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Fort Tilden Shore Access and Resiliency Project

The Zofnass Program at Harvard University

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Judith Rodríguez prepared this case study under the supervision of Prof. S.N. Pollalis as the basis for research and class discussion rather than to illustrate either effective or ineffective handling of the design, the construction or an administrative situation of a project.

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"*Key for the project was the use of a natural material that could be sacrificial if necessary and would not leave man-made residuals and would be low maintenance from a financial perspective. Resilience and sustainability coming together through economics*." [1]
Nicolaas Veraart, Louis Berger

Summary

The Fort Tilden Shore Access and Resiliency Project case study evaluates the variables that affect the business case for sustainably improving resilience of a coastal national park while maintaining accessibility and safety considerations. Fort Tilden is a former U.S. Army installation in Queens New York and is now part of the Gateway National Recreation Area administered by the National Park Service (NPS). Fort Tilden serves as active and passive open space, includes historic resources, and provides coastal habitat. The park experienced significant damages from hurricane Sandy, which displaced the foredune system, exposed the bulkhead and groin system, damaged historic buildings, and compromised safety and access.

In response to the hurricane damages, the NPS initiated a project to understand the potential impacts from future storms on existing natural and cultural resources, infrastructure, and safety of surrounding communities. The NPS developed a full range of alternatives that included an evaluation of resilience, sustainability, and cost efficiency, with the goal to use this project as a guide for siting and designing future coastal protection measures. The resulting solution, seeks to balance the various goals and objectives, addressing the potential impacts from future storms on existing natural and cultural resources, infrastructure, and on the safety of surrounding communities.

[1] Nicolaas Veraart, Louis Berger, emails exchange with the project team in 2019.

Project Data Table

Project Name:	Fort Tilden Shore Access and Resiliency Project
Estimated Sustainability Savings:	Range of $412,000 to $25,185,000 in savings when compared to the initial costs estimates of the other project action alternatives.
Project Type:	National Park – includes reconstruction of two roads, removal of buildings and partial removal of bulkhead, and natural habitat restoration
Location:	Rockaway Beach Boulevard, New York
Area:	98 acres
Owner / Client:	National Park Service (NPS), U.S. Department of the Interior
Project Team:	**Contractors**: Bulkhead/buildings removal: Renova Environmental Services Shore road/Range road: Lee Construction
	Engineer/Designer: Louis Berger (bulkhead and building assessments) Lee Construction with Langan (design-build of Shore road)
	Facility/Project Manager: National Park Service
	Consultants: Louis Berger, Kirk Associates
Project Lifespan	25 years
Current Status:	Under construction
Funding sources:	NPS Hurricane Sandy, Federal Highway Administration Emergency Relief for Federally Owned Roads (FHWA, ERFO) Grant, and NPS Line Item Construction
Delivery Method:	Design Build
Overall investment cost estimate:	$7,337,000 total estimated net cost of construction. Previously at VA workshop, estimated at $6,346,000.
Planning, Design & Construction cost estimates:	The Bulhead/Buildings Removal for NET construction was awarded at $2,758,868 Shore Road/Range Road NET Construction award at $1,390,443 Value Analysis (VA) Approximately 25,000.00
Total Life Cycle Costs estimate:	$9,276,000 (present worth)
O&M costs estimate	$464,039 per year

1. Introduction

The Fort Tilden Shore Access and Resiliency Project is one of several projects in the region undertaken after Hurricane Sandy impacted New York City in October 29, 2012. Fort Tilden is a national park and former U.S. Army installation that is owned, operated, and maintained by the National Park Service (NPS). Fort Tilden is part of the Gateway National Recreation Area (GATE) located in the Rockaway Peninsula in Queens, New York City, shown in figure 1. The park currently serves as an active and passive open space of about 98 acres that includes coastal habitat, beach access, coastal wetlands, grassy areas, ball fields, trails, historic buildings, and access roads.

A key feature of Fort Tilden is that it is one of the few beach access points in the NYC area facing the Atlantic Ocean to the south. It is also located near several residential areas, the Roxbury residential community borders to the north, the Jacob Riis Park to the east, and the Breezy Point private residential community to the west, also shown in figure 1.

Figure 1. Fort Tilden project area is located inside the Jamaica Bay Unit of GATE, in Queens, New York. Source: Fort Tilden Shore Access and Resiliency Project Environmental Assessment, NPS, February 2016, p. 2 (hereafter referred as EA).

The extreme winds and storm surge from Hurricane Sandy made physical changes to the park that affected the safety, access, and historical resources. Figure 2 shows the physical changes at the shoreline and beach areas, which include the displacement of the foredune system, the destruction of the western part of the Shore Road, the exposure of the bulkhead and groin system, and damages to several historic military buildings, such as the Battery Kessler. The destruction caused by the hurricane also created new beach habitats suitable for threatened and endangered shore birds, and plants.

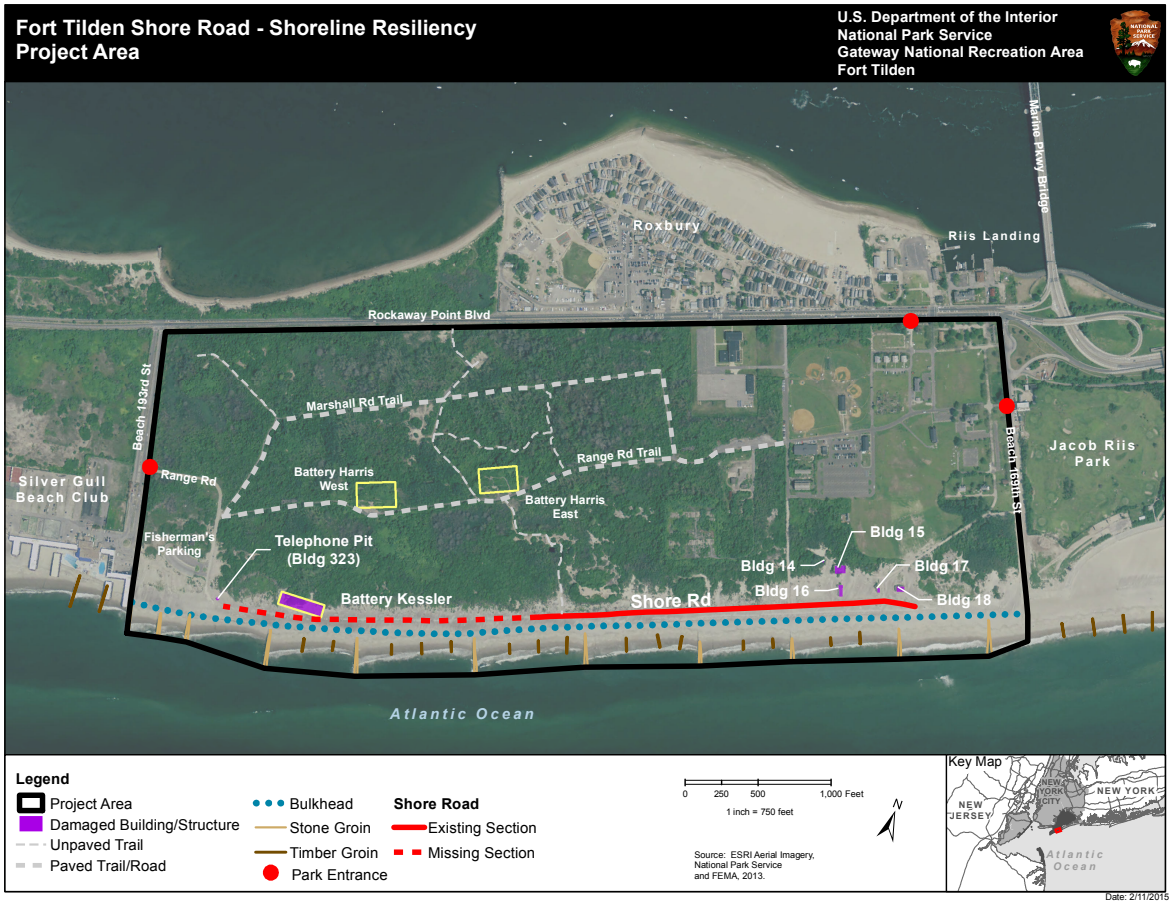

Figure 2. Physical changes from hurricane damage at project area. Source: "Gateway National Recreation Area begins planning process for the Fort Tilden Shore Road - Shoreline Resiliency project, Queens, New York", NPS, accessed July 2018, https://parkplanning.nps.gov/document.cfm?parkID=237&projectID=48054&documentID=64054

In response to these changes, NPS developed a project with the purpose to reduce the risks of damage to the beach, protect critical cultural and natural resources, ensure safe public beach access, and provide opportunities for recreation and visitor experience.[2, 3] In addition NPS is using this project as a guide for siting and designing future coastal protection measures.[4]

NPS defines *resiliency* as the ability of natural systems and constructed infrastructure to withstand the forces of large storms, to quickly recover, and/or efficiently and cost-effectively be restored or reconstructed.[5] *Resiliency* has been a key consideration, embedded in the NPS planning process and business case considerations of the Fort Tilden Shore Access and Resiliency Project.

All the alternatives for the project had to be consistent with NPS Climate Adaptation Goals for parks in effect at the time, which are the following:[6] 1) Incorporate climate change consideration into NPS planning frameworks; 2) Promote ecosystem resilience and enhance restoration, conservation, and preservation of park natural resources; 3) Develop, prioritize, and implement management strategies to address climate-sensitive cultural resources; 4) Include climate-related vulnerability assessments in project approval and funding decisions; 5) Enhance the sustainable maintenance, design, and construction of park infrastructure.

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2 Heather Unger, Manager, Corporate Sustainability at Louis Berger (A WSP Company).

3 Fort Tilden Shoreline Resiliency Project Value Analysis Final Report, National Park Service, April 15, 2016.

4 Bearmore, B., Ozolin, B., Sacks, P. *Fort Tilden Historical Bulkhead Assessment.* Ports 2016: Port Planning and Development. 2016

5 National Park Service (NPS), 'Phase IV - Evaluation (Part 1 – Factors and Definitions)' in Fort Tilden Shoreline Resiliency Project Value Analysis Final Report, National Park Service, April 15, 2016, p.26.

6 NPS, "Adaptation Goals" in Climate Change Adaptation, 2015, accessed in June 2018, https://www.nps.gov/subjects/climatechange/adaptation.htm

Within this framework, the strategy for the project was developed. A range of project alternatives incorporated recommendations from the 2014 NPS Gateway General Management Plan, input from stakeholders, and included as part of the planning process interdisciplinary decision-making throughout the public scoping process, in the Value Analysis workshop to select a preferred project alternative, and in the development of the Environmental Assessment (EA). Louis Berger was hired as a consultant to assist the NPS in conducting a bulkhead assessment, developing project alternatives, coordinating a value analysis workshop, and preparing the EA.[7]

The EA was prepared in compliance with National Environmental Policy Act (NEPA) and NPS Director's Order #12: *Conservation Planning, Environmental Impact Analysis and Decision Making*, which commits NPS to make informed decisions that perpetuate the conservation and protection of park resources unimpaired for the benefit and enjoyment of future generations.[8] All proposed actions need to be fully and openly evaluated, as part of the procedures to ensure that both adverse and beneficial impacts are evaluated. The evaluation included the provisions[9] stated below:

- Meaningful participation by the public and other stakeholders;
- Development and critical evaluation of alternative courses of action;
- Rigorous application of scientific and technical information in the planning, evaluation and decision-making processes;
- Use of NPS knowledge and expertise through interdisciplinary teams and processes; and
- Aggressive incorporation of mitigation measures, pollution prevention techniques, and other principles of sustainable park management in all actions.

