1.0 INTRODUCTION

On behalf of Grantee the State of New York, the Governor's Office of Storm Recovery (GOSR), serving under the auspices of the New York State Homes and Community Renewal's Housing Trust Fund Corporation (HTFC), and acting under authority of the U.S. Department of Housing and Urban Development's (HUD) regulations at 24 CFR Part 58, and in cooperation with other involved, cooperating, interested agencies, has prepared this environmental impact statement (EIS) to analyze potential impacts of one or more proposed initiatives (Proposed Actions) intended to enhance coastal and social resiliency along the Tottenville shoreline of the South Shore of Staten Island, NY (see **Figure 1-1**).[1]

These initiatives include the Living Breakwaters Project (Breakwaters Project) and Tottenville Shoreline Protection Project (Shoreline Project). The Breakwaters Project and Shoreline Project each have independent utility, but both projects would be located in the same geographic region. The two projects would largely be funded through New York State's Community Development Block Grant-Disaster Recovery (CDBG-DR) grant. The proposed Breakwaters Project, a layered resiliency approach to promote risk reduction through erosion prevention, wave energy attenuation, and enhancement of ecosystems and social resiliency, was awarded $60 million through HUD's June 2013 Rebuild by Design (RBD) competition. Additional project funding will be leveraged as required by HUD for RBD projects. The proposed Shoreline Project includes a series of shoreline risk reduction measures, including an earthen berm, a hardened hybrid dune/revetment system, eco-revetments, raised edge (revetment with trail), wetland enhancement, and shoreline plantings. Approximately $9.3 million of CDBG-DR funds from the NY Rising Community Reconstruction Program will be used to implement this project.

In addition to geographic location, the projects share certain synergies in terms of design, as well as purpose and need, and combine to create a layered approach to shoreline resilience within the study area. Thus, there is strong rationale for designing and implementing the Breakwaters and Shoreline Projects through one integrated planning process to improve coastal resiliency along Staten Island's south shoreline. To facilitate a thorough examination of cumulative effects and synergies between the projects, GOSR has determined that they should be analyzed as part of the same environmental review. Additionally, these projects are analyzed individually and in combination as alternative actions that may also advance some of the same coastal resiliency goals and objectives. This analysis will ensure that the actions undertaken will minimize the potential for adverse environmental impacts, to the extent practicable.

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[1] Pursuant to the HUD National Environmental Policy Act (NEPA) implementing procedures, GOSR, as responsible entity, must certify that it has complied the related laws and authorities identified by 24 C.F.R. § 58.5 and must consider the criteria, standards, policies and regulations of these laws and authorities. See **Appendix A** for the maps and figures used to analyze these requirements.

3/9/2017

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Coastal and Social Resiliency Initiatives for Tottenville Shoreline

Project Area

Figure 1-1

1.1 PROJECT AREA AND VICINITY

The Proposed Actions would be undertaken in the Tottenville section of Staten Island, along the neighborhood's southern shoreline and offshore within the waters of Raritan Bay. Tottenville is located at the southwestern tip of Staten Island, and is the southernmost neighborhood in New York City and State. It is bounded by water on three sides, with the Arthur Kill to the west and north and Raritan Bay to the south. The project area is located in the southwestern corner of Tottenville where these waterways meet (see **Figure 1-1**). Land uses in the project area are characterized by a mix of parkland and residential uses, with some privately owned vacant parcels.

1.1.1 RARITAN BAY

Raritan Bay, off the southern and eastern shorelines of Staten Island, is a shallow urban estuary that contains significant habitat for shellfish and marine, estuarine, and anadromous fish. It supports multiple commercial fisheries and recreationally important fish species. The open waters of the bay provide important habitat for overwintering and staging waterfowl and marine mammals can occur in the area.

1.1.2 CONFERENCE HOUSE PARK AND OTHER AREA OPEN SPACES

The largest single land use in the project area is Conference House Park, a 265-acre park under the jurisdiction of the NYC Department of Parks and Recreation (NYC Parks). Extensive natural areas make up the park, including large tracts of maritime forest, creeks and ponds, bluffs, coastal wetlands, and beaches lining the shore. The western portion of Conference House Park contains numerous amenities and attractions, including grassy and densely wooded areas, historic architectural resources, a visitor's center, the Lenape Playground at Swinnerton Street and Billop Avenue, walking and biking paths, hiking trails, and the "South Pole" marking the southernmost point of New York State. The park extends eastward along the shoreline in a narrow expanse that includes beach areas, grassy areas, and look out points from the terminus of certain streets including Manhattan Street and Sprague Avenue. The shoreline is fringed by a sand and cobble beach. A man-made temporary dune, installed following Superstorm Sandy, comprised of sand filled barrier bags provides interim erosion control and coastal flood risk reduction from approximately Swinnerton Street to Sprague Avenue. The area near Page Avenue represents the eastern limits of Conference House Park. West of Page Avenue is a grassy undeveloped site that contains a few trees and a narrow paved street. The site is adjacent to the shoreline at a slightly raised elevation. Prior to Superstorm Sandy, this site contained a two-story house that was owned by NYC Parks. Due to severe structural damage, the house was demolished and the site has remained undeveloped since the building's demolition. East of Page Avenue is a wooded area within the boundaries of Conference House Park with a small parking area adjacent to the waterfront.

Events and organized activities offered at Conference House Park include tours, exhibitions, community events, volunteer programs within the park such as tree plantings and cleanups as well as at the historic houses, beach walks, birding talks and walks, kayaking, outdoor drawing workshops, fishing, family activities, outdoor movies, and citizen science programs.

In addition to Conference House Park, several park uses are present in the eastern portion of the project area. Hybrid Oak Woods Park is located along both sides of Joline Avenue north of Bruno Lane and Tricia Way. This smaller passive park, roughly 10 acres in size, consists of

woodlands without any developed park facilities. The Tottenville Pool, another NYC Parks facility, is located north of Hybrid Oak Woods Park along Hylan Boulevard at Joline Avenue. East of Page Avenue, the study area contains extensive wooded lands including the Butler Manor Woods—a component of the Mount Loretto Unique Area—under the jurisdiction of the NYS Department of Environmental Conservation (NYSDEC). Mount Loretto Unique Area encompasses approximately 18 acres of wetlands within Butler Manor Woods and contains hiking trails.

These open spaces contain upland forest and estuarine and freshwater wetland systems that support numerous species of native plants and animals.

1.1.3 INLAND AREAS

Inland from Conference House Park, the project area is residential in nature, characterized by single-family detached and attached houses. West of Brighton Street, these residential areas are adjacent to a wooded section of Conference House Park primarily along Billop Avenue and Swinnerton Street; east of Brighton Street, residential areas are developed in closer proximity to the shoreline with beach and vegetated upland separating the neighborhood from the waters of Raritan Bay. Since Superstorm Sandy, some homes in this coastal area have been elevated. The blocks between Loretto Street and Sprague Avenue contain several developments consisting of two-family houses and attached single-family houses on small private streets. East of Sprague Avenue to Page Avenue, large vacant or wooded areas are interspersed with tracts of single-family houses including some houses on larger lots. In the area south of Amboy Road, approximately 80 percent of the population own their home. South of Hylan Avenue, owner occupancy is slightly higher at 81.3 percent. The remaining population rent their homes.

1.2 PROJECT BACKGROUND

Staten Island's South Shore was once buffered from wave action by a wide, shallow bathymetric shelf known as the "West Bank." Until the mid-19th century, oyster reefs and then leased oyster beds extended across the shallow waters of Raritan Bay, filtering water, enhancing the biodiversity and quality of the fisheries in the lower harbor and buffering the south shore from erosion-causing wave action. In the 19th and 20th centuries, changes in land use and populations drove widespread decline in water quality, habitat extents and beach widths across the bay, decreasing the quality of the Bay ecosystem and increasing coastal risk to inhabitants and assets along its shoreline.

On October 29, 2012, Superstorm Sandy approached New York City with tropical-storm-force winds. The resultant waves and storm surge battered the city's coastline, causing 44 deaths in New York City—23 of which occurred in Staten Island—the destruction of homes and other buildings, and damage to critical infrastructure. Sandy's effects—including powerful waves and large volumes of water—were particularly intense in neighborhoods across Southern Queens, Southern Brooklyn, and the East and South Shores of Staten Island. According to the New York City Department of Buildings (NYCDOB), these neighborhoods accounted for over 70 percent of the buildings in Sandy-inundated areas that had been seriously damaged or destroyed as of December 2012.

Winds out of the northeast generated powerful waves along the South Shore of Staten Island (which adjoins the waters of Raritan Bay), resulting in significant erosion, including at the area's protective bluffs and along the shoreline areas with already narrow beach conditions. The peak

storm tides in Tottenville measured approximately 16 feet, almost five feet higher than at the Battery in Manhattan. Many of the homes that were hit around Tottenville Beach were destroyed. Tottenville businesses also sustained structural damage, with some emerging from the storm with only wall studs remaining on the first floors.[2]

Superstorm Sandy significantly impacted the project area, highlighting existing deficiencies in the project area's resiliency and ability to adequately protect populations and facilities from major coastal storm events.

1.2.1 REBUILDING AND RESILIENCY PLANNING

Following the storm, the City formed the Special Initiative for Rebuilding and Resiliency (SIRR) to analyze the impacts of the storm on the city's buildings, infrastructure, and people; assess climate change risks in the medium term (2020s) and long term (2050s); and outline strategies for increasing resiliency citywide. *PlaNYC—A Stronger, More Resilient New York*, June 2013, was the result of that effort, and contains Community Rebuilding Resiliency Plans for five particularly vulnerable neighborhoods in NYC, one of which is the East and South Shores of Staten Island. In developing the plan for the East and South Shores, two task forces met regularly and numerous formal and informal working sessions were held, including two public workshops in March 2013. These sessions provided an opportunity to the affected communities to inform SIRR staff of specific priorities and challenges that needed to be addressed. Two key priorities identified were developing coastal and shoreline protections, and ensuring public access to the waterfront.

The Community Rebuilding Resiliency Plan for the East and South Shores of Staten Island outlines specific initiatives to address coastal protection, buildings, critical infrastructure and community and economic recovery. With respect to coastal protection, the City's proposals were based on a multi-faceted analysis which considered the nature and likelihood of coastal hazards, the potential impact of these hazards on the built environment and critical infrastructure, and the likely effectiveness of the proposed measures. In addition, the coastal protection measures were informed by the New York City Department of City Planning's (NYCDCP's) *Urban Waterfront Adaptive Strategies (UWAS)* study, June 2013 (funded by a HUD Sustainable Communities Regional Planning Grant), which examined the underlying geomorphology of the various regions. The study demonstrated that the South Shore of Staten Island is particularly vulnerable to erosion during extreme events, as well as on a day-to-day basis. As described in the *New York City Hazard Mitigation Plan* (2014), "Coastal erosion can cause extensive damage to public and private property because it brings structures closer to the water's edge. If erosion is not mitigated, the structures will become inundated with water, resulting in damage or destruction." This report also notes that along the South Shore of Staten Island, 415 acres and 96 building "centroids" are located within the New York State Department of Environmental Conservation (NYSDEC)-mapped Coastal Erosion Hazard Areas (CEHAs)[3].

Based on an evaluation of the City's entire shoreline and categorization of each shoreline reach by its geomorphology and land use, the UWAS study provides a description and an assessment of coastal resiliency measures that would be appropriate for each of the different categories of

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[2] *PlaNYC—A Stronger, More Resilient New York*, June 2013.

[3] Identification of a building's "centroid" indicates that the majority of the building is located within the CEHA.

shoreline evaluated. This study categorizes the Tottenville Shoreline as “Oceanfront Slopes,” a typology characterized by glacial till plains and hills, low fetch, medium elevation/medium slopes, unreinforced shorelines, and a mix of sediment types. For this type of reach, strategies that were identified with high “likely applicability” included upland waterfront parks, in-water breakwaters, artificial reefs, and constructed breakwater islands. Shoreline seawalls were also found to have likely applicability, however the study notes that seawalls may disrupt sediment transport and lead to the erosion of beaches.

Based on the work described above, coastal protection initiatives were recommended in the Community Rebuilding Resiliency Plan for the East and South Shores of Staten Island, including along the Tottenville reach. In particular, Coastal Protection Initiative 15 calls for the implementation of a “living shoreline project—likely to consist of oyster reef breakwaters, beach nourishment, and maritime forest enhancements—in areas adjacent to Conference House Park in Tottenville.”

Also included in the Plan are other initiatives proposed for Tottenville, which are in various stages of progress. For example, Coastal Protection Initiative 24 calls for the United States Army Corps of Engineers (USACE) to work with the City to complete its longstanding study for the East and South Shores of Staten Island, Phase 2 of which includes developing a plan for ongoing beach nourishment to restore sand rapidly after extreme weather events.

One New York: The Plan for a Strong and Just City (OneNYC), April 2015, is currently the City’s comprehensive strategy and policy directive to address long-term challenges related to climate change, an evolving economy, and aging infrastructure OneNYC is overseen and implemented by the Mayor’s Office of Sustainability and the Mayor’s Office of Recovery and Resiliency, and incorporates and expands on all the planning work undertaken in PlanNYC as well as *A Stronger, More Resilient New York*. In particular, the following three initiatives comprise Vision 4: Coastal Defense:

- Initiative 1, Strengthen the city’s coastal defenses: Complete the City's $3.7 billion coastal protection plan, a program of infrastructure investments, natural area restoration, and design and governance upgrades of which nearly half is funded.
- Initiative 2, Attract new funds for vital coastal protection projects: Continue to identify and secure new sources of funds for infrastructure to reduce coastal flooding risk.
- Initiative 3, Adopt policies to support coastal protection: Align and adopt policies to support the right investments in coastal protection, and ensure those investments are operated and maintained effectively.

Among its many components, Vision 4 describes investments to improve low-lying shorelines across the city, including in the South Shore of Staten Island. Elements of the proposed Breakwaters and Shoreline Projects are specifically described in the OneNYC planning document as measures to address this policy.

1.2.2 REBUILD BY DESIGN

In June 2013, HUD launched Rebuild by Design, a competition to respond to Superstorm Sandy’s devastation in the northeast region of the United States and promote a design-led approach to pro-active planning for long-term resilience and climate change adaptation. The winning proposals would be implemented using CDBG-DR funding as well as other public and private-sector funding sources. In June 2014, following a year-long research and design process during which the design teams met and collaborated with regional experts, government entities,

elected officials, issue-based organizations, local community groups and individuals, HUD announced the winning proposals. The Staten Island Living Breakwaters Project, which proposed a resiliency approach to promote risk reduction through erosion prevention, wave energy attenuation, and enhancement of ecosystems and social resiliency, was one of the selected projects. As a result, New York State has been allocated $60 million of CDGB-DR program funds to implement the project along the Tottenville shoreline of the South Shore of Staten Island. With an ecologically enhanced breakwater system to address wave energy and shoreline erosion at Tottenville, this proposal responds to the City's Coastal Protection Initiative 15. Progress on this initiative has been tracked and reported in the OneNYC 2016 Progress Report.

1.2.3 NY RISING COMMUNITY RECONSTRUCTION PROGRAM

The NY Rising Community Reconstruction Program was established by New York State to provide rebuilding and revitalization assistance to communities severely damaged by Superstorm Sandy, Hurricane Irene and Tropical Storm Lee. The Tottenville Shoreline Protection Project was conceived through the NY Rising planning process, and proposes new shoreline protection features as a coastal resiliency strategy for the Tottenville area. New York State proposes to use approximately $9.3 million of CDBG-DR program funds to implement this project.

1.2.4 HARBOR ESTUARY AND RARITAN BAY PLANNING

Any coastal resiliency strategy proposed for Tottenville should be considered in the context of its location and its consistency with other plans or policies relevant to the area. As described above, the South Shore of Staten Island adjoins the waters of Raritan Bay, which supports a diverse community of aquatic biota, but has also been impacted by upland development and discharges that have resulted in degraded water and habitat quality, as well as sediment contamination. Once home to a rich estuarine environment, robust coastal habitat and vibrant destination for water-based recreation and other activities, the Raritan Bay and South Shore of Staten Island have suffered significant land loss and habitat degradation over the last century.

A Comprehensive Restoration Plan has been developed for the Hudson-Raritan Estuary (HRE CRP) by the USACE and the Port Authority of New York and New Jersey (PANYNJ) to restore and protect habitat within the Hudson-Raritan Estuary. The Plan was developed in partnership with the NY-NJ Harbor & Estuary Program (HEP) with the contribution and collaboration of the U.S. Environmental Protection Agency (USEPA), U.S. Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration (NOAA), NYSDEC, Hudson River Foundation, NY/NJ Baykeeper, and other federal, state (NY and NJ), and city agencies as well as non-governmental organizations and academic and research institutions. The Plan identifies 12 Target Ecosystem Characteristics (TECs), which are used to outline strategies for ecological restoration within the Hudson-River Estuary. These TECs include wetlands; habitat for waterbirds; coastal and maritime forests; oyster reefs; eelgrass beds; shorelines and shallows; habitat for fish, crab, and lobsters; tributary connections; enclosed and confined waters; sediment contamination; public access; and acquisition. The HRE CRP specifically identifies restoration opportunities in many of the TEC categories for the study area. The Living Breakwaters project area is identified in the plan as having high suitability for oyster reef restoration. The final report was released in June 2016.

NYCDCP's *New York City Vision 2020: New York City Comprehensive Waterfront Plan* (2011) is another study that provides context for resiliency planning along the Tottenville shoreline. Vision 2020 was prepared in partnership with State and federal agencies, including NYSDEC, the Port Authority of New York and New Jersey and the U.S. Army Corps of Engineers. Among its many goals are expanded public access to the waterfront and waterways; enhancement of the public experience of the waterways that surround New York—including promoting water recreation and creating the waterfront infrastructure needed for events, cultural activities and educational programs; and identification of strategies to increase the City's resilience to climate change and sea level rise.

Providing public access along the City's coastline is also the intent of Policy 8 of the City's Waterfront Revitalization Program. This policy, along with the goals of Vision 2020, is consistent with the priorities identified by the South Shore community during its engagement with the City following Superstorm Sandy.

