Pawcatuck River, Rhode Island
Coastal Storm Risk Management
Feasibility Study

Final Integrated Feasibility Report
& Environmental Assessment

February 2018

CRMC
Rhode Island
Coastal Resources
Management Council

U.S. Army Corps of Engineers
North Atlantic Division
New England District

Pawcatuck River, Rhode Island

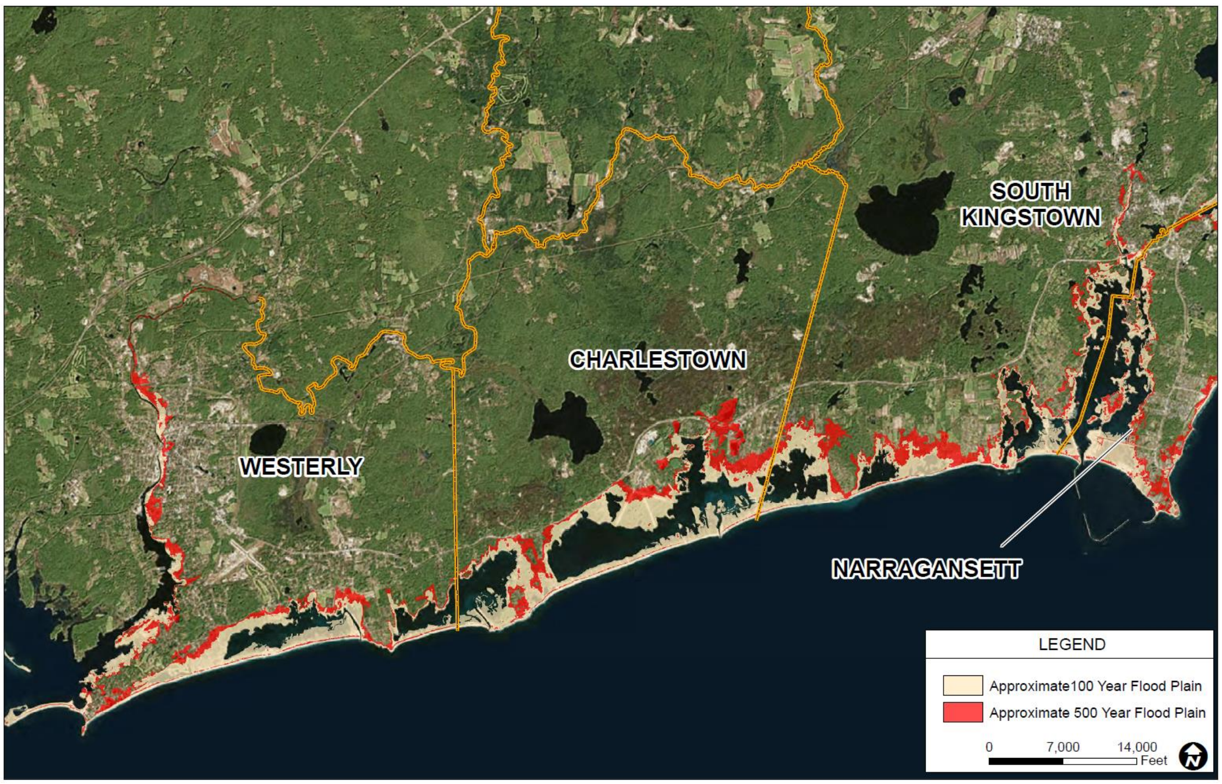
Coastal Storm Risk Management Feasibility Study

Final Integrated Feasibility Report & Environmental Assessment February 2018

Pawcatuck River, Rhode Island
Coastal Storm Risk Management Feasibility Study

EXECUTIVE SUMMARY

This Final Integrated Feasibility Report and Environmental Assessment is for the Pawcatuck River, Rhode Island (Washington County), Coastal Storm Risk Management Feasibility Study. The study area is on the south coast of Rhode Island and includes about 28 miles of moderately developed coast in the towns of Westerly, Charlestown, South Kingstown, and Narragansett. The study area includes a series of coastal barrier beaches that front seven coastal ponds. The floodplain completely encompasses the barriers and ponds as shown in the figure below.



Residential and commercial properties in the Pawcatuck River coastal floodplain are all vulnerable to inundation from coastal storms. Property on the coastal barriers are subject to flood inundation, wave effects, and to a lesser extent, erosion. The study area includes about 4,800 structures most of which are residential. There is some commercial property in Westerly and South Kingstown. Point Judith in Narragansett has the largest concentration of commercial property and is home to the third largest fishing port in New England. The total value of the existing residential and commercial inventory is estimated to be worth over $600 million. Rock revetments are located along approximately 23% of the beach front properties within Westerly and 31% in the Matunuck area of South Kingstown. Other than that, the shoreline consists of sandy barrier beaches.

The Feasibility Study plan formulation considered a range of structural and nonstructural measures to reduce the risk of storm damage in the study area. Through an iterative planning process, potential coastal storm risk management measures were identified, evaluated, and compared. Initial screening of alternatives determined that detailed study of structural (sheet pile floodwalls and tide gates), soft structural (beach fill/nourishment), and nonstructural (elevation and buyout of properties) should be conducted in Westerly due to the amount of denser development there. Conversely, only nonstructural alternatives made sense for full evaluation in the towns of Charlestown, South Kingstown, and Narragansett.

Beach nourishment consists of the artificial building up and/or widening of the beach by the placement of sand fill material on the shore to reduce storm damages. Beach nourishment projects require periodic re-nourishment to replace sand lost to erosion. For the purposes of the study, it was assumed that sufficient sand fill could be obtained from both upland and offshore sources (i.e. within a 5 mile radius).

Evaluation of costs and benefits (damage reduction) of the alternatives showed that the cost of several of the structural alternatives in Westerly exceeded the benefits to be provided by the alternative. This included beach fill alternatives, a new west floodwall, combination of new east and west floodwalls, and combination tide gate and west floodwall in Misquamicut village in Westerly. The east floodwall and a stand-alone tide gate in the Winnapaug Pond breachway were determined to be marginally justified (i.e. >1.0 benefit to cost ratio) but not as economically attractive as the nonstructural alternatives. Based on an evaluation of the costs and benefits of the nonstructural alternatives, elevation of individual structures was identified as the tentatively selected plan to reduce coastal storm risk for all four communities in the study area.

The Tentatively Selected Plan (TSP) for coastal storm risk management in the Pawcatuck River coastal watershed was to elevate the first floors of 341 residential structures in the four communities +1-foot above the FEMA designated base flood elevation. Following USACE and public review of the TSP and the Agency Decision Milestone meeting, it was decided the study team would: conduct a performance based sea level change analysis (the ‘intermediate’ rate was found to be the best performing rate, defined as when water levels have not reached or exceeded the first floor elevation, over the economic and planning horizons), economically evaluate certain structures for potential flood proofing and acquisition, and optimize the analysis to determine the National Economic Development (NED) plan. The NED plan consists of elevating the first floors of 357 primarily residential structures, dry flood proofing 21 primarily commercial structures, and the acquisition of 7 properties located in Coastal Barrier Resource Act units. Working with the communities, the Rhode Island Coastal Resources Management Council (RICRMC), the non-Federal sponsor, identified 102 structures that if elevated would subject these sub-standard constructed, single season use structures to additional storm damage risk (in addition, these structures are not owned by the same entity who owns the land), 7 structures that were scheduled for elevation through other means, and 1 structure that had already been elevated. These structures were eliminated from the NED plan as well as the 7 properties identified for acquisition. The final selected (i.e. recommended) plan is a Locally Preferred Plan (LPP) consisting of elevating 247 primarily residential structures and flood proofing 21 commercial structures. Of the estimated $531,372,000 in total damages in the study area, the proposed LPP eliminates $236,556,000 of those damages or 45% of the total by applying nonstructural flood risk management measures to only 7% of the properties in the study area.

PROJECT AREA

The Pawcatuck River coastal project area is in the towns of Westerly, Charlestown, South Kingstown, and Narragansett in Washington County. The project area is located in the coastal floodplain along the south facing shore of Rhode Island on Block Island Sound.

SELECTED PLAN FEATURES

The LPP consists of elevating the first floors of 247 structures in the four study area communities. The first floors will be elevated to a height corresponding to the FEMA designated Base Flood Elevation (BFE), ranging from +11 feet North Atlantic Vertical Datum of 1988 (NAVD88) to +17 feet NAVD88, plus 1 additional foot in accordance with Corps/NFIP standards, 0.8 feet to account for intermediate sea level rise over the next 50 years, and another 0.2 feet to account for sea level rise which has occurred since the current sea level was published (1992) and present. Properties eligible for elevation, by town, are as follows:

- Westerly: Elevate 49 Structures
- Charlestown: Elevate 45 Structures
- South Kingstown: Elevate 72 Structures
- Narragansett: Elevate 81 Structures

Twenty-one primarily commercial structures (6 in Westerly, 4 in South Kingstown, and 11 in Narragansett) are also included in the LPP for flood proofing. They consist of large multi-story hotels, sheet metal buildings, brick on concrete slab buildings, etc.

Construction Method: Elevation of individual structures will rely on conventional residential construction methods. First, existing structures will be elevated using lifting jacks and supported on temporary cribbing foundations. Temporary utility connections will be put into place to allow occupants to remain in the structure throughout construction. A new or extended foundation would then be constructed. Those structures located in the AE-zone (area of high risk subject to inundation by the 1% chance flood) of the floodplain will be provided with a new concrete wall foundation. Those in the VE-zone (similar to AE but subject to storm induced waves) will be placed on new concrete piers. Once ready, the structures will then be lowered onto the new foundations and the permanent utility connections made.

Dry flood proofing consists of sealing all areas from the ground level up to approximately 3 feet of a structure to reduce the risk of damage from storm surge resulting from storms of a certain magnitude by making walls, doors, windows and other openings resistant to penetration by storm surge waters. Walls are coated with sealants, waterproofing compounds, or plastic sheeting is placed around the walls and covered, and back-flow from water and sewer lines prevention mechanisms such as drain plugs, standpipes, grinder pumps, and back-up valves are installed. Openings, such as doors, windows, sewer lines and vents, may also be closed temporarily, with sandbags or removable closures, or permanently. Critical utilities may be relocated to a less vulnerable elevation. Additional information about flood proofing can be found in Appendix I.

PROJECT COST

The Project First Cost (see Appendix E) estimate is broken out by cost component in Table E-1. The Project First Cost includes the initial construction, a risk-based contingency, pre-construction engineering & design, and construction management. Real estate requirements for a voluntary nonstructural plan like this will consist of acquiring rights of entry for survey and exploration (during final design to determine eligibility of the structure), temporary work area easements for construction, staging and storage, temporary relocation assistance benefits (tenants only), and permanent restrictive easements, which will be defined in more detail during the design stage of the project. The LPP initial construction Project First Cost is estimated at $53,438,000. **This is the most current cost estimate for the project, which differs slightly from the "working" estimates that were used in the alternatives analysis throughout the report.** Operation, maintenance, repair, rehabilitation and replacement (OMRR&R) costs are expected to be 'de-minimis' and will be confined to periodic site visits by the non-Federal sponsor in order to determine that the requirements of the OMRR&R Manual are being met. An average annual cost of $100 per structure has been included in the annual cost calculations. The owner of the property will be responsible for all costs associated with maintaining, repairing, rehabilitating and replacing the elevated structure. Costs for these efforts have not been calculated.

Table E-1. Locally Preferred Plan Cost Estimate

(October 2017 Price Levels)

Account/Cost Component	Cost
Initial Construction Cost (Project First Cost)	
01 – Real Estate Incidentals/Temporary Relocations	$2,790,000
19 – Elevation of Structures	$30,750,000
19 – Flood Proof Structures	$1,507,000
Contingency (28.7%)	$9,957,000
Subtotal	$45,004,000
30 – Pre-Construction Engineering & Design	$3,822,000
31 – Construction Management	$4,612,000
Total	**$53,438,000**

REAL ESTATE REQUIREMENTS

Detailed discussion of the potential real estate requirements can be found in the Real Estate Report (Appendix F). The project impacts approximately 268 residential and commercial structures. Nonstructural flood-proofing measures will be offered to owners of eligible structures on a voluntary basis. For those structures that are determined to be eligible, the non-Federal sponsor will be required to obtain the real estate interests (in this case, temporary work area easements for construction, staging and storage areas, temporary relocation assistance benefits (tenants only), and permanent restrictive easements) for the project and their costs are then credited against the non-Federal share of the project. Federal costs ($55,000) for oversight of the non-Federal sponsor's efforts are included in the estimate.

ENVIRONMENTAL IMPACTS

The implementation of this nonstructural LPP has the least amount of impacts to natural resources. Elevations will occur within the same footprint of existing structures requiring only the minor removal of vegetation or tree trimming to enable equipment access, as needed. Any tree removal will comply with the U.S. Fish and Wildlife Service guidelines to avoid impacts to the northern long-eared bat.

PUBLIC USE AND ACCESS

There is no public use or access requirements for the nonstructural project.

ECONOMIC ANALYSIS

The Annual Benefit and Cost Summary of both the NED and LPP are provided in Table E-2. The Project First Cost (October 2017 price levels) is annualized over a 50-year period of analysis at the Fiscal Year Federal interest rate (FY18 of 2.75%) for evaluation of water resource projects. Dividing the average annual benefit of the project by the average annual cost results in an estimated benefit-to-cost ratio. The benefits were inflated to 2018 prices using the CWCCIS composite cost index for consistency in comparison.

Table E-2. NED and LPP Annual Cost and Benefit Summary (FY18 Discount Rate 2.75%)

Item	NED Plan	LPP
NED Project Economic Cost - FY18 Discount Rate		
Initial Investment Cost		
First Cost (includes constr., cont., PED, S&A, RE)	$75,586,000	$53,438,000
Interest During Construction @ 2.75%	$87,000	$61,000
Total Investment Cost	$75,673,000	$53,499,000
Annualized Investment Cost	$2,803,000	$1,982,000
OMRR&R		
Annualized Maintenance Cost	$40,000	$28,000
Average Annual Cost	$2,843,000	$2,010,000
NED Economic Benefit		
Total Average Annual Benefits	$11,099,000	$8,762,000
Net Benefit and BCR		
Average Annual Net Benefits	$8,256,000	$6,752,000
NED Benefit-Cost Ratio	3.9	4.4

*Individual home elevation is calculated to take 2-3 months of construction. The overall construction duration of this project is five years assuming five contractors are working on the project simultaneously.

FEDERAL AND NON-FEDERAL PROJECT COST SHARING

In accordance with the cost share provisions in Section 103 of the Water Resources Development Act (WRDA) of 1986, as amended (33 U.S.C. 2213), the Federal and non-Federal shares are as follows: Initial construction is cost shared 65% Federal and 35% non-Federal. Table E-3 (current price level) and E-4 (fully funded) provide the details of the Cost Apportionment for both the NED and LPP plans. The Total Project (aka Fully Funded) Cost is escalated to the midpoint (November 2023) of construction. **The LPP is the selected plan for implementation.**

Table E-3. Cost Apportionment of the NED and LPP Plans (Current Price Level)

	NED Plan			LPP		
	Total	Federal Share	Non-Federal Share	Total	Federal Share	Non-Federal Share
Construction	$59,257,000	$40,780,000	$18,477,000	$41,935,000	$28,873,000	$13,062,000
Lands & Damages	$4,305,000	$77,000	$4,228,000	$3,069,000	$55,000	$3,014,000
Planning, Engineering & Design	$5,436,000	$3,741,000	$1,695,000	$3,822,000	$2,632,000	$1,190,000
Construction Management	$6,588,000	$4,533,000	$2,055,000	$4,612,000	$3,175,000	$1,437,000
Total Project Cost	$75,586,000	$49,131,000	$26,455,000	$53,438,000	$34,735,000	$18,703,000

Table E-4. Cost Apportionment of the NED and LPP Plans (Fully Funded)

	NED Plan			LPP		
	Total	Federal Share	Non-Federal Share	Total	Federal Share	Non-Federal Share
Construction	$66,456,000	$45,533,000	$20,923,000	$46,556,000	$31,932,000	$14,624,000
Lands & Damages	$4,504,000	$81,000	$4,423,000	$3,211,000	$58,000	$3,153,000
Planning, Engineering & Design	$6,108,000	$4,185,000	$1,922,000	$4,262,000	$2,924,000	$1,338,000
Construction Management	$8,379,000	$5,741,000	$2,638,000	$5,687,000	$3,901,000	$1,786,000
Total Project Cost	$85,446,000	$55,540,000	$29,906,000	$59,716,000	$38,815,000	$20,901,000

Pawcatuck River, Rhode Island
Coastal Storm Risk Management Feasibility Study

TABLE OF CONTENTS

**Sections of text marked with an asterisk are applicable to the satisfaction of National Environmental Policy Act (NEPA) requirements*

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Pawcatuck River, Rhode Island
Coastal Storm Risk Management Feasibility Study

Chapter 1: Introduction

1.1 Final Integrated Feasibility Report and Environmental Assessment

The U.S. Army Corps of Engineers (USACE), New England District prepared this Final Integrated Feasibility Report and Environmental Assessment (FIFREA) for the Pawcatuck River, Coastal Storm Risk Management Feasibility Study. This report presents the final selected plan, in this case a Locally Preferred Plan (LPP) for managing coastal storm risk along the south coast of Rhode Island (Figures 1 and 2). The towns of Westerly, Charlestown, South Kingstown, and Narragansett are located in Washington County. Over the course of the review process, the report will be updated to include input from Rhode Island Coastal Resources Management Council (RICRMC), who is the non-Federal Sponsor, local governments, natural resource agencies, and the public.

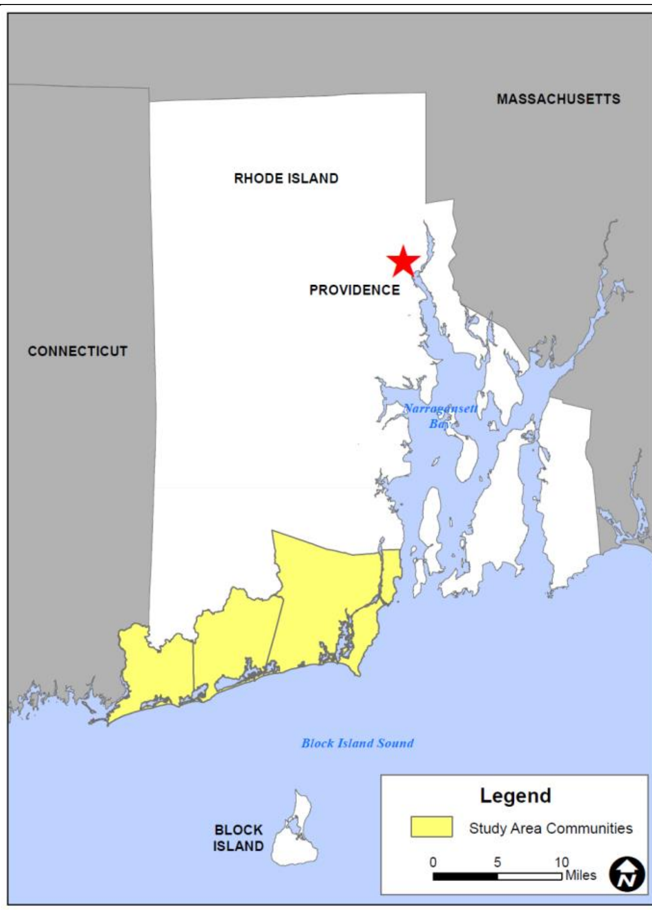


Figure 1. Pawcatuck Coastal Study Location Map

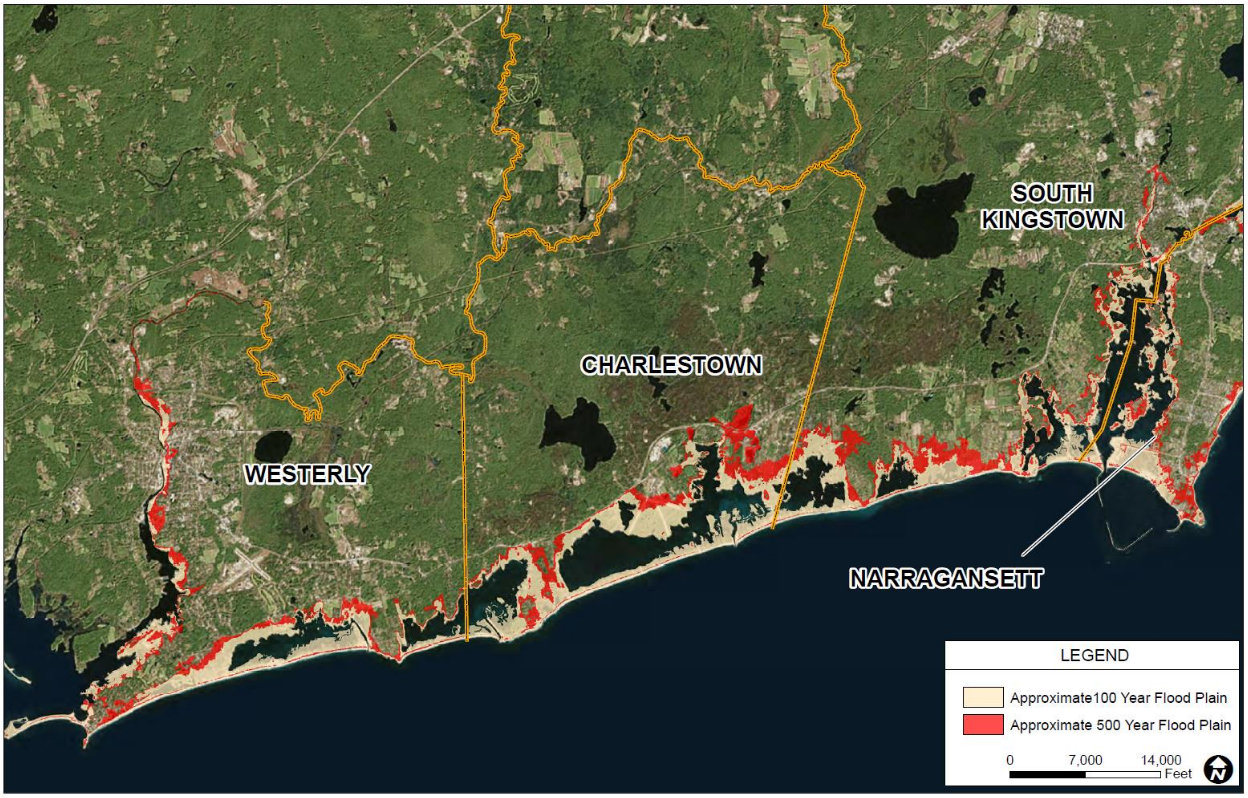


Figure 2. Pawcatuck River Study Area – Coastal Floodplain

The Federal objective of water and related land resources project planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements (Principles and Guidelines (P&G), 1983).

Water and related land resources projects are formulated to alleviate problems and take advantage of opportunities in ways that contribute to this objective. Pursuant to this, the FIFREA (1) summarizes the problems, needs, and opportunities for coastal storm risk management along the southern Rhode Island coast; (2) presents and discusses the results of the plan formulation for protection of coastal resources; (3) identifies specific details of the Final Selected Plan, including inherent risks; (4) and will be used in part to determine the extent of the Federal interest and local support for the plan.

A draft of the IFREA was released for concurrent public and agency technical review. USACE has evaluated an array of alternatives including beach nourishment, a tide gate, floodwalls, and nonstructural measures for the identification of the final selected plan. The final selected plan was determined based on comments from public and agency review, which included additional feasibility level optimization for this FIFREA.

1.2 National Environmental Policy Act Requirements

This FIFREA was prepared pursuant to the National Environmental Policy Act (NEPA), the Council on Environmental Quality's (CEQ) Guidance Regarding NEPA Regulations, and the USACE's Procedures for Implementing NEPA (Engineering Regulation [ER]-200-2-2).

An environmental assessment (EA) is a concise public document prepared by the Federal agency to determine whether the proposed action has the potential to cause significant environmental effects (40 Code of Federal Regulations (CFR) 1508.9(a)). The purposes of an EA are to:

- provide evidence and analysis sufficient to determine whether an Environmental Impact Statement (EIS) is required;
- aid a Federal agency's compliance with NEPA when no EIS is necessary;
- facilitate preparation of an EIS when one is necessary; and serve as the basis to justify a finding of no significant impact (FONSI).

The EA must discuss:

- the need for the proposed action;
- the proposed action and alternatives;
- the probable environmental impacts of the proposed action and alternatives;
- and the agencies and persons consulted during preparation of the EA.

NEPA requires Federal agencies to integrate the environmental review into their planning and decision-making process. This integrated report is consistent with NEPA statutory requirements. The report reflects an integrated planning process, which avoids, minimizes, and mitigates adverse project effects associated with coastal storm risk management actions. Sections of the report that are required to fulfill the requirements of National Environmental Policy Act (NEPA) of 1969 are marked with an asterisk (*) in the headings.

1.3 Study Purpose Need for Action

The purpose of the study is to determine if there is a technically feasible, economically justified and environmentally compliant recommendation for Federal participation in coastal storm risk management for the Pawcatuck River coastal study area in Westerly, Charlestown, South Kingstown, and Narragansett, RI. The study is needed as existing coastal floodplain properties are at risk from coastal storm damage. Some property owners have implemented individual solutions but the area continues to experience storm damage due to flood inundation, wave effects, and to a lesser extent, erosion.

1.4 Study Authority

This study is authorized in a resolution approved by the Committee on Public Works of the United States Senate, dated September 12, 1969 (also known as the Southeastern New England (SENE) resolution). This resolution by the Committee on Public Works of the United States Senate gives the Army Corps of Engineers the authority to investigate solutions for "flood control, navigation, and related purposes in Southeastern New England …" Authorization and funding for this study is also provided under investigations heading, Title X, Chapter 4, Division A of the Disaster Relief Appropriations Act of 2013, Public Law 113-2 (127 Stat. 23) enacted January 29, 2013 (hereinafter "DRAA 13").

The Secretary of the Army is authorized, at full Federal expense using funds provided in DRAA 13, to complete ongoing flood and storm damage reduction studies in areas that were impacted by Hurricane Sandy in the North Atlantic Division of the United States Army Corps of Engineers, which includes the Pawcatuck River Coastal Storm Risk Management Feasibility Study. The New England District prepared the FIFREA decision document for review by the North Atlantic Division (NAD) and approval at Corps Headquarters in Washington, DC by the Chief of Engineers for transmittal to Congress.

1.5 Non-Federal Sponsor

The Non-Federal Sponsor for the study is the Rhode Island Coastal Resources Management Council (RICRMC). Based on Public Law 113-2, the feasibility study was completed with 100% Federal funding.

1.6 Prior Studies, Reports, and Existing Water Projects

In 2013 the New England District conducted a focus area analysis for the coastal portion of the Pawcatuck River watershed. This analysis was part of the larger North Atlantic Coastal Comprehensive Study (NACCS). The analysis described the study area, its problems, and recommended the continuation of the study into the feasibility phase for coastal storm risk management. In January 2014, USACE and the RICRMC executed a Feasibility Cost Sharing Agreement (FCSA).

Prior reports that have been prepared by the USACE documenting coastal storm damage along the south shore of Rhode Island study area include:

- A plan to construct a hurricane barrier from the Sand Hill Cove area of Point Judith, across the south side of Point Judith Pond, and terminating in the Matunuck area of South Kingstown, was developed in 1960. The barrier consisted of a series of beach berms, walls, and engineered dikes. A 300-foot wide navigation opening would remain (no retractable structure proposed) at the inlet to Point Judith Pond. The proposal was not supported by the public or regulatory community and was therefore never moved beyond the study phase.

- A comprehensive plan (beach fill, numerous groins, tide gates and pump stations) to restore and protect Misquamicut Beach was developed by the USACE (New England Division) as an "Interim Hurricane Survey of Westerly, Rhode Island" and transmitted by the Secretary of the Army to Congress in July 1964. The project was subsequently authorized by Congress in December 1965. However, due to a lack of local interest, the project was never constructed and was subsequently de-authorized in January 1986.

- Misquamicut Beach, Shore Protection and Flood Damage Reduction Reconnaissance Report, Westerly, Rhode Island (January 1994). The report could not determine an economically justified plan for storm damage protection along the Westerly shoreline. The study was terminated and no further action taken.

- The Rhode Island South Coast Habitat Restoration Feasibility Report and Environmental Assessment was completed in June 2002. It recommended dredging of flood shoals in Ninigret, Quonochontaug, and Winnapaug ponds to restore 57 acres of eelgrass habitat that had been buried through sedimentation moving into the ponds through the breachways. Sedimentation basins were included in the design. Twenty additional acres of anadromous fish habitat were recommended to be restored at Cross Mills Pond by constructing a Denil fish ladder. Implementation of each of these projects was to be under Section 206 of the Continuing Authorities Program. To date, only the Ninigret Pond restoration project has been implemented.

Constructed Federal Projects:

- Sand Hill Cove Beach, Narragansett. This beach erosion control project, east of the entrance to Point Judith Pond, was completed in 1955 and consists of widening the beach by 65 feet, constructing five stone groins and a steel bulkhead behind the eastern half of the beach.

- Misquamicut Beach, Beach Erosion Control Project. The project was authorized by the River and Harbor Act of 3 July 1958, as amended. The authorized beach erosion control project, completed in 1959, involved the placement of approximately 90,000 cubic yards of a suitable sand fill along 3,250 feet of shoreline. The beach is roughly 150 feet wide shoreward of the mean high water line with a top elevation of +7.5 feet MLW.

- Ninigret Pond, Habitat Restoration Project. This restoration project was constructed under Section 206 of the Continuing Authorities Program. The project restored aquatic vegetation, in the form of eelgrass, to the flood tidal shoal of Ninigret Pond. About 40 acres of the flood tidal shoal were dredged to a depth of 0.75 meters (2.5 feet) below Mean Low Water (MLW). Eelgrass was restored in the dredged areas through a combination of natural succession and seeding. A 3.5-acre sedimentation basin was dredged to 8 feet below MLW to prevent future shoaling in the restored eelgrass areas. About 200,000 cubic yards of dredged sand was pumped directly to East and Charlestown beaches for disposal.

1.7 Study Area

As shown in Figures 1 and 2 above, the study area faces the Atlantic Ocean for approximately 28 miles. The study area includes the coastal floodplains of the towns of Westerly, Charleston, South Kingston, and Narragansett (terminating at Point Judith). All towns are within the 2nd Congressional District.

Five primary damage areas were initially identified for further study based on their density of development and potential to support a federally constructed project as shown in Figure 3: Area 1 is the Misquamicut area in Westerly (Little Maschaug Pond to Winnapaug Pond Breachway), Area 2 is the barrier beach and property located behind it in Charlestown/South Kingstown, Area 3 is located at Matunuck in South Kingstown (Roy Carpenter's Beach to Matunuck Point), Area 4 is located in Narragansett (Sand Hill Cove), and Area 5 is the low lying area surrounding Point Judith Pond. Residential and commercial properties in these areas experience damage during coastal storm events.