The NPS, in cooperation with the Federal Highway Administration - Eastern Federal Lands Highway Division, prepared the EA to evaluate the range of alternatives addressing access, safety, and shoreline resiliency at Fort Tilden. The proposed project alternative must achieve the following provisions:[10]

1. Provide safe access for visitors and emergency first responders.
2. Improve safety along the beach in response to the exposed bulkhead.
3. Coordinate with actions by surrounding communities, agencies, and other entities along the Rockaway Peninsula.
4. Provide alternate emergency egress for surrounding communities prior to and following a storm event.

The EA documented the evaluation of the alternatives as well as the activities for public involvement.[11] NPS sought written comments from the public on the proposal from March 8, 2016 to March 25, 2016.[12] The alternatives were evaluated on meeting goals and objectives set for the resiliency and sustainability of Fort Tilden. The resulting solution, which is currently being implemented, seeks to balance the goals and objectives set for the project.

Early in the planning process, the NPS team identified the stakeholders and their anticipated interests in the project, which are listed in table 2. The stakeholders involved in the project include agencies from the city government, federal government, and state government, as well as nonprofit and adjacent community organizations, NPS staff, park visitors, and other interested parties. The project incorporates comments and ideas from the general public and affected communities gathered at several informational public sessions held by NPS.

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7 Heather Unger, Manager, Corporate Sustainability at Louis Berger (A WSP Company).

8 NPS, NPS Director's Order #12: Conservation Planning, Environmental Impact Analysis and Decision Making, 2001, p.2, accessed in June 2019, https://www.nps.gov/policy/DOrders/DO_12.pdf

9 Ibid, p.3.

10 NPS, Fort Tilden Shore Access and Resiliency Project Environmental Assessment, p.4, accessed in May 2019, https://parkplanning.nps.gov/document.cfm?parkID=237&projectID=48054&documentID=70897, (hereafter referred as EA).

11 "Gateway begins planning process for the Fort Tilden Shore Road Shoreline Resilience project Queens New York", National Park Service, accessed in July 2018, https://www.nps.gov/gate/learn/news/gateway-begins-planning-process-for-the-fort-tilden-shore-road-shoreline-resilience-project-queens-new-york.htm

12 EA, p.4 (page before i).

Stakeholder	Type	Anticipated Interest
Mayor's Office of Recovery and Resiliency	City Government Agencies	Coordination with ongoing resiliency projects, SIRR, OneNYC and CDBG-DR Action Plan
NYC Department of Planning		Coordination with Resilient Neighborhood Plans
NYC Department of Parks & Recreation		Coordination with Rockaway Parks Concept Plan and other Parks Projects
NYC Department of Transportation		Coordination with transportation capital projects
Fire Department NY		Adequate fire safety
U.S. Army Corps of Engineers, NY District	Federal Government Agencies	Rockaways Reformulation Study, Section 404
U.S. Fish & Wildlife Service		Section 7
Federal Highway Administration		ERFO eligible work
FEMA		Resiliency of Fort Tilden
Congressional Delegates & Authorizing and Appropriating Committees		Environmental protection and sound funding strategy
New York State Department of Environmental Conservation, Region 2	State Government Agencies	ECL Article 25, Conservation, Environmental Protection, SPDES
MTA Bridges & Tunnels		Coordination with CB-24 Rockaway Crossings Master Plan and MPB
New York State Office of Parks, Recreation and Historic Preservation		Protection of Cultural Resources, Section 106
NYS DOS CZM and Hazards Group		Safety
Breezy Point Cooperative	Non-Profit/ Community Organizations	Adjacent community, concerns with emergency egress which were addressed by providing secondary access via Range Road
Queens Community District 14		Quality of life, adjacent communities in Breezy Point and Roxbury
Rockaway Parks Conservancy		Park conservation on the Rockaway Peninsula
Park Staff	National Park Service Staff	Resource management, access to beach
Park Police		Access to beach for security and patrol
Maintenance		Ease of maintenance
Regional Staff		Coordination with regional priorities and Sandy rebuilding projects
DSC Staff		Implementation, funding, schedule and project management
Fishermen	Park Visitors	High quality visitor experience, parking near beach, bike-pedestrian access to beach, wayfinding
Beachgoers and Picnickers		
Hikers		
Birders		Wildlife
Bikers		Maintaining good biking trails
School Groups	Others	Opportunities to learn about history and natural environment
History enthusiasts		Preservation of cultural resources
Concessionaires		Visitation
Community Boards		Fort Tilden meeting needs of community
Ferry Operators		Visitation
Civics to the east		Visitation
Arts Community		Natural resource preservation
Tenants at Fort Tilden: a) Rockaway Artists Alliance b) Silver Gull Beach Club c) Little League		Access to the area
Scientific community: a) Jamaica Bay Science and Resilience Institute		Resilience of Fort Tilden and the ecology of nearby Jamaica Bay

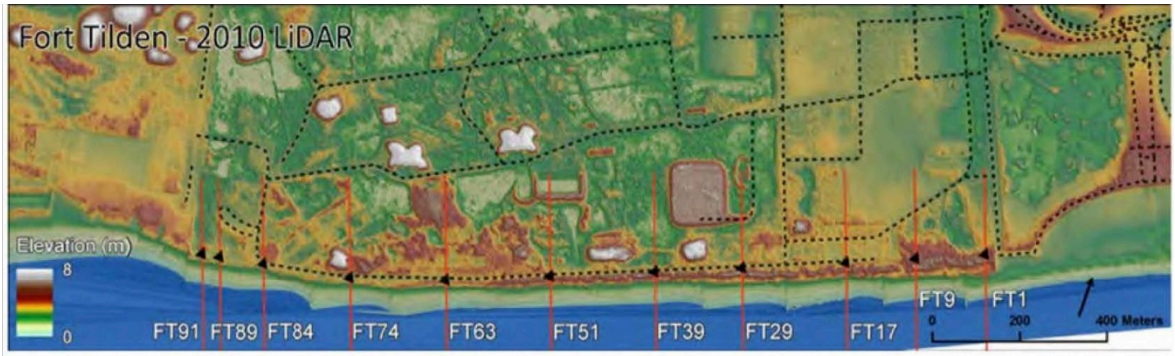
Table 2. Identified stakeholders and interests. Source: NPS, Fort Tilden Shoreline Resiliency Project Value Analysis Final Report, National Park Service, April 15, 2016, p. 20-21.

Design and Planning Challenges

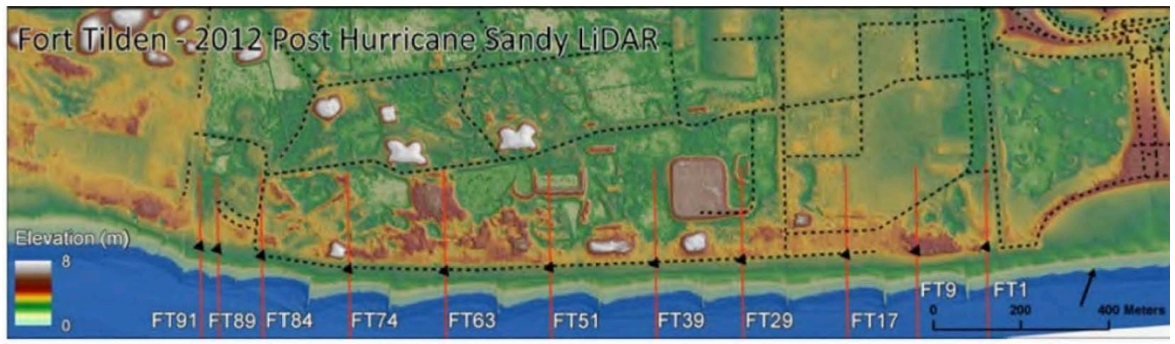
The site presented several challenges to the design and planning of the Fort Tilden Shore Access and Resiliency Project. Among the main challenges are damages and safety hazards created from Hurricane Sandy, the increased use of facilities by visitors during the summer[13], and the site's dynamic beach-dune landscape, which is vulnerable to climate change.

Damages and Safety Hazards caused by Hurricane Sandy

When Hurricane Sandy made landfall, the extreme winds and storm surge caused substantial damage to the area. Coastal areas in New York were declared federal disaster areas. This enabled NPS to apply for Federal Transit Administration funding. In Fort Tilden, Shore Road was one of the key assets that was damaged—the western extent of this concrete road collapsed as the sand foundation eroded and the concrete slabs broke into pieces. Figure 3 illustrates the loss in elevation along shore road and along the dune features. The dunes lost elevation and were displaced, having reestablished inland from the previous location.



Digital Elevation Model of Shore Road area within Fort Tilden prior to Hurricane Sandy, derived from 2010 LiDAR data. Light green elevations are in the flat sandy beach. Dark green elevations are in the upper beach adjacent to the dune and inland of the dune feature. Tan and brown elevations are higher than the sand beach, they characterize the dune feature. Shore Road is the dotted line immediately inland of the beach. Other dotted lines represent locations of existing roads identified on orthophotos. In addition, the figure includes the locations of profile lines that were constructed using LiDAR data sets (from 2010 and from 2012) and field surveys conducted in December, 2014.



Digital Elevation Model of Shore Road area within Fort Tilden after Hurricane Sandy, using post-Sandy 2012 LiDAR data sets. Elevation categories are the same as in Figure 1. Dotted lines represent locations of roads prior to Hurricane Sandy. Black triangles on profile line locations represent the 0.0 distance position incorporated on the profiles. The profiles extend seaward and landward from these starting points.

Figure 3. Images of digital elevation models from Fort Tilden pre and post Hurricane Sandy showing the displacement of the coastal foredune system. Source: NPS, EA, p. 26-27.

The historic timber bulkhead and groins, which were built circa 1940s became a safety hazard to park visitors, and staff as it was exposed. The winds, waves, and flooding action from the hurricane washed away the sands and exposed part of the structures. Many of the exposed structural elements, such as piling, waling, and vertical timbers are missing, heavily weathered or not attached. Timber elements buried under the sand have decayed and show substantial rot. The few tiebacks remaining are not attached and have no structural capacity.