1.2.5 RAISE SHORELINES CITYWIDE STUDY

In 2014, the New York City Economic Development Corporation (NYCEDC) announced its intention to study and identify high-risk shorelines citywide that are most vulnerable to sea level rise and erosion, and then prioritize those shorelines for future design and construction of resiliency measures. This study analyzed approximately 43 miles of at-risk shoreline across the five boroughs (including the South Shore of Staten Island) with a goal to evaluate localized measures to reduce coastal risk, make recommendations for resiliency investments, and coordinate with other local coastal protection actions. As part of this coordination, coastal strategy recommendations for the area in Tottenville identified in the Raise Shorelines Citywide Study (along the eastern stretch of Conference House Park) have been incorporated into the proposed Shoreline Project. Citywide, the Raise Shorelines budget is $100 million of which "approximately 30 percent of funding will be used to implement protection initiatives in Southern Staten Island."[4]

1.2.6 CITY, STATE, AND FEDERAL AGENCY COORDINATION

As noted in the City's PlaNYC Progress Report 2014:

> *In addition to moving forward its own projects, New York City took formal steps to establish a leadership role in advancing coastal protection initiatives. This involved a high level of coordination with federal and state funding and regulatory agencies including USACE, HUD, FEMA and New York State DEC. Leadership has also been established on the City level through the Coastal Protection Working Group, which brings senior level agency designees together to coordinate protection initiatives. In addition, the City has worked closely with the several federal HUD-sponsored Rebuild by Design teams and the State's New York Rising Community Reconstruction Program to ensure federal and state funded projects through these programs are aligned with and advance the City's coastal protection priorities.*

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[4] https://www.nycedc.com/sites/default/files/files/rfp/qa-documents/Raise%20Shorelines%20Citywide%20QA%20FINAL.pdf

One such coordinated effort resulted in the March 2015 *Coastal Green Infrastructure Research Plan for New York City*, prepared for NYSDEC, the New England Interstate Water Pollution Control Commission (NEIWPCC) and jointly managed by the Hudson River Estuary Program, NYCDCP and New York City Mayor's Office of Recovery and Resiliency. The plan is intended to aid decision-makers as they evaluate strategies to protect New York Harbor's future. The research plan examines six coastal green infrastructure strategies (including constructed breakwaters), summarizes the latest scientific understanding of the ecological and risk reduction benefits of these strategies, and describes research needs moving forward. The overall plan is intended to inform planning to protect coastal communities, provide habitat to sustain fisheries, and provide opportunities to connect New Yorkers to their local waterfront.

1.3 PROJECT PURPOSE, NEED, AND OBJECTIVES

The Proposed Actions would reduce the risk of wave action and coastal erosion, address the impacts of coastal flooding, and increase the resiliency of the communities and ecosystems within the project area, thereby protecting critical infrastructure and facilities, residences, businesses, and ecological resources during hurricanes and other severe weather storm events. The Proposed Actions will also enhance aquatic habitats, and foster community education on coastal resiliency. The ability to meet this purpose is discussed in below.

1.3.1 PURPOSE

The purpose of the Proposed Actions is to reduce wave action and coastal erosion along the shoreline in Tottenville, while enhancing ecosystems and shoreline access, use and stewardship. This is consistent with the City's Coastal Protection Initiatives and planning studies for the Tottenville area. The proposed project goals would be achieved using a layered approach that would address wave action, impacts of coastal flooding and event-based (i.e., short-term/storm-related) and gradual (long-term) shoreline erosion, while restoring and enhancing ecosystems, improving waterfront access and engaging with the community through educational and stewardship programs directly related to the coastal resiliency actions. It is highly important that the actions both provide coastal protection and ecological enhancement, and at the same time serve as a means to engage and educate the public on local ecosystems and innovative coastal resiliency strategies in an era increasingly affected by climate change. The coastal structures associated with the Proposed Actions would be designed for a 50-year service life, though the functional life of the projects is anticipated to be longer.

The ability to meet this purpose is measured in terms of the following goals and objectives of the Proposed Actions:

- RISK REDUCTION
    - Attenuate wave energy;
    - Address both event-based and long-term shoreline erosion / preserve beach width; and
    - Address the impacts of coastal flooding.
- ECOLOGICAL ENHANCEMENT
    - Increase diversity of aquatic habitats consistent with the Hudson-Raritan Estuary plan priorities (e.g., oyster reefs and fish and shellfish habitat).
- SOCIAL RESILIENCY

- Foster community education on coastal resiliency directly tied to and building off the structural components of this resiliency initiative;
- Increase physical and visual access to the water's edge;
- Enhance community stewardship of on-shore and in-water ecosystems; and
- Increase access to recreational opportunities.

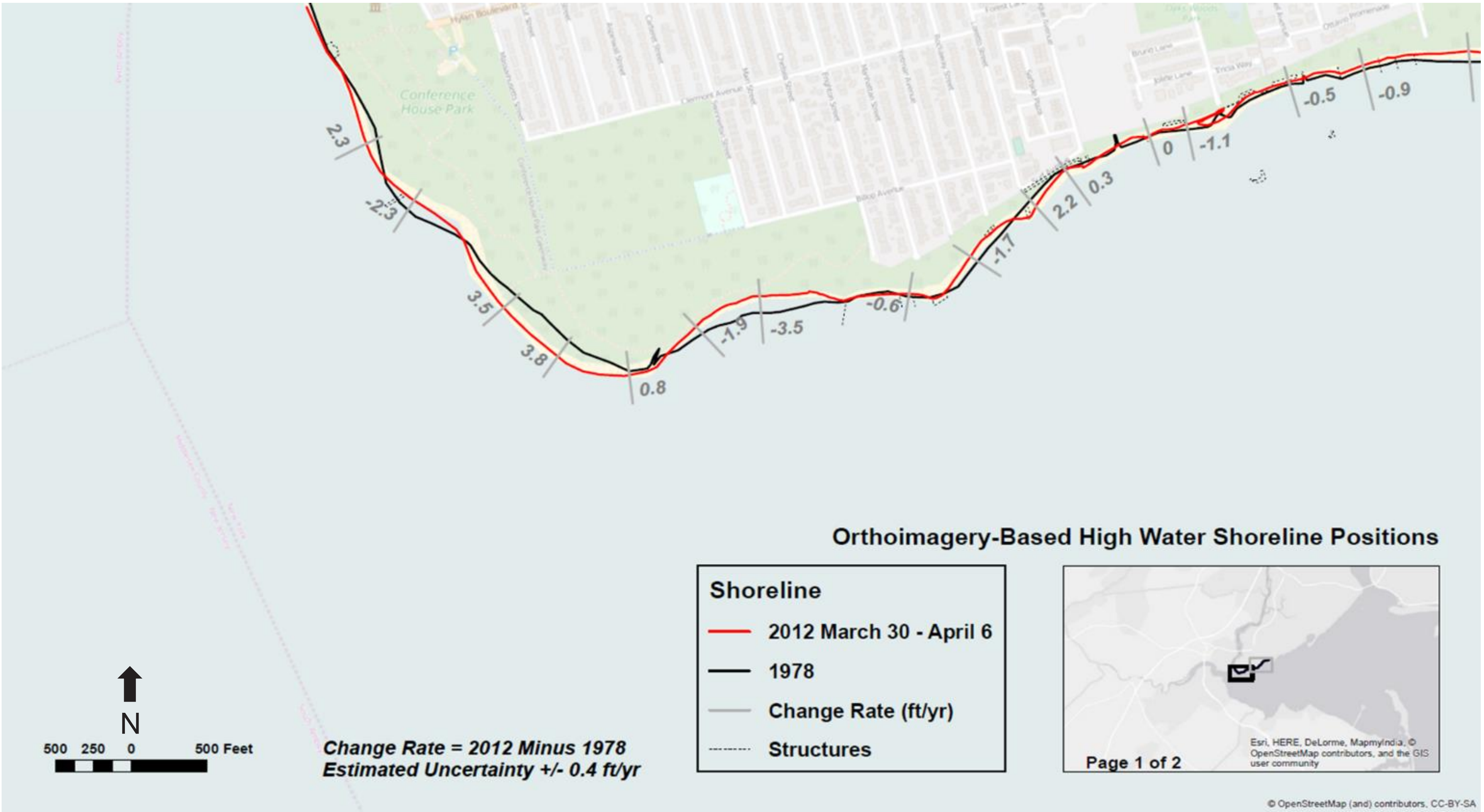
1.3.2 NEED

Staten Island is exposed to extreme wave action and coastal flooding during hurricanes and other severe storm events due to its location at the mouth of the New York Bight, which funnels storm-driven waves into New York Harbor, Raritan Bay, and the shoreline of Staten Island. The Raritan Bay and South Shore of Staten Island was once home to a rich estuarine environment, robust coastal habitat and vibrant destination for water-based recreation and other activities. Over the last century, this area has suffered significant land loss and habitat loss/degradation. As described above, the South Shore of Staten Island is vulnerable to both event-based and gradual coastal erosion and land loss (see **Figure 1-2**). The project area has experienced dramatic net erosion between 1978 and 2012. The greatest historic erosion rates were seen in the southern part of the project area in Conference House Park, just north of Wards Point where the erosion rate was over 3 feet per year. In general, while some small areas showed accretion, and some areas eroded less, large parts of the shoreline within the project area were eroded at rates ranging from 1 foot to over 3 feet per year (from 1978 to 2012). Some areas of accretion were observed, usually updrift of shoreline structures such as groins or storm sewer outfalls, but higher rates of erosion were generally observed down-drift of such structures. Overall, beaches in the project area have experienced an annual net loss of sediment. Narrow beaches lead to less protection for on-shore assets from wave action and coastal erosion, as well as less space for residents and visitors to enjoy the shoreline experience, and access the shoreline and nearshore waters.

1.4 DESIGN METHODOLOGY

As described above, the Proposed Actions include the implementation of one or more proposed initiatives intended to enhance coastal and social resiliency along the Tottenville shoreline of the South Shore of Staten Island, NY. These initiatives include the Breakwaters Project and Shoreline Project. This section summarizes the design methodology employed to characterize existing and future conditions in the project area and model the effectiveness of the initiatives in meeting the goals and objectives of the Proposed Actions. Future conditions were modeled in consideration of up to 30 inches of sea level rise (consistent with 6 NYCRR Part 490 projections and New York City Panel on Climate Change (NPCC) projections for the 2050s to the 2080s timeframe),[5] and for varying storm conditions. Modeling efforts were focused on screening and

[5] New York State's Community Risk and Resiliency Act (CRRA) requires that applicants for certain State programs demonstrate that they have taken into account future physical climate risks from storm surges, sea-level rise and flooding, and required the Department of Environmental conservation (NYSDEC) to establish official State sea-level rise projections. In February 2017, NYSDEC adopted a rule (6 NYCRR Part 490) defining the existing projections for use. The 6 NYCRR Part 490 projections for the downstate region are consistent with the New York City Panel on Climate Change's (NPCC), projections for the New York City region. Based on the adopted model projections, 30 inches of sea level-rise could occur by the 2050s under the 'High' scenario, representing the 90th percentile of model projections, by the



Source: SCAPE / Landscape Architecture PLLC

NOTE: Negative rates indicate erosion, positive rates indicate accretion

Shoreline Change 1978-2012

Figure 1-2

eliminating design scenarios that did not meet the goals and objectives of the Proposed Actions, and advancing feasible project designs that would meet those goals and objectives. This Final Environmental Impact Statement (FEIS) analyzes the preliminary 60 percent design scenario for the Breakwaters Project and the refined 30 percent design scenario for the Shoreline Project. These are described in detail below under "Alternatives Analyzed in this EIS." Design scenarios that were modeled and did not meet the goals and objectives of the Proposed Actions are discussed under "Alternatives Considered and Eliminated," below.

1.4.1 BREAKWATERS PROJECT

To inform the design and the benefits of the proposed breakwaters system, an understanding of existing wave conditions and shoreline erosion and the response of these conditions to the proposed project were required. Additionally, understanding of the existing hydrodynamics and water circulation patterns and potential changes due to the proposed project were critical to the understanding of any potential water quality effects of the breakwater system. The following evaluations and modeling were performed to characterize baseline wave conditions, shoreline response, currents, and nearfield flows and sediment motion, as well as evaluate various breakwater design alternatives:

Wave Transformation Modeling—Nearshore wave conditions were established by transforming wave conditions from the offshore to the nearshore using the Simulating Waves Nearshore (SWAN) wave transformation model. A baseline wave climate of Raritan Bay was developed to determine historic wave conditions and as input to modeling used to predict breakwater impacts on wave climate and long term shoreline change. The long-term wave climate was developed by transforming wave hindcast[6] data from a USACE Wave Information Study station at the entrance of New York Harbor.

Shoreline Change Analysis—In parallel, historic aerial imagery was used to determine how the shoreline has changed over time. Orthoimagery of the shoreline between 1978 and 2012 was used to develop historical shoreline positions and to calibrate the shoreline change model.

Shoreline Change Modeling—Long-term shoreline change modeling used the GENEralized model for SImulating Shoreline changes (GENESIS) with simulation results calibrated and validated to the historically observed shorelines presented in the Shoreline Change Analysis section. The model was used to screen design scenarios and assess shoreline change impacts.

Design Wave Transformation Near Breakwaters—The transformation of design wave conditions in proximity to the breakwaters during normal tidal conditions and severe storm events was analyzed using the REFraction DIFfraction (REFDIF) wave model on waves from prevailing wave directions. Additionally, a more detailed assessment of the waves in the nearshore region in the lee of the breakwaters was assessed using the nonlinear wave model, FUNWAVE.

2080s within the 'Middle Range' at approximately the 50th percentile of model projections, (as well as by 2100 within the 'Middle Range' at approximately the 40th percentile of model projections). Note that the ranges represent the percentiles of the modeled runs, but do not represent a probability of occurrence.

[6] Retrospective forecasting of waves using measured wind and wave information.

Storm Induced Beach Profile Response Modeling—Event-based beach profile change in the project region outside the Shoreline Project was modeled using the Storm-induced BEAch Change (SBEACH) and Cross-SHORE (CSHORE) beach erosion models. SBEACH is a USACE numerical model which simulates beach profile change by predicting beach, berm and dune erosion due to storm waves and water levels. Similarly, CSHORE is a one-dimensional time-averaged nearshore profile model for predictions of cross-shore wave height, water level, wave-induced steady currents, and beach profile evolution. The models use differing approaches to calculate change in the beach profile shapes and CSHORE performed better in the project area based on limited available calibration/verification data.

Nearfield Circulation and Sediment Movement Modeling—Flow and sediment motion around the breakwaters and particularly the reef streets was modeled using the computation fluid dynamics model, FLOW-3D, for various water levels and tidal conditions. This was primarily to aid in the ecological design process, including the configuration of the reef streets (a habitat design element of the Breakwaters Project.

Water Circulation Modeling—Additionally, a hydrodynamic model of tidal circulation in the bay was developed to assess the preliminary potential water quality impacts using the 2D hydrodynamic mode of the Delft3D-FLOW model.

Using these baseline data, modeling was conducted to assess changes in the shoreline position, wave environment, and water circulation in response to the proposed breakwater system. These results were also used to assess the performance of the proposed breakwater layouts and geometries by optimizing their design to achieve the goals of reduced erosion and reduced wave exposure (using a target goal of wave heights of less than 3 feet in the lee of the breakwaters in up to a 100-year storm with 30 inches of sea level rise). Details of the modeling for the Breakwaters Project can be found in **Appendix E-5**, “Living Breakwaters Design Modeling.”

1.4.2 SHORELINE PROJECT

In order to determine potential impacts the Shoreline Project could have on long-term shoreline change in Tottenville, several modeling efforts were undertaken to determine future performance of the four main Proposed Actions elements: the earthen berm, hybrid dune/revetment system, eco-revetments, and raised edge (revetment with trail). Using collected cross-shore transect data, the existing condition of the Tottenville beach at each transect was modeled using USACE’s SBEACH model, a numerical model that simulates beach profile change by predicting beach, berm, and dune erosion caused by storm waves and water levels. The condition of the shoreline (overtopping, run-up, and scour) at each transect was simulated under various storm conditions. Each simulation included consideration of sea level rise. Additional models were used to simulate sediment settlement, slope stability, and drainage and seepage patters at each of the Shoreline Project components.

Wind generated waves are defined by their height, length, and period. The nearshore wave conditions developed for the Breakwaters Project (described above) were found to be appropriate for use as inputs to the numerical models for the Shoreline Project. Additional inputs for SBEACH modeling included information about sediment properties and nearshore topography. Effective grain size was determined using information from grab samples collected as part of the project’s sampling program.

1.5 PROJECT ALTERNATIVES

The development and evaluation of project alternatives is central to the National Environmental Policy Act (NEPA) and New York's State Environmental Quality Review Act (SEQRA) processes. This section identifies the alternatives that will be analyzed in this EIS for the build year of 2020 (the year of completion of the project), and discusses alternatives that were considered but eliminated from further study because they do not sufficiently meet the Proposed Actions' purpose and need and were not considered practicable.

1.5.1 ALTERNATIVES ANALYZED IN THIS EIS

ALTERNATIVE 1—NO ACTION ALTERNATIVE

The No Action alternative assumes that no new structural risk reduction projects or marine habitat restoration projects will be implemented in the project area. This alternative also assumes that current trends with respect to coastal conditions at Tottenville—i.e., relating to erosion, wave action, ecosystems, and water quality—will continue. Temporary dunes, constructed by NYC Parks as interim protective measures post-Sandy, are currently in place and would continue to exist under the No Action Alternative. The No Action alternative also presumes that existing strategies to educate New Yorkers and the general public on the risks posed by climate change will remain the same in the study area. In this sense, the No Action Alternative is inconsistent with a number of the public policies, which encourage that positive action be taken to improve coastal resiliency and reduce communities' vulnerability to future storm damage.

Under this alternative, there would also be no intervention to create in-water structural habitat, living shorelines, or any other ecological enhancements to in-water and on-shore habitats in the project area, and therefore policy goals relating to environmental improvements to the Staten Island waterfront would not be advanced.

It is expected that land use patterns in the project area would remain unchanged. A number of filings have been approved by NYCDOB for infill housing in the study area; these consist entirely of single-family and two-family housing in portions of the study area that already contain housing. Based on review of databases maintained by NYCDCP and NYCDOB, no major developments or development proposals are expected by the 2020 analysis year. The existing Conference House Park Pavilion is undergoing renovations as a result of storm damage (to be completed in 2018).

The project area has experienced dramatic net erosion between 1978 and 2012. The greatest historic erosion rates were seen in the southern part of the project area in Conference House Park, just north of Wards Point where the erosion rate was over 3 feet per year. In general, while some small areas showed accretion, and some areas eroded less, large parts of the shoreline within the project area were eroded at rates ranging from 1 foot to over 3 feet per year (from 1978 to 2012). Some areas of accretion were observed, usually updrift of shoreline structures such as groins or storm sewer outfalls, but higher rates of erosion were generally observed down-drift of such structures. Overall, beaches in the project area have experienced an annual net loss of sediment. Narrow beaches lead to less protection for on-shore assets from wave action and coastal erosion, as well as less space for residents and visitors to enjoy the shoreline experience, and access the shoreline and nearshore waters.

These processes would continue in the future under the No Action Alternative, and may increase due to sea level rise and changes in storm frequency and/or intensity. Numeric simulation of

shoreline changes using a shoreline response numerical modeling system revealed that in the southwestern portions of the site (southwest of Sprague Avenue) both the overall pattern and rates of shoreline erosion and accretion are likely to continue into the future, including erosion rates of 1.0 to 2.0 feet per year between Loretto Street and Manhattan Street, and between 2.0 and 3.5 feet per year in Conference House Park between Main Street and Wards Point. Northeast of Sprague Avenue, modeling indicates that the general pattern of erosion and accretion will remain the same as those observed historically, though the simulation shows future rates of change slightly lower than those historically observed (see **Figure 1-3**).

