulative Impacts

The minor adverse impacts of the TSP on the aforementioned resource areas would not increase to significant adverse impact levels when combined with past, present, or reasonably foreseeable future impacts from other regional projects. These minor impacts are primarily associated with construction of the TSP. Cumulative adverse impacts on recreation, wetlands, water quality, sediment transport, fish and wildlife, and essential fish habitat would remain minor and short-term. This is due to the coastal storm protections afforded by the TSP to regional projects that have or are planned to restore and/or protect coastal resources located within the study area. Accordingly, the minor adverse impacts associated primarily with construction of the TSP would be offset by the cumulative long-term beneficial impacts of the TSP on, and in combination with, restorative regional projects.

Under the Alternative Action, the long-term significant adverse impacts on coastal resources within Jamaica Bay would remain at these levels in context to other regional projects. Additionally, because the Alternative Action does not provide protections to the interior coastal resources within Jamaica Bay, the Alternative Action would potentially reverse any beneficial impacts generated by other regional projects in this area. Therefore, the Alternative Action would, on its own, result in cumulative adverse impacts on coastal resources within this area; these coastal resources include wetlands, wildlife and habitat…

Implementation of the Proposed Action is not expected to have a significant cumulative adverse impact on any of the resource areas evaluated in this Draft HSGRR/EIS. Cumulative net positive impacts would be realized in the local socioeconomic environment and many resource areas where protection from coastal storm events is beneficial to the resource (e.g., vegetation, wildlife, recreation).

The Proposed Action would not significantly, cumulatively increase regional impacts in the areas identified by the cumulative impact analysis methodology. Minor and beneficial cumulative impacts are discussed in the following sections.

#### 7.25.8.1 Soils

The Proposed Action would cumulatively contribute to beneficial long-term direct impacts that would occur from the resulting built structures (e.g., groins, seawalls, floodwalls) that retain and capture littoral materials native to the beach communities and/or limit the effects of wave and storm surge erosion. Construction and extension of groins and construction of seawalls and floodwalls under the Proposed Action and similar regional projects would result in continued protection of beach sands and upland soils from wave action and erosion that result from significant storm events. Cumulative beneficial long-term direct impacts on soils would occur as a result of the Proposed Action and similar regional projects due to beach renourishment actions, where beach sands are replenished at prescribed intervals over project life cycles.

Cumulative minor adverse direct short-term impacts to soils would occur as a result of implementation of the Proposed Action due to such construction activities as clearing, grading, trench excavation, backfilling, and the movement of construction equipment within the project areas. Soil compaction and disturbance to and mixing of discrete soil strata cumulative impacts would be reduced through implementation of BMPs to control erosion and sedimentation during construction (e.g., installation of silt fences). Cumulative impacts would be reduced further because areas disturbed by construction activities (e.g., temporary access roads) would be restored at the end of project execution.

#### 7.25.8.2 Sediments (bathymetry and sediment budgets)

The Proposed Action would contribute to minor adverse indirect long-term impacts on sediment budgets. Construction of seawalls and floodwalls reduces sediment deposition in Jamaica Bay. Hardening of the bay's perimeter and changing the bay's physical contours may reduce sediment deposition in the bay.

Construction of seawalls and/or bulkheads in portions of the Jamaica Bay Northwest segment would cumulatively contribute to minor long-term adverse impacts on bathymetry, as they are generally recommended where a similar structure is already present. Additional scouring at the toe of the structural measures could result from amplified wave energy and increased erosion and sediment transport associated with these hardened structures. Short-term direct adverse impacts to bathymetry in Jamaica Bay could occur due to construction activities where increased sediment generation could affect depth of the water column. These effects would be minor and short-term, limited to the period of construction. Implementation of BMPs to control sedimentation and erosion and the large extent of Jamaica Bay compared to the construction footprint would minimize adverse impacts on the overall bathymetry of Jamaica Bay.

#### 7.25.8.3 Water Quality (surface and ocean)

Implementation of the Proposed Action would cumulatively contribute to long term benefits by directly addressing anticipated wave climate, and preventing future shoreline erosion. Groins have the potential to alter wave climates, but would have a long-term benefit by reducing future beach renourishment requirements.