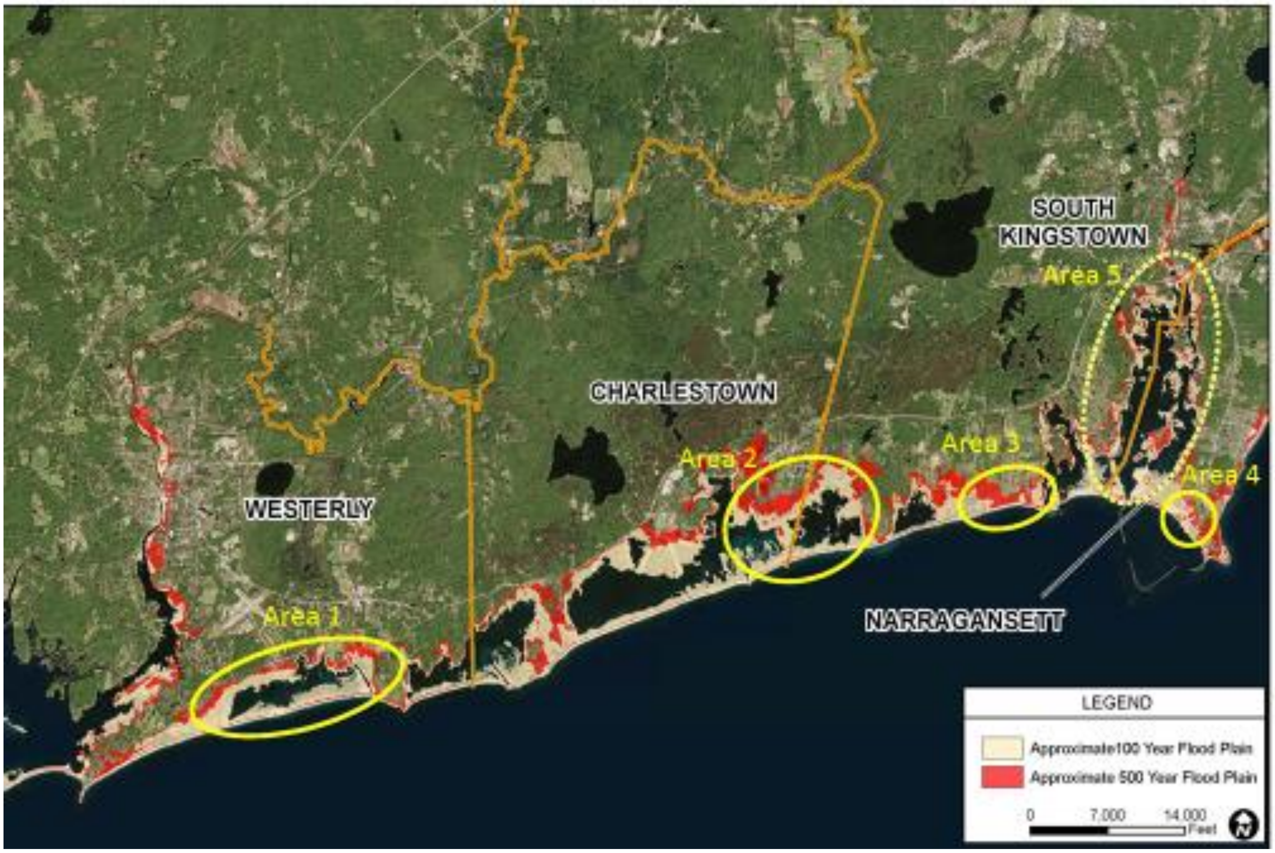


Figure 3. Study Area

Chapter 2: Existing Conditions

Existing conditions serve as the basis for the characterization of problem identification and projection of future without project conditions. Existing conditions are described in this Chapter (coastal setting, storms and assets at risk) and in Chapter 3 (environmental resources).

2.1 Coastal Setting and Storms

Climate. The south coast of Rhode Island has a moderate coastal climate with warm, humid summers and moderately cold winters. The temperature averages 51 degrees Fahrenheit (°F) annually, ranging from a low monthly average of 32°F in February to a high monthly average of 72°F in July. The average annual precipitation ranges from 40 to 45 inches and is fairly evenly distributed throughout the year.

Tides. The mean tide range along the south coast of Rhode Island is estimated at 2.53 feet and the mean spring tide range is estimated at 3.13 feet. Tide ranges in the coastal ponds vary and are not as extreme as the open ocean tides. This is due to the constriction of the pond inlets. Tide information for the ocean and an example coastal pond are shown in Table 1.

Table 1. Estimated Tidal Datum's for the Study Area

	Ocean	Winnapaug Pond, Westerly
Condition	Elevation (feet, NAVD88*)	Elevation (feet, NAVD88)
Mean spring high water	+1.46	+1.10
Mean higher high water	+1.13	+0.82
Mean high water	+0.92	+0.69
NAVD88	0.00	0.00
Mean tide level	-0.35	-0.05
Mean low water	-1.61	-1.08
Mean lower low water	-1.74	-1.16
Mean spring low water	-1.94	-1.28

*North American Vertical Datum of 1988 (NAVD88)

<u>Historical Storms</u>. Two types of storms of primary significance along the south shore of Rhode Island are tropical storms (hurricanes), which typically impact the Rhode Island area in summer and fall and extratropical storms (nor'easters), which occur predominantly between November and March but can also occur during other times of the year. Nor'easters are usually less intense than hurricanes but tend to have much longer durations. These storms often cause high water levels and intense wave conditions and are responsible for significant erosion and flooding throughout the coastal region. Table 2 lists historic storms that have impacted the study area.

Table 2. Historic Storms Impacting Rhode Island

Disaster Number	Date	Incident Description	Declaration Type
4212	04/03/2015	Severe Winter Storm	Major Disaster
4107	3/22/2013	Severe Winter Storm	Major Disaster
4089	11/3/2012	Hurricane Sandy	Major Disaster
3355	10/29/2012	Hurricane Sandy	Emergency
4027	9/3/2011	Tropical Storm Irene	Major Disaster
3334	8/27/2011	Hurricane Irene	Emergency

3311	3/30/2010	Severe Storms and Flooding	Emergency
1894	3/29/2010	Severe Storms and Flooding	Major Disaster
1704	5/25/2007	Severe Storms and Flooding	Major Disaster
3255	9/19/2005	Hurricane Katrina Evacuation	Emergency
3203	2/17/2005	Snow	Emergency
3182	3/27/2003	Snowstorm	Emergency
1091	1/24/1996	Blizzard	Major Disaster
3102	3/16/1993	Blizzard	Emergency
913	8/26/1991	Hurricane Bob	Major Disaster
748	10/15/1985	Hurricane Gloria	Major Disaster
548	2/16/1978	Snow, Ice	Major Disaster
3058	2/7/1978	Blizzards and Snowstorms	Emergency
39	8/20/1955	Hurricane Diane, Flood	Major Disaster
23	9/2/1954 9/21/1938	Hurricane Carol Hurricane	Major Disaster Major Disaster

2.0 http://www.fema.gov/disasters/grid/state-tribal-government/34

Coastal Storm Climatology. Existing coastal processes in the Pawcatuck area are driven by high energy waves and water levels generated by both tropical and extratropical storms. Based on data developed for the NACCS (NACCS[1], USACE 2015), significant tropical storm events impacted the Pawcatuck area at a frequency of approximately once every 5.75 years. These tropical storms occur between June and November with 74 percent of the storms occurring in the months of August and September.

Extratropical storms, on the other hand, are a frequently occurring storm type that impacts the study area annually with significant events occurring at a rate of approximately one storm per year. Extratropical storms typically occur at the project area between early fall through the

[1] The North Atlantic Coast Comprehensive Study (NACCS) addresses the coastal areas defined by the extent of Hurricane Sandy's storm surge in the District of Columbia and the States of New Hampshire, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, Pennsylvania, Delaware, Maryland, and Virginia. The Engineer Research and Development Center (ERDC) conducted rigorous regional statistical analysis and detailed high-fidelity numerical hydrodynamic modeling for the North Atlantic coastal region to quantify coastal storm wave, wind, and storm-driven water level extremes. The NACCS modeling efforts included the latest atmospheric, wave, and storm surge modeling and extremal statistical analysis techniques. Products from this work incorporated into the Coastal Hazards System (CHS) database include simulated winds, waves, and water levels for approximately 1,050 synthetic tropical events and 100 extratropical events computed at over 3 million computational locations. A smaller number -18,000 locations -save the same information at higher frequency for more convenient/concise data handling. These storm events are determined to span the range of practical storm probabilities.

spring (October through May) with most occurring in the months of November through February.

Tropical storm events are typically fast moving storms associated with elevated water levels and large waves whereas extratropical storms are slower moving with comparatively lower water level elevations and large wave conditions. Both storm types can produce beach erosion and morphology change, as well as coastal inundation, leading to economic losses to property within the study area.

Relative Sea Level Change (RSLC). The mean sea level trend at New London, CT (NOAA 8461490) is 0.00738 feet/year NAVD88 based on regionally corrected mean sea level data over 69 years (see Figure 4). This gauge was selected to represent the project site since it was the closest long term gauge to the project location. Mean sea level at New London was last published in 1992. Given the historic mean sea level change rate above, RSLC from 1992 to present is 0.2 ft. In addition to the historic rate, USACE calculated intermediate and high rates of RSLC of 0.017 and 0.047 ft/year, respectively. Over the next 50 years this equates to additional increases in sea level of about 0.4 ft for the low, 0.8 ft for the medium, and about 2.3 ft, for the high rate (or 0.6 ft, 1.0 ft, and 2.5 ft relative to published sea level).

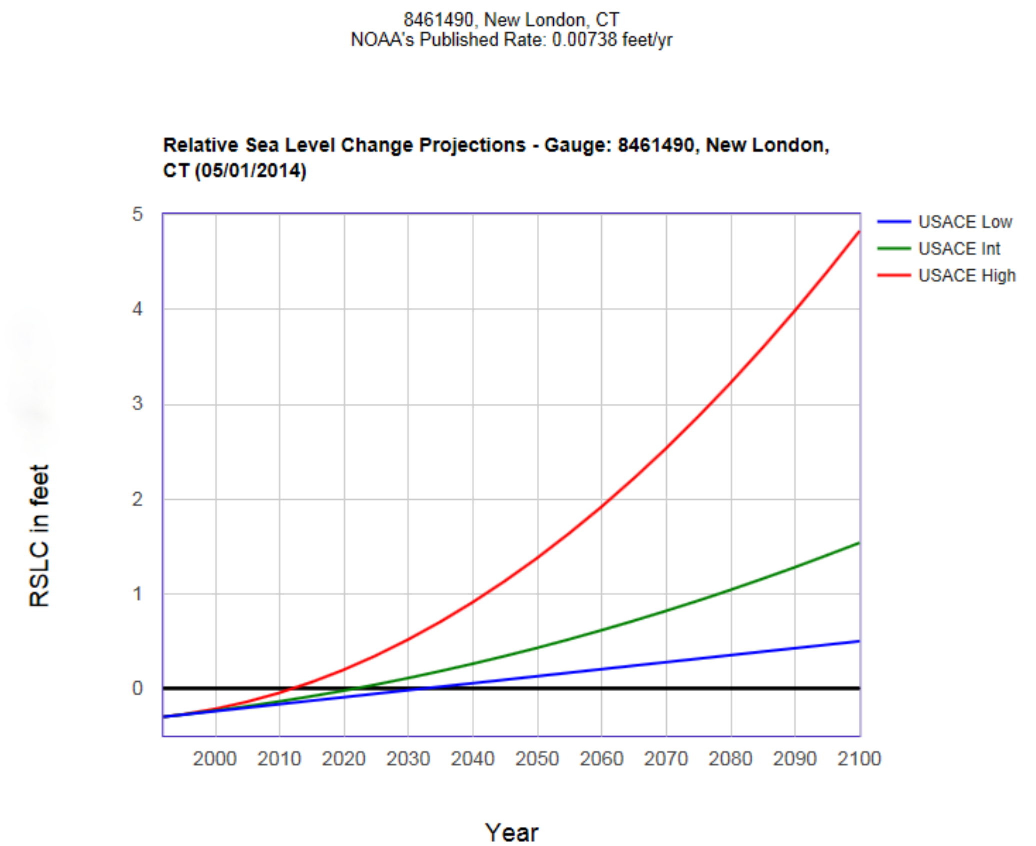


Figure 4. Mean Sea Level Change Trend

<u>Beach Erosion</u>. Coastal erosion is a shore process that reduces the width of the beach. These processes include long-shore and cross-shore sediment transport resulting from both typical and storm induced wave conditions. In some cases, the storm-induced erosion component of beach change, although devastating to development, may be short-term in nature. Following storms, the coastline tends to reshape itself into its former configuration, and some of the sand displaced from the beach is returned by wave action. The beach shape then conforms to the prevailing wave climate and littoral processes. However, over time, portions of the beach can experience permanent land loss. In developed areas, bulkheads and revetments will help to limit landward erosion but these structures may fail due to toe erosion and wave overtopping.

In addition to physical damage to structures due to coastal events, shoreline erosion in the study area has resulted in the loss of state, town and private property over time. Analyzing erosion rates (1939-2004) provided by the RICRMC, it is apparent that erosion is a greater problem in the Charlestown (~1.5 feet/year) and Matunuck area of South Kingstown (~1.5 feet to as much as +5 feet/year) and less of a concern in the other areas (< 1-foot/year). Erosion rates appear to be increasing over the last couple of decades as opposed to earlier in the period of record.

FEMA Floodplain. The most recent (2014) Flood Insurance Study (FIS) and associated mapping for Washington County Rhode Island was consulted during the study. That information was particularly useful for determining stage-frequency data for the evaluation of alternatives affecting the backshore study area as it includes wave effects. Development of this stage-frequency data can be found in Appendix C and a summary can be found in Table 3 below. The PDT also used the NACCS study (2015) generated stage-frequency curves at save point stations in the nearshore of the Pawcatuck study area. This data was found to be the best water level data for evaluating structural measures along the shore even though it does not include full wave effects. This was not an issue as the model used to evaluate structural measures, Beach-fx, develops its own storm induced water levels. Stage frequency information for five save stations in the near shore of Westerly (around 1500 feet off shore) were used and are summarized in Figure 5.

Table 3. Stage-Frequency Data used for Evaluations in the Backshore Area (feet, NAVD88)

Return Period	VE 14	VE 15	VE 16	VE 17	AE 11	AE 12	AE 13	AE 14
2	7	7	7	8	5	5	5	5
10	8	9	9	10	5	6	7	8
25	10	11	12	13	6.5	7.5	8.5	9.5
50	12	13	14	14.5	8.5	9.5	10.5	11.5
75	13.3	14.3	15.3	16	10	11	12	13
100	14	15	16	17	11	12	13	14
250	16	17	18	19	13	14	15	16
500	18	19	20	21	14	15	16	17

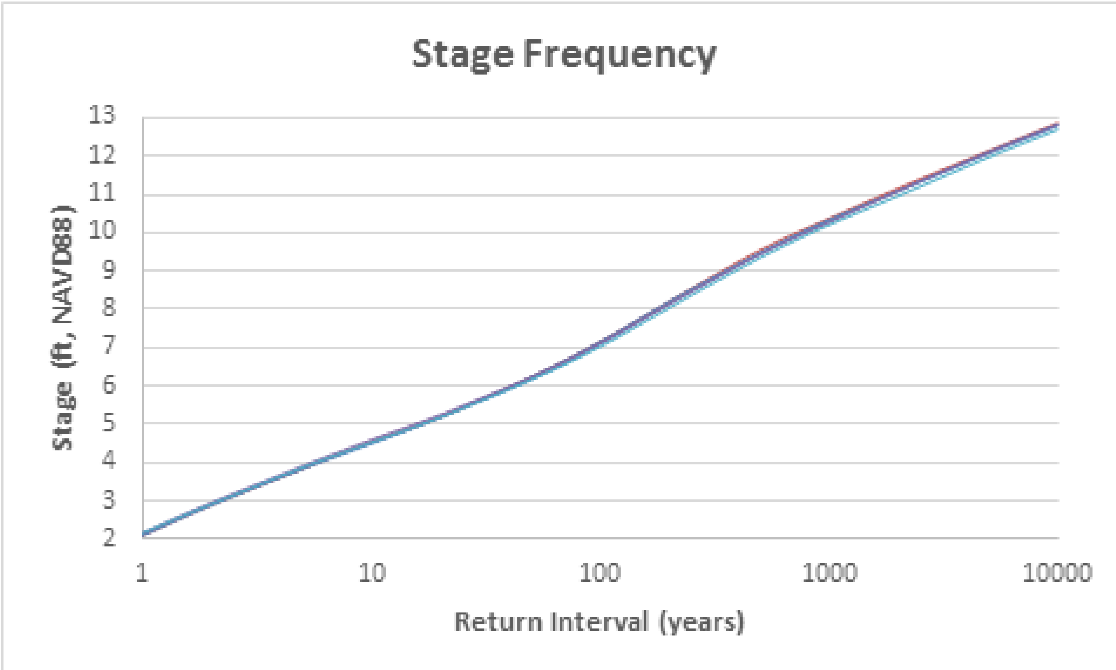


Figure 5. Stage-Frequency Curve used for Structural Evaluations along the Shore

2.2 Existing Coastal Structures

USACE conducted field visits of the study area in April 2014 and August 2015 to visually inspect existing coastal storm risk management structures along the shoreline. During the field visits, the existing structures were inventoried to determine the location, size, type, and qualitative condition. Exposed areas were also noted and erosion conditions in these areas were documented. The data collected was used in conjunction with the elevation survey data collected by the USACE survey team to document existing conditions for use with coastal and economic models.

The primary method of reducing risk against erosion for the residential and commercial properties are stone revetments installed by individual owners to protect their properties. These revetments were noted in the Westerly and Matunuck area of South Kingstown, only. Overall, the revetments appear to be in good condition in Westerly (most likely due to post-Sandy repair work) and good to fair in the Matunuck area (some more recently completed; some older, smaller sized stone designs). In most cases, the revetments are contiguous with adjacent revetments to provide a continuous risk reducing measure against erosion. The rock revetments are located along approximately 23% of the beach front properties within the Westerly study area and 31% in the Matunuck study area.

The only other protective measures observed were numerous sand fencing arrangements in all the damage reaches. Erosion appears to be more of a factor in the Charlestown and Matunuck areas though the Charlestown beach front appears to recover more naturally over time than Matunuck.

The only groins observed in the study area were the ones in the Sand Hill Cove area. These groins are afforded a fair amount of protection from the Point Judith Breakwater and are in fair condition. The Point Judith Breakwater, constructed between the late 1800's and the early part of the 20th century, is in good to poor condition. The east arm of the breakwater, damaged as a result of Hurricane Sandy, was recently repaired.

2.3 Critical Infrastructure

Rhode Island has a well maintained transportation system that provides the means for reliable evacuation ahead of large coastal events. Recent hurricane transportation analyses conducted by FEMA and the USACE (FEMA, 2016) illustrate that fact. As can be seen in Figure 6 below, the floodplain is relatively narrow along the south coast of Rhode Island and there are multiple feeder roads and well-marked evacuation routes leading away from the coast to service an evacuation. This, combined with better warning times, and the lack of other critical infrastructure (e.g. fire, police, hospitals, schools, shelters, etc.) located in the floodplain, ensure that critical infrastructure are not a primary concern in the study area.

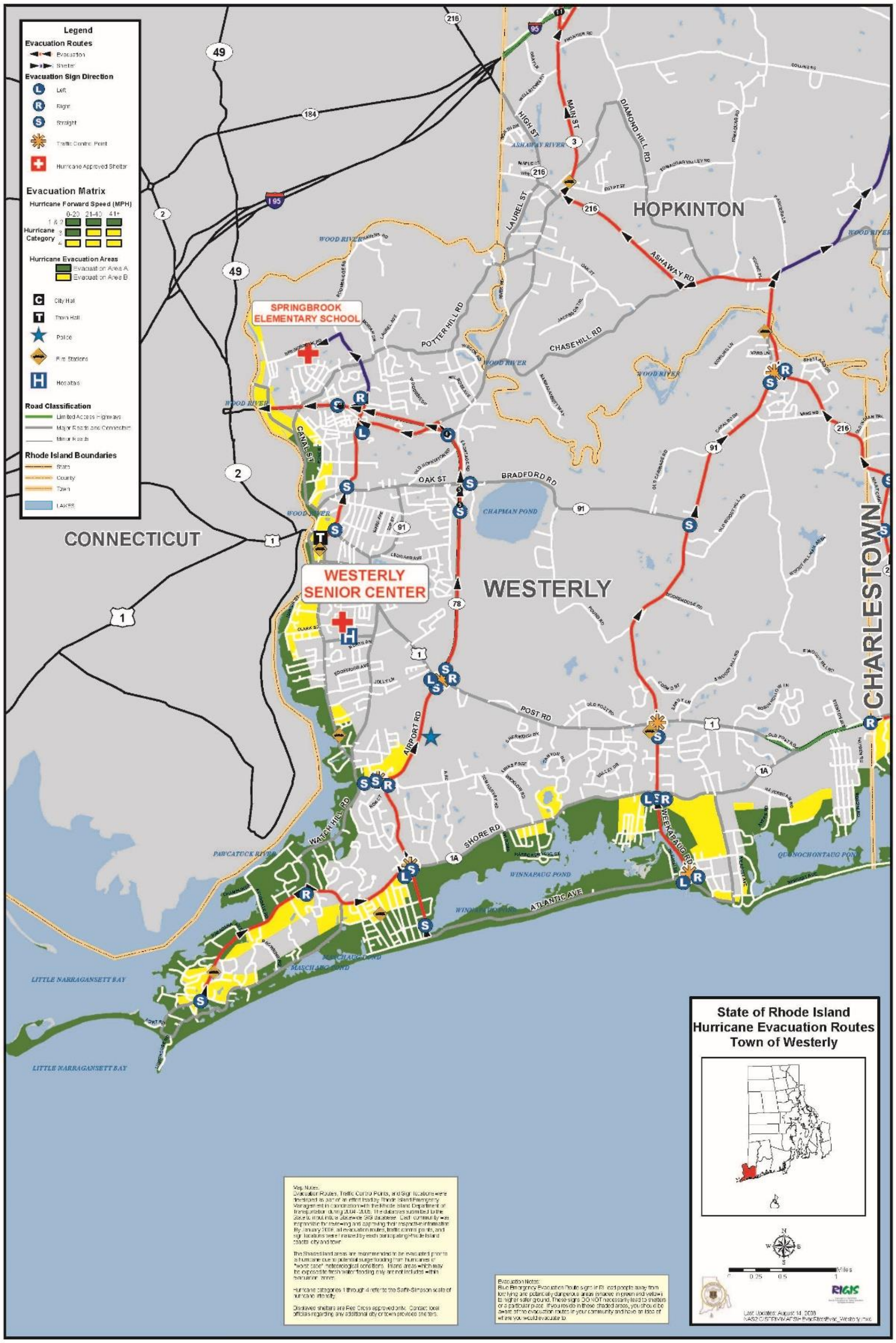


Figure 6. Evacuation Routes, Zones and Critical Infrastructure, Westerly, RI

Chapter 3: Existing Conditions Affected Environment*

This description of the existing environment conditions is in accordance with the requirements of National Environmental Policy Act (NEPA), and serves as the baseline for Chapter 5: Environmental Impacts and Chapter 6: Cumulative Impacts of this final integrated report.

3.1 Topography, Geology, and Soils

The study area is located along the southern portion of Rhode Island from Watch Hill in the town of Westerly to Point Judith in the town of Narragansett. The area includes approximately 28 miles of coast and many of Rhode Island's salt water ponds. The physiography of the area was shaped by glaciation during the Pleistocene epoch, which began 2.5 to 3 million years ago; final deposition of material occurred during the Wisconsin glaciation 10,000-20,000 years ago. The geology of the area is characterized by bedrock overlain by thick deposits of glacial till and postglacial deposits and outwash plains (USDA 1981).

Underlying bedrock in the study area is predominantly Narragansett Pier granite and other granitic rock units (Hermes *et al.* 1994 in Masterson *et al.* 2007). As the glacier receded, a thick layer of unsorted glacial till was deposited and meltwater-sorted deposits of sand, gravel and silt formed kames, eskers, terraces, and outwash plains in the landscape. Barrier beach, tidal-delta sands and lagoonal fine-grained sediments overlie coarser glacial deposits in the salt pond areas. The westerly flow pattern of the Pawcatuck River, which drains a large portion of the study area and flows into the Atlantic Ocean in the town of Westerly, is guided by the Charlestown Moraine. The Charlestown Moraine is a large irregular linear ridge of glacial drift which runs from west of Point Judith to Watch Hill (Masterson *et al.* 2007). The south shore of Rhode Island has also been shaped by the action of waves and longshore currents.

The project area soils are primarily glacially derived. In the lowlands and adjacent to bays, the soil base is sedimentary. Along the west side of Narragansett Bay and in river valleys, glacial outwashes of sand and gravel are rapidly drained. Soil types located along the shoreline in the five focus areas include sandy and cobbly surfaces labeled as beaches and areas of dunes (eolian deposits) such as Hooksan sand. Outwash plain soils are also common in the project area such as Agawam fine sandy loams (0-8% slope classified as prime farmland soil), Bridgehampton silt loam (0-3% slope classified as prime farmland soil and 3-8% slope classified as farmland of statewide importance) and Enfield silt loam (0-3% slope classified as prime farmland soil and 3-8% slope classified as farmland of statewide importance). Soils found on hills and convex landform soils include Canton and Charlton fine sandy loam (0-8% slope is a prime farmland soil; 8 to 15% slope is a farmland of statewide importance). Areas which have high density development are classified as an Urban complex singularly or in association with varying soil series such as Hooksan-Urban Land complex. Poorly drained and wetland soils commonly found in the project area include Stissing silt loam, Mansfield mucky silt loam, Matunuck mucky peat, Freetown muck, and Sandyhook mucky fine sand (USACE 2014).

As previously stated, of the five high damage areas within the south coastal study area, the Misquamicut area in Westerly (Little Maschaug Pond to Weekapaug Breachway) was the only area in which structural measures could likely have been built. Misquamicut Beach is a barrier beach composed of fine to medium grained sand with some areas containing pebbles. Littoral drift carries sand from the Pawtucket River/Watch Hill area west along the shore to the east. Some of this sand is deposited along Misquamicut Beach (USACE 2014). There is a residential area in the back shore area that is bordered by Winnapaug Pond to the east and Little Maschaug Pond to the west.

Within the Westerly area, topography rises from sea level along the beaches to the town‘s highest elevation, Mt. Moriah, at 249 feet above sea level, in the northwestern corner of the town. On the west side of the town, the elevation of downtown Westerly rises from approximately 10 feet along the river to 150 feet near Westerly High School. At the center of the town is a large wetland complex, including the Crandall Swamp and Chapman Pond, which are between 30-40 feet above sea level. Woody Hill, in the east-central part of town, rises to 200 feet above sea level (Town of Westerly 2009).

Soils in the Westerly area consists of predominantly Hooksan-Urban Land complex, Succotash-Urban Land complex, Merrimack-Urban Land complex and urban land (0-3 percent slope, sandy substratum) in the residential and state beach development area; and beaches (sandy surface) and Hooksan sand (3-8 percent slope) along Misquamicut Beach. The topography in the Westerly area is stable and is not expected to change in the future.

Surveys to document the grain size of the Misquamicut Beach project area were conducted on September 25, 2015. The grain size data showed that the sediments in the high-, mid-, and low-intertidal areas were predominately a mix of fine sands and medium sands. The low-intertidal areas also had minor fractions of coarse sands and gravel. The June 2016 Sediment Sampling and Benthic Community Analysis for Misquamicut Beach, Westerly, Rhode Island is included in Appendix A1.

The Federal Farmland Protection Policy Act (FPPA) of 1981 was enacted to minimize the extent to which federal programs contribute to the irreversible conversion of farmland to nonagricultural uses. The Act applies to farmland with soil types classified as prime, unique, or of statewide or local importance. Prime farmland soils are those that have the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and are also available for these uses. Soils designated as having statewide importance, are also important for the production of food, feed, fiber, forage, and oil seed crops. Soils designated as Prime farmland and Farmland of Statewide Importance are located throughout the five focus areas. Within the Westerly project area (Area 1), Merrimac fine sandy loam (0 to 3% slope), which is designated as a prime farmland soil and Deerfield loamy fine sand, which is designated as a soil of statewide importance, are located adjacent to the eastern border of the Misquamicut residential development (USDA 1981).

The sediment deposition, coastal transport process and sediment sampling in the Westerly off-shore area is discussed in Section 3.2.3 Coastal Processes.

3.2 Water Resources

3.2.1 Regional Hydrogeology and Groundwater Resources

The study area is located south of the Pawcatuck Basin Aquifer System which was designated as a sole source aquifer of drinking water for the residents of that area by the U.S. Environmental Protection Agency (USEPA) on 13 May 1988 (53 FR 17108). This sole source designation establishes that there are no viable alternative sources of sufficient supply, and if contamination were to occur, it would pose a significant public health hazard and a serious financial burden to the area's residents. The aquifer consists of extensive deposits of stratified drift generally located in the lowland areas of the basin. The recharge areas or highland portions of the basin consist of stratified drift and till deposits. Bedrock outcrops can also be found in these highland areas (USEPA 1988).

A more detailed analysis of existing conditions was conducted for Westerly due to the potential for structural measures. The primary source of water supply for the Town of Westerly comes from eleven (11) gravel-packed and gravel-developed wells located at seven well fields within the Pawcatuck River Aquifer Region. The majority of the water comes from the Westerly and Bradford sand and gravel groundwater reservoirs (or aquifers), all of which are located in the Lower Pawcatuck sub-basin (which is part of the USEPA 1988 designated sole-source aquifer). The Bradford reservoir and the majority of the Westerly reservoir are classified as GAA groundwater sources, and are thus suitable for public drinking water use without treatment. The remaining portion of the Westerly reservoir is classified as GB which defines it as a source which may not be suitable for public or private drinking without treatment (Town of Westerly 2014a). The total system production capability is 7.43 million gallons per day. Sampling conducted to determine the presence of any radioactive, biological, inorganic, volatile organic, or synthetic organic contaminants indicate the quality of the ground water is excellent with no regulatory violations (Town of Westerly 2014b). The area likely proposed for structural measures in Westerly is located south of the USEPA designated sole-source aquifer.