These erosion rates, combined with projected sea level rise, could eliminate some beach sections and leave others completely inaccessible at high tide, eliminating continuous public access along the shoreline and reducing the protective beach, which is first line of defense against erosion and waves.

ALTERNATIVE 2 (PREFERRED ALTERNATIVE)—THE LAYERED TOTTENVILLE SHORELINE RESILIENCY STRATEGY: LIVING BREAKWATERS AND TOTTENVILLE SHORELINE PROTECTION PROJECT (LAYERED STRATEGY)

The Layered Strategy consists of the implementation of two individual projects that, when integrated as one initiative, may provide greater overall coastal risk reduction and promote social resilience (see **Figure 1-4)**. These projects were developed through separate, but related, planning initiatives arising out of the Superstorm Sandy recovery efforts. Implemented together, the projects would be planned and designed as a single, integrated coastal resiliency strategy for this area. By providing two layers of coastal risk reduction, these components, as further described below, are intended to improve current shoreline erosion conditions, serve to further reduce wave action, provide for ecological enhancement and promote social resiliency.

As discussed above, modeling efforts for the proposed initiatives were focused on advancing feasible project designs that would meet the goals and objectives of the Proposed Actions. This FEIS analyzes the preliminary 60 percent design scenario for the Breakwaters Project and the refined 30 percent design scenario for the Shoreline Project.

It is anticipated that the State of New York, non-profit organizations, and other government agencies involved in the construction and ownership of elements of the Layered Strategy will maintain and operate their respective project components. Through final design, GOSR will develop robust maintenance and operation plans, working collaboratively with appropriate state, city and federal agencies, as well as non-profit organizations.

The individual components of the Layered Strategy are discussed below.

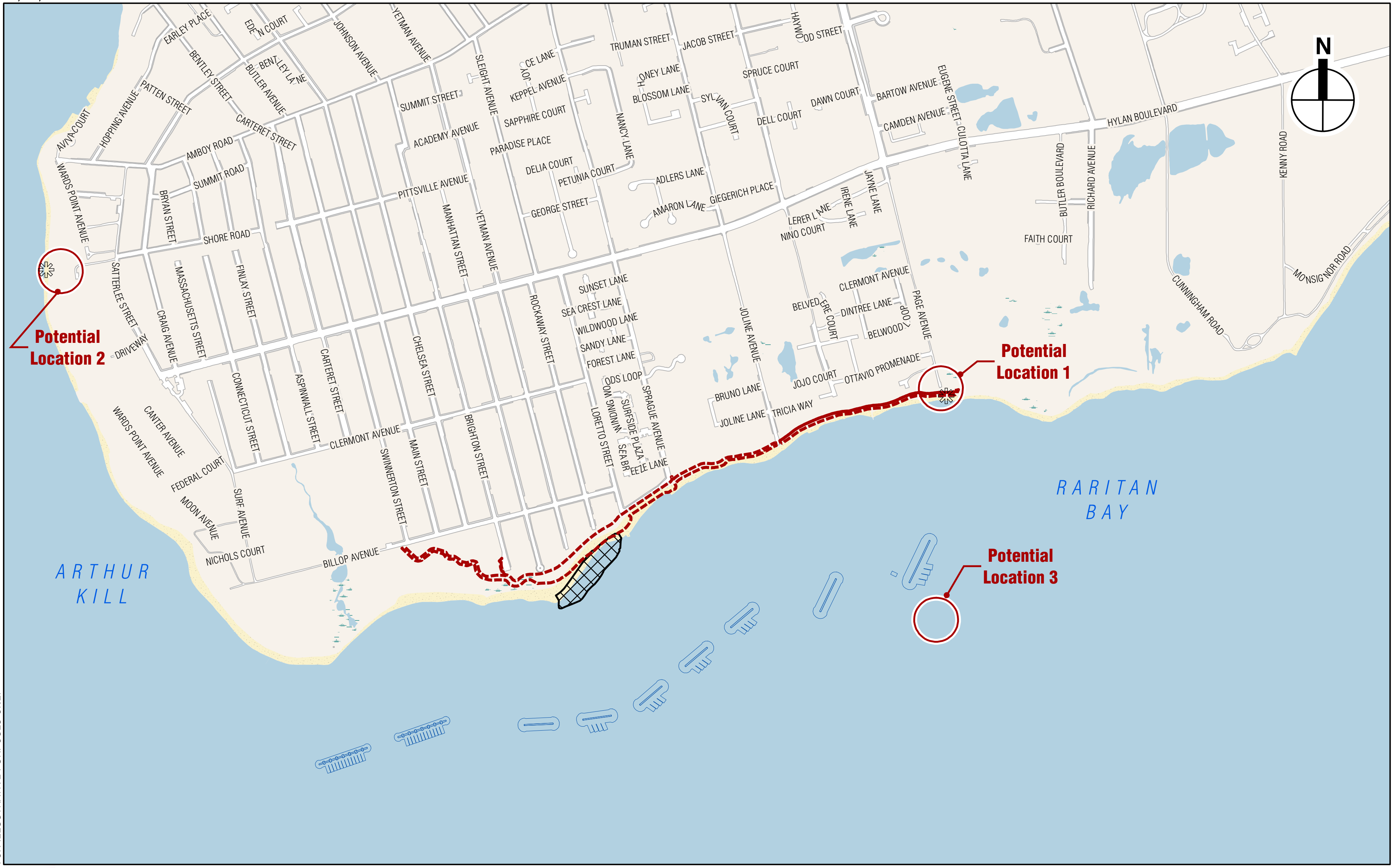
Living Breakwaters Project (Rebuild-by-Design)

As mentioned above, the concept for the Breakwaters Project was developed as part of the HUD sponsored design competition, Rebuild by Design, from 2013 through 2015. The winning proposal included an ecologically enhanced breakwaters system that would span an approximately 13,000 linear foot stretch off the Tottenville shoreline, a community Water Hub on-shore, and programming for stewardship and citizen science. In preparation for the advancement of design, a robust data collection effort was undertaken, including, but not limited to, a bathymetric survey, site-specific sediment sampling, geotechnical boring collection, environmental/habitat surveys, and hydrographic studies. Following detailed analysis of these data and iterative modeling efforts, the design of the system was refined to the 30 percent design scenario (as described in the Draft Environmental Impact Statement (DEIS), and subsequently,

Source: *SCAPE / Landscape Architecture PLLC*

Shoreline Change under No Action Alternative

11/13/2017



Proposed Breakwater Features

Proposed Shoreline Restoration Area

Proposed Shoreline Project Elements

Potential Location of Proposed Water Hub (exact location to be determined)

Proposed Floating Dock (associated with Water Hub Potential Locations 1 and 2 only)

Potential Water Access

0 2,000 FEET

Coastal and Social Resiliency Initiatives for Tottenville Shoreline

Project Location

Figure 1-4

the preliminary 60 percent scenario (as described in this FEIS). Throughout the process, the footprint of the breakwaters has reduced significantly, minimizing the potential for impacts, from the original RBD conceptual alignment of 13,000 linear feet of breakwaters, to 3,900 linear feet in the 30 percent design phase, to a total length of 3,200 feet in the preliminary 60 percent design phase. The modeling and analysis performed in the preliminary 60 percent scenario demonstrated that the goals and objectives of the Proposed Actions would be met with this much more targeted system, using groupings of breakwater structures to respond to the changing character of the shoreline, observed shoreline change patterns and the predominant storm wave direction **(**see **Figures 1-5 and 1-6**).

The primary Breakwater Project components are described below.

Breakwaters System—One of the key components of the Breakwaters Project is an ecologically enhanced breakwater system designed to reduce wave energy at the shoreline, and prevent or reverse shoreline erosion while creating hard/structured marine habitat. The breakwater system as currently proposed (preliminary 60 percent design) would have nine breakwater segments with a total length of approximately 3,200 linear feet within Raritan Bay and would be located between approximately 790 and 1,170 feet from the shoreline. Additionally, the vast majority of the breakwater structures would be located more than 1,700 feet from the Federal Navigation Channel with the closest breakwater segment located more than 700 feet from the channel. The breakwater structures would occupy approximately 495,900 square feet (approximately 11.4 acres) on the bottom of Raritan Bay and result in the placement of 151,780 CY of rock and ecologically enhanced concrete within Raritan Bay, approximately 115,990 CY of which would be placed below mean high water (MHW). The breakwaters would be positioned and designed to optimize reduction in both wave height and shoreline erosion, while enhancing habitat and minimizing habitat displacement and navigational impacts.

The breakwaters will be rubble mound structures made of a combination of hard stone and biologically enhanced concrete armor units. While materials and the basic construction of the breakwaters will be the same across all segments, three types of breakwaters, defined largely by their differences in crest elevation (in North American Vertical Datum of 1988 [NAVD88]) and overall height, are proposed: Type A, Type B, and Type C (see **Figure 1-7**). All would extend some height above MHW. The overall breakwater system layout has been designed to reduce or reverse shoreline erosion along the length of the project area. Breakwater crest elevations, orientation and locations were also based on the relative need for storm wave attenuation at different locations along the shoreline.

Type A breakwaters, or “low crested” breakwaters, have been designed to prevent shoreline erosion but would have minimal impact on wave heights during severe storms. The Type A breakwaters have been designed for locations where the shoreline and assets near it are less vulnerable to storm wave action. Two segments of Type A breakwaters would be installed in the western portion of the project site near Ward’s Point. These breakwaters would have a crest elevation of 5 feet NAVD88 and an overall height of 11 feet and their crests would still remain above MHW with up to 30 inches of sea level rise. Together the two segments would be approximately 900 feet long, and result in the placement of 19,940 CY in the bay, of which 18,840 CY would be below MHW within a 2.8-acre footprint.

Type B and C breakwaters have been designed to reduce risk to the portions of the shoreline most vulnerable to storm wave action. Five segments of Type B breakwaters would be installed; together these segments would be approximately 1,500 feet long, with a crest elevation of 14 feet, an overall height of 20 feet, and result in the placement of approximately 79,870 CY in the

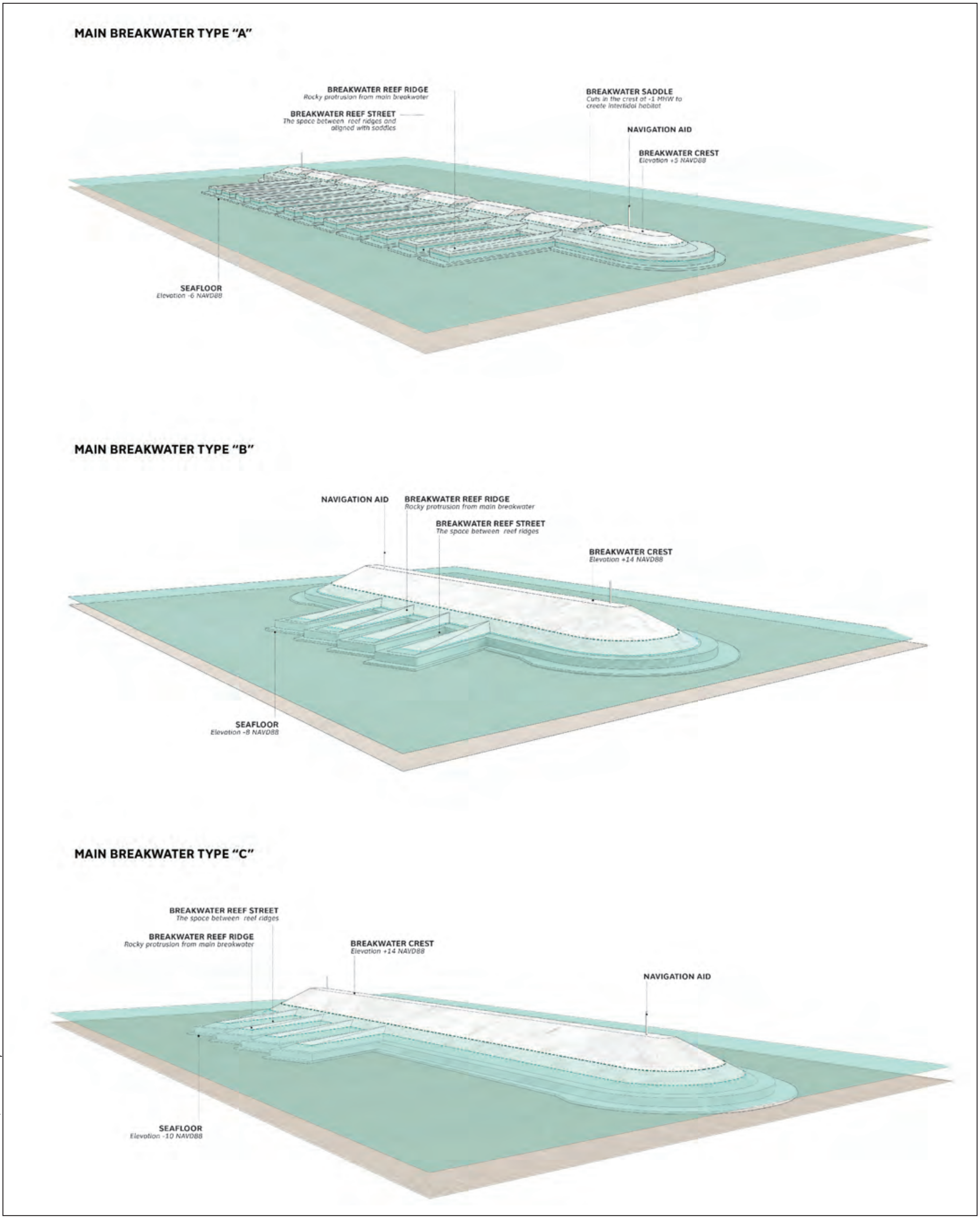
Proposed Breakwaters Project

Figure 1-5

FOR ILLUSTRATIVE PURPOSES ONLY

View of Proposed Breakwaters Structures

Figure 1-6



Source: *SCAPE / Landscape Architecture PLLC*

Proposed Breakwater Types

Figure 1-7

bay, of which 57,520 CY would be below MHW within a 5.7-acre footprint. Two Type C breakwaters would be installed offshore in the eastern portion of the project site. Together, these segments would be approximately 800 feet long, with a crest elevation of 14 feet, an overall height of 24 feet, and result in the placement of approximately 51,970 CY within the bay, of which approximately 39,630 CY would be below MHW within a 3.0-acre footprint. Considering up to 30 inches sea level rise, modeling indicates that these breakwaters would be able to reduce wave heights to less than 3 feet in a 100-year storm event (a severe storm of a 1-percent probability in any given year), thereby reducing event-based as well as long term shoreline erosion and structural damage to assets on shore.

As a system, the breakwaters would be capable of reducing storm wave heights to three feet or less in up to a 100-year storm with 30 inches of sea level rise, reducing storm wave exposure to the southern shore of Staten Island. Wave attenuation provided by the breakwaters on a day-to-day basis would help to maintain beach conditions by reducing long term beach erosion rates, reducing exposure of shoreline structures to erosion, and encouraging accretion in priority beach zones. The breakwater system would help to minimize the potential for down-drift erosion by holding sand in the system through wave energy reduction along the shoreline. At the western tip of the study area near Ward’s Point, the breakwaters would likely reduce sand migration into the Federal Navigation Channel. The breakwaters were also designed to encourage shoreline growth, or accretion, in places where the beach is most narrow, as well as to reverse the pattern of historic landloss, promoting the stabilization or accretion of beach in areas of the greatest observed historic land loss (see **Figure 1-8**).

The proposed breakwater system would increase habitat diversity through the establishment of structural habitat, which is currently limited within Raritan Bay. The breakwater structures have been designed to have varying levels of elevation, inclination, bio-enhancing materials, textures, interstitial spaces, and grain sizes in order to create a diversity of habitat characteristics for aquatic biota. The breakwaters would be primarily constructed as rubble mound (rock) structures with a bedding layer, stone core and outer layers consisting of armor stone or bio-enhancing concrete armor units. In the subtidal and intertidal areas, up to one third of the armor stone would be bio-enhancing concrete units rather than stone, creating an “enhanced” habitat surface. Certain breakwater segments would have a series of rocky protrusions or “reef ridges” that would extend approximately 65 feet seaward, generally perpendicularly from the main breakwater. These reef ridges and the narrow spaces between them, “reef streets,” would add to the diversity of available habitats within the intertidal and subtidal zones, including interstitial spaces between armor units by providing pockets of complexity within the structure. These areas could generate additional opportunities for ecological enhancement (see **Figure 1-9**).

As discussed above, the vast majority of the breakwater structures would be located more than 1,700 feet from the Federal Navigation Channel. The location of the breakwater segments would be marked in accordance with US Coast Guard requirements, and the segments would be spaced far enough apart to avoid interference with recreational boating in Raritan Bay. In addition, the breakwaters would be positioned and marked to ensure they will not interfere with any navigation activities.