The Proposed Action would cumulatively contribute to minor short-term direct adverse impacts to ocean waters due to disturbance of subsurface sediments during construction of groins, walkovers, living shorelines, bulkheads, sea walls, and dredging of sand from the offshore borrow area. Water quality would quickly return to baseline conditions after construction activities are completed. It is anticipated that these minor short-term direct adverse construction impacts would be further minimized by implementation of BMPs.

Minor direct short-term impacts to surface water quality would occur due to common construction activities such as clearing, grading, trench excavation, backfilling, and the movement of construction equipment used during execution of the common project elements. Water quality impacts to surface water would primarily be related to increases in turbidity and suspended solids as a result of increased erosion and sedimentation, which would cause a short-term reduction in oxygen levels. These adverse construction impacts would be minimized by implementation of BMPs (e.g., silt curtains, work at low tide out of the water).

#### 7.25.8.4 Vegetation (including invasive species and terrestrial habitat)

The Proposed Action would contribute positive benefits to regional terrestrial habitats in conjunction with other similar projects listed above. Projects initiated in the ROI would benefit from the shoreline and inlet CSRM features of the Proposed Action, which would serve to impede extreme storm surges, such as those experienced during Hurricane Sandy, from destroying or impeding establishment of beach vegetation communities. Similarly, terrestrial habitats that are undergoing enhancement through regional project efforts along the shores of Coney Island, Jamaica Bay, and Rockaway Peninsula will be exposed to less risk from storm surges.

Construction of floodwalls and/or levees associated with the Breezy Point portion of the Rockaway Bayside reach, as well as shared portions of the Jamaica Bay Northwest reach, would have a footprint and maintained easement area that would have both long-term minor adverse impacts to ruderal, urban, maritime forest, dune and beach habitats. In addition, areas within the limits of disturbance would have short-term minor adverse impacts to these habitats.

#### 7.25.8.5 Wetlands (including aquatic habitat)

The Proposed Action would contribute positive benefits to regional aquatic habitats in conjunction with other similar projects listed above. Projects initiated in the ROI would benefit from the shoreline and inlet CSRM features of the Proposed Action. For example, the Storm Surge Barrier would reduce the potential for extreme storm surges, such as those experienced during Hurricane Sandy, to destroy or impede establishment of restored marshes in Jamaica Bay.

Construction of buried sea walls and/or groins along the Rockaway Atlantic Ocean Shorefront, as well as portions of the Jamaica Bay Northwest segments, shared by both Action Alternatives, would have short-term minor adverse impacts on beach habitats, aquatic habitat, and potentially associated dune habitats at each nourishment area. These aquatic and terrestrial habitats are likely to be recolonized from nearby communities and benthic aquatic habitats are expected to-establish to a similar community within a 1 to 2-year period (USACE 1995). No permanent impacts associated with habitat structure and/or vegetation are anticipated in this segment, as the seawall will be buried with sand in an effort to restore the existing habitat type. In fact, the project will have a net long-term benefit on these habitats by stabilizing the shoreline, increasing sediment the sediment budget, and minimizing future renourishment activities necessary to support a healthy North Atlantic Upper Ocean Beach community.

Construction of bulkheads or seawalls in both the Rockaway Bayside and Jamaica Bay Northwest reaches would have short-term minor adverse impacts to existing hardened shorelines as well as adjacent intertidal mudflat habitat.

#### 7.25.8.6 Fish

The Proposed Action would contribute positive benefits to regional fish species. Constructed groins would create areas suitable for recruitment and protection for numerous fish species. Construction and extension of groins would provide living spaces for the food resource on which fish species rely and would provide shelter from wave attacks for the existing and surrounding fish communities.

The Proposed Action would contribute to minor short-term direct adverse impacts on adult and juvenile life stages of nearshore fish during construction, as mobile fish would be temporarily displaced from foraging habitat as they retreat from the area in response to construction activities. Construction related increases in turbidity and suspended solids will cause a short-term reduction in oxygen levels and reduce visibility for feeding (Reilley et al. 1978, Courtenay et al., 1980). Impacts are expected to be minor, given the temporary nature of the disturbance and the availability of suitable adjacent habitat. Adult and juvenile life stages and their prey species would quickly reestablish themselves after completion of construction.