3.2.2 Surface Water

The headwaters of the Pawcatuck River are located in Wordens Pond in South Kingstown. The river flows generally in a southwesterly direction, meandering through open and sparsely settled country, swamps, ponds and lakes for approximately 33 miles where it discharges into Little Narragansett Bay at the Rhode Island-Connecticut state line. The Usquepaug, Wood, and Ashaway rivers are the major tributaries of the Pawcatuck (RIDEM 2011).

Portions of the Pawcatuck River have been designated as impaired by the Rhode Island Department of Environmental Management (RIDEM) due to exceedances in water quality standards. The Upper Pawcatuck (from Bradford Dye to the Bridge at Route 3) and the Lower Pawcatuck (tidal) are listed as impaired due to high bacteria, elevated lead and nitrate concentrations, heavy metal pollutants and low dissolved oxygen. No shell fishing is allow in the tidal portion of the Pawcatuck River (RIDEM 1996). There are several potential sources of bacteria in the Pawcatuck River watershed including malfunctioning onsite wastewater treatment systems, agricultural activities, waterfowl and wildlife waste, and storm water runoff from developed areas. The water quality goal is for all waterbodies to comply with state water quality standards (RIDEM 2011).

The Pawcatuck River is designated as a Class B fresh water stream, and its applicable designated uses are primary and secondary contact recreation and fish and wildlife habitat (see Table 4 for water quality criterion). The freshwater portion of the Pawcatuck River has both a warm and cold water fisheries designation depending on segment location. Freshwater rivers and streams, and lakes and ponds are designated cold water, warm water or unassessed based upon the potential for the presence of brook trout. The tidal portion of the Pawcatuck River in Westerly, from the Route 1 Bridge to Little Narragansett Bay, is designated as Class SB saltwater stream and its applicable designated uses are primary and secondary contact recreation, shellfish harvesting for controlled relay and depuration and fish and wildlife habitat. The waters of Block Island Sound along the south facing coast of the Rhode Island are rated SA. This is the highest saltwater quality level and is considered to have good aesthetic, wildlife, and recreational value (RIDEM 2009).

There are two salt water ponds located in Westerly; Winnapaug Pond to the east and Little Maschaug Pond to the west. The 476 acre Winnapaug Pond is open to Block Island Sound by a rock-lined channel and jetties referred to as the Weekapaug Breachway. Winnapaug Pond is relatively shallow with expansive sandy shoals along the southern shore. The water quality of the pond was assessed as “good” in 2014 with no impairments noted (USEPA 2014a). Winnapaug Pond is designated as a Class SA saltwater (RIDEM 2009). In a cooperative effort between federal, state and local agencies, a dredging project to remove 70,000 cubic yards of sediment from the pond to restore eelgrass habitat and improve flushing has been proposed (USACE 2002).

Little Maschaug Pond is a small, brackish pond approximately 12 acres in size. It is bordered by the Misquamicut residential area to the east, a golf course to the west and the barrier beach to the south which separates Little Maschaug Pond from Block Island Sound. The water quality of the pond was assessed as “good” in 2014 with no impairments noted (USEPA 2014b). Water quality is designated as Class A in Little Maschaug Pond by the RIDEM (RIDEM 2009). Although Little Maschaug Pond is designated as Class A fresh water, there is no fisheries designation.

Table 4. State of Rhode Island Class-Specific Criteria*				
	Fresh Water		Sea Water	
	Class A	***Class B***	***Class SA***	***Class SB***
Dissolved Oxygen (DO)	DO not less than 75% saturation (daily average); minimum DO 5 mg/l for cold water fisheries and DO not less than 60% saturation (daily average); minimum DO 5.0 mg/l.	Same as Class A	Above a seasonal pycnocline, not less than a 4.8 mg/l more than once every three years. Below the seasonal pycnocline, conditions for Aquatic Life Uses do not fail to meet protective thresholds, more than once every three years.	Same as Class SA
Sludge deposits, solid refuse, floating solids, oil, grease, scum	None allowed	None allowed	None allowed	None allowed
Color and turbidity.	None in such concentrations that would impair any usages specifically assigned to class. Turbidity not to exceed 5 NTU over background.	None in such concentrations that would impair any usages specifically assigned to class. Turbidity not to exceed 10 NTU over natural background.	None in such concentrations that would impair any usages specifically assigned to class. Turbidity not to exceed 5 NTU over background.	None in such concentrations that would impair any usages specifically assigned to class. Turbidity not to exceed 10 NTU over background.
Fecal Coliform Bacteria (MPN/100ml)	Not to exceed a geometric mean value of 200 MPN/100 ml and not more than 10% of the total samples taken shall exceed 400 MPN/100 ml	Same as Class A	Not to exceed a geometric mean value of 50 MPN/100 ml and not more than 10% of the total samples taken shall exceed 400 MPN/100 ml	Same as Class SA
Enterococci	Non-Designated Bathing Beach Waters Geometric Mean Density(GMD): 54 colonies/100 ml Designated Bathing Beach Waters GMD: 33 colonies/100 ml Single Sample Maximum*****: 61 colonies/100 ml	Same as Class A	Geometric Mean Density: 35 colonies/100 ml Single Sample Maximum*****: 104/100 ml	Same as Class SA
Taste and odor	None other than of natural origin	Same as Class A	None allowable except as naturally occurs.	None in such concentrations that would impair any usages specifically assigned to this class
pH (Standard Units)	6.5 - 9.0 or as naturally occurs.	Same as Class A	6.5 - 8.5 but not more than 0.2 units outside of the normally occurring range.	Same as Class SA
Temperature/ Temperature increase	No activity shall raise temperature of the receiving waters above the recommended limit.	Same as Class A	No activities shall increase temperature except where the increase will not exceed the recommended limit.	Same as Class SA
Chemical constituents	a. None in concentrations harmful to humans or fish and wildlife. b. Ambient concentration of a pollutant not to exceed the Ambient Water Quality Criteria and Guidelines,	Same as Class A	a. None in concentrations or combinations that could be harmful to humans or fish and wildlife b. Ambient concentration of a pollutant shall not exceed the RI DEM Ambient Water Quality Criteria & Guidelines.	Same as Class SA
Nutrients	a. Average Total Phosphorus shall not exceed 0.025 mg/l b. None in such concentration that would impair any usages specifically assigned to said Class	Same as Class A	None in such concentration that would impair any usages specifically assigned to said Class.	Same as Class SA

* Criterion abridged from State of Rhode Island Department of Environmental Management Water Quality Regulations - July 2006 Amended December 2009

3.2.3 Coastal Processes

Three primary factors shape coastal zone morphology: ocean factors, beach characteristics, and other natural physical variables. Ocean factors include waves, tidal variations, storm surges, and sea level change. Beach characteristics include beach sediment volume, composition, and grain size. Other natural variables include rainfall runoff, groundwater flow, pore pressures, and existing vegetative cover (Komar 1998 in USACE 2015). All three factors interact in a dynamic process, which defines the coastal zone area.

Erosion and the high energy coastal environment is evident throughout the project area in the form of narrowing beaches or cobbly substrates such as the eastern portion of the Matunuck area of South Kingstown. Anthropogenic influences also play a significant role in shaping the coastal zone. As shorelines retreat due to longshore currents, wave and tidal action, and storm events, artificial structures are often constructed to slow down or minimize further erosion. These structures typically modify the coastal zone to increase sediment retention within heavily utilized or populated areas (USACE 2000 in USACE 2015). There are rock revetments and groins scattered throughout the study area. Within Westerly, the 476 acre Winnapaug Pond is open to Block Island Sound by the Weekapaug Breachway, a rock-line channel and jetties.

A beach sand renourishment project (P.L. 84-99) was completed at Misquamicut Beach in Westerly by the U.S. Army Corps of Engineers in 2015 using an upland sand source. As part of the evaluation of that project, the area from Watch Hill to the Weekapaug Breachway was studied by Boothroyd *et al*. (2009) to identify a nearshore dredge material placement site that could have the potential to nourish Misquamicut Beach (as an alternative to placing sand on the beach and grading). Results showed there is a depositional platform sand sheet of fine to very fine sand which extends approximately 300 to 600 feet from the shoreline. Along the eastern and western ends of the study area the depositional platform is significantly wider (Weekapaug Breachway, 2100 feet wide; Watch Hill point 1000 feet wide). Except for the extreme end of the study area, the offshore extent of the platform corresponds to a water depth of approximately 18 feet (Boothroyd *et al*., 2009 in USACE 2014). Sediment transport on the depositional platform is controlled by wave orbital motion that transports sediment onshore and combined flows that transport sediment offshore. Transport of sediment on the sand sheet occurs at least 90 days per year during periods of post-storm recovery through long-term depositional stages, and 30 of those days can be attributed to a southwest sea breeze generated waves (Boothroyd *et al*., 2009 in USACE 2014). Offshore migration of sand across the shore face is dominated by storm-generated combined flows; this is thought to occur 2-6 days per year independent of extreme extra-tropical cyclone or hurricane events. Longshore transport is predominantly to the east (Boothroyd *et al*., 2009 in USACE 2014).

As part of the planning for the 2015 Misquamicut Beach nourishment project, USACE investigated several nourishment alternatives, including the placement of dredged material from other federal projects in the nearshore with the expectation that it will be deposited on the beach; hydraulically dredging sand from shoaled areas within Winnapaug Pond and pumping it directly onto the beach; and mining sand from an offshore borrow site and pumping it directly from a scow or hopper onto the beach. None of these alternatives were determined to be effective or feasible to construct the Misquamicut beach berm/dune system. An upland sand source was used to complete the 2015 project.

Structural measures were considered along the shoreline of Westerly, including beach nourishment at Misquamicut Beach. As such, the USACE sought additional information regarding the potential to use an off shore sand source since there are no offshore borrow areas currently permitted by the State in this region of Block Island Sound. In August of 2015, the USACE, surveyed the spatial extent and depth of sand off of Misquamicut Beach to determine if a sufficient quantity of sand is available in the nearshore area. The survey area was located outside of the influence of littoral processes, which naturally nourish the beach, but at a depth that would facilitate a cost effective dredging operation. Survey methods undertaken to meet the established objectives included side scan sonar, sub-bottom profiling, and underwater video surveys (USACE 2015b).

Based upon the survey results, the 2 mi^2 (3.2 km^2) off-shore site was classified into four bottom types based on side scan sonar acoustic backscatter properties. The first bottom type consists of coarse to medium sand with scattered shell fragments and fine gravel transitioning to clean sand with distance from the shoreline. Isolated pockets of fine sand are present in this area. This area represents approximately 78%, or 1.5 mi^2 (3.8 km^2) of the overall survey area (USACE 2015b). The second bottom type generally consists of fine sand and silt with small scale relief features. This bottom type is present in the northwest portion of the survey area and appears in a deltaic pattern, interspersed with braided fingers of coarser sand and gravel extending perpendicular from the shoreline. This area includes approximately 0.1 mi^2 (0.3 km^2) of the overall survey area. The third bottom type is a coarse substrate consisting of cobble, gravel, and sand with numerous small to medium sized boulders. This bottom type includes an area just under 0.19 mi^2 (0.5 km^2) that generally corresponds with the shallower areas. The fourth bottom type consists of dense macroalgae beds over sand or rocky substrate. This bottom type covers just under 0.1 mi^2 (0.3 km^2) and occurs in several shallower areas in the northern portion of the survey area (USACE 2015b).

A sub-bottom profiler transmits low frequency acoustic energy which is able to penetrate the sea floor and reflect off sub-surface sediment layers. Sub-bottom profiles collected in the study area (see Figure 7) suggest that the offshore deposits of sandy material occur in lenses that generally extend 1 to 3 meters (3-9 feet) below the surface before another strong acoustic reflector is encountered (representing a change in sediment type/density). In some of the areas where the surficial material was classified as sand the acoustic signal exhibited poor penetration or an obscured return at depth. This is typical of coarse sands and gravel, but without accompanying sediment cores it is not possible to determine the sediment type or thickness below the surface.

3.3 Vegetation

3.3.1 Upland

The majority of the State of Rhode Island is forested (61.1%). The state is divided into two geographic regions, the Eastern New England Upland in the northwest west, and the Coastal Lowland in the south and east. The Eastern New England Upland is characterized by forested rolling hills; the highest point is Jerimoth Hill, 812 feet above sea level, near North Foster. The five focus areas evaluated as part of this study are located in the Coastal Lowlands Region which is characterized by low, rounded slopes with fewer trees, sandy beaches and salt ponds. The elevation in this region ranges from 200 feet to sea level (Rhode Island 2016).

Misquamicut Beach is a barrier beach affronting a large estuarine pond (Winnapaug Pond). Dunes created by windblown sand on the beach were largest at the east end of the beach before Hurricane Sandy (USACE 1994). The dunes were damaged by Hurricane Sandy and recreated by bulldozed sand; much of the dunes are currently vegetated by crabgrass (*Digitaria sanguinalis*). The back sides of the dunes are vegetated with dune plants on the east and west ends of the beach and the front sides are sparsely vegetated (most of it being crabgrass) or bare. The dune vegetation along the back side of a few of the dunes consists of American beach grass (*Ammophila breviligulata*), beach rose (*Rosa rugosa*), beach pea (*Lathyrus* sp.), seaside goldenrod (*Solidago semperviens*), golden hedge-hyssop (*Gratiola aurea*), and other species.

Upland vegetation within the residential portion of the area is limited to maintained areas characterized by lawns, landscaping shrubs and trees.

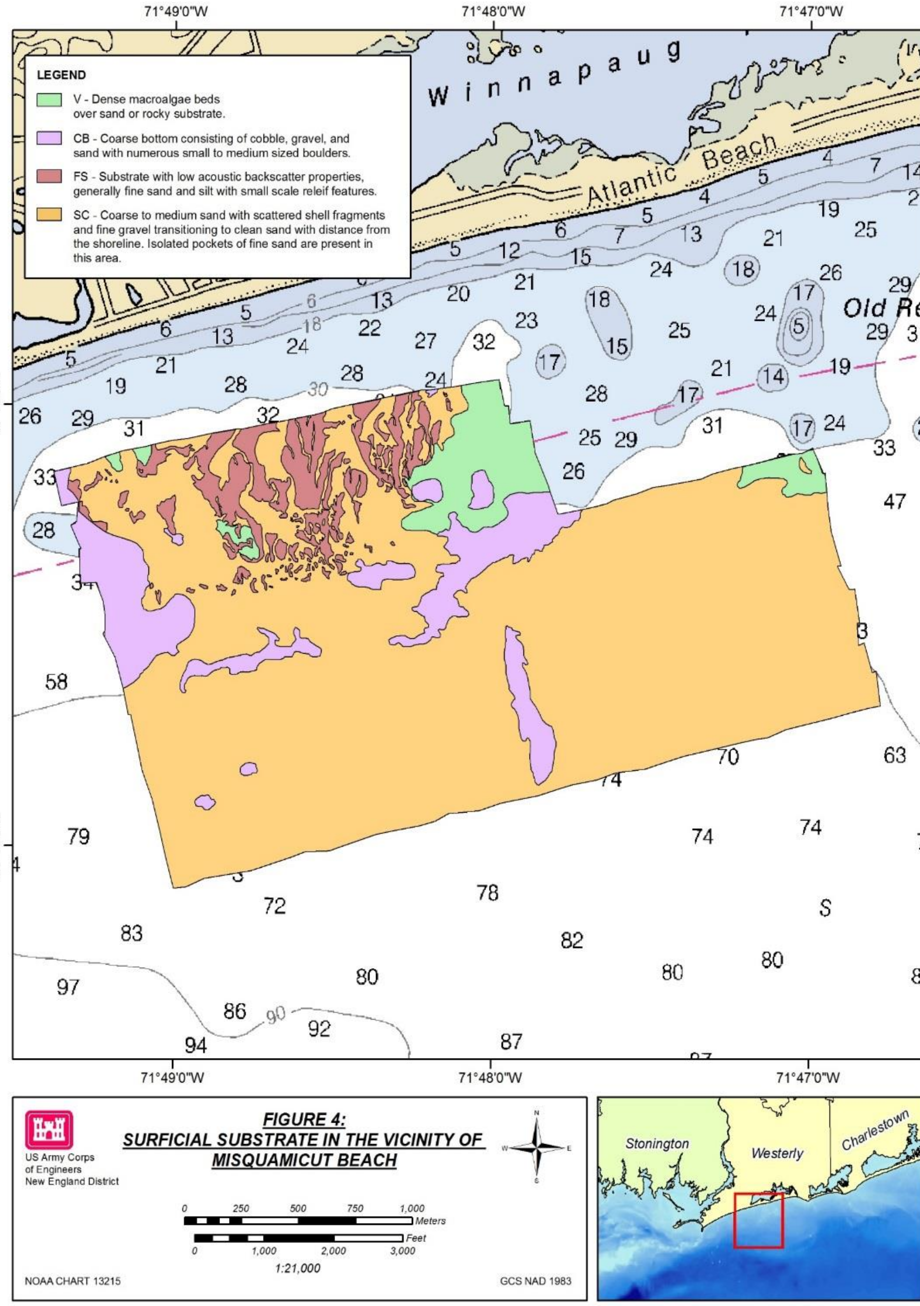


Figure 7. Surficial Substrate in the Vicinity of Misquamicut Beach

3.3.2 Wetland

The study area is located within the Special Ponds Region of Rhode Island which forms the southwestern boundary of the Atlantic Ocean from Watch Hill to Point Judith. There are many brackish coastal lagoons separated from the ocean by a low narrow strip of land within this stretch of the coastline. The nine salt ponds, from west to east include Maschaug, Winnapaug, Quonochontaug, Ninigret, Green Hill, Trustom, Cards, Potter, and Point Judith (Salt Pond Coalition 2016).

Of the nine salt ponds in the Special Ponds Region, Winnapaug Pond, is the only one located in the vicinity of potential structural measures (e.g., beach nourishment, tide gate) proposed for construction in the Westerly project area. Winnapaug Pond is approximately 470 acres in size and is bordered by a major state beach (Misquamicut) on the western end of the barrier beach where there is a concentration of commercial properties (e.g., hotels, restaurants, etc.) and dense residential development. On the eastern end of the barrier beach, Winnapaug Pond is connected to the ocean by the Weekapaug Breachway, a rock lined channel. Farmland and golf courses are located along the northern shore. The gradual conversion of open space to housing developments and condominium clusters is indicative of the developmental pressures in the area (Salt Pond Coalition 2016).

Winnapaug Pond has a small watershed and very little fresh water input from stream flow. There is a high volume of tidal flushing and extensive shoaling from sand being carried into the pond on the flood tide and sand being swept over the barrier beach during past storm events. The pond is shallow but due to the high flushing, water quality remains good, finfish populations appear to be healthy and there are abundant shellfish resources in the shoals (Salt Pond Coalition 2016).

A smaller brackish pond, Little Maschaug Pond, is located at the western end of the barrier beach in Westerly. This pond is approximately 12 acres in size and is non-tidal; salt water enters the pond through overwash or salt spray resulting in low salinity (approximately 7 parts per thousand). Little Maschaug Pond is bordered on the east by dense residential development and to the north by a golf course (Salt Pond Coalition 2016).

U.S. Fish and Wildlife Service (USFWS) National Wetland Inventory maps show the diversity of wetland types within the coastal ponds region. Wetland classification is based upon the Classification of Wetlands and Deepwater Habitats (Cowardin *et al.* 1979) which divides wetlands into systems, subsystems, classes and subclasses with modifiers for water regime. All five wetland systems; Marine (saltwater), Estuarine (saltwater environment with freshwater inputs), Riverine (fresh and saltwater environment contained within a channel), Lacustrine (freshwater lake), and Palustrine (freshwater) are represented within the project area.

Due to the proposed structural measures within the town of Westerly, more detailed wetland information is provided for this area. The most abundant freshwater wetland type within the town of Westerly is forested wetlands, dominated by the presence of woody vegetation 20 feet or taller in height. Westerly has approximately 2,905 acres of forested wetlands (approximately 15 percent of the town). Additionally, within Westerly, there are approximately 608 acres of scrub-shrub wetland (3 percent of the town), 151 acres of freshwater emergent wetlands (0.75 percent of the town), and 303 acres of estuarine emergent wetlands (1.5 percent of the town) (Town of Westerly 2009).

Based upon the U.S. Fish and Wildlife Service National Wetland Inventory (RIGIS 2015), there are four wetland systems represented in the Westerly focus area; Marine, Estuarine, Lacustrine and Palustrine and eleven wetland habitat classifications. There are two Marine (open ocean) wetland subsystems; subtidal and intertidal which comprise the sand shores and deep water habitats seaward of Misquamicut Beach and in the general project vicinity. There are also two estuarine wetland subsystems associated with Winnapaug Pond; subtidal with an unconsolidated bottom substrate and vegetated intertidal areas. These wetlands are characterized by persistent emergent and scrub-shrub vegetation; some areas have non-native invasive *Phragmites australis* within the wetland plant community.

There are several different Palustrine wetland classes in the project area. There is a large freshwater scrub-shrub wetland with broad-leaved deciduous vegetation located north of the Misquamicut residential development and another large freshwater forested wetlands with broad-leaved deciduous vegetation located east of the Misquamicut residential development. Little Maschaug Pond is classified as a freshwater pond with some saltwater influence and the adjacent Maschaug Pond is classified as a lacustrine water body (lake). There are also several small freshwater ponds throughout the golf course (with modifiers for being diked or impounded) and a large freshwater emergent wetland also located within the golf course proper.

The RIDEM and RICRMC require permits for all proposed projects that may alter the natural character of wetlands and their functions and/or values. Westerly does not have any additional wetland regulations or requirements (Town of Westerly 2009). RIDEM and the RICRMC also have programs in place for the protection of riparian buffers; 50 feet adjacent to wetlands and 100 and 200 feet adjacent to rivers and streams depending on the width of the watercourse. For coastal areas, RICRMC policy requires coastal buffer zones for certain new/improved residential development and proposed commercial and industrial development (Town of Westerly 2009).

3.4 Fish and Wildlife

3.4.1 Finfish

Typical sport fish found offshore are scup (*Stenotomus chrysops*), tautog (*Tautoga onitis*), black sea bass (*Centropristis striata*), striped bass (*Morone saxatilis*), and bluefish (*Pomatomus* *saltatrix*). In season, winter flounder (*Pseudopleuronectes americanus*) and fluke (*Paralichthys oblongus*) can also be found.

The State of Rhode Island has been conducting a coastal fishery resource assessment surveys seasonally (Fall and Spring) since 1979 to monitor recreationally important finfish stocks in Narragansett Bay, Rhode Island Sound, and Block Island Sound. See Table 5 for a list of the species captured in Block Island Sound during these seasonal tows.

Table 5. Fish species collected from Block Island from the RI DEM Trawl Survey (seasonal tows) conducted from ten fixed stations.

Alewife	Northern Pipefish
American Lobster	Northern Puffer
American Sand Lance	Northern Searobin
American Shad	Northern Sennet
Atlantic Cod	Ocean Pout
Atlantic Herring	Ocean Quahog
Atlantic Mackerel	Orange Filefish
Atlantic Menhaden	Planehead Filefish
Atlantic Moonfish	Pollock
Atlantic Seasnail	Porcupinefish
Atlantic Silverside	Red Goatfish
Atlantic Tomcod	Red Hake
Atlantic Torpedo Ray	Rough Scad
Bay Anchovy	Round Herring
Bigeye	Scup
Bigeye Scad	Sea Raven
Black Sea Bass	Sea Scallop
Blue Crab	Short Bigeye
Blue Runner	Shortfin Squid
Blueback Herring	Silver Hake
Bluefish	Skates
Bluespotted Cornetfish	Smallmouth Flounder
Butterfish	Smooth Dogfish
Clearnose Skate	Snowy Grouper
Conger Eel	Spiny Dogfish
Crevalle Jack	Spot
Cunner	Spotted Hake
Fawn Cusk-eel	Striped Anchovy
Fourspot Flounder	Striped Bass
Goosefish	Striped Searobin
Gulfstream Flounder	Summer Flounder
Hickory Shad	Surf Clam
Horseshoe Crab	Tautog

Inshore Lizardfish	Weakfish
Lined Seahorse	White Hake
Little Skate	Windowpane Flounder
Longfin Squid	Winter Flounder
Longhorn Sculpin	Winter Skate
Mackerel Scad	Yellowtail Flounder
Northern Kingfish	

Also found during the State survey were the following invertebrates: lobsters (*Homarus americanus*), horseshoe crabs (*Limulus polypherus*), blue crabs (*Callinectes sapidus*), and surf clams (*Spisula solidissima*), ocean quahogs (*Arctica islandica*), sea scallops (*Placopecten magellanicus*), skates (general), little skate (*Raja erinacea*), winter skate (*Leucoraja ocellata*), longfin squid (*Logio pealeii*) and shortfin squid (*Illex illecebrosus*) (USACE 2014).

3.4.2 Shellfish

Benthic sampling was conducted as part of the preparation of the EA for the previous Misqamicut Beach project (USACE 2014) which identified several juvenile surf clams in the proposed nearshore dredged material placement area and a few juvenile soft-shell clams (*Mya arenaria*) were found in the nearshore environment directly adjacent to the beach (see Section 3.4.3 for more detailed information). No known commercial or recreational shellfish beds exist in the nearshore area off Misquamicut Beach, but the area is approved for shellfishing by the State of Rhode Island (USACE 2014).

Due to the lack of hard substrate including rocks, lobsters (*Homarus americanus*) are not prevalent in the project area. There is a rock reef (piles) approximately 200 yards to one-half mile offshore that supports some finfish habitat and could provide limited habitat for lobsters.

3.4.3 Benthic Resources

Benthic samples were taken on September 30, 2014 from three areas along Misquamicut Beach at the mean sea level (MSL), mean low water (MLW), and the -15 foot depth contour adjacent to the beach as part of the previous Misqamicut Beach project (USACE 2014). The intertidal areas (MSL and MLW) contained 2-7 species and 9-82, respectively. Mole crabs (*Emerita talpoida*) were found in all of these samples in low numbers. Five different amphipod species were collected from the intertidal areas, most in low numbers except for sample 6-MLW (on western end of beach) which contained 72 individuals of *Gammarus annulatus*. This same species of amphipod was found in all the samples collected from -15 foot depth contour. A few polycheates were also collected from the intertidal areas. The deeper water contained more species (11-23) and individuals (188-413). The nearshore environment adjacent to the eastern end of the beach contained more species, but no one sample contained a large number of individuals as was found in the other nearshore sites (USACE 2014).

In addition, six benthic grab samples were taken offshore of Misquamicut Beach from a proposed dredged material placement site that could potentially serve as feeder berm to adjacent beach areas on July 15, 2010. The number of individuals per 0.04 m^2 sample from the Misquamicut site was low in comparison to typical estuarine and shelf environments (14 to 156). The number of species per sample was highly variable, ranging from 7-21. A group of species adapted for life on sandy sediments were relatively abundant and present in the majority of samples. These include the haustorid amphipods, *Acanthohaustorius millsi*, *Protohautorius deichmannae*, and *Bathyporeia quoddyensis*; the *ampeliscid amphipod*, *Byblis serrata*; the lysianassid amphipod *Psammonyx nobilis*; the bivalves *Spisula solidissima* (juv.) and *Tellina agilis*; and the polychates, *Goniadella gracilis*, *Syllis* sp. *Nephtys picta*, and *Polygordius jouinae*. The free burrowing haustorids and *P. nobilis* are typically found on mobile sand. The other species occupy tubes and burrows on more stable sediments. The very small polychaetes *G. gracilis* and *Syllis* sp. live interstitially within coarse sediments. Most of the species present in small numbers at this site are also adapted for sandy habitats. Most of the less dominant species present in these samples are also adapted for sandy habitats, however there are also some that are more often found on cohesive sand and silt sediments (*Mediomastus ambiseta*, *Nucula annulata*, *Pectinaria gouldii*, *Tharyx acutus*, *Pollicirrus medusa*, or on hard bottoms *Crepidula*, *Mytilus* spat. These species found only in low densities and in only one or two samples can be considered not as well adapted for the sampled environment and not indicative of the conditions at that site (USACE 2014).

A beach sand renourishment project was completed on Misquamicut Beach by the U.S. Army Corps of Engineers in 2015 using an upland sand source. The project involved the placement of sand fill at the Misquamicut Beach to restore the beach to its authorized design. Approximately 90,000 cubic yards (cy) of sand was graded to a 1:15 seaward slope from above mean high water to mean low water (USACE 2014).

Surveys to document the current benthic communities of the Misquamicut Beach project area were conducted on September 25, 2015. The benthic communities in the high-intertidal area were generally azoic or consisted of typical opportunistic annelid species (oligochaetes) and nematodes. The communities in the mid-intertidal areas were similar and were generally azoic or consisted of a few typical sandy beach species (oligochaetes, nematodes, and mole crabs). The low-intertidal communities were dominated by typical opportunistic annelid species (oligochaetes and spionid polychaetes). All intertidal zones displayed low diversity and low abundance of organisms. The low diversity and abundance of organisms and the presence of opportunistic species would seem to be indicative of the benthic community recovery following the recent beach nourishment project (completed in 2015). The June 2016 Sediment Sampling and Benthic Community Analysis for Misquamicut Beach, Westerly, Rhode Island is included in Appendix A1.

3.4.4 Reptiles and Amphibians

No site-specific reptile or amphibian surveys have been conducted in the study area. No amphibians are expected to inhabit the shoreline project area because of the density of development and lack of freshwater habitat within the project footprint. The common garter snake (*Thamnophis sirtalis*) is frequently found in lawns and so may be found in some residential areas within the project. The common garter snake is 16 to 30 inches in length and consumes many kinds of insects, slugs, worms and an occasional small frog or mouse. Several threatened and endangered sea turtles and whale species may occur near the project area (see Section 3.5 Threatened and Endangered Species for additional information).

3.4.5 Birds

No site-specific bird surveys have been conducted in the study area, however bird species likely to be present are those tolerant of development. The most abundant species likely to be found in the project area are habitat generalists that are tolerant of development such as house sparrow (*Passer domesticus*), mourning dove (*Zenaida macroura*), crow (*Corvus brachyrhynchos*), eastern tufted titmouse (*Parus bicolor*), northern cardinal (*Cardinalis cardinalis*), Carolina wren (*Thryothorus ludovicianus*), American robin (*Turdus migratorius*), gray catbird (*Dumetella carolinensis*), European starling (*Sturnus vulgaris*), common grackle (*Quiscalus quiscula*), and brown-headed cowbird (*Quiscalus major*).

The diversity of habitats found within the salt pond watersheds supports a variety of birds, both year round residents and migratory species. Shorebirds are one group that depends significantly on the salt ponds habitats. Waterfowl (ducks and geese) are common inhabitants of the salt ponds but use the area most heavily during migration and wintering periods.

