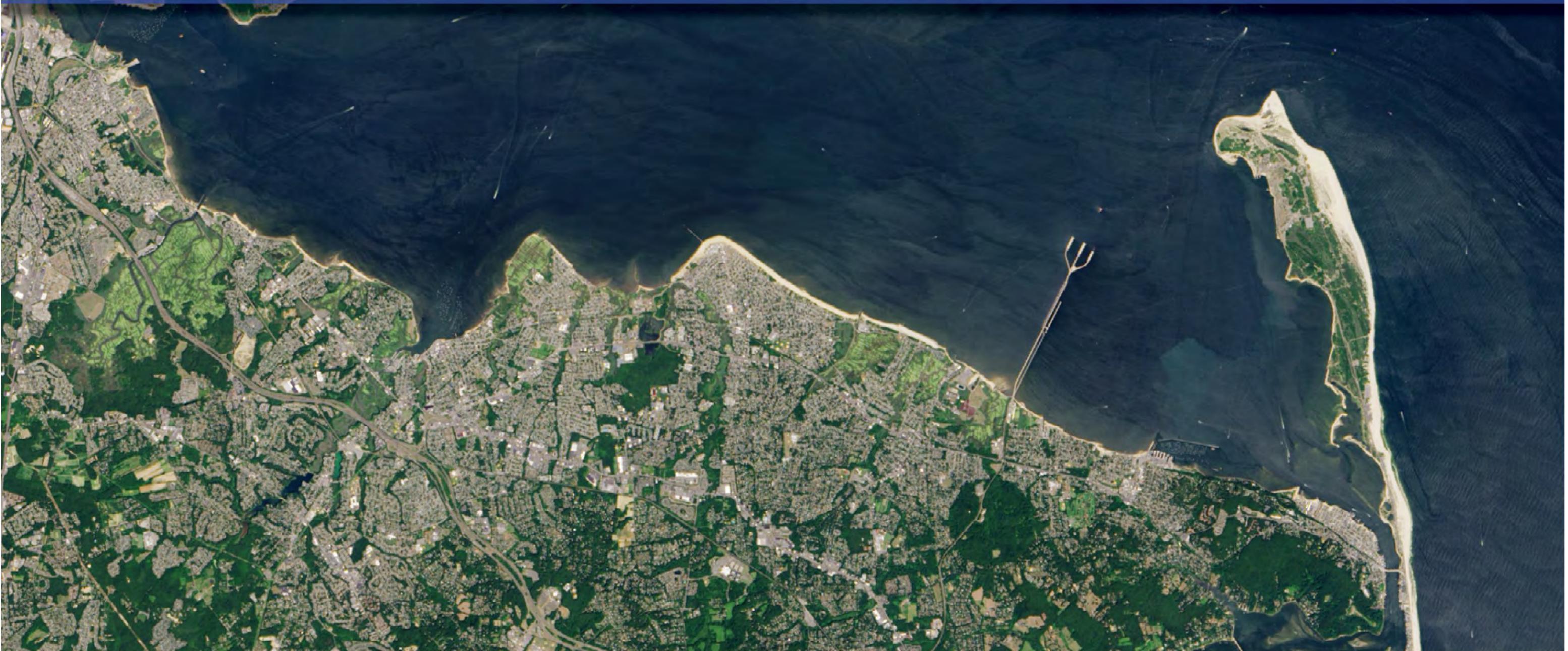


# RARITAN/SANDY HOOK BAY COASTAL RESILIENCE PLANNING STUDY



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DECEMBER 2019

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A special thanks to the Technical Advisory Committee (TAC) for their contribution and support in the development of this plan. A complete list of the TAC is located in Appendix E.

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*Disclaimer: "This study was prepared under contract with Monmouth County, New Jersey, with financial support from the Office of Economic Adjustment, Department of Defense. The content reflects the views of the Joint Land Use Study (JLUS) Policy Committee and does not necessarily reflect the views of the Office of Economic Adjustment."*

## EXECUTIVE SUMMARY

The Raritan/Sandy Hook Bay Coastal Resilience Planning Study (Coastal Resilience Planning Study) continues the work of the Joint Land Use Study for Naval Weapons Station (NWS) Earle. The purpose of the Coastal Resilience Planning Study is to select coastal resilience projects that could improve the sustainability and resiliency of NWS Earle facilities and navigational channels; the US Army Corps of Engineers (ACE) projects; and the Bayshore municipalities from current and future coastal hazards.

The Study Area includes the entire Monmouth County southern Raritan/Sandy Hook Bayshore, north of NJ Route 36, between Cliffwood Beach (Aberdeen Township) and Gateway National Seashore–Sandy Hook Unit. The Study Area crosses eight municipalities: Aberdeen Township, Keyport Borough, Union Beach Borough, Hazlet Township, Keansburg Borough, Middletown Township, Atlantic Highlands Borough and Highlands Borough. The waterfront facilities of NWS Earle; USACE and Earle maintained navigational channels; and a number of proposed and existing USACE shore protection project sites are located within the Study Area.

## TECHNICAL ADVISORY COMMITTEE

The consultant, Michael Baker International, partnered with the Project Manager from the Monmouth County Division of Planning and the Community Plans and Liaison Office from Naval Weapons Station (NWS) Earle (Project Team) to recruit a Technical Advisory Committee (TAC) for this plan. The TAC is comprised of representatives from Federal, state, and municipal governments; academia; and non-profits. After the TAC was assembled, the Project Team held a kick-off meeting to introduce the project, the Project Team, and gather information from each partner on current projects and conditions in the Study Area. The Project Team and the TAC collaborated at regular meetings and via email to compile and review background research, review proposed concept sites, select final preferred sites and project alternatives, and plan for implementation.

## DATA COLLECTION

The Project Team and the TAC compiled information from local knowledge, Army Corps of Engineers project fact sheets, municipal and County documents, and various state sources to identify a total of 65 completed, ongoing, or potential coastal resilience and flood mitigation projects within the Study Area. Of these 65 projects, 22 projects were complete or under construction, seven projects were in the planning phase, and 36 potential projects were identified.

Projects that were considered complete, under construction, or in the planning phase were later used to develop input layers for the Site Suitability Analysis and to inform the development of concept plans for the most suitable project sites.

Figure 1: TAC Meeting #3 (June 2019)



## SITE & PROJECT SELECTION

The Project Team chose to evaluate site suitability based on six categories: Direct Benefits to NWS Earle, Flood Exposure, Natural Systems, Social Considerations, Infrastructure, and Existing Projects. Each of these categories had corresponding sub-categories with indicator variables for analysis.

Each sub-category variable was converted to a raster file format, which stores information by numerical values for GIS analysis. Using a quantitative weighted overlay analysis, the Project Team assigned a numerical value to every cell in each sub-category's raster to indicate that cell's suitability for future coastal resilience projects. Each sub-

category was then weighted according to its relative importance as determined by the TAC. Using the weighted overlay output, the Project Team and the TAC evaluated the 36 potential projects to identify opportunities for integrating highly-ranked and complementary projects into a single, more holistic, proposed coastal resilience solution. Ultimately, concept plans were developed for 11 proposed coastal resilience projects.

## PROJECT SUMMARIES

As a result of the data collected and the site suitability analysis, a concept plan design, photo simulation, environmental constraints map, and materials and quantities list were created for the final 11 proposed coastal resilience projects:

1. Whale Creek Restoration/Cliffwood Beach Stabilization
2. Happy Meadows Wetland Restoration
3. Flat Creek Restoration
4. Keansburg Beach Replenishment
5. Compton Creek Wetland Restoration
6. Belford Beach Stabilization
7. Ware Creek Resiliency Project
8. Leonardo Resiliency Project
9. Many Mind Creek Beach Restoration
10. Henry Hudson Trail Shoreline Protection
11. Highlands Stormwater Improvements

### 1. Whale Creek Restoration/Cliffwood Beach Stabilization

Cliffwood Beach (Aberdeen Township) is at risk of erosion and the marsh surrounding Whale Creek currently experiences flooding during high tides. The concept plan proposes Restoring salt marshes will enhance their ability to act as natural buffers to reduce impacts of storm-induced surge and waves while the maritime forest berm will help provide a buffer to Lakeshore Drive. The proposed wave attenuating devices, dune restoration, and beach replenishment would complete the proposed improvements by reducing the potential for erosion.

Figure 2: Cliffwood Beach, Aberdeen Township, NJ (October 2019)



## 2- Happy Meadows Wetland Restoration

Cliffwood Beach (Aberdeen Township) and the Borough of Keyport are at risk of coastal flooding due to their low-lying locations surrounding Matawan Creek, which flows into Lake Lefferts and Lake Matawan. Extensive Phragmites in the Happy Meadows tidal marsh dominates the creek between Ravine Drive and the mouth of Keyport Harbor. The concept plan proposes restoring marshlands to enhance their ability to act as natural buffers to reduce impacts of storm-induced surge and waves, as well as a maritime forest berm to provide a buffer to the surrounding residential area.

Figure 3: Happy Meadows, Aberdeen Township, NJ (October 2019)



## 3- Flat Creek Restoration

Union Beach is at risk of coastal flooding due to its low-lying location containing large tracts of Bayshore wetlands and tidal Flat Creek. The floodplain along Flat Creek is an ecologically-sensitive area that has been disturbed and has eroded over time, degrading conditions, causing flooding and negative environmental impacts. The proposed concept intends to restore the marsh surrounding Flat Creek and create an upland maritime forest berm buffering local residences from the marsh. The proposed concept could enhance, but not interfere with any USACE work for Union Beach, and help reduce flooding on Route 36, which provides access to the NWS Earle Pier Complex.

Figure 4: Flat Creek, Union Beach, NJ (June 2017)



## 4- Keansburg Beach Replenishment

Keansburg is at risk of current and future coastal flooding due to its low-lying location adjacent to Raritan Bay. As an active U.S. Army Corps of Engineers beach replenishment project, material available from Federal channels could potentially be used to replenish the beach and could help absorb flood events along the long shoreline; upland dune enhancement is also proposed.

Figure 5: Keansburg, NJ (October 2019)



## 5 - Compton Creek Wetland Restoration

Belford and Port Monmouth (Middletown Township) are at risk of coastal flooding due to their low-lying locations containing Compton Creek. The proposed concept site is primarily north of Broadway where Compton Creek enters a 2,000-foot wide Salt Hay Grass-dominated floodplain characterized by historic drainage and mosquito ditches. Current mitigation strategies include an existing bulkhead, a rock groin breakwater, and possible future maintenance dredging by the USACE. The concept proposes a marsh restoration, an upland berm maritime forest along Church Road, and repairs to the existing bulkhead along Belford Harbor.

Figure 6: Compton's Creek, Middletown, NJ (July 2016)



### 6 - Belford Beach Stabilization

Belford (Middletown Township) experiences coastal flooding in the low-lying locations between the tidal waterways of Compton Creek and Ware Creek. This location includes the Belford Ferry Terminal and other utility facilities that serve NWS Earle. The proposed concept includes marsh restoration and an upland maritime forest berm along Ware Creek; the proposed concept also includes beach replenishment and upland dune restoration at the beach near Belford Harbor.

### 7 - Ware Creek Resiliency Project

Ware Creek and the surrounding marsh are tidally influenced and impacted by stormwater run-off and coastal erosion. The site contains a sandy beach, low and high marsh areas grading up into upland wooded habitat adjacent to the NWS Earle Pier Complex. The concept plan proposes restoring marshlands to enhance their ability to act as natural buffers to reduce impacts of storm-induced surge and waves, as well as upland restoration to provide a buffer to Normandy Road. Upland dune restoration landward of the replenished beach and expansion of the wave-attenuating oyster reef, currently within the NWS Earle Security Zone, could serve as nature-based solutions to mitigate flooding, erosion, and storm surge.

### 8 - Leonardo Resiliency Project

Adjacent to Sandy Hook Bay in Leonardo (Middletown Township) is a small depressed area surrounding an unnamed tidal creek. Located between the NWS Earle Pier Complex and Leonardo State Marina, the site contains a sandy beach, low and high marsh areas grading up into upland wooded habitat surrounded by residential lots. Stormwater collects in this 'bowl' particularly during high tides and contributes to nuisance flooding. The concept plan proposes marsh restoration bordered to the west by a maritime forest berm to provide a buffer to Normandy Road and neighboring properties. Upland dune restoration landward of the replenished beach, along with the expansion of the wave-attenuating oyster reefs within the NWS Earle Security Zone could serve as nature-based solutions to mitigate flooding and storm surge.

### 9 - Many Mind Creek Beach Restoration

Many Mind Creek, which drains into Sandy Hook Bay, contributes to flooding in Atlantic Highlands due to constrained flow at the outlet. The concept plan proposes clearing the existing outlet to allow the creek to properly discharge into the bay through a replenished beach; the plan further proposes an upland dune restoration to help protect the community from storm damage and flooding as well as provide habitat for local fauna.

Figure 7: Many Mind Creek, Atlantic Highlands, NJ (October 2019)



### 10 - Henry Hudson Trail Shoreline Protection

The Atlantic Highlands coastal bluffs, Henry Hudson Trail, the Bayshore Outfall Authority's force main pipe are at risk of current and future coastal flooding and erosion during storm events with damaging wave erosion and shoreline failure. The proposed concept intends to reduce erosive wave action and stabilize the shoreline and coastal bluffs to prevent damage to adjacent coastal bluff residences, protect the Regional trail access and stabilize and protect the function of the Bayshore Regional Sewer outfall pipe.

Additionally, the project will enhance the coastal experiences of the Trail and provide valuable coastal habitats for such coastal species as horseshoe crabs and beach nesting birds. Using wave attenuation devices/structures and the beneficial reuse of dredged sands the project will mitigate high energy waves and buffer the vulnerable

coastline.

### 11 - Highlands Stormwater Improvements

Highlands is at risk of current and future coastal flooding due to its low-lying location. The concept proposes potential locations for additional stormwater pump stations to help direct excess water into Sandy Hook Bay. Stormwater infrastructure improvements are proposed along the Route 36 roadway and in Veterans Memorial Park to capture runoff from higher elevations to the south. The proposed concept further suggests clearing sediment from the Jones Creek channel to help accommodate the increased water volume from Route 36. These stormwater improvements will help reduce flooding in downtown Highlands and on Route 36, which provides access to the NWS Earle Pier Complex.

Figure 8: Snug Harbor/Jones Creek: Highlands, NJ (October 2019)



### PLAN CONSISTENCY AND INTEGRATION

The concepts proposed in this plan align with many of the goals of the JLUS in a variety of categories, including:

**Land Use.** B.3. Land Conservation-Identify and pursue purchase of land that provide additional NWS buffer, storm/flood protection, and/or environmental enhancement.

**Economic Development.** C.6. Implementation of Bayshore Region Strategic Plan-Promote recreational amenities in the Bayshore Region, as outlined in the Bayshore Region Strategic Plan (2006), in

conjunction with NWS Earle requirements near secure waterfront areas and the pier. Promote continued use of County Park lands including Bayshore Waterfront Park, Henry Hudson Trail, Popamora Point, and Mount Mitchell as key locations that draw tourists to waterfront destinations and encourage the County Park System and NWS Earle to work together to reduce potential conflicts.

**Transportation. D.5. Bay: Channel Dredging**-Encourage support for accelerated maintenance of Sandy Hook channel.

**Utilities. E.3. Sewage Treatment**-Investigate flood-proofing measures for sewage treatment facilities servicing NWS Earle and surrounding neighborhoods.

#### Climate Resilience.

- **F.1. Storm Surge/Water Levels:** Encourage coordinated Federal, State, County, and Middletown Township effort to implement a naturalized beach erosion/shoreline protection project protecting both Navy and County/community waterfronts. Encourage the continuation of habitat restoration work at Bayshore Waterfront Park.
- **F.2. Storm Surge:** Develop a Marsh & Dune Restoration Plan that identifies where Navy dredge material can be beneficially used for storm protection. Coordinate with all parties prior to the Navy's next navigational channel and ship berthing dredging effort, including the County Division of Public Works and Engineering and the County Park System to determine if their facilities in the Bayshore might be suitable locations.
- **F.3. Localized Flooding:** Investigate potential joint stormwater management improvement projects to reduce local flooding in Leonardo community adjacent to the Navy's waterfront property.
- **F.4. NJ FRAMES:** Continue to work with NJ FRAMES as they develop resiliency recommendations.
- **F.5. Vulnerability Assessment:** Conduct site specific vulnerability assessments of critical assets exposed to future flood hazards, including: TOMSA facilities, Ferry Terminals,

Marinas, etc.

- **F.7. Community Rating System:** Continue to encourage improvement in Community Rating System (CRS) certifications by leveraging additional resilience efforts to generate analyses that will qualify for CRS points.
- **F.8. Transportation Corridors:** Consistent with the identification of work locations, identify critical transportation routes that may be subject to future storm damage and periodic inundation from nuisance flooding that would prevent commuting or base access to NWS Earle.
- **F.9. Local Planning Documents:** Sea level rise raises the baseline conditions for all types of coastal flooding. Revise County and local planning documents to reflect water level rise and exposure assessment that is integrated into coastal flood hazard planning using frameworks consistent with the Navy Handbook and Federal guidance. Also, work with the NJ Department of Transportation (DOT) and the Department of Environmental Protection (DEP) on integration consistency.

Further, the concepts proposed in this plan align with the stated goals and objectives of the 2016 Monmouth County Master Plan, reproduced here:

**Master Plan Goal #2:** Promote the protection a conservation of natural and cultural resources to help guarantee out long-term sustainability.

#### Principle 2.1 Natural Resources Objectives:

B. Protect, conserve, and enhance the county's significant, diverse, natural, and scenic resources utilizing sound ecological protection and restoration measures.

C. Protect habitat and ecological diversity by encouraging the preservation of large, contiguous tracts of land.

G. Promote the consideration of such overarching issues as sea level rise, saltwater intrusion, and development impacts on aquifer recharge and stormwater management in decision making related to water supply and wastewater.

**Master Plan Goal #3:** Promote Beneficial Development and Redevelopment that continues to support Monmouth County as a highly desirable place to live, work, play, and stay.

#### Principle 3.6 Recovery and Community Resiliency Objectives:

A. Participate with our stakeholders in developing long-term recovery, mitigation, and resiliency plans to better protect communities, people, businesses, infrastructure, services, and resources against the effects of natural and manmade disasters.

B. Promote and support actions and efforts that increase natural resiliency.

H. Identify natural resources such as stream corridors, frequently flooded properties, steep slopes, century forests, and coastal lowlands that contribute to community resiliency.

#### RECOMMENDED MONITORING PROTOCOLS

In monitoring the proposed concepts, we will refer to the following protocol documents published by the National Park Service (NPS) and The Nature Conservancy (TNC) and others:

- [Northeast Coastal and Barrier Network Salt Marsh Vegetation Monitoring Protocol Implementation Plan Standard Operating Procedures Version 1.0](#)
- [Northeast Coastal and Barrier Network Salt Marsh Vegetation Monitoring Protocol Implementation Plan Version 1.0](#)
- [Monitoring Nekton in Salt Marshes A Protocol for the National Park Service's Long-Term Monitoring Program, Northeast Coastal and Barrier Network](#)
- [Northeast Coastal and Barrier Network Geomorphological Monitoring Protocol: Part I—Ocean Shoreline Position](#)
- [Northeast Coastal and Barrier Network Geomorphological Monitoring Protocol Part II – Coastal Topography](#)
- [The Surface Elevation Table and Marker Horizon Technique A Protocol for Monitoring Wetland Elevation Dynamics](#)
- [Mid-Atlantic Network Forest Vegetation Monitoring Protocol](#)
- [Oyster Habitat Restoration: Monitoring and Assessment Handbook](#)
- [Salt Marsh Restoration Monitoring Guidelines](#)

## 1. INTRODUCTION

### PURPOSE

Naval Weapons Station (NWS) Earle was commissioned in 1943 with a mission to provide ordnance for all Atlantic Fleet Carrier and Expeditionary Strike Groups and support strategic Department of Defense ordnance requirements. It is the largest Weapons Station on the East Coast. The facility encompasses a total of 11,851 acres in 3 major landward elements; a 17-mile Normandy Road/Rail Ammunition Transportation Corridor; and a 2.2-mile-long Pier Complex in Raritan/Sandy Hook Bay. Military vessels use a navigational channel maintained by the Army Corps of Engineers and a specific NWS Earle maintained channel to provide access between the NWS Pier Complex and the open ocean.

Monmouth County, in partnership with NWS Earle and the 13 municipalities that surround NWS Earle, completed the Joint Land Use Study (JLUS) for Naval Weapons Station Earle (referred to as JLUS) in December 2017. This report was made possible by the U.S. Department of Defense (DOD), Office of Economic Adjustment (OEA), who provides funding for local governments to undertake JLUS studies in partnership with their military installation. Joint Land Use Studies aim to minimize operational effects on neighboring jurisdictions and limit the encroachment of the civilian community within a Military Influence Area (MIA) that impair the continued operational utility of the military installation or could impact public health, safety and welfare. The JLUS included 37 recommendations, nine of which focused on coastal resilience measures.

During Superstorm Sandy, the NWS Earle waterfront complex suffered 34 million dollars in damage. The surrounding communities also suffered extensive damage that impacted NWS Earle through the disruption of utilities, support services, and vehicular access, as well as increased Bayfront erosion that could have long-term impacts to the future operation, resiliency and safety of the pier, navigational channels and landward facilities. The surrounding communities that serve and house personnel that work at NWS Earle also suffered significant flood and damage during Sandy. These communities are

struggling with increased storm and tidal flooding. Roads and utilities are experiencing more frequent impacts, likely connected to sea level rise, and require more adaptive measures.

This Coastal Resilience Planning Study is the second phase of the JLUS and will meet the need for additional coastal adaptation planning in the southern Bayshore. To identify specific opportunities for coastal adaptation, Monmouth County and NWS Earle worked with local, county, and state stakeholders through a community-driven, cooperative, strategic planning process.

The three goals of the Coastal Resilience Planning Study are:

1. To encourage local, county, and state government agencies to continue to work closely with NWS Earle to identify potential sites and projects that would support new coastal resilience measures to protect the continued operational utility of the military installation, while preserving and protecting the public health, safety, and welfare of those living along the southern Raritan/Sand Hook Bayshore, with proximity to this active military installation;
2. To seek to improve post-storm resiliency along the Bayshore for the military installation, existing and proposed Army Corps of Engineers (USACE) shoreline protection projects, and the surrounding communities through increased climate adaptation planning, both on base and in the neighboring communities and;
3. To ensure preservation, protection, and post-storm resiliency of the Strategic Highway Network (STAHNET) including the Normandy Road/Rail Corridor, enabling the deployment of military assets outside of the continental United States at the direction of the National Command Authority, while protecting the safety of the surrounding communities.

The Coastal Resilience Planning Study identifies projects intended to increase the sustainability and improve the resiliency of NWS Earle facilities and navigational channels; the USACE projects; infrastructure/roadways that serve NWS Earle facilities; and the local communities that are within the NWS Earle Military Influence Area or

are served by USACE projects.

### STUDY AREA

The Study Area for the Coastal Resilience Planning Study includes the Raritan/Sandy Hook Bayshore, bounded by NJSH Route 36 to the south, Raritan and Sandy Hook Bay to the north, Cliffwood Beach (Aberdeen Township) to the west, and Gateway National Seashore–Sandy Hook Unit to the east. The Study Area includes several waterfront facilities of NWS Earle and the US Coast Guard Station, Federal and state-maintained navigational channels, and a number of existing and proposed USACE shore protection project sites. There are eight municipalities in the project area: Aberdeen Township, Keyport Borough, Union Beach Borough, Hazlet Township, Keansburg Borough, Middletown Township, Atlantic Highlands Borough, and Highlands Borough (listed from west to east). See Figure 10 Study Area Map for more detail on the Study Area.

Figure 9: Highlands, NJ: Looking North Towards New York City



Figure 10: Study Area Map



## 2. TECHNICAL ADVISORY COMMITTEE

The Technical Advisory Committee (TAC) was formed to assist the Project Team in prioritizing the initial sites/projects and ultimately informing the development of concept plans for the 11 most suitable projects. A wide variety of stakeholder groups were invited to participate in the TAC. These included: Monmouth County agencies, such as the Division of Public Works and Engineering, Office of Emergency Management, Mosquito Control Division, and Monmouth County Park System, NWS Earle, the US Coast Guard Sandy Hook Station, USACE New York Region, New Jersey Sea Grant Consortium, the State Department of Environmental Protection, the eight municipalities within the Study Area, representatives of academia and local, related environmental groups. Ultimately, not all invitees participated. For a full list of TAC participants, see Appendix E.

The Project Team engaged the TAC throughout the study process and solicited their feedback through four TAC meetings. Detailed below is a brief description of the study process and stakeholder engagement milestones.

### OVERVIEW OF STUDY PROCESS & TIMELINE

Over the course of the study, the Project Team worked with participating TAC members to collect background information, select potential sites and projects, and identify required permits and sources for implementation funding. The study process was divided into three phases, data collection, site and project selection, and concept plan development.