Additional minor short-term direct adverse impacts on nearshore fish communities would occur as a result of dredging sand from the borrow areas. According to the NPS environmental documents prepared for borrow efforts indicate the adverse impacts are not significant (GMP/EIS, 2014). Additional minor short-term direct impact on benthic feeding fish species (e.g., windowpane, summer and winter flounder) would be experienced, due to temporary displacement during dredging for borrow areas. Impacts are considered minor because benthic feeding fish species are expected to avoid construction areas and feed in the surrounding area; therefore, would not be adversely affected by the temporary localized reduction in available benthic food sources. Because adverse effects to essential fish habitat would be minor, the essential fish habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations would be satisfied.

Minor short-term direct adverse impacts on nearshore fish communities would be realized by less mobile life stages (eggs and larvae) of nearshore fish, e.g., Atlantic butterfish, red hake, windowpane flounder, winter flounder, summer flounder, and scup, if present at the time of construction activities. Impacts would occur because of short-term changes to water quality, including resuspension of sediments in the water column and changes to the quality or quantity of soft bottom substrates, as discussed in Section 7.2 Bathymetry and Sediments. Impacts are considered minor, given the large extent of the Atlantic Ocean and Jamaica Bay compared to the project construction footprint. Implementation of BMPs to control sedimentation and erosion during construction would further minimize adverse impacts on eggs and larvae of nearshore fish species.

Mitigation discussed in Section 5.3.1 Habitat Impacts and Mitigation Requirements is intended to offset long-term unavoidable adverse impacts to natural habitats affected by the Proposed Action.

### 7.25.8.7 Benthic Community

The Proposed Action would contribute positive benefits to regional benthic shellfish species. Constructed groins would create areas suitable for recruitment and protection for numerous shellfish species. Construction and extension of groins would provide living spaces for the floral and faunal communities on which benthic species rely and would provide shelter from wave attacks for the existing and surrounding benthic communities. Some species, such as rockweeds (Fucus spp.), oysters, and barnacles (Balanus spp.) would flourish on the newly constructed groins (Carter 1989). Various floral species such as rockweed and spongomorpha (Spongomorpha spp.), and faunal species such as barnacle, oyster, and blue mussel, are expected to move into the area and colonize living space on groins (USACE 1995). Rockweeds are known to support numerous organisms, including both autotrophs and heterotrophs. In addition, rockweeds provide shelter, moisture at low tide, and food especially for the sessile epifaunal and epiphytic groups (Oswald et al. 1984). Gastropods, bivalves, and crustaceans are all common inhabitants of rockweeds.

Minor short-term direct adverse impacts to benthic communities are anticipated from construction activities associated with the common project elements, including future periodic renourishment. Construction would cause increased sedimentation, resulting in the smothering of existing sessile benthic communities in the vicinity of construction areas. Some mortality of shellfish, and polychaetes is expected for individuals that cannot escape during the construction process. Motile shellfish species would be able to relocate temporarily outside of the immediate project area.

### 7.25.8.8 Wildlife

The Proposed Action would cumulatively contribute to the beneficial long-term direct and indirect impacts on protected species populations, as discussed in Section 7.13 Protected Species. Beach renourishment of Coney Island and Rockaway beaches associated with the Proposed Action would support healthy North Atlantic Upper Ocean Beach communities; therefore, species that rely on that vegetation community would benefit for the Proposed Action and similar regional projects.

The Proposed Action would cumulatively contribute to short-term direct minor adverse impacts to the species discussed in Section 7 Environmental Consequences. The Proposed Action and similar regional actions may cause minor adverse impacts associated with short-term construction activities that may cause direct mortality of individuals or contribute indirectly to mortality of individuals due to temporary destruction of habitat on which a species relies.

### 7.25.8.9 Protected Species and Critical Habitat

The Proposed Action would cumulatively contribute to beneficial long-term direct impacts on federally and state listed threatened and endangered species. As discussed in Section 7.6 Aquatic and Terrestrial Environments, vegetation stabilization and renourishment of Rockaway Beach would support healthy North Atlantic Upper Ocean Beach; therefore, habitats for seabeach amaranth, piping plover, red knot, roseate tern and other species that use this habitat would benefit for the 50-year life of the project. Construction of seawalls and floodwalls associated with the Atlantic Ocean Shorefront Planning Reach, the limited Rockaway Bayside reach, and the limited

Jamaica Bay Northwest reach would protect shoreline vegetation from physical degradation, likewise preserving habitat for these species. Overall habitat within the intertidal zone would increase as the beach is widened with beach fill and groin structures would reduce the rate of beach loss. The physical characteristics of the intertidal habitat will not be altered because the grain size of fill material will be the same as that of project footprint native sand. USACE is engaged with the USFWS to ensure the latest reasonable and prudent measures for Piping Plovers (USFWS 2014) and standard BMPs are incorporated into the projects' Plans and Specifications detailing specific conservation measures to be undertaken to minimize potential adverse effects to protected species under their jurisdiction.