Misquamicut State Beach is a public beach that is heavily populated during the summer months and the areas around the beach are developed so it provides only limited wildlife habitat value. Currently, the beach width is not conductive for shore bird nesting. Herring gulls (*Larus argentatus*), great blackbacked gulls (*Larus marinus*), double-crested cormorants (*Phalacrocorax auritus*) and sanderlings (*Calidris alba*) have been observed resting and feeding in the study area. Laughing gulls (*Leucophaeus atricilla*) and other birds use the beach to feed.

3.4.6 Mammals

Site specific studies describing the diversity and abundance of mammals within the study area are not available. Mammals likely to inhabit the study area would be generalist tolerant of development such as raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), gray squirrel (*Sciurus carolinensis*), and opossum (*Didelphis virginiana*).

Many species of mammals can be found within the diverse habitats of the Salt Ponds Region. These include, in addition to the animals listed above, small mammals, such as meadow voles (*Microtus pennsylvanicus*), white-footed mice, (*Peromyscus leucopus*) Eastern cottontail (*Sylvilagus floridanus*), chipmunks (*Tamias striatus*), and bats; medimum-sized mammals, such as red (*Vulpes vulpes*) and gray fox (*Urocyon cinereoargenteus*), muskrat (*Ondatra zibethicus*), mink (*Neovison vison*), ermine (*Mustela erminea*) and river otter (*Lontra canadensis*); and large mammals, such as white-tailed deer (*Odocoileus virginianus*) and coyote (*Canis latrans*). There is a small but increasing winter population of seals (Town of Westerly 2009).

3.5 Federal Threatened and Endangered Species

The following species were identified by the U.S. Fish and Wildlife Service Information, Planning and Conservations System (IPaC) website as threatened or endangered resources that may occur in the study area (USFWS 2016):

- Red knot (*Calidris canutus rufa*) – Threatened
- Roseate Tern (*Sterna dougallii dougallii*) – Endangered
- Northern Long-eared Bat (*Myotis septentrionalis*) – Threatened

<u>Red Knot</u> - The red knot, was listed as a federally threatened species on January 12, 2015. The red knot makes one of the longest yearly migrations of any bird, traveling 15,000 km (9,300 mi) from its Arctic breeding grounds to Tierra del Fuego in southern South America. During migration, red knots concentrate in huge numbers at traditional staging grounds. Delaware Bay is an important staging area during spring migration, where the knots feed on the eggs of spawning horseshoe crabs. The red knot breeds in drier tundra areas, such as sparsely vegetated hillsides. Outside of breeding season, it is found primarily in intertidal, marine habitats, especially near coastal inlets, estuaries, and bays (USFWS 2015b). No known survey efforts have been conducted within the project area for red knot. According to the ebird.org website (Cornell Lab of Ornithology 2017), there have been observations of red knot in the Quonochontaug Pond in Charlestown, and Trustom Pond National Wildlife Area and East Matunuck State Beach vicinity in South Kingstown. It appears that some South County beaches

and marshes are used by red knots as a transient stopover to or from their breeding grounds in the Canadian Arctic. It is unlikely that red knot would utilize the developed areas proposed for home elevation and flood proofing as foraging areas due to the lack of suitable habitat.

Roseate Tern - The northeastern population of the roseate tern was designated as federally endangered on 2 November 1987. Roseate terns were once abundant but a variety of threats have resulted in much-reduced populations. According to the 1998 U.S. Fish and Wildlife Service Roseate Tern Recovery Plan – Northeastern Population, the numbers of roseate terns were severely reduced in the 1870's and 1880's by commercial hunting for the millinery trade. The total number of roseate terns was estimated to be roughly 2,000 pairs at the lowest point in about 1890 (Nisbet 1980 in USFWS 1998). Roseate tern populations increased following protection efforts but declined again to a low of 2,500 pairs in 1977 due to habitat loss and gull encroachment.

Roseate terns generally nest on sandy, gravelly, or rocky islands. As per the U.S. Fish and Wildlife Service 2010 Caribbean Roseate Tern and North Atlantic Roseate Tern (*Sterna dougallii dougallii*) 5-Year Review: Summary and Evaluation, in 2009, approximately 94% of the population of Roseate Tern pairs were concentrated at just 3 colonies: Great Gull Island, New York (NY); Bird Island, Marion, Massachusetts (MA); and Ram Island, Mattapoisett, MA (USFWS 2010). Roseate terns feed almost exclusively on small and/or juvenile fish; occasionally it includes crustaceans and insects in its diet. Its feeding habits are fairly specialized, consuming primarily sand lance. Roseate terns capture food mainly by plunge-diving (diving from heights of 1-12 meters (m) and often submerging to ≥ 50 centimeters (cm)), but also by surface-dipping and contact-dipping (MA NHESP 2007).

Northern Long-eared Bat - The northern long-eared bat (*Myotis septentrionalis*) (NLEB) was recently listed as a federally threatened species by the U.S. Fish and Wildlife Service (April 2, 2015) and is listed as being present throughout the state of Rhode Island. This listing took effect on May 4, 2015. Increased mortality of the bat caused by white-nose syndrome, an infectious wildlife disease that poses considerable threats to hibernating bat species, has been the primary contributor to a significant decline in the population of the NLEB since 2007 (USFWS 2015a). The NLEB was once widespread throughout New England, but due to white-nose syndrome, the population in New England has declined by at least 90 percent (USFWS 2015b.)

Suitable summer habitat for the NLEB consists of a wide variety of forested/wooded habitats where the bats roost, forage, and travel and have also been observed roosting in human-made structures, such as buildings, barns and sheds. Bats roost singly or in colonies underneath bark, in cavities, or in crevices of both live and dead trees. Individual trees may be considered suitable habitat when they exhibit the characteristics of a potential roost tree and are located within 1,000 feet of other forested/wooded habitat. Females give birth between late May to late July and roost in maternity colonies composed of approximately 30 to 60 bats. In winter, the NLEB hibernates in caves and mines, called a hibernacula.

Since the project area encompasses such a large tract of land (the South County region), a site assessment for potential NLEB habitat has not been conducted. In addition, no acoustical surveys have been conducted for the project area. Therefore, it is assumed that the NLEB is present in the project area.

In addition to the species listed in the USFWS IPaC website (USFWS 2016) as discussed above, the USFWS was concerned about the potential for piping plover (*Charadrius melodus*) to be found in the Misquamicut State Park and Misquamicut Beach area in their Planning Aid Letter dated August 12, 2015. In addition, portions of the initial focus area boundaries intersect with designated piping plover habitat.

<u>Piping Plover</u> - Piping plovers, which are federally listed as threatened, breed on coastal beaches along the Atlantic coast from Canada to North Carolina. The birds arrive in late March, early April and establish nesting territories. Pairs of birds will form nests (shallow depressions) in the sand on the high beach close to the dunes on wide open beaches and shorelines. They feed in the intertidal zone at low tide. The piping plover nesting season may extend into late August although individual pairs may fledge young as early as July.

Structural measures were proposed in the Westerly project area (e.g., beach renourishment, floodwalls, tide gate) and therefore, more detailed information regarding existing conditions is provided for that area. In 2015, the Corps placed 90,000 cubic yards of sand fill at Misquamicut Beach to restore the beach to its authorized design profile following the damage caused by Hurricane Sandy. Piping plovers were not known to nest on Misquamicut State Beach prior to the 2015 Erosion Control Project and the USFWS, in a letter dated December 24, 2013, concurred that the Misquamicut Beach project was unlikely to have adverse effects on the federally threatened piping plover. However, the re-engineered beach could provide suitable piping plover nesting habitat once the beach was widened and as such, the U.S. Fish and Wildlife Service began a piping plover monitoring and management plan in cooperation with the Rhode Island Department of Environmental Management.   No nesting piping plovers were identified during 2014 or 2015 according to Nick Ernst, former piping plover coordinator at the Rhode Island National Wildlife Refuge Complex (Ernst per. comm., June 2015). The current piping plover coordinator, Ryan Kleinert, noted that that the monitoring did identify tracks and foraging of several adult plovers, but no nesting birds (Kleinert per. email comm., June 2015). The monitoring plan is anticipated to remain in place indefinitely.

A Planning Aid Letter dated August 12, 2015 was received from the USFWS for the project. It was anticipated in the early planning phase that the proposed project would involve additional beach nourishment on Misquamicut State Park and possibly floodwalls and beach fill at Misquamicut Village. As such, the USFWS provided the following conservation measures to be included in the project to avoid adverse effects to piping plovers and their roosting, foraging and potential nesting habitat on Misquamicut Beach State Park:

- beach fill will maintain a 10 horizontal to 1 vertical slope beach profile;
- implementation of post-construction monitoring for piping plover presence beginning April 1 (in accordance with the USFWS management guidelines);
- implementation of the USFWS guidelines for managing piping plovers if they nest at Misquamicut Beach State Park; and
- time-of-year restriction for construction activity of April 1 to August 31 if breeding piping plovers are documented within the vicinity of the project.

Further analysis was conducted when the final selected plan was selected to determine potential impacts to piping plover. The location of individual house lots proposed for elevation or flood proofing were compared to the boundaries of designated piping plover habitat. (Note: The piping plover habitat locations were the most recent available pursuant to an email dated 3 August 2016 from Susi von Oettingen, Endangered Species Biologist, USFWS New England Field Office.) None of the individual houses proposed for elevation or flood proofing are located within designated piping plover habitat in Westerly, Charlestown, South Kingstown or Narragansett. However, there are three houses proposed for elevation within the vicinity of Roger Wheeler State Park approximately 200, 500 and 900 feet west of the parking lot on the northern side of Sand Hill Cove Road in Narragansett. The beach seaward of the Roger Wheeler State Park parking lot is designated as piping plover habitat. In addition, there is one house located approximately 200 feet from East Beach in Westerly. A portion of this barrier beach in the Watch Hill area of Westerly is designated as piping plover habitat (see Figure 8).

In addition, alternatives within the Westerly project area involved in-water work and as such, had the potential to impact aquatic species designated on the National Marine Fisheries Service (NMFS) species distribution maps website (http://www.greateratlantic.fisheries.noaa.gov/protected/section7/guidance/maps/index.html). The Misquamicut Beach (Westerly) project location overlaps with areas of potential distribution for Atlantic sturgeon (*Acipenser oxyrinchus*); sea turtles of the New England region including the threatened Atlantic loggerhead (*Caretta caretta*) and green sea turtle (*Chelonia mydas*) and endangered Atlantic leatherback (*Dermochelys coriacea*) and Atlantic Kemp's ridley (*Lepidochelys kempi*); as well as large Atlantic whales including the endangered humpback (*Megaptera novaeangliae*), right (*Eubalaena glacialis*), and fin (*Balaenoptera physalus*) whales.

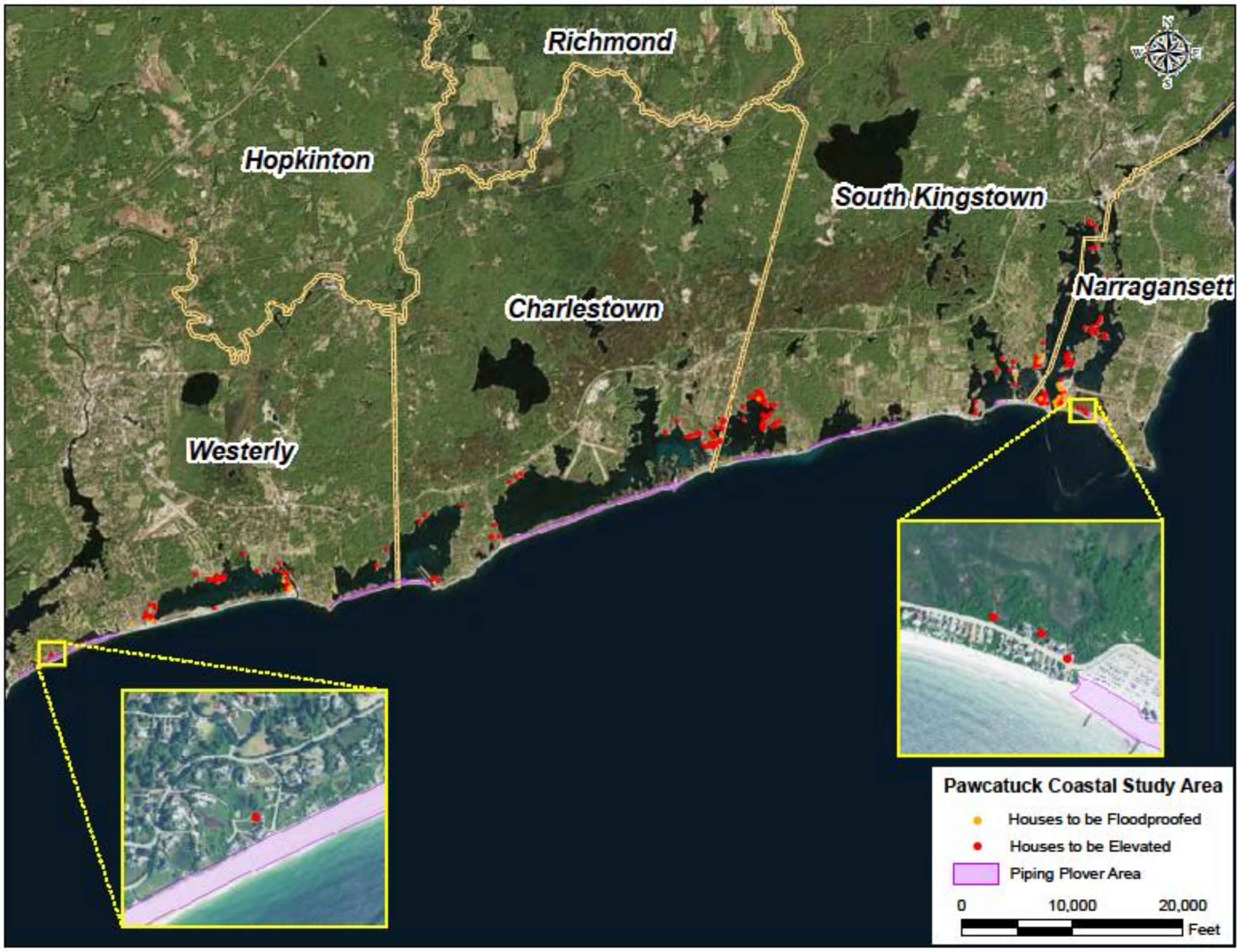


Figure 8. Project Activities in Proximity to Piping Plover Habitat

Atlantic sturgeon - Atlantic sturgeon from any of the five Distinct Population Segments (DPS), (Gulf of Maine DPS is listed as threatened other four DPSs are listed as endangered), may be present in the project area. After emigration from the natal estuary, sub-adult and adult Atlantic sturgeon forage within the marine environment, typically in waters less than 50 meters depth (ASSRT 2007 in USACE 2014). Atlantic sturgeons are occasional visitors to the nearby Little Narragansett Bay area (Dillingham *et al.* 1993 in USACE 2014), most likely while making coastal migrations or while foraging for benthic invertebrates and small fish such as sand lance. In bays and harbors foraging often occurs at or near areas with submerged vegetation or shellfish resources. The project area does not provide suitable habitat for overwintering; so the presence of Atlantic sturgeon is likely limited to the warmer months. The nearest spawning rivers are the Kennebec River, Maine and the Hudson River, New York, so no eggs, larvae or juvenile Atlantic sturgeon are likely to occur in the project area.

Sea Turtles - Four species of federally listed threatened or endangered sea turtles are found seasonally in coastal Rhode Island waters including offshore environments of Narragansett Bay, Block Island Sound, Rhode Island Sound, and nearby coastal and continental shelf areas (the Special Area Management Plan [SAMP] area). These species include the threatened loggerhead and green sea turtles, and the endangered Kemp's ridley and leatherback sea turtles. These species migrate to and from habitats extending from Florida to New England, with overwintering concentrations in southern waters.

The leatherback turtle is a highly pelagic fast swimming open water animal where it forages in search of jellyfish. The leatherback is the most likely sea turtle species to be encountered in the SAMP area (although the areas where they can be abundant are beyond the SAMP area). Their occurrence is during the warmest part of the year in summer and early fall (Kenney *et al.* 2010).

Although loggerhead turtles are much more abundant off southern New England than leatherbacks they are less likely to occur in nearshore waters or in the SAMP area. The loggerhead, has a conspicuously large, block-like head, and averages 3 ft. long and 300 pounds. It is possible for loggerheads to occur occasionally in the SAMP area in summer or fall. Loggerheads feed on benthic organisms found in large bay systems and forage in the open waters in search of hard-shelled prey (crabs, crustaceans, mollusks), in addition to jellyfish, fish and eelgrass. Juvenile loggerheads regularly inhabit bays where they feed mainly on crustaceans and shellfish (Kenney *et al.* 2010).

The most endangered and smallest of the sea turtles, the Kemp's ridley averages 20-28 inches long and 80-110 pounds. The Kemp's ridley appears to prefer estuarine areas where green crabs and mussels are found. Kemp's ridley sea turtles are much rarer that the leatherbacks or loggerheads having been sighted off southern New England only a few times, including within the SAMP area. Their main center of distribution is off the southeastern U.S. and in the Gulf of Mexico. However, small juveniles known to utilize shallow developmental habitats around eastern Long Island and Cape Cod might transit through the SAMP area (Kenney *et al.* 2010).

There has been only one recent sighting of a green sea turtle off southern New England, outside of the SAMP area. They are primarily found in shallow, tropical waters. However, small juveniles are known to utilize shallow developmental habitats around eastern Long Island and Cape Cod, and might transit through the SAMP area (Kenney *et al.* 2010). While green sea turtles may be in the waters, these occurrences would be considered rare.

Large Atlantic Whales - Several endangered whale species have the potential to be transiting through the waters off of the Rhode Island coast including the humpback, finback, and right whale. Right whales are primarily transiting the offshore environments of Narragansett Bay, Block Island Sound, Rhode Island Sound, and nearby coastal and continental shelf areas (the Special Area Management Plan [SAMP] area) on their way to more northerly feeding and concentration areas during the spring and fall. There may be occasional years when they linger in the waters off of Rhode Island for feeding for days or weeks rather than just transiting through on migration. Humpback whale presence in the area is variable and probably a response to the changing distribution of preferred food sources. For the most part, humpbacks are in transit through the SAMP area from May through September on their northward migration to summering areas in the Gulf of Maine. Fin whales are the most abundant large whale in southern New England, and are widespread in continental shelf waters. Finback whales occupy both deep and shallow waters and are probably the most abundant large cetacean in the SAMP. They are most abundant in spring and summer, but do have some presence during the winter months (Kenney *et al.* 2010). These whale species are unlikely to occur within the shallow depths just off the beach area.

3.6 State Threatened and Endangered Species

The Natural Heritage Areas depicted on Figure 9 identify the estimated habitat and range locations of rare species or "naturally noteworthy" communities (both animals and plants) for the entire project area (RIGIS 2016). Some of these designated areas overlap with five focus areas shown on Figure 3. State-listed rare species which typically utilized the salt ponds include the seaside sparrow (*Ammodramus maritimus*), northern harrier (*Cirus cyaneus*), American bittern (*Botaurus lentiginosus*) (Town of Westerly 2009).   In addition, the U.S. Fish and Wildlife Service maintains lists of bird species classified as Nongame Migratory Bird Species of Management Concern in the Continental United States. Species from this list that occur in the Salt Ponds Region include the three state-listed rare species mentioned above in addition to the black rail (*Laterallus jamaicensis*) (Town of Westerly 2009). These species utilize the fresh and saline marshes and wet meadows of the Salt Pond Region.

The houses proposed for elevation under the Locally Preferred Plan (LPP) overlap with Natural Heritage Area designations in some locations in Westerly, Charlestown, South Kingstown and Narragansett. The Rhode Island Department of Environmental Management is responsible for maintaining lists of plant and animal species in Rhode Island that are of regulatory conservation interest. Based upon the Natural Heritage recorded observations, four (4) species of birds and five (5) species of plants are located in the vicinity of proposed project activities. The beaches, marshes and fresh water ponds within the project area provide habitat for these species.

In Westerly, tall wormwood (*Artemisia campestris*) and northern blazing star (*Liatris scariosa*) were recorded as being located approximately 200 and 300 feet, respectively, from proposed project activities. As well, one house proposed for elevation is located in the vicinity of designated piping plover (*Charadrius melodus*) habitat as described in Section 3.5 Federal Threatened and Endangered Species.

In Charlestown, the seaside sparrow (*Ammodramus maritimus*), clapper rail (*Rallus. longirostris*), willet (*Catoptrophorus semipalmatus*) and king rail (*R. elegans*) were observed in the project vicinity. The distance from project activities ranged from 100 feet (seaside sparrow) to approximately 750 feet.

There are four (4) plant species listed in the vicinity of project activities in the towns of South Kingstown and Narragansett. These include feverwort (*Triosteum perfoliaturn*), Scotch lovage (*Ligusticum scothicum*), and annual sea-pink (*Sabatia stellaris*) with distances from project activities of 850, 1,000, and 1,600 feet, respectively. In addition, the American bittern (*Botaurus lentiginosus*) was observed 1,100 feet from project activities. Houses proposed for elevation in Narragansett are also located in the vicinity of designated piping plover habitat as described in Section 3.5 Federal Threatened and Endangered Species.

3.7 Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act mandates that federal agencies conduct an Essential Fish Habitat (EFH) consultation with NOAA Fisheries regarding any of their actions authorized, funded, or undertaken that may adversely affect EFH. Essential Fish Habitat is broadly defined as “those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity.” The alternatives involving beach nourishment, floodwalls and a tide gate in the town of Westerly had the potential to impact EFH. As such, as stated in the NMFS EFH descriptions (http://www.nero.noaa.gov/ro/doc/list.htm), thirteen federally managed species had the potential to occur within the Westerly portion of the project area. No in-water or work in intertidal habitat was proposed at any other project location. Managed species listed for the Westerly project area included Atlantic cod (*Gadus morhua*); Atlantic sea herring (*Clupea harengus*); bluefish (*Pomatomus saltatrix*); king mackerel (*Scomberomorus cavalla*); Spanish mackerel (*Scomberomorus maculatus*); cobia (*Rachycentron canadum*); common thresher shark (*Alopias vulpinus*); blue shark (*Prionace glauca*); dusky shark (*Charcharinus obscurus*); shortfin mako shark (*Isurus oxyrhyncus*); sandbar shark (*Charcharinus plumeus*); bluefin tuna (*Thunnus thynnus*); and sand tiger shark (*Odontaspis taurus*). Upon further analysis of alternative measures, the nonstructural alternative (house

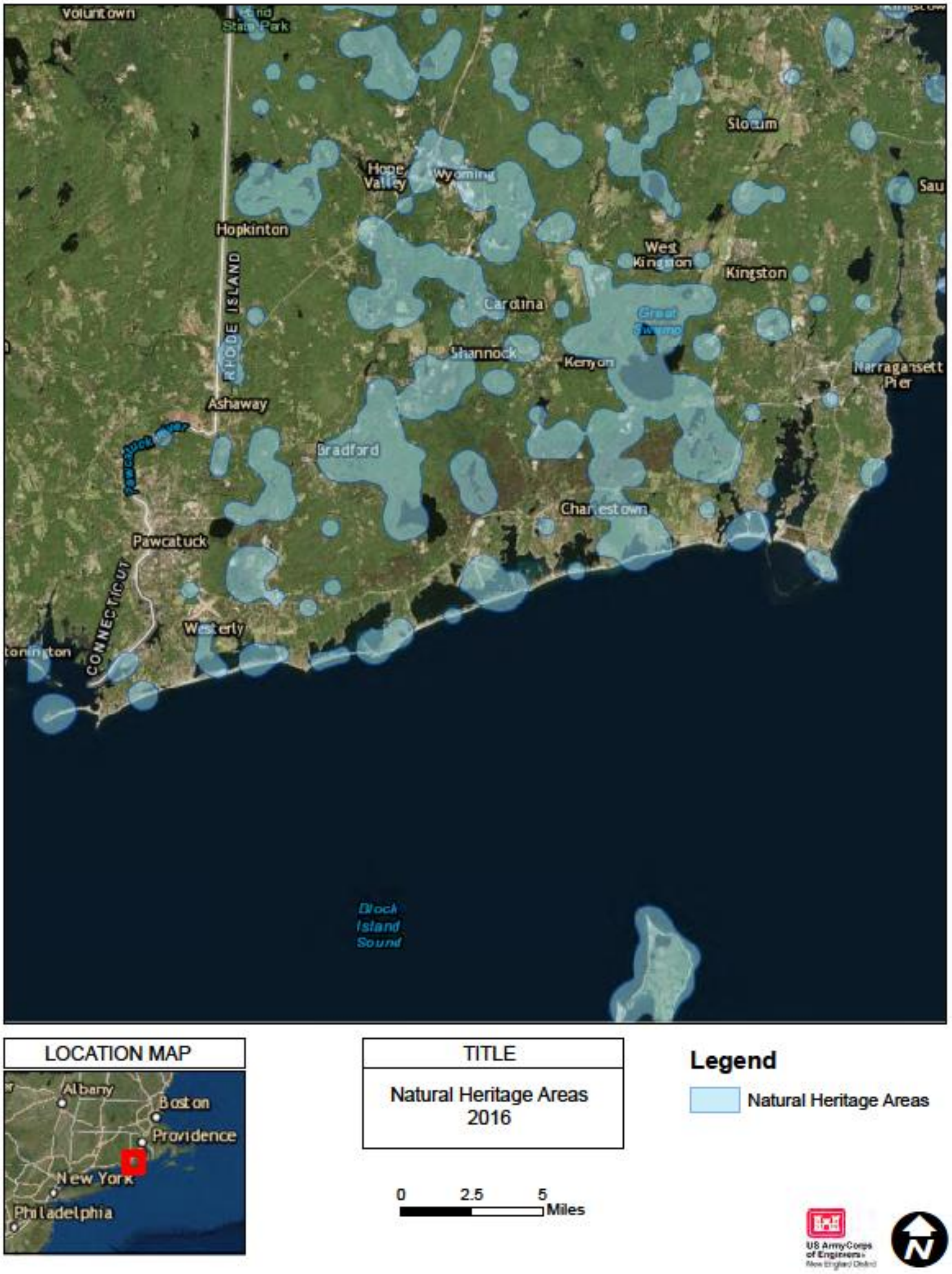


Figure 9. Natural Heritage Areas

elevation and flood proofing) was determined to be the final selected plan in all locations. As there is no in-water work or work in intertidal habitat, an EFH review was not prepared for this project.

3.8 Socioeconomic

The majority of Rhode Island population is concentrated in densely urbanized areas leaving more than half of the state forested or in agricultural use. In 2000, there were approximately 1 million residents in the state of Rhode Island with 82 percent of residents living in the twenty largest cities. Approximately 16% of residents were living in Providence, the largest city in Rhode Island. There is a high degree of developmental pressures in recent years with 25 percent of the state's forest and agricultural land being converted to other uses since 1970 (RICRMP 2016).

The only structural alternatives proposed were located in Westerly (e.g., beach nourishment, floodwalls and tide gate). The Misquamicut State Beach is owned by Rhode Island Department of Environmental Management and managed by the Division of Parks and Recreation. It is a major recreational resource; there were 223,046 visitors during the summer of 2013. The beach provides recreational opportunities to local residents and the general public. It is also of importance to commercial establishments, since visitors to the beach spend money in nearby businesses. There are 2600 parking spots available for a fee that provides funds for the RIDEM Area Recreation and Development Fund (USACE 2014).

3.8.1 Demographics

The project area is located in Washington County which encompasses the south coastal region of Rhode Island. According to the 2010 census, Washington County had a population of 127,094 individual and 62,206 housing units. At that time, Washington County's population was 93.8% white, 1.2% black, 0.9% American Indian, 1.6% Asian, 2.4% Hispanic and 1.8% two or more races (U.S. Census Bureau 2015).

According to the 2010 census, Westerly has a population of 17,936 individuals and 8577 housing units. Of those only 348 are for seasonal, recreational or occasional use. Westerly's population is 92.2% white, 1.0% black, 0.5% American Indian, 3.0% Asian, 3.2% Hispanic and 2.2% two or more races (U.S. Census Bureau 2015). The beach front provides protection from storm and flood damage to the beach house pavilion and associated structures as well as Atlantic Avenue, and some protection for the nearby homes and businesses.

3.8.2 Economy and Employment

Since 1950, Rhode Island saw a decline in manufacturing and growth in service-producing jobs, such as health, business, and educational services, and wholesale and retail trade which is typical of the nation as a whole. In 2001, service-producing sectors accounted for 82 percent of total employment (390,000 jobs) (RICRMP 2016). In 2010, the median household between 2009 and 2014 income in Washington County was $72,784 with 10.4% of persons below the poverty level as compared to 13.6% for the State of Rhode Island (U.S. Census 2015).

As a potential location for structural measures, additional socioeconomic information is provided for the town of Westerly. Favorable aspects which support a stable economy in Westerly's include good financial position, reserves, modest existing debt burden, recent property appreciation resulting in an expanded tax base, and market value of homes. Westerly is primarily a town of small employers with a significant history of textile manufacturing and finishing and printing. Of Rhode Island's top 100 employers, there are two with headquarters in Westerly: the Westerly Hospital and The Washington Trust Company. Westerly's economic base includes many other businesses that cater to the seasonal tourist industries, ranging from bed and breakfast establishments, and other inns and hotels. In 2007, nearly $154 million in new residential construction projects was underway in Westerly and nearly $42 million in new commercial development projects approved along US Route 1 (Town of Westerly 2009).

The median household income in Westerly between 2009 and 2013 was $57,265. There were 12.1% of persons below the poverty level in the town of Westerly as compared to 13.6% for the State of Rhode Island (U.S. Census 2015). The town population increases during the summer due to the presence of seasonal residents and the daily visitors to Westerly's beaches. Overtime and seasonal employee needs are highest at the town transfer station, town beaches and public safety employees. The average unemployment rate in Westerly from 2005 to 2007 was approximately 4.3 percent, which is generally recognized as near full employment, while the state rate was 5.1 percent. In the midst of the 2008-2009 economic downturn, the local rate was approximately 10 percent compared to a state rate of 12.1 percent (Town of Westerly 2009).

3.9 Environmental Justice

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" require federal agencies to identify and address disproportionately high and adverse human health or environmental effects of its program, policies, and activities on minority and low-income populations in the U.S., including Native Americans. The proposed action will not have any disproportionate high or adverse impacts on minority or low-income populations, or any adverse short or long-term environmental justice impacts because the proposed action will be elevating houses. None of the houses proposed for elevation are located within environmental justice populations.

Executive Order 13045, "Protection of Children from Environmental Health Risks and Safety Risks," requires federal agencies to identify and assess environmental health risks and safety risks that may disproportionately affect children. The proposed action will not pose any significant or adverse short or long-term health and safety risks to children. Access to properties where houses are being elevated will be controlled during construction activities.