### DATA COLLECTION

During this phase, the Project Team met to review assembled background data, 14 relative recommendations from the JLUS, a list of priority projects, and the presentation planned for the first TAC meeting.

The Kick-off TAC Meeting (also known as TAC Meeting #1) took place on January 15, 2019 where TAC members were briefed on the JLUS background which led to the creation of this plan, the goals of the Coastal Resilience Plan, and the project schedule.

Figure 11: Pre-TAC Meeting January 9, 2019



The TAC members participated in a mapping exercise to identify ongoing, planned, or potential coastal resilience projects within the Study Area. The ongoing and planned projects were later used to inform the development of comprehensive coastal resilience project concept plans. The potential projects would serve as the starting point for the site and project selection.

Data continued to be collected throughout the entire planning process, including during subsequent TAC meetings. The data collection process is further detailed in Section 3 Data Collection of this Coastal Resilience Planning Study.

Figure 12: Mapping Exercise by the TAC #1 January 15, 2019

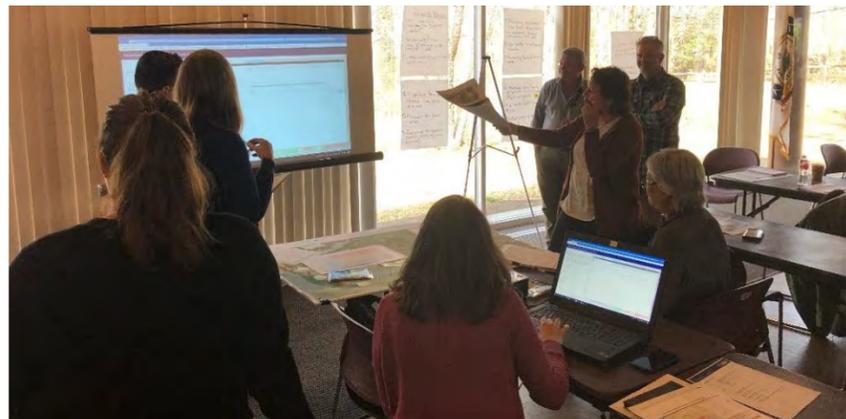


## SITE & PROJECT SELECTION

The potential projects identified by Monmouth County, NWS Earle, and the TAC were then assessed to determine the suitability of each project/site. Suitability criteria were crafted by the Project Team and reviewed during TAC Meeting #2 held in April 2019. Criteria were developed to ensure that the selected projects further the goals of NWS Earle and the recommendations laid out in the JLUS. After reaching agreement about the suitability criteria and weighted overlay methodology applied (detailed in Section 4 of this report), the suitability of potential projects was quantified by the Project Team.

During TAC Meeting #2, the Project Team also presented the online priority site selection tool. All ongoing, planned, and potential projects identified during TAC Meeting #1 were uploaded to the tool. Using the interactive mapping platform, TAC members were able to review the projects already incorporated and add additional projects for inclusion in the analysis. More information about the site selection tool is presented in Section 3 Data Collection.

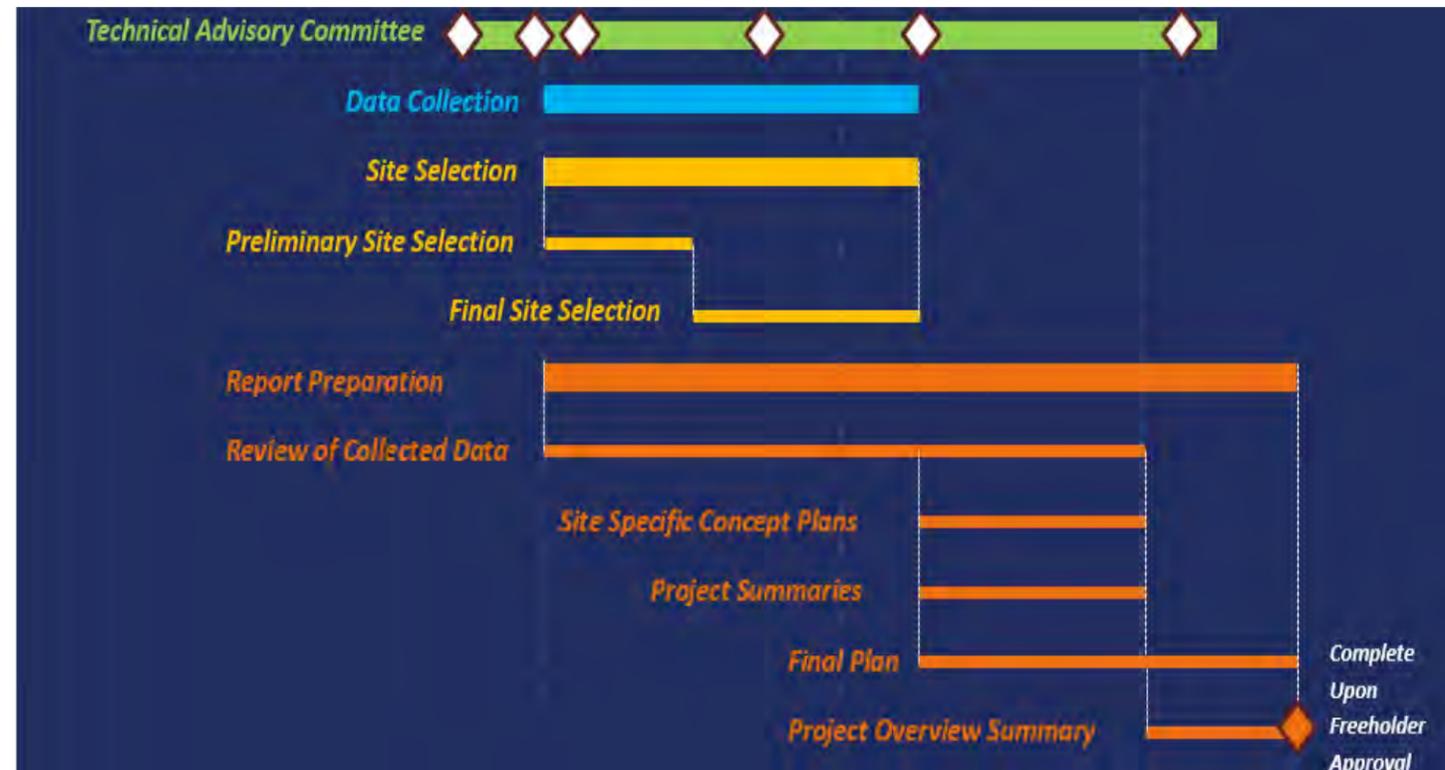
Figure 13: TAC #2 Meeting April 02, 2019



The potential sites added during TAC meeting #2 and through the online priority site selection tool were assessed also for suitability. The results of the Site Suitability Analysis were revealed during TAC Meeting #3, held on June 27, 2019. The Project Team worked with the TAC to combine highly-ranked and complementary projects into comprehensive coastal resilience solutions. This ultimately resulted in the identification of 11 resilience projects.

During TAC Meeting #3, the Project Team also presented a draft concept plan, concept imagery, environmental constraints map, and the materials and quantity list for one of the potential project sites. The TAC provided feedback on these draft deliverables which informed the development of concept plans for the remaining sites. The Project Timeline, including all the TAC meetings is presented below in Figure 14 Project Timeline.

Figure 14: Project Timeline



## CONCEPT PLAN DEVELOPMENT

The Project Team crafted draft concept plans and environmental permitting/constraint maps for 11 potential projects. Because all proposed concepts were planned for publicly owned sites, the Project Team held a series of meetings with those that own or manage the properties selected. Meeting attendees including representatives from the municipalities, the County Park System, County Division of Engineering and NWS Earle. The intent was to further refine the concept plans but during these meetings the Project Team was able to learn about further issues and new opportunities. During the meetings each participating municipality and the Park System agreed to consider passing resolutions in support of the plan (see Appendix D).

During TAC Meeting #4, held in October 2019, all 11 projects and draft concept plans were reviewed by the TAC. After incorporating feedback and suggestions from the TAC, the concept plans were finalized, and project summaries were developed. These are included in Section 5 of this report. TAC feedback was also solicited for determining the environmental permitting requirements and potential funding sources documented in the Permitting & Funding Matrix in Section 6.

### 3. DATA COLLECTION

To develop coastal resilience solutions that build on existing efforts in Monmouth County, a thorough evaluation was conducted of existing and proposed concepts within the Study Area. Information on related projects was collected by working closely with county staff, municipalities, and members of the TAC. These projects included:

- USACE Navigation, Harbors, Shallow Projects
- USACE Flood & Coastal Storm Damage Reduction Projects
- Bayshore Coastal Resilience Projects (CRPs) recommended in the Hudson Raritan Estuary Ecosystem Restoration Study
- Adaptation Action Scenarios recommended by the NJ Fostering Regional Adaptation through Municipal Economic Scenarios (NJ FRAMES) program
- NY/NJ Baykeeper oyster restoration pilot

Additionally, the Project Team consulted the following planning documents to further their understanding of the Study Area and ongoing efforts:

- NWS Earle Joint Land Use Study (December 2017)
- Monmouth County Master Plan - (Adopted 2016)
- Monmouth County Profile (2018)
- Monmouth County At-A-Glance (2018)
- Natural Features Study for Monmouth County (1975, as updated)
- Monmouth County Unique Areas study (1978, as updated)
- Monmouth County Open Space Plan (2019)
- Monmouth County Park System Park Recreation Services Plan (2010)
- Monmouth County Road Plan (2012)
- Multi-Jurisdictional Natural Hazard Mitigation Plan for Monmouth County (2015)
- Monmouth County Coastal Evacuation Routes Study (2009)
- Sandy Hook Route 36 Corridor Summertime Traffic Study (2001)
- Monmouth County Future Wastewater Service Area Map (2013, as amended)

- Monmouth County Farmland Preservation Plan: The Comprehensive Plan (2008)
- Bayshore Region Strategic Plan (2006)
- Bayshore Waterfront Access Plan (1991)
- Bayshore Trail System Design Manual (1993)
- Monmouth County Scenic Roadway Plan (2001)
- Bulkhead Improvements at the Belford Harbor, Coastal Engineering Analysis & Design Recommendations Project Memo (DRAFT April 2017)

Specifically, the team considered the future resiliency projects recommended in Section 6 of the JLUS. These recommendations included:

- Coordinate efforts to implement a naturalized beach erosion/shoreline protection project along Navy and community waterfronts
- Develop a plan for beneficial reuse of dredge material
- Maintenance of culverts along Normandy Road
- Oyster restoration in Sandy Hook Bay
- Storm drainage improvements in neighboring municipalities
- Ware Creek resiliency efforts (improve tidal flow, nourish marsh, improve stormwater outfalls, stabilize existing dunes, install oyster reef)
- Identify critical transportation routes that may be subject to future storm damage and inundation

Projects and sites ultimately recommended by this Coastal Resilience Planning Study build on and support the recommendations of the JLUS.

To determine which projects and project sites should be considered by this analysis, The Project Team consulted with the TAC. Three different categories of projects or potential project sites were identified:

- Projects Complete or Under Construction
- Projects in Planning Phase
- Future Project Sites

A total of 65 completed, ongoing, or potential coastal resilience and flood mitigation projects were identified within the Study Area. These were collected as points within the online Site Suitability Analysis Tool.

22 projects complete or under construction were identified. These included:

- Dredging for the Seastreak Ferry
- Shoal Harbor Bulkhead Design & Reconstruction
- Belford Shoreline Stabilization

Seven projects in the planning phase were identified. These included:

- Preservation of Horseshoe crab habitat at Whale Creek
- Natco Lake Renovation and Restoration

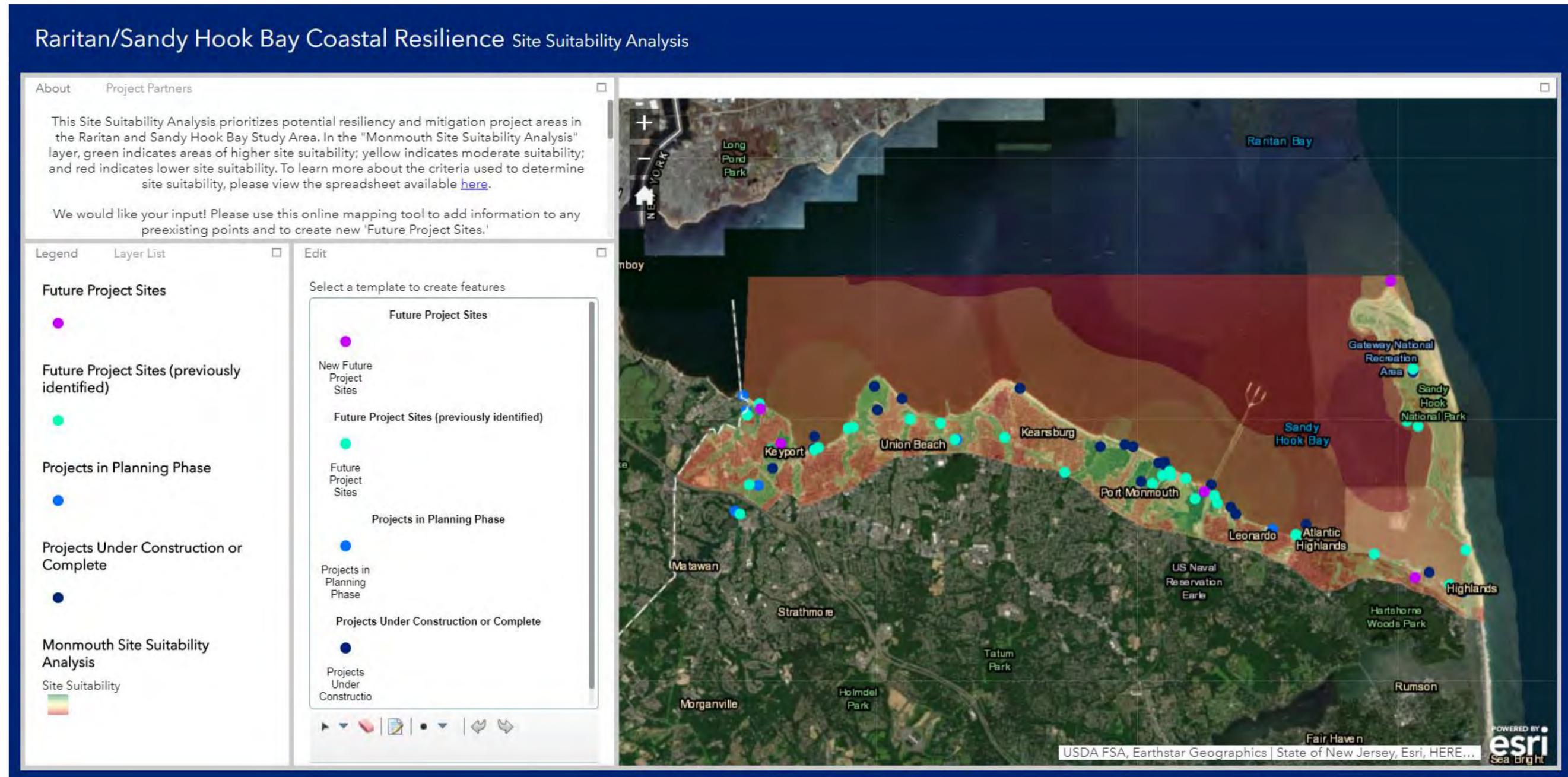
36 potential projects were identified. These included:

- Living shoreline placement along the Henry Hudson Trail
- Wetland restoration along Compton Creek
- Beach nourishment near Ware Creek

Information about project sites collected during the first and second TAC meetings was added to an online Site Suitability Analysis tool supported by ArcGIS Online (AGOL, Figure 15). Using the tool's interactive features, TAC members were able to add future project sites throughout the data collection phase.

Projects that were considered complete, under construction, or in the planning phase were later used to develop input layers for the Site Suitability Analysis and to inform the development of concept plans for the most suitable project sites. The future project points were the starting points for the Site Suitability Analysis. Because the specifics of these future projects were not known at the time of the analysis, a single point feature was used to represent each project within an ArcGIS shapefile.

Figure 15: Online Site Suitability Analysis Tool



## 4. SITE & PROJECT SELECTION

### CRITERIA SELECTION

To determine which sites within the Study Area were most suitable for future coastal resilience projects, a Site Suitability Analysis was conducted. Working closely with the TAC, criteria were selected to evaluate site suitability. These criteria are consistent with the priorities outlined in the JLUS.

Ultimately, the Project Team chose to evaluate site suitability based on six categories. Sub-categories were selected to indicate site suitability with respect to each of these categories:

- **Direct Benefits to NWS Earle:** Sites and projects are more suitable if they are adjacent to NWS Earle or close to a Federal channel.
  - *Indicator Variables Used in Analysis:*
    - Proximity to Federal Channels
    - Compatible Land Uses
- **Flood Exposure:** Sites and projects are more suitable if they are currently exposed to nuisance flooding or will likely be exposed to flooding due to sea level rise in the future.
  - *Indicator Variables Used in Analysis:*
    - Nuisance Flooding
    - Future Flooding Above Mean Higher High Water (MHHW).
- **Natural Systems:** Sites and projects are more suitable if they are in natural areas that will increase stormwater capacity and resiliency.
  - *Indicator Variables Used in Analysis:*
    - Land Suitable for Acquisition
    - Wetlands/Marshes/Sub-Tidal Shallows/Dunes

- **Social Considerations:** Sites and projects are more suitable if they are in areas of high social vulnerability or areas with a high concentration of cultural resources.
  - *Indicator Variables Used in Analysis:*
    - Social Vulnerability
    - Cultural Resources Inventory
- **Infrastructure:** Sites and projects are more suitable if they have the potential to increase the resilience of routes of importance and critical facilities.
  - *Indicator Variables Used in Analysis:*
    - Routes of Importance
    - Critical Facilities
- **Existing Projects:** Sites and projects are more suitable if they are near existing US Army Corps projects or other ongoing mitigation and resiliency projects.
  - *Indicator Variables Used in Analysis:*
    - USACE Projects
    - Other Mitigation/Resiliency Projects

### RASTER PROCESSING

Because the available sub-category datasets were in a variety of different formats (points, polygons, density maps, etc.), they were first converted into a common file type called a raster, which stores information in a numerical format, with one number assigned to each pixel (cell). A raster cell size of 10 feet by 10 feet was used for all sub-categories. Converting the datasets to a common file type was the first step necessary to allow for a direct comparison of site suitability criteria at future project locations.

After each sub-category variable was converted to a raster file format a numerical value was assigned to every cell in each raster dataset. This numerical value was used to indicate that cell's suitability relative

to the other cells in the dataset, based on a 0 to 5 scale. A value of 0 indicates a cell has the least suitable conditions for future coastal resilience projects (or there are no data available) and a value of 5 indicates a cell has the most suitable conditions for future coastal resilience projects.

For example, areas closer to Federal Channels are more likely to be receiving sites for dredged material. Because beneficial reuse is a priority for NWS Earle, cells located within one mile of a Federal Channel were assigned a higher value to indicate their suitability. Cells located more than three miles from a Federal Channel were assigned a lower value. For Routes of Importance, roadways designated as Strategic Highway Network (STRAHNET), coastal evacuation routes, or that serve county or municipally owned facilities, were assigned a higher value and all other roadways received a lower value.

See Table 2 for descriptions of all criteria and their corresponding suitability values. The criteria were designed to place higher values on cells that would meet the goals of the Coastal Resilience Planning Study and the JLUS. Criteria were reviewed and agreed upon by the members of the TAC.

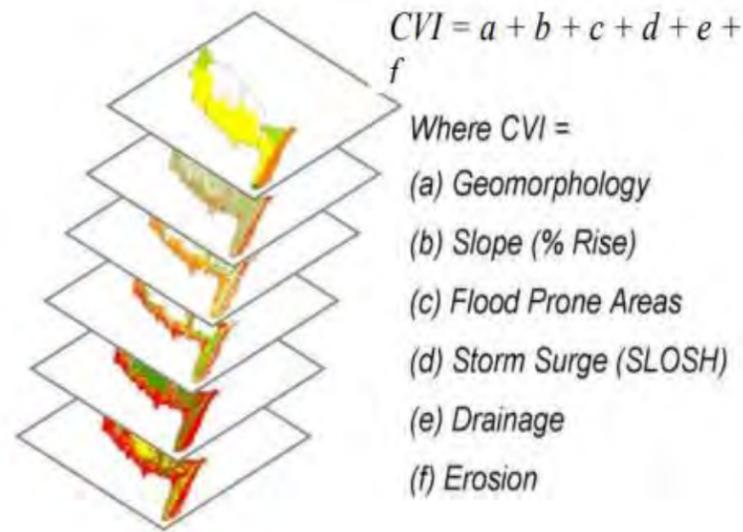
### WEIGHTED OVERLAY ANALYSIS

After assigning each cell a value to represent its suitability within each sub-category, a weighted overlay analysis was conducted. Sub-categories were assigned a weight according to the relative importance of that criteria as determined by the TAC. For example, the sub-categories within the direct benefits to NWS Earle category held the greatest weight in the analysis. Sites that meet these criteria are more suitable for potential projects.

Using the weighted sum tool in ArcGIS, the value of each cell was multiplied by the assigned category weight. The weighted values for each criterion were then summed together for each cell. The resulting value, the weighted sum, represents each cell's overall suitability for a coastal resilience project. Weighted sum, or overall suitability score, of cells ranged between 0.15 and 3.2 with higher values indicating more suitable areas. Figure 16 illustrates how site suitability is mapped with green colors indicating areas of higher overall suitability and red colors

indicating areas of lower overall suitability.

Figure 16 Suitability Mapping Process (NJDEP)



## BUFFER SENSITIVITY ANALYSIS

To determine the suitability score for each of the 36 potential projects, a buffer sensitivity analysis was done. A buffer analysis helps give a better idea of the suitability of the larger area surrounding potential project points. Site suitability scores were determined for future projects using no buffer, a buffer with a 50ft radius, 100ft radius and 500ft radius. Suitability scores for buffered future project points were determined by taking the average value of raster cells within the buffered area. Scores and ranking order of future projects were compared across the 4 buffering options.

Ultimately, the project team decided to use a 100-foot radius buffer to determine the site suitability scores for each potential project. A 100-foot buffer radius is most appropriate because the size (in acres) of potential projects varies widely across the Study Area and the points initially placed in GIS might not precisely represent the project's location. Future project sites were then ranked by their average site suitability score, calculated within the buffered area. The higher the suitability score, the higher the project's rank. Of the 36 potential projects, 11 were removed from the study due to a lack of information and/or concerns about feasibility.

Table 1. Potential Project Suitability Score and Rank

Project Name	Site Suitability Score	Rank
Compton Creek Wetland Restoration	2.76	1
Lennox Rd. / Ross Field Flooding	2.65	2
Ware Creek Resiliency Project	2.62	3
Happy Meadows 1 – Flood	2.41	4
CRP – Compton Creek	2.38	5
Belford Beach Stabilization	2.29	6
Whale Creek/ Treasure Lake Tributary	2.22	7
CRP – Leonardo	2.22	8
Creek Rd. Erosion	2.20	9
Compton's Creek Inner (Federal)	2.09	10
CRP – Flat Creek	1.95	11
CRP – Many Mind Creek	1.82	12
Bulkhead and Pump Installation	1.67	13
Ware Creek Beach Erosion	1.63	14
Route 36 Corridor	1.56	15
Henry Hudson Trail	1.49	16
River Gardens Park Flooding	1.42	17
CRP – Natco Lake/ Thorns Creek	1.40	18
Keyport Harbor Living Shorelines	1.37	19
Chingarora Creek Flooding	1.35	20
Belford Redevelopment	1.35	21
Cliffwood Beach Erosion	1.33	22
CRP – Matawan Beach/Keyport	1.15	23
Bayside Drive	1.06	24
Dredge Material Placement	0.80	25

## PROPOSED COASTAL RESILIENCE SOLUTIONS

Upon review of the 25 remaining potential projects, the team found that many were close in proximity to one another or were integral components of solving a larger, regional issue. Working with the TAC, the Project Team identified opportunities for integrating highly-ranked and complementary potential projects into a single, more holistic,

proposed coastal resilience solution for specific geographic reaches. Ultimately, concept plans were developed for 11 proposed coastal resilience solutions.

More details on the goals and benefits of each of these projects, concept plans, estimated materials, monitoring approach, permitting requirements and funding opportunities can be found in Sections 5 Project Summaries and Section 6 Permitting & Funding Matrix.