The Proposed Action would cumulatively contribute to minor short-term direct impacts to threatened and endangered species. Shoreline intertidal, subtidal, upper beach, and dune wildlife habitats would be impacted due to such construction activities as clearing and grading for temporary access road construction. Wetland habitats would be impacted by changes in surface water quality from increases in near shore turbidity and suspended solids as described in Section 7.3 Surface Water, affecting freshwater-dependent and saltmarsh-dependent wildlife species. Terrestrial upper beach zone and dune communities, dominated by sand and beachgrass would experience minor short-term direct impacts due to construction of permanent pedestrian access ramps and walkways and placement of sand barriers. Placement of groins would result in small losses of intertidal beach and subtidal aquatic habitats located within groin footprints, although groins attract benthic invertebrates and fish species that are food resources for, roseate tern, red knot, and osprey.

These activities will likely have impacts on the beach habitats of seabeach amaranth and the nesting habitat of the piping plover and roseate tern at Breezy Point and Rockaway Beaches, and the beach foraging habitat for migrating red knots dependent on horseshoe crab reproduction on beaches in Jamaica Bay, Breezy Point, and Rockaway Beaches. Implementation of BMPs to limit construction activities during the breeding and migratory seasons and protect areas where seabeach amaranth populations are present should further minimize adverse impacts on these threatened and endangered species.

Minor short-term direct adverse impacts on threatened and endangered marine, whales and sea turtles, and anadromous species are expected at the time of construction these mobile species would be able to retreat from the area in response to if these species are temporarily displaced; however, impacts are expected to be minor because construction activities would be constructed during "construction windows". Impacts are considered minor, given the temporary nature of the disturbance, the availability of suitable adjacent habitat, and the large extent of the Atlantic Ocean compared to the project construction footprint.

Dredging offshore areas has the potential to impact the Federally-listed species Atlantic Sturgeon habitat by removal/burial of benthic organisms and increased turbidity from dredging and construction activities. Hydraulic dredges can directly impact sturgeon and other fish by entrainment in the dredge. Dredging may also impact important habitat features of Atlantic sturgeon if these actions disturb benthic fauna. Alteration of rock substrate is not a concern as this does not occur in the project area. Indirect impacts to sturgeon from either mechanical or hydraulic dredging include the potential disturbance of benthic feeding areas, disruption of spawning migration, or detrimental physiological effects of re-suspension of sediments in spawning areas.

The USACE is consulting with NMFS to ensure the latest protective BMPs are incorporated into the projects' Plans and Specifications detailing specific conservation measures to be undertaken to minimize potential adverse effects to protected aquatic species under their jurisdiction. The planned construction methods will incorporate BMPs, thereby reducing the temporary water quality impacts and general disturbances resulting from in-water construction activities. Additionally, transient listed species are expected to avoid the project area during construction activities. Therefore, the project is not likely to significantly adversely affect these protected species.

## 7.26 Any Adverse Environmental Impacts That Cannot Be Avoided Should the TSP Be Implemented

The TSP will result in minor temporary environmental impacts as identified in Table 6-2 Permanent and Temporary Habitat Impacts. Permanent impacts will be fully mitigated by the creation of 247 acres of natural habitat. No other long-term environmental impacts are expected to occur as a result of the TSP.

## 7.27 Any Irreversible or Irretrievable Commitments of Resources Involved in the Implementation of the TSP

The labor, capital, and material resources expended in the planning and construction of this project are irreversible and irretrievable commitments of human, economic, and natural resources. Careful attention was paid to selecting and placing CSRM structures to minimize environmental impacts, nonetheless the TSP does cause permanent habitat impacts (Table 7-4). No other long-term environmental impacts are expected to occur as a result of the TSP.