3.10 Cultural Resources

Human presence in Rhode Island stretches back ten thousand years. Over this long period of precontact Native American occupation, substantial changes occurred in the physical environment and in human subsistence practices. The greatest environmental changes occurred during the Paleo-Indian Period, from 8,000 to 6,000 B.C. As the climate warmed and the glaciers melted, the water level rose, inundating the coastal plain rivers. Mastodon, caribou, moose and giant beaver inhabited the forests. Sites from the Paleo-Indian Period are rare; there is one such site recorded in Lincoln, Rhode Island.

During most of the Archaic Period (6,000 to 500 B.C.) the climate continued to warm, becoming even milder than it is today. Sea levels continued to rise, reaching a level close to today's by about 3,000 B.C. There are more Archaic sites, located in a wider range of habitats and containing a far broader assortment of artifacts, than in the previous period. Among these artifacts are tools for hunting deer, birds, and small mammals, for preparing nuts and other wild plant foods, and for working wooden objects. Ground stone axes and soapstone bowls appear for the first time.

Archaic sites are most commonly found on freshwater streams and saltwater inlets and coastal ponds. At these locations, spring runs of herring or salmon were harvested and shellfish or various kinds were gathered. Evidence of these sites are found as large piles of shell or middens with other artifacts intermixed.

During the Woodland Period (500 B.C. to 1500 A.D.), the climate cooled slightly. Sites dating from this period are larger than earlier sites because larger groups began living together, managing and harvesting the abundant nut crops or exploiting the coastal shellfish and spring runs of alewife and other anadromous fish. When the climate warmed again slightly later in the period, the growing season increased, allowing a predictable yearly harvest of corn and other domestic crops.

Woodland Period sites in this part of Rhode Island are located in much the same places as sites from the earlier Archaic Period. Eventually the de-emphasis on seasonal movement to procure food and the growing emphasis on agriculture led to the establishment of permanent camps along the coastal plain and fertile floodplain terraces along the rivers (Rhode Island Historic Preservation and Heritage Commission 2002).

By the time of the first European contact, in the early 1500s, the Native Americans were settled in semi-permanent villages led by sachems. They were subjects of the Narragansett tribe whose dominion included all of what is now Rhode Island west of Narragansett Bay.
The discussion of historic period sites will go from Area 1 to Area 5. An overview of the histories of Westerly, Charlestown, South Kingstown, and Narragansett found that the study areas were undeveloped except for the lone fishing shack until the onset of the popularity of the seashore as a vacation destination beginning in the mid to late nineteenth century.

In Westerly around 1894, a group of Westerly men bought land and built cottages along the ocean at Misquamicut. It is a summer resort comprised largely of small, unpretentious summer cottages, largely early to middle twentieth century structures, in a densely populated area between the Shore Road (Route 1A) and Block Island Sound and the west end of Winnapaug Pond. Until the land was purchased in 1894, it was only used by fishermen, hunters, picnickers, and swimmers. Pleasant View, as it was known, made slow progress until about 1903, when the Pleasant View House was established. In the next eight years came a good road, a post office, a water system and electricity, and the place grew considerably. In 1928, the name was changed to Misquamicut, the Indian name for Westerly. The Misquamicut Historic District is eligible for the National Register of Historic Places (NR) because of its role in the settlement of the town of Westerly (Rhode Island Historical Preservation Commission 1978).

In the area encompassing part of Charlestown and part of South Kingstown the houses along Charlestown Beach and north of the Charlestown Breachway (inlet) are an area known as Sea Lea. This densely settled summer colony contains modest cottages on small lots. In South Kingstown is the area known as Green Hill Beach.

Charlestown Beach is one of several communities along the barrier beach, most of which date from the late nineteenth century. A few houses and two hotels were standing in the 1890s. In the following decade a few more beach cottages were built by local residents. But, the major development came in the twentieth century, with the widespread use of the automobile and improved highways. In 1937, the beach had cottages and three seasonal hotels and offered surf fishing, bathing and camping. The 1938 hurricane destroyed or damaged 185 cottages at Charlestown Beach and several people died. New buildings, including a pavilion built in 1948, were demolished by Hurricane Carol in 1954, but most of the houses damaged then were rebuilt.

This densely settled summer colony contains modest cottages on small lots. Sea Lea is listed in the Rhode Island inventory of historic places. It has not yet been evaluated for eligibility on the NR (Rhode Island Historical Preservation Commission 1981).

Green Hill Beach in South Kingstown remained unused and undeveloped until about the last decade of the nineteenth century. Circa 1895, a row of seven, closely spaced cottages were constructed directly on the ocean front. They are no longer extant. In the early twentieth century, more summer houses were built and Green Hill became a “summer colony.” A number of shipwrecks and groundings in the area, most notably the wreck of the *John Paull* on February 10, 1893, resulted in the establishment of a life-saving station at Green Hill in 1912. The station remained active until 1933. Currently, a large number of summer cottages occupy a relatively small, densely settled area on Green Hill Beach Road and several side streets near the Sound. The Green Hill Area is listed in the Rhode Island inventory of historic places. It has not yet been evaluated for eligibility on the NR.

The Matunuck area is in South Kingstown (Roy Carpenter’s Beach) to Matunuck Point). There is little historical information on Carpenter’s Beach or Matunuck Point. A summer colony began to emerge at Carpenter’s Beach in the early twentieth century. Its first dwellings were temporary tents, but later small cottages were built, clustered together in a small space. It is considered one of the most densely settled summer communities along the entire Rhode Island shore. At Matunuck Beach, there were several hotels and cottages to accommodate visitors. Most of the beach became densely populated, but in a few places, such as the Matunuck Point summer colony, separated from the beach crowd, lots were much larger and exclusive as were the summer houses. The St. Romuald Chapel is listed on the Rhode Island historic inventory but has not yet been evaluated for eligibility on the NR. The Roman Catholic chapel is a one story, wood shingled church building constructed in the early twentieth century to serve the Matunuck Point summer colony and then later the Matunuck Beach community (Rhode Island Historical Preservation Commission 1984).

In Sand Hill Cove, a low lying portion of the study area around Point Judith Pond, while there is some early to mid-twentieth century summer resort development particularly on the islands in Point Judith Pond, the town of Narragansett’s main tourist attraction was Narragansett Pier. Fishing was a more important activity in this area in the nineteenth century both on the ocean and in Point Judith Pond. Alewives, bass, smelt, and white perch, as well as oysters and some clams and scallops were taken and exported to Providence, Newport, and New York.

Sand Hill Cove was at one time the location of a breachway to Point Judith Pond. It was used by small coastal traders for access to the pond. The Great Gale of 1815 filled in the breachway and a new one formed about one mile to the west. The breachway required periodic digging to insure the passage of migrating fish. Shifting and shoaling of the breachway was a constant concern until a permanent opening was dredged in the early twentieth century.

There are no resort communities listed on the Rhode Island historic inventory. However, there is Galilee, the small fishing village on the east side of the breachway into Point Judith Pond. Development was minor until 1935 when the state and the federal Public Works Administration constructed two piers and dredged a large anchorage just inside Point Judith Pond, attracting a number of fishing vessels. The hurricane of 1938 did severe damage at Galilee, and most of the current buildings postdate that time period.

In contrast to Narragansett Pier, Galilee is a working waterfront. The landward side of Great Island Road is for the tourist providing rooms, food, and souvenirs. On the waterfront, are fish shacks, wharves, piers, and the slip for the Block Island ferry. There are masts, booms, and derricks. Galilee is a favorite destination of visitors to Narragansett.

On Great Island Road is the U.S. Coast Guard Station and Boathouse constructed in 1940. It is a one story, hip-roofed structure with a side-lighted portico entry flanked by single, large door openings. There are small gabled dormers in the roof. The station along the Point Judith Breachway, was built here after the former life-saving station near the Point Judith lighthouse burned in 1938. The Coast Guard Station and Boathouse is listed on the Rhode Island Inventory of historic inventory but has not yet been evaluated for the NR.

The Point Judith Harbor of Refuge and the Point Judith channel into the pond are also listed on the Rhode Island historic inventory, but have not been evaluated for eligibility for the NR. During the nineteenth century Point Judith was considered one of the most beautiful places on the Atlantic Coast. A number of ships passed this point regularly but the rocky shore afforded few places to launch a lifeboat. The National Harbor of Refuge was authorized by Congress in 1890 so that a launching place for the Life Saving Service could be established. Initial work on the jetties began in 1905, however, it was not until 1914 that the central section was completed. Creation of the channel into Point Judith Pond created a safe harbor for boats and made possible the existence of one of Rhode Island’s major fishing centers (Rhode Island Historical Preservation 1991).

3.11 Coastal Zone Management

The State of Rhode Island administers its federally approved coastal zone program through the Coastal Resources Management Council (RICRMC). Pursuant to the Federal Coastal Zone Management Act (CZM), Rhode Island has defined its coastal zone boundaries and developed policies to be utilized to evaluate projects within the designated coastal zone (1971 enabling legislation Title 46 Chapter 23 Rhode Island General Laws, as amended). The development of the Rhode Island Coastal Resources Management Program (RICRMP) was approved by the RICRMC in 1977, and federally-approved in 1978 (RICRMP 1996).

Pursuant to Section 307 of the Coastal Zone Management Act (CZMA) (16 USC §§ 1451-1464), federal agencies conducting an activity which is reasonably likely to affect any land or water use or natural resource of the coastal zone, are required to do so in a manner consistent, to the maximum extent practicable, with the enforceable policies of the state's coastal management program developed and implemented under the CZMA. Rhode Island's approved coastal zone, for the purposes of exercising the federal consistency requirement of the CZMA, includes the area encompassed within the state's seaward boundary (three miles) to the inland boundaries of the state's 21 coastal communities. The RICRMP "Redbook," the Council's Special Area Management Plans and Energy Amendments, and adopted State Guide Plan elements together make up Rhode Island's federally approved coastal program (RICRMP 1996).

The Rhode Island Coastal Resource Management Council (CRMC) provided a conditional CZM consistency concurrence for Pawcatuck River Coastal Risk Management project dated October 31, 2017 based on the current project description and anticipation of Corps approval for the LPP (see Appendix A2). The State's final consistency concurrence of the federal action will be determined after the USACE files a formal consistency determination with the CRMC in accordance with 15 CFR § 930 Subpart C following USACE Headquarters approval of the project.

3.12 Land Use and Zoning

Approximately 65% of the land in Washington County is still undeveloped, of which 31% is permanently protected natural habitat. A rich diversity of habitat types (forest, wetlands and open farmland) support 75% of all species found in Rhode Island including 63% of Rhode Island's rare plants and animals. Not surprisingly, due to its beautiful landscape and ocean nexus, the area was the third fastest growing region in New England with a population increase of 20% during the 1990's (Bobrowski *et al.* 2001). Between 2000 and 2010, the average population increase in Washington County was considerably lower, at a rate of 0.4%, however, the Town of South Kingston still grew 9.7% during that time (2000 and 2010 - US Census Bureau).

As a result of the high value of natural resources and on-going developmental pressure, the Washington County Regional Planning Council, in a collaborative effort between federal, state and local agencies, established the South County Greenspace Project to assist local communities in the inventory and prioritizing of natural, cultural and recreational resources. These efforts allowed unfragmented green space corridors to be designated on the regional scale (versus on a town to town basis) to more effectively manage development and preservation and encourage sustainable economic growth in the region. The "Smart Growth" tools that were developed included a set of Model Zoning Ordinances, and a Development Site Assessment Guide for use by individual communities which could be tailored to the site-specific conditions and needs if individual towns (Washington County Regional Planning Council 2003). The project local sponsor will assure that proposed project activities are in compliance with applicable state and local laws and zoning ordinances.

A more detailed evaluation of land use was conducted for the Westerly area due to the potential for structural measures (e.g., beach nourishment, floodwalls, tide gate) in that area. A land use inventory was completed as part of the preparation of the town of Westerly's Comprehensive Plan (Town of Westerly 2009). Table 6 summarizes the area and the proportion of each of the land use category in the Town of Westerly.

Table 6. Existing Land Use

Land Use	Acres	Percent of total
Agriculture—includes actively farmed land (cropland, pastures, and orchards). About 248 acres of farmland is being conserved through acquisition of development rights or conservation easements	2,046	10.3%
Commercial-Mixed Use—includes all commercial uses consisting of retail, services and professional uses, and areas with both commercial and residential uses such as the downtown area and part of Watch Hill	728	3.7%
Community Facilities—includes schools, churches, government buildings, community safety facilities, hospitals, airport, rail yard, roads, other transportation uses, public utilities, and the transfer station	2,144	10.7%
Industrial—includes manufacturing and quarrying operations	436	2.2%
Conservation, Recreation, and Open Space—includes golf courses, marinas, beaches, parks and other recreation, cemeteries, and vacant land that is protected from development by conservation easements or other permanent protection	4,112	20.6%
Residential—includes all residential uses	7,193	36.0%
Vacant—most of this land is currently forested; it includes land that is potentially developable and land that would be difficult to develop such as wetlands, inland sandy soils, and rock outcrops	2,385	11.9%
Water—includes inland fresh water and salt ponds; the Pawcatuck River and Little Narragansett Bay are not included	923	4.6%

Source: 2009 Town of Westerly Comprehensive Plan, Section 1.1 Existing Land Use, Table 1-1

Westerly contains approximately 31.2 square miles (19,967 acres) of land area. Research conducted as part of this Comprehensive Plan project found that approximately 78 percent (15,536 acres) of Westerly's land is either developed or permanently committed to conservation (Town of Westerly 2009). The 2010 population of 17,936 and a town area of 31.2 square miles yield a population density of 575 persons per square mile (U.S. Census 2015).

Residential land use occupies 7,193 acres of land representing 36 percent of the town‘s area. These uses are primarily concentrated in the western and southern portions of the town. Along the southern shore area, much of the residential development is a combination of year-round and seasonal housing, with an increasing trend toward year-round use. The greatest density along the shore is located in the Misquamicut area (Town of Westerly 2009).

The Zoning Ordinance is a critical tool for controlling the type, density, and appearance of development within the town. Westerly‘s last comprehensive update of its Zoning Ordinance was enacted in 1998. The 1998 ordinance created multiple residential zoning districts which reflect the development which occurred under earlier zoning ordinance provisions (smaller lot sizes) and provided lot sizes for areas not already developed which reflect the availability or lack of municipal water and/or sewer, and natural constraints upon the land. In addition, previous to the 1998 ordinance, there were only two commercial zoning districts prior which did not reflect the unique issues presented by commercial development in discrete areas of the town. The 1998 Zoning Ordinance established a total of 22 districts: 8 residential districts, 9 commercial districts, 3 industrial districts and 2 special districts. In addition to these districts, there are 5 overlay districts, which were created to protect resources, reduce hazards and permit certain types of prescribed developments which would otherwise not be allowed (Town of Westerly 2009).

3.13 Hazardous, Toxic, and Radioactive Waste

In anticipation of potential structural measures being undertaken in the Westerly project area (e.g., beach nourishment, floodwall, tide gate), a search of federal and state environmental databases was conducted for a corridor study along the shoreline. The researched area was approximately one mile west, east, north, and south of the proposed shoreline in Westerly. Governmental agency records were reviewed for information that would be helpful in determining the environmental status, the presence, or potential of hazardous, toxic, or radioactive waste (HTRW) contamination.

Hazardous waste spills have been documented in the Crandall, Noyes Avenue and White Rock wellhead protection areas (URI 2003 in Town of Westerly 2009). As of 2006, the RIDEM had inventoried 38 leaking underground storage tanks, several of which are located within Westerly‘s aquifer recharge and wellhead protection areas (Town of Westerly 2009). Elevated levels of nitrates and bacteria, which can result from failing septic systems, have been detected in the system (URI 2003 in Town of Westerly 2009). Research at the University of Rhode Island estimates that septic systems account for more than 50 percent of all nitrogen entering the watershed as recharge groundwater (Pawcatuck Watershed Partnership 1998 in Town of Westerly 2009). The Noyes Avenue and White Rock well head protection areas have both experienced chemical contamination events from fuel spills. The wells in the system have also exhibited elevated levels of sodium, resulting from winter road salting (URI 2003 in Town of Westerly 2009).

A governmental agency records search was not accomplished for the remainder of Washington County since only nonstructural measures (e.g., flood proofing, house elevations) were proposed in the area. An evaluation of the potential for hazardous, toxic, or radioactive waste (HTRW) contamination or underground tanks will be accomplished during the detailed planning phase of the project for individual houses proposed for elevation.

3.14 Aesthetic and Scenic Resources

The southern coast of Rhode Island includes a string of salt ponds, wetlands, barrier beaches and dunes, rocky shores and bluffs, upland fields and woodlands. A number of valuable water resources in the watershed provide unique habitats for numerous rare and endangered species and recreational opportunities to residents and visitors. Beautiful coastal vistas and scenic views undoubtedly contribute to the increase in visitors to South County during the summer months.

3.15 Recreation

The study area is located in the Coastal Lowlands Region which is characterized by low, rounded slopes with fewer trees, sandy beaches and salt ponds. A large network of federal, state and local public access sites support a host of outdoor activities such as biking, hiking, boating, fishing, birdwatching, whale watching, golf, surfing, diving, canoeing, kayaking, riding, etc. The barrier beaches, which separate land from sea along much of the state's southern shoreline, are heavily utilized during the summer drawing over 1.9 million visitors each year, including many out of state visitors. Rhode Island’s freshwater swamps, marshes, bogs, ponds, lakes, reservoirs, and 1,498 miles of rivers and streams attract kayakers, canoeists, swimmers and fishers as well as motor boaters. It is anticipated that the demands for recreation and leisure activities will likely continue to increase in the coastal region (Rhode Island Statewide Planning Program 2009).

A more detailed analysis of recreational opportunities was undertaken for the Westerly project since structural measures were proposed in that area. The town of Westerly has four golf courses located in the southern portion of the town and eight marinas located along the Pawcatuck River.

Beaches are located along most of the town‘s shoreline. There are also parks and other recreation areas, cemeteries, and vacant land protected from development by conservation easements or other permanent protection. The largest single tract of vacant land is the Woody Hill Wildlife Management Area. Other tracts have been acquired and preserved by the Westerly Municipal Land Trust and private conservation organizations. Westerly contains approximately 31.2 square miles (19,967 acres) of land area. These land use categories account for 4,112 acres of land or 20.6 percent of the town‘s area (Town of Westerly 2009).

3.16 Air Quality

In accordance with the Clean Air Act of 1977, as amended, the US Environmental Protection Agency (USEPA) developed National Ambient Air Quality Standards (NAAQS) to establish the maximum allowable atmospheric concentrations of pollutants that may occur while ensuring protection of public health and welfare, and with a reasonable margin of safety. The USEPA measures community-wide air quality based on NAAQS measured concentrations of six criteria air pollutants; carbon monoxide, sulfur dioxide, respirable particulate matter, lead, nitrogen dioxide, and ozone. Utilizing this information, the USEPA designates attainment areas and non-attainment areas nationwide. Non-attainment areas are designated in areas where air pollution levels persistently exceed the national ambient air quality standards. The Project area is located in Washington County, Rhode Island which meets the attainment criteria for all NAAQS priority pollutants (USEPA 2016a).

The state of Rhode Island is located within the Ozone Transport Region (OTR) which extends northeast from Maryland and includes all six New England states. The interstate transport of air pollution from other states can contribute significantly to violations of the 2008 ozone NAAQS within the OTR. Under the Clean Air Act (CAA), states within the OTR are required to submit a State Implementation Plan (SIP) and install a certain level of controls for the pollutants that form ozone, even if they meet the ozone standards. The state of Rhode Island has and approved SIP and has submitted periodic revisions to the EPA for approval in conformance with the CAA.

Fugitive dust and emissions from construction vehicles and related equipment is expected to be minor and temporary and should not have a significant impact to local air quality. No changes in local or regional air quality should occur with the construction and operation of the proposed project.

3.17 Greenhouse Gases (GHGS)

Greenhouse gases trap heat within the earth's atmosphere which can increase temperatures. The largest source of greenhouse gas emissions from human activities in the United States is from burning fossil fuels for electricity, heat, and transportation (USEPA 2016b).

3.18 Noise

Noise is defined as unwanted sound. The day-night noise level (Ldn) is widely used to describe noise levels in any given community (USEPA 1978). The unit of measurement for Ldn is the "A"-weighted decibel (dBA), which closely approximates the frequency responses of human hearing. The primary source of noise in the study area is vehicular traffic on local roadways and local construction projects that may be underway. Although noise level measurements have not been obtained in the study area, they can be approximated based on existing land uses. The typical Ldn in residential areas ranges from 39 to 59 dBA (USEPA 1978). It is assumed that the existing sound levels in the study area are roughly within this range.

Chapter 4: Plan Formulation

The 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Implementation Studies (Principles and Guidelines) laid out an iterative 6-step planning process used for all USACE Civil Works studies in developing and evaluation of alternatives. For coastal storm risk management problems, the study team develops and evaluates potential alternatives consistent with USACE policy, regulations, and guidance. From the range of alternatives compared, the team will identify the plan with the highest net National Economic Development (NED) benefits while protecting the Nation's environment.

4.1 Problem and Opportunity Statements

The problem and opportunity statements and discussion provided below set the focus of the feasibility study. These statements are developed at the start of the study and lead to the identification of the study objectives.

<u>Problems</u>

- Continued damage to residential and commercial property in the coastal floodplain due to hurricanes, tropical storms, and nor'easters
- Wave and flood damage along the immediate coast line
- Storm surge flooding along the backshore of the coastal ponds
- Continued loss of natural barrier beaches due to coastal storms on top of rising sea levels

- Despite changing sea levels and coastlines, coastal property still commands high prices and generates high tax revenues and there is resistance to radical changes to these areas
-

<u>Opportunities:</u>

- Reduce the threat of damages to existing residential and commercial property caused by coastal storms
- Improve the overall resiliency of the south coast of Rhode Island in the wake of coastal storms

The general water resource problem to be addressed is the vulnerability of the south coast of Rhode Island to storm damage from storm surge and wave attack (erosion to a lesser extent). These forces constitute a risk of flood damages to public and private property.

Due to the geography of southern New England in relation to the Atlantic coast, Rhode Island is vulnerable to both extra-tropical storms such as nor'easters, and tropical storms such as hurricanes. Historically, most hurricanes striking the New England region have curved northward on tracks which paralleled the eastern seaboard maintaining a slight north northeast track direction. The State of Rhode Island geographically projects eastward into the Atlantic with a southern exposed shoreline; placing it directly in the path of any storms tracking along the eastern seaboard.

The arrival of Hurricane Sandy on October 29, 2012 was preceded by Coastal Flood Warnings and mandatory evacuations in Rhode Island for coastal towns, low lying areas and mobile homes. Major evacuations from Rhode Island towns along Narragansett Bay and the Southern Atlantic Coast included Bristol, Charlestown, Fall River Middletown, Narragansett, South Kingston, Tiverton and Westerly.

The storm surge of Hurricane Sandy destroyed houses and businesses, damaged pilings and deck supports, blew out walls on lower levels, and moved significant amounts of sand and debris into homes, businesses, streets, and adjacent coastal ponds. Propane gas tanks were dislodged from houses, septic systems were damaged and underground septic tanks were exposed, creating potential hazardous material exposure. The National Guard was called out to restrict entry to the community of Misquamicut (located in the town of Westerly) due to the devastation.

The Westerly Sun newspaper reported that "houses were ripped from their stilts and deposited in the streets while other structures appeared precariously perched over the ocean." In some areas, roads were either flooded or covered in three feet of sand.

More than $39.4 million in support from four Federal disaster relief programs was used to assist Rhode Island's recovery efforts from Hurricane Sandy. A more detailed discussion of storm damage is contained in Section 4 of Appendix B.

The table below shows the number of structures, by town, that are vulnerable to coastal storms along Rhode Island's south coast. Figure 10 shows property damage after Hurricane Sandy in 2012.

Table 7. Number of Structures in the Floodplain

Town	1% Chance Floodplain	0.2% Chance
Narragansett	1,000	1,800
South Kingstown	1,200	1,500
Charlestown	900	1,300
Westerly	1,700	2,100
TOTAL	4,800	6,700

Figure 10. Damaged Home after Hurricane Sandy (October 2012)

4.2 Planning Goals/Objectives

The project goal is to provide coastal storm risk management for the south coast of Rhode Island study area. Plans are formulated to achieve **planning objectives.** Planning objectives and constraints are generated from the problems and opportunity statements. A planning objective asserts the intended purposes of the planning process and is a statement of what solutions should try to achieve.

<u>Goal</u>

- Provide Coastal Storm Risk Management for the Study Area

<u>Planning Objectives</u>

- Reduce Coastal Storm Damage to Coastal Floodplain Properties
- Reduce Emergency Response Costs
- Maintain or Improve Natural Coastal Floodplain

4.3 Planning Constraints

Constraints are restrictions that limit the extent of the planning process. They can be divided into **general constraints** and **study-specific constraints**. General planning constraints are the technical, legal, and policy constraints to be included in every planning study that are recognized in the development of alternatives, but not explicitly used to eliminate alternatives in the screening process. Study-specific planning constraints are statements identified in particular for the study that are used to specifically screen alternatives.

<u>General Constraints</u>

- Plans should be formulated and evaluated in compliance with USACE regulations and NEPA.
- Plans should avoid and minimize environmental impacts to the maximum degree practicable.
- Plans should not adversely impact threatened or endangered species, and their habitat.
- Plans should be compliant with all Federal environmental laws, Executive Orders, and guidance.
- Plans should represent sound, safe, and acceptable engineering solutions.

<u>Study Specific Constraints</u>

- The plans should not restrict or significantly alter current shoreline/ocean access and use;

- Elevation (nonstructural) of property must be to an elevation, at a minimum, equal to the 1% recurrence level +1-foot, per ECB 2013-33 (further refinement of structure target elevations may be conducted during the final design phase); and
- Viable (proximity & longevity) sources of sand for beach fill solutions.

4.4 Future Without Project Condition

The future without project condition serves as the base condition to use as a comparison for all the other alternatives. The future without project condition within the period of analysis (2020-2070) for this study is identified as continued damages to coastal floodplain structures and property from future storm events. This will result in continued maintenance and reconstruction of residential and commercial property.

4.4.1 Environmental Without Project Conditions

In the absence of Federal action, existing coastal floodplain properties will remain at risk from coastal storm damage. Some individual property owners may continue to implement solutions and/or state or Federal agencies may implement individual erosion control projects or repairs as needed but the area would continue to experience storm damage due to flood inundation, wave effects, and erosion. The effects of climate change (e.g., sea level rise, increased storm activity) may increase damages and erosion of barrier beaches and sedimentation of coastal lagoons along the coast of Rhode Island. In addition, there may be some impacts to wetland, flora and fauna, threatened and endangered species, HTRW, etc. over the study time period. However, the location, intensity and magnitude of impact to environmental resources is dependent on specific storm events (see Chapter 6 for a more detailed description of impacts to natural resources).

4.4.2 Economic and Social Without Project Conditions

Much of the coastal floodplain in the study area is already developed; there are limited opportunities for new expansion. There are a few vacant parcels spread throughout the study reach, most of which are behind the barriers and strictly regulated in terms of development. The total value of the existing residential and commercial inventory in the study area is estimated to be close to $400 million.

It is assumed that in the absence of a Federal project, homeowners and businesses will continue individual efforts to repair damages after coastal storms. In the event a residential or commercial structure sustains damage equal to or greater than 50% of its depreciated replacement cost, it is assumed that the structure will be flood proofed (e.g. elevated) in accordance with NFIP and local rules. Other coastal storm damage (e.g. road repair and clean-up, debris removal) will continue to occur.

4.4.3 Estimate of Future Without Project Damages

In order to estimate damages in the Without Project condition in Westerly, the USACE Beach-fx software was utilized. Beach-fx was developed by the USACE Engineering Research and Development Center (ERDC) in Vicksburg, Mississippi. Coastal modeling to provide the storm response data base for Beach-fx was performed using SBEACH software (Storm-induced Beach Change Model). This model simulates cross-shore beach, berm, and dune erosion produced by storm waves and water levels. The storm suite used for the study area was developed from The North Atlantic Coast Comprehensive Study (NACCS) information. The NACCS modeling efforts included the latest atmospheric, wave, and storm surge modeling and external statistical analysis techniques. Products from this work include simulated winds, waves, and water levels for approximately 1,050 synthetic tropical events and 100 extratropical events computed at over 3 million computational locations. (See Appendix C, Coastal Engineering.)

The Beach-fx model links the predictive capability of coastal evolution modeling performed with project area infrastructure information, structure and content damage functions, and economic valuations to estimate the costs and total damages under various shore risk management alternatives. Beach-fx fully incorporates risk and uncertainty, and is used to simulate future hurricane and storm damages at existing and future years and to compute accumulated present worth damages and costs. Beach-fx is an event-driven life-cycle model that estimates damages and associated costs over the 50-year period of analysis based on storm probabilities, tidal cycle, tidal phase, beach morphology and many other factors. Damages or losses to developed shorelines include buildings, parking lots, roads, seawalls, revetments, and bulkheads.

Typically, the shoreline being modeled under Beach-fx is a long, straight beach area (typical for the south facing coast of Rhode Island), or a single pocket cove.

Only the Westerly damage zone was analyzed using Beach-fx as it was determined early in the study through a process of screening alternatives that only this area sustained sufficient damages to support costly structural storm risk management measures (e.g. beach fills, walls, tide gates, etc.) and Beach-fx was the best tool to integrate the various damage modes that might occur in the reach (e.g. flood, wave, and erosion).

The other three towns of Charlestown, South Kingstown, and Narragansett, were found to only warrant nonstructural measures for further evaluation. Damages in those towns were therefore estimated using a more standard USACE certified model, HEC-FDA (Flood Damage Analysis). Developed by the USACE Hydrologic Engineering Center, the software provides the capability to perform an integrated hydrologic engineering and economic analysis during the formulation and evaluation of flood risk management plans and is especially useful in evaluating the single damage mode (flooding) in those damage areas.

Future Without Project Condition Damages. The Beach-fx (Westerly) and the HEC-FDA (all other damage areas) models were used to estimate damages to the assets over the 50 year period of analysis with no Federal action (i.e. the "future without project condition" (FWOP)). For the alternatives evaluation and comparison a low rate of sea level rise was assumed. Detailed information on the damage inventory, damage calculations, and Beach-fx are provided in Appendix B, Economics.

Table 8 provides a summary of structure, content, and armor damages for the FWOP. Structure damages include damages to commercial and residential buildings. Content damages, includes damages to material items housed within the buildings. Armor damages include damages to the existing armor protection structures. No land loss or traffic delay costs were included as they were relatively small.

Table 9 provides the annualized damages for the four towns.