Table 2. Descriptions of Site Suitability Assessment Categories

Sub-Category	Criteria	Value
1A – Proximity to Federal Channels	Located within 1 mile of a Federal channel	3
	Between 1-3 miles of a Federal channel	2
	More than 3 miles from a Federal channel	1
1B – Compatible Land Uses	High or “More Compatible” land use adjacent to NWS Earle boundary	5
	High or “More Compatible” land use within the Military Influence Area (MIA)	4
	High or “More Compatible” land use outside of the MIA	3
	Medium or “Conditionally Compatible” land use in the Study Area	1
	Low or “Less Compatible” land use in the Study Area	0
2A – Nuisance Flooding	Subject to shallow coastal, or nuisance, flooding	4
	Not subject to shallow coastal, or nuisance flooding	0
2B – Future Flooding Above Current MHHW	Flooded by water 0-3ft above current MHHW	4
	Flooded by water 3-7ft above current MHHW	3
	Flooded by water 7-12ft above current MHHW	2
	Flooded by water 12+ft above current MHHW	0
3A – Land Suitable for future projects & available for acquisition	Public land adjacent to publicly preserved land	2
	Vacant private land adjacent to publicly preserved land	1
	Developed private land adjacent to publicly preserved land	1
	Any parcel not adjacent to publicly preserved land	0
3B – Wetlands/Marshes/Sub-Tidal Shallows/ Dunes	Within 200ft of a wetland/salt marsh/sub-tidal shallow or dune	3
	Not within 200ft of a wetland/salt marsh/sub-tidal shallow or dune	0
4A – Social Vulnerability Index (SVI)	Census tracts with an overall SVI within the upper quartile (top 75%)	4
	Census tracts with an overall SVI within the middle quartile (between 25-75%)	3
	Census tracts with an overall SVI within the lower quartile (bottom 25%)	1
	Outside data coverage	0
4B – Cultural Resources Inventory	Within the NJ Archaeological Grid	3
	Within the NJ Historic Grid	3
	200ft or less from the Monmouth County’s Cultural and Heritage Virtual Tours or other historic property	2
	Not located in NJ Archaeological Grid, NJ Historic Grid or within 200ft of the Cultural & Historic Virtual Tour or historic property	0
5A – Routes of Importance	Designated as a coastal evacuation route	4
	Routes that serve county or municipally owned facilities	4
	Not designated as a coastal evacuation route or serving county or local facilities	0
5B – Critical Facilities	Critical facility property flooded by water 0–3ft above current MHHW	4
	Critical facility property flooded by water 3-7ft above current MHHW	3
	Critical facility property flooded by water 7-12 ft above current MHHW	1
	No critical facility on property or critical facility property outside of are flooded by water 12ft + above current MHHW	0
6A – USACE Projects	Project < 2,000 feet from another USACE project	3
	Project > 2,000 feet from another USACE project	0
6B – Mitigation/Resiliency Projects	Project < 2,000 feet from another mitigation/resiliency project	3
	Project > 2,000 feet from another mitigation/resiliency project	0

Table 3. Description of Sub-Categories and Data Sources

Category	Category Description	Sub-Categories	Sub-Category Source Dataset	Sub-Category Descriptions	Sub-Category Weight	Overall Category Weight
1 – Direct Benefits to NWS Earle	Sites and projects are more suitable if they are adjacent to NWS Earle or close to a Federal channel.	1A – Proximity to Federal Channels	USACE, Ongoing	Priority is given to project areas likely to receive beneficial use of dredged materials based on distance to nearest Federal channel. Area of analysis included open water and 300ft setback from the shoreline.	15%	30%
		1B– Compatible Land Uses	NJOIT-OGIS, 2017 NWS Earle JLUS Table 5.05	Priority is given to project areas of compatible land use (as identified in the JLUS) that are located within the Military Influence Area (MIA) or that border the NWS Earle boundary. Compatible land uses are identified in the JLUS should promote the operational utility of the military installation and preserving and protecting the public health, safety, and welfare of those living near this active military installation.	15%	
2 – Flood Exposure	Sites and projects are more suitable if they are currently exposed to nuisance flooding or will likely be exposed to flood due to Sea Level Risk in the future.	2A – Nuisance Flooding	NOAA, 2018	Priority is given to project areas that are currently vulnerable to nuisance or high tide flooding.	12.5%	25%
		2B – Future Flooding Above MHHW	NJFRAMES, 2017	Priority is given to project areas that are vulnerable to elevated water levels of 3ft, 7ft, and 12ft over current Mean Higher High Water (MHHW).	12.5%	
3 - Natural Systems	Sites and projects are more suitable if they are in natural areas that will increase resiliency and stormwater capacity.	3A– Land Suitable for future projects & available for acquisition	NJOIT-OGIS, 2018	Priority is given to private land that may be acquired and preservation of natural land areas that will increase post-storm resiliency and/or stormwater capacity.	12.5%	25%
		3B – Wetlands/Marshes/Sub-Tidal Shallows/ Dunes	NJDEP, 2012	Priority is given to project areas located near wetlands, marshes, sub-tidal shallows and dunes.	12.5%	
4 – Social Considerations	Sites and projects are more suitable if they are in areas of high social vulnerability or areas with a high concentration of cultural resources.	4A – Social Vulnerability Index	CDC, 2016	Priority is given to project areas located within areas of higher social vulnerability.	2.5%	5%
		4B – Cultural Resources Inventory	Monmouth County, 2018	Priority is given to project areas with higher concentrations of cultural resources.	2.5%	
5 - Infrastructure	Sites and projects are more suitable if they have the potential to increase the resilience of routes of importance and critical facilities.	5A– Routes of Importance	Monmouth County, 2018	Priority is given to project areas that improve drainage along routes of importance.	5.0%	10%
		5B – Critical Facilities	Monmouth County, 2018	Priority is given to project areas that protect critical facilities.	5.0%	
6 - Existing Projects	Sites and projects are more suitable if they are near existing US Army Corps projects or ongoing mitigation and resiliency projects.	6A – USACE Projects	USACE, 2018	Priority is given to project areas located near existing US Army Corps projects.	2.5%	5%
		6B – Mitigation/Resiliency Projects	TAC Outreach, 2018	Priority given to projects areas located near existing mitigation and resiliency projects.	2.5%	

## 5. PROJECT SUMMARIES

The 11 proposed coastal resilience projects include:

1. Whale Creek Restoration/Cliffwood Beach Stabilization
2. Happy Meadows Wetland Restoration
3. Flat Creek Restoration
4. Keansburg Beach Replenishment
5. Compton Creek Wetland Restoration
6. Belford Beach Stabilization
7. Ware Creek Resiliency Project
8. Leonardo Resiliency Project
9. Many Mind Creek Beach Restoration
10. Henry Hudson Trail Shoreline Protection
11. Highlands Stormwater Improvements

Figure 17 Final Concept Plan Locations details the approximate location of each proposed coastal resilience project. For each of the proposed projects, a concept plan design, photo simulation (with project narrative), environmental constraints map, and estimated materials and quantities are included. The concept diagrams show the general location of design features, environments and ecological habitats that were determined to best address the concerns of the TAC and resilience opportunities for the project area. Concept imagery, or photo simulations, show realistic aerial representations of the project areas before and after implementation to demonstrate the potential outcomes of the proposed concepts. The environmental constraints maps included for each project can be used as tools to determine the possible challenges or concerns regarding design and regulations at specific locations within the project area. Materials and the quantities of materials needed for specific projects have also been identified in the tables that follow. Quantities for sediment requirements were calculated in GIS using three-dimensional volumetric measurements based on delineated areas of improvement. Quantities for plant materials were calculated on a set number per acre based on existing documentation from US Department of Agriculture (USDA) Plant Fact Sheets, New Jersey Sea Grant Coastal Sand Dune Planting Guidance, and American Littoral Society Bradley Beach Maritime Forest Plant List.

In Section 6, environmental permits, monitoring protocols, and potential funding sources for project implementation are identified. All 11 using

proposed concepts strive to increase the sustainability and improve the resilience of NWS Earle facilities and navigational channels; the USACE projects; infrastructure/roadways that serve NWS Earle facilities; and the local communities that are within the NWS Earle MIA or are served by USACE projects.

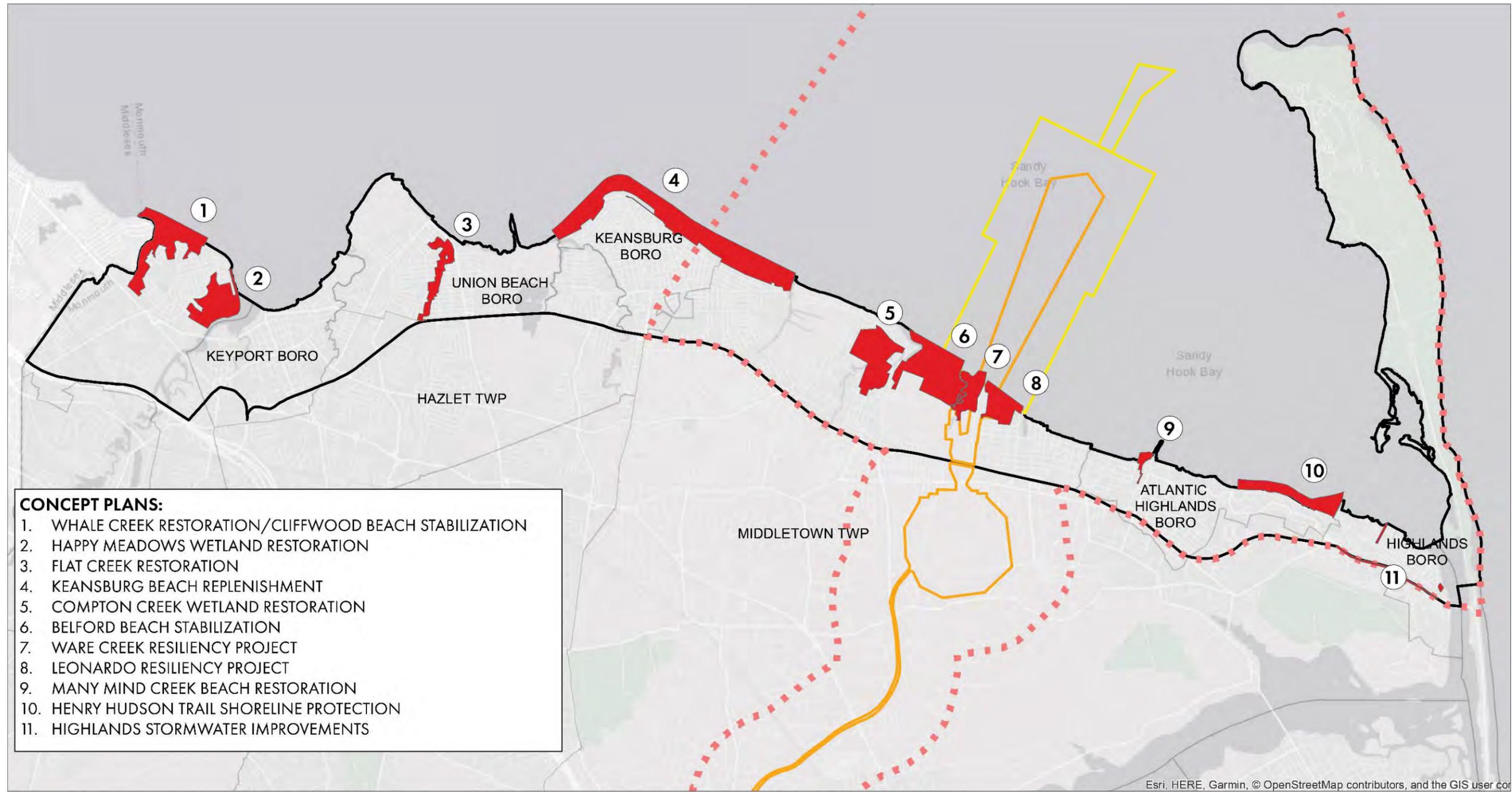
Many of the proposed coastal resilience projects feature several design components. These include: beach replenishment, upland dune restoration, marsh restoration, maritime forest berm construction, coastal protection structure restoration and installation, channel dredging and outlet clearing, stormwater improvements, and the installation of wave attenuation devices. Each of these design components is described briefly here.

- **Beach Replenishment** – A wider beach area can reduce storm and flooding damage by acting as a buffer to coastal infrastructure. During a beach replenishment project, sand lost from an area due to longshore currents or erosion is replaced with sand from other sources. Opportunities to repurpose dredge materials for beach replenishment should be coordinated with the USACE.
- **Channel and Outlet Clearing**– Maintaining existing channels and outlets in place by removing sedimentation enables flood waters to drain from inland areas. If channels are not maintained, water does not drain effectively, and flooding can result. Properly maintained channels are also critical to the resilience of all industries that use them. Sediment removed can be used for other coastal resilience project design components.
- **Installation of Wave Attenuation Devices** – Offshore structures parallel to the coast provide protection from the energy of the waves and reduce damage and erosion. Wave attenuation devices can take many forms including oyster reefs and breakwaters. Wave attenuation devices are most effective when installed seaward of an erosion-prone or beach replenishment areas.
- **Maritime Forest Berm Construction** – Berms provide a barrier from flooding and habitat. Planting these berms with native

coastal tree and shrub species ensures soil stability and increases the survival potential of vegetation exposed to salt spray and coastal winds.

- **Stormwater Improvements** – Installing stormwater pump stations and retention facilities and clearing stormwater outfalls can reduce flooding along roads.
- **Upland Dune Restoration** – Well-developed dune systems provide a barrier between waves and coastal properties. An upland dune restoration project could involve stabilizing an existing dune system to be a more effective barrier through identification and mitigation of potential breach points, moving or modifying beach access points, installing sand fences, or replacing invasive plants with native plants. Creating new dunes landward of replenished beaches can also provide additional protection. These dunes would require planting with native materials for stabilization.
- **Wetland/Marsh Restoration** – Healthy marshes provide a wide variety of benefits to the surrounding areas. They are vital coastal habitats, can protect the coastline from waves and storms, absorb stormwater, and play an important role in nutrient cycling and filtration. Restoration projects may include an evaluation of the area's hydrology and adjustment of nearby water control structures, replacing invasive plants with native plants species, and/or thin layer deposition of dredge materials to restore soil elevations and mitigate sea level rise. Wetland restorations recommended here take a phased approach to account for the varying degrees of marsh degradation and different marsh elevations present.

Figure 17: Final Concept Plan Locations

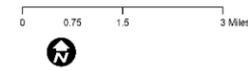


- CONCEPT PLANS:**
1. WHALE CREEK RESTORATION/CLIFFWOOD BEACH STABILIZATION
  2. HAPPY MEADOWS WETLAND RESTORATION
  3. FLAT CREEK RESTORATION
  4. KEANSBURG BEACH REPLENISHMENT
  5. COMPTON CREEK WETLAND RESTORATION
  6. BELFORD BEACH STABILIZATION
  7. WARE CREEK RESILIENCY PROJECT
  8. LEONARDO RESILIENCY PROJECT
  9. MANY MIND CREEK BEACH RESTORATION
  10. HENRY HUDSON TRAIL SHORELINE PROTECTION
  11. HIGHLANDS STORMWATER IMPROVEMENTS



- LEGEND**
- Concept Plan Boundary
  - NWS Earle Restricted Area
  - NWS Earle Military Influence Area
  - NWS Earle Boundary
  - Study Area

Final Concept Plan Locations  
**Raritan/Sandy Hook Bay Coastal Resilience Planning Study**  
 Monmouth County, NJ



1. WHALE CREEK RESTORATION/CLIFFWOOD BEACH STABILIZATION CONCEPT DIAGRAM



# 1. WHALE CREEK RESTORATION/CLIFFWOOD BEACH STABILIZATION PHOTO SIMULATION

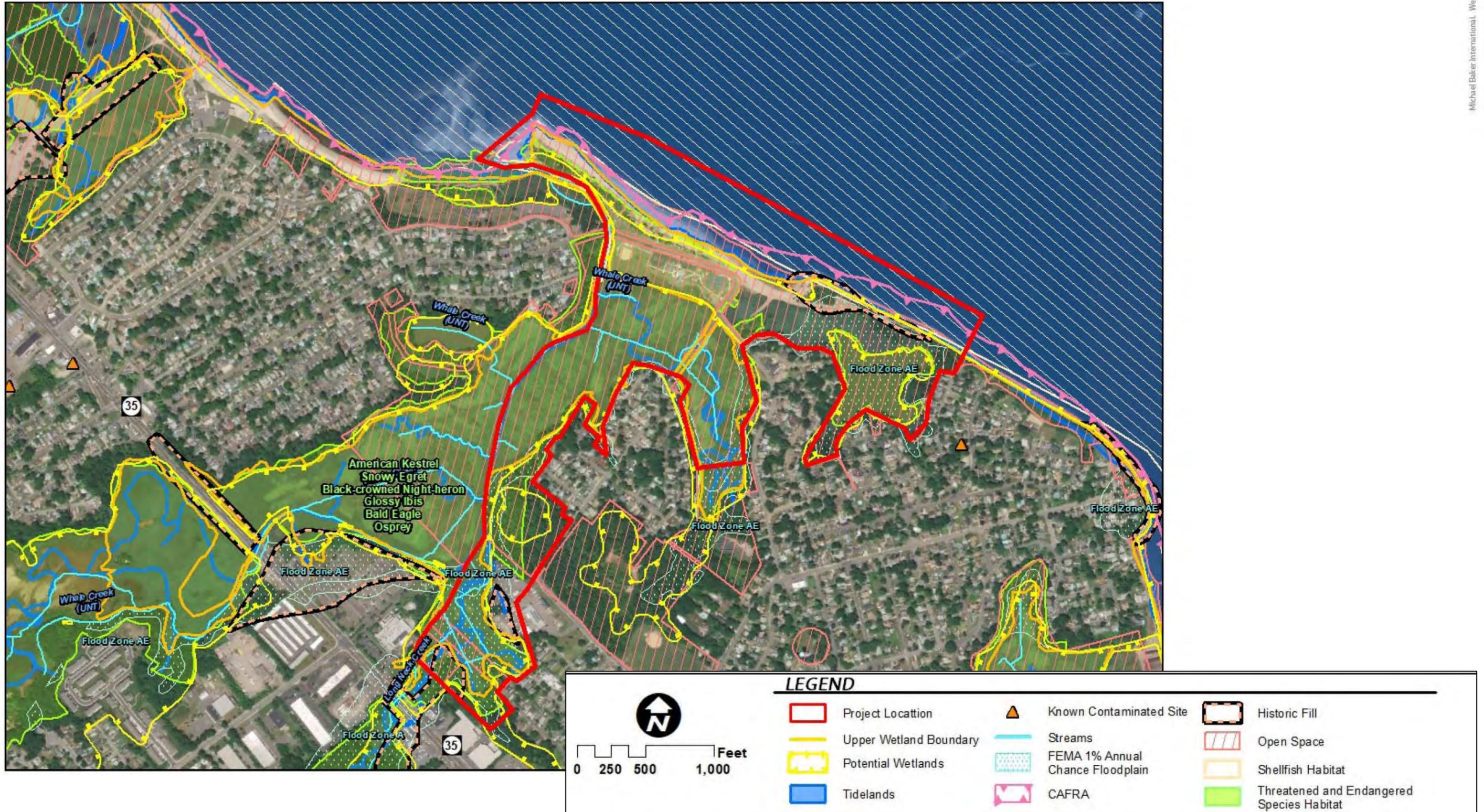


**LEGEND**

— Project Location

Cliffwood Beach (Aberdeen Township) is at risk of erosion and the marsh surrounding Whale Creek currently experiences flooding during high tides. The concept plan proposes Restoring salt marshes will enhance their ability to act as natural buffers to reduce impacts of storm-induced surge and waves while the maritime forest berm will help provide a buffer to Lakeshore Drive. The proposed wave attenuating devices, dune restoration, and beach replenishment would complete the proposed improvements by reducing the potential for erosion.

1. WHALE CREEK RESTORATION/CLIFFWOOD BEACH STABILIZATION ENVIRONMENTAL CONSTRAINTS



# 1. WHALE CREEK RESTORATION/CLIFFWOOD BEACH STABILIZATION MATERIALS & QUANTITIES



### LEGEND

- Project Location
- Beach Replenishment Area
- Potential Oyster Reef Expansion
- Upland Dune Restoration
- Marsh Restoration Area
- Upland Berm Maritime Forest
- Potential Phase 2

W hale Creek Materials Needed			
Project Component	Material Type	Amount	Units
Beach Replenishment (berm @ 4ft NAVD88)	Dredged Material - Sand	35,610	Cubic Yards
Marsh Restoration (berm @ 3.5ft NAV88)	Dredged Material - Sand/Silt	38,069	Cubic Yards
	Spartina alterniflora	131,002	Seedlings
Wave Attenuation Devices (bottom @ -2 ft NAVD88, top @ +2 ft NAVD88)	Wave Attenuation Blocks	31,542	12" X 8" Blocks
Phase 2 Marsh Restoration (healthy marsh @ 3ft NAVD88)	Dredged Material - Sand/Silt	2,978	Cubic Yards
	Spartina alterniflora	32,610	Seedlings
Upland Dune Restoration (dune @ 10ft NAVD88)	Dredged Material - Sand	20,442	Cubic Yards
	Morella pensylvanica	1,148	#2 Containers
	Ammophila breviligulata	185,279	Seedlings
Upland Maritime Forest Berm (berm @ 6ft NAVD88)	Dredged Material - Sand/Silt	4,513	Cubic Yards
	Morella pensylvanica	264	#2 Containers
	Rosa virginiana	140	#2 Containers
	Juniperus Virginiana	63	Ball & Burlap
	Prunus maritima	36	#2 Containers
	Panicum virgatum	5,492	Seedlings