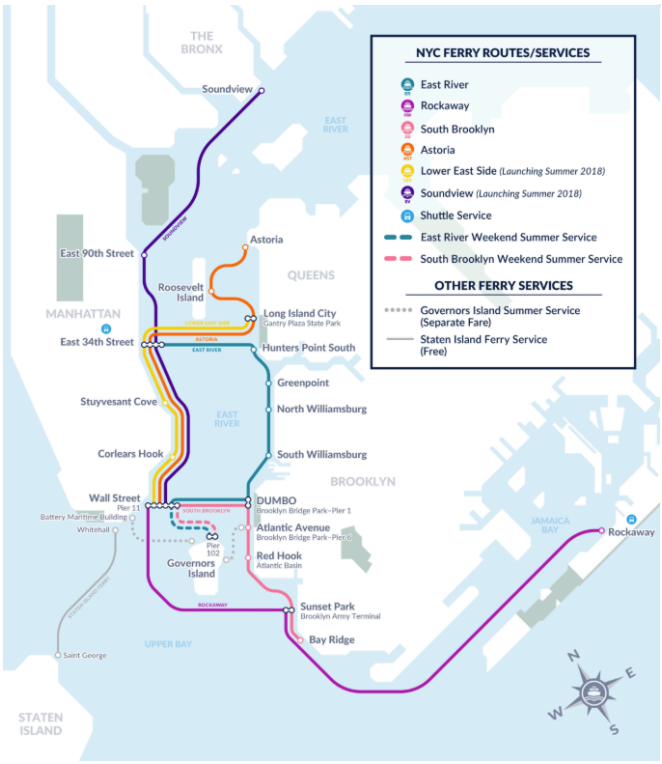
In addition historic military buildings along the coast close to Shore Road, deteriorated more from the hurricane action. Many of the buildings had already been classified as ruins. This represented another

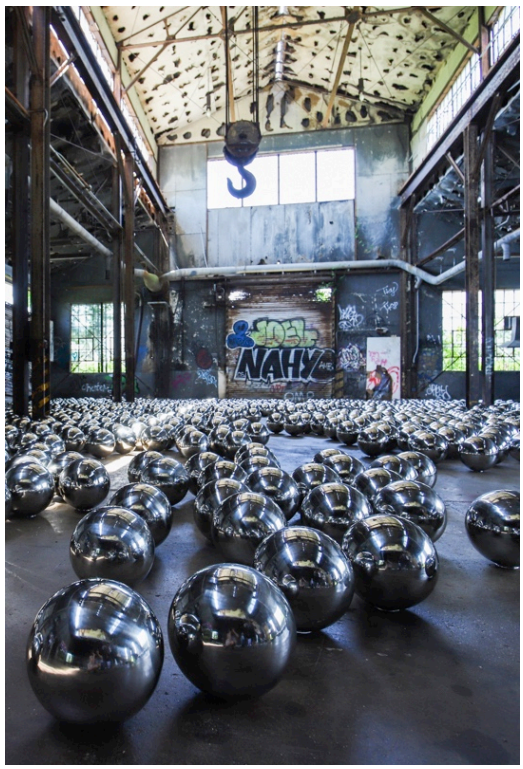
[13] Interview with NPS park rangers and Louis Berger during the Fort Tilden site visit on February 27, 2018.

safety hazard, as buildings were publicly accessible. This includes the Telephone Pit Building, Battery Kessler, and buildings 14 to 18.

Increased Use of Park Facilities

During a site visit, the NPS park rangers explained that the natural coastline experience that the park offers has increased visitation to the beach area. Fort Tilden has become a popular summer destination for New Yorkers, especially for visitors coming from Brooklyn. As shown in figure 4, the NYC Ferry added a route to the Rockaway peninsula that provides a key public transit link between the Rockaways and Sunset Park in 41 minutes, and to Lower Manhattan in 57 minutes.[14]





Figures 4 (left). NYC Ferry route to Rockaway (purple line). Source: NYC Ferry, accessed in July 2018, https://www.ferry.nyc/routes-and-schedules/route/rockaway/

Figure 5 (right). Art exhibition from Yayoi Kusama's 'Narcissus Garden' in FT former train garage building. Source: Sai Mokhtari, Gothamist, accessed in July 2018, http://gothamist.com/2018/07/02/fort_tilden_yayoi_kusama.php#photo-1

Visitation at Fort Tilden has also increased from arts and culture events housed at several historic buildings located inland from the coast, near Range and Murray Roads. According to the rangers, the park rents the historic buildings for different activities and funds go into the restoration funds for the maintenance and conservation of the assets. An example of the reuse of the historic buildings is the 'Rockaway!' 2018 art festival that is organized by MoMA as a free public event that has been occurring at Fort Tilden for several years, an art exhibition is shown in figure 5.[15]

Fort Tilden's dynamic beach-dune landscape

The Rockaway Peninsula developed naturally in a western direction as a result of longshore sediment transport. The processes of erosion and sedimentation continuously change the shoreline and dune zone. Much of the shoreline existence is dependent on this human interaction as the peninsula is stationary because of the jetty system. The dynamic beach-dune landscape at Fort Tilden's coastal area has been a challenge for NPS. In the 1940s, groins were built along Fort Tilden's shoreline in an

[14] NYC Ferry, accessed in July 2018, https://www.ferry.nyc/routes-and-schedules/route/rockaway/

[15] "Rockaway! 2018: Narcissus Garden by Yayoi Kusama", MoMA PS1, accessed in July 2018, https://www.moma.org/calendar/exhibitions/4995

attempt to trap sand as it moves naturally westward, producing offsets in the beach and the foredune from east to west.

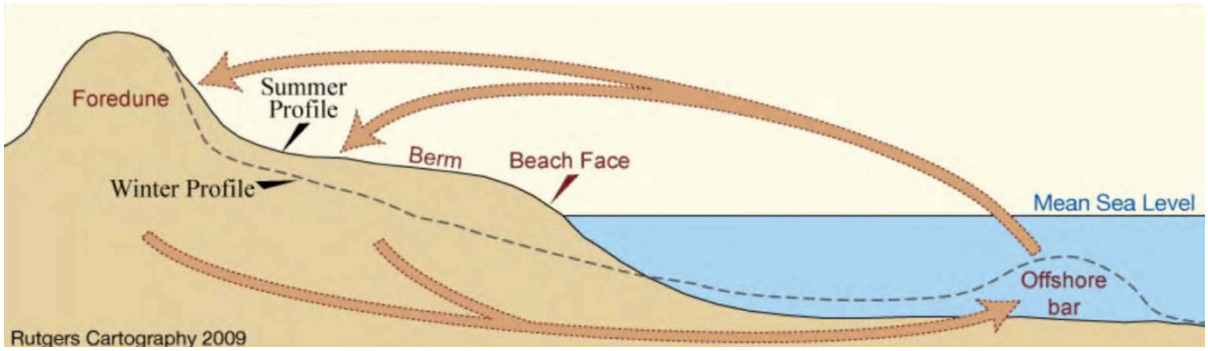


Figure 3. Beach-dune exchange system. Source: NPS, EA, p. 23.

As shown in figure 3, the beach face and beach surface at Fort Tilden is backed by a vegetated foredune. The form of foredune systems is influenced by a number of factors, including the shape of the coastline, shape and size of the beach in front of the foredune, currents and swell of the ocean, prevailing winds, frequency of storm events, and particle size of the sand.

Coastal dunes protect landward areas from flooding and erosion by acting as a buffer against eroding wave action. Although the dunes were severely eroded and displaced by Hurricane Sandy, there has been some recovery as the eastern margin is showing greater volume gains due to the large bare sand source area in Riis Park. The foredune decreases in overall dimension and volume toward the western margin with low wash over sand masses contributing to the dune volume and form at the Fisherman's parking lot.

New Habitat Protection for Endangered Shore Bird

The storm created new habitat for the piping plover (*Charadrius melodus*), an endangered shore bird, that breeds on dry sandy beaches with little or no beach grass. Its nests are usually above the high tide line on the beaches, sand flats, sand spits, and gently sloping dunes. The piping plover habitat is limited, as it is only found at the shore, on barrier islands, sandy beaches, and dredged material disposal islands. It is a federally threatened and state endangered small bird.

Project alternatives developed for the Fort Tilden Shore Access and Resiliency Project must respond to the site and address its design and planning challenges.

2. Project Development

The project development consisted in various planning and design phases that involved the completion of several tasks spanning from 2013 to 2018. The major tasks are summarized below.

Shoreline Structures Assessment

The first task involved a Shoreline Structures Assessment to inspect the conditions of the historical timber groins and bulkhead remaining on Fort Tilden Beach after Hurricane Sandy, and their current remaining structural capacity. According to the Louis Berger team[16], the condition assessment included visual inspection of exposed bulkhead components and digging eight excavation pits to inventory buried components. The ultimate objective of the field condition assessment was to identify and prioritize deficiencies in need of repair or replacement, gather information to provide an estimate of remaining service life, and provide possible repair or replacement concepts. The team completed an alternatives analysis to evaluate options for removing, repairing, or replacing the existing bulkhead. The assessment indicated that the bulkhead and wooden groins were structurally obsolete and had no remaining service

16 Ibid.

life.[17] The alternatives analysis included nine options or approaches to address bulkhead and groin condition, which are included in the Appendix.

Wetland Delineation
The wetland delineation of USACE jurisdictional wetlands and New York State Department of Environmental Conservation tidal and freshwater wetlands was performed within portions of the Project Area that may be impacted by project alternatives. [18]

Structural and Hazardous Materials Evaluation of Buildings

The Structural and Hazardous Materials Evaluation of Buildings consisted of a site inspection and structural evaluation of four buildings located on Fort Tilden Beach. It helped establish what is the condition of the structures, in order to determine if restoration is possible, or if condemnation should be considered due to structural issues. The evaluation included a limited asbestos and lead-based paint inspection of Buildings 15-18, including visual observation, material sampling, and laboratory sample analysis of suspect Asbestos-Containing Materials (ACM) and Lead Based Paints (LBP). As ACM and LBP were identified in building roofs.[19] The deteriorated structures of the buildings 15 to 18 were recommended for demolition.

Environmental Assessment and Value Analysis Workshop
Prior to the Value Analysis workshop, a range of management alternatives were prepared to address the safety, access and resource needs caused by Hurricane Sandy. The management alternatives were evaluated in the Value Analysis workshop where representatives of NPS, state and federal agencies, academic institutions, and local community groups worked together to refine the range of alternatives under consideration, in order to recommend a park preferred alternative for further evaluation in the environmental assessment using the Choosing by Advantages evaluation methodology. This methodology helped to identify potential impacts of the preferred alternative, to discuss mitigation measures, to analyze project costs and value based cost savings, and to recommend an implementation and funding strategy.

The EA evaluated four alternatives: a no-action alternative and three action alternatives, which were analyzed for their potential impacts on the natural and human environment. Five topics which informed the corresponding impact topics evaluated in the EA included: Coastal Landscape, Special Status Species, Historic Districts, Visitor Use and Experience, and Public Health and Safety.

3. National Park Service Project Strategy

The strategy of NPS for the Fort Tilden Shore Access and Resiliency Project is based on the agency's established planning and decision-making process. This process is in compliance with NEPA and the NPS Director's Order #12, as well as incorporating the NPS Climate Adaptation Goals for parks, and the planning recommendations from the 2014 NPS Gateway General Management Plan.

As part of NPS Director's Order #12, a range of alternative courses of action for the project, also known as Concept Design Alternatives, were needed to be developed and to be critically evaluated, in order to find a park-preferred course of action. All the alternatives considered take into account the provisions and guidance delineated for the project.

The park-preferred alternative must comply with the past park planning documents and the NPS policy, which provided the framework for developing alternatives for this project. The 2014 NPS Gateway General Management Plan[20] describes the desired future condition for the project area. According the

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17 Bearmore, B., Ozolin, B., Sacks, P. *Fort Tilden Historical Bulkhead Assessment.* Ports 2016: Port Planning and Development. 2016, p. 750.

18 Ibid.

19 Ibid.

20 EA, p. 7.

plan and the park rangers,[21] the beach area at Fort Tilden belongs in the Natural Zone part of the park, where the desired conditions include:

- Allowing visitors to enjoy the quiet, solitude, and sense of connection inspired by the natural world; having opportunities to directly experience the natural resources and solitude; and managing open areas to preserve natural resources while allowing for the enjoyment of the outdoors and nature.
- Promote opportunities for environmental education programming and nature study;
- Offer a natural coastal experience at Fort Tilden's ocean and bay shorelines, more than other Gateway beaches; and
- Develop appropriate access points and visitor amenities to support increased beach use.