Table 8. Total Estimated Damages (2020-2070) Without-Project Condition

Study Area	Structure/Content Damage	Armor Damage	Total Damage
Westerly	$66,588,000	$9,419,000*	$76,007,000
Charlestown	$47,220,000	-	$47,220,000
South Kingstown	$210,777,000	-	$210,777,000
Narragansett	$173,096,000	-	$173,096,000
Total	$497,681,000	$9,419,000	$507,100,000

*Armor damage shown calculated using Beach-fx; all others values shown calculated using HEC-FDA.

Table 9. Without-Project Average Annual Damages

Study Area	Average Annual Damage	Average Annual Armor Damage	Average Annual Total Damage
Westerly	$2,527,000	$375,000	$2,902,000
Charlestown	$1,792,000	-	$1,792,000

South Kingstown	**$7,999,000**	**-**	**$7,999,000**
Narragansett	**$6,569,000**	**-**	**$6,569,000**
Total	**$18,887,000**	**$375,000**	**$19,262,000**

Note: Federal Water Resources Discount Rate FY17, 2.875%

4.5 Key Uncertainties

Limitations to the quantity and quality of information result in uncertainties. Six major uncertainties in this phase of the planning process are:

Uncertainty of future sand supplies. Beach fill alternatives may not be feasible if a suitable sand source is too expensive and/or not available for project construction and periodic re-nourishment. Based upon the quantities of sand identified in the development of the study it is assumed that sand could be supplied both from an offshore source (to be determined) and upland sources. There are currently no known or permitted offshore sand sources. Both options will be analyzed but only those alternatives that can support the more expensive trucked sand alternative will be carried forward for further consideration given the uncertainties associated with obtaining approvals for the mining of suitable material from an offshore location.

Survey Data. No topographic surveys were completed for individual properties. Instead, available data and remote sensing techniques were used. This is an inherent data uncertainty but it was cost prohibitive to obtain detailed surveys for so many structures (~4,000).

Stage-Frequency Information. Stage-frequency information was obtained from two different sources (NACCS, FEMA FIRMs) none of which is exact. The NACCS water level information does not include wave effects. Since it was only used to evaluate structural measures in Beach-fx and SBEACH modeling develops the waves for Beach-fx, this was not seen as an issue. For the flooded areas behind the barriers and coastal ponds, solid water surface data is not readily available. The PDT used the Flood Insurance data to develop stage-frequency curves for the various flood zones shown on the Flood Insurance maps. Though not a substitute for 2-dimensional modeling that could be developed for these areas, the method is solid and provides wave induced stage-frequency information for the backshore.

Sea Level Change (SLC). The rate of SLC in future years is not known, but there are several projections of what may occur varying from low (historic) to high rate of change projections. This uncertainty will be addressed by considering three rates of rise per USACE guidance in ER 1100-2-8162 (31 December 2013) and Engineering Technical Letter 1100-2-1 (30 June 2014).

Based on historical climate data for the area and professional judgment, the economic damages were initially calculated assuming the low (historic) rate of SLC, which generally provides a conservative estimate of damages that will be used for alternatives comparison. The Tentatively Selected Plan (TSP) was evaluated under both the intermediate and the high rates of SLC as a sensitivity analysis prior to release of the draft report.

Subsurface Investigations. Existing information was used from the Westerly study area to characterize the subsurface conditions for the wall and tide gate designs.

Real Estate Risk (private property). Most of the study area is privately owned. Ownership issues and current public access improvement requirements for USACE projects contribute to uncertainties related to local acceptability and the schedule for project implementation. Also, no detailed appraisals were conducted at this level of study; instead the PDT relied on assessor's data (assessed values and depreciated replacement cost) for its evaluations.

4.6 Management Measures – Screening of Candidate Measures

Strategies to address coastal storm risk include accommodation, retreat, and no action (USACE 2015). To enact these strategies, structural measures (physical modifications designed to reduce the frequency of damaging levels of flood inundation) and nonstructural measures (actions to reduce flood damages without significantly altering the nature or extent of flooding) may be deployed. Examples of accommodation include the elevation of structures at risk (nonstructural) or the construction of seawalls, bulkheads, revetments, breakwaters, groins, etc., which are all considered hard structural measures. Beach nourishment is also a structural measure, but it is considered a soft structural measure. Retreat measures consist of moving at-risk structures back from the shoreline and/or property buy-outs (nonstructural).

In the 1950s and 1960s, USACE favored hard structures for reducing the risk of beach erosion. The armoring measures are excellent for protecting property, however, the hard structures can result in increased erosion in front and on the sides of the armor. Also, armoring prevents the natural processes of sand migration. Groins are similar in that they hold sand on one side of the structure (up-drift), but lose sand on the other side (down-drift). Since the 1970s, soft alternatives have been favored over hard structures and are more often selected for risk management projects.

Measures to reduce coastal storm damages considered for this project are discussed below. The measures can be used individually or combined with other management measures to form alternative plans. The list of measures considered was derived from a variety of sources including prior studies, the public scoping process, and the study team's experience. All measures were screened for their capability to meet objectives, be feasible economically, be constructible, and avoid constraints to be included in the Initial Alternatives Array.

Structural Measures:

Storm Surge Barrier

This structural measure was eliminated from further consideration due to the nature of the coastline involved (sandy, low lying shore), the environmental impacts associated with them, extremely large costs, navigation and coastal use constraints.

Beach Fill and Dunes

This structural measure was retained as it has proved a successful coastal storm risk management feature and fits within the current coastal landscape and use. Sufficient sand sources to construct and maintain these features will be difficult to obtain. Dredging sand from the coastal ponds and offshore sources will be examined further.

Breakwaters and Groins with Beach Restoration

Hardening the shoreline with these structures will prove to be very expensive, can interrupt the natural movement of sand through the study area, impede coastal use, and cause undue environmental harm. The measure was not retained for further consideration.

Shoreline Stabilization

Hardened revetments were not considered for the same reasons outlined above for breakwaters and groins. However, cobble berms or "dynamic" revetments have proven successful in other parts of the country. This feature was examined economically for the Matunuck area in South Kingstown and found to lack sufficient benefits to be considered further.

Small individual levees, berms and floodwalls

These structures function in the same manner as structural project levees, berms and floodwalls but are much less extensive. Small levees or floodwalls are usually built to ring a single building or a few adjacent buildings. These measures are intended to reduce the flood risk but not eliminate floodplain management and flood insurance requirements.

This measure was excluded from further evaluation. The buildings in these damage zones are relatively close to each other and are intermixed with wetlands so it is unlikely that the measure could be implemented from a practical and regulatory standpoint.

Seawalls/Walls/Dikes/Tide Gates

Seawalls along the barrier beaches were found to be too expensive to support the benefits of these moderate to low populated areas. However, small sheet walls may make sense in the Misquamicut village area of Westerly to protect property from flooding of Winnapaug Pond. This measure was retained for further consideration as they could be used to protect against flanking flood waters. An earthen dike structure in the Sand Hill Cove area of Narragansett was determined to be economically infeasible and dropped from further consideration.

Nonstructural Measures:

Elevating Buildings

Other than relocating a building entirely from the coastal storm hazard area, elevating buildings is the nonstructural measure (doesn't modify the flood) that provides the greatest flood risk management. Local building codes determine the maximum height to which a structure can be elevated.

Buildings would be elevated on solid concrete foundation walls (AE-zone) or appropriately designed piers (VE-zone). If the foundation below the first floor is an enclosed perimeter, then appropriately sized vents must be included to allow flooding of the space below the first floor to balance static water pressures. Appropriate access to the elevated first floor will be provided and all utilities, including furnaces and electrical panels, will be elevated.

Preliminary economic analysis of this measure showed promise.

Acquisition/Relocation

This measure requires purchasing impacted properties outright or physically moving the building and buying the land upon which the building is located. In both cases the impacted property reverts to protected open space. Development of acquisition and relocation plans to achieve the planning objectives and retain such aspects as community tax base and neighborhood cohesion can be part of any acquisition/relocation project. This measure may be applicable anywhere within the study area. Cost (especially outright acquisition), structural integrity of the building and land availability will be the primary deciding factors on whether this is a viable alternative.

Preliminary economic analysis of this measure showed marginal promise. Until more specific information is developed, this measure was retained for further evaluation.

Dry Flood Proofing

This measure waterproofs the building envelope. This measure can provide flood risk management for residential and commercial buildings but it is recognized for flood insurance purposes by the NFIP only for commercial buildings. Masonry or concrete buildings can generally be dry flood proofed up to design depth of 3 to 4 feet. This concept does not work with basements or with crawl spaces. For buildings with basements and/or crawlspaces, dry flood proofing could only be considered if the first floor is made impermeable to floodwater.

The measure was retained for further evaluation as there are a number of commercial structures in the study area that may benefit from it.

Wet Flood Proofing

As a stand-alone measure, all construction materials and finishing materials are required to be water resistant. Flood vents are installed in the walls to allow floodwaters into the building and equalize the hydrostatic forces. All utilities must be elevated above the design flood elevation. Due to these requirements, wet flood proofing of finished residential buildings is generally not recommended. Wet flood proofing is applicable to commercial and industrial buildings when combined with a flood warning, flood preparedness and flood response plan. This measure is generally not applicable to large flood depths and high velocity flows.

Similar to dry flood proofing, there may be some merit to wet flood proofing some of the identified commercial structures.

Flood Warning Systems and Flood Preparedness Plans

These measures are applicable to the entire study area. All of the above nonstructural measures, with the exception of buyout and relocation to a completely flood-free site, should be combined with the development and implementation of flood warning and preparedness planning.

Comprehensive storm warning systems and evacuation plans are currently in place, therefore, the measure was not retained for further evaluation.

National Flood Insurance Program (NFIP), Land Use Development Rights/Regulations & Community Response Education

Flood mitigation and floodplain regulation parts of the NFIP are the two measures that reduce flood risk. Five mitigation programs exist within the NFIP. They are the hazard mitigation grant program (HMGP), pre-disaster mitigation grant program, flood mitigation assistance program, repetitive loss program, and severe repetitive loss program. Within the floodplain regulation part of the NFIP, this serves as a nonstructural mitigation measure indirectly through adoption of minimum floodplain management standards by communities participating in the NFIP. While theoretically these minimum floodplain management standards are good, in reality the focus on the 1% AEP and has actually promoted development and increased flood risk within those floodplains occupied.

Comprehensive flood insurance is available and educational programs are being developed (at least in Westerly). This measure was not retained for further evaluation.

Natural and Nature-Based Features

Though not a stand-alone measure, NNBF was looked at as a complimentary measure to some of the structural measures that were retained. The high energy environment (storm surge and waves) and relatively deep ocean waters just off the coast of the study area does not lend itself to NNBF measures for the beach fill, wall, or revetment measures. Nor does NNBF work well with the structures along the backshore of coastal ponds. These areas do not have much room for NNBF due to the proximity of residential property to the water and the unacceptable loss of coastal pond habitat. These measures were not retained for further evaluation

4.7 Initial Alternatives Array – Evaluation of Retained Measures

Management measures retained in the Initial Measures Array were evaluated for inclusion in the Final Alternatives Array based on the degree to which the alternative meets the project objectives and minimizes or avoids project constraints. The objective of maintaining/improving the coastal floodplain, while considered, was not used as a basis for screening out a particular alternative. Specifically, measures were further evaluated based on the ability of the measure to reduce storm induced damages, be cost effective, be efficient, and minimize environmental impacts. Also considered were property ownership and State and Local environmental agencies input regarding solutions. The Initial Measures Array are evaluated in Table 10.

Table 10. Evaluation of Initial Measures

		Objectives			Feasibility				
		Reduce coastal storm hazards & damages?	Provide protection for health/safety?	Maintain or improve the natural coastal floodplain?	Feasible to design & construct?	Economically feasible?	Restrict or significantly alter current coastal access & use?	Negatively impact existing storm Protection structures?	Retained for Further Evaluation?
Structural	Storm Surge Barrier[1]	Yes	Yes	No	Yes	No	Yes	Yes	No
	Beach Fill and Dunes[2]	Yes	Yes	Yes	Yes	Yes	No	No	Yes
	Breakwater w/Beach Restoration	Yes	Yes	No	Yes	No	Yes	No	No
	Groins w/Beach Restoration	Yes	Yes	No	Yes	No	Yes	No	No
	Jetty Extension w/Sand Bypass	Yes	Yes	No	Yes	No	Yes	No	No
	Shoreline Stabilization (Cobble Berm)	Yes	Yes	No	Yes	No	No	No	No
	Small individual levees, berms or walls	Yes	Yes	No	No	No	No	No	No
	Seawall/Walls/Dikes/Tide Gates[3]	Yes	Yes	No	Yes	Yes	Yes	No	Yes
Nonstructural	Elevation	Yes	Yes	No	Yes	Yes	No	No	Yes
	Acquisition/Relocation	Yes	Yes	Yes	Yes	Yes	No	No	Yes
	Flood proofing (dry & wet)	Yes	Yes	No	Yes	Yes	No	No	Yes
	Flood warning & Management plan[4]	Yes	Yes	Yes	Yes	Yes	No	No	No
	National Flood Insurance Program[4,5]	Yes	Yes	No	Yes	Yes	No	No	No
	Land Use Development Regulations[4]	Yes	Yes	Yes	Yes	Yes	No	No	No
	Community Education [4]	Yes	Yes	Yes	Yes	Yes	No	No	No
NNBF[5]	Living Shorelines	Yes	No	Yes	No	No	Yes	No	No
	Wetlands[6]	No	No	Yes	No	No	Yes	No	No
	Reefs	Yes	Yes	No	No	No	Yes	No	No

[1] The applicability of storm surge barriers cannot be determined based on shoreline type. It depends on other factors such as coastal geography.

[2] Beaches and dunes are also considered Natural and Nature-Based Features.

[3] Walls and gates found warranted for only the inlet and backshore area of Westerly.

[4] Requires implementation action by others for success.

[5] Only mitigation & regulation portions of the NFIP have the potential to reduce risk of damage and health/safety risk.

[6] Natural and Nature-Based Features. Wetlands could include sub-aquatic vegetation restoration.

4.8 Final Array of Alternative Plans

The Final Array of Alternative Plans for the study area were developed from the identified measures discussed above in Section 4.7. An alternative plan is a set of one or more management measures functioning together to address one or more planning objectives.

Using the preliminary economic analysis of the various damage areas and parametric cost estimates of the measures described above, the study team determined that the following final array of alternatives would be chosen for more detailed study. Beaches, cobble berms and dike alternatives evaluated in Charlestown, South Kingstown, and the Sand Hill Cove area of Narragansett were not economically justified due to the high cost of renourishment and smaller study areas containing lower structure values. A hurricane barrier was evaluated for the Point Judith area of Narragansett, but the high cost of construction and possible impacts to the existing federal navigation channel did not lead to a positive benefit-cost ratio (BCR). The only area that was able to support further analysis of structural measures was the Westerly area. The other three communities, though showing significant damages, contain development that is much more spread out geographically, and could not support the costs of the structural measures. Non-structural measures showed economic promise for all four towns.

Westerly:

1. **No Action Alternative**

Under this Alternative, no Federal action would be taken to protect the properties within Westerly. Failure to take action would result in further damage to residential and commercial property along the shore and around Winnapaug Pond. This without project condition alternative serves as the baseline against which the other alternatives in the area are evaluated. This alternative was run in both Beach-fx and in HEC-FDA and the results are documented in Tables 8 and 9.

2. **Beach Fill and Floodwalls in the Backshore (Misquamicut Village)**

The beach would extend 4,000 linear feet across the developed property in Misquamicut Village. Two different beach profiles were run for this alternative: a minimum profile (+12 feet NAVD88 dune crest, 50-foot wide berm @ +9 feet NAVD88, 51 cy/ft density) and a maximum profile (+14 feet NAVD88 dune crest, 100-foot wide berm @ +9 feet NAVD88, 138 cy/ft density). The beach would be constructed with a 1:10 sideslope that terminates at the -10 to -15-foot NAVD88 contour. Two new flanking steel sheet pile floodwalls would extend along the east (3,900 feet) and west (2,100 feet) sides of Misquamicut village with a crest elevation equal to the +10.5 feet NAVD88 (~2% AEP protection level). The walls would have retractable closure gates where they cross Atlantic Avenue.

3. Beach Fill Alone (Misquamicut Village)

The 4,000 linear feet beach is described in Alternative 2.

4. Beach Fill Alone (but larger)

This beach would extend the 4,000 linear foot beach by another 5,000 feet; providing coastal storm risk management for additional properties to the east of Misquamicut Village including the Misquamicut State Beach pavilion and parking area. Beach profiles were similar to those described in Alternative 2 above.

5. Beach Fill + West Floodwall + Tide Gate in the Breachway

This alternative would include the 9,000-foot beach fill project described in Alternative 4 and combine it with the West Floodwall described in Alternative 2 and a removable tide gate structure in the pond breachway. The tide gate would consist of several steel stop logs that would be inserted by crane into a concrete structure constructed across the breachway to Winnapaug Pond when the area is threatened by excessive storm surge. Once in place the tide gate would reduce the risk to the entire backshore area from flooding up to the +10.5 feet NAVD88 elevation. This alternative was seen as the most comprehensive solution of storm damage as it eliminates storm induced property damages to the shorefront homes and business in Misquamicut Village as well as all of the backshore damages that occur from flooding of the two abutting coastal ponds.

6. Non Structural Alternative (elevation and/or acquisition)

All of the structures in the Misquamicut coastal floodplain were analyzed to determine which would qualify for elevation and/or acquisition. Using topographic data for the area (2010 LIDAR) we determined the ground elevation for each structure and then determined the first floor elevation from assessor's photographs. All properties in the 1% AEP floodplain were evaluated using HEC-FDA software to determine the benefit-cost ratio (BCR) for each structure. For initial analysis, the target elevation was set to the Base Flood Elevation (BFE) plus 1 foot based on ECB 2013-33. A BCR of 0.9 or higher was considered appropriate to determine initial eligibility due to uncertainty in model parameters. Final eligibility will consider structures with a BCR between 0.9 and 1.0 only where they show neighborhood cohesion with other targeted structures.

Charlestown:

1. **No Action Alternative**

Under this Alternative, no Federal action would be taken to protect the properties within Charlestown.

2. **Non Structural Alternative (elevation and/or acquisition)**

All of the residential structures along Charlestown Beach have already been elevated. Therefore, the nonstructural analysis for this area focused on the backshore areas surrounding Ninigret, Green Hill, and Quonochontaug ponds. The analysis was performed as described previously for Westerly (Alternative #6).

South Kingstown:

1. **No Action Alternative**

Under this Alternative, no Federal action would be taken to protect the properties within South Kingstown.

2. **Non Structural Alternative (elevation and/or acquisition)**

The analysis was performed as described previously for Westerly (Alternative #6). The area is unusual in that it has several properties that have one owner but include many small residential structures that may be eligible for elevation or acquisition.

Narragansett:

1. **No Action Alternative**

Under this Alternative, no Federal action would be taken to protect the properties within Narragansett.

2. **Non Structural Alternative (elevation and/or acquisition)**

The analysis was performed as described previously for Westerly (Alternative #6). This area is unusual in that it has a very robust commercial fishing fleet (3rd largest in New England), ferry services to Block Island, many land based fishing businesses and a Coast Guard station located at the breachway to the pond. Most of these and other commercial establishments most likely can't be elevated. However, wet flood proofing opportunities may exist for some of these structures.

4.9 Costs for Alternatives

Detailed cost estimates for each alternative were developed in order to compare alternatives and calculate the Benefit/Cost Ratio for evaluation purposes. For Alternatives 2 thru 5 in Westerly, initial placement volumes and renourishment volumes (present value) were calculated in the Beach-fx model. Cost estimates are based on an estimated sand placement cost of $24/cy for dredged sand and $41/cy for trucked sand from an upland source. The rate includes pre-construction engineering and design, and construction management. Contingencies for the beach fill alternatives ranged from 34% to 41%. Costs for wall and tide gate alternatives were estimated using a conceptual design to determine material and quantities and include pre-construction engineering and design and construction management. Contingencies on these features ranged from 26% to 41%. Contingency percentages were estimated for the alternatives using the abbreviated cost risk methodology.

There were no mitigation costs associated with the wall and tide gate alternatives.

Real Estate Costs were estimated for the structural alternatives and include the permanent easement cost, incidental costs, and contingencies.

Elevation costs for six different structure types were estimated for both the AE and VE flood zones (see Table 11 below). Detailed cost information is provided in Appendix E. Evaluation of property acquisitions were estimated using the assessed value of the property as a surrogate for the comparable flood-free cost analysis. These costs were deemed to be comparable in most cases due to the high cost of coastal property in the area. The costs for acquisition also included a demolition/restoration cost of $100,000 for each property.

Table 11. Initial Estimated Costs of Typical Residential Structures

SAMPLE ELEVATION COSTS

A ZONE STRUCTURES	Base Cost	Contingency	Subtotal	PED & S/A	TOTAL	Notes
Simple ranch	$79,995	25.85%	$100,674	20%	$120,808	
Complicated raised ranch	$136,086	25.85%	$171,264	20%	$205,517	
Complicated 2 story with slab	$154,410	25.85%	$194,325	20%	$233,190	
Complicated 2 story with basement	$128,444	25.85%	$161,647	20%	$193,976	
Complicated 1 story ranch with basement	$93,069	25.85%	$117,127	20%	$140,553	
Simple 2 story	$92,635	25.85%	$116,581	20%	$139,897	
Average	*$114,107*		*$143,603*		*$172,324*	

V ZONE STRUCTURES	Base Cost	Contingency	Subtotal	PED & S/A	TOTAL	Notes
Simple ranch	$115,822	25.85%	$145,762	20%	$174,914	
Complicated raised ranch	$171,913	25.85%	$216,353	20%	$259,623	
Complicated 2 story with slab	$190,238	25.85%	$239,415	20%	$287,297	
Complicated 2 story with basement	$164,272	25.85%	$206,736	20%	$248,084	
Complicated 1 story ranch with basement	$128,896	25.85%	$162,216	20%	$194,659	
Simple 2 story	$128,462	25.85%	$161,669	20%	$194,003	
Average	*$149,934*		*$188,692*		*$226,430*	

4.10 Economic Evaluation and Comparison

The structural alternatives (only affecting Westerly) were evaluated using Beach-fx. All nonstructural alternatives, where depth of flooding was the main damage driver, were evaluated and compared using HEC-FDA modeling software. A proposed project is considered economically justified if the economic benefits of the project exceed the costs (e.g. if it has a benefit to cost ratio greater than 1.0). The project that reasonably maximizes the net economic benefits (i.e. highest net average annual benefits) while protecting the Nation's environment is identified as the National Economic Development "NED" plan.

As the study team began the detailed analysis it was decided that the structural alternatives listed above for Westerly first needed to be broken down into their individual measures for analysis. That way the team could determine what each measure was contributing to the overall benefit pool of an alternative. It was suspected that some of the measures did not make sense economically as their contributing benefits couldn't support their incremental costs.

The calculation of benefits (reduction in damages) for the structural alternatives in Westerly were evaluated using the Beach-fx model developed for the beach, wall, and tide gate measures. Damages for both the without and with project conditions were determined to calculate the reduction in damages achieved by each alternative. A 50-year planning period (2020-2070) and the FY16 discount rate of 3.125% were used for present value (PV) calculations. Table 12 lists the alternatives simulated in the initial modeling runs.

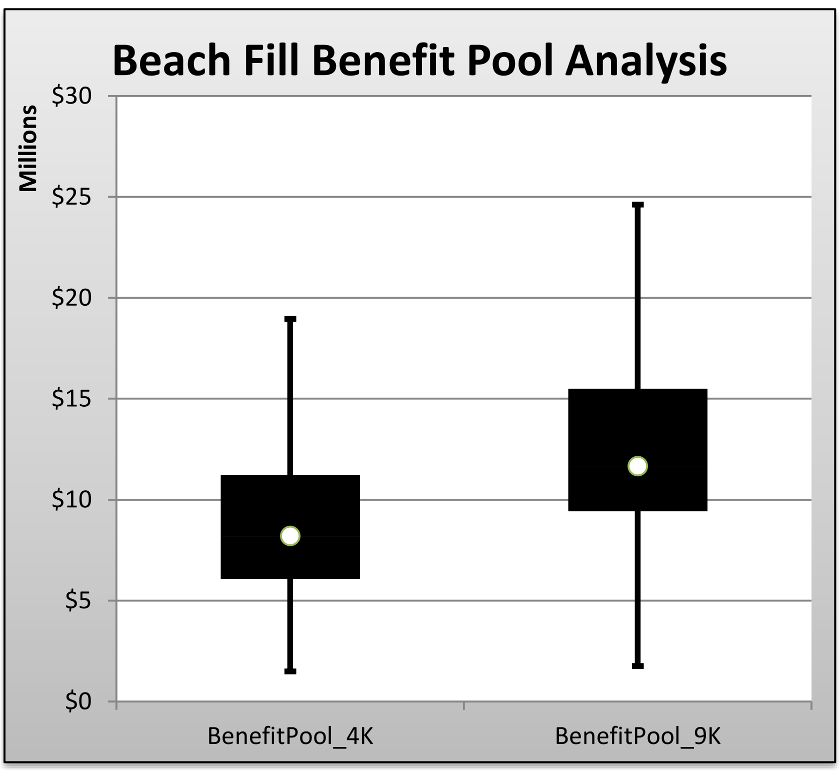
Table 12. List of Initial Modeling Runs for Westerly

Initial Run	Description
1	Without Project
2A	4,000' Beach – '4k'(dredged sand, minimum profile)
2B	4,000' Beach (trucked sand 'TH', minimum profile)
2C	4,000' Beach (dredged sand, maximum profile)
2D	4,000' Beach (trucked sand 'TH', maximum profile)
3A	9,000' Beach – '9k' (dredged sand, minimum profile)
3B	9,000' Beach (trucked sand 'TH', minimum profile)
3C	9,000' Beach (dredged sand, maximum profile)
3D	9,000' Beach (trucked sand 'TH', maximum profile)

4	West Floodwall
5	East Floodwall
6	East &West Floodwall
7	Tide Gate
8	Tide Gate – West Floodwall

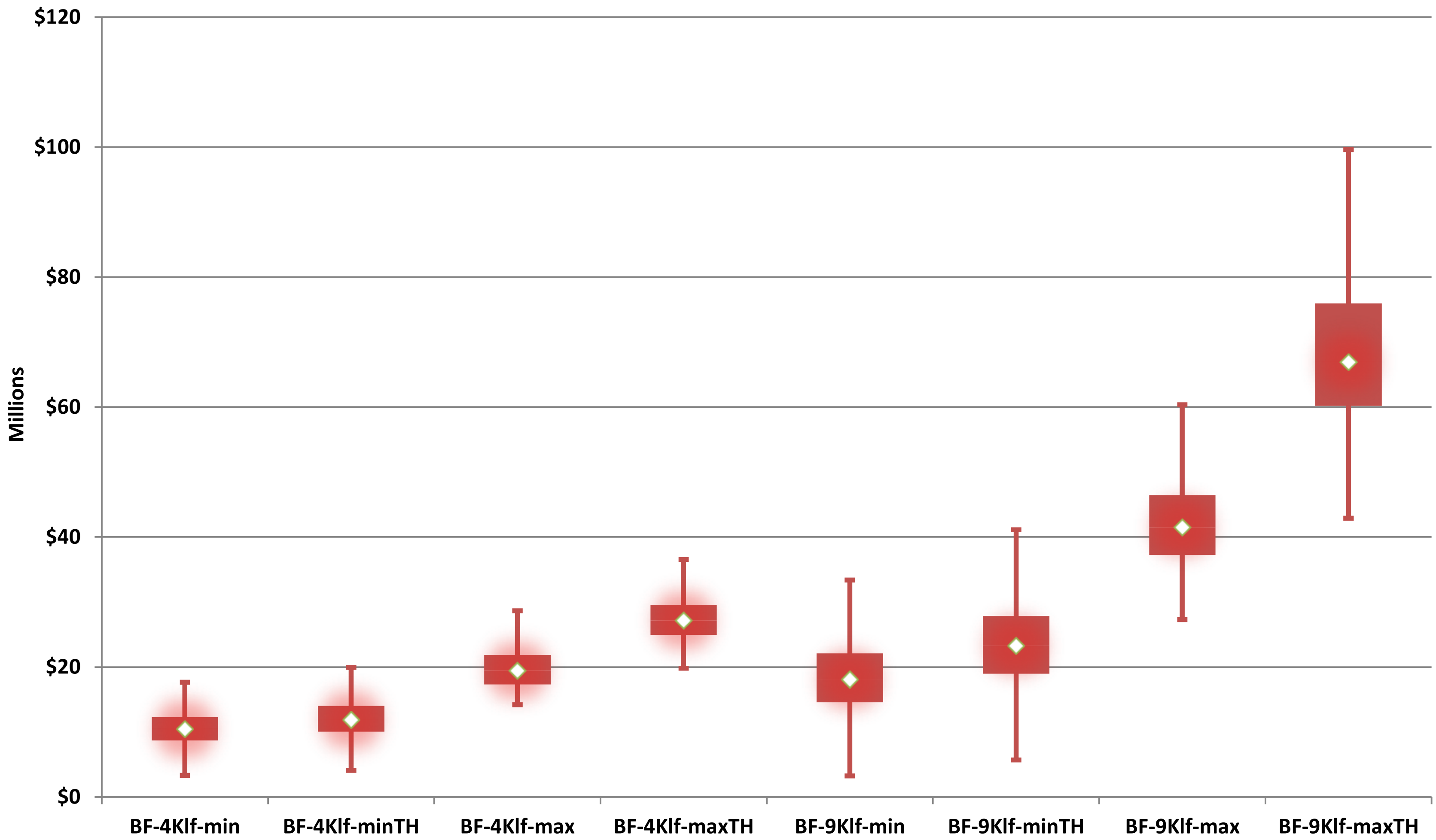
Average benefits (assuming all damages were eliminated) generated from these model runs for the 4,000-foot and 9,000-foot beaches, were $9million and $12.6million, respectively. This includes damages reduced for structures, contents, and armoring (existing revetments). The range of results for these runs is shown in Table 12 below. The table includes "box and whisker" plots showing the range of possible benefits including the mean/minimum/maximum values, and 25%-75% quartile ranges.

Table 13. Potential Range of Damages Reduced w/Beach Fill



The range of total sand fill costs (initial placement and all nourishment but no other costs) for the various beach fill (i.e. BF) runs are summarized in Table 14.