2. HAPPY MEADOWS WETLAND RESTORATION  
CONCEPT DIAGRAM



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## 2. HAPPY MEADOWS WETLAND RESTORATION PHOTO SIMULATION

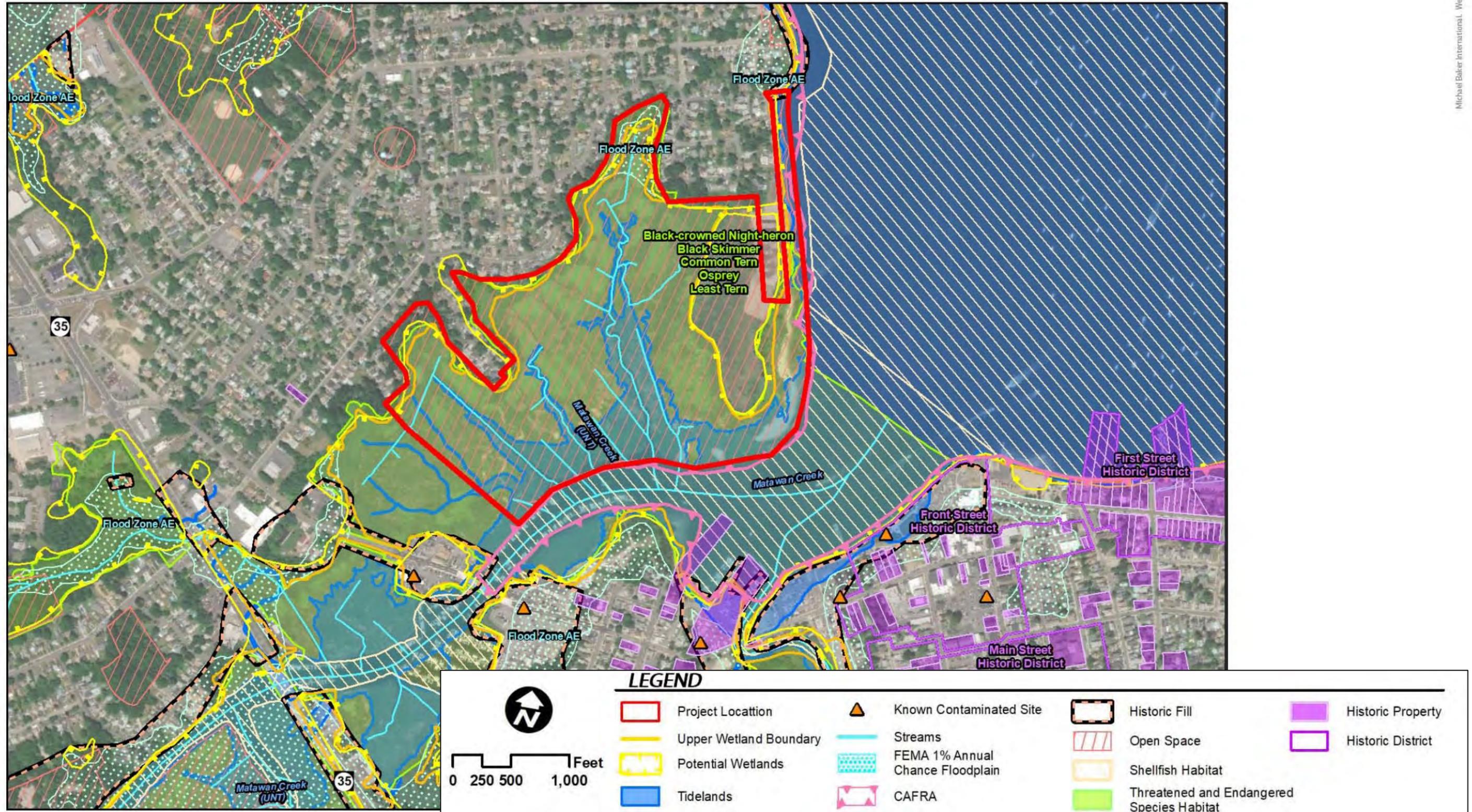


### LEGEND

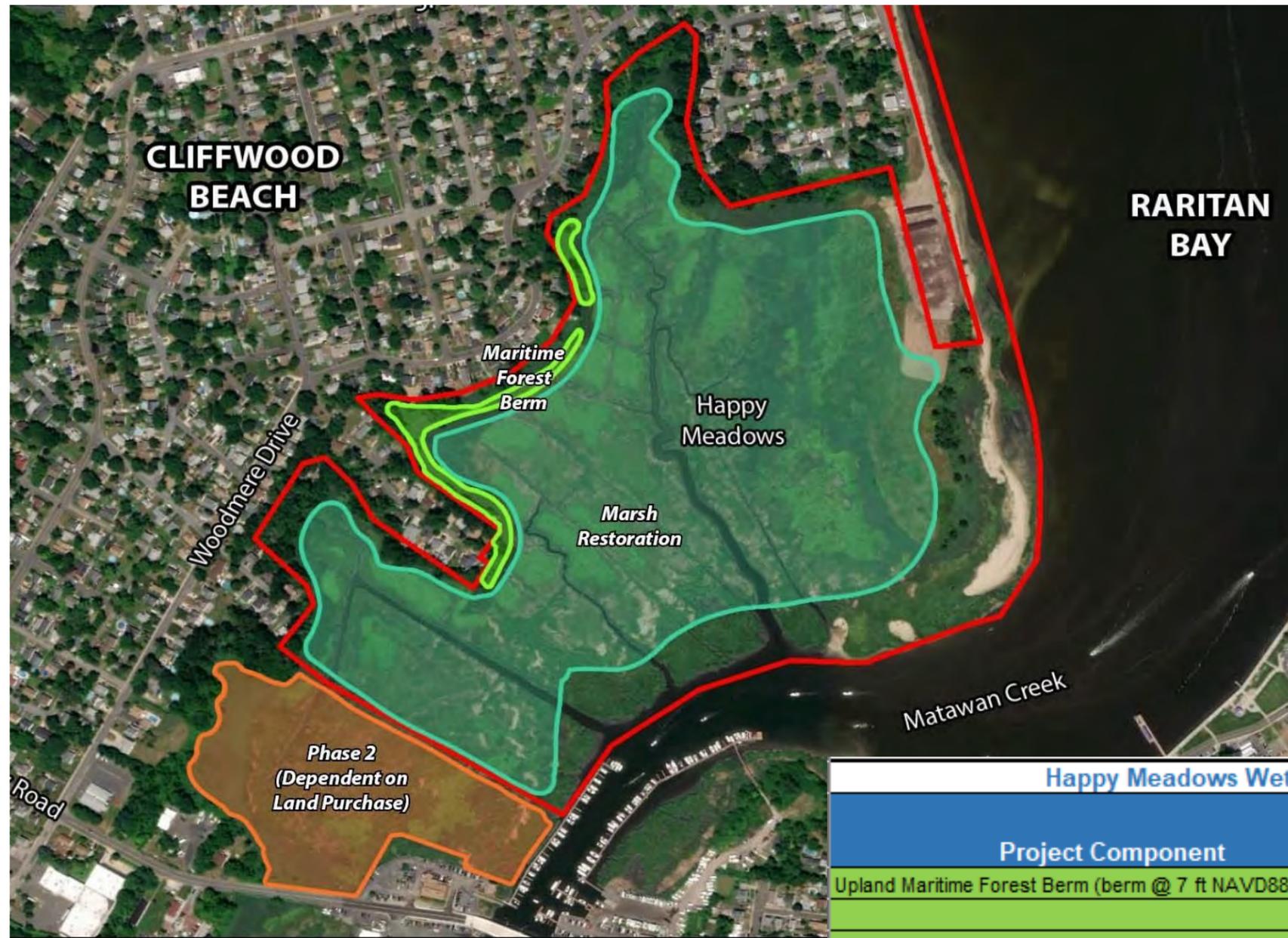
— Project Location

Cliffwood Beach (Aberdeen Township) and the Borough of Keyport are at risk of coastal flooding due to their low-lying locations surrounding Matawan Creek, which flows into Lake Lefferts and Lake Matawan. Extensive Phragmites in the Happy Meadows tidal marsh dominates the creek between Ravine Drive and the mouth of Keyport Harbor. The concept plan proposes restoring marshlands to enhance their ability to act as natural buffers to reduce impacts of storm-induced surge and waves, as well as a maritime forest berm to provide a buffer to the surrounding residential area.

2. HAPPY MEADOWS WETLAND RESTORATION ENVIRONMENTAL CONSTRAINTS



## 2. HAPPY MEADOWS WETLAND RESTORATION MATERIALS & QUANTITIES

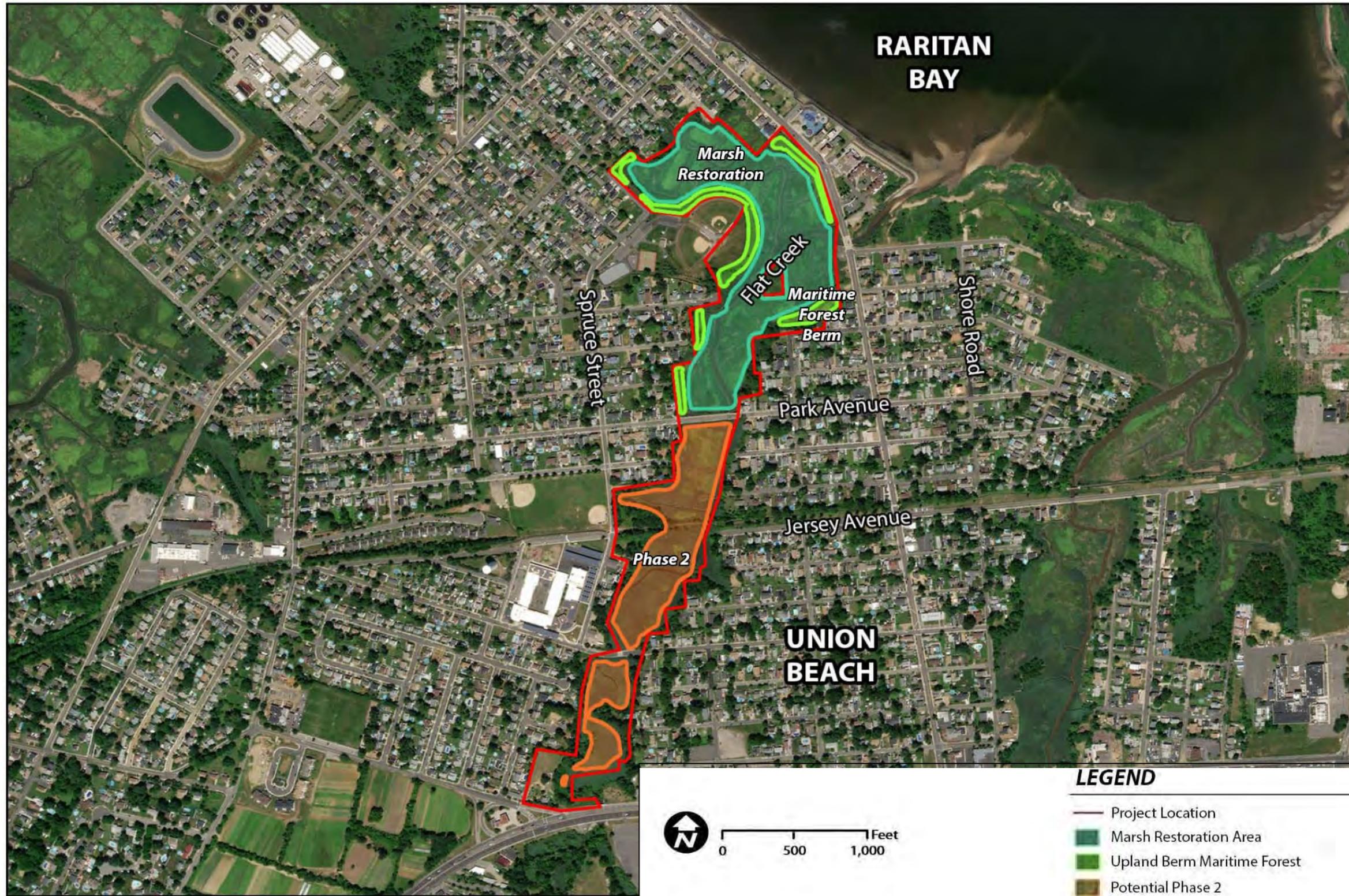


### LEGEND

- Project Location
- Beach Replenishment Area
- Upland Berm Maritime Forest
- Marsh Restoration Area
- Potential Phase 2

Happy Meadows Wetland Restoration Baseline Materials Needed			
Project Component	Material Type	Amount	Units
Upland Maritime Forest Berm (berm @ 7 ft NAVD88)	Dredged Material - Sand/Silt	18,839	Cubic Yards
	Morella pensylvanica	871	#2 Containers
	Rosa virginiana	463	#2 Containers
	Juniperus Virginiana	209	Ball & Burlap
	Prunus maritima	118	#2 Containers
	Panicum virgatum	18,156	Seedlings
Marsh Restoration (healthy marsh @ 3.5 ft NAVD88)	Dredged Material - Sand/Silt	101,572	Cubic Yards
	Spartina alterniflora	305,657	Seedlings
Phase 2 Marsh Restoration (healthy marsh @ 3 ft NAVD88)	Dredged Material - Sand/Silt	6,957	Cubic Yards
	Spartina alterniflora	64,538	Seedlings

3. FLAT CREEK RESTORATION  
CONCEPT DIAGRAM



### 3. FLAT CREEK RESTORATION PHOTO SIMULATION

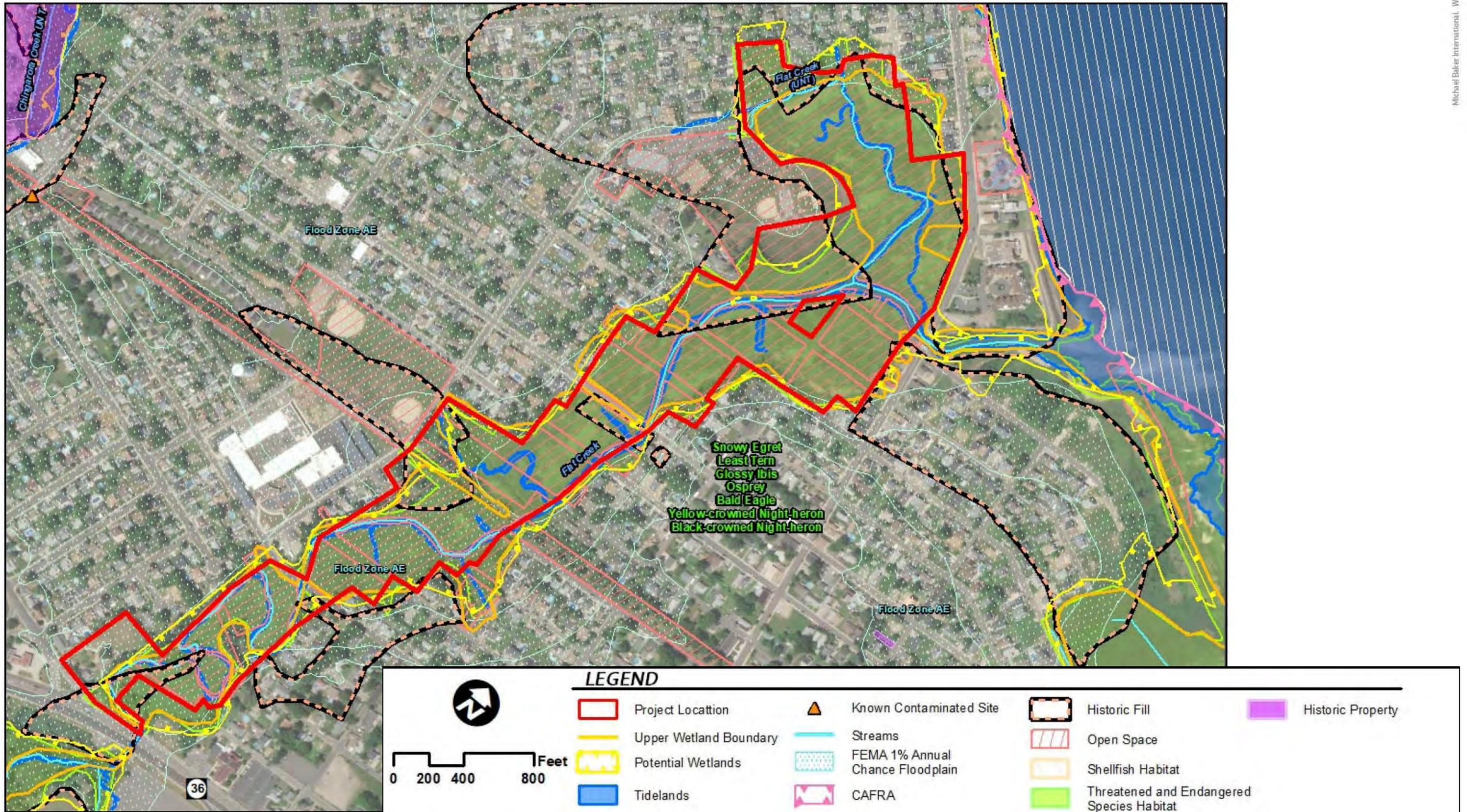


**LEGEND**

— Project Location

Union Beach is at risk of coastal flooding due to its low-lying location containing large tracts of Bayshore wetlands and tidal Flat Creek. The floodplain along Flat Creek is an ecologically-sensitive area that has been disturbed and has eroded over time, degrading conditions, causing flooding and negative environmental impacts. The proposed concept intends to restore the marsh surrounding Flat Creek and create an upland maritime forest berm buffering local residences from the marsh. The proposed concept could enhance, but not interfere with any USACE work for Union Beach and help reduce flooding on Route 36, which provides access to the NWS Earle Pier Complex.

3. FLAT CREEK RESTORATION ENVIRONMENTAL CONSTRAINTS



### 3. FLAT CREEK RESTORATION ESTIMATED MATERIALS & QUANTITIES



**LEGEND**

- Project Location
- Marsh Restoration Area
- Upland Berm Maritime Forest
- Potential Phase 2

**Flat Creek Restoration Baseline Materials Needed**

Project Component	Material Type	Amount	Units
Marsh Restoration (healthy marsh @ 3.5 ft NAVD88)	Dredged Material - Sand/Silt	41,740	Cubic Yards
	Spartina Alterniflora	100,909	Seedlings
Phase 2 Marsh Restoration (healthy marsh @ 3 ft NAVD88)	Dredged Material - Sand/Silt	8,052	Cubic Yards
	Spartina Alterniflora	67,929	Seedlings
Upland Maritime Forest Berm (berm @ 6 ft NAVD88)	Dredged Material - Sand/Silt	16,858	Cubic Yards
	Morella pensylvanica	1,139	#2 Containers
	Rosa virginiana	605	#2 Containers
	Juniperus Virginiana	273	Ball & Burlap
	Prunus maritima	154	#2 Containers
	Panicum virgatum	23,733	Seedlings

4. KEANSBURG BEACH REPLENISHMENT  
CONCEPT DIAGRAM



#### 4. KEANSBURG BEACH REPLENISHMENT PHOTO SIMULATION

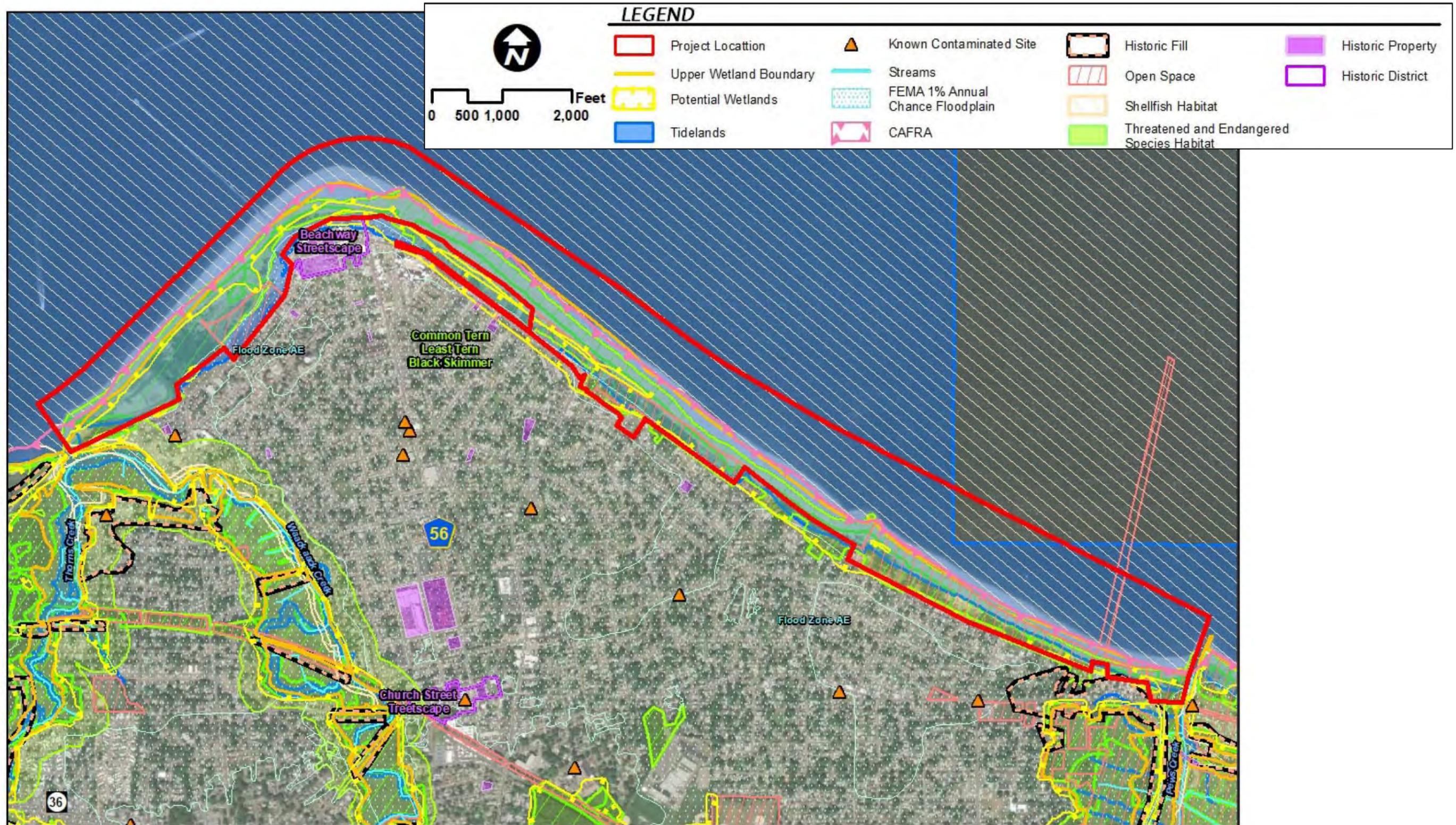


#### LEGEND

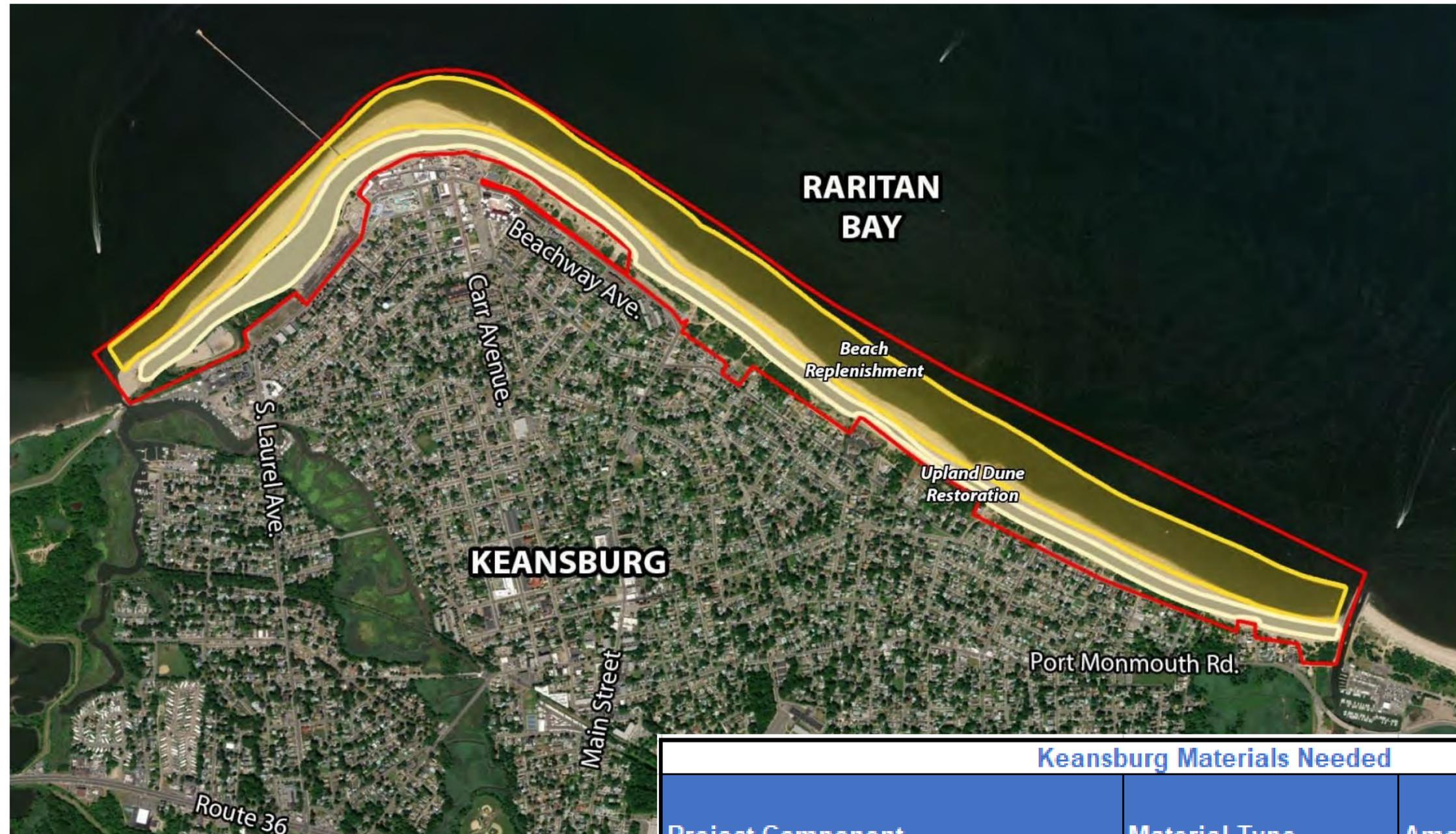
— Project Location

Keansburg is at risk of current and future coastal flooding due to its low-lying location adjacent to Raritan Bay. As an active U.S. Army Corps of Engineers beach replenishment project, material available from Federal channels could potentially be used to replenish the beach and could help absorb flood events along the long shoreline; upland dune enhancement is also proposed.

4. KEANSBURG BEACH REPLENISHMENT ENVIRONMENTAL CONSTRAINTS



#### 4. KEANSBURG BEACH REPLENISHMENT ESTIMATED MATERIALS & QUANTITIES



**LEGEND**

- Project Location
- Beach Replenishment Area
- Upland Dune Restoration

Keansburg Materials Needed			
Project Component	Material Type	Amount	Units
Beach Replenishment (berm @ 5.5 ft NAVD88)	Dredged Material - Sand	1,467,455	Cubic Yards
Upland Dune Restoration (dune @ 13 ft NAV88)	Dredged Material - Sand/Silt	154,924	Cubic Yards
	Morella pensylvanica	30,892	#2 Containers
	Ammophila breviligulata	1,752,744	Seedlings

5. COMPTON CREEK WETLAND RESTORATION  
CONCEPT DIAGRAM



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## 5. COMPTON CREEK WETLAND RESTORATION PHOTO SIMULATION



**LEGEND**

— Project Location

Belford and Port Monmouth (Middletown Township) are at risk of coastal flooding due to their low-lying locations containing Compton Creek. The proposed concept site is primarily north of Broadway where Compton Creek enters a 2,000-foot wide Salt Hay Grass-dominated floodplain characterized by historic drainage and mosquito ditches. Current mitigation strategies include an existing bulkhead, a rock groin breakwater, and possible future maintenance dredging by the USACE. The concept proposes a marsh restoration, an upland berm maritime forest along Church Road, and repairs to the existing bulkhead along Belford Harbor.

5. COMPTON CREEK WETLAND RESTORATION ENVIRONMENTAL CONSTRAINTS



## 5. COMPTON CREEK WETLAND RESTORATION ESTIMATED MATERIALS & QUANTITIES



### LEGEND

- Project Location
- Marsh Restoration Area
- Upland Berm Maritime Forest
- Bulkhead Restoration
- Potential Phase 2
- Potential Phase 3

Note: Phase 3 dependant on potential aquisition of properties.