Another key consideration of the project is sustainable design, which is defined by NPS as the minimal use of energy, materials, and labor over time to ensure reduced long-term depletion of nonrenewable resources. According to the NPS policy, the project must also seek to:

- Protect Natural and Cultural Resources
- Provides for Sustainable/ Resilient Approach to Management of Coastal Area
- Provide for Visitor Enjoyment, Safety, Mobility and Access
- Improve Operational Efficiency and Sustainability

a) Use of Concept Design Alternatives

The following four concept design alternatives were considered for the project:

Alternative A: No Action.
This alternative reflects the future environment if "no project" occurs at the damaged areas in Fort Tilden. According to the EA, having a no-action alternative would allow the existing bulkhead to remain in place and continue to decay. The areas with lesser damage, such as the eastern part of the Shore Road would remain, and continue to provide access to the beach for staff of Gateway National Recreation Area (GATE), emergency utility terrain vehicles (UTVs), bicyclists and pedestrians.

The areas presenting more damages, such as the western portion of Shore Road destroyed by Hurricane Sandy would be removed, and not reconstructed. Emergency beach access would be possible by UTVs for GATE staff, and visitor access would be for pedestrians only.

At Range Road, bicycle and pedestrian access would continue, as the road functions as an informal trail that is not universally accessible. It can provide access for NPS vehicles and routine maintenance, and in case of an emergency, if necessary Range Road could be used as an alternate east-west emergency egress route, prior to or following a future storm event.

Parking for visitors would continue to be limited at Fisherman's Parking in the western lot, and to the east at the T4 parking lot and the lot near buildings 15–18.

No major repairs or improvements would be made to Battery Kessler, Buildings 15–18, and the Telephone Pit Building. If funding was available, minor repairs to secure or stabilize the buildings could be undertaken.

[21] Interview with NPS park rangers and Louis Berger during the Fort Tilden site visit on February 27, 2018.

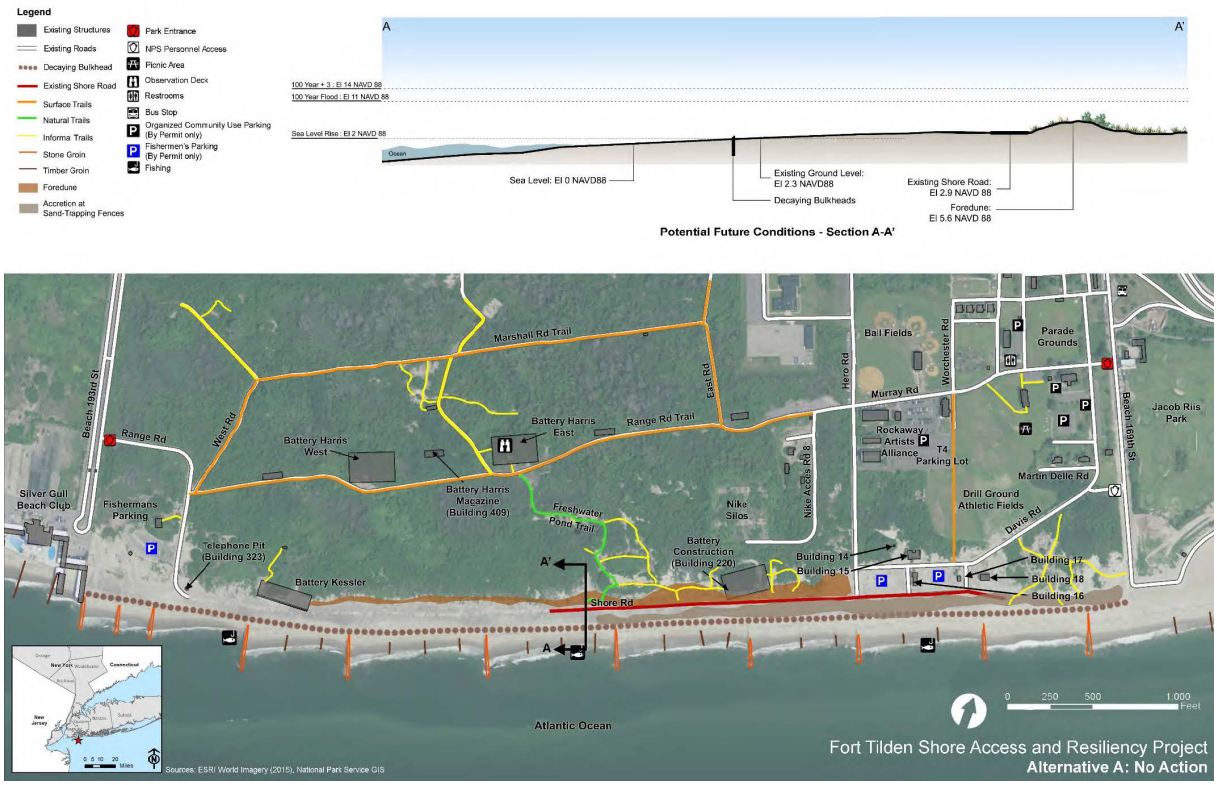

Figure 4. Fort Tilden Project Alternatives A-D. Source: NPS, EA, p. 8.

Action Alternatives (B - D)

Alternatives B, C and D, which are the alternatives requiring action, have several components in common. All action alternatives call for the rehabilitation of Range Road into a universally accessible bicycle and pedestrian road, which also serves as an alternate east-west emergency egress route for the surrounding community. In terms of parking, the visitor parking would be exclusively at the existing Fisherman's Parking to the west, and the other parking areas located towards the east, at the T4 parking lot and at lot near buildings 15–18, would require a NPS-issued Fishing-Parking 1-year permit. In all action alternatives, the wayfinding and signage would be improved, as appropriate.

According to NPS policy on high flood risk locations, demolition would occur at the deteriorated Telephone Pit building and buildings 15–18, due to the prohibitive costs associated with stabilizing and making the buildings resilient. Funding for adaptive reuse of the buildings is highly unlikely under current NPS priorities and budgets. Natural habitat restoration would occur in the locations of the demolished buildings.

Alternative B: Full Nature Restoration

In addition to the common elements to the action alternatives, the alternative B would restore coastal habitats and processes to offer a natural coastal experience to visitors at Fort Tilden.

In order to restore the natural habitat, this alternative would require complete removal of the existing bulkhead and wooden groins and removal of the destroyed and undamaged portions of western Shore Road.

Pedestrian beach access would be provided through access points at the Fisherman's Parking areas located at the eastern and western limits of the beach. The emergency beach access for GATE staff would be limited to UTVs. The Battery Kessler building would be integrated into the dune system by covering it with sand fill and native vegetation.

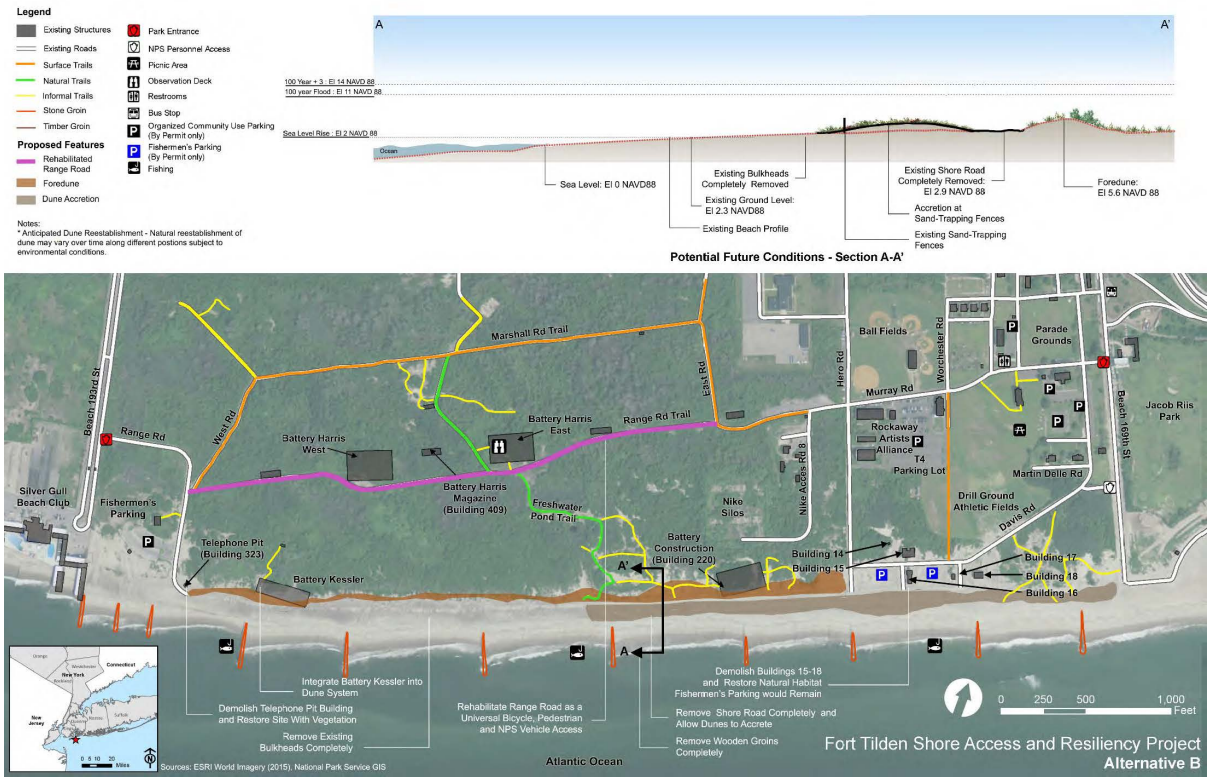

Figure 5. Fort Tilden Project Alternative B. Source: NPS, EA, p. 10.

Alternative C: Elevated Pathway

This alternative would connect Fort Tilden to Jacob Riis Park at the east, by constructing an elevated pathway along the vegetation line. It would also provide erosion mitigation of the western part of Fort Tilden through a vegetated revetment at the western limits of the beach.

The elevated pathway is approximately 10 feet wide, following the vegetation line along the coast. Its vertical elevation is 5 feet NAVD 88, which ranges from 2 to 4 feet above the existing ground elevation, extending from Jacob Riis Park into the Fisherman's Parking lot at the west. Along the path, three universally accessible beach access points would be provided. The emergency access for GATE staff UTVs would also be provided along the elevated pathway. The materials anticipated for the elevated pathway could include precast concrete, fiberglass, or galvanized structural steel, which would be determined during design.

On the western limits, near the Fisherman's Parking, a partially buried stone revetment would be 11 feet high from the North American Vertical Datum of 1988 (NAVD 88), which is the 100-year storm event elevation without freeboard that is located at the vulnerable western end of the beach. It also would serve as a connection to the Silver Gull Beach Club to the west and higher elevations to the east. The buried portion of the revetment would be planted with native vegetation.

In this alternative, there is partial elimination of the existing bulkhead, which would be limited to the removal of 3 feet below the existing ground line. Shore road would also be eliminated, by removing the undamaged eastern portion of the road. Due to this elimination, beach access for bicyclists and pedestrians would be done via the elevated pathway.

The elevated pathway would circulate around the Battery Kessler structure, which would be allowed to continue to decay naturally, although visitor safety would be improved by securing all entrances.