Table 14. Life Cycle (50 year) Sand Fill Summaries

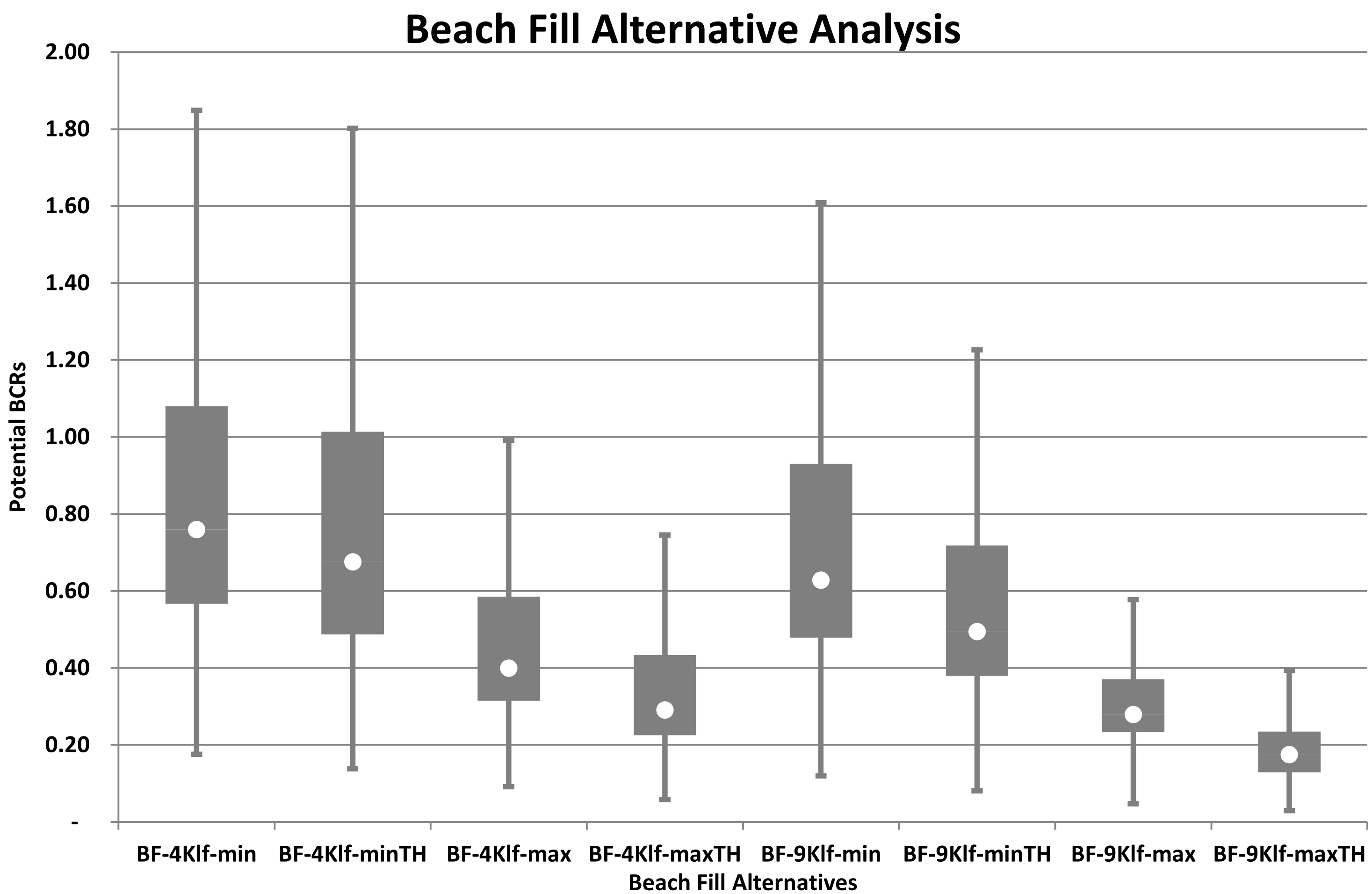


Key: BF-4K min = 4,000-foot beach fill, minimum profile, dredged sand

BF-4k max TH = 4,000-foot beach fill, maximum profile, trucked sand

Table 14 shows that the range of life cycle costs for a beach fill alternative from a low of about $10 million to a high of $65 million. The screening process showed that very few of the beach fill runs show economic viability; using the average cost resulted in none. A statistical summary of the range of potential benefit-cost ratios for the various Beach-fx modeling runs for the beach fill measures is shown in Table 15.

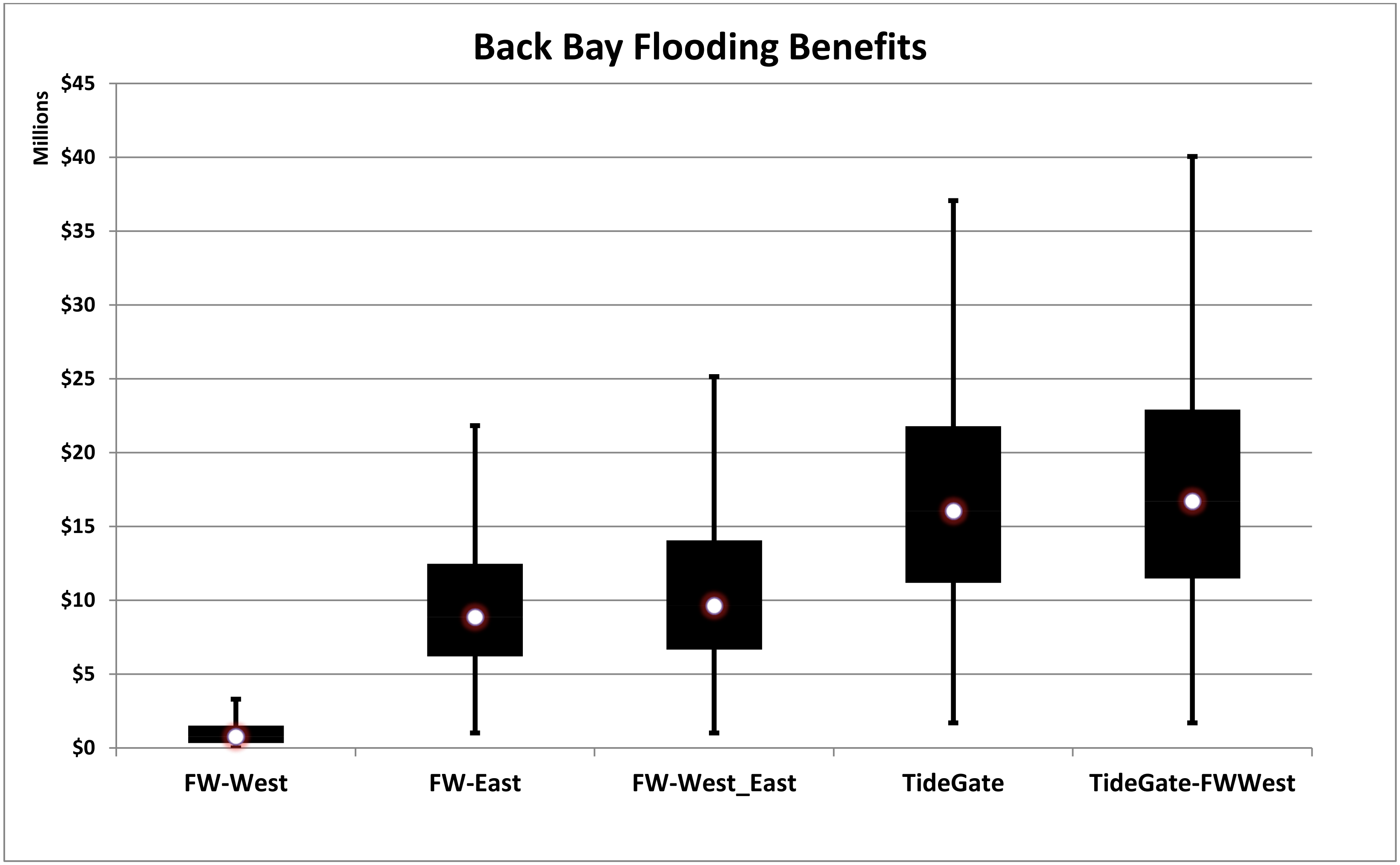
Table 15. Screening BCR's



The screening process assumed all damage was eliminated (no residual damages) and did not include the full costs of the measures (i.e. excluded Real Estate and IDC). The overall results show that the beach design parameters chosen ('min' and 'max') were just not robust enough to indicate a positive performance against future coastal storms. A beach profile greater than the 'max' beach profile does not make sense either as a larger beach will be very difficult to construct (enormous losses during construction) and the overall costs to construct will just increase as increased storm performance is sought. As a result, no further analysis of the beach fill measures was attempted.

Similarly, initial screening runs of the floodwalls (i.e. FW) and tide gate and their impact on reducing back shore flooding damages (structures and contents) in Westerly were analyzed. The range of total benefits associated with those measures are shown in Table 16.

Table 16. Benefits of Structural Walls and Tide Gate



Total costs for the various wall and tide gate measures were calculated to be:

Floodwall West	$ 4.8 million
Floodwall East	$ 9.3 million
Combined West/East	$14.7 million
Tide Gate	$14.1 million
Tide Gate & West Wall	$19.6 million

The resulting Benefit-Cost Analysis for the measures are summarized in Table 17 based on the mean of potential benefits.

Table 17. Floodwall and Tide Gate Alternatives - Benefit-Cost Analysis

Alternative	FW-West	FW-East	FW-West East	Tide Gate	Tide Gate - FWWest
Damages Reduced	$994,607	$9,484,110	$10,478,717	$16,569,778	$17,564,386
Annualized Benefits	$39,575	$377,373	$416,948	$659,311	$698,887
Annualized Costs	$191,308	$370,476	$582,951	$562,738	$779,731
Annual Net Benefits	**($151,733)**	**$6,897**	**($166,003)**	**$96,574**	($80,844)
BCR	**0.21**	**1.02**	**0.72**	**1.17**	**0.90**

Based on this initial analysis only the Tide Gate and East Floodwall were economically justified and retained.

Since alternatives 2, 3 and 4 of the original list of alternatives for Westerly included beach fills and beach fills were not found to be economically feasible, none of the original list of alternatives makes economic sense. However, the PDT did conclude that the Tide Gate and East Floodwall, as stand-alone projects, are economically viable and should be listed as economically viable solutions. Therefore, the list of alternatives was revised to include the following in Westerly.

1. No Action – Without Project Condition
2. East Floodwall
3. Tide Gate
4. Nonstructural (Elevation)

The calculation of benefits (reduction in damages) **for the nonstructural alternatives in all study reaches** were evaluated using HEC-FDA software. Damages for both the without and with project conditions were determined in order to calculate the reduction in damages achieved by either elevating structures or acquiring the properties outright. A 50-year planning period (2020-2070) and the FY16 discount rate of 3.125% were used for present value (PV) calculations. In every case, elevation of structures was the superior plan to acquisition due to the very high costs of property in the study area.

Westerly - Alternative 4

The Nonstructural evaluation in Westerly resulted in the following information.

Elevate 45 Structures:

Total Investment Cost: $8,771,600
Average Annual Cost: $349,000
Average Annual Benefit: $824,900
Annual Net Benefit: $475,900
BCR: 2.4

Nonstructural evaluations (Alternative 2) were performed in the other three towns as well. This was the only alternative evaluated against the without project condition in those areas.

Charlestown - Alternative 2

The Nonstructural evaluation in Charlestown resulted in the following information.

Elevate 44 Structures:

Total Investment Cost: $7,998,000
Average Annual Cost: $318,300
Average Annual Benefit: $732,000
Annual Net Benefit: $413,700
BCR: 2.3

South Kingstown - Alternative 2

The Nonstructural evaluation in South Kingstown resulted in the following information.

Elevate 172 Structures:

Total Investment Cost: $31,388,300
Average Annual Cost: $1,249,000
Average Annual Benefit: $4,492,300
Annual Net Benefit: $3,243,300
BCR: 3.6

Narragansett - Alternative 2

The Nonstructural evaluation in Narragansett resulted in the following information.

Elevate 80 Structures:

Total Investment Cost: $13,939,500
Average Annual Cost: $554,700
Average Annual Benefit: $1,479,800
Annual Net Benefit: $925,100
BCR: 2.7

4.11 Environmental

The Final Array of Alternative Plans for the study area were developed from the identified measures as previously discussed in Section 4.7. The only area that was able to support structural measures was the Westerly area. Nonstructural measures showed economic promise for all four towns.

A summary of the environmental impacts of each of the structural measures economically justified in Westerly and nonstructural measures proposed in all four communities are shown on Table 18. The only alternatives evaluated that might require mitigation due to permanent environmental impacts are the construction of the East Floodwall or the Tide Gate in Westerly. The wall has an estimated impact of 2,400 square feet on wetlands and the tide gate has an estimated impact of 5,400 square feet on sub-tidal habitat. It is unclear at this time if the sub-tidal impacts would need to be mitigated. No final cost for mitigation at the East Floodwall was calculated. It could be substantial; making a marginally justified alternative not justified. In-water work and beach fill would require additional environmental permitting (Section 404 and 401 of the Clean Water Act, Essential Fish Habitat Review pursuant to the Magnuson-Stevenson Act, and coordination with the National Marine Fisheries Service pursuant to the Endangered Species Act).

The nonstructural alternative has the least amount of impacts to natural resources as shown on Table 18. Structure elevations or dry flood proofing will occur within the same footprint of existing structures requiring only the minor removal of vegetation or tree trimming to enable equipment access, as needed. Any tree removal will comply with the U.S. Fish and Wildlife Service guidelines to avoid impacts to the northern long-eared bat (see Section 6.5 Federal Threatened and Endangered Species).

With regard to indirect impacts, there are three houses proposed for elevation located within 200, 500 and 900 feet of designated piping plover habitat (i.e., the beach located seaward of the Roger Wheeler State Park parking lot) and one house located within 200 feet of designated piping plover habitat East Beach in the Watch Hill area of Westerly. Indirect impacts to piping plover may occur due to construction activities although these potential impacts are not expected to be significant considering the level of on-going human related disturbances in the area associated with the Roger Wheeler State Park and East Beach, especially during the summer months (e.g., traffic, beach goers, swimming, etc.). Therefore, the proposed project may affect but is not likely to adversely affect this species because the effects to piping plover are expected to be insignificant or discountable. The U.S. Fish and Wildlife Service concurred with the USACE'S "not likely to adversely affect" determination in a letter dated December 14, 2017 pursuant to the Endangered Species Act (see Section 6.5 Federal Threatened and Endangered Species).

Table 18 – Comparison of Environmental Effects of Alternatives

		Final Array Alternatives					
		No Action *	Beach Fill and Floodwalls in Westerly	Beach Fill (4,000 linear feet) in Westerly	Beach Fill (9,000 linear feet) in Westerly	Beach Fill + West Floodwall + Tide Gate in the Breachway	Structure Elevation or Dry Flood Proofing in Westerly, Charlestown, South Kingstown and Narragansett
Environmental Resources							
Topography, Geology and Soils		Potential	Yes (topography/soil)	Yes (topography/soil)	Yes (topography/soil)	Yes (topography/soil)	No
Water							
	Hydrogeology/ Groundwater	Potential	No	No	No	No	No
	Surface Water	Potential	Yes (in-water work)	Yes (in-water work)	Yes (in-water work)	Yes (in-water work)	No
	Coastal Processes	Potential	Yes (sand fill and hard structural measures)	Yes (sand fill)	Yes (sand fill)	Yes (sand fill and hard structural measures)	No
Vegetation							
	Upland	Potential	Yes (vegetation burial/removal)	Potential (vegetation burial)	Potential (vegetation burial)	Yes (vegetation burial/removal)	Potential (vegetation removal or trimming for equipment access, as needed)
	Wetland (intertidal/subtidal)	Potential	Yes (fill in intertidal/subtidal)	Yes (fill in intertidal/subtidal)	Yes (fill in intertidal/subtidal)	Yes (fill in intertidal/subtidal)	No
Fish and Wildlife							
	Finfish	Potential	Yes (in-water work)	Yes (in-water work)	Yes (in-water work)	Yes (in-water work)	No
	Shellfish	Potential	Yes (burial/water quality)	Yes (burial/water quality)	Yes (burial/water quality)	Yes (burial/water quality)	No
	Benthic	Potential	Yes (burial)	Yes (burial)	Yes (burial)	Yes (burial)	No
	Reptiles/Amphibians	No	No	No	No	No	No
	Birds	Potential	Yes (feeding, resting disruption)	Yes (feeding resting disruption)	Yes (feeding, resting disruption)	Yes (feeding, resting disruption)	Yes (temporary displacement)
	Mammals	Potential	Yes (temporary displacement)	Yes (temporary displacement)	Yes (temporary displacement)	Yes (temporary displacement)	Yes (temporary displacement)
Threatened and Endangered Species							
	Federal	Potential	Yes (indirect)	Yes (indirect)	Yes (indirect)	Yes (indirect)	Yes (indirect)
	State	Potential	Potential	Potential	Potential	Potential	No
Essential Fish Habitat		Potential	Potential	Potential	Potential	Potential	No
Socioeconomics		Potential	Yes	Yes	Yes	Yes	Yes
Environmental Justice		No	No	No	No	No	No
Cultural		No	Potential	No	No	Potential	No
Coastal Zone Management		Potential	Yes	No	No	Yes	No
Land Use Zoning		Yes	Yes	No	No	Yes	No
HTRW		No	No	No	No	No	No
Aesthetic/Scenic		Potential	Yes (long-term)	Yes (short-term)	Yes (short-term)	Yes (long-term)	No

Recreation	Potential	Yes (short-term)	Yes (short-term)	Yes (short-term)	Yes (short-term)	No
Air Quality (NAAQS/GHG)	No	No	No	No	No	No
Noise	Yes (short-term)	Yes (short-term)	Yes (short-term)	Yes (short-term)	Yes (short-term)	Yes (short-term)

* The study area will continue to experience storm damage due to flood inundation, wave effects, and erosion. Although individual structures or natural resources may be affected over the 50-year life of the project, specific impacts are dependent on the intensity and location of storm events.

4.12 Other Social Effects Benefits and Regional Economic Development

In the Other Social Effects (OSE) category, the benefit of the alternatives are to reduce safety and health risks that occur during and after storms. Certainly a floodwall or tide gate that actually reduces flood inundation will result in the benefit of safeguarding health and safety and will also improve the recovery process. Elevating property or dry flood proofing will improve a building's ability to resist direct flood and other (mold) damage and that translates to improved safety as well. Structure elevation or dry flood proofing will and does not eliminate the need for evacuation when called to do so. It only improves the recovery process and cost after an event.

The Regional Economic Development Account (RED), reflect changes in the distribution of regional economic activity that result from each alternative plan. No items are identified that would impact the RED account.

4.13 Identification of Tentatively Selected Plan

The project that reasonably maximizes the net economic benefits (i.e. highest net average annual benefits) while protecting the Nation's environment is identified as the National Economic Development "NED" plan. To identify the NED plan, the alternative with the largest net benefit for each town was selected. This comparison identified Alternative 4 in Westerly and Alternative 2 in the communities of Charlestown, South Kingstown, and Narragansett as the alternatives that maximize net benefits and, therefore, the Tentatively Selected Plan (TSP). A summary of NED, Environmental Quality (EQ), OSE, and RED of the justified alternatives in Westerly is shown in Table 19. The environmental impacts are greatly reduced with the nonstructural alternative as discussed in Section 4.11 (see Table 18). The nonstructural plan in the other three towns is similarly reflected.

Table 19. – Comparison of Alternatives NED, EQ, OSE, and RED Accounts in Westerly

	No Action	Flood Wall East in Westerly	Tide Gate in Westerly	Structure Elevation or Flood Proofing in Westerly
NED (total annual residual damage)	$2.5million	Yes ($2.4million)	Yes ($2.2million)	Yes ($1.3million)

EQ	Potential impacts - severity dependent on future storm events	Short and long term direct and indirect impacts	Short and long term direct and indirect impacts	Potential minor short-term impacts
OSE	Existing social behavior: mitigate as funding allows, evacuation as necessary and clean-up from storm events	Yes, recovery efforts greatly reduced. Evacuation not eliminated.	Yes, recovery efforts greatly reduced. Evacuation not eliminated.	Yes, but recovery effort compared to structural alternatives greater. Evacuation not eliminated.
RED	Existing economic activity	Slight/temporary increase in local employment	Slight/temporary increase in local employment	Slight/temporary increase in local employment

The TSP would seek to elevate the first floors of approximately 341 residential structures above the Base Flood Elevation in the four communities. Economic benefits of the TSP are summarized below in Table 20. **The costs shown in this table reflect the "working estimates" available during the analysis and are slightly different (lower) than the updated costs (October 2017 price level) shown in the Executive Summary and Chapters 5 and 9 that follow.**

The TSP meets the 1983 Principles and Guidelines Criteria of completeness, effectiveness, efficiency, and acceptability. The plan includes all necessary components to obtain the objectives (complete), is the plan with the largest net benefits (efficient), the plan makes a significant contribution to the planning objectives to reduce coastal storm damages to development and is acceptable as a solution for reducing damages on the open coast that is adaptable to rising sea level. Optimization of the TSP occurred after public review of the draft IFREA.

Table 20. Tentatively Selected Plan, Annual Benefit and Cost Summary
(October 2015 Price Level, FY16 3.125 % discount rate, IDC applied)

	Westerly	**Charlestown**	**South Kingstown**	**Narragansett**	**All Towns**
Annual Benefit					
-Damage Reduction	$824,900	$732,000	$4,492,300	$1,479,800	$7,529,000
Annual Cost	$349,000	$318,300	$1,249,000	$554,700	$2,471,000
Annual Net Benefit	$475,900	$413,700	$3,243,300	$925,100	$5,058,000
Benefit-Cost Ratio	2.4	2.3	3.6	2.7	3.1

4.14 Risk and Uncertainty Analysis

Risk and uncertainty has been explicitly factored into the economic analysis of this project. A statistical risk based model, Beach-fx, was used in the study to formulate and evaluate the structural alternatives in Westerly. The nonstructural evaluations used for all four study area communities were conducted using HEC-FDA, which is a probability based model.

Sensitivity modeling runs were also initially conducted for the nonstructural analysis to capture the effect of "intermediate" (0.8 feet over 50 years) and "high" (2.3 feet over 50 years) sea level change over time on the TSP (see Table 21).

Table 21. Percent Increase in the Total Number of Structures Added to the TSP with Alternative Sea Level Change Rates

	Percent Change from Low	
	Intermediate rise	**High rise**
Westerly	18%	36%
Charlestown	25%	66%
Narragansett	6%	34%
South Kingston	3%	34%
TOTAL	**9%**	**38%**

Chapter 5: Final Selected Plan (FSP)*

5.1 Post-TSP Analysis

Following the development of the TSP as described in Chapter 4, the draft IFREA was reviewed concurrently by USACE and the public. Comments from all the reviewers were collected, analyzed, and several meetings with the Vertical Team were held to discuss resolution of the comments. The Agency Decision Milestone meeting that included the non-Federal sponsor was then held. At that meeting it was decided to continue the study by refining/optimizing the TSP. This additional analysis revolved around three major comments: the proper use of future sea level change in the analysis; structure elevation is not an eligible (i.e. can't spend Federal funds) activity in a U.S. Fish & Wildlife designated Coastal Barrier Resource Act (CBRA) areas, and the 46 structures identified for potential dry flood proofing were not thoroughly explored.

One of the major review comments revolved around the fact that the TSP was based on the 'low' or 'historic' rate of sea level rise and that a risk based decision regarding sea level change had not been conducted. Further consultation with the Corps' Climate Preparedness & Resilience Community of Practice suggested that final plan selection must also consider how the uncertainty across all future sea level scenarios (i.e. intermediate and high) affects risk levels and plan performance through either a robust design or adaptive capacity. None of the sea level scenarios is considered more likely than any other, nor should it be assumed that the future will follow any one of the scenarios exactly. To address this uncertainty, project performance was assessed by estimating the duration the project will perform at or above a desired level.

Should the project design include 0.4 feet of sea level rise corresponding to the ‘low’ scenario but experience either the ‘intermediate’ or ‘high’ rate, the project will perform successfully (defined as when water levels have not reached or exceeded the first floor elevation) until sometime between the years 2031 and 2070, a 39 year range centered about the year 2051. In this scenario there is a high likelihood the project will not perform, on average, as designed as it falls short of both the economic (2070) and planning horizon (2120) targets.

Should the project design include 0.8 feet of sea level rise corresponding to the ‘intermediate’ scenario but experience either the ‘low’ or ‘high’ rate, the project will perform successfully until sometime between the years 2042 and 2127, an 85 year range centered about the year 2084. In this scenario there is a high likelihood the project will over perform as designed, on average, when compared to the economic target but under perform when compared to the planning horizon target.

Finally, should the project design include 2.3 feet of sea level rise corresponding to the ‘high’ scenario but experience either the ‘low’ or ‘intermediate’ rate, the project will perform successfully until sometime between the years 2070 and 2332, a 262 year range centered about the year 2201. In this scenario there is a high likelihood the project will over perform as designed, on average, when compared to both the economic and planning horizon targets.

Based on this additional analysis, it was decided that the intermediate rate of sea level rise offers the best balance between potentially unlikely scenarios (i.e. the historic sea level rise rate continuing indefinitely and the high rate including accelerated rates of change cause by warming temperatures and accelerated ice melt) that risk underperformance and overperformance. See section 3.0 of Appendix C for a more detailed discussion regarding sea level change and risk.

The economic models were then re-run with the structures’ target elevation set at BFE + 1 foot in accordance with ECB 2013-33 + intermediate sea level rise (0.2 ft from 1992 to present and 0.8 ft for projected SLC over the next 50 years). Cost estimates of individual structures and interest rate were also updated at this time. Optimization of the nonstructural alternative was conducted by increasing the lower bound target elevation from BFE + 1 + intermediate sea level rise by another foot and then two feet.

The second issue raised during the review process was the fact that elevating structures in a CBRA area was not an ‘eligible’ activity and therefore those properties could not be included in the elevation plan. They could, however, be considered for acquisition. Fifteen properties were affected by this and they were re-analyzed for economic justification to be bought out. It was determined that 7 of the 15 were economically justified.

The final issue raised that required additional analysis were the 46 properties identified during the TSP that may be eligible for dry flood proofing. These structures consisted of concrete and metal commercial structures, mobile homes, large hotels and restaurants. After further examination it was determined that only 21 of these structures had sufficient damages and were built in such a way that they could be economically justified for dry flood proofing.
All of this additional analysis resulted in a National Economic Development (NED) plan that consists of: elevating 357 structures to a target elevation of BFE + 1' + intermediate sea level change, the flood proofing of 21 primarily commercial structures, and the acquisition of 7 CBRA related properties, including their demolition and restoration of the site to natural conditions. The economics of the NED plan are as follows (October 2017 price level and FY18 Discount Rate):

Total Investment Cost: $75,673,000
Average Annual Cost: $2,843,000
Total Without Project Damages: $531,372,000
Total With Project Residual Damages: $231,695,000
Total With Project Benefits: $299,677,000
Average Annual Benefit: $11,099,000
Annual Net Benefit: $8,256,000
BCR: 3.9

The non-Federal sponsor, the RICRMC, has indicated their support for **most** of the NED plan. Working with the communities, the Rhode Island Coastal Resources Management Council (RICRMC), the non-Federal sponsor, identified 102 structures that if elevated would subject these sub-standard constructed, single season use structures to additional storm damage risk (in addition, these structures are not owned by the same entity who owns the land), 7 structures that were scheduled for elevation through other means, and 1 structure that had already been elevated. These structures were eliminated from the NED plan as well as the 7 properties identified for acquisition. The resulting final selected plan is a Locally Preferred Plan (LPP) consisting of elevating 247 structures and flood proofing of the 21 mainly commercial structures. The economics of the Locally Preferred Plan are as follows (October 2017 price level and FY18 Discount Rate):

Total Investment Cost: $53,438,000
Average Annual Cost: $2,010,000
Total Without Project Damages: $531,372,000

Total With Project Residual Damages: $294,816,000
Total With Project Benefits: $236,556,000
Average Annual Benefit: $8,762,000
Annual Net Benefit: $6,752,000
BCR: 4.4

Nine structures identified for elevation in the NED plan have BCRs between 0.9 and 1.0: one in Westerly, one in Charlestown, one in Narragansett and six in South Kingstown. These properties were included in the NED Plan because of their proximity (community cohesion) to other structures identified for elevation (BCRs greater than or equal to 1.0). One of these nine properties (South Kingstown) was dropped from the Locally Preferred Plan. The non-Federal sponsor is aware in the increase (~$63million) in residual damages with the LPP.

5.2 Proposed Action/Plan Components

The proposed project involves the elevation and dry flood proofing of certain individual structures. The **Locally Preferred Plan** (i.e. final selected plan) consists of elevating the first floors of 247 structures and flood proofing 21 commercial structures in the four study area communities. The first floors will be elevated to a height corresponding to the FEMA designated Base Flood Elevation (BFE), ranging from +11 feet North Atlantic Vertical Datum of 1988 (NAVD88) to +17 feet NAVD88, plus 1-foot in accordance with Corps/NFIP standards, plus 0.2 ft to account for sea level rise since the current mean sea level was published (1992), and another 0.8 feet to account for intermediate sea level rise over the next 50 years.

5.3 LPP Features

Properties eligible for elevation and flood proofing, by town, are as follows (see Figures 11 through 14):

- Westerly: Elevate 49 and Flood Proof 6 Structures
- Charlestown: Elevate 45 Structures
- South Kingstown: Elevate 72 and Flood Proof 4 Structures
- Narragansett: Elevate 81 and Flood Proof 11 Structures

The flood proofed structures consist of large multi-story hotels, sheet metal buildings, brick on concrete slab buildings, etc.

Construction Method: Elevation of individual structures will rely on conventional residential construction methods. First, existing structures will be elevated using lifting jacks and supported on temporary cribbing foundations. Temporary utility connections will be put into place to allow occupants to remain in the structure throughout construction. A new or extended foundation would then be constructed. Those structures located in the AE-zone of the floodplain will be provided with a new concrete wall foundation. Those in the VE-zone will be placed on new concrete piers. Once ready, the structures will then be lowered onto the new foundations and permanent utility connections made.

Dry flood proofing consists of sealing all areas from the ground level up to approximately 3 feet of a structure to reduce the risk of damage from storm surge resulting from storms of a certain magnitude by making walls, doors, windows and other openings resistant to penetration by storm surge waters. Walls are coated with sealants, waterproofing compounds, or plastic sheeting is placed around the walls and covered, and back-flow from water and sewer lines prevention mechanisms such as drain plugs, standpipes, grinder pumps, and back-up valves are installed. Openings, such as doors, windows, sewer lines and vents, may also be closed temporarily, with sandbags or removable closures, or permanently. Critical utilities may be relocated to a less vulnerable elevation. Additional information about flood proofing can be found in Appendix I.

Real Estate Requirements. USACE projects require the non-Federal sponsor provide lands, easements, rights-of-way and relocations, and disposal/borrow areas (LERRDs) for a project. The nonstructural elevation measures described above will be offered to owners of structures that have been determined to be eligible and that have voluntarily consented to grant a temporary work area easement for construction, staging and storage areas and a permanent easement limiting alteration of the structure for human habitation below a height corresponding to the targeted first floor elevation for each structure. The non-Federal sponsor will also be required to provide temporary relocation assistance benefits to tenants occupying eligible structures. Details are provided in Appendix F, Real Estate Report and in Section 9.4.