Compton Creek Wetland Restoration Baseline Materials Needed

Project Component	Material Type	Amount	Units
Bulkhead Restoration (replace existing)	Steel Sheeting	2,000	Linear Feet
Marsh Restoration (healthy marsh @ 3.5 ft NAVD88)	Dredged Material - Sand/Silt	45,174	Cubic Yards
	Spartina alterniflora	189,476	Seedlings
Phase 2 Marsh Restoration (healthy marsh @ 3 ft NAVD88)	Dredged Material - Sand/Silt	30,124	Cubic Yards
	Spartina alterniflora	238,161	Seedlings
Phase 3 Marsh Restoration (healthy marsh @ 3 ft NAVD88)	Dredged Material - Sand/Silt	13,723	Cubic Yards
	Spartina alterniflora	148,353	Seedlings
Upland Maritime Forest Berm (berm @ 9 ft NAVD88)	Dredged Material - Sand/Silt	30,789	Cubic Yards
	Morella pensylvanica	977	#2 Containers
	Rosa virginiana	519	#2 Containers
	Juniperus Virginiana	234	Ball & Burlap
	Prunus maritima	132	#2 Containers
	Panicum virgatum	20,359	Seedlings

6. BELFORD BEACH STABILIZATION  
CONCEPT DIAGRAM



**LEGEND**

Project Location	Marsh Restoration Area
Breakwater Installation	Upland Berm Maritime Forest
Beach Replenishment Area	Upland Dune Restoration
	Wave Attenuation Devices

0 500 1,000 Feet

## 6. BELFORD BEACH STABILIZATION PHOTO SIMULATION

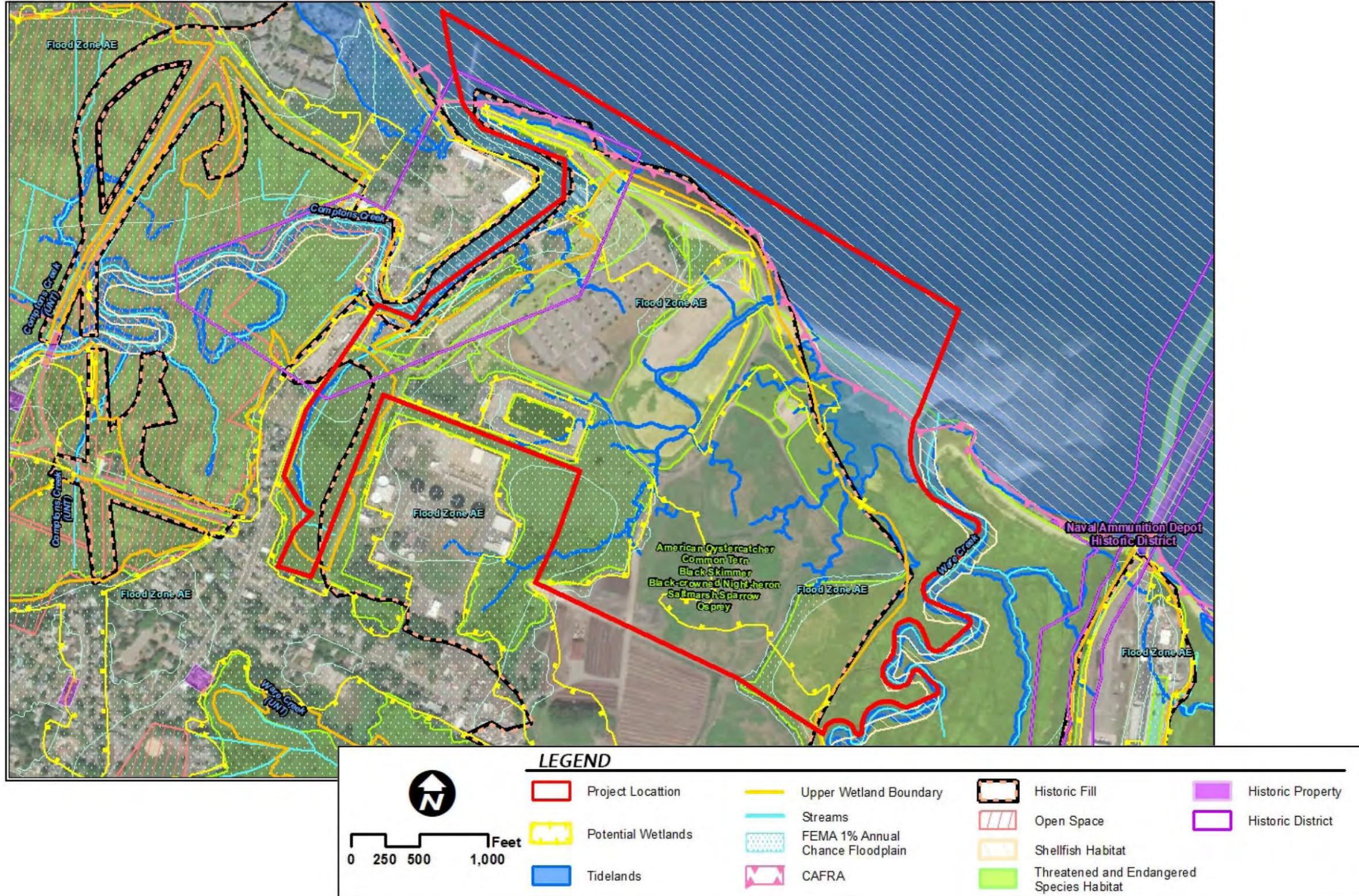


### LEGEND

— Project Location

Belford (Middletown Township) experiences coastal flooding in the low-lying locations between the tidal waterways of Compton Creek and Ware Creek. This location includes the Belford Ferry Terminal and other utility facilities that serve NWS Earle. The proposed concept includes marsh restoration and an upland maritime forest berm along Ware Creek; the proposed concept also includes beach replenishment and upland dune restoration at the beach near Belford Harbor.

6. BELFORD BEACH STABILIZATION ENVIRONMENTAL CONSTRAINTS



## 6. BELFORD BEACH STABILIZATION ESTIMATED MATERIALS & QUANTITIES



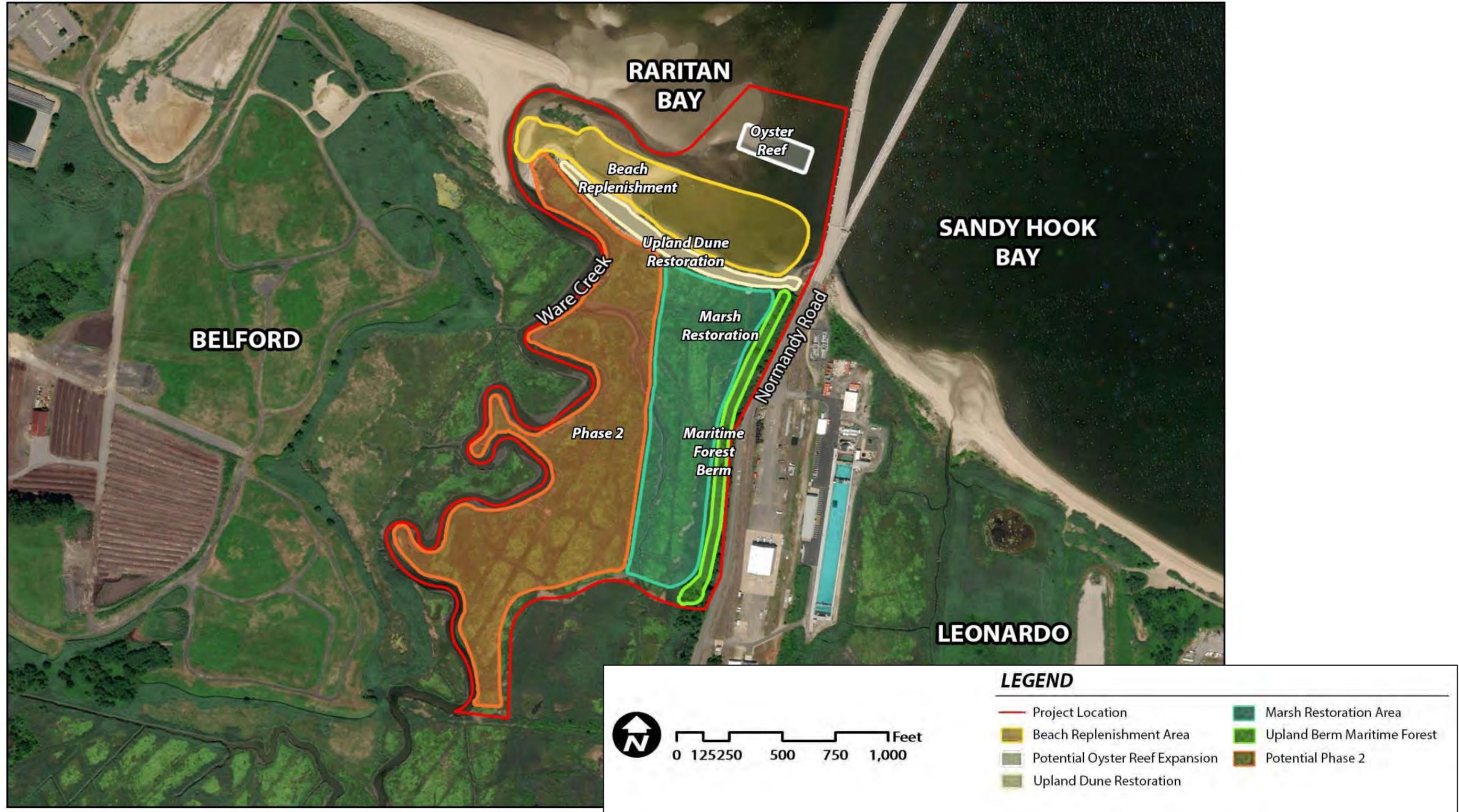
Belford Beach Stabilization Baseline Materials Needed

Project Component	Material Type	Amount	Units
Beach Replenishment (berm @ 8 ft NAVD88)	Dredged Material - Sand	336,156	Cubic Yards
Marsh Restoration (healthy marsh @ 2 ft NAVD88)	Dredged Material - Sand/Silt	203	Cubic Yards
	<i>Spartina alterniflora</i>	77,251	Seedlings
Upland Dune Restoration (dune @ 15 ft NAVD88)	Dredged Material - Sand	61,063	Cubic Yards
	<i>Morella pensylvanica</i>	1,023	#2 Containers
	<i>Ammophila breviligulata</i>	165,030	Seedlings
Upland Maritime Forest Berm (berm @ 12 & 20 ft NAVD88)	Dredged Material - Sand/Silt	78,418	Cubic Yards
	<i>Morella pensylvanica</i>	1,893	#2 Containers
	<i>Rosa virginiana</i>	1,006	#2 Containers
	<i>Juniperus Virginiana</i>	453	Ball & Burlap
	<i>Panicum virgatum</i>	39,434	Seedlings
	<i>Prunus maritima</i>	256	#2 Containers
Wave Attenuation (bottom @ -2 ft NAVD88, top @ +2 ft NAVD88)	Concrete Blocks	87,171	12" X 8" Blocks
Terminal Groin (bottom @ -2 ft NAVD88, top @ +2 ft NAVD88)	Concrete Blocks	27,846	12" X 8" Blocks

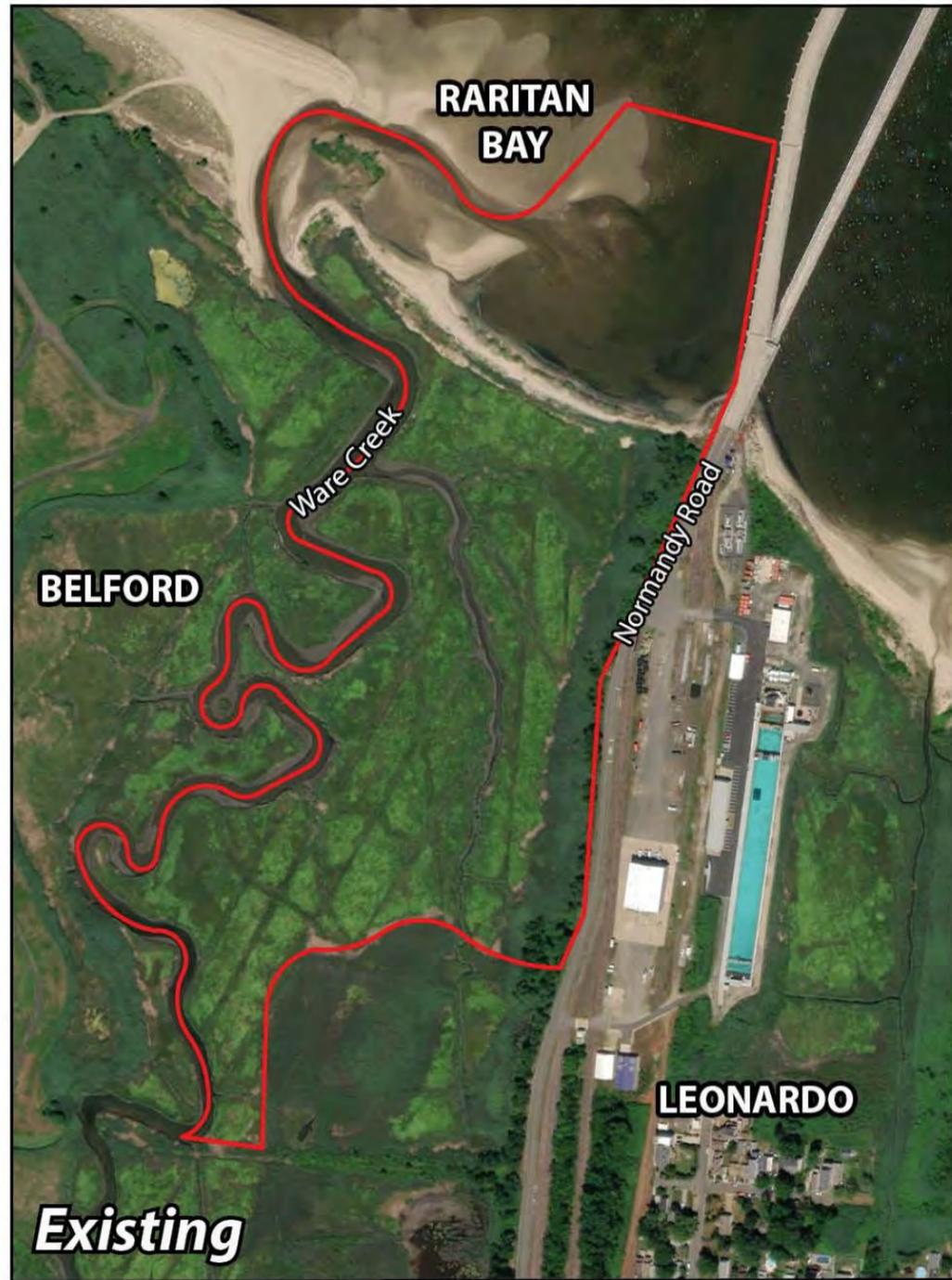
### LEGEND

- Project Location
- Breakwater Installation
- Beach Replenishment Area
- Marsh Restoration Area
- Upland Berm Maritime Forest
- Upland Dune Restoration
- Wave Attenuation Devices

7. WARE CREEK RESILIENCY PROJECT  
CONCEPT DIAGRAM



## 7. WARE CREEK RESILIENCY PROJECT PHOTO SIMULATION

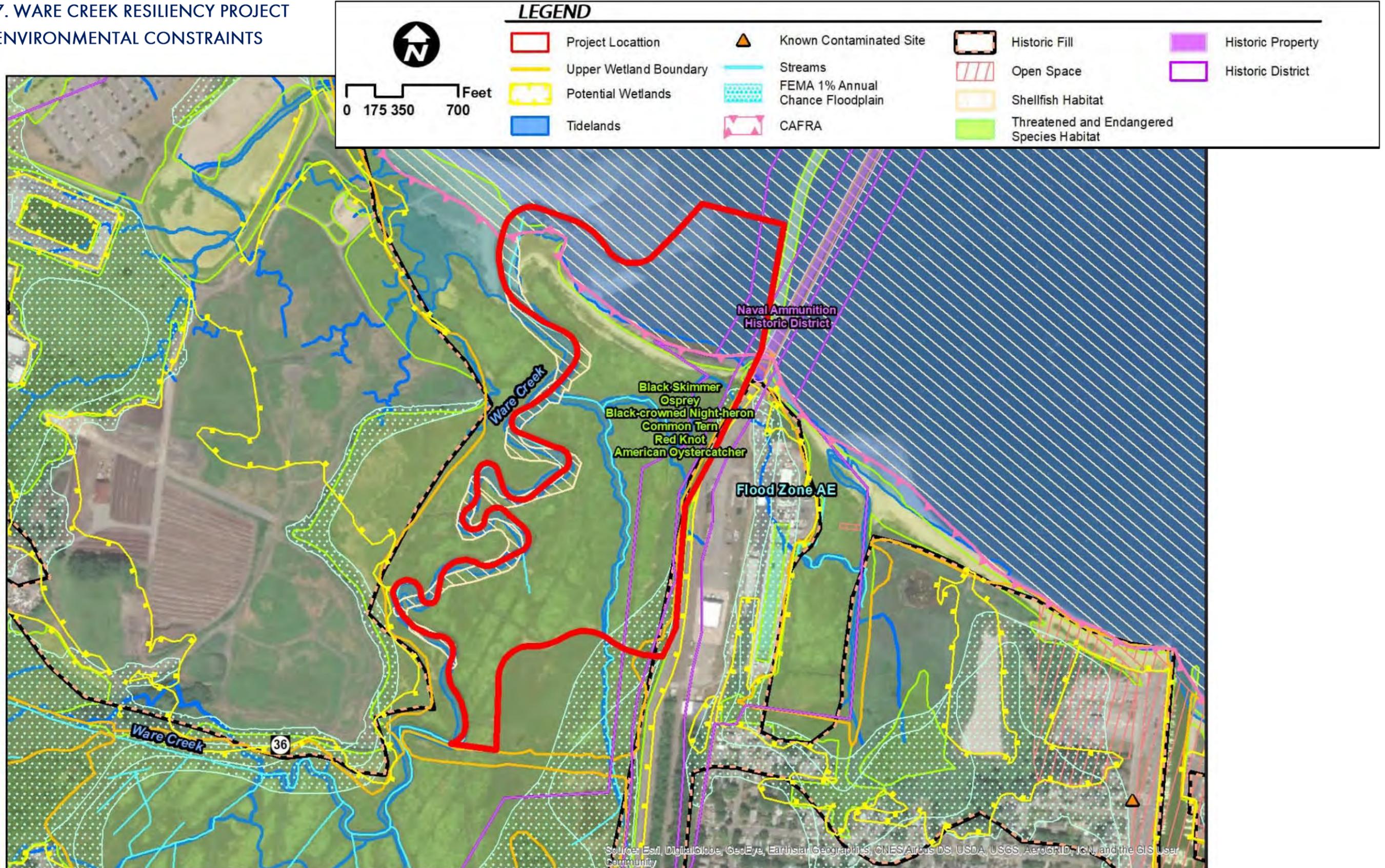


### LEGEND

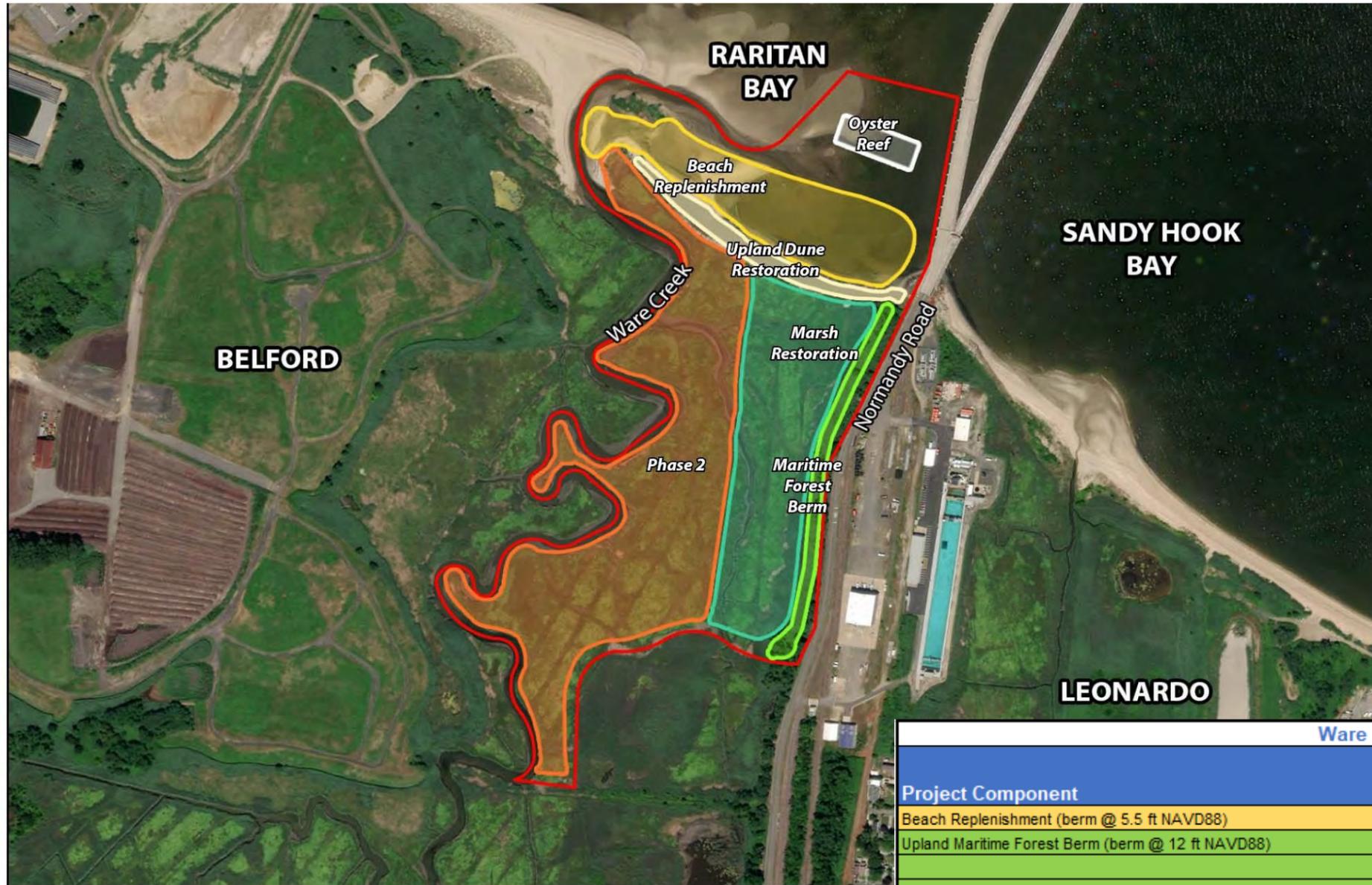
— Project Location

Ware Creek and the surrounding marsh are tidally influenced and impacted by stormwater run-off and coastal erosion. The site contains a sandy beach, low and high marsh areas grading up into upland wooded habitat adjacent to the NWS Earle Pier Complex. The concept plan proposes restoring marshlands to enhance their ability to act as natural buffers to reduce impacts of storm-induced surge and waves, as well as upland restoration to provide a buffer to Normandy Road. Upland dune restoration landward of the replenished beach and expansion of the wave-attenuating oyster reef, currently within the NWS Earle Security Zone, could serve as nature-based solutions to mitigate flooding, erosion, and storm surge.