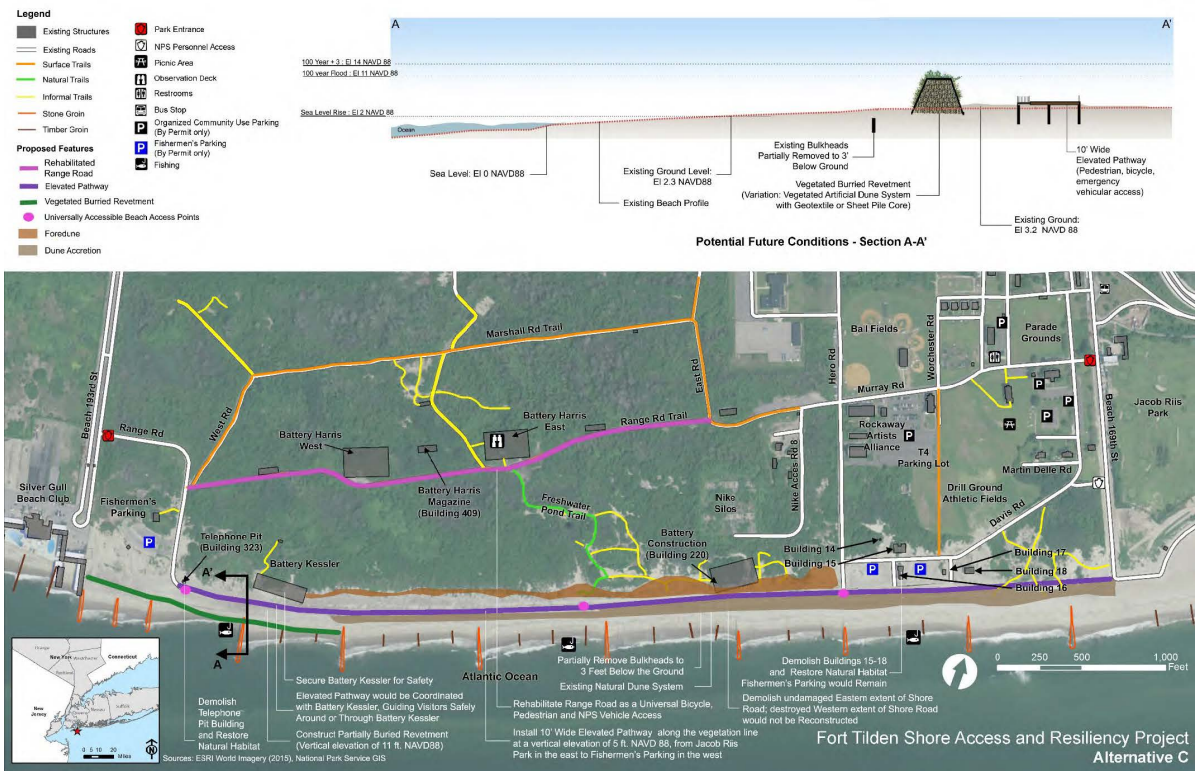

Figure 6. Fort Tilden Project Alternative C. Source: NPS, EA, p. 12.

Alternative D: Clay-Shell Pathway — *The park-preferred alternative and current project.*
This alternative improves connections to the western limits of the beach by constructing a pathway made of sustainable paving materials on the destroyed portion of Shore Road. Shore Road would continue to provide ongoing beach access for GATE staff, emergency vehicles, and contiguous beach access for bicyclists and pedestrians. The undamaged eastern portion of the road will remain in place, and a sustainable pathway will be constructed on the destroyed portion of the road, made of a clay base with shell aggregate. The surface made of clay-shell media is an environmentally friendly surface that can be cost-effectively reconstructed if affected by a future storm event.

Shore Road will continue connecting the existing Shore Road to Fisherman's Parking. It will also provide emergency beach access for GATE staff UTVs. In order to improve safety, the existing wooden groins would be completely removed, and the bulkhead removed to 3 feet below the existing ground line.

Dune accretion is facilitated with the installation of sand-trapping fences in areas where dunes previously existed, which are areas parallel to the extents of Shore Road. Once dunes are reestablished, paths for pedestrian beach access would be demarcated using the sand-trapping fences through the dunes at an angle.

As in alternative C, the structure of Battery Kessler would be allowed to continue decaying naturally, and all entrances secured to improve visitor safety.

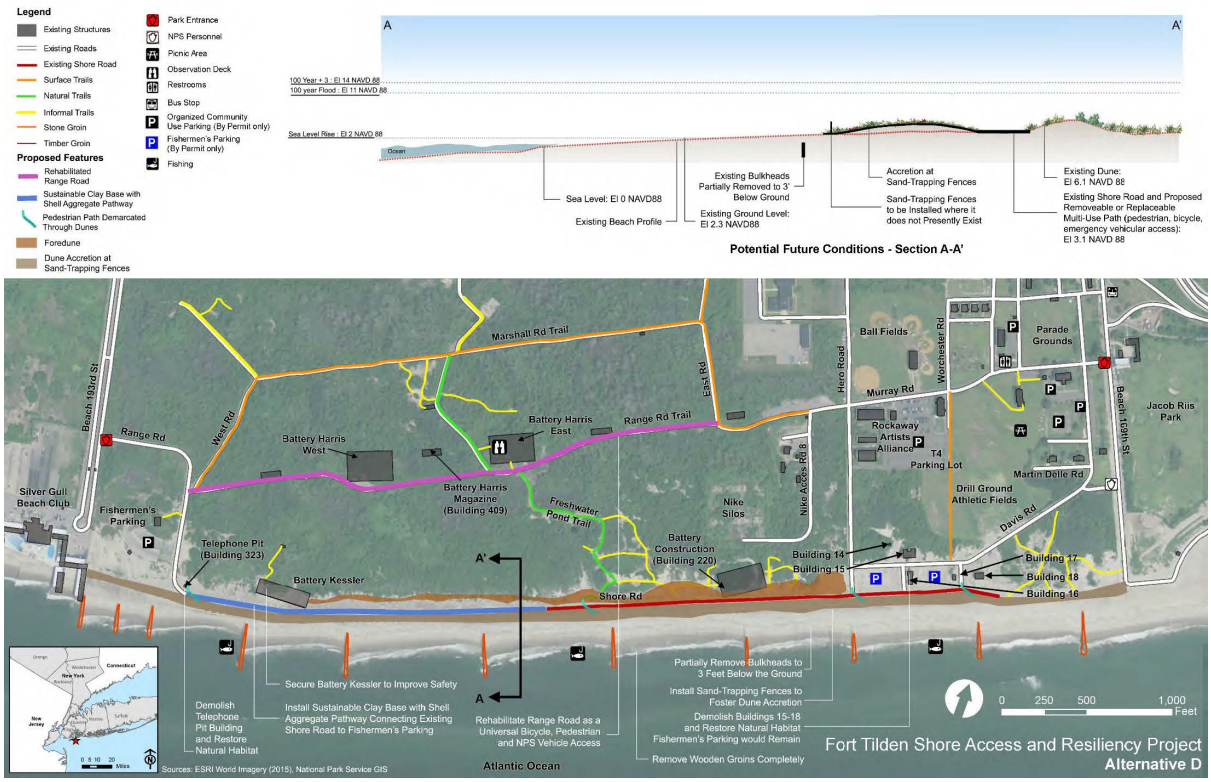

Figure 7. Fort Tilden Project Alternative D. Source: NPS, EA, p. 14.

b) Use of a Valuation Process

The NPS chose to include a value analysis (VA) process into the planning and decision-making process of the Fort Tilden Shore Access and Resiliency Project. According to NPS, the VA is a process of arriving at an optimal solution to a complex issue through a structured and reasoned analysis of the factors and functions related to the issue.[22] This is facilitated through the VA workshop, which is a structured team process to achieve essential functions at the lowest lifecycle cost with the required performance, reliability, quality, consistency, and safety factors, as well as achieving NPS mission priorities, such as resource protection, sustainability and visitor experience. In a VA workshop the essential functions for the project are studied, cost estimates are analyzed, and stakeholders identified. In this case, the VA analysis focused on taking safety, maintenance, natural/cultural resources, maintenance, operations, visitor experience, and best value into account.

In order to evaluate the alternatives, several evaluation factors were developed for having a structured evaluation method and common criteria. The VA workshop included another in house evaluation method, Choosing by Advantages (CBA), where the relative importance of the advantages or benefits of each alternative are weighed and considered in a cost, preferably in the life cycle cost context. The CBA results help the team to develop recommendations for implementation, which in this case were made by workshop participants that included the NPS client team, with members from NPS Gateway, NPS Hurricane Sandy Recovery Team, NPS Denver Service Center, Eastern Federal Lands Highway Division; the consultants' team from Louis Berger and Kirk Value Planners, and a Coastal Geomorphologist from Rutgers University. Accordingly, it's expected that the client address the rationale for not implementing any value study recommendations developed at the workshop.[23]

22 Value Analysis in the NPS, National Park Service, accessed in June 2018, https://www.nps.gov/dscw/design_vafiles.htm

23 Ibid.

The use of VAs in project planning has been growing at NPS, several tools and templates are publicly available for download at their website.[24] During the VA Workshop for the project at Fort Tilden, the study team refined the range of concept design alternatives that were under consideration, compared them, and finally recommended a park-preferred alternative for further evaluation in the EA, which is Alternative D (alternative E in the VA workshop). The team discussed the potential impacts of the preferred alternative, mitigation measures; analyzed project costs and value-based cost savings, and recommended an implementation and funding strategy.

The VA Workshop for this project involved six phases, which were structured as follows:[25]

Phase I – Information. Session on specifics, reference documents, and recent meetings.
Phase II – Functional Analysis. Analyzing stakeholders and their interests, performing the function analysis and force field analysis. This phase helps answer "why" the specific functions of the project are to be done.
Phase III – Creativity. Brainstorming of ideas for the design, 14 ideas were generated.
Phase IV – Evaluation (Part 1 & 2). The first part dedicated to define the evaluation factors for the CBA, and the second part was for the CBA evaluation.
Phase V – Development. Discussion on alternatives shoreline resiliency and risk analysis.
Phase VI – Recommendation. Selection of a park-preferred alternative for the project.

Choosing by Advantages (CBA) Evaluation Factors
The project alternatives were evaluated with the CBA method using factors and sub-factors that were defined in the VA workshop and based on NPS objectives. Seven factors and eleven sub-factors, as shown below, were used as criteria in the CBA evaluation of four alternatives, and an additional alternative, which was developed during the workshop for consideration.

1) Protect Natural and Cultural Resources.
    a) Minimizes disturbance to natural resources
    b) Allows natural coastal processes to continue and supports sediment pathways.
    c) Minimize impact to cultural resources.
2) Provides for Resilient Approach to Management of Coastal Area.
    a) Provides for design to respond to climate change
3) Provide for Visitor Enjoyment and Access.
    a) Provides for a visitor experience / access consistent with the Gateway Management Plan (GMP).
4) Provides for Safety.
    a) Provides for safe visits and working conditions.
5) Improve Operational Efficiency, Reliability, and Sustainabiliity.
    a) Improves efficiency and sustainability of park maintenance operations.
6) Minimizing the risk of impacts to adjacent communities
    a) Minimizing the risk of direct and indirect impacts to adjacent communities from flooding.
    b) Provides emergency egress route to Rockaway Point Boulevard
7) Cost.[26]
    a) Initial cost (short-term)
    b) Life cycle cost (long term)

During the CBA evaluation process a matrix was developed to compare all the project alternatives, their scores and attributes. The matrix summarized the scores from each alternative by combining all the

[24] Ibid.
[25] NPS, Value Analysis Study. Fort Tilden Shoreline Resiliency Project, 2016, p.2.
[26] This was calculated using cost estimates and life cycle cost analysis.

points allocated to criteria found in six evaluation factors. The maximum of points achievable by each criterion was established by workshop participants through consensus, using a scale of importance allocation to the advantages that ranged from 1 to a maximum of 100, considered a paramount advantage.