**Table 7-4 Permanent Habitat Impacts**

| Habitat Type | Permanent Impacts (Acres) |
|---|---|
| Subtidal Bottom | 34.6 |
| Intertidal Mudflat | 7.5 |
| Intertidal Wetlands | 0 |
| Non-Native Wetlands | 0.4 |
| Beach | 13 |
| Dune | 4 |
| Maritime Forest/Shrub | 20.6 |
| Ruderal | 24.4 |
| Rip Rap/Bulkhead | 6.5 |
| Urban | 18.7 |
| Total | 129.7 |

## 7.28 Relationship Between Local Short-term Uses of Man's Environment and the Maintenance and Enhancement of Productivity

Implementation of the TSP would result in the loss of habitat types as indicated in Table 7-4 Permanent Habitat Impacts. These impacts will be fully mitigated by the creation of 247 acres of natural habitat in Jamaica Bay. The mitigation acres would restore native marsh habitats, which would provide a net ecological productivity increase of 917 DSAYs more than existing conditions (see the MFR #8 attachment to the Environmental Appendix).

## 7.29 Energy and Natural or Depletable Resource Requirements and Conservation Potential of Various Alternatives and Mitigation Measures

NEPA regulations in 40 CFR 1502.16 (e) and (f) require a discussion of project energy requirements and natural or depletable resource requirements, along with conservation potential of alternatives and mitigation measures in an EIS. Energy (fuel) will be required to construct the new levee system and reconstruct existing systems, but this is a short-term impact. Construction of the TSP would not result in a significant depletion of depletable energy or natural resources.

## 7.30 Greenhouse Gases

It is important to note that CEQ 2014 does not mandate mitigation, only consideration of the effects of the proposed action and consideration of climate change when selecting proposed alternatives and mitigation of other environmental impacts.

The CEQ 2014 guidance on the consideration of GHGs in NEPA reviews focuses on two key points: 1) the potential effects of the proposed action on climate change as indicated by its GHG emissions, and 2) the implications of climate change for the environmental effects of the proposed action. Projects that emit more than 25,000 metric tons (tonnes) of carbon dioxide equivalents ($CO_2e$) emissions on an annual basis should provide quantitative estimates. Table 7-5 provides the annual $CO_2$ emissions by year, in tonnes. Note that $N_2O$ and $CH_4$, while not estimated, only slightly increase the total $CO_2e$ compared to the $CO_2$ estimates, as $CO_2$ is by far the most dominant GHG from diesel-fueled engines. GHG emission estimates are provided in Environmental Impacts section of the Environmental Appendix.

### Table 7-5: GHG Emissions by Calendar Year, tonnes

| | Estimated Emissions, tonnes per year | | | | |
|---|---|---|---|---|---|
| **GHG** | **2017** | **2018** | **2019** | **2020** | **2021** |
| $CO_2$ | 9,653 | 14,479 | 14,479 | 0 | 0 |

The TSP is not anticipated to exceed the 25,000 metric tons of $CO_2e$, the CEQ 2014 indicator level. The generation of GHG emissions associated with the project's construction activities will be temporary in nature, spanning only the construction period and the project will not introduce permanent new mid- nor long-term sources of GHG generation. In fact, it is anticipated that the TSP will help reduce emissions of GHGs. The very nature of the TSP-related projects are to enhance the resiliency of the coastline ecosystems by constructing dunes and related beach/coastal infrastructure to combat rising sea levels, erosion and flood damage to infrastructure.

The project includes the protection of Atlantic shores, Jamaica Bay, mainland upland ecosystems, and restoration of vegetation lost through erosion, all of which will contribute to carbon sequestration and dune structural resiliency during storms. The protection of these ecosystems provided by the comprehensive TSP will enable the greater coastal ecosystem to continue to sequester carbon through sustainable vegetation growth as a result of the project and will minimize future storm damage further inland and associated reconstruction emissions. As a result, $CO_2e$ generation during future emergency response cleanup and restoration of the coastline will be avoided. Therefore, it is anticipated that the project will have a net-benefit long-term local impact related to climate change.

The FWOP scenario may produce a slight increase in GHG emissions due to the fact that the implementation of the TSP should be accomplished in a more efficient and organized manner than individual and emergency response projects. For example, additional mobilization and demobilization, emergency response conditions, and other elements associated with numerous individual projects which would continue to be needed under the FWOP scenario could reduce the overall efficiency of protecting the coast, which would lead to increases in GHG emissions.