7. WARE CREEK RESILIENCY PROJECT ENVIRONMENTAL CONSTRAINTS



## 7. WARE CREEK RESILIENCY PROJECT ESTIMATED MATERIALS & QUANTITIES



### LEGEND

- Project Location
- Beach Replenishment Area
- Potential Oyster Reef Expansion
- Upland Dune Restoration
- Marsh Restoration Area
- Upland Berm Maritime Forest
- Potential Phase 2

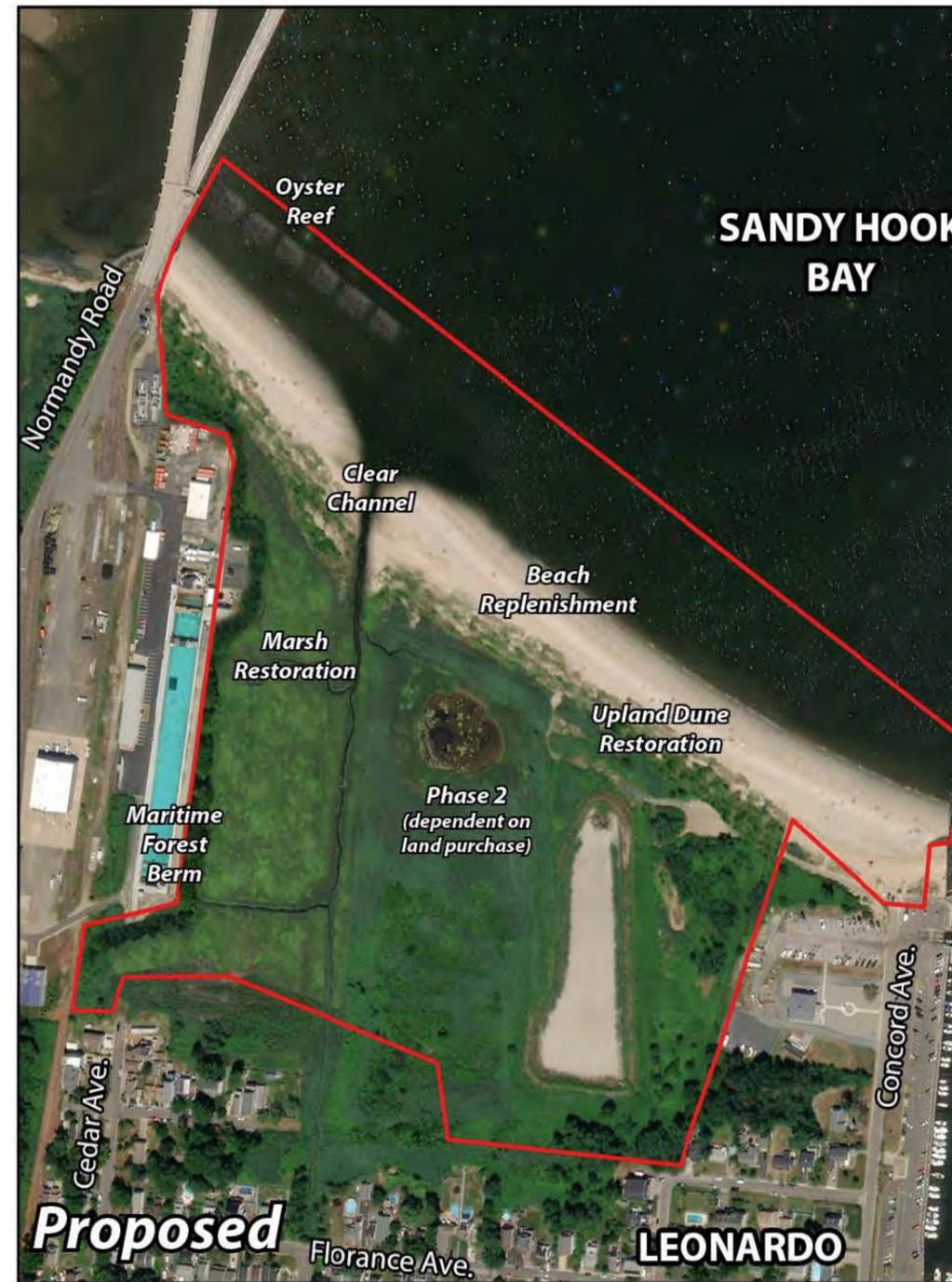
Ware Creek Materials Needed

Project Component	Material Type	Amount	Units
Beach Replenishment (berm @ 5.5 ft NAVD88)	Dredged Material - Sand	44,334	Cubic Yards
Upland Maritime Forest Berm (berm @ 12 ft NAVD88)	Dredged Material - Sand/Silt	27,463	Cubic Yards
	Morella pensylvanica	620	#2 Containers
	Rosa virginiana	329	#2 Containers
	Juniperus Virginiana	149	Ball & Burlap
	Prunus maritima	84	#2 Containers
	Panicum virgatum	12,921	Seedlings
Marsh Restoration (healthy marsh @ 3.5 ft NAV88)	Dredged Material - Sand/Silt	9,717	Cubic Yards
	Spartina Alterniflora	42,418	Seedlings
Potential Oyster Reef Expansion (bottom @ -2 ft NAVD88, top @ +2 ft NAVD88)	Concrete Oyster Castle Blocks	3,882	12" X 8" Blocks
Phase 2 Marsh Restoration (healthy marsh @ 3 ft NAVD88)	Dredged Material - Sand/Silt	13,564	Cubic Yards
	Spartina Alterniflora	93,088	Seedlings
Upland Dune Restoration (berm @ 8 ft NAVD88)	Dredged Material - Sand	12,718	Cubic Yards
	Morella pensylvanica	396	#2 Containers
	Ammophila breviligulata	63,949	Seedlings

8. LEONARDO RESILIENCY PROJECT  
CONCEPT DIAGRAM



## 8. LEONARDO RESILIENCY PROJECT PHOTO SIMULATION

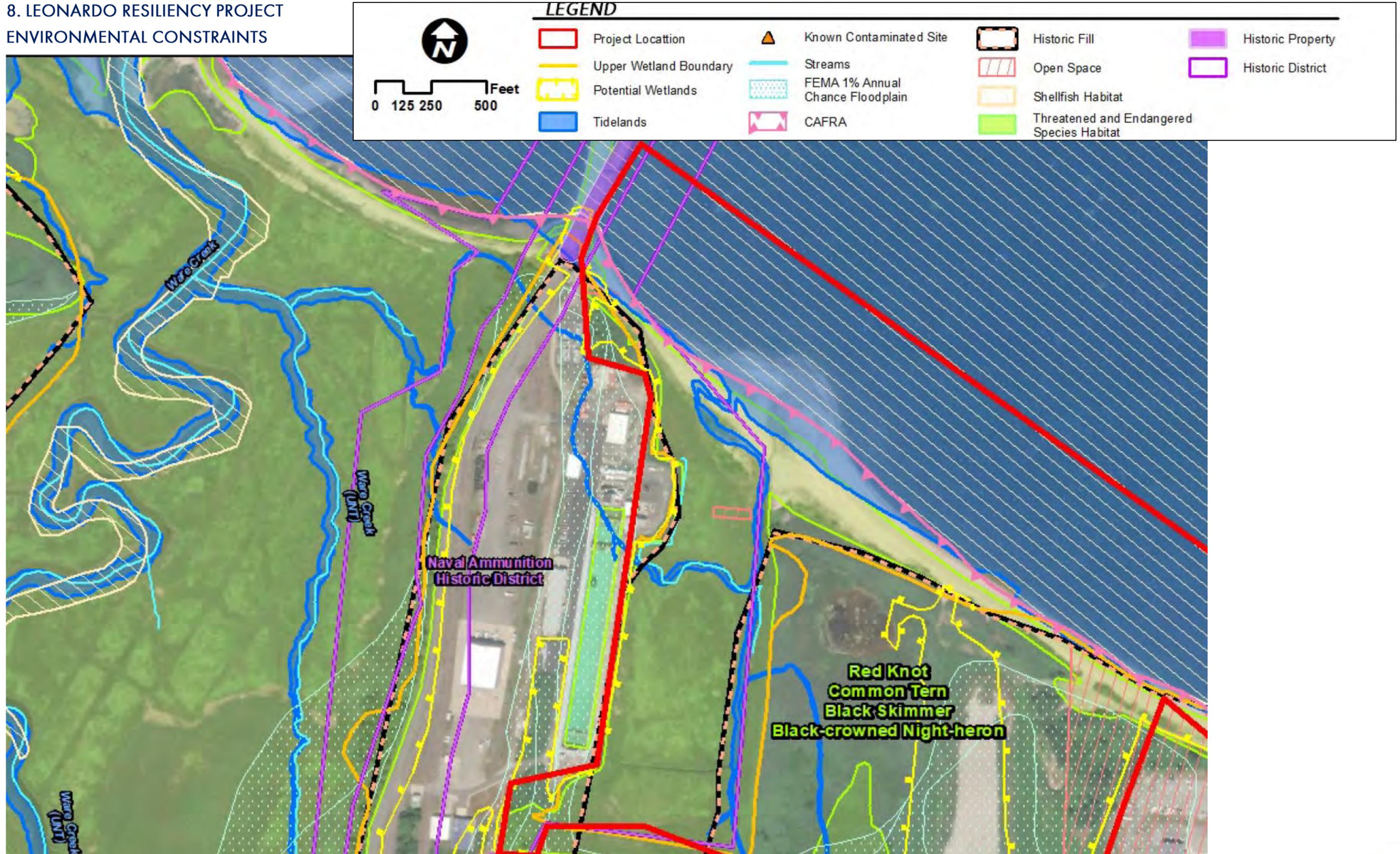


### LEGEND

— Project Location

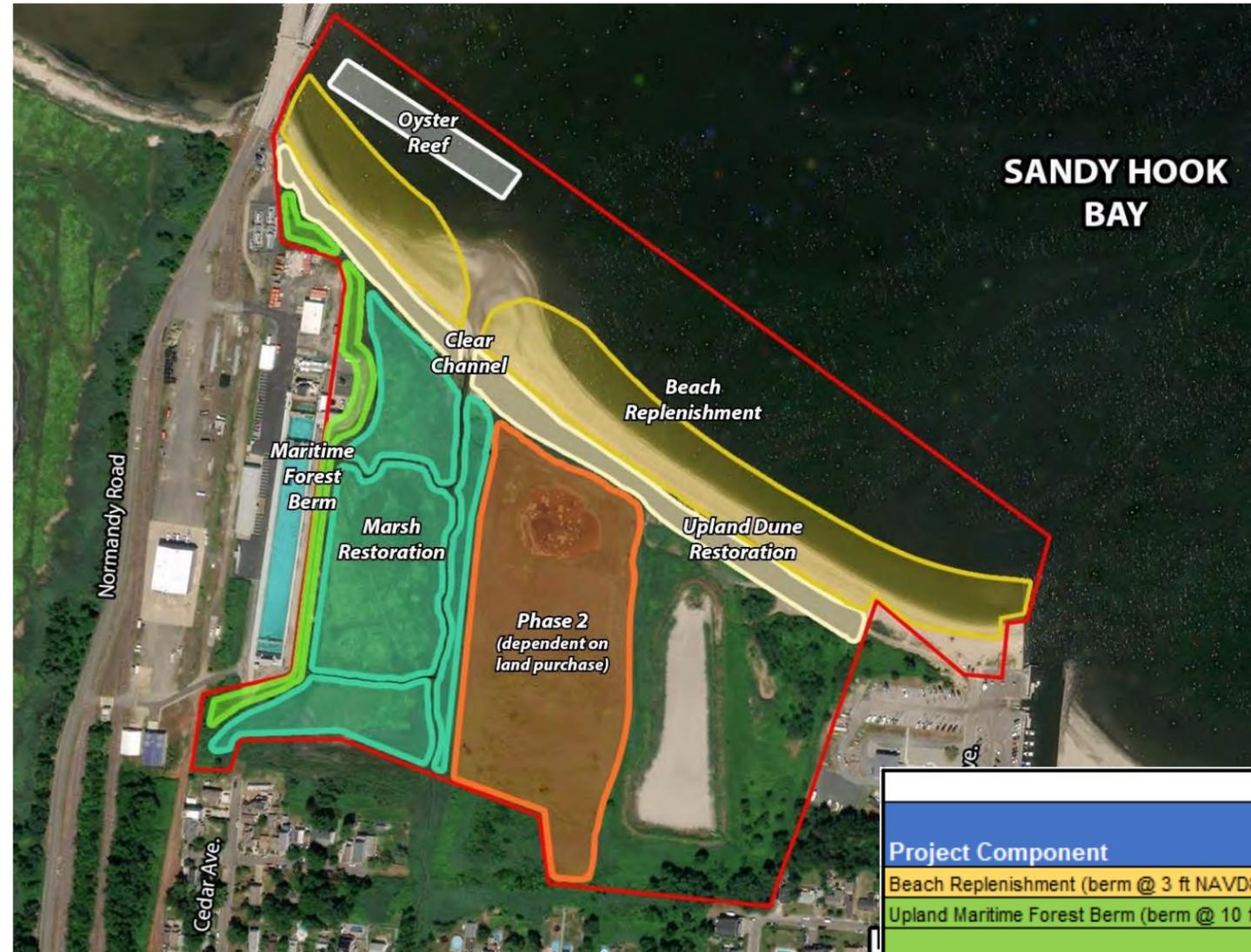
Adjacent to Sandy Hook Bay in Leonardo (Middletown Township) is a small depressed area surrounding an unnamed tidal creek. Located between the NWS Earle Pier Complex and Leonardo State Marina, the site contains a sandy beach, low and high marsh areas grading up into upland wooded habitat surrounded by residential lots. Stormwater collects in this 'bowl' particularly during high tides and contributes to nuisance flooding. The concept plan proposes marsh restoration bordered to the west by a maritime forest berm to provide a buffer to Normandy Road and neighboring properties. Upland dune restoration landward of the replenished beach, along with the expansion of the wave-attenuating oyster reefs within the NWS Earle Security Zone could serve as nature-based solutions to mitigate flooding and storm surge.

8. LEONARDO RESILIENCY PROJECT ENVIRONMENTAL CONSTRAINTS



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## 8. LEONARDO RESILIENCY PROJECT ESTIMATED MATERIALS & QUANTITIES



### LEGEND

- Project Location
- Beach Replenishment Area
- Potential Oyster Reef Expansion
- Upland Dune Restoration
- Marsh Restoration Area
- Maritime Forest Restoration Area
- Potential Phase 2

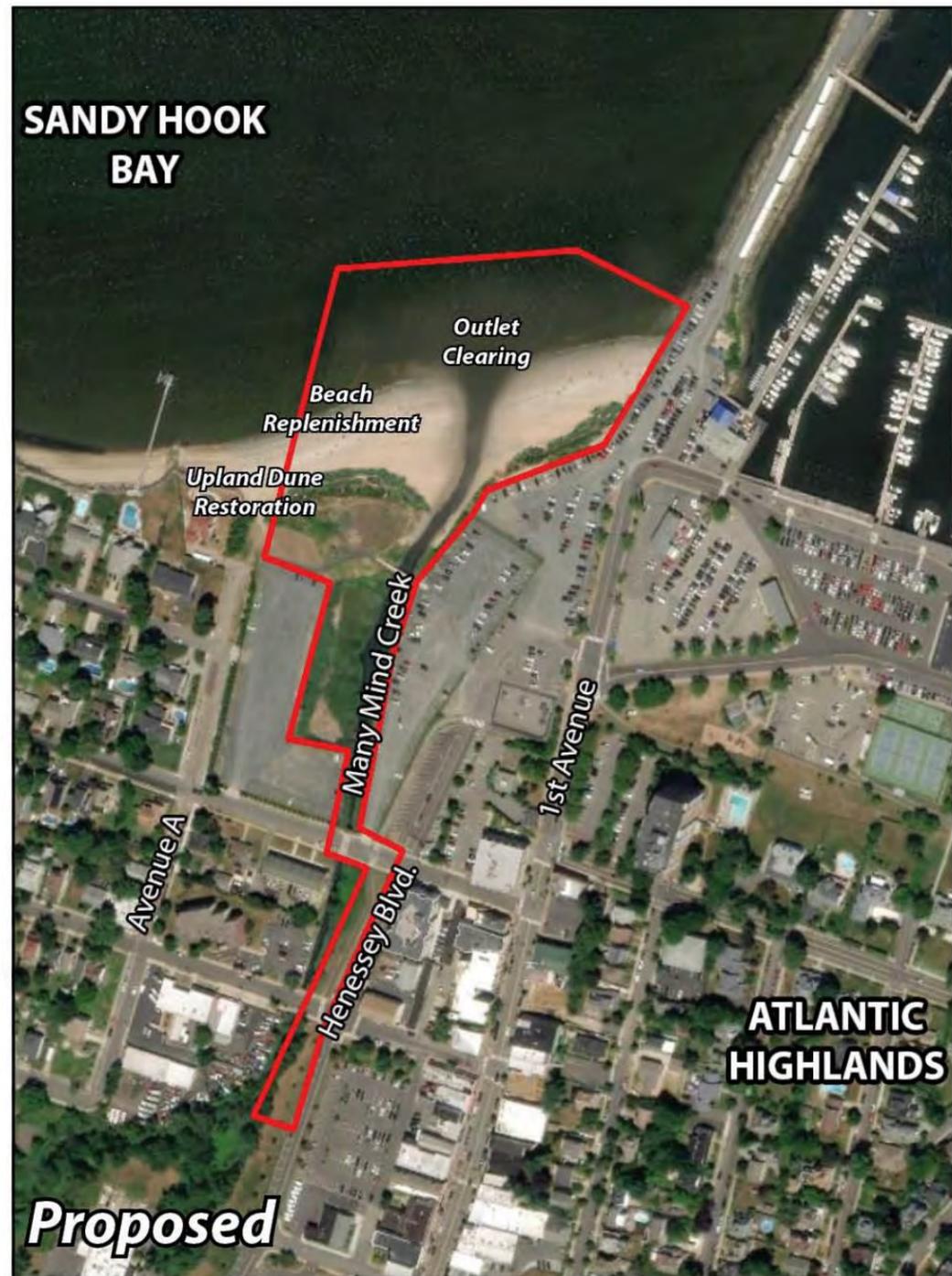
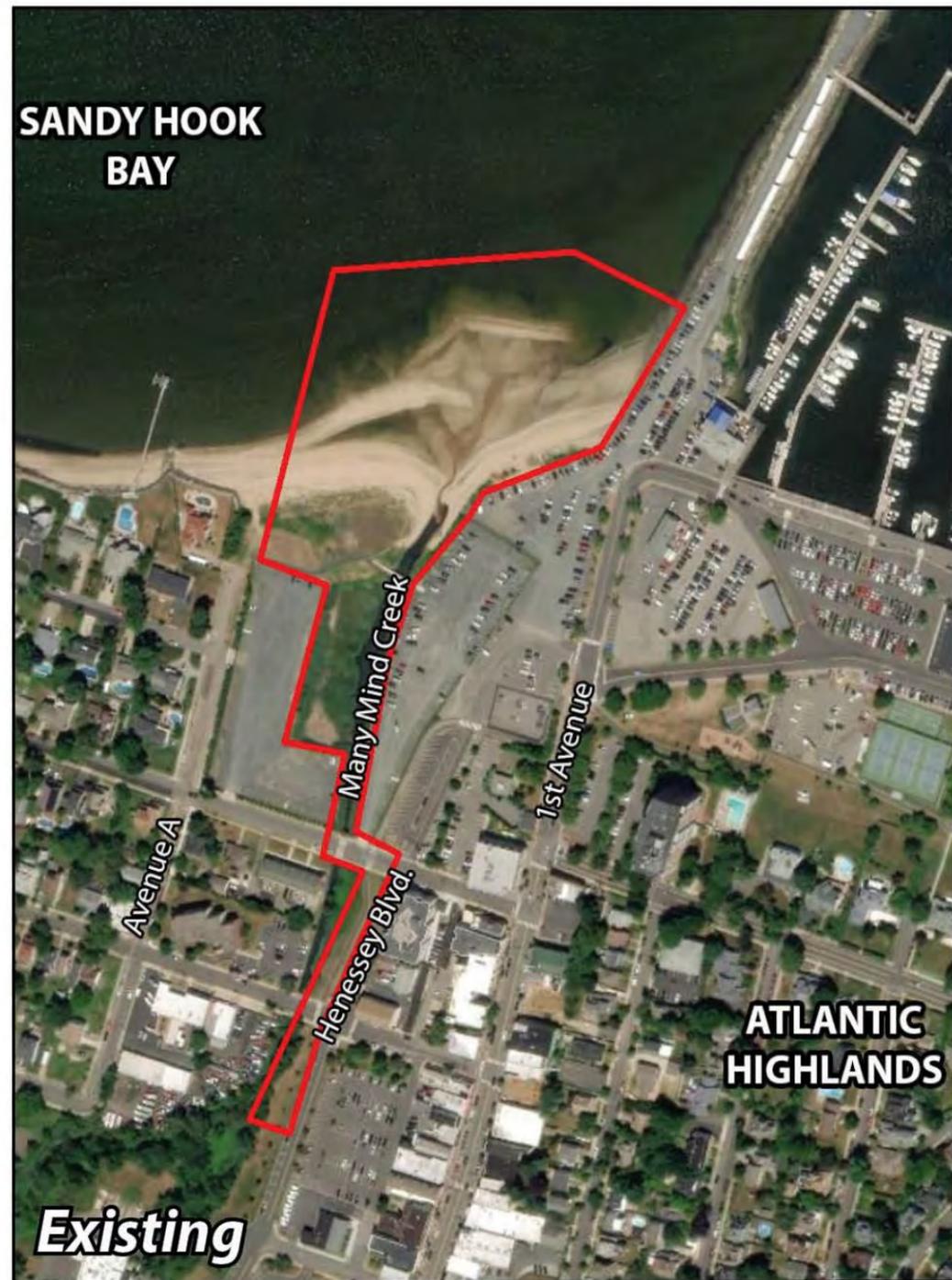
Leonardo Materials Needed

Project Component	Material Type	Amount	Units
Beach Replenishment (berm @ 3 ft NAVD88)	Dredged Material - Sand	42,980	Cubic Yards
Upland Maritime Forest Berm (berm @ 10 ft NAVD88)	Dredged Material - Sand/ Silt	12,469	Cubic Yards
	Morella pensylvanica	370	#2 Containers
	Rosa virginiana	196	#2 Containers
	Juniperus Virginiana	89	Ball & Burlap
	Prunus maritima	50	#2 Containers
	Panicum virgatum	7,699	Seedlings
Marsh Restoration (berm @ 3.5 ft NAV88)	Dredged Material - Sand/ Silt	5,212	Cubic Yards
	Spartina alterniflora	46,770	Seedlings
Potential Oyster Reef Expansion (bottom @ -2 ft NAVD88, top @ +2 ft NAVD88)	Concrete Oyster Castle Blocks	15,708	12" X 8" Blocks
Phase 2 Marsh Restoration (healthy marsh @ 3 ft NAVD88)	Dredged Material - Sand/ Silt	325	Cubic Yards
	Spartina alterniflora	48,734	Seedlings
Upland Dune Restoration (dune @ 10 ft NAVD88)	Dredged Material - Sand	22,585	Cubic Yards
	Morella pensylvanica	750	#2 Containers
	Ammophila breviligulata	121,032	Seedlings
Maintenance Dredging (from -2 ft NAVD88)	Dredged Material - Sand	3695	Cubic Yards

9. MANY MIND CREEK BEACH RESTORATION  
CONCEPT DIAGRAM



## 9. MANY MIND CREEK BEACH RESTORATION PHOTO SIMULATION

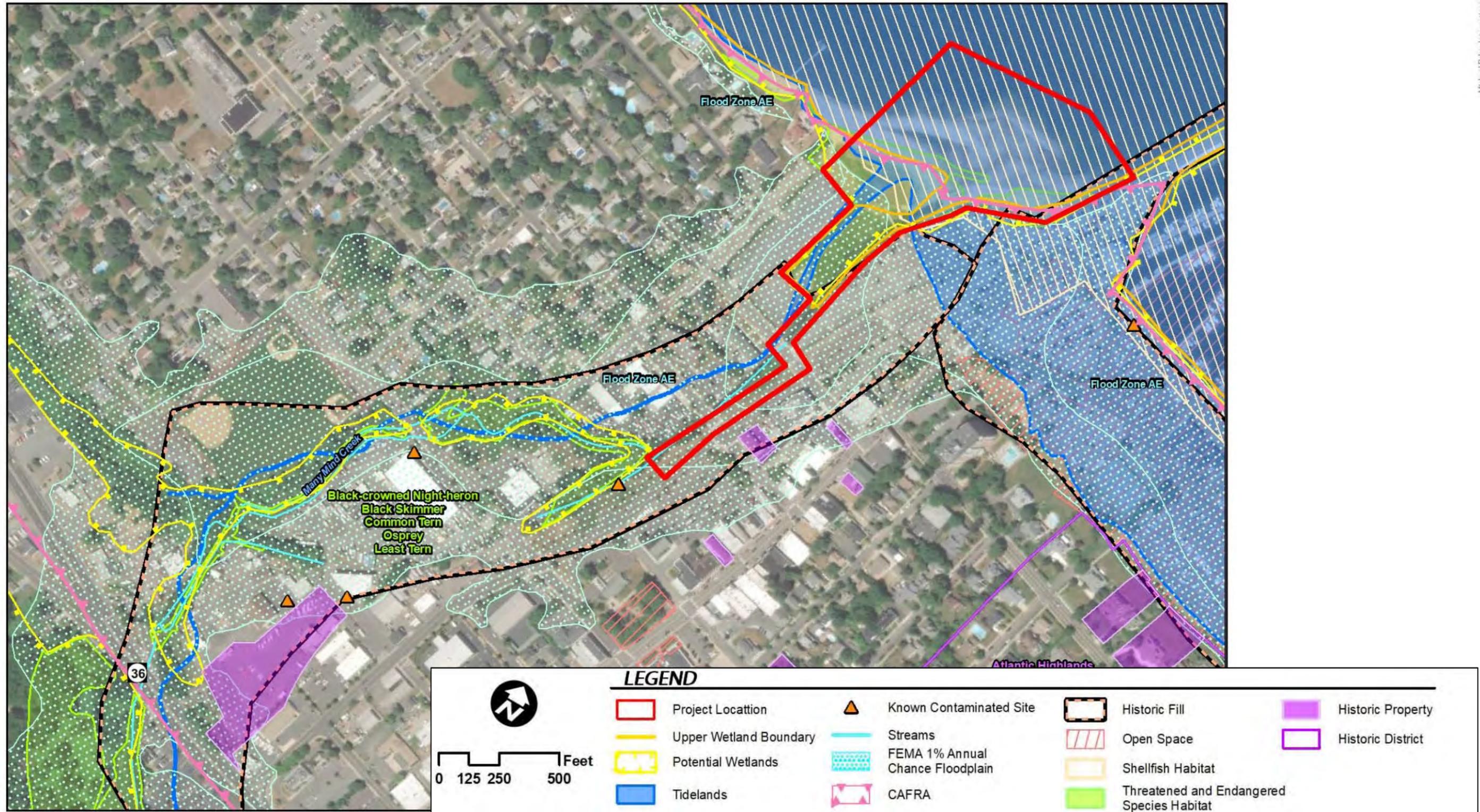


### LEGEND

— Project Location

Many Mind Creek, which drains into Sandy Hook Bay, contributes to flooding in Atlantic Highlands due to constrained flow at the outlet. The concept plan proposes clearing the existing outlet to allow the creek to properly discharge into the bay through a replenished beach; the plan further proposes an upland dune restoration to help protect the community from storm damage and flooding as well as provide habitat for local fauna.