The cost estimates for each alternative, which included initial and lifecycle costs were combined in CBA importance allocation to costs graphs, found in figure 8-9. These results helped highlight the advantages of each alternative through the comparison of their benefits, initial costs, and life cycle costs. In the workshop the Alternative E was selected as the park-preferred alternative, which was later renamed as Alternative D in the EA. This alternative received the highest score according to importance allocation, which was quantified in terms of benefits using the CBA evaluation factors, combined with the lowest initial costs, when compared to the other action alternatives according to the 'CBA Importance to Initial Cost Graph' as shown in figure 8 below. Its 410 score and an approximately $6,346,000 initial cost, places the park-preferred alternative as the best value among all other action alternatives. This represents estimated savings ranging from $412,000 to $25,185,000 when compared to the action alternatives.

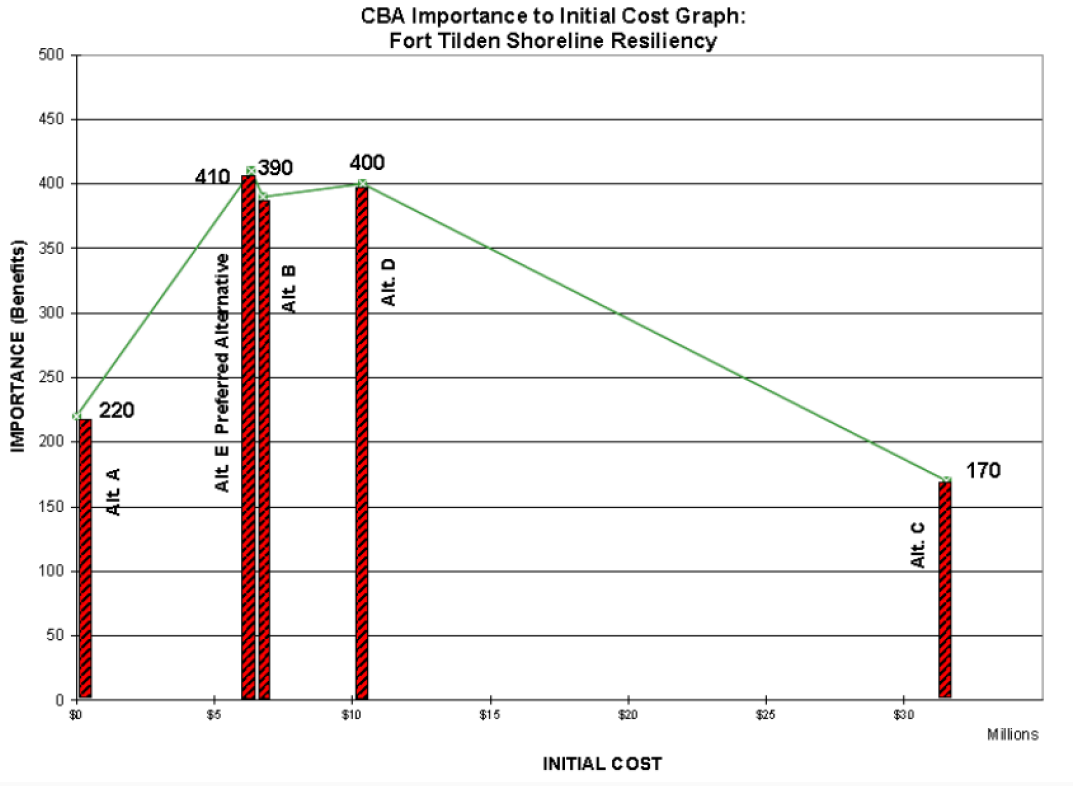

Figure 8: 'CBA Importance to Initial Cost Graph' showing Alternative E as highest scoring. Source: NPS, Value Analysis Study. Fort Tilden Shoreline Resiliency Project, 2016, p.43.

The life cycle costs were estimated at 25 years for all alternatives. The 'CBA Importance to Life Cycle Cost Graph' shows alternative E (Alternative D in the EA) as being the third lowest in life cycle at approximately a total cost of $9,276,000[27] dollars, which is about $433,000 more than Alternative B, and a difference of more than 27 million dollars when compared to Alternative C.

[27] Ibid, p. 41.

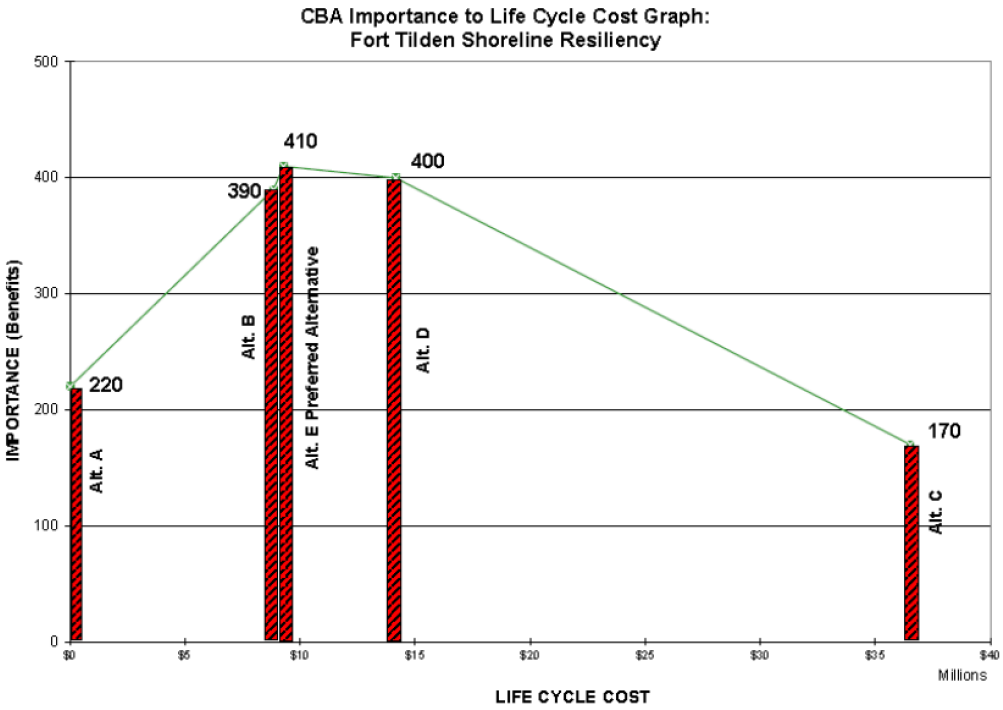

Figure 9: 'CBA Importance to Life Cycle Cost Graph' showing Alternative E as highest scoring, and third lowest in life cycle cost. Source: NPS, Value Analysis Study. Fort Tilden Shoreline Resiliency Project, 2016, p. 44.

After the CBA analysis, all the project alternatives were discussed in terms of their shoreline resiliency. A risk model was developed to evaluate the risks, as low, medium or high, for the project in general, and to identify mitigation measures. Workshop participants considered the following five risks of the highest concern. For each of these risks, several mitigation measures were developed.

- Public perception about not protecting the shoreline
  - Mitigation 1. Better communication of actual risk
  - Mitigation 2. Explain how Ft Tilden contributes to their risk resolution
  - Mitigation 3. Explain difference between bay side and ocean side flooding
- Project timeline and risk of losing funding if project is not implemented quickly
  - Mitigation 1. Get the EA done by April 2016
  - Mitigation 2. Decisions and revised cost estimates by November 13, 2015
- Risk in type of design build contracting
  - Mitigation 1. Performance and need for quality assurance (QA/QC)
  - Mitigation 2. May not have a fully competitive selection process
  - Mitigation 3. Multiple contracts
- Sea level rise and exposure/ vulnerability of investment
  - Mitigation 1. Better information for design decisions
  - Mitigation 2. Recognition of changing exposure
  - Mitigation 3. Design for climate change impacts
  - Mitigation 4. Design for adaptive environment
- USACE activities and how they impact Fort Tilden
  - Mitigation 1. Proper Coordination

The last day of the VA workshop consisted in developing recommendations, where the Alternative E (renamed as D in the EA) was confirmed as the park preferred option.

b) Alternative D Selection- Key Advantages of the Park-preferred Option

Following the VA, the design concept alternatives were evaluated further in the environmental assessment. The EA evaluated four different alternatives from A-D, merging alternatives D and E into alternative D. Alternatives B through D also provide for emergency east/west egress through a universally accessible bicycle/pedestrian pathway, improve wayfinding, and demolish buildings located in the floodplain.

Alternative D was selected because it balanced visitor safety and access concerns with natural resources protection and shoreline resiliency. Alternative D is approximately $25.2 million less expensive compared to Alternative C, which would have constructed an elevated pathway along the current location of Shore Road. Alternative D is slightly less expensive to construct compared to Alternative B because it only partially removes the existing bulkhead. The lifecycle costs of Alternative D are over $1 million more compared to Alternative B because NPS will need to continue to maintain Shore Road under Alternative D.[28]

Alternative	Initial Cost	Lifecycle Cost
A – No Action – allows for existing coastal processes to continue and maintains current management practices	$0	$0
B – restores and protects coastal habitats and processes to offer a natural coastal experience to visitors	$6,758,000	$8,843,000
C – connects Fort Tilden to Jacob Riis Park by constructing an elevated pathway and providing for erosion mitigation through a vegetated revetment	$31,531,000	$36,521,000
D – restores and protects coastal habitats and processes while increasing passive recreational use by constructing pathway of sustainable clay base with shell aggregate in location of destroyed portion of Shore Road and facilitates dune accretion using sand-trapping fences.	$6,346,000	$9,276,000

Table 3. Project alternatives initial cost and lifecycle cost. Source: Nicolaas Veraart, VP at Louis Berger, and Heather Unger, Manager, Corporate Sustainability at Louis Berger, presentation 'Fort Tilden Shore Access and Resiliency Project' at the Zofnass Program Workshop: Putting Together the Puzzle of Sustainable Infrastructure, October, 2017.

Minimizes safety hazard: Partial removal of the historic bulkhead

The partial removal of the historic bulkhead provides visitor safety and enables sustainable and resilient coastal management. According to the bulkhead assessment, the partial removal of the historic bulkhead was selected because it was the most cost-effective way to achieve the main objectives of visitor safety and enable sustainable and resilient coastal management. The partial removal was over $5.3 million less expensive than completely rebuilding the bulkhead. It was also nearly $600,000 less expensive than complete removal of the bulkhead, which would only provide marginal additional safety and environmental benefits.

[28] Nicolaas Veraart, VP at Louis Berger, and Heather Unger, Manager, Corporate Sustainability at Louis Berger, presentation 'Fort Tilden Shore Access and Resiliency Project' at the Zofnass Program Workshop: Putting Together the Puzzle of Sustainable Infrastructure, October, 2017.