Reduction of GHG emissions will be considered in the selection of mitigation options, as feasible. The TSP is anticipated to be the most efficient approach to coastal management for the study area, and thus is anticipated to generate the lowest GHG emissions.

# 8 IMPLEMENTATION REQUIREMENTS

This chapter provides a summary of the implementation requirements for the project in a preliminary format. The Final HSGRR/EIS will provide additional and more detailed implementation requirements.

## 8.1 Division of Plan Responsibilities and Cost-Sharing Requirements

The Project Partnership Agreement (PPA) is a binding agreement between the Federal Government and the non-Federal sponsor, which must be approved and executed prior to the start of construction. The PPA sets forth the obligations of each party. The non-Federal sponsors must agree to meet the requirements for non-Federal responsibilities, which will be identified in future legal documents. Some of the likely responsibilities are:

- Provide a minimum percentage (to be determined prior to the Final HSGRR/EIS), but not to exceed 50 percent, of total flood risk management costs attributable to the structural alternative as further specified below:
  - Pay, during design, some percentage (to be determined prior to the Final HSGRR/EIS) of design costs in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;
  - Pay, during construction, some percentage (to be determined prior to the Final HSGRR/EIS) of total flood risk management costs attributable to the structural alternative;
  - Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on LERRDs to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the project; and
- Pay, during construction, any additional funds necessary to make its total contribution equal to at least some percentage (to be determined prior to the Final HSGRR/EIS) of total flood risk management costs. Shall not use funds from other Federal programs, including any non-Federal contribution required as a matching share, to meet any of the non-Federal obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds for such purpose is authorized;
- Not less than once each year, inform affected interests of the extent of protection afforded by the project;
- Agree to participate in and comply with applicable Federal floodplain management and flood insurance programs;
- Comply with Section 402 of the WRDA of 1986, as amended (33 U.S.C. 701b-12), which requires a non-Federal interest to prepare a floodplain management plan within one year

after the date of signing a project cooperation agreement, and to implement such plan not later than one year after completion of construction of the project;

- Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the project;
- Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the level of protection the project affords, hinder operation and maintenance of the project, or interfere with the project's proper function;
- Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;
- For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and state laws and regulations and any specific directions prescribed by the Federal Government;
- Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;
- Hold and save the U.S. free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the U.S. or its contractors;
- Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 CFR Section 33.20;
- Comply with all applicable Federal and state laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army

Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army”; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141- 3148 and 40 U.S.C. 3701 – 3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c et seq.);

- Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;
- Assume, as between the Federal Government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project;
- Agree, as between the Federal Government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA; and
- Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 103(j) of the WRDA of 1986, Public Law 99-662, as amended (33 U.S.C. 2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

## 8.2 Costs for the Tentatively Selected Plan

The cost estimate included here is intended to provide an estimate of total costs of the TSP. A revised and more detailed MCACES cost estimate will be provided for the plan selected in the Final HSGRR/EIS. The TSP cost is included in Table 6-4 TSP Cost Estimate.

## 8.3 Cost Sharing Apportionment

Once a final cost estimate is developed for the plan carried forward for feasibility-level design, a cost-sharing apportionment table will be developed. Cost sharing will be based on Public Law 113-2 (29Jan13), The Disaster Relief Appropriations Act of 2013, which provides 100% Federal funding, as long as the appropriated funds remain available.

## 8.4 Views of the Non-Federal Sponsors and Others

The New York State Department of Environmental Conservation, acting as the non-Federal sponsor, supports the TSP. The NYC Mayor’s Office of Recovery and Resiliency, the local sponsor to New York State, also supports the TSP. Other project partners, including NYC Department of Parks and Recreation, NYC Department of Environmental Protection, and the National Park Service also support the TSP.

## 8.5 Tentatively Selected Plan and Recent USACE Initiatives

### 8.5.1 USACE Campaign Plan

The TSP addresses the Chief of Engineers Campaign Plan Goal 2: Deliver enduring and essential water resource solutions using effective transformation strategies.