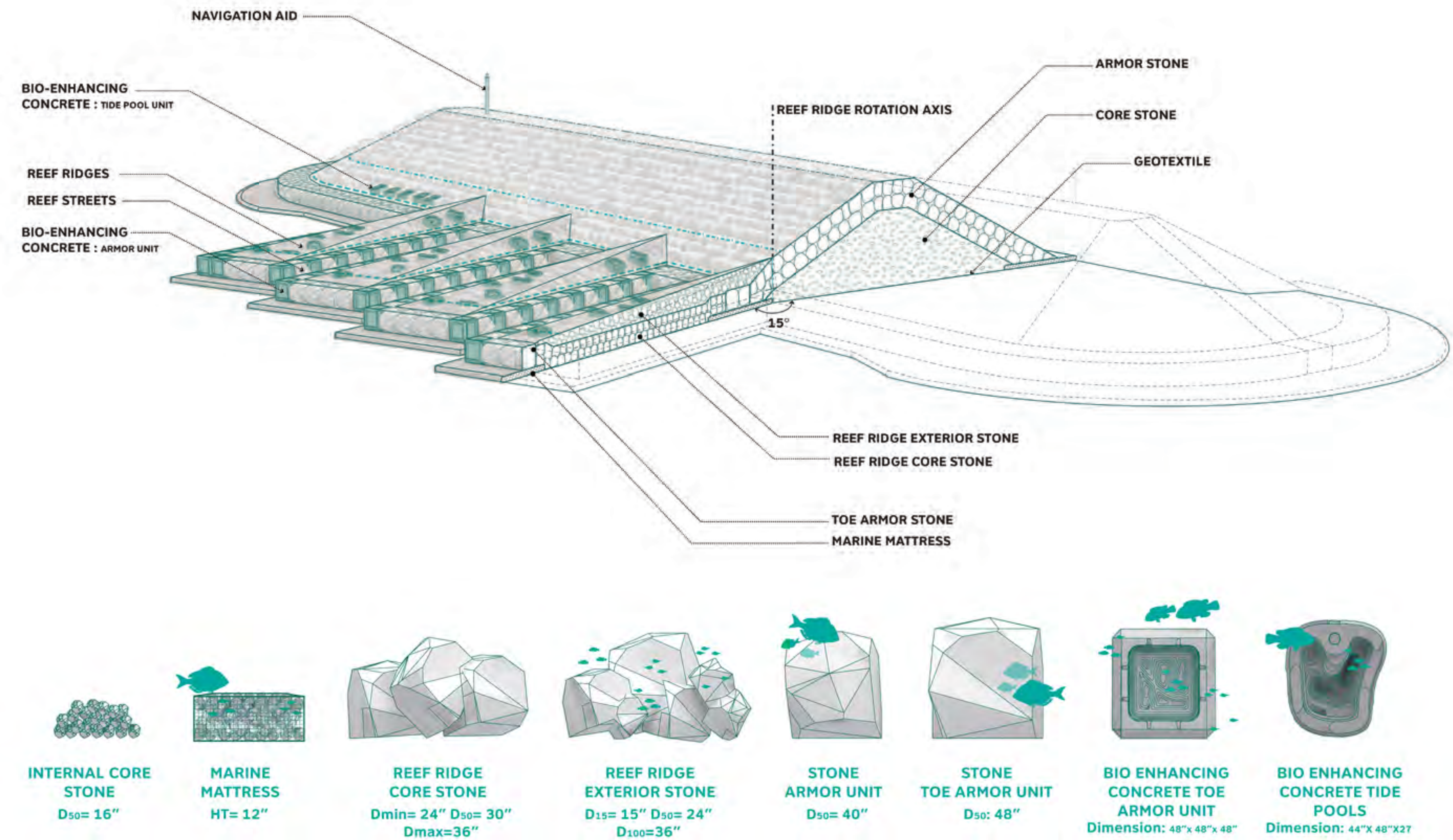
Shoreline Restoration—Sand placement to restore the historic shoreline position is being proposed between Loretto Street and Manhattan Street, downdrift (southwest) of the outfall at Loretto Street, where building the beach will have the most benefit in the vicinity of elements of the proposed Shoreline Project (see below), and where the beach is currently narrow and has experienced high rates of historic erosion (around 2.0 ft/year from 1978 to 2012). At the time of

Source: *SCAPE / Landscape Architecture PLLC*

Shoreline Change with and without Proposed Actions

Figure 1-8

12.13.17



Source: *SCAPE / Landscape Architecture PLLC*

Proposed Breakwater Materials

Figure 1-9

sand placement, the proposed area of shoreline restoration would extend along approximately 806 feet of shoreline in an area of approximately 3.1 acres, of which approximately 2.6 acres would be below MHW (+2.08 NAVD88). About 17,404 cubic yards (CY) of sand, approximately 11,637 CY of which would be below MHW, would be placed in this location to establish a wider beach in what is currently a narrow and erosion-prone section of the beach. This 3.1-acre area was selected for one-time shoreline restoration because of high historical and projected erosion rates and narrow beach width. The shoreline restoration would extend the beach at +5.0 NAVD88 by approximately 50 feet and then slope downward to meet the existing bathymetry. This one-time placement of sand would approximate the historic 1978 shoreline position, augment the accretion potential that can be provided by the breakwaters and add sediment to the overall system, particularly contributing to one of the narrowest and most erosion-prone areas of beach in the site and generally enhancing overall beach growth potential.

Water Hub—With the goal of promoting social resiliency, a proposed community Water Hub—including associated wayfinding, interpretive signage, and monitoring locations at points along the shoreline—would provide a place for access to the waterfront, orientation, education, information on shoreline resiliency, community gathering space and if located on-shore, potential equipment storage for NYC Parks maintenance. In particular, the Water Hub programming could include classrooms and labs, engaging students in waterfront education, citizen's science, oyster restoration and reef building, and cultivating long-term estuary stewardship. The educational programming for the Water Hub would directly tie to the in water components, as well as to any shoreline resiliency components of the Proposed Actions. In addition to ecological engagement, the Water Hub facilities and programs are intended to educate residents on the risks and benefits of living in the coastal environment and build awareness, preparedness and stewardship within the community. The Water Hub may also include other elements, such as, exhibition space, maintenance-related storage space and offices, and terrace space.

One of three potential locations under consideration will be selected for siting the Water Hub—Potential Location 1 would be in the vicinity of the southern terminus of Page Avenue (involving the construction of a new structure).[7] Potential Location 2 would be in the north-western portion of Conference House Park (involving the rehabilitation and adaptive reuse of an existing NYC Parks building). Potential Location 3 would involve a "floating" Water Hub—a vessel operated by a non-profit organization (e.g., BOP). The vessel would visit the breakwater project area for education and monitoring and would be docked at existing facilities in the City.

Potential Location 1 (On-Shore):

Potential Location 1 is located in the vicinity of the southern terminus of Page Avenue. At this location, there are two options for the construction of the Water Hub. The first, Page East Option, would locate the proposed Water Hub in an existing Conference House Park parking lot and surrounding wooded area immediately east of Page Avenue. The second, Page West Option,

[7] Since the publication of the DEIS, in response to public comments received during the public review process and additional feasibility considerations, Potential Location 1 for the Water Hub (in the vicinity of the southern terminus of Page Avenue) has been removed from further consideration. However, in the interest of completeness and to ensure a detailed comparative assessment of potential alternatives, this FEIS conservatively retains the analyses that were presented in the DEIS that were associated with this location.

would use a grassy site west of Page Avenue that has previously contained a two-story NYC Parks building (which was demolished in 2016 due to substantial damage caused by Superstorm Sandy) (see **Figures 1-10 and 1-11**). Although the design is still being developed, the proposed Water Hub structure is anticipated to be small in scale, ranging from approximately 38-feet (potential location west of Page Avenue) to 48-feet (potential location east of Page Avenue) in height, clad in materials to enhance visual connections to the nearby waterfront areas (see **Figures 1-12 and 1-13**). It would have a rooftop observation deck and solar panels. The proposed Water Hub facility is expected to include an enclosed 5,000-square-foot building and approximately 35,500 square feet of site improvements that would include landscaping, parking and utility spaces and designated space for the use of NYC Parks vehicles and equipment. The proposed Water Hub would also provide direct on-site waterfront access. It is anticipated that the facility would be used by the New York Harbor Foundation, NYC Parks, and local schools and community groups.

At Potential Location 1, access to the water from the shore would be provided by means of a seasonally deployed temporary floating boat launch. Anchored about a foot above MHW the approximately 8-foot-wide temporary boat launch would extend approximately 210 feet.

The Water Hub site would include parking for visitors, as well as several on-shore and near-shore landscape elements in the area of the proposed Water Hub.

Potential Location 2 (On-Shore):

Potential Location 2 is located in the north-western portion of Conference House Park. At this location, there are two options for the adaptive reuse of existing NYC Parks buildings for Water Hub programming. The first, the Biddle House Option, would locate the programming for the Water Hub within the existing Henry Hogg Biddle House (Biddle House). The Biddle House has been designated a New York City Landmark (NYCL) and in a comment letter dated November 9, 2016, the New York City Landmarks Preservation Commission (LPC) indicated that the house appears eligible for listing on the State/National Register (S/NR-eligible). The second, the Rutan-Beckett House Option, would locate the programming for the Water Hub within the existing Rutan-Beckett House which is located southwest of the Biddle House.

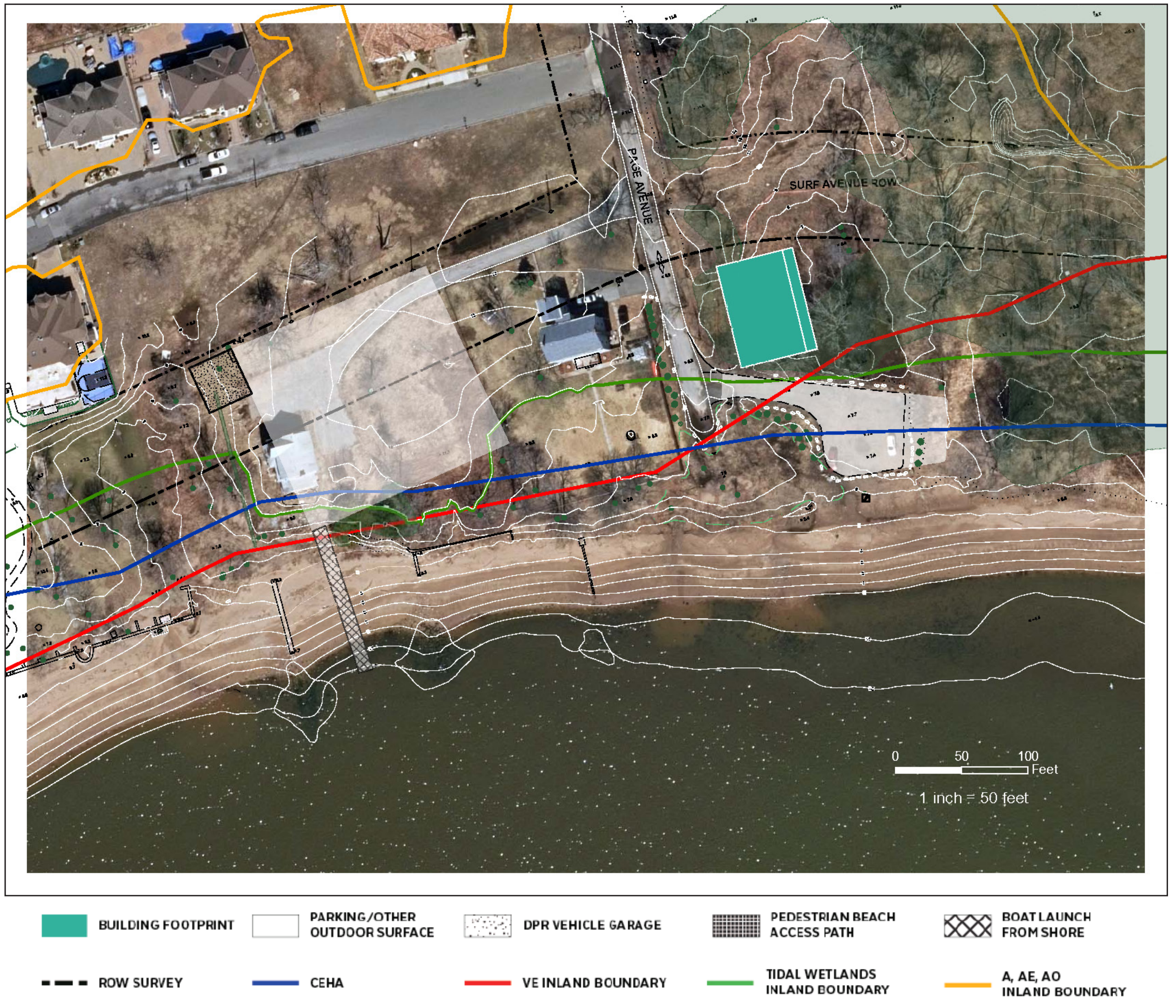
Similar to Potential Location 1, Potential Location 2 would include access to the water. This access would be provided in the area of one of the houses being adaptively reused for Water Hub activities. Water access would be provided with Americans with Disabilities Act (ADA) accessible pathways and ramps from the grounds of the house being adaptively reused to the beach area, and a seasonally deployed temporary floating boat launch to the water. (see **Figures 1-14 and 1-15**).

Parking for Water Hub activities at Potential Location 2 would be accommodated at the existing Conference House Park Visitor's Center.

Should Water Hub programming be located at Potential Location 2, a small facility to provide seating, wayfinding, interpretive elements and potential storage for kayaks and beach cleaning equipment would be constructed near the terminus of Page Avenue. This structure would be a pavilion, shed or other light structure (approximately 400 sf). This facility may be connected to the City's water supply but would not require sanitation sewer connections. The existing parking facilities at the terminus of Page Avenue would be used to access this facility. Additional wayfinding, interpretive signage, and monitoring locations would be integrated along the length of the shoreline as part of the Water Hub's educational programming.