A Clay-based Crushed Shell Aggregate for Shore Road: Low Maintenance Resilient Natural Material for the Egress Route

> "*Key for the project was the use of a natural material that could be sacrificial if necessary and would not leave man-made residuals and would be low maintenance from a financial perspective. Resilience and sustainability coming together through economics*." [29]

The western section of Shore Road that was destroyed by hurricane Sandy would be reconstructed using natural materials, a clay-based and crushed shell aggregate surface. It is the more cost-effective option, when compared to cost of replacing the damaged areas with a concrete road. The crushed shell aggregate road is an innovative feature of the selected alternative. Considerable research was conducted to identify material that was inexpensive so it could be replaced if it got washed away, but strong enough to withstand minor storms and drive an emergency vehicle over. The material also had to be natural and require very limited maintenance. Other alternatives of man-made materials such as mats were dismissed because their partial breakdown could cause problems for the ecosystem, unless more O&M was committed. The crushed shell path with clay base was modeled after NPS Assateague Island National Park Seashore parking lot, but was modified to be more resistant as a linear configuration.

According to Nicolas Veraart, the crushed shell was used in Assateague Park, which was used an example on what the project team looked at for consideration. When storms buried or washed away asphalt parking lots there, the parking lots were moved inland and had the pavement replaced with crushed clam shells, assuming that surf would one day would wash them into the ocean or bays anyway. The design was adapted for use in a narrow path on the sand at Fort Tilden, as it is structurally different from using it for a large flat parking area.[30]

Through this redesign, Shore Road, which also has historic value, would continue to be a pedestrian and bicycle-friendly emergency egress route for neighboring community. The existing road was not accessible to everyone and the adjacent community desired a second emergency egress route.[31]
In addition, the visitors with fishing permits desired to keep beach road access.

Return to Nature: The Removal of existing structures located within the floodplain

Hurricane Sandy caused adverse effects on the historic properties located in the floodplain. Many of the existing buildings were severely damaged. The removal of deteriorated structures allows the area to return to a natural state and support habitat, such as an increased wetland area at the park. This action improves connectivity and ecological function on the non vegetated tidal wetlands and on benthic habitat.

The removal of the deteriorated structures improves safety. NPS had also concerns on safety and on the high costs of maintaining buildings located within the floodplain. The NPS entered into a memorandum of agreement (MOA) with the New York State Historic Preservation Officer that outlines the mitigation measures required to offset the adverse effect on the historic properties at Fort Tilden. Mitigation measures include actions such as three-dimensional scanning and recordation of Batteries Kessler and 220; digital photos of Batteries Kessler and 220 and the structures at the Nike site for the New York Cultural Resource Information System; development of text and images on the World War II history of Fort Tilden for the park's mobile application; and archeological monitoring of demolition activities at Buildings 15–18 and the Telephone Pit Building. The memorandum of agreement also

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29 Nicolaas Veraart, Louis Berger, emails exchange with the project team in 2019.

30 Ibid.

31 Heather Unger, Louis Berger, emails exchange with the project team in 2018.

states that all work will be halted in the event that previously unknown archeological resources are discovered or if sacred objects and objects of cultural patrimony are discovered.

New Habitat Protection for Endangered Shore Bird

The storm created new habitat for the piping plover (*Charadrius melodus*), an endangered shore bird, that breeds on dry sandy beaches with little or no beach grass. Its nests are usually above the high tide line on the beaches, sand flats, sand spits, and gently sloping dunes. The piping plover habitat is limited, as it is only found at the shore, on barrier islands, sandy beaches, and dredged material disposal islands. It is a federally threatened and state endangered small bird.

Alternative D would enhance habitat through the installation of sand-trapping fences for dune accretion, and continue protecting its habitat. The habitat protection falls into the regulatory requirement, also in consistency with NPS mission, as well as other agencies such as Fish and Wildlife Service.

4. Sustainability Performance: Envision® rating system checklist assessment

An Envision sustainability performance evaluation was not conducted as part of the Project. Louis Berger retroactively performed the Envision evaluation using the checklist[32] from version 2.0 of the rating system. The assessment was presented by Heather Unger, Manager, Corporate Sustainability at Louis Berger, presentation 'Fort Tilden Shore Access and Resiliency Project' at the Zofnass Program Workshop: Putting Together the Puzzle of Sustainable Infrastructure, October, 2017.

As shown in figure 10, the project achieved the highest scores in Climate and Risk category, due to the strong resiliency considerations by NPS. Natural World follows as second best achieved category due to the habitat restoration actions and conservation practices. Leadership is the third best-achieved category, due to NPS commitment, stakeholder integration, extending the park's useful life. The fourth category in order of achievement is Quality of Life, improving safety, preserving views, local character and enhancing the public space. Lastly comes Resource Allocation category with reductions in net embodied energy from replacing concrete with a natural material on Shore road.

Credit Category	Applicable	Submitted	Percentage
QUALITY OF LIFE	170	68	40%
LEADERSHIP	121	60	50%
RESOURCE ALLOCATION	101	21	21%
NATURAL WORLD	101	63	62%
CLIMATE AND RISK	101	83	82%
Total Points / %	594	295	50%

Figure 10: Envision assessment results by category. Source: Heather Unger, Louis Berger.

[32] The Envision® rating system checklist is a quick assessment tool to give an overview of the sustainability performance of a project. The checklist is based on Envision® v2.

Quality of life

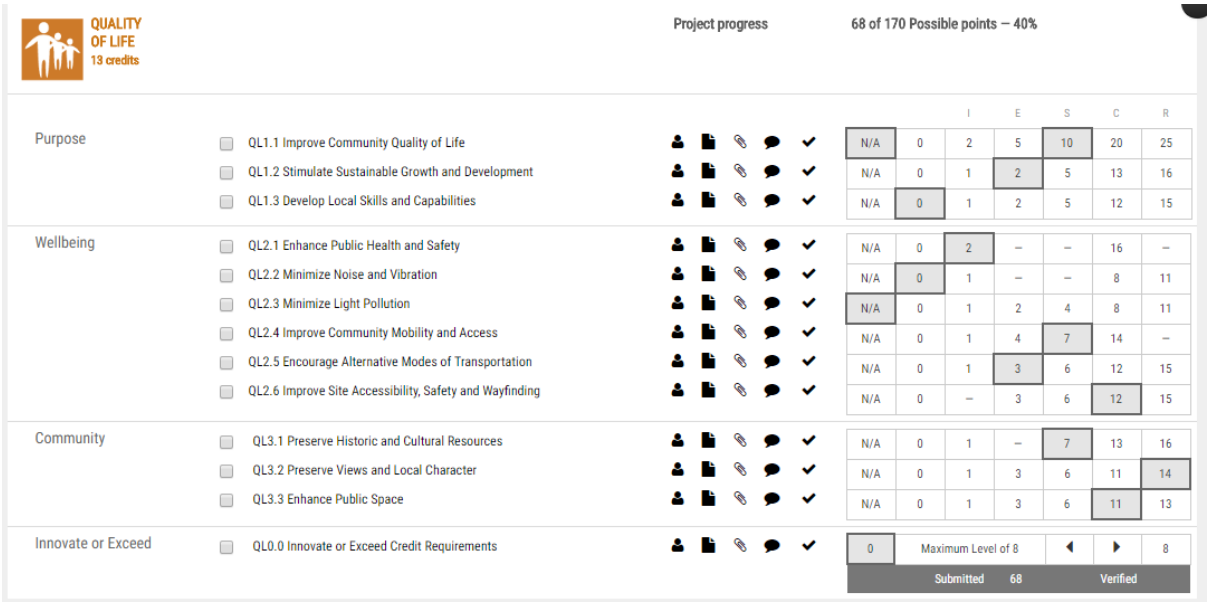

Figure 11: Quality of Life results by credits. Source: Heather Unger, Louis Berger.

Figure 11 shows achievement by credit, summarized by the following main features.

Main QL Features

- **Preserve Views and Local Character:** The project improved the local character by restoring parts of Fort Tilden to a more natural state. An ineffective and hazardous bulkhead was removed and sand trapping fences were installed, facilitating the natural accumulation of dunes. Newly created habitat for endangered shore birds was protected. Deteriorating buildings located in the flood zone were removed. A damaged concrete road was replaced with a more natural solution of crushed shell aggregate.
- **Enhance Public Space:** The project enhanced public space by significantly improving access for users by rebuilding a road destroyed during Sandy and creating an accessible road that can also be used for emergency egress. The project also restores natural habitat, removes safety hazards, and protects bird habitat.
- **Improve Site Accessibility, Safety and Wayfinding:** One of the main goals of the project was to improve safety. The project involved removing an exposed bulkhead that posed safety concerns as well as demolishing several deteriorating buildings that contained lead and asbestos and were located in the flood zone. Site accessibility was improved through creation of a pedestrian and bicycle-friendly emergency egress route. The original road was not accessible to all.
- **Improve Community Quality of Life:** The EA process involved extensive stakeholder input. The project improved a national park used by adjacent communities and created an emergency egress route for these communities to use in the event of an emergency.

The only credit that was NA was minimize light pollution because there is no lighting.

Leadership

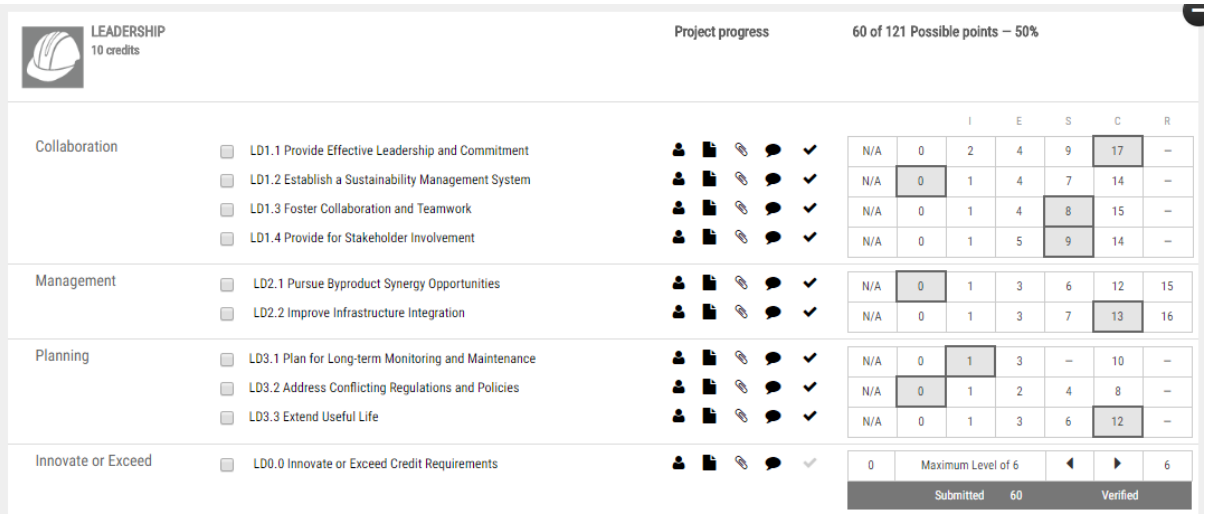

Figure 12: Leadership results by credits. Source: Heather Unger, Louis Berger.

Figure 12 shows achievement by credit, summarized by the following main features.

Main LD features

- **Provide Effective Leadership and Commitment:** Sustainability and resilience were core NPS values and goals for the project.
- **Improve Infrastructure Integration:** The project was designed with community context and regional planning in mind. Based on community input, an accessible emergency egress road was planned and the damaged Shore Road was rebuilt more sustainably and resilient to continue to provide access to local fisherman. The project team considered how the Fort Tilden project connected to other resiliency projects in the region.
- **Extend Useful Life:** One of the main features of the project is rebuilding the damaged section of Shore Road. The project team identified an innovative solution to rebuild using crushed shell aggregate, which is a more sustainable and resilient solution.
- **Foster Collaboration and Teamwork:** Collaboration and teamwork were essential to the success of this project. Stakeholder engagement was an important part of the EA process. The Value Analysis Workshop and Choosing by Advantages methodology enabled the project team to consider and compare feasible alternatives with respect to the NPS goals, including sustainability and resilience.