9. MANY MIND CREEK BEACH RESTORATION ENVIRONMENTAL CONSTRAINTS



## 9. MANY MIND CREEK BEACH RESTORATION MATERIALS & QUANTITIES



### LEGEND

- Project Location
- Beach Restoration Area & Outlet Clearing
- Upland Dune Restoration

Many Mind Materials Needed			
Project Component	Material Type	Amount	Units
Beach Replenishment (berm @ 2.5ft NAVD88)	Dredged Material - Sand	7,888	Cubic Yards
Maintance Dredging (from -2 ft NAVD88)	Dredged Material - Sand	338	Cubic Yards
Upland Dune Restoration (dune @ 8-10 ft NAV88)	Dredged Material - Sand/Silt	4,872	Cubic Yards
	Morella pensylvanica	102	#2 Containers
	Ammophila breviligulata	16,458	Seedlings

10. HENRY HUDSON TRAIL SHORELINE PROTECTION  
CONCEPT DIAGRAM



## 10. HENRY HUDSON TRAIL SHORELINE PROTECTION PHOTO SIMULATION



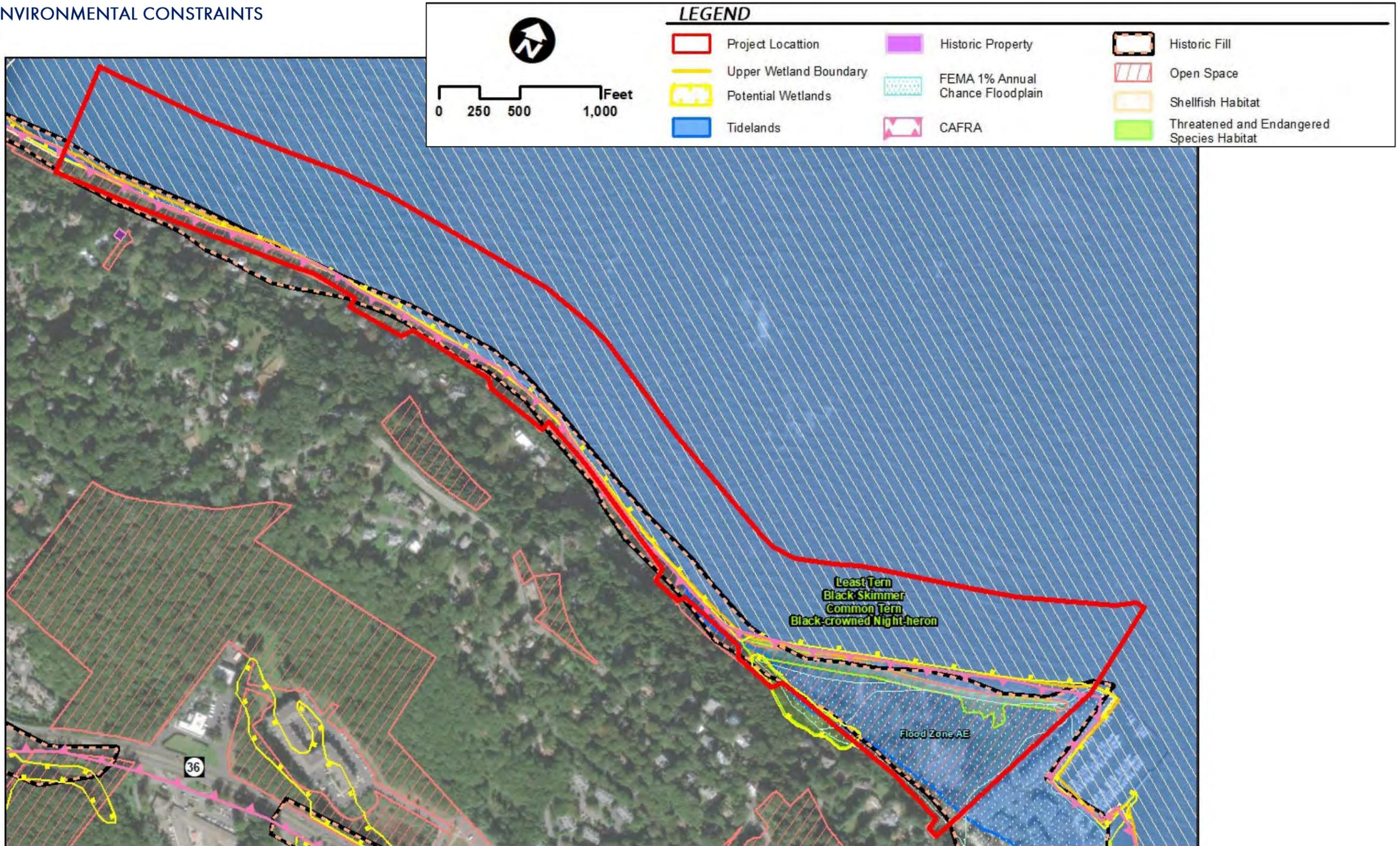
**LEGEND**

— Project Location

The Atlantic Highlands coastal bluffs, Henry Hudson Trail, the Bayshore Outfall Authority's force main pipe are at risk of current and future coastal flooding and erosion during storm events with damaging wave erosion and shoreline failure. The proposed concept intends to reduce erosive wave action and stabilize the shoreline and coastal bluffs to prevent damage to adjacent coastal bluff residences, protect the Regional trail access and stabilize and protect the function of the Bayshore Regional Sewer outfall pipe.

Additionally, the project will enhance the coastal experiences of the Trail and provide valuable coastal habitats for such coastal species as horseshoe crabs and beach nesting birds. Using wave attenuation devices/structures and the beneficial reuse of dredged sands the project will mitigate high energy waves and buffer the vulnerable coastline.

10. HENRY HUDSON TRAIL SHORELINE PROTECTION ENVIRONMENTAL CONSTRAINTS



10. HENRY HUDSON TRAIL SHORELINE PROTECTION  
ESTIMATED MATERIALS & QUANTITIES



**LEGEND**

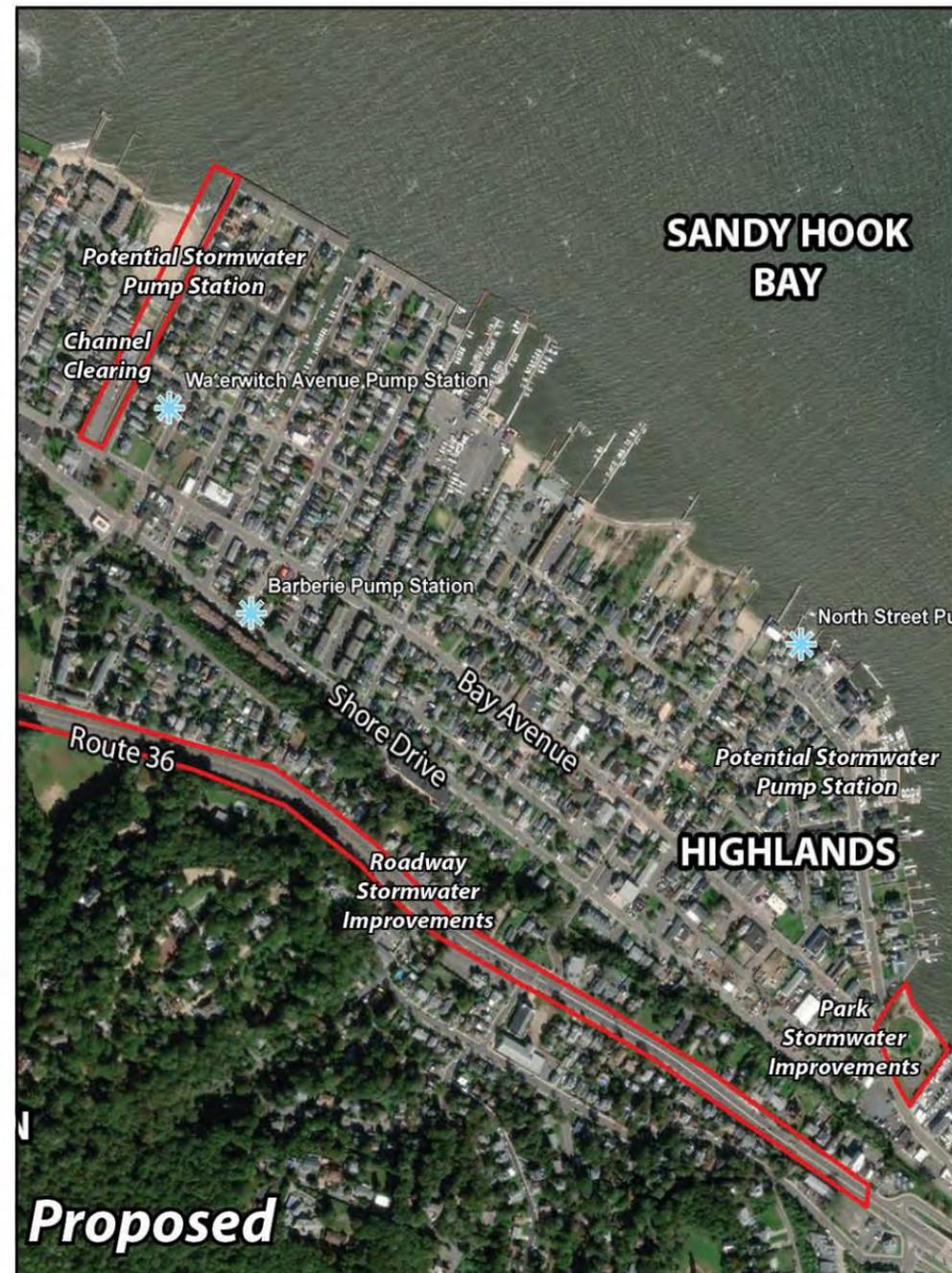
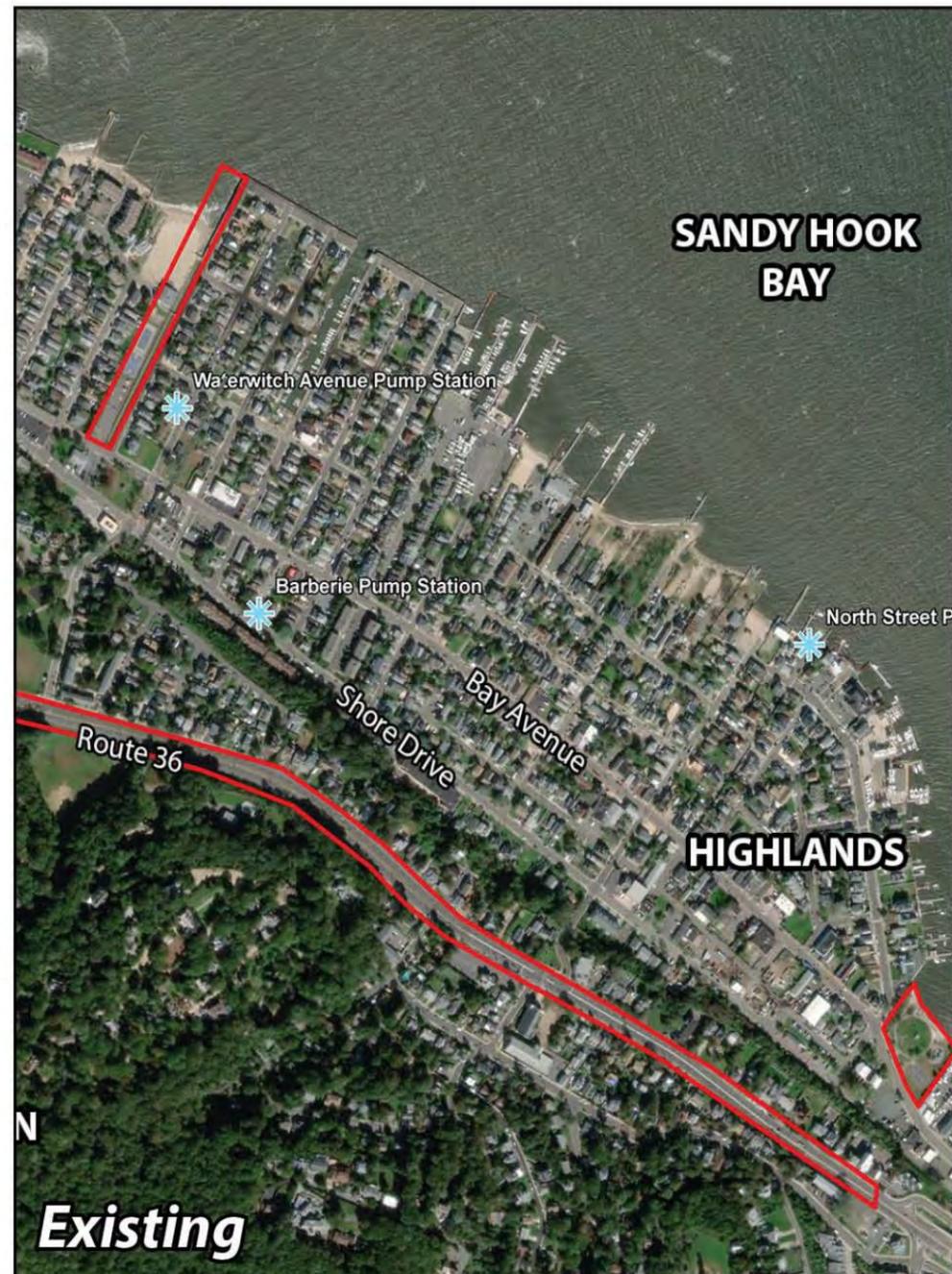
- Project Location
- Breakwater Installation
- Beach Replenishment Area

Henry Hudson Trail Shoreline Protection Baseline Materials Needed			
Project Component	Material Type	Amount	Units
Beach Replenishment (berm @ 3 ft NAVD88)	Dredged Material - Sand	60,360	Cubic Yards
Breakerwater Installation (bottom @ -2 ft NAVD88, top @ +2 ft NAVD88)	Concrete Blocks	21,840	12" X 8" Blocks

11. HIGHLANDS STORMWATER IMPROVEMENTS  
CONCEPT DIAGRAM



# 11. HIGHLANDS STORMWATER IMPROVEMENTS PHOTO SIMULATION

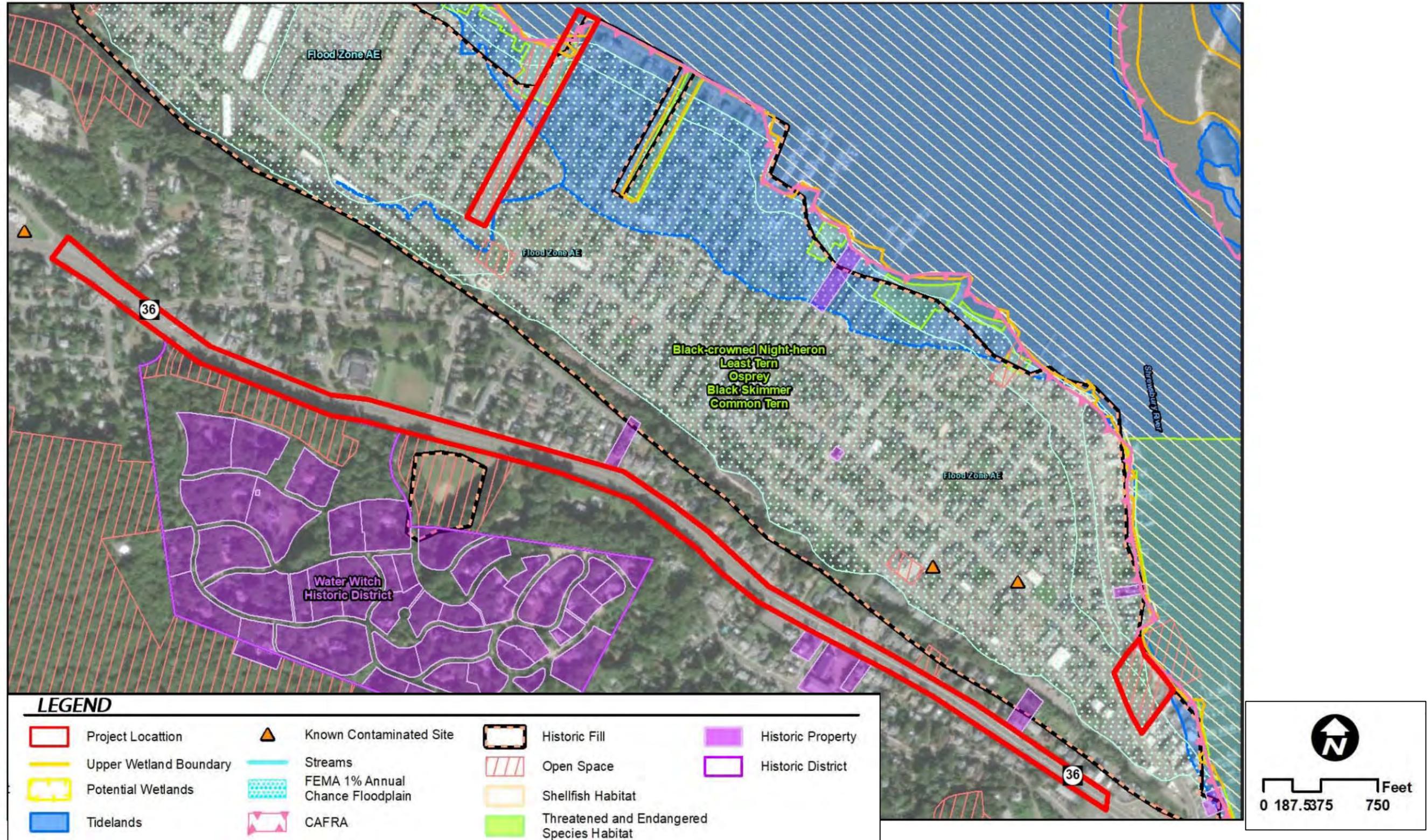


### LEGEND

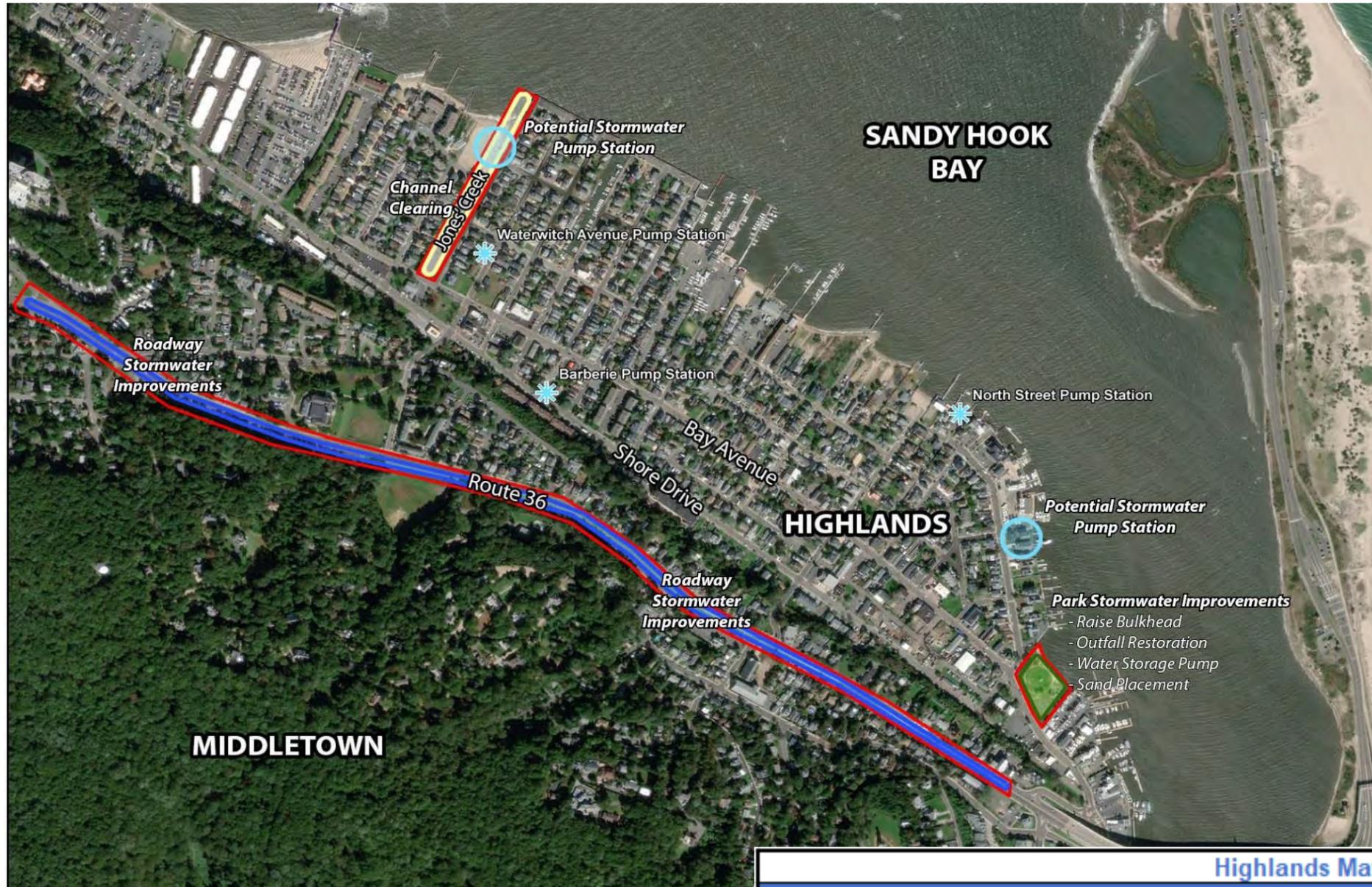
— Project Location

Highlands is at risk of current and future coastal flooding due to its low-lying location. The concept proposes potential locations for additional stormwater pump stations to help direct excess water into Sandy Hook Bay. Stormwater infrastructure improvements are proposed along the Route 36 roadway and in Veterans Memorial Park to capture runoff from higher elevations to the south. The proposed concept further suggests clearing sediment from the Jones Creek channel to help accommodate the increased water volume from Route 36. These stormwater improvements will help reduce flooding in downtown Highlands and on Route 36, which provides access to the NWS Earle Pier Complex.