Proposed Water Hub Location 1—
Page West Option

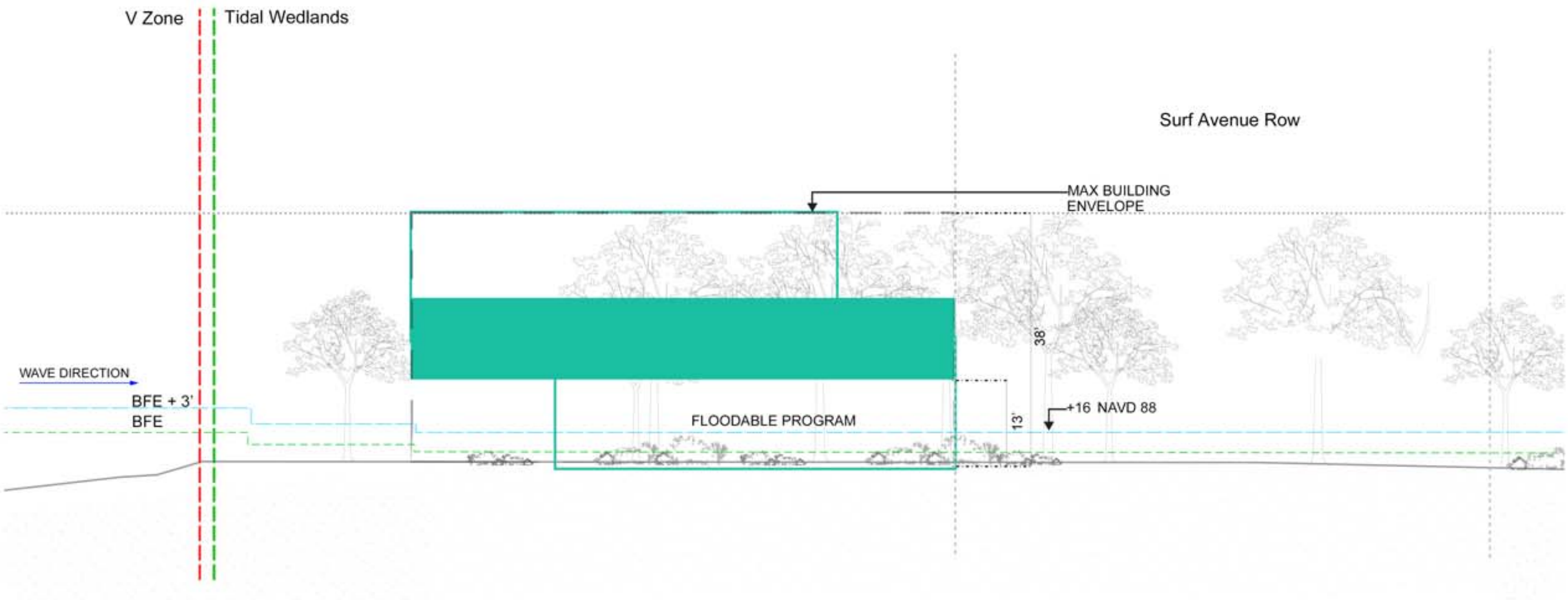
Figure 1-10

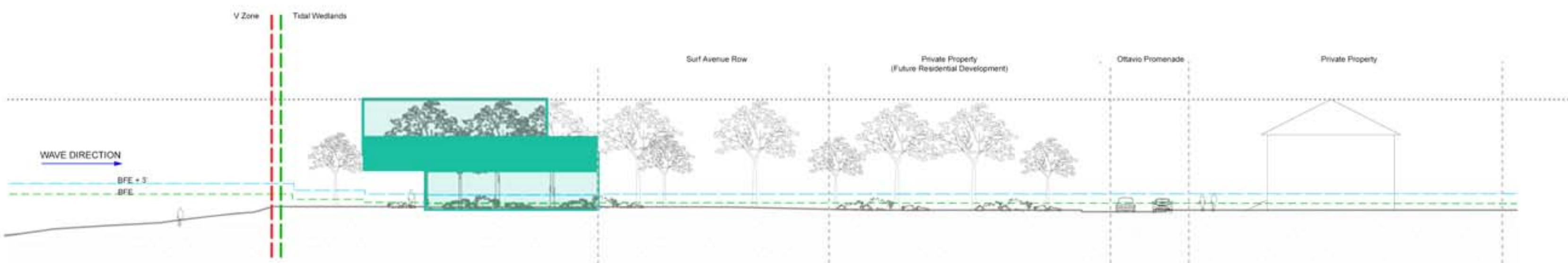


***Source:** Stantec / RACE Coastal Engineering*

Proposed Water Hub Location 1—
Page East Option

Figure 1-11

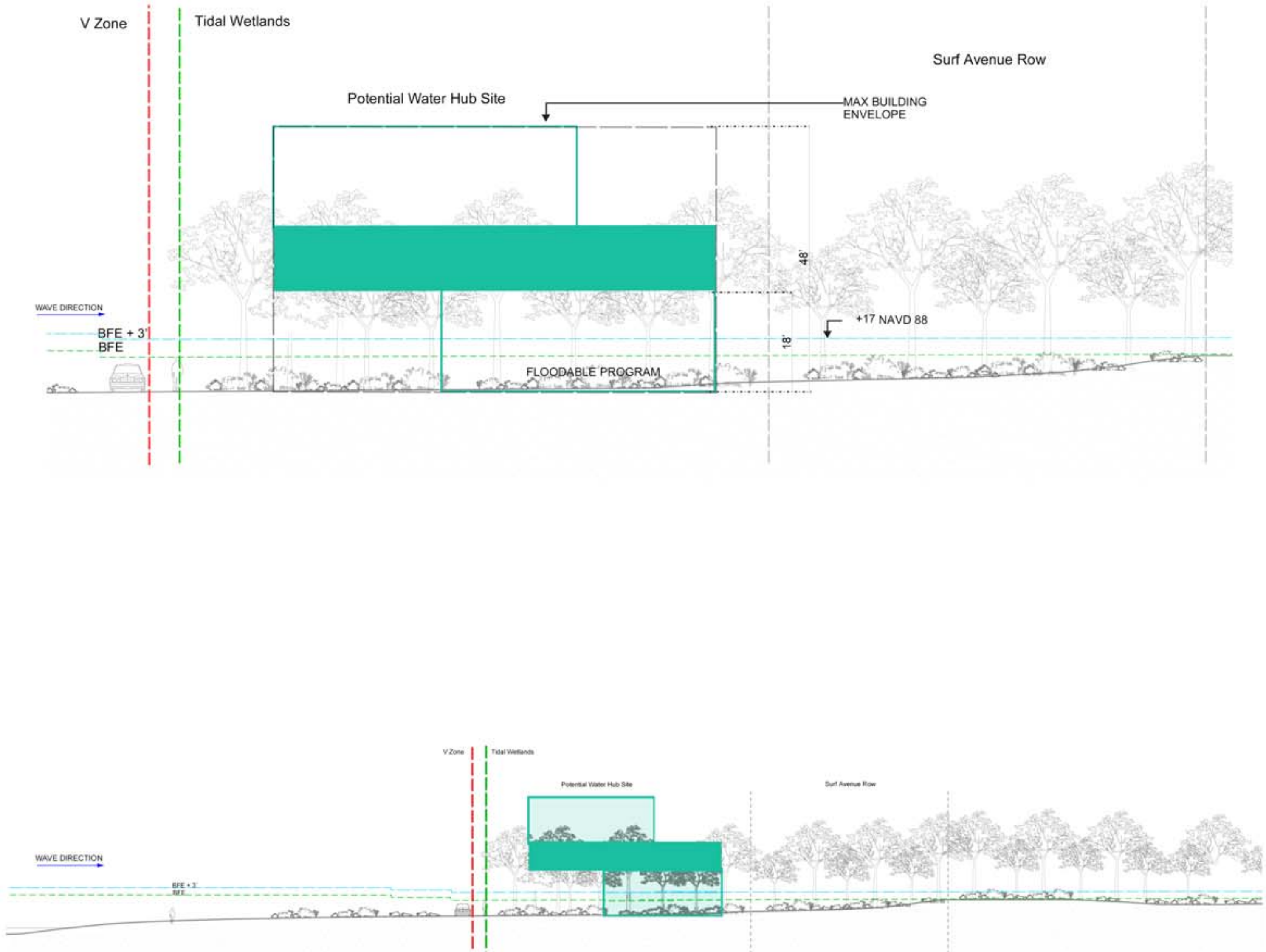




FOR ILLUSTRATIVE PURPOSES ONLY

Proposed Water Hub Location 1— Page West Option Sections

Figure 1-12



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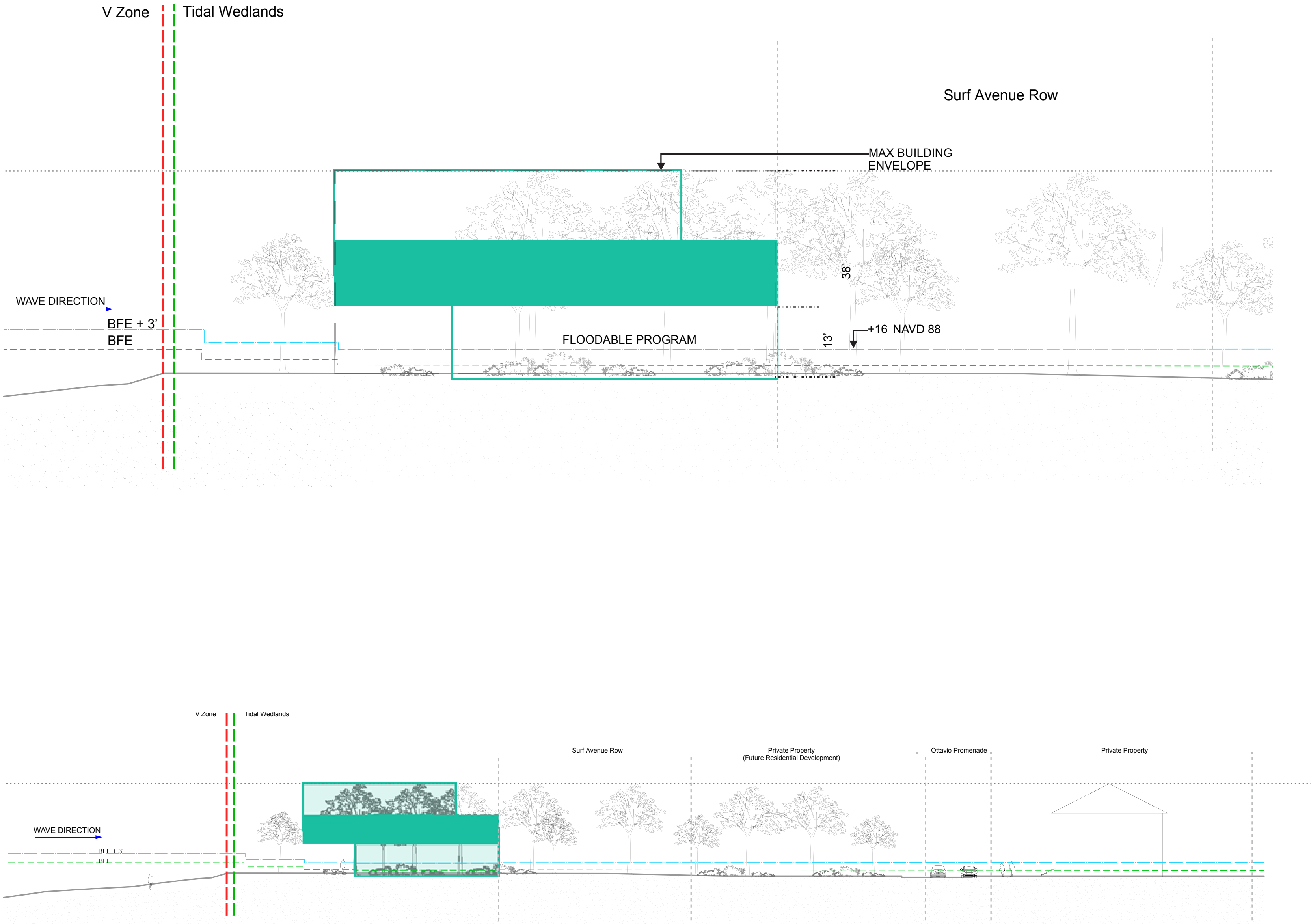
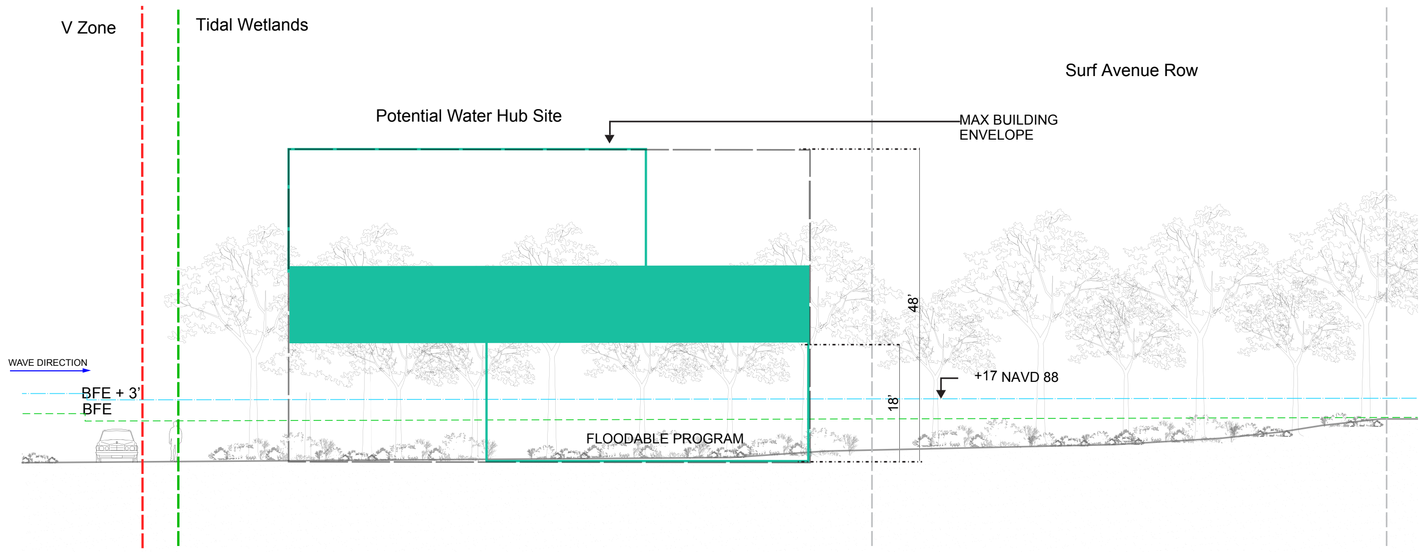
Proposed Water Hub Location 1—
Page East Option Sections

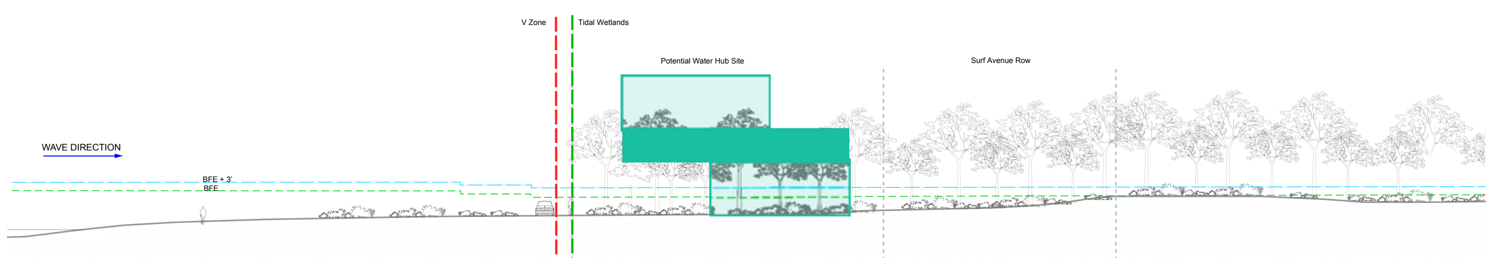
Figure 1-13



Proposed Water Hub Location 1—
Page West Option Sections

Figure 1-12



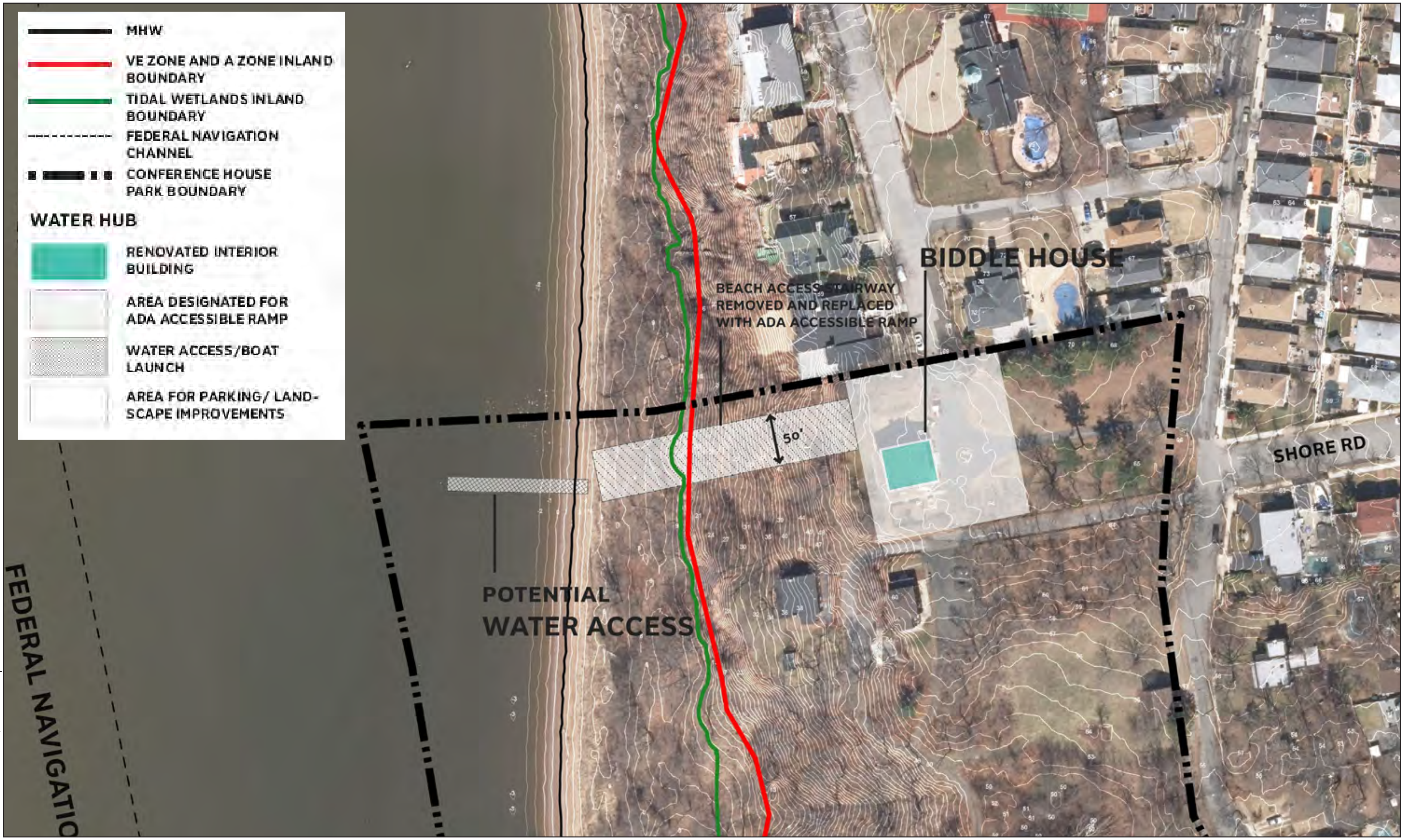


FOR ILLUSTRATIVE PURPOSES ONLY

Proposed Water Hub Location 1—
Page East Option Sections

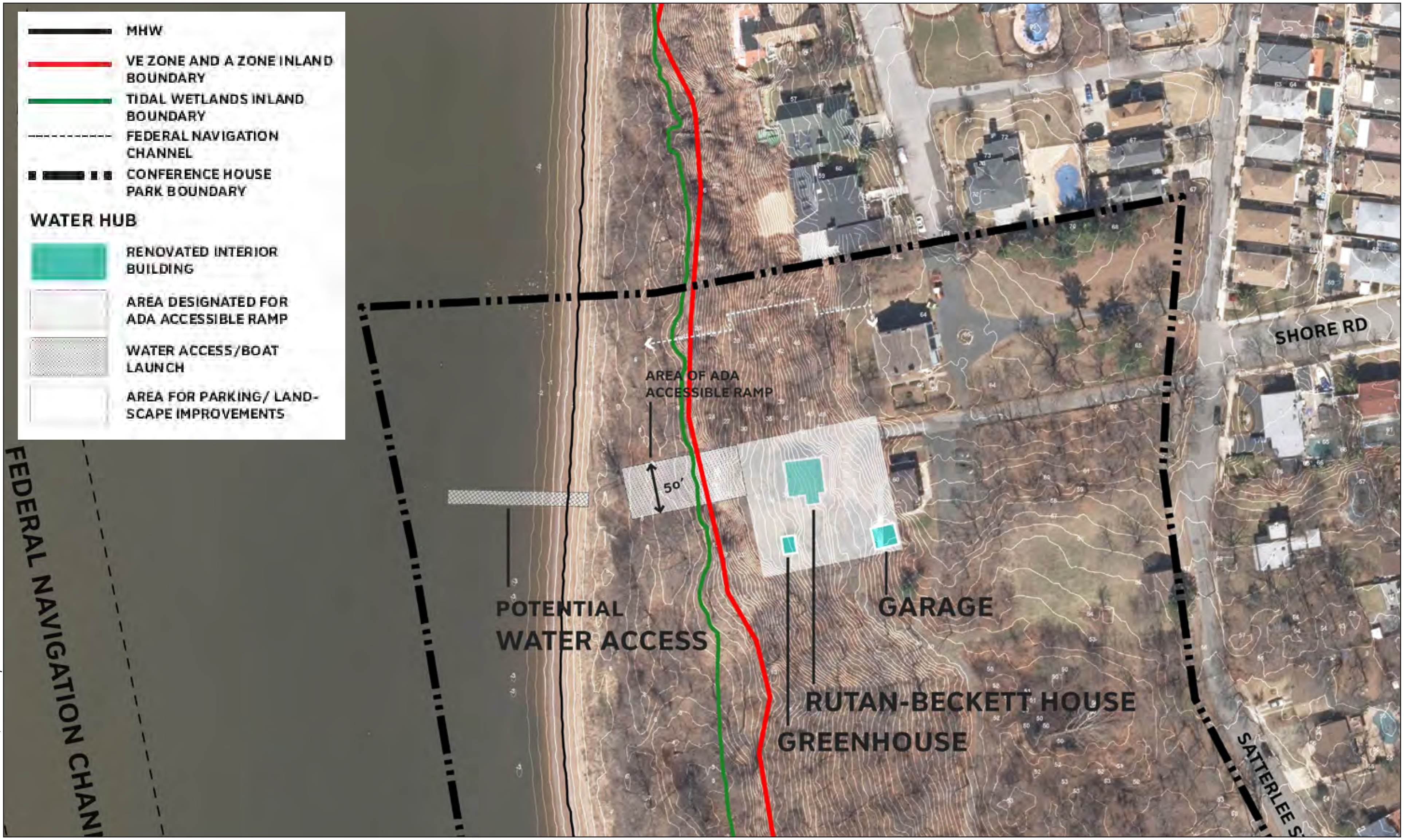
Figure 1-13

11.2.17



Source: *SCAPE / Landscape Architecture PLLC*

Proposed Water Hub Location 2—
Biddle House Option



Source: *SCAPE / Landscape Architecture PLLC*

Proposed Water Hub Location 2—
Rutan-Beckett Option

Figure 1-15

Potential Location 3:

Potential Location 3 would involve a “floating” Water Hub, or vessel operated by a non-profit organization (e.g., BOP). The vessel would be docked at existing facilities in the City (serving local groups and community members when docked locally) and would visit the project area approximately once per week from April through November for student based teaching events, and host community events approximately twice per month. When in the project area, the vessel would anchor near the breakwater structures for observation/monitoring and education activities. Should Water Hub programming be located at Potential Location 3, wayfinding, interpretive elements, and potential storage for kayaks would be constructed near the terminus of Page Avenue. Additional wayfinding, interpretive signage, and monitoring locations would be integrated along the length of the shoreline as part of the Water Hub’s educational programming. No additional parking facilities would be required with this option. Also, because this option does not include an on-shore building for Water Hub programming, a seasonally deployed temporary floating boat launch would not be included as part of the project.

Seasonal Floating Dock—Should Water Hub programming be located at Potential Location 1 or 2, a temporary seasonal floating dock measuring about 30 feet by 50 feet, with a total area of 1,500 square feet, would be installed near the Type C eastern breakwaters segments for observations, monitoring, maintenance and stewardship, including specifically, for vessels operated by project stewards. The floating dock would not be required for Potential Location 3, because education and monitoring activities could occur directly from the vessel or “floating” Water Hub.

Tottenville Shoreline Protection Project (NY Rising Community Reconstruction Program and Raise Shorelines Citywide Study)

The Shoreline Project had its genesis in the New York Rising Community Reconstruction initiative established by Governor’s Office of Storm Recovery and was further developed in consultation with NYC Parks. The plan for the East and South Shores of Staten Island included hybrid dunes with a stone core and sand cap, planted for stabilization, from Brighton Street to Joline Avenue, including two beach access points. After evaluating site-specific field data such as site surveys and borings, and in response to public input, it became clear that one coastal strategy did not fit all areas of the shoreline as was originally proposed as part of the New York Rising Community Reconstruction planning process. In some cases, there was not enough space on the beach between the property line of Conference House Park and above mean high water to accommodate the width that a hybrid dune would require (for example, the area where Surf Avenue is built out between Loretto Street and Sprague Avenue). Additionally, in response to public comments during the EIS public scoping process, the area west of Brighton Street to Swinnerton Street was added to the project.