All of the LD credits were applicable. One opportunity to score better would be to develop a sustainability management plan.

Resource Allocation

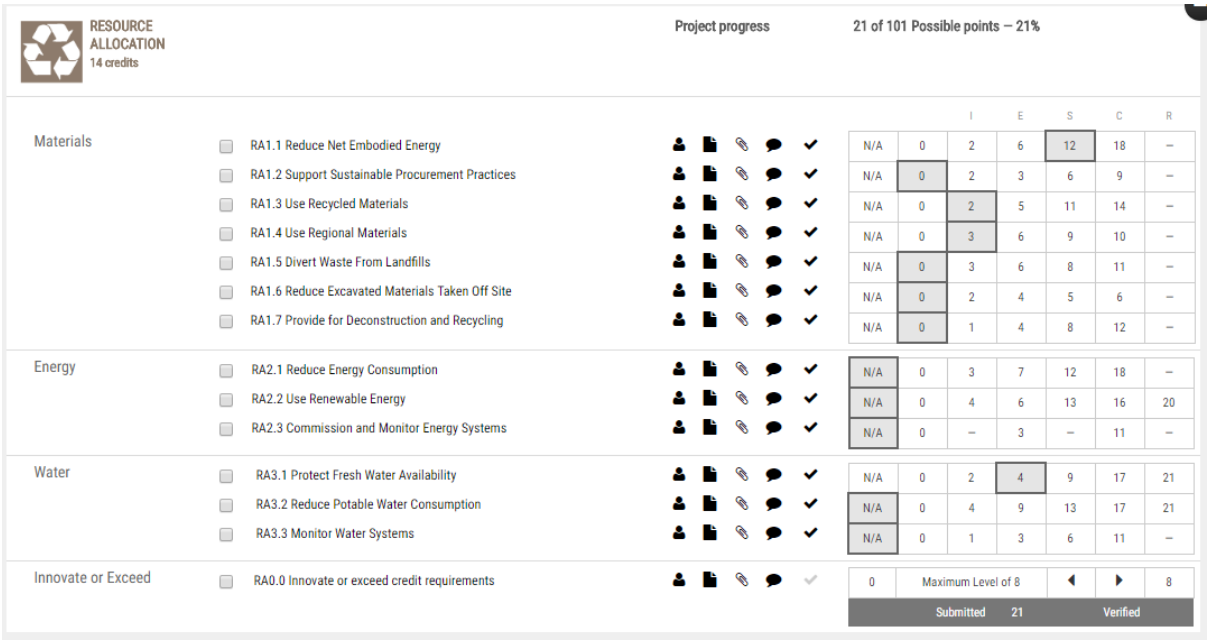

Figure 13: Resource Allocation results by credits. Source: Heather Unger, Louis Berger.

Figure 13 shows achievement by credit, summarized by the following main features.

Main RA features

- **Reduce net embodied energy:** Although a lifecycle assessment was not performed, the team assumes that by rebuilding Shore Road using crushed shell aggregate as opposed to concrete, that there is at least a 40% reduction in net embodied energy.

Many of the RA credits were NA because the project will not use energy or water for potable or non-potable uses. The project could have scored higher in the RA category if they developed a plan for how to better integrate sustainability into the construction and demolition process.

Natural World

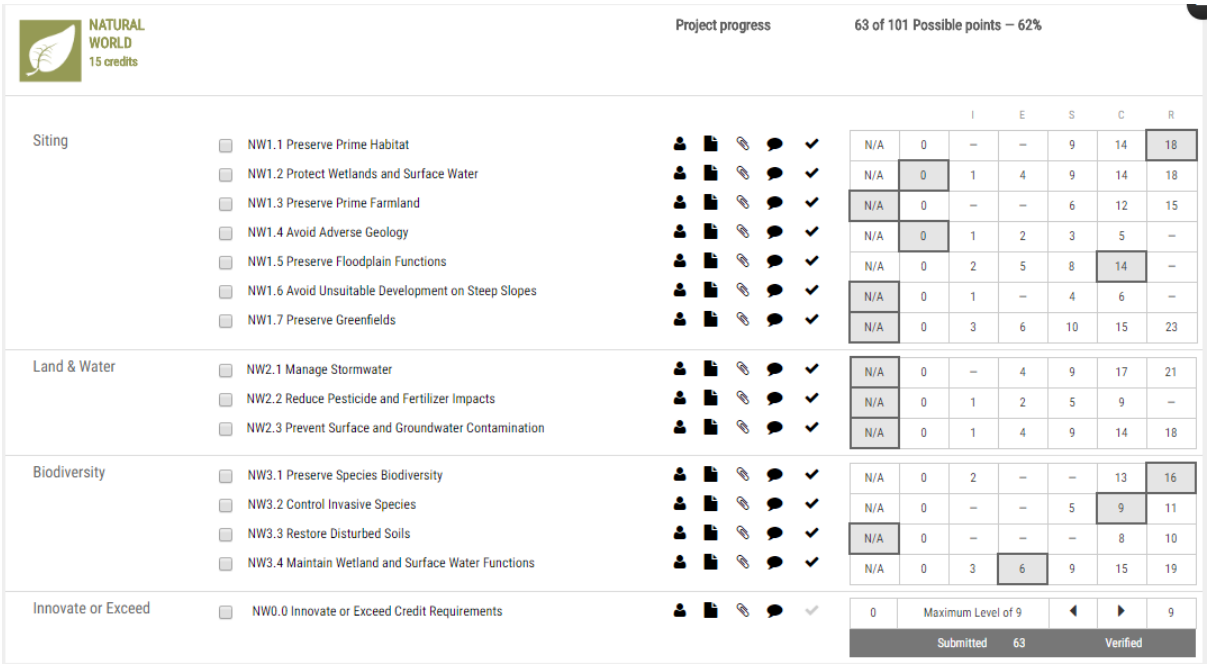

Figure 14: Natural World results by credits. Source: Heather Unger, Louis Berger.

Figure 14 shows achievement by credit, summarized by the following main features.

Main NW features

- **Preserve Prime Habitat:** The project restores habitat by removing existing structures and installing sand-trapping fences to encourage natural dune accumulation.
- **Preserve Floodplain Functions:** The project removes several damaged buildings located in the floodplain, which if rebuilt, would be subject to flooding and other damage during future storms.
- **Preserve Species Biodiversity:** The project was designed to protect newly formed habitat for endangered shore birds. The project also restores natural habitat by removing structures located within the floodplain.

Climate and Risk

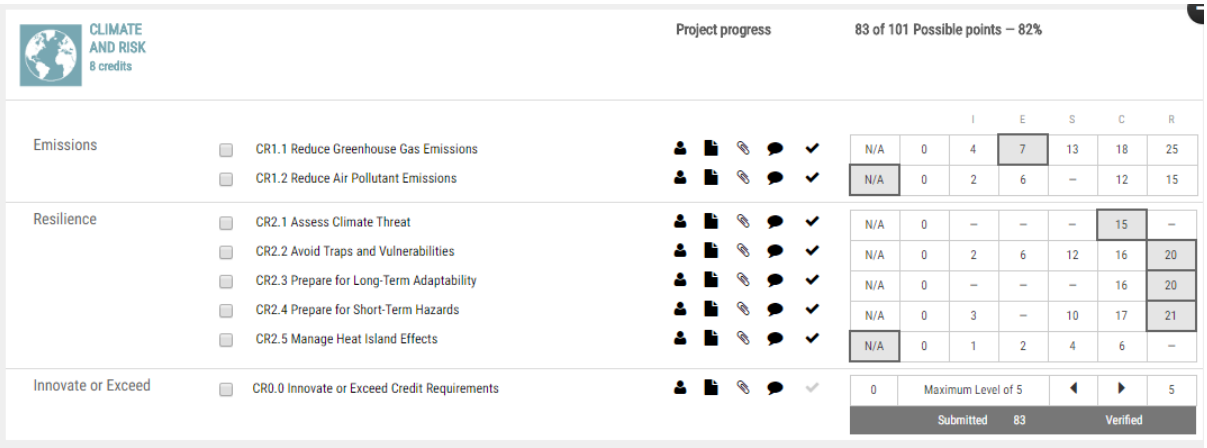

Figure 15: Climate and RIsk results by credits. Source: Heather Unger, Louis Berger.

Figure 15 shows achievement by credit, summarized by the following main features.

Main CR features

- **Assess Climate Threat:** Although a formal vulnerability assessment was not conducted, the purpose of the project was to rebuild Fort Tilden to be resilient to future storms resulting from climate change. The project involved extensive community engagement.
- **Prepare for Long-Term Adaptability:** The project is a shoreline restoration project following the effects of Sandy. The project was designed to make Fort Tilden, and the adjacent areas, more resilient to future storms. The project removes buildings located within the floodplain and restores natural habitat and processes. Shore Road will be rebuild using inexpensive, sustainable material that can more easily be replaced if damaged.
- **Prepare for Short-Term Hazards:** The project eliminated short-term hazards including removal of the exposed bulkhead and damaged buildings. The project restored natural habitat and processes, which will make Fort Tilden more resilient to future storms.

The project scored very well in the CR category because the purpose of the project was to rebuild Fort Tilden to be more resilient.

5) Conclusions and Next Steps

The use of a valuation process helped the NPS develop a cost effective design concept that promotes sustainable and resilient design and construction, and maintenance of park infrastructure. Through this process the NPS was able to thoroughly evaluate multiple alternatives, risks, incorporate feedback from stakeholders, and improve the park-preferred project alternative.

The design helps promote ecosystem resilience on the shore through habitat restoration, conservation, and preservation of park natural resources. The project also improves visitor access, safety and provides a route for emergency egress.
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The project began construction early 2018, and is projected to finish in 2019.

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Appendix

Bulkhead alternatives assessment.

Table comparing bulkhead alternatives by objectives and costs.

Alternative	Description	Objective	Cost
0 – Do Nothing	No action alternative	Revert to natural beach	$0
1 – Complete Removal	Remove existing bulkhead	Eliminate safety hazard	$1,620,000
2 – Partial Removal	Remove existing bulkhead to 2-feet below ground	Minimizes safety hazard	$1,090,000
3 – Construct New Bulkhead In-Place	New sheet pile bulkhead	Protect beach during 100-year event	$6,460,000
4 – Construct Riprap Revetment In-Place	New riprap revetment	Protect beach during 100-year event	$1,940,000
5 – Construct Bulkhead Near Shore Road	New bulkhead installed along road	Protect Shore Road during a > 100-year event	$6,120,000
6 – Construct Riprap Revetment Near Shore Rd	New riprap revetment along road	Protect Shore Road during a > 100-year event	$1,680.000
7 – Construct Bulkhead Near Gun Battery	230 feet of new bulkhead along gun battery	Protect Gun Battery during 100-year event	$470,000

Source: Veraart, N., Unger, H., (2017) Fort Tilden Access and Resiliency Project, Presentation Zofnass Program Workshop: Putting Together the Puzzle of Sustainable Infrastructure, October, 2017.

Site visit images

Images (top) dune habitat, (bottom) eastern portion of Shore Road. Source: J. Rodriguez

Exposed bulkhead on western area of Fort Tilden. Source: J. Rodriguez