11. HIGHLANDS STORMWATER IMPROVEMENTS  
ENVIRONMENTAL CONSTRAINTS



# 11. HIGHLANDS STORMWATER IMPROVEMENTS ESTIMATED MATERIALS & QUANTITIES



### LEGEND

- Project Locations
- ✦ Existing Pump Station
- Potential Stormwater Pump Station Location
- Park Stormwater Improvements
- Roadway Stormwater Improvements
- Channel Dredging

Highlands Materials Needed			
Project Component	Material Type	Amount	Units
Maintance Dredging (from -2 ft NAVD88)	Dredged Material - Sand	6385	Cubic Yards
Pump Station Installation	N/A	2	Quantity
<b>Veteran Park Stormwater Improvements</b>			
Raise Bulkhead	Steel sheeting	403	Linear Feet
Sand Placement (raise to highest elevation @ 8ft NAV88)	Dredged Material - Sand	6,357.66	Cubic Yards
Outfall Restoration	N/A	N/A	N/A
Water Storage Pump	N/A	1	Quantity
Roadway Stormwater Improvements	N/A	7922	Linear Feet

## 6. PERMITTING & FUNDING MATRIX

Project Name	Monitoring Plan <sup>1</sup>	Potential Permits	Potential Funding <sup>2</sup>
<p>1. Whale Creek Restoration/Cliffwood Beach Stabilization</p>	<p>Maritime Forest Berm: Annually measure height and density of select species.</p> <p>Beach Replenishment: Twice per year (spring and fall) – Conduct GPS survey along shoreline of project area. Collect topographic data along beach dune profiles</p> <p>Marsh Restoration: ranges, see Appendix C for more detail</p> <p>Wave Attenuation: Annually – and Continuously</p>	<p>Federal Permits/Approvals:</p> <ul style="list-style-type: none"> <li>National Environmental Policy Act (NEPA) review</li> <li>United States Army Corp of Engineers (USACE) approval</li> <li>USEPA Sole Source Aquifer project review</li> <li>Compliance with Executive Order 11990 – Protection of Wetlands</li> <li>Compliance with Executive Order 11988 - Floodplain Management</li> <li>National Marine Fisheries Service consultation</li> <li>Endangered Species Act Section 7 consultation</li> <li>Section 106 of the National Historic Preservation Act consultation</li> </ul> <p>State Permits/Approvals:</p> <ul style="list-style-type: none"> <li>NJDEP Coastal Wetlands Permit</li> <li>NJDEP Waterfront Development Permit</li> <li>NJDEP Coastal Area Facilities Review Act (CAFRA) Permit</li> <li>NJDEP Tidelands Conveyance</li> <li>NJDEP Threatened and Endangered Species coordination</li> <li>NJDEP Green Acres Program approval</li> <li>Compliance with the NJDEP Flood Hazard Area Control Act Rules through the Coastal Zone Management Permit</li> <li>Compliance with NJDEP Stormwater Management Rules</li> <li>NJ Pollutant Discharge Elimination System (NJPDDES) Permit</li> <li>Soil Erosion and Sediment Control Certification</li> </ul>	<ul style="list-style-type: none"> <li>New Jersey Corporate Wetlands Restoration Partnership (NJCWRP)</li> <li>FEMA Hazard Mitigation Assistance (HMA)</li> <li>National Fish and Wildlife Foundation (NFWF) Acres for America</li> <li>National Oceanic and Atmospheric Administration (NOAA)</li> <li>US Fish and Wildlife Service (FWS)</li> <li>Environmental Protection Agency (EPA)</li> </ul>
<p>2. Happy Meadows Wetland Restoration</p>	<p>Maritime Forest Berm: Annually measure height and density of select species.</p> <p>Marsh Restoration: ranges, see Appendix C for more detail</p>	<p>Federal Permits/Approvals:</p> <ul style="list-style-type: none"> <li>National Environmental Policy Act (NEPA) review</li> <li>United States Army Corp of Engineers (USACE) approval</li> <li>USEPA Sole Source Aquifer project review</li> <li>Compliance with Executive Order 11990 – Protection of Wetlands</li> <li>Compliance with Executive Order 11988 - Floodplain Management</li> <li>National Marine Fisheries Service consultation</li> <li>Endangered Species Act Section 7 consultation</li> <li>Section 106 of the National Historic Preservation Act consultation</li> </ul> <p>State Permits/Approvals:</p> <ul style="list-style-type: none"> <li>NJDEP Coastal Wetlands Permit</li> <li>NJDEP Waterfront Development Permit</li> <li>NJDEP Coastal Area Facilities Review Act (CAFRA) Permit</li> <li>NJDEP Tidelands Conveyance</li> <li>NJDEP Threatened and Endangered Species coordination</li> <li>NJDEP Green Acres Program approval</li> <li>Compliance with the NJDEP Flood Hazard Area Control Act Rules through the Coastal Zone Management Permit</li> </ul>	<ul style="list-style-type: none"> <li>New Jersey Corporate Wetlands Restoration Partnership (NJCWRP)</li> <li>FEMA Hazard Mitigation Assistance (HMA)</li> <li>National Oceanic and Atmospheric Administration (NOAA)</li> <li>US Fish and Wildlife Service (FWS)</li> <li>National Fish and Wildlife Foundation (NFWF) Acres for America</li> <li>Environmental Protection Agency (EPA)</li> </ul>

Project Name	Monitoring Plan <sup>1</sup>	Potential Permits	Potential Funding <sup>2</sup>
		<ul style="list-style-type: none"> <li>• Compliance with NJDEP Stormwater Management Rules</li> <li>• NJ Pollutant Discharge Elimination System (NJPDES) Permit</li> <li>• Soil Erosion and Sediment Control Certification</li> </ul>	
3. Flat Creek Restoration	<p>Maritime Forest Berm: Annually measure height and density of select species.</p> <p>Marsh Restoration: ranges, see Appendix C for more detail</p>	<p>Federal Permits/Approvals:</p> <ul style="list-style-type: none"> <li>• National Environmental Policy Act (NEPA) review</li> <li>• United States Army Corp of Engineers (USACE) approval</li> <li>• USEPA Sole Source Aquifer project review</li> <li>• Compliance with Executive Order 11990 – Protection of Wetlands</li> <li>• Compliance with Executive Order 11988 - Floodplain Management</li> <li>• National Marine Fisheries Service consultation</li> <li>• Endangered Species Act Section 7 consultation</li> <li>• Section 106 of the National Historic Preservation Act consultation</li> </ul> <p>State Permits/Approvals:</p> <ul style="list-style-type: none"> <li>• NJDEP Coastal Wetlands Permit</li> <li>• NJDEP Waterfront Development Permit</li> <li>• NJDEP Coastal Area Facilities Review Act (CAFRA) Permit</li> <li>• NJDEP Tidelands Conveyance</li> <li>• NJDEP Threatened and Endangered Species coordination</li> <li>• NJDEP Green Acres Program approval</li> <li>• Compliance with the NJDEP Flood Hazard Area Control Act Rules through the Coastal Zone Management Permit</li> <li>• Compliance with NJDEP Stormwater Management Rules</li> <li>• NJ Pollutant Discharge Elimination System (NJPDES) Permit</li> <li>• Soil Erosion and Sediment Control Certification</li> </ul>	<ul style="list-style-type: none"> <li>• New Jersey Corporate Wetlands Restoration Partnership (NJCWRP)</li> <li>• FEMA Hazard Mitigation Assistance (HMA)</li> <li>• National Oceanic and Atmospheric Administration (NOAA)</li> <li>• NJDEP Blue Acres (Phase 2)</li> <li>• National Fish and Wildlife Foundation (NFWF) Acres for America</li> <li>• Environmental Protection Agency (EPA)</li> </ul>
4. Keansburg Beach Replenishment	Beach Replenishment: Twice per year (spring and fall)	<p>Federal Permits/Approvals:</p> <ul style="list-style-type: none"> <li>• National Environmental Policy Act (NEPA) review</li> <li>• United States Army Corp of Engineers (USACE) approval</li> <li>• USEPA Sole Source Aquifer project review</li> <li>• Compliance with Executive Order 11990 – Protection of Wetlands</li> <li>• Compliance with Executive Order 11988 - Floodplain Management</li> <li>• National Marine Fisheries Service consultation</li> <li>• Endangered Species Act Section 7 consultation</li> <li>• Section 106 of the National Historic Preservation Act consultation</li> </ul> <p>State Permits/Approvals:</p> <ul style="list-style-type: none"> <li>• NJDEP Coastal Wetlands Permit</li> <li>• NJDEP Waterfront Development Permit</li> <li>• NJDEP Coastal Area Facilities Review Act (CAFRA) Permit</li> <li>• NJDEP Tidelands Conveyance</li> <li>• NJDEP Threatened and Endangered Species coordination</li> <li>• NJDEP Green Acres Program approval</li> <li>• Compliance with the NJDEP Flood Hazard Area Control Act Rules through the Coastal Zone Management Permit</li> </ul>	<ul style="list-style-type: none"> <li>• New Jersey Department of Transportation (NJDOT)</li> <li>• Environmental Protection Agency (EPA)</li> <li>• National Oceanic and Atmospheric Administration (NOAA)</li> <li>• National Fish and Wildlife Foundation (NFWF)</li> </ul>

Project Name	Monitoring Plan <sup>1</sup>	Potential Permits	Potential Funding <sup>2</sup>
5. Compton Creek Wetland Restoration	<p>Maritime Forest Berm: Annually m</p> <p>Marsh Restoration: ranges, see Appendix C for more detail</p>	<ul style="list-style-type: none"> <li>• Compliance with NJDEP Stormwater Management Rules</li> <li>• NJ Pollutant Discharge Elimination System (NJPDES) Permit</li> <li>• Soil Erosion and Sediment Control Certification</li> </ul> <p>Federal Permits/Approvals:</p> <ul style="list-style-type: none"> <li>• National Environmental Policy Act (NEPA) review</li> <li>• United States Army Corp of Engineers (USACE) approval</li> <li>• USEPA Sole Source Aquifer project review</li> <li>• Compliance with Executive Order 11990 – Protection of Wetlands</li> <li>• Compliance with Executive Order 11988 - Floodplain Management</li> <li>• National Marine Fisheries Service consultation</li> <li>• Endangered Species Act Section 7 consultation</li> <li>• Section 106 of the National Historic Preservation Act consultation</li> </ul> <p>State Permits/Approvals:</p> <ul style="list-style-type: none"> <li>• NJDEP Coastal Wetlands Permit</li> <li>• NJDEP Waterfront Development Permit</li> <li>• NJDEP Coastal Area Facilities Review Act (CAFRA) Permit</li> <li>• NJDEP Tidelands Conveyance</li> <li>• NJDEP Threatened and Endangered Species coordination</li> <li>• NJDEP Site Remediation approval</li> <li>• NJDEP Green Acres Program approval</li> <li>• Compliance with the NJDEP Flood Hazard Area Control Act Rules through the Coastal Zone Management Permit</li> <li>• Compliance with NJDEP Stormwater Management Rules</li> <li>• NJ Pollutant Discharge Elimination System (NJPDES) Permit</li> <li>• Soil Erosion and Sediment Control Certification</li> </ul>	<ul style="list-style-type: none"> <li>• New Jersey Corporate Wetlands Restoration Partnership (NJCWRP)</li> <li>• FEMA Hazard Mitigation Assistance (HMA)</li> <li>• National Oceanic and Atmospheric Administration (NOAA)</li> <li>• US Fish and Wildlife Service (FWS)</li> <li>• National Fish and Wildlife Foundation (NFWF) Acres for America</li> <li>• Environmental Protection Agency (EPA)</li> </ul>
6. Belford Beach Stabilization	<p>Maritime Forest Berm: Annually</p> <p>Beach Replenishment: Twice per year (spring and fall)</p> <p>Marsh Restoration: ranges, see Appendix C for more detail</p> <p>Wave Attenuation: Annually – and Continuously</p> <p>Breakwaters and Bulkheads: Annually and Continuously</p>	<ul style="list-style-type: none"> <li>• Compliance with NJDEP Stormwater Management Rules</li> <li>• NJ Pollutant Discharge Elimination System (NJPDES) Permit</li> <li>• Soil Erosion and Sediment Control Certification</li> </ul> <p>Federal Permits/Approvals:</p> <ul style="list-style-type: none"> <li>• National Environmental Policy Act (NEPA) review</li> <li>• United States Army Corp of Engineers (USACE) approval</li> <li>• USEPA Sole Source Aquifer project review</li> <li>• Compliance with Executive Order 11990 – Protection of Wetlands</li> <li>• Compliance with Executive Order 11988 - Floodplain Management</li> <li>• National Marine Fisheries Service consultation</li> <li>• Endangered Species Act Section 7 consultation</li> <li>• Section 106 of the National Historic Preservation Act consultation</li> </ul> <p>State Permits/Approvals:</p> <ul style="list-style-type: none"> <li>• NJDEP Coastal Wetlands Permit</li> <li>• NJDEP Waterfront Development Permit</li> <li>• NJDEP Coastal Area Facilities Review Act (CAFRA) Permit</li> <li>• NJDEP Tidelands Conveyance</li> <li>• NJDEP Threatened and Endangered Species coordination</li> <li>• Compliance with the NJDEP Flood Hazard Area Control Act Rules through the Coastal Zone Management Permit</li> </ul>	<ul style="list-style-type: none"> <li>• New Jersey Corporate Wetlands Restoration Partnership (NJCWRP)</li> <li>• FEMA Hazard Mitigation Assistance (HMA)</li> <li>• Environmental Protection Agency (EPA)</li> <li>• National Oceanic and Atmospheric Administration (NOAA)</li> <li>• National Fish and Wildlife Foundation (NFWF)</li> </ul>

Project Name	Monitoring Plan <sup>1</sup>	Potential Permits	Potential Funding <sup>2</sup>
		<ul style="list-style-type: none"> <li>• Compliance with NJDEP Stormwater Management Rules</li> <li>• NJ Pollutant Discharge Elimination System (NJPDES) Permit</li> <li>• Soil Erosion and Sediment Control Certification</li> </ul>	
7. Ware Creek Resiliency Project	<p>Maritime Forest Berm: Annually</p> <p>Beach Replenishment: Twice per year (spring and fall)</p> <p>Marsh Restoration: ranges, see Appendix C for more detail</p>	<p>Federal Permits/Approvals:</p> <ul style="list-style-type: none"> <li>• National Environmental Policy Act (NEPA) review</li> <li>• United States Army Corp of Engineers (USACE) approval</li> <li>• USEPA Sole Source Aquifer project review</li> <li>• Compliance with Executive Order 11990 – Protection of Wetlands</li> <li>• Compliance with Executive Order 11988 - Floodplain Management</li> <li>• National Marine Fisheries Service consultation</li> <li>• Endangered Species Act Section 7 consultation</li> <li>• Section 106 of the National Historic Preservation Act consultation</li> </ul> <p>State Permits/Approvals:</p> <ul style="list-style-type: none"> <li>• NJDEP Coastal Wetlands Permit</li> <li>• NJDEP Waterfront Development Permit</li> <li>• NJDEP Coastal Area Facilities Review Act (CAFRA) Permit</li> <li>• NJDEP Tidelands Conveyance</li> <li>• NJDEP Threatened and Endangered Species coordination</li> <li>• Compliance with the NJDEP Flood Hazard Area Control Act Rules through the Coastal Zone Management Permit</li> <li>• Compliance with NJDEP Stormwater Management Rules</li> <li>• NJ Pollutant Discharge Elimination System (NJPDES) Permit</li> <li>• Soil Erosion and Sediment Control Certification</li> </ul>	<ul style="list-style-type: none"> <li>• New Jersey Corporate Wetlands Restoration Partnership (NJCWRP)</li> <li>• FEMA Hazard Mitigation Assistance (HMA)</li> <li>• National Fish and Wildlife Foundation (NFWF) Acres for America</li> <li>• Environmental Protection Agency (EPA)</li> <li>• National Oceanic and Atmospheric Administration (NOAA)</li> <li>• The Nature Conservancy (TNC)</li> </ul>
8. Leonardo Resiliency Project	<p>Maritime Forest Berm: Annually</p> <p>Beach Replenishment: Twice per year (spring and fall)</p> <p>Marsh Restoration: ranges, see Appendix C for more detail</p>	<p>Federal Permits/Approvals:</p> <ul style="list-style-type: none"> <li>• National Environmental Policy Act (NEPA) review</li> <li>• United States Army Corp of Engineers (USACE) approval</li> <li>• USEPA Sole Source Aquifer project review</li> <li>• Compliance with Executive Order 11990 – Protection of Wetlands</li> <li>• Compliance with Executive Order 11988 - Floodplain Management</li> <li>• National Marine Fisheries Service consultation</li> <li>• Endangered Species Act Section 7 consultation</li> <li>• Section 106 of the National Historic Preservation Act consultation</li> </ul> <p>State Permits/Approvals:</p> <ul style="list-style-type: none"> <li>• NJDEP Coastal Wetlands Permit</li> <li>• NJDEP Waterfront Development Permit</li> <li>• NJDEP Coastal Area Facilities Review Act (CAFRA) Permit</li> <li>• NJDEP Tidelands Conveyance</li> <li>• NJDEP Threatened and Endangered Species coordination</li> <li>• NJDEP Green Acres Program approval</li> <li>• Compliance with the NJDEP Flood Hazard Area Control Act Rules through the Coastal Zone Management Permit</li> <li>• Compliance with NJDEP Stormwater Management Rules</li> </ul>	<ul style="list-style-type: none"> <li>• New Jersey Corporate Wetlands Restoration Partnership (NJCWRP)</li> <li>• FEMA Hazard Mitigation Assistance (HMA)</li> <li>• National Fish and Wildlife Foundation (NFWF) Acres for America</li> <li>• NJDEP Blue Acres</li> <li>• Environmental Protection Agency (EPA)</li> <li>• National Oceanic and Atmospheric Administration (NOAA)</li> <li>• The Nature Conservancy (TNC)</li> </ul>

Project Name	Monitoring Plan <sup>1</sup>	Potential Permits	Potential Funding <sup>2</sup>
<p>9. Many Mind Creek Dredging and Restoration</p>	<p>Beach Replenishment: Twice per year (spring and fall)</p>	<ul style="list-style-type: none"> <li>• NJ Pollutant Discharge Elimination System (NJPDES) Permit</li> <li>• Soil Erosion and Sediment Control Certification</li> </ul> <p>Federal Permits/Approvals:</p> <ul style="list-style-type: none"> <li>• National Environmental Policy Act (NEPA) review</li> <li>• United States Army Corp of Engineers (USACE) approval</li> <li>• USEPA Sole Source Aquifer project review</li> <li>• Compliance with Executive Order 11990 – Protection of Wetlands</li> <li>• Compliance with Executive Order 11988 - Floodplain Management</li> <li>• National Marine Fisheries Service consultation</li> <li>• Endangered Species Act Section 7 consultation</li> <li>• Section 106 of the National Historic Preservation Act consultation</li> </ul> <p>State Permits/Approvals:</p> <ul style="list-style-type: none"> <li>• NJDEP Coastal Wetlands Permit</li> <li>• NJDEP Waterfront Development Permit</li> <li>• NJDEP Coastal Area Facilities Review Act (CAFRA) Permit</li> <li>• NJDEP Tidelands Conveyance</li> <li>• NJDEP Threatened and Endangered Species coordination</li> <li>• Compliance with the NJDEP Flood Hazard Area Control Act Rules through the Coastal Zone Management Permit</li> <li>• Compliance with NJDEP Stormwater Management Rules</li> <li>• NJ Pollutant Discharge Elimination System (NJPDES) Permit</li> <li>• Soil Erosion and Sediment Control Certification</li> </ul>	<ul style="list-style-type: none"> <li>• New Jersey Corporate Wetlands Restoration Partnership (NJCWRP)</li> <li>• FEMA Hazard Mitigation Assistance (HMA)</li> <li>• National Oceanic and Atmospheric Administration (NOAA)</li> <li>• Environmental Protection Agency (EPA)</li> <li>• National Fish and Wildlife Foundation (NFWF)</li> </ul>
<p>10. Hendry Hudson Trail Shoreline Protection</p>	<p>Beach Replenishment: Twice per year (spring and fall)</p> <p>Breakwaters and Bulkheads: Annually and Continuously</p>	<p>Federal Permits/Approvals:</p> <ul style="list-style-type: none"> <li>• National Environmental Policy Act (NEPA) review</li> <li>• United States Army Corp of Engineers (USACE) approval</li> <li>• USEPA Sole Source Aquifer project review</li> <li>• Compliance with Executive Order 11990 – Protection of Wetlands</li> <li>• Compliance with Executive Order 11988 - Floodplain Management</li> <li>• National Marine Fisheries Service consultation</li> <li>• Endangered Species Act Section 7 consultation</li> <li>• Section 106 of the National Historic Preservation Act consultation</li> </ul> <p>State Permits/Approvals:</p> <ul style="list-style-type: none"> <li>• NJDEP Coastal Wetlands Permit</li> <li>• NJDEP Waterfront Development Permit</li> <li>• NJDEP Coastal Area Facilities Review Act (CAFRA) Permit</li> <li>• NJDEP Tidelands Conveyance</li> <li>• NJDEP Green Acres Program approval</li> <li>• Compliance with the NJDEP Flood Hazard Area Control Act Rules through the Coastal Zone Management Permit</li> <li>• Compliance with NJDEP Stormwater Management Rules</li> <li>• NJ Pollutant Discharge Elimination System (NJPDES) Permit</li> <li>• Soil Erosion and Sediment Control Certification</li> </ul>	<ul style="list-style-type: none"> <li>• FEMA Hazard Mitigation Assistance (HMA)</li> <li>• The Nature Conservancy (TNC)</li> <li>• National Oceanic and Atmospheric Administration (NOAA)</li> <li>• National Fish and Wildlife Foundation (NFWF)</li> </ul>

Project Name	Monitoring Plan <sup>1</sup>	Potential Permits	Potential Funding <sup>2</sup>
11. Highlands Bulkhead and Pump Installation	Breakwaters and Bulkheads: Annually and Continuously  Stormwater Infrastructure: Annually	Federal Permits/Approvals: <ul style="list-style-type: none"> <li>• National Environmental Policy Act (NEPA) review</li> <li>• United States Army Corp of Engineers (USACE) approval</li> <li>• USEPA Sole Source Aquifer project review</li> <li>• Compliance with Executive Order 11990 – Protection of Wetlands</li> <li>• Compliance with Executive Order 11988 - Floodplain Management</li> <li>• National Marine Fisheries Service consultation</li> <li>• Endangered Species Act Section 7 consultation</li> <li>• Section 106 of the National Historic Preservation Act consultation</li> </ul> State Permits/Approvals: <ul style="list-style-type: none"> <li>• NJDEP Coastal Wetlands Permit</li> <li>• NJDEP Waterfront Development Permit</li> <li>• NJDEP Coastal Area Facilities Review Act (CAFRA) Permit</li> <li>• NJDEP Tidelands Conveyance</li> <li>• NJDEP Threatened and Endangered Species coordination</li> <li>• NJDEP Site Remediation approval</li> <li>• NJDEP Green Acres Program approval</li> <li>• NJDEP Air Quality Permit</li> <li>• Compliance with the NJDEP Flood Hazard Area Control Act Rules through the Coastal Zone Management Permit</li> <li>• Compliance with NJDEP Stormwater Management Rules</li> <li>• NJ Pollutant Discharge Elimination System (NJPDES) Permit</li> <li>• Soil Erosion and Sediment Control Certification</li> </ul>	<ul style="list-style-type: none"> <li>• FEMA Hazard Mitigation Assistance (HMA)</li> <li>• NJDEP Blue Acres</li> <li>• Environmental Protection Agency (EPA)</li> <li>• National Oceanic and Atmospheric Administration (NOAA)</li> <li>• National Fish and Wildlife Foundation (NFWF)</li> </ul>

<sup>1</sup> See Appendix C. Monitoring Plan Details for additional information.

<sup>2</sup> See Appendix F. Potential Funding for additional information.

RESOLUTION FORMALLY ACCEPTING THE  
MONMOUTH COUNTY PLANNING BOARD  
PUBLICATION ENTITLED  
RARITAN/SANDY HOOK BAY COASTAL RESILIENCE PLANNING STUDY

Paul Kiernan offers the following Resolution and moves its adoption:

**WHEREAS**, the *Monmouth County Master Plan* recommends new and continuing partnerships for resource protection, and assisting municipalities to improve community resiliency; and

**WHEREAS**, the *Monmouth County Master Plan* recognizes the importance of Naval Weapons Station Earle and the need for continued cooperation with the Navy through the development of plans such as the 2017 *Monmouth County Joint Land Use Study for Naval Weapons Station Earle*, and joint projects including regional flood hazard mitigation efforts; and

**WHEREAS**, the 2017 *Monmouth County Joint Land Use Study for Naval Weapons Station Earle* offered nine recommendations relative to climate resilience; and

**WHEREAS**, Monmouth County received a follow-up grant from the Department of Defense, Office of Economic Adjustment to implement some of the resilience recommendations through the preparation of a study entitled "*Raritan/Sandy Hook Bay Coastal Resilience Planning Study*"; and

**WHEREAS**, during the planning process for the *Raritan/Sandy Hook Bay Coastal Resilience Planning Study* the Monmouth County Division of Planning formed a Technical Advisory Committee and invited representatives from the Bayshore municipalities, various county, state and federal agencies, academia, and local environmental and non-profit groups, with related project experience to inform and guide plan development; and

**WHEREAS**, the *Raritan/Sandy Hook Bay Coastal Resilience Planning Study* resulted in the development of eleven concept plans for coastal projects on public lands that are intended to promote the ongoing mission of Naval Weapons Station Earle while increasing the sustainability and resilience of the Bayshore communities; and

**WHEREAS**, the Monmouth County Planning Board was kept apprised of the development of the plan throughout the year-long study period with numerous presentations by the staff, including a final presentation on December 16, 2019; and

**WHEREAS**, the participating municipalities and the Monmouth County Board of Recreation Commissioners passed Resolutions in support of the concept plans within their jurisdiction; and

**WHEREAS**, the report is now complete and ready for posting on the Monmouth County website.

**NOW, THEREFORE, BE IT RESOLVED** by the Monmouth County Planning Board that the "*Raritan/Sandy Hook Bay Coastal Resilience Planning Study*" is hereby formally accepted and approved for publication and shall be posted on the Monmouth County Division of Planning website for public use and knowledge.

Seconded Freeholder Lillian G. Burry and adopted by the following roll call vote:

In the affirmative:	Charles Casagrande, James Giannelli, Nancy Grbelja, Paul Kiernan, Joseph Ettore, James Schatzle, Freeholder Lillian G. Burry
In the negative:	None
Abstain:	Freeholder Deputy Director Susan M. Kiley
Absent:	Jennifer DiLorenzo, Marcy McMullen, Freeholder Pat Improveduto, John Mele

I do hereby certify that the foregoing is a true copy of a Resolution adopted by the Monmouth County Planning Board at a meeting on January 21, 2020



JoAnn Denton

SECRETARY TO THE BOARD