The South Shore of Staten Island was also analyzed as part of NYCEDC’s Raise Shorelines Citywide Study with a goal to evaluate localized measures to reduce coastal risk, make recommendations for resiliency investments, and coordinate with other local coastal protection actions. Evaluation of the Tottenville shoreline resulted in recommendations which to the extent relevant, informed elements of the Shoreline Project. In particular, the area between Joline Avenue and Page Avenue was added to the Shoreline Project to address vulnerable coastal conditions identified in the Raise Shorelines Citywide study.

Thus, a comprehensive design was developed to respond to the changing character of the shoreline between approximately Carteret Street and Page Avenue. These include a series of

shoreline risk reduction measures, including an earthen berm, a hybrid dune/revetment system, eco-revetments (one section between Brighton Street and Manhattan Street, and one section between Loretto Street and Sprague Avenue), raised edge (revetment with trail), wetland enhancement, and shoreline plantings. ADA-accessible pathways, access points and overlooks would be constructed along the shoreline protection system (see **Figure 1-16)**. With the exception of a small portion of the Shoreline Project proposed within an unbuilt portion of the NYCDOT Surf Avenue right-of-way, all on-shore project components under Alternative 2 would be constructed within the boundaries of Conference House Park.[8]

The temporary dune system that stretches from approximately Swinnerton Street to Sprague Avenue would be removed and replaced with the Shoreline Project elements proposed for this stretch of the shoreline.

The Shoreline Project has been designed to withstand storm wave action and overtopping of the shoreline structures, and to be resilient to sea level rise of 30 inches, and provide some level of risk reduction from coastal flooding. These on-shore risk-reduction measures would augment the wave attenuation and risk reduction potential provided by the Breakwaters Project.

The primary Shoreline Project components are described below.

Earthen Berm—From approximately Carteret Street to Brighton Street through a wooded portion of Conference House Park, the system would include an earthen berm that would serve as a tie-in to a section of eco-revetment followed by a reinforced, planted hybrid dune/revetment system proposed from approximately Brighton Street to Loretto Street. The proposed earthen berm would be approximately 25 feet (ft) wide ranging in height between approximately 1 and 7.5 feet above grade, and extending approximately 948 linear feet. It would extend through the portion of Conference House Park west of Brighton Street which is characterized by a dense successional hardwood forest. The earthen berm is being designed to blend in with the existing landscape (see **Figure 1-17**).

Hybrid Dune/Revetment System—The proposed reinforced, planted hybrid dune/revetment system would extend along the shoreline between Manhattan and Loretto Streets, for approximately 937 linear feet. The hybrid dune/revetment system would be at an elevation of approximately 14 feet (approximately 1 foot higher than the exiting temporary dune system, and with a 70- to 90-ft width. The crest of the hybrid dune/revetment would be approximately 10 ft wide. The proposed hybrid dune/revetment system would provide a more gradual transition from upland elements to the shoreline (see **Figure 1-18**).

Eco-Revetments

Between Brighton Street and Manhattan Street:

The proposed eco-revetment in this area would extend approximately 338 linear feet between Brighton Street (at the eastern terminus of the earthen berm) to Manhattan Street. This project element would bring the risk reduction system upland of the western portion of the hybrid dune/revetment system described above, along the northern edge of a 0.8-acre delineated

[8] As with other areas in Conference House Park where park uses are within the NYCDOT Surf Avenue right-of-way, a memorandum of understanding (MOU) between NYC Parks and NYCDOT will be in place prior to construction to accommodate portions of the Shoreline Project.

11.2.17

***Source:** Stantec / RACE Coastal Engineering*

Proposed Shoreline Project

Figure 1-16

Source: *Stantec / RACE Coastal Engineering*

FOR ILLUSTRATIVE PURPOSES ONLY

Proposed Earthen Berm
Figure 1-17

Source: Stantec / RACE Coastal Engineering

FOR ILLUSTRATIVE PURPOSES ONLY

Proposed Hybrid Dune Revetment

Figure 1-18

wetland. The eco-revetment would comprise a pathway and rip rap with joint plantings, providing continuous access along this stretch of the project area.

Between Loretto Street and Sprague Avenue:

The proposed eco-revetment would extend approximately 396 linear feet between Loretto Street and Sprague Avenue. It would begin at a transition point from the eastern end of the hardened dune system. The eco-revetment would comprise a bioswale (a landscape feature designed to remove pollution from surface runoff water), sloped plantings, a pathway (approximately 3.5 feet above the sidewalk), and concrete steps, depending on the location along the shoreline (see **Figure 1-19**). A paved sidewalk along Surf Avenue would be developed that would border a five-foot-wide bioswale, separated by a six-inch curb. The top of the eco-revetment would include an eight-foot-wide paved pathway connecting the two access points on either end of the eco-revetment.

Raised Edge (revetment and trail)—In this area the limit of wave action does not extend into the community, and the residential community is less dense near the shoreline. Therefore the goal for this area is to control erosion while accounting for future sea level rise. Based on the recommendations and design considerations from the study, the Shoreline Project has identified revetments as appropriate strategies along this stretch, which would incorporate a modest rising of the grades at the edge of the beach and would account for projected sea level rise. A proposed waterfront side stone revetment would border an approximately five-foot-wide bioswale and eight foot wide raised trail that would begin at Sprague Avenue and extend approximately 2,536 linear feet to approximately 600 feet east of Page Avenue. The proposed trail would be either concrete or asphalt, designed to enhance accessibility to the shoreline (see **Figure 1-20**).

Transition nodes would connect certain project elements; these would consist of concrete pavers connected to sidewalks or trails and stairways to allow shoreline access. In the area between Loretto Street and Sprague Avenue, an overlook would be constructed at Loretto Street for the transition of the hybrid dune/revetment system to the eco-revetment and an enhanced overlook would be constructed at Sprague Avenue for the transition of the eco-revetment to the raised edge. Green infrastructure would be implemented wherever possible.

Temporary dunes, constructed by NYC Parks as interim protective measures post-Sandy, are currently in place from approximately Swinnerton Street to Sprague Avenue. These temporary dunes would be replaced with the shoreline elements proposed along this stretch.

1.5.2 ALTERNATIVE 3—BREAKWATERS WITHOUT SHORELINE PROTECTION SYSTEM

Alternative 3 would develop the Breakwaters Project components as described in Alternative 2, including the proposed in-water breakwaters, shoreline restoration, Water Hub elements and accessory boat launch and seasonal floating dock near the breakwaters. None of the Shoreline Project components would be developed under Alternative 3.

As described above for the Layered Strategy, or Alternative 2, the breakwaters system on its own would provide substantial protection against shoreline erosion. The breakwaters system is designed to reduce or reverse the long-term historic erosion observed across the site, and to “grow” the shoreline where the beach is narrowest and where erosion risk threatens to increase the exposure of vulnerable assets to erosion and limit future access to the beach. The breakwaters system would also provide effective wave attenuation as described under Alternative 2. However, the added on-shore risk reduction provided by the Shoreline Project that

FOR ILLUSTRATIVE PURPOSES ONLY

Proposed Eco-Revetment
(between Loretto Street and Sprague Avenue)

Figure 1-19

FOR ILLUSTRATIVE PURPOSES ONLY

Proposed Raised Edge
Figure 1-20

would augment the wave attenuation potential provided by the Breakwaters Project would not occur under Alternative 3. Additionally, this alternative would not benefit from the potential risk reduction from coastal flooding provided by the Shoreline Project. The ecosystem services benefits provided by structured habitat created by the breakwaters as well as the social and educational benefits provided by the Water Hub would still accrue.

1.5.3 ALTERNATIVE 4—SHORELINE PROTECTION SYSTEM WITHOUT BREAKWATERS

Alternative 4 would develop the Shoreline Project components as described in Alternative 2, including the proposed earthen berm, hybrid dune/revetment, eco-revetments and raised edge, wetland enhancement, shoreline plantings, and maritime forest restorations. Americans with Disabilities Act (ADA) accessible pathways, access points and overlooks would be constructed along the shoreline protection system. None of the Breakwaters Project components would be developed under Alternative 4.

As described in Alternative 2, the Shoreline Project has been designed to withstand storm wave action and overtopping of the shoreline structures, and to be resilient to sea level rise of 30 inches and provide some level of risk reduction from coastal flooding. However, this alternative would not benefit from the wave attenuation that would be provided offshore with the Breakwaters Project as with Alternative 2. While meeting some of the goals and objectives of the Proposed Actions, the shoreline erosion goals, as well as the ecological enhancement and social resiliency goals would not be fully met with this alternative.

1.5.4 ALTERNATIVES CONSIDERED AND ELIMINATED

The coastal strategy concepts for the Proposed Actions were developed as part of the HUD sponsored design competition Rebuild by Design, the NY Rising Community Reconstruction Program and the Raise Shorelines Citywide Study, during which alternative coastal strategies were considered. In addition, during the design process for the Breakwaters Project and Shoreline Project various design alternatives were assessed. These coastal strategy and design alternatives—and the reasons they were not considered for further evaluation—are described below.

COASTAL STRATEGY ALTERNATIVES

Alternatives Considered for the Breakwaters Project

Rebuild by Design was a multi-stage regional design competition that analyzed potential coastal resilience strategies for sites throughout the Sandy-affected region in order to identify innovative and site-specific approaches that would be effective at reducing coastal risk and fostering broader community resilience. Living Breakwaters was a strategy developed for the South Shore of Staten Island, following an exploration of a variety of other coastal strategies.

As a part of the initial stage of the competition, a series of resilience strategies for various shallow-water environments were explored, all aimed at the ultimate project objectives to reduce risk, enhance ecologies, and foster social resilience. The effectiveness of these strategies for wave attenuation in different contexts in New York Harbor were preliminarily evaluated during the competition using the ADCIRC hydrodynamic model and SWAN wave model. However, modeling results are only one element within many that determined the potential effectiveness and appropriateness of each strategy in relation to the Tottenville community, environmental and

public interest considerations, and construction and regulatory feasibility. Ultimately, the Living Breakwaters were identified for the Tottenville site based on their ability to achieve the risk reduction goals articulated in the purpose and need. Additional strategies were also considered. While some of these alternative strategies are appropriate for some shallow water environments, they were ultimately not identified as practicable resilience strategies for this area of Staten Island for reasons described below, and were not considered further.

Beach Nourishment/Re-Nourishment (alone)

Beach nourishment is the (periodic) placement of sand on and adjacent to an existing beach into shallow waters along the shoreline to extend the shoreline and widen the beach, resulting in a beach berm. A wider beach can increase and enhance waterfront public open space and reduce the risk of upland infrastructure to ongoing erosion by providing sacrificial beach width. The beach can also provide some wave attenuation benefits for smaller, more frequent storm events as long as storm surge elevations are not significantly higher than the beach. While beach nourishment of sufficient size, if maintained (regularly re-nourished), can provide some wave attenuation and act as sacrificial erosion protection to the land behind, given the high surge elevations experienced on the south shore of Staten Island, a beach berm alone would provide little storm wave reduction benefit, and thus beach nourishment alone would not fulfill the project purpose and need. At the project site, beach nourishment is not sustainable without additional protective and stabilizing features (such as breakwaters) and would need to be regularly maintained (re-nourished) over time, resulting in periodic disturbance to beach users, wildlife and fish and benthic invertebrates during each of these sand placement events, rather than a one-time construction event. Beach nourishment/re-nourishment would not meet the risk reduction goal of addressing impacts of coastal flooding, nor the ecological enhancement goal of increasing diversity of aquatic habitats within Raritan Bay, or the social resiliency goals and objectives of the Proposed Actions. For all of these reasons, beach nourishment alone was not considered practicable and was not evaluated further.

Groins (Groins Alone or Groins Plus Beach Nourishment)

Groins are generally shore perpendicular rock or sheet pile structures designed to trap and retain sediment from longshore transport. Groins interrupt the longshore sediment transport accumulating sediment on the updrift side and depriving sediment to the downdrift side resulting in a pattern of accretion and erosion adjacent to the structure. This effect can be partly mitigated by prefilling the groin with sediment allowing more sediment to bypass the end of the structure. Groins are often constructed in groups (fields) or together with other shoreline protection measures to reduce the downdrift impacts. Groins would not meet the risk reduction goals of attenuating wave energy before it reaches the shore. While groins would address shoreline erosion, this would occur by blocking longshore transport, increasing the potential for erosion elsewhere along the shoreline. Groins would not meet the risk reduction goal of addressing impacts of coastal flooding, the ecological enhancement goal of increasing diversity of aquatic habitats within Raritan Bay, or the social resiliency goals and objectives of the Proposed Actions. For all of these reasons, groins were not considered practicable and were not evaluated further.

Constructed/Restored Wetlands

Coastal wetlands can attenuate waves and even absorb surge waters, reducing wave and coastal flooding impacts within coastal communities. Existing coastal wetlands in the New York region are threatened by development, erosion, and sea level rise inundation and require sediment

replacement and nourishment to maintain and expand their protective footprints. Dredging provides a potential source for sediment that can be used to restore these coastal wetlands. Federally maintained recreational channels, such as the Intracoastal Waterway provide sources for clean dredge material that can be used for nearby larger-scale wetland restoration. At the local scale, regulatory structures can be streamlined to allow family-owned marinas to nourish wetlands adjacent to their properties, recycling sediment within the sediment shed and protecting their own waterfront facilities from damaging wave action.

In order to be effective on their own for wave attenuation and surge abatement, a wide swath of wetlands would be needed along the shoreline to absorb wave energy—studies have shown that it takes 1.3 to 3.8 miles of marsh to generate a 1-foot reduction in storm surge (USACE, 1963). Such extensive wetlands off the south shore of Staten Island would require massive amounts of fill, including infill of the federal navigation channel which would disrupt navigation into and out of the Arthur Kill, and replacement of large areas of intertidal and subtidal habitat with wetland habitat. In addition, while there is interest in variety along the shoreline and potentially pockets of living shorelines, the character of the beach is valued by local residents, and such expansive and complete change to the shoreline and nearshore to coastal wetlands would completely alter the shoreline character and ecology. Additionally, there are no small marinas or navigable waterways in the vicinity of the Tottenville shoreline south of Lemon Creek and east of Tottenville Marina that could provide a source of suitable fill material from maintenance dredging. Therefore, large quantities of suitable fill material would need to be derived from other sources, with potential impacts associated with the removal of this material. Constructed wetlands would also not meet the social resiliency goals and objectives of the Proposed Actions. For all of these reasons, constructed/restored wetlands were not considered practicable and were not evaluated further.

Sills (Sill-type Living Shorelines)

A Living Shoreline is a protected, stabilized coastal edge made of natural materials; they use plants and other natural elements—sometimes in combination with hardened shoreline structures—to stabilize estuarine coasts, bays, and tributaries. Sills are continuous low-profile breakwater structures made of stone or other material resistant to erosion and wave action. Sill-type living shorelines are low-crested structures (typically stone) placed parallel to the shore so that marsh can be planted behind them. The structures are intended to attenuate daily wave action and protect or help restore landward vegetation, typically a wetland or marsh, from wave damage and erosion. While such low crested structures in combination with vegetation establishment are effective at attenuating day-to-day waves, their low crests would mean that they are not effective at attenuating storm waves during high surge events and thus would not meet the risk reduction goals and objectives of the Proposed Actions of attenuating wave energy and addressing the impacts of coastal flooding. While sills and sill-type living shorelines would provide erosion protection, such near shore structures would also likely interrupt longshore transport processes, depriving sediment to the down drift areas, exacerbating erosion in those areas. While sill-type living shorelines would provide some near-shore rocky structure, they would be in shallow water and lack subtidal habitat and the intertidal habitat diversity provided by structures in deeper water, and would only partially meet the ecological enhancement goal and objectives of the Proposed Actions In addition, such sills would not meet the social resiliency goals of the Proposed Actions. They would not promote connectivity to the water for people as they would place dense vegetation and structure between people and the water (which may pose a public access hazard), and are not usually utilized on public beaches. While there is interest in variety along the shoreline and potentially pockets of living shorelines, the character

of the beach is valued by local residents, and the extended application of these living shorelines across the project area would completely alter the shoreline character and ecology and occupy a larger footprint in the nearshore. For all of these reasons, sill-type living shorelines were not considered practicable and were not evaluated further.

Other Sills (beach sills, headland breakwaters, etc.)

Sills can also be used to stabilize and protect beach berms and form headlands. Headland Breakwaters (versus detached breakwaters such as the proposed Living Breakwaters) are low breakwaters or rock sills placed close to shore with the intent that the breakwaters connect to the shore either immediately or over time with a sand spit or “tombolo.” Such breakwaters typically include initial sand placement behind them, but even without this initial placement of sand, the intent is that they will eventually be connected to the shore through the formation of a “tombolo” or sand spit between the beach and the breakwater. The breakwater structures are placed strategically along a shoreline with the understanding that the land between the structures will erode to a predicted stable bay-shape over time. Because of this, they create a heavily scalloped shoreline, with areas of eroding shoreline between the sand spit or tombolos. The beach width at the project site is not sufficient to allow for the formation of such bays without either causing erosion of the existing or proposed onshore features or including extensive initial beach fill seaward of the existing shoreline as part of the project in order to retain an accessible public beach and avoid the potential erosion of onshore features. While such low crested structures are effective at attenuating day-to-day waves, their low crests would mean that they are not effective at attenuating storm waves during high surge events and thus would not meet the risk reduction goals and objectives of the Proposed Actions of attenuating wave energy and addressing the impacts of coastal flooding. While sills would provide erosion protection, such headlands or tombolos alter longshore transport and break it into individual littoral cells between the headlands with little sediment movement passing around the headlands. In addition, while headland breakwaters would provide some nearshore rocky structure, they would be in shallow water and connected to the land and lack subtidal habitat and the intertidal habitat diversity provided by structures in deeper water, and would only partially meet the ecological enhancement goal and objectives of the Proposed Actions. In addition, such sills and headland breakwaters would not meet the social resiliency goals of the Proposed Actions. For all of these reasons, sills were not considered practicable and were not evaluated further.

Constructed Reefs or Subtidal Breakwaters

Constructed reefs and subtidal breakwaters have successfully been installed in various coastal environments primarily to control shoreline erosion and in some cases build beaches. Some propriety subtidal breakwater systems also can provide structured habitat enhancement (such as Reef Balls, oyster castles, etc.). As these types of systems are intended to remain submerged, they do not provide significant storm wave attenuation, especially during elevated water levels, nor would they provide the erosion protection risk reduction goal and objective of the Proposed Actions. Constructed reefs or subtidal breakwaters would not meet the social resiliency goals of the Proposed Actions. Submerged structures such as these within the shallow water habitat of this portion of Raritan Bay would also have the potential to affect navigation safety. For all of these reasons, constructed reefs or subtidal breakwaters were not considered practicable and were not evaluated further.

Floating Wave Attenuators

Floating wave attenuators can be effective in reducing short period waves, typically in protected bays or harbors. They have been utilized, at least on an experimental basis, to reduce erosion and loss of wetlands due to wave action. Typically, floating breakwaters are not utilized in open coast areas where they are not effective in reducing longer period (>3 second) waves. Certain propriety floating breakwater designs may include habitat enhancing features, such as wetland plantings. During storm conditions, longer period waves (>3 seconds) occur within Raritan Bay within the project area. Therefore, floating wave attenuators would not meet the risk reduction goals and objectives. Floating wave attenuators would only partially meet the ecological enhancement goals and objectives, and would not meet the social resiliency goals and objectives of the Proposed Actions. Additionally, such structures would incur high maintenance costs. For all of these reasons, floating wave attenuators were not considered practicable and were not evaluated further.