Objective 2a: Modernize the Civil Works project planning program and process. This Draft HSGRR/EIS contributes to the objective defined within Goal 2. This report recommends specific solutions to water resource problems and opportunities based on risk-informed decisions. It was developed in close collaboration with stakeholders and partners. The SMART planning principles and risk-informed decision-making were applied in this study and the study complies with the 3x3x3 Rule, which establishes the timeframe and costs required to complete the study.

Objective 2c: Deliver quality solutions and services. This objective is measured by successfully meeting or exceeding established commitments for schedule, cost, and quality to ensure consistent, high-quality performance. The cost estimate for the TSP has not been developed at this point in the study. When the cost estimate is developed, a Cost and Schedule Risk Analysis and a Risk Management Plan will be performed/developed to ensure the authorized cost limits are set and cost risks are managed.

### 8.5.2 Environmental Operating Principles

Environmental consequences of construction and operation of the TSP have been considered in avoiding and minimizing impacts; remaining unavoidable impacts would be fully mitigated. Sustainability was an integral consideration in the development of flood risk reduction recommendations. A risk management and systems approach was developed with input from the USACE Risk Management Center and the Flood Risk Management Planning Center of Expertise; operation of the projects will also employ a risk management approach. Coordination with stakeholders and the general public began with four public scoping meetings, continued with stakeholder updates, and extensive resource agency input during impact modeling. Resource agency knowledge and evaluation methods developed for similar projects were applied in the impact analysis. A thorough NEPA and engineering analysis has ensured that we will meet our corporate responsibility and accountability for actions that may impact human and natural environments in the Sabine and Brazoria regions. This analysis will be transparent and communicated to all individuals and groups interested in USACE activities.

# 9 PUBLIC INVOLVEMENT

## 9.1 Public Involvement Activities

A series of public scoping meetings were held in the study area after the Alternatives Milestone meeting, but prior to the TSP Milestone Meeting. The meeting format included a presentation of the study purpose, alternatives considered and analyses of performance and cost of alternative plans. Posters highlighting pertinent analyses and findings of the study were available before and after the presentation to allow the attendees to circulate from area to area and pose questions and express concerns to technical staff.

Common concerns expressed included the sense of urgency to move to construction of a risk management feature. Other concerns included maintaining access to the water, preserving views, and balancing risk management with environmental impacts. The features were presented as lines only, and no renderings were available.

The post-Sandy environment afforded USACE an unusual opportunity to coordinate the reformulation effort with many Agencies and stakeholders. A Public Agency Council convened regularly to address Jamaica Bay issues of flooding, environmental quality and sustainability, and USACE. Reformulation goals and objectives were jointly identified. Without project conditions reflected careful consideration of ongoing efforts of partner agencies, and impacts of the Reformulation effort considered all proposals for future efforts of other agencies within the study area.

Following public release of the document, additional public meetings will provide more detailed analysis of the alternative plans, feature plans, and identification of impacts.

## 9.2 Distribution List*

This Section Under Development

# 10 RECOMMENDATIONS

## 10.1 Overview

A diligent effort was made to coordinate and collaborate with resource agencies, non-governmental entities, and environmental interests throughout the study process and public meetings. Environmental resource concerns were addressed early in the study process to assure that adverse impacts were avoided to the maximum extent practicable. The recommendations contained herein reflect the information available at this time. To ensure the TSP complies with all applicable laws and policies and is acceptable to the public, this Draft HSGRR/EIS will undergo public, policy, and technical review. The results of these reviews and the results of additional investigations will support the final recommendation contained in the Final HSGRR/EIS.

## 10.2 Recommendation

Based on the planning objectives and USACE policy, the TSP is likely to be considered the Recommended Plan, as listed above. Analyses performed to identify and assess CSRM alternatives for the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay study area support the recommendation for comprehensive storm risk management. This does not preclude a decision to refine or alter the TSP at the Agency Decision Milestone (ADM) based on responses from public, policy, and technical reviews of this Draft HGRR/EIS, specifically for the alignment of the Storm Surge Barrier, the proposed work on NPS lands and residual risk features. A final decision will be made at the ADM following the reviews and higher-level coordination within USACE to select a plan for feasibility-level design and recommendation for implementation. Coordination with the natural resource agencies will continue throughout the study process as required by the Fish and Wildlife Coordination Act.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels with the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorizations and implementation funding. However, prior to transmittal to the Congress, the non-Federal sponsor, the state, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

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