Bay Nourishment/Shallowing

Bay nourishment, defined as the shallowing of bathymetric features, would support and replenish shallow estuarine systems that are threatened by shoreline urbanization, dredge channel creation, maritime traffic, water pollution, and continued sea level rise. Nourishing salt marshes and tidal ecosystems to their shallower water depths would have protective functions, dissipating waves and deflecting hurricane storm surges to reduce flood risks for waterfront neighborhoods. Bay nourishment, however, may potentially limit water access for vessels, change water dynamics, and alter water temperatures. Different degrees of nourishment were considered—restoring areas to their historic depths wholesale, as well as options to maintain navigability.

Nourishment is more effective in confined areas, such as Jamaica Bay. With its wide mouth, strong connection to the water flows of the Raritan and Hackensack rivers, the Raritan bay is a very different type of water body that would likely require much more extensive fill to achieve similar wave or surge reducing effects. The bathymetry of the Bay, in particular off the shoreline of Tottenville is already quite shallow from the shoreline to the federal navigation channel. The federal navigation channel, which frames the nearshore of the Tottenville project area, is an important navigation corridor and shallowing this could limit Maritime Access to the Arthur Kill. Bay nourishment/shallowing would also not meet the ecological enhancement goal and objectives of increasing aquatic habitat diversity, or the social resiliency goals and objectives of the Proposed Actions. For all of these reasons, bay nourishment/shallowing was not considered practicable and was not evaluated further.

Alternatives for the Tottenville Shoreline Protection Project

As discussed above, the Shoreline Project had its genesis in the New York Rising Community Reconstruction initiative established by Governor's Office of Storm Recovery. The program coordinated with State and Federal agencies to help guide the development of feasible projects. The plan for the South Shore of Staten Island included dunes with a stone core and sand cap, planted for stabilization, from Brighton Street to Joline Avenue. Additional coastal strategy alternatives evaluated for the Shoreline Project are discussed below.

Levee

During the design process, a levee, an alternative strategy to a dune, was evaluated for feasibility and appropriateness along the Tottenville shoreline. The evaluation determined that while a levee would provide protection from wave action and still water flooding, the structure would need to be very large in scale (at approximately an elevation of 23 feet), would be visually

obtrusive, would restrict community waterfront access, would not meet the social resiliency goals and objectives of the Proposed Actions, and would be cost prohibitive (see **Figure 1-21**). For all of these reasons, this strategy was not considered practicable and was eliminated from further consideration.

Seawalls, Bulkheads or Ecologically Enhanced Seawalls or Bulkheads

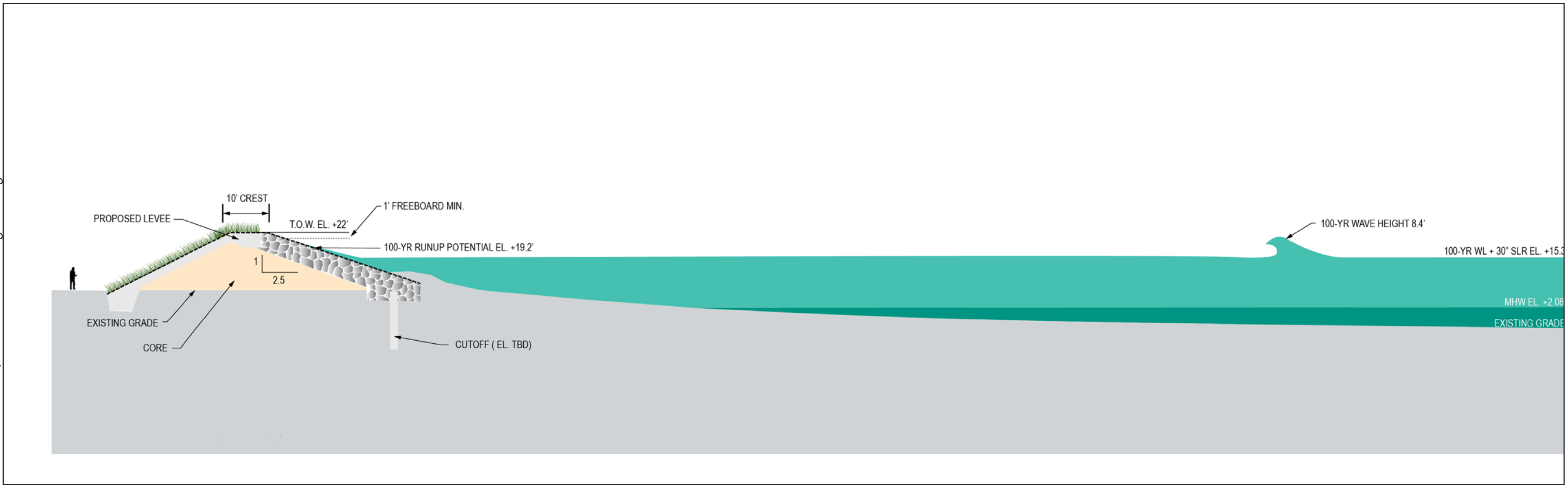
Seawalls and bulkheads are hard structural features placed at the shoreline to stabilize the upland and prevent further erosion of the shoreline. They are typically used when there is not sufficient space available for more gradually sloped and "natural"/ecologically sensitive options. Seawalls and bulkheads tend to have greater impacts on existing habitats and disrupt existing/natural hydrologic and sediment processes. Ecologically enhanced seawalls or bulkheads (which can be referred to as absorptive edges) are modified seawalls or bulkheads designed to provide shallower slopes that expand the interface between land and water and introduce hard or soft habitat features into the structures. They are typically proposed to replace seawall and bulkhead infrastructure that has been destroyed, structurally impaired, ore deteriorated over time. This expanded interface provides more surface area for friction plantings, designed to attenuate waves and prevent erosion of the shoreline. Absorptive edges attempt to mimic coastal ecosystems and the risk reduction benefits of hard structural features while attempting to mitigate some of their negative environmental impacts. Absorptive edges are ecologically engineered with a range of materials including reinforced ecological concrete, stone, gabions, and geotextiles to prevent erosion to edges located in high velocity wave environments.

The shoreline of the south shore of Staten Island is largely beach, with a gradually sloping shoreline. With the exception of intermittent groins and one revetment, the shoreline is not currently hardened. While space between the MHW line and adjacent homes and infrastructure is at times narrow, it is generally relatively wide, providing space for beach, and often dunes and upland forest. There is a large tidal range and a wide area of intertidal beach habitat. As a hardened condition is found at only a very limited extent along the Tottenville shoreline, and there is sufficient public land adjacent to the beach and in the near shore to explore less environmentally impactful strategies that support the project purpose and need to provide erosion reduction, wave attenuation and habitat creation, seawalls and bulkheads were not advanced as a potential strategy for the Tottenville Shoreline. Absorptive edges are also not a strategy suited for the entire project area for the reasons above, but at specific targeted locations where existing hardened structures are present, these measures may be suitable for incorporation into the design of the Shoreline Project. For all these reasons, seawalls, bulkheads, or ecologically enhanced seawalls or bulkheads were not considered practicable and were not considered further.

DESIGN ALTERNATIVES

Breakwaters Project

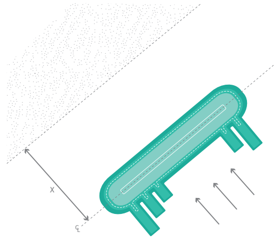
The design of the breakwater system will consist of offshore, detached breakwater segments. Distance from shore, breakwater segment length, gap width and crest elevation are anticipated to have the greatest effect on the breakwaters' influence on wave action and sediment movement (see **Figure 1-22**). Initial analysis and modeling efforts examined design alternatives to evaluate the impact of breakwater length, spacing, and distance from shore on long-term shore change (erosion and accretion over a 20-year period) and the wave climate in the lee of the breakwaters. Additional modeling simulations were performed on potential breakwater system configurations to determine system performance and evaluate various layout options to minimize footprint



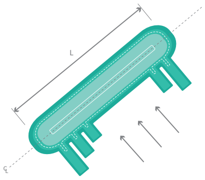
Source: *Stantec / RACE Coastal Engineering*

Coastal Strategy Alternative: Levee

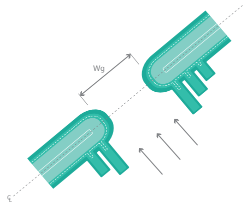
Figure 1-21



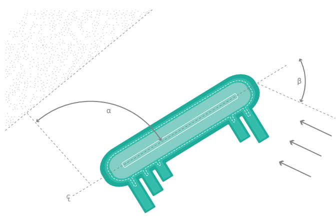
Distance from Shore (X) is the distance of the breakwater centerline from the shoreline. For the purpose of this project, the shoreline will be assumed to be the mean high water (MHW) line.



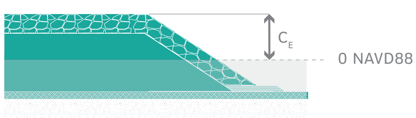
Breakwater Length (L) is the length of an individual breakwater segment's centerline in the long direction (as measured at elevation 0 NAVD88, approx. +.24 MSL, +2.62 MLW).



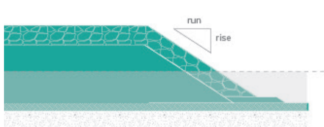
Gap Width (Wg) is the distance between the end of one breakwater segment and an adjacent breakwater measured along the breakwater centerline at 0 NAVD88 (approximately .24 MSL).



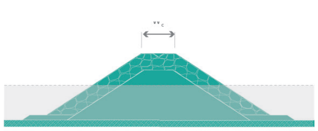
Orientation is the angle of the breakwater segment relative to the shoreline or prevailing wave direction.



Crest Elevation (Ce) is the elevation of the top of the breakwater relative to 0 NAVD88. 0 NAVD88 in this location is approximately 2.62′ above MLW and 2.08′ below MHW.



Side slope (ss) is the angle of the face of the main breakwater segment, expressed as the rise (vertical dimension) over the run (horizontal dimension). Side slope may vary based on material and habitat requirements, among other factors. Side slopes may vary across the system, and between the landward and ocean-ward side of the breakwater. For 30% design, it is assumed that the side slope of the main breakwater segments will be 1:2.



Crest width (Wc) is the width of the flat portion of the emergent crest of the breakwaters. For 30% design, it is currently assumed that the crest width of all breakwaters shown will be 13 feet. The total width of individual breakwater segments will vary across the system based on a variety of factors including the breakwater's crest elevation, crest width, water depth, breakwater type/construction, material, side slopes, and tolerated bottom coverage or habitat displacement.

Source: *SCAPE / Landscape Architecture PLLC*

Breakwaters Design Features

Figure 1-22

while achieving project goals. In the 30 percent design phase, 15 design alternatives were evaluated. Those that did not adequately meet the project's goals and objectives were subsequently eliminated from further consideration. Further refinements were evaluated during the 60 percent design phase of the preferred alternative. Throughout the process, the footprint of the breakwaters has decreased significantly, minimizing the potential for impacts associated with the placement of the breakwater materials within Raritan Bay—from the original RBD conceptual alignment of 13,000 linear feet of breakwaters, to 3,900 linear feet in the 30 percent design phase, to a total length of 3,200 feet in the preliminary 60 percent design phase.

The first three design alternatives (or scenarios) are shown on **Figure 1-23**. Scenarios 1 through 3 explored various overall lengths of breakwaters systems, breakwater segment lengths, and gap widths. Scenario 1 explored a breakwater system that would stretch linearly off shore spanning a length of approximately 3,900 feet, from west of Wards Point to approximately Cunningham Road. This scenario was found to provide effective shoreline stabilization in almost all areas, with the least effect for the portion of the shoreline farthest from the breakwater structures. This system was eliminated as it showed trapping of greater amounts of sediment updrift, potentially limiting the potential for sediment capture downdrift. Scenario 2 evaluated a shorter system (from approximately Brighton Street to just east of Page Avenue) with smaller gap widths. This system was found to act like a single breakwater, effective at allowing fewer and lower waves through. However, with sediment being trapped updrift and without coverage offshore west of Brighton Street, this system would have the potential to exacerbate erosion in the western part of Conference House Park. Scenario 3 explored longer breakwater segments with wide spacing between them, and adding coverage west near Wards Point. While the long segments would be effective with respect to wave attenuation, there would be little wave attenuation in the wide gaps between them.

Scenarios 4 through 7 are shown in **Figure 1-24**. In response to the information gathered from the modeling efforts described above, Scenario 4 explored the effects of varying the breakwater layout by region along the shore, with lower crested breakwaters in the western portion offshore from Wards Point. This alternative was found to stabilize the shoreline along its length, and was effective with respect to wave height reduction throughout most of the project area. However, sediment trapped in the eastern portion would not reach the western areas where accretion is desired. Also, the lower crested segments along the western edge showed little effectiveness in attenuating waves under higher water levels. Scenario 5 modified Scenario 4, bringing the breakwaters closer to shore and removing segments in the eastern portion to allow sediment to move further west along the shore. This breakwater configuration increased shoreline accretion and wave attenuation. Significant accretion was found between Page Avenue and Manhattan Street, but erosion continued further west. Scenarios 6 and 7 evaluated "minimalist" alignments with and without an area of shoreline restoration between approximately Manhattan Street and Sprague Avenue. The shoreline restoration would shift the shoreline outward and the breakwaters behind it were shown to retain the sand. Therefore, a "one-time" placement could be sufficient over the long-term.

Figures 1-25 and 1-26 depict Scenarios 8 through 15, in which various groupings of breakwaters were evaluated to address the western, central and eastern shoreline areas. Scenario 8 was developed but deemed infeasible and therefore was not modeled. Scenarios 9 through 12 were developed to explore the impacts on shoreline change of various breakwater alignments with a minimized/reduced overall footprint. A system with the western and central breakwaters segments closer to shore was explored in Scenario 9, including the elimination of the western-most section. This system was shown to enhance shoreline protection in the central and western

Scenario 1

Scenario 2

Scenario 3

Source: *SCAPE / Landscape Architecture PLLC*

Design Scenarios: 1 through 3

Figure 1-23

Scenario 4

Scenario 5

Scenario 6

Scenario 7

***Source:** SCAPE / Landscape Architecture PLLC*

Design Scenarios: 4 through 7

Figure 1-24

NOT MODELED

Scenario 8

Scenario 9

Source: SCAPE / Landscape Architecture PLLC

Scenario 10

Scenario 11

Design Scenarios: 8 through 11

Figure 1-25

Scenario 12

Scenario 13

Scenario 14

Scenario 15

Source: *SCAPE / Landscape Architecture PLLC*

Design Scenarios: 12 through 15

Figure 1-26

areas, but the removal of the western-most segments resulted in considerable erosion of Wards Point. In Scenario 10, the central segments were repositioned and moved farther offshore, and the western breakwater segment was moved westward to add coverage at Wards Point. This improved the shape of the central shoreline without any noticeable loss in shoreline retention, but continued erosion was projected adjacent to Wards Point. Scenarios 11 and 12 explored the effects of eliminating, splitting and adding back of breakwater segments with varying results in terms of erosion along those areas, and increased wave exposure between the central and eastern groupings due to the removal of one of the eastern segments.

Shoreline change modeling of Scenarios 9 through 12 indicated that the desired beach growth/erosion reduction for the central section of the project area was achievable, however, did not yet yield the shoreline stabilization or erosion reversal desired for the southwestern section of the project area (Wards Point). Scenarios 13 and 14 focused on the western-most segments and found that moving that grouping westward and lengthening the segments would improve the shoreline shape and virtually eliminate erosion in that area. Consistent beach accretion was achieved between approximately Yetmen Street and Page Avenue. However, the wave exposure between the central and eastern groupings would continue to occur. To address this, Scenario 15 evaluated the effects of adding an additional breakwater segment to the central and eastern groupings in order to provide storm wave attenuation (analysis of historic wave data indicate that the vast majority of large storm waves come from the east and southeast), while considering the need to balance shoreline response. This resulted in additional accretion in the eastern portion of the shoreline but a reduction of accretion farther downdrift to the west. The addition of a one-time shoreline restoration for the narrow and erosion prone beach between Manhattan and Loretto Streets to the breakwater alignment modeled in Scenario 15 achieved the positive shoreline response of Scenario 14 while offering the additional storm wave attenuation of Scenario 15 and was ultimately selected as the preferred 30 percent design scenario.

During 60 percent design, additional modeling was undertaken to optimize the breakwater layout (see **Figure 1-27**).[9] The design wave conditions were refined to take into account the directionality observed in the transformed wave data set. Based on this information, further modifications were made to the breakwater alignment to reduce the overall breakwater footprint and volume without compromising shoreline response and storm wave attenuation goals. These design modifications included first increasing the spacing between the breakwaters in the central section (increasing the gap width from 100’ to 200’ while maintaining the same east and west end points in the system) which resulted in the elimination of one breakwater segment in this section (six to five). This interim scenario (Scenario 16) was modeled in GENESIS, and found to have a desirable shoreline response. Further opportunity for optimization was identified in Scenario 17, which modified the eastern group of two breakwaters by shortening both breakwaters and moving one of the breakwaters closer to shore, resulting in a further reduction in footprint and volume. The resulting alignment (Scenario 17) was analyzed in GENESIS and demonstrated the potential for a more even shoreline response. The storm wave attenuation performance of Scenario 17 was also analyzed with REFDIF and found to achieve the storm wave attenuation performance targets of the project. Thus, it was concluded that the Scenario 17

[9] The DEIS provided an analysis of the 30 percent design parameters of the proposed breakwater system. The analyses presented in this FEIS are based on the preliminary 60 percent design, which include modifications that have been made since the publication of the DEIS.

Scenario 16

Scenario 17

Source: *SCAPE / Landscape Architecture PLLC*

Design Scenarios: 16 through 17

Figure 1-27

layout met the performance goals of shoreline retention and wave attenuation while minimizing breakwater footprint and volume.

As discussed above, these design alternatives were modeled to determine system performance and evaluate various layout options to minimize footprint while achieving project goals. Based on the results, it was determined that a configuration of breakwaters as proposed under Scenario 17 with a one-time placement of sand for shoreline restoration as explored in Scenario 7 (with a reduction in linear feet of sand by approximately half) would achieve the desired wave attenuation and shoreline response to meet the project goals and objectives. This combination is proposed as the preliminary 60 percent design scenario and is analyzed as part of Alternative 2, the Preferred Alternative.

Shoreline Project

As part of the NY Rising Community Reconstruction initiative, the plan for the South Shore of Staten Island included hybrid dunes with a stone core and sand cap, planted for stabilization, from Brighton Street to Joline Avenue. After evaluating site-specific data, it became apparent that between Loretto Street and Sprague Avenue, there was not enough space on the beach to accommodate the width that a dune would require. Additionally, between Sprague Avenue and Joline Avenue, site-specific data indicated that the limit of wave action does not extend into the community, and the residential community is less dense near the shoreline. Therefore the goal for this area was focused on erosion control while accounting for future sea level rise. For these reasons, the proposed hybrid dune/revetment system was shortened to address the area between Brighton Street to Loretto Street.

Several design alternatives for the proposed hybrid dune/revetment were evaluated for different storm scenarios (see **Figures 1-28 and 1-29**). These alternatives include the following:

- Dune without stone core; and
- Dune with stone core.

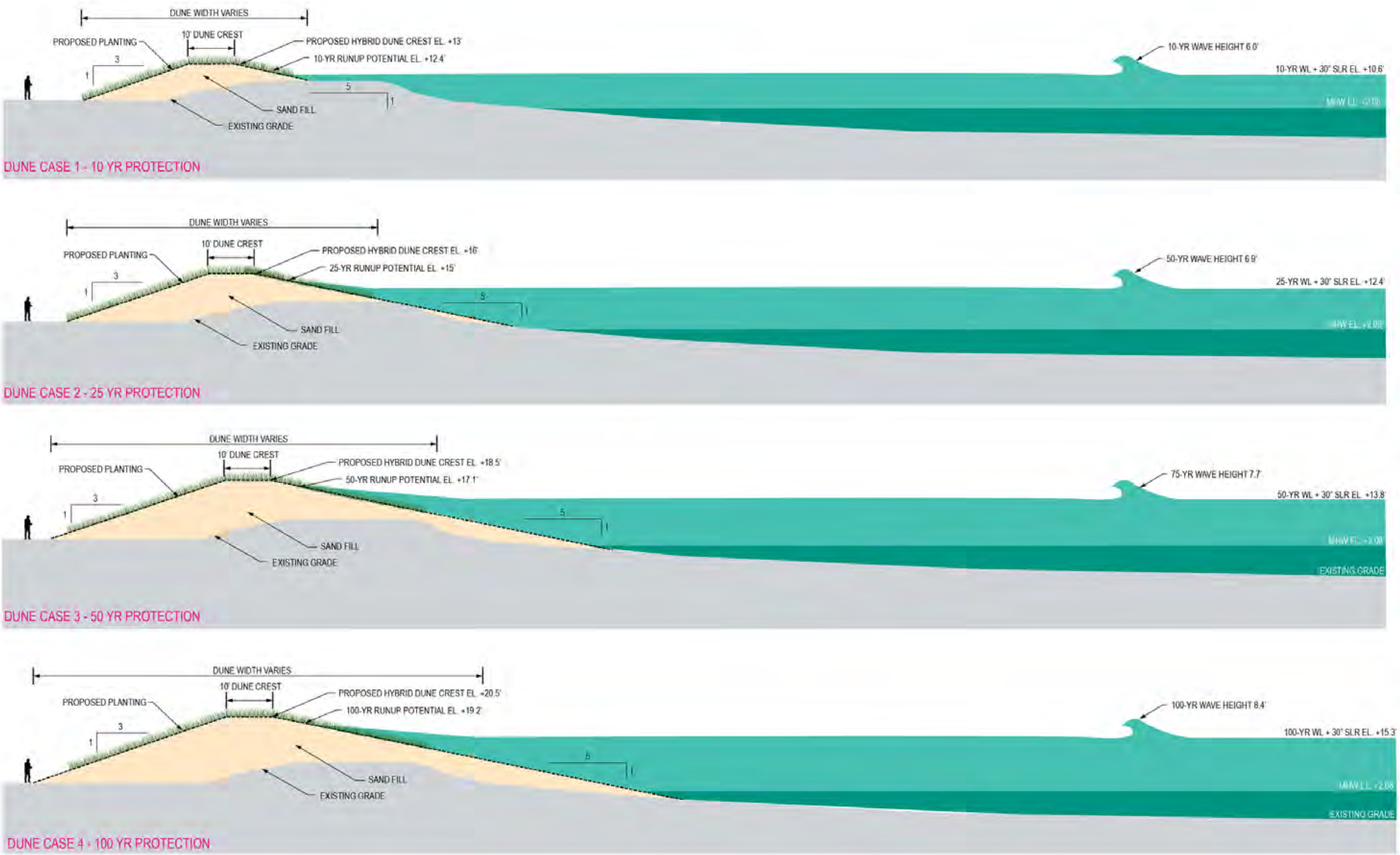
These dune alternatives were evaluated at various crest elevations for wave-breaking potential and over-topping protection level.

The design scenarios that would not include a stone core would experience loss of sand and, therefore, effectiveness during extreme storm events, requiring long-term sand replenishment and maintenance. For these reasons, these design alternatives were eliminated from further consideration.

Protecting from over-topping from 50-year and 100-year storm events would require crest elevations of more than 18 feet, which would be visually obtrusive, would restrict community waterfront access, and would be cost prohibitive. For these reasons, these design alternatives were eliminated from further consideration. Therefore, a design scenario that would provide the desired level of risk reduction, withstand overtopping during severe storm events, and meet the project goal of maintaining waterfront access was advanced as the 30 percent design and is analyzed as part of part of Alternative 2, the Preferred Alternative.

1.6 POTENTIAL REGULATORY APPROVALS

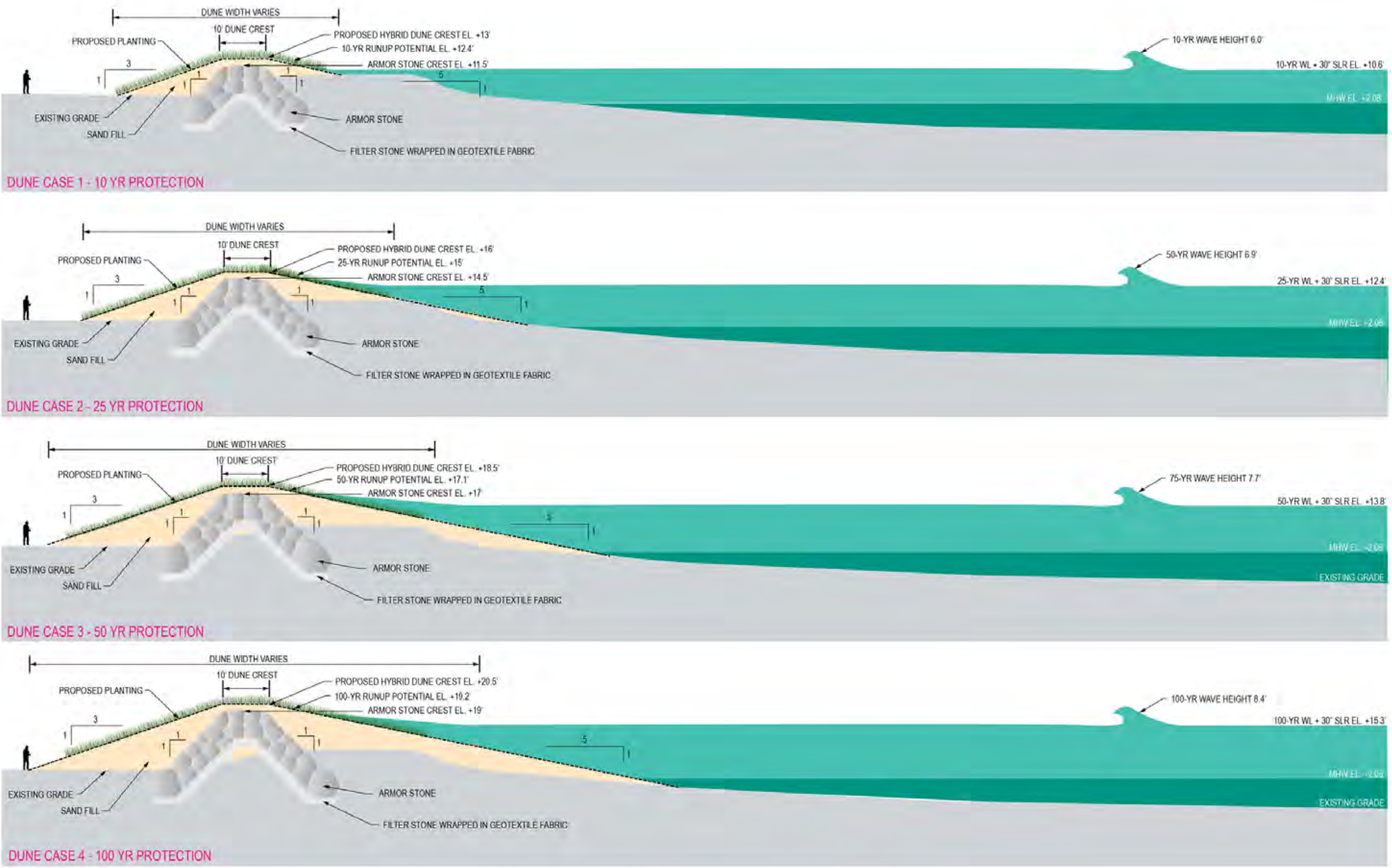
Implementation of the Proposed Actions may involve federal, state and local approvals, and is subject to NEPA and SEQRA and their implementing regulations. The Federal, State and City



Source: *Stantec / RACE Coastal Engineering*

Design Alternative:
Dune without Stone Core

Figure 1-28



***Source:** Stantec / RACE Coastal Engineering*

Design Alternative: Dune with Stone Core

Figure 1-29

agencies that may potentially be involved in the environmental review and permitting process for the Proposed Actions include:

1.6.1 FEDERAL

- United States Department of Housing and Urban Development—Disbursement of funds, administration of CDBG-DR grant to the State of New York; review of Action Plan Amendments.
- United States Army Corps of Engineers—Issuance of permits for discharges of dredged or fill material into Waters of the U.S. (Section 404 of the Clean Water Act [33 USC 1344]); and issuance of permits for structures and work within navigable waters (Section 10 of the Rivers and Harbors Act [33 USC 403]).
- Environmental Protection Agency, U.S. Fish and Wildlife Service, National Marine Fisheries Service—Advisory agencies to Army Corps of Engineers during permit review focusing on activities that affect wetlands, protected species and Essential Fish Habitat.
- United States Coast Guard—Coordination and authorization regarding marking/lighting for new in-water structures, and placement of construction barges.
- Federal Emergency Management Agency—Review of breakwater and shoreline protection system design with respect to Flood Hazard Areas.

1.6.2 STATE OF NEW YORK

- Governor's Office of Storm Recovery—Acting on behalf of Grantee the State of New York, and under the auspices of the Homes and Community Renewal's Housing Trust Fund Corporation, funding decisions for Proposed Actions and responsibility for environmental review, decision-making, and action under 42 U.S.C. § 5304(g).
- Department of Environmental Conservation—Permits related to activities in tidal wetlands or adjacent areas (Article 25), freshwater wetlands or buffer areas (Article 24), or protection of waters (Article 15), Water Quality Certification (Section 401); coastal erosion management permit for structures in the Coastal Erosion Hazard Area (CEHA, Article 34), License to Collect, Possess, or Sell for shell fish placement and post-construction biological monitoring, potential Beneficial Use Determination (BUD) relating to potential re-use of excavated fill or material.
- Department of State—Coastal Zone Consistency for Federal direct and funding actions, as well as actions requiring Federal permits.
- Office of General Services—Review of actions involving use of State-owned submerged lands or payment of royalties for materials removed from such lands, as well as possible issuance of a lease, license and/or easement.
- Office of Parks, Recreation, and Historic Preservation—Advisory role in federal permit review process pursuant to Section 106 of the National Historic Preservation Act (NHPA) with respect to designated and protected properties on the State and National Register and Eligible buildings and places. Assessment of potential submerged cultural resources. Interested party with respect to secondary impacts to natural resources on State-owned lands.

1.6.3 CITY OF NEW YORK

- Department of Parks and Recreation—Jurisdiction for land under water along project area shoreline and upland areas within Conference House Park; as well as review of plans and designs for modifications to parkland, including permits and natural resources oversight in connection with forest/tree protection and protection/restoration of aquatic resources and adjacent wetland maritime shrubland resources.
- Department of Environmental Protection—Possible stormwater management, water and sewer infrastructure, natural resources.
- New York City Planning Commission/Planning Department—Planning and Coastal Zone Consistency decision-making.
- New York City Public Design Commission—Review of art, architecture and landscape features proposed for City-owned property and capital projects.
- Landmarks Preservation Commission—Advisory agency for activities on or near sites of historic or archeological value.
- New York City Department of Buildings—Construction permits.
- New York City Department of Transportation—Current jurisdiction of certain mapped right of ways in project area, possible street and traffic oversight.

1.7 PRELIMINARY CONSULTATION

Since the October 2014 notice, GOSR has engaged in a series of meetings and consultations with federal, state, and local agencies concerning the alternatives described in the scoping document. Many of these consultations were coordinated by the Sandy Regional Infrastructure Resiliency Coordination group (SRIRC). The SRIRC was created by the federal Sandy Recovery Office and serves as the primary facilitator for federal agency coordination on recovery/resiliency projects. Specifically, the alternatives described in the scoping document were discussed before the New York City Technical Coordination Team (TCT) and the Coastal Resiliency TCT. In addition, in February 2015, GOSR received initial feedback on its technical approach and scoping document from the Federal Review and Permitting panel, which is also coordinated by the SRIRC. The SRIRC process has been, and will continue to be, an integral component of the planning, review, permitting, and implementation of the alternatives described in this document.

Further, on January 30, 2015, GOSR circulated a lead agency/cooperating agency letter to involved and interested federal, state, and local agencies, along with a preliminary version of the draft scoping document. GOSR received verbal or written comments on the draft scope from, among others, USACE, NYSDEC, NYSDOS, and New York City agencies, including NYC Parks.

To date, the following federal agencies, have agreed to participate, to the extent possible, as cooperating agencies under NEPA:

- USACE;
- EPA; and
- NOAA/NMFS.

HUD, which grants GOSR the authority under 24 CFR Part 58, to serve as the responsible entity under NEPA, will also be deeply engaged in the EIS process.

GOSR is also actively coordinating with State and local involved and interested agencies under SEQRA, including NYSDEC, NYSDOS, OPHRP, OGS, and the New York City agencies, including the New York City Mayor's Office of Environmental Coordination (MOEC), NYC Parks, NCDOT, NYCDCP, New York City Department of Environmental Protection (NYCDEP), Mayor's Office of Sustainability, NYCDOT, and the New York City Landmarks Preservation Commission.

1.8 ENVIRONMENTAL REVIEW PROCESS

On behalf of the State of New York, GOSR, acting under the auspices of New York State Homes and Community Renewal's Housing Trust Fund Corporation, as the Responsible Entity in accordance with 24 CFR 58.2(a)(7) and as the lead agency responsible for environmental review, decision-making, and action under 42 U.S.C. § 5304(g), determined that the Proposed Actions have the potential to result in significant adverse environmental impacts. Therefore, at GOSR's request, HUD issued a Notice of Intent to Prepare an EIS (NOI EIS) to satisfy NEPA procedural requirements in accordance with 24 CFR Part 1502. The NOI EIS was published in the Federal Register on April 20, 2015. The EIS also satisfies the requirements of the State Environmental Quality Review Act (SEQRA), and GOSR shall serve as lead agency for purposes of SEQRA.

The environmental review process provides a means for decision-makers to systematically consider environmental effects along with other aspects of project planning and design, to evaluate reasonable alternatives, and to identify, and mitigate where practicable, any significant adverse environmental impacts.

1.8.1 SCOPING PROCESS

The first step in preparing the EIS document is the public scoping process. Scoping, or creating the scope of work, is the process of focusing the environmental impact analysis on the key issues relevant to the proposed project. As described above, the scope of work and the proposed impact assessment criteria to be used in the EIS is largely based on the methodologies and guidance set forth in the 2014 *City Environmental Quality Review (CEQR) Technical Manual*.

The Draft Scope of Work (Draft Scope) for this project was issued on April 1, 2015. The NOI EIS included notice of the public scoping session held on April 30, 2015. Oral and written comments were received during the public scoping session. Written comments were accepted from issuance of the Draft Scope through the public comment period which ended June 15, 2015. The Final Scope of Work for the DEIS was issued on April 1, 2016 and reflects modifications due to certain design advancements since the issuance of the Draft Scope of Work as well as changes made in response to relevant public comments on the Draft Scope.

1.8.2 ENVIRONMENTAL IMPACT STATEMENT

As the recipient of HUD CDBG-DR funds, GOSR is conducting the environmental review for the Proposed Actions in accordance with 24 Code of Federal Regulations (CFR) Part 58, 40 CFR Parts 1500-1508 and 6 NYCRR Part 617. Because the Proposed Actions are located in New York City, the *CEQR Technical Manual* serves as a guide with respect to methodologies and impact criteria for evaluating the Proposed Actions' impacts. Accordingly, the

environmental review is being prepared in accordance with NEPA, SEQRA, and in consideration of CEQR guidance. In addition, review of the Proposed Actions is being coordinated with review pursuant to other applicable State and local laws and regulations, such as Section 106 of the National Historic Preservation Act of 1966 (NHPA).

The Notice of Availability and Notice of Completion for the DEIS for the Proposed Actions was issued by GOSR on March 24, 2017. GOSR held a duly noticed public hearing on the DEIS on April 26, 2017, at Public School 6, 555 Page Avenue, Staten Island, NY 10307. The comment period remained open for receiving written comments until May 8, 2017. This FEIS has been prepared, including a summary of the comments and responses on the DEIS and any necessary revisions to the DEIS to address the comments. No sooner than 30 days after publishing the FEIS, GOSR, as lead agency, will prepare a Record of Decision and Statement of Findings that describe the preferred alternative for the project, its environmental impacts, and any required mitigation.

1.8.3 ONGOING CONSULTATION AND PUBLIC ENGAGEMENT

Since the publication of the Final Scope of Work for the DEIS, GOSR has held a number of meetings with local community residents, Staten Island Community Board 3, elected officials, preservation and environmental groups, and other local and regional community based organizations. GOSR established a Citizens Advisory Committee (CAC) to offer additional opportunity for public input and for the State, and its design teams, to receive advice on design as the project progresses through construction. To date, eight public CAC meetings have been held in the Tottenville, Staten Island community providing an opportunity for input on project elements and design. The CAC also joined GOSR and its design teams on multiple shore-walks to further raise awareness of the project site and the elements of the project as it progressed through design.

In addition, GOSR has worked closely with NYC Parks, the Mayor’s Office of Recovery and Resiliency, NYCEDC, the Dormitory Authority of the State of New York, and other city, state and federal agencies including the SRIRC as design of the Proposed Projects progressed. In July 2015, GOSR entered into a Memorandum of Agreement with NYC Parks outlining terms for project coordination including the design process, environmental review, public outreach, permitting and other actions related to the design and construction of the Proposed Projects.

GOSR will continue to consult with key federal (including USACE, NOAA/NMFS, USFWS, and USEPA), state (including DOS, OPRHP, and NYSDEC), and City agencies (including MOEC, NYC Parks, NYCDEP, and NYCDOT) as needed throughout the environmental review process. ✷