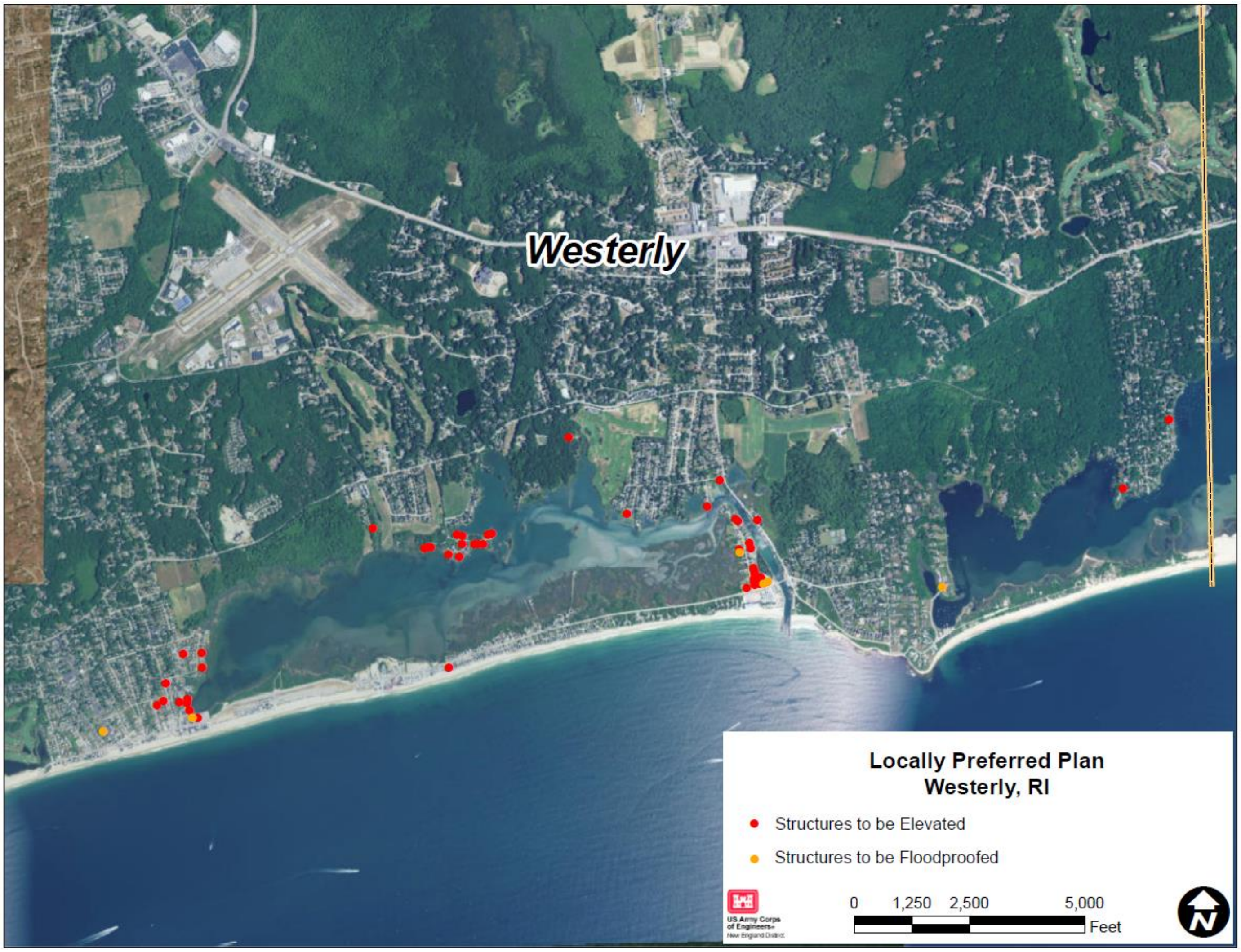


Figure 11. LPP Locations in Westerly

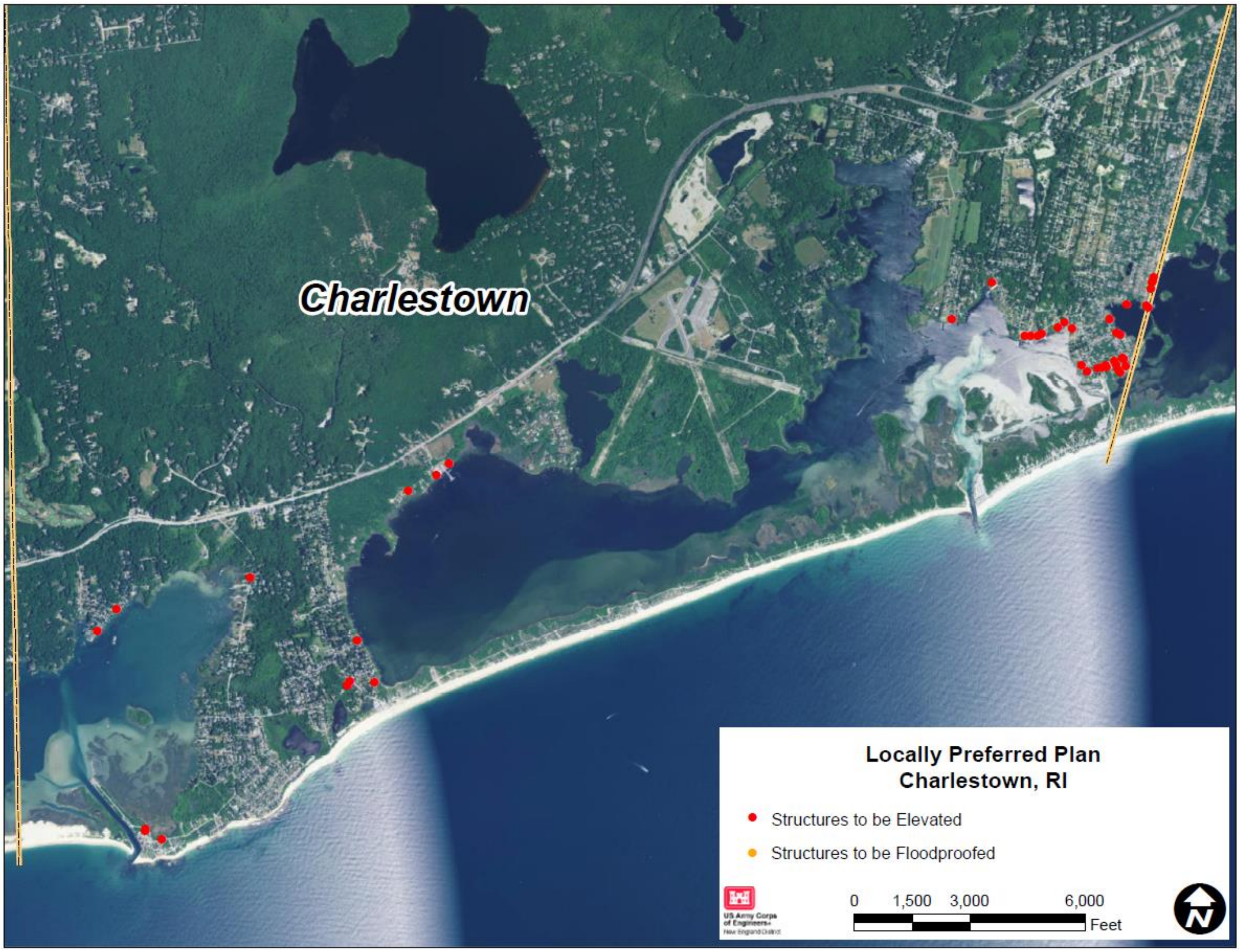


Figure 12. LPP Locations in Charlestown

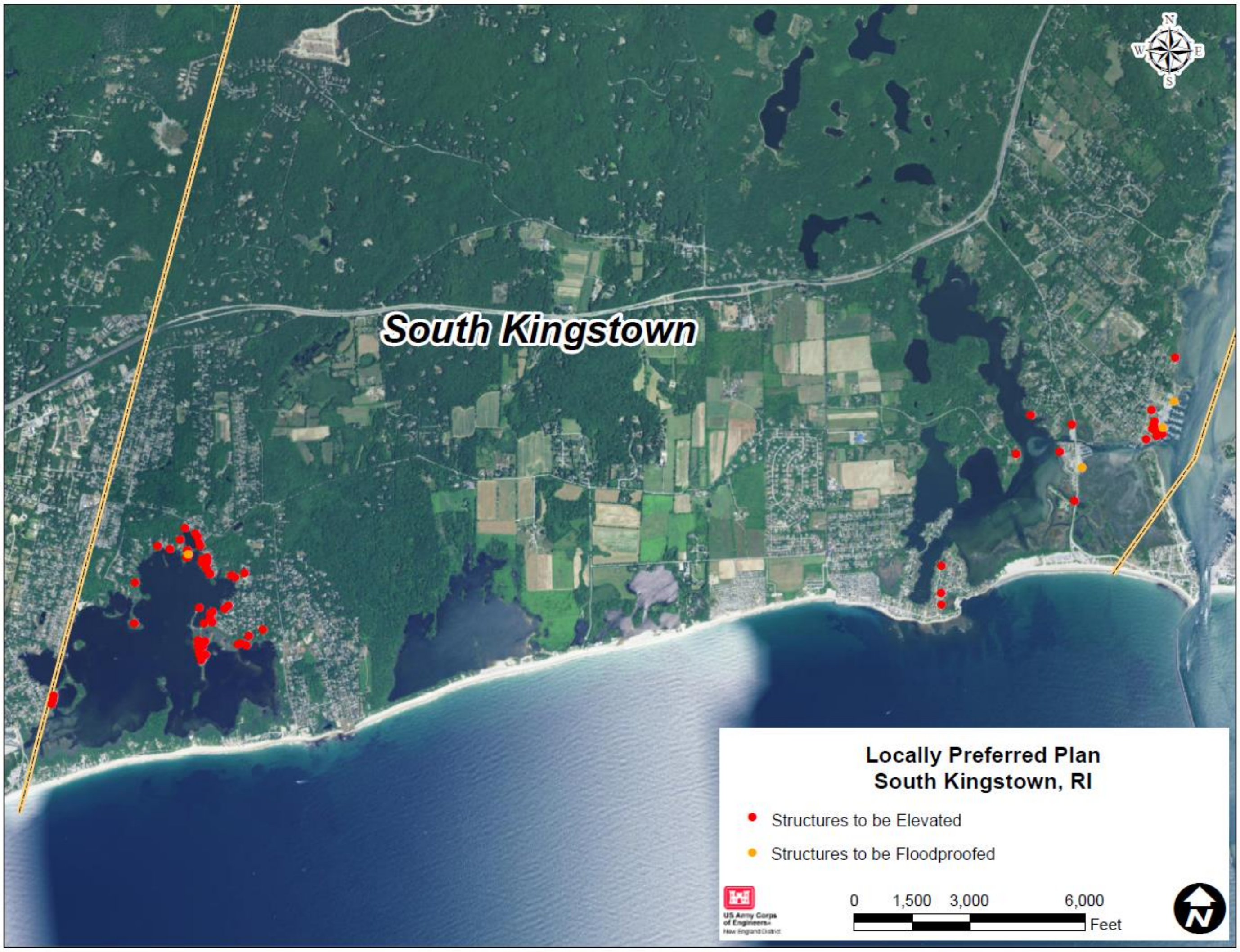


Figure 13. LPP Locations in South Kingstown

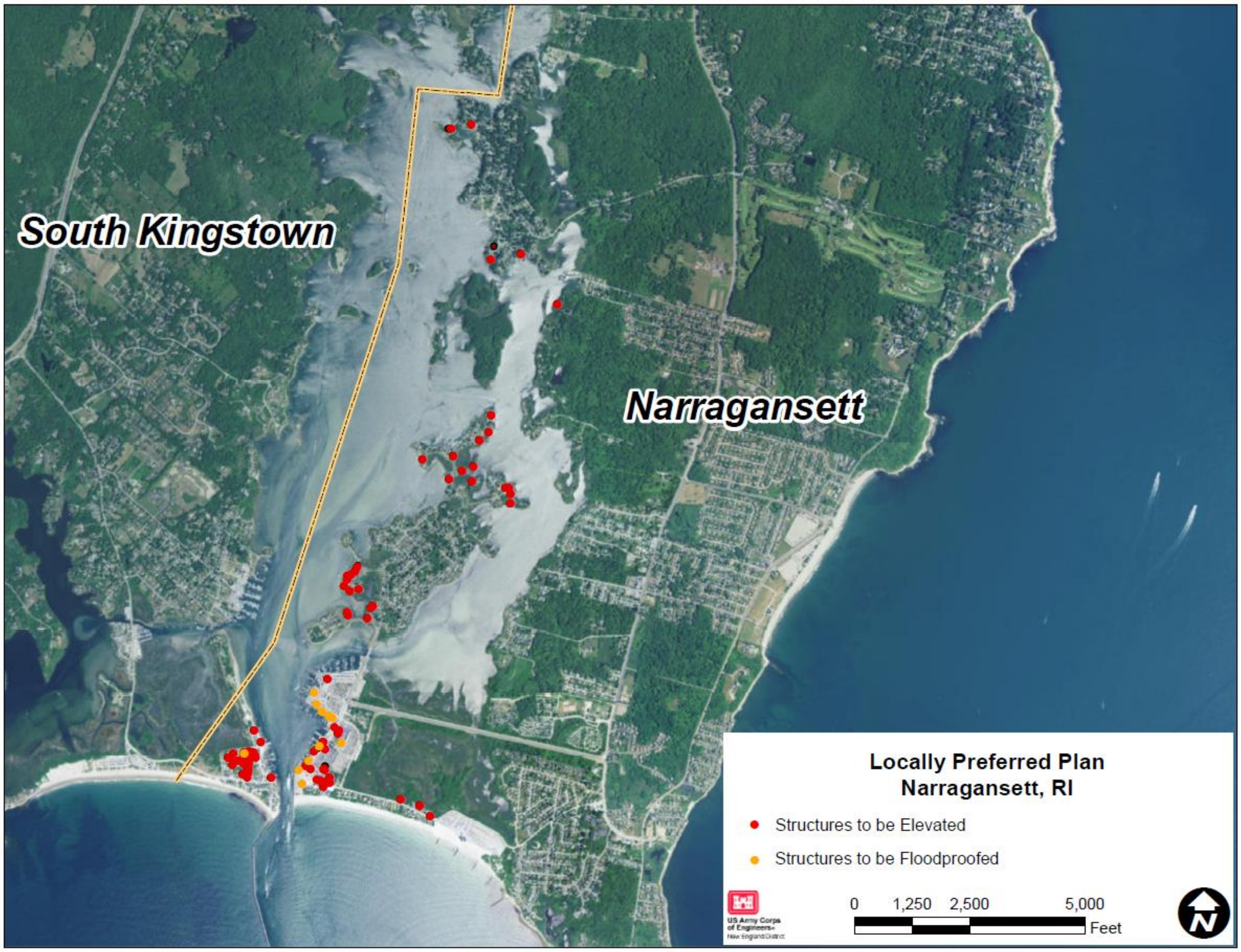


Figure 14. LPP Locations in Narragansett

5.4 LPP Cost Estimate

The costs presented for the LPP were developed using the USACE Micro-Computer Aided Cost Estimating System (MCACES), Second Generation (MII). The MII cost estimate used RS Means, MII Cost Libraries, and vendor quotations. The project contingencies were developed through and Cost and Schedule Risk Analysis (CSRA) tool provided by the USACE Cost Center of Expertise. Detailed information for the cost estimates can be viewed in the Cost Engineering Appendix (Appendix E).

The Project First Cost (see Appendix E) estimate is broken out by cost component in Table 22. The Project First Cost includes the initial construction, a risk-based contingency, pre-construction engineering & design, and construction management. Real estate requirements for a voluntary nonstructural plan like this will consist of acquiring rights of entry for survey and exploration (during final design to determine eligibility of the structure), temporary work area easements for construction, staging and storage areas, temporary relocation assistance benefits (tenants only), and permanent easements, which will be defined in more detail during the design stage of the project. Operation, maintenance, repair, rehabilitation and replacement (OMRR&R) costs are expected to be 'de minimis' and will be confined to periodic site visits by the non-Federal sponsor; the property owner is ultimately responsible for maintenance of the project. An average annual cost of $100 per structure has been included in the annual cost calculations. The LPP initial construction Project First Cost is estimated at $53,438,000.

Table 22. Locally Preferred Plan Cost Estimate

(October 2017 Price Level)

Account/Cost Component	**Cost**
Total Project Cost Summary (Project First Cost)	
01 – Real Estate Incidentals/Temporary Relocations	$2,790,000
19 – Elevation of Structures	$30,750,000
19 – Flood Proof Structures	$1,507,000
Contingency (28.7%)	$9,957,000
Subtotal	$45,004,000
30 – Pre-Construction Engineering & Design	$3,822,000
31 – Construction Management	$4,612,000
Total	**$53,438,000**

5.5 Average Annual Cost and Benefit of the LPP

The Annual Benefit and Cost Summary of the LPP is provided in Table 23. The Project First Cost (October 2017 price levels) is annualized over a 50-year period of analysis at the Fiscal

Year Federal interest rate (FY18 of 2.75%) for evaluation of water resource projects. Dividing the average annual benefit of the project by the average annual cost results in an estimated benefit-to-cost ratio. The benefits were inflated to 2018 prices using the CWCCIS composite cost index for consistency in comparison.

Table 23. LPP Annual Benefit and Cost Summary (FY18 Discount Rate 2.75%)

LPP Project Economic Cost	
Initial Investment Cost	
Project First Cost (const., cont., PED, S&A, RE)	$53,438,000
*Interest During Construction	$61,000
Total Investment Cost	$53,499,000
Capital Recovery Factor @ 2.75%	0.0370
Average Annual Cost	$1,982,000
OMRR&R	
Annual Maintenance Cost	$28,000
LPP Annual Economic Cost	$2,010,000
LPP Economic Benefit	
Total Average Annual Benefit	$8,762,000
Net Benefit and BCR	
Average Annual Net Benefit	$6,752,000
LPP Benefit-Cost Ratio	4.4

*Individual home elevation is calculated to take 2-3 months of construction. The overall construction duration of this project is five years assuming five contractors are working on the project simultaneously.

5.6 Economic, Environmental, and Other Social Effects

In reducing damages from future events, the LPP (i.e. the final selected plan) contributes to National Economic Development.

USACE guidance requires that study alternatives be evaluated under all accounts the National Economic Development (NED), Regional Economic Development (RED), Other Social Effects (OSE) and Environmental Quality (EQ). NED effects have been addressed above and in the Economics Appendix. RED effects would be the impact of project spending, either direct or induced, on the local economy. It is expected that with increased Federal spending on structure elevation and commercial flood proofing, income and employment would show some modest temporary increase. The reduction in coastal storm damages will also help to maintain the current residential population and associated tax base. Improving overall resiliency of the study area in response to coastal storms is the primary effect on the OSE account.

The environmental effects (EQ account) of the LPP are discussed in the next sections of the report.

Chapter 6: Environmental Impacts*

6.1 Topography, Geology, and Soils

No-Action Alternative: Under the No-Action alternative, topography may change due to soil erosion as a result of storm events and flooding. The effects of climate change, such as the increased intensity and frequency of storm events, may cause changes to topography and soils in the project area. However, the amount and location of change would be dependent on site-specific conditions and the magnitude of a storm event. The geology of the project area would not be expected to change within the 50-year project lifespan.

Structural Alternatives in Westerly: Short and long-term changes to topography and soil would occur with the beach fill, flood wall and tide gate alternatives proposed for Westerly. No impacts would occur to the geology of the area.

Proposed Action: Individual structure elevations or flood proofing may result in minor topographic changes to individual lots. These short and long-term changes to topography and soil are not considered significant. No impacts will occur to the geology with the implementation of the proposed action.

6.2 Water Resources

6.2.1 Regional Hydrogeology and Groundwater Resources

No Action Alternative: The 50-year life of the project is not long enough to effect change to the regional hydrogeology. Increased development in the project area may put additional pressure on groundwater resources. However, projects affecting groundwater resources would be subject to federal, state and local laws and regulations promulgated to protect this resource.

Structural Alternatives in Westerly: No short and long-term changes to regional hydrogeology and groundwater resources would be expected with the beach fill, flood wall or tide gate alternatives proposed for Westerly.

Proposed Action: The implementation of the proposed action will have neither short nor long-term impacts to regional hydrogeology and groundwater resources. The proposed project involves the elevation of existing residential structures and flood proofing of primarily commercial structures and is not expected to increase development in the project area.

6.2.2 Surface Water

No Action Alternative: The project area will continue to be subject to storm events and flooding over the life of the project. Natural flood processes will continue under the no action alternative.

Structural Alternatives in Westerly: There would be short and long-term impacts to surface water with the structural alternatives in Westerly. Beach fill, flood walls and construction of a tide gate would require in-water work and as such, would trigger the need for environmental permitting (e.g., Clean Water Act (CWA) Section 401 Water Quality Certificate, Section 404(b)(1) Evaluation, Essential Fish Habitat review under the Magnuson-Stevenson Act). See section 6.3.2 for more detailed information about potential the impacts to surface water from the tide gate.

Proposed Action: Best management practices will be implemented during construction of the proposed action to minimize sediment laden storm water runoff. There will be no long-term impacts to surface water. There is no in-water work or fill in wetlands proposed and therefore, a Clean Water Act (CWA) Section 401 Water Quality Certificate, Section 404(b)(1) Evaluation and Essential Fish Habitat review are not required.

6.2.3 Coastal Processes

No Action Alternative: The no action alternative will have neither short nor long-term impacts to coastal processes. Although there may be projects implemented to address the effects of coastal erosion during the life of the project, the location and type of project would be dependent on damages which occur during specific storm events. Environmental restoration or repair projects would be subject to review and permitting under federal and state laws and regulations.

Structural Alternatives in Westerly: There would be short and long-term impacts to coastal processes with the structural alternatives in Westerly. Beach fill would continue to erode requiring periodic re-nourishment to maintain the design profile; the flood walls and tide gate alternatives would prevent erosion and flooding which interferes with the natural sediment transport process potentially preventing replenishing sediments from reaching backshore wetlands and barrier beaches in the vicinity. Structural measure would also trigger the need for environmental permitting (e.g., Clean Water Act (CWA) Section 401 Water Quality Certificate, Section 404(b)(1) Evaluation, Essential Fish Habitat review under the Magnuson-Stevenson Act).

Proposed Action: The project would not change the coastal erosion or sediment transport process within the project area. However, the proposed action will reduce the influence of the existing coastal processes on the land-based structures. In particular, the selected plan will provide coastal storm risk management to various residential and commercial structures.

6.3 Vegetation

6.3.1 Upland

No Action Alternative: The no action alternative may have some minor impacts to upland vegetation as a result of storm events or coastal flooding. The amount of change would be dependent on site-specific conditions and the magnitude of a storm events.

Structural Alternatives in Westerly: A detailed vegetation survey was not conducted of the site-specific conditions of each structural alternative (e.g., beach fill, floodwall, tide gate). However, impacts to upland vegetation, the burial or removal of vegetation, would be expected to occur within the footprint of each proposed structure.

Proposed action: Implementation of the proposed action may involve the removal of landscaping or ornamental vegetation to enable construction vehicle access. The removal of upland vegetation will be assessed during the preparation of plans and specifications. The removal of trees will be accomplished in accordance with USFWS recommendations for the protection of the northern long-eared bat (see Section 6.8). Therefore, these potential short and long term impacts are not considered significant.

6.3.2 Wetlands

No Action Alternative: The project area will continue to be impacted by coastal storm events over the life of the project which may affect wetlands in the project area. The magnitude and location of impacts to the salt pond and other coastal wetlands (e.g., inundation, sedimentation, etc.) would be dependent on specific storm events.

Structural Alternatives in Westerly: The beach fill, floodwall, and tide gate alternatives would result in both direct and indirect impacts to wetlands. Direct impacts involve the placement of fill in wetlands (intertidal and subtidal areas) within the footprint of the structure. The footprint of the beach fill involves two different alternatives; a 4,000 linear foot berm (+12 feet NAVD88 dune crest, 50-foot wide berm @ +9 feet NAVD88, 51 cy/ft density) and a 9,000 linear foot berm (+14 feet NAVD88 dune crest, 100-foot wide berm @ +9 feet NAVD88, 138 cy/ft density). The footprint of the 4,000 and 9,000 linear foot beach fill was calculated to be 23.5 and 51.9 acres, respectively. A portion of this footprint would be located in the intertidal zone.

The east and west flanking steel sheet pile floodwalls are 3,900 feet and 2,100 feet in length, respectively. Wetland impacts associated with floodwall construction (e.g., the wall footprint and drainage structures) was estimated to be 300 sf for the east wall and 2,400 for the west wall.

The tide gate would likely be located in the Weekapaug Beachway, a rock lined channel that connects Winnapaug Pond to the ocean. The footprint of the tide gate was estimated to be approximately 5,400 sf with a total disturbed area of 21,800 sf (including the structure). The closure of the tide gate may also restrict tidal inundation to 36 acres of intertidal habitat/wetlands in Winnapaug Pond (the area located between MHW [1.4 ft NGVA29] to MLW [-0.2 NGVD29]) and prevent flushing to the entire pond (430 acres in size). Inundation in the higher elevations/floodplain with high salinity ocean waters would be permanently eliminated. Although tide gate closure would likely be infrequent and of shore duration, a more detailed evaluation would be needed to assess the potential short and long-term impacts to the flora and fauna of Winnapaug Pond from the tide gate operation (e.g., effects on *Phragmites australis* infestation, benthic community, etc.). Due to the in-water work and impacts to wetlands, structural alternatives would also trigger permitting and requirements for mitigation of unavoidable impacts (e.g., Clean Water Act (CWA) Section 401 Water Quality Certificate, Section 404(b)(1) Evaluation, Essential Fish Habitat review under the Magnuson-Stevenson Act).

Proposed Action: There will be no short or long-term direct impacts to wetlands as a result of the proposed project. Construction activities will be located within the footprint of existing structures.

6.4 Fish and Wildlife

6.4.1 Finfish

No action Alternative: The project area will continue to be impacted by coastal storm events over the life of the project which may affect finfish species which utilize the salt ponds in the area (which may be subject to inundation or sedimentation during coastal storms). The magnitude and location of impacts to finfish would be dependent on specific storm events. In addition, finfish are mobile and would generally move from impacted areas and as such, these impacts are not expected to be significant.

Structural Alternatives in Westerly: The placement of beach fill (and re-nourishment events), construction of the floodwalls and/or the tide gate would likely have some short-term impacts to water quality. The tide gate would also restrict the movement of fish in and out of Winnapaug Pond during storm events although these events would likely be infrequent and of short duration. Finfish are mobile and would generally move from impacted areas and as such, these impacts are not expected to be significant. In-water work also triggers the need for an Essential Fish Habitat review under the Magnuson-Stevenson Act.

Proposed Action: The proposed action has no in-water work and therefore, no short or long-term impacts on fish will occur.

6.4.2 Shellfish

No Action Alternative: The project area will continue to be impacted by coastal storm events over the life of the project which may affect shellfish in the project area. However, the magnitude and location of impacts to shellfish (e.g., erosion and sedimentation) would be dependent on specific storm events.

Structural Alternatives in Westerly: As shown in benthic sampling (USACE 2014), surf clams, soft-shelled clams and lobsters are not prevalent in the near shore Misquamicut Beach area. In addition, there is no known commercial or recreational shellfish beds off of Misquamicut Beach. As such, the implementation of structural measures in the Westerly area is not expected to significantly impact shellfish resources. An Essential Fish Habitat (EFH) review pursuant to the Magnuson-Stevenson Act would be required to evaluate impacts to EFH in more detail should structural measures be implemented.

Proposed Action: The proposed action has no in-water work and therefore, no short or long term impacts on shellfish will occur.

6.4.3 Benthic Resources

No Action Alternative: The project area will continue to be impacted by coastal storm events over the life of the project which may affect benthic resources in the project area. However, the magnitude and location of impacts to benthos (e.g., erosion and sedimentation) would be dependent on specific storm events.

Structural Alternatives in Westerly: The implementation of structural measures in the Westerly area will effect intertidal habitat through short-term water quality impacts and the direct burial of benthic organisms. These resources would be expected to re-populate over time through natural recruitment from neighboring areas but there would be some temporal impacts to the quantity and diversity of benthic organisms. An Essential Fish Habitat (EFH) review pursuant to the

Magnuson-Stevenson Act would be required to evaluate impacts to EFH (e.g., intertidal habitat, benthic resources, etc.) in more detail should structural measures be implemented.

Proposed Action: The proposed action has no in-water work and therefore, no short or long term impacts on benthic resources will occur.

6.4.4 Reptiles and Amphibians

No Action Alternative: The project area will continue to be impacted by coastal storm events over the life of the project which may affect reptiles and amphibians in the project area. However, the magnitude and location of impacts to reptiles and amphibians would be dependent on specific storm events. As stated in section 3.4.4, there are low numbers, if any, reptiles and amphibians in the construction area and therefore, these impacts are not expected to be significant

Structural Alternatives in Westerly: The implementation of structural measures in the Westerly area is not expected to have significant long or short-term impacts to reptiles and amphibians.

Proposed Action: The implementation of the proposed action is expected to have neither short nor long-term impacts on reptiles and amphibians. As stated in section 3.4.4, there are low numbers, if any, reptiles and amphibians in the construction area.

6.4.5 Birds

No Action Alternative: The project area will continue to be impacted by coastal storm events over the life of the project which may affect bird habitat and food resources. Birds are mobile and would generally move from impacted areas and as such, significant impacts are not expected, however, the magnitude and location of these effects would be dependent on specific storm events.

Structural Alternatives in Westerly: The implementation of structural measures in the Westerly area is not expected to have significant long or short-term impacts to birds due to their mobility.

Proposed Action: The most abundant species in the project area are likely to be habitat generalists that are tolerant of development. Increased noise and heavy machine activity could cause their displacement or disruption in foraging within the immediate vicinity of the construction. Avian species are highly mobile and are expected to avoid the construction area and return after completion of the construction. There will be no long-term impacts on bird species. See Sections 6.8 and 6.9 for additional information regarding federal and state listed bird species, respectively.

6.4.6 Mammals

No Action Alternative: The project area will continue to be impacted by coastal storm events over the life of the project which may affect mammal habitat and food resources. Smaller mammals would be affected more that large mammals which have the ability to move from impacted areas. The magnitude and location of impacts to mammals would be dependent on specific storm events. However, neither short nor long-term significant impacts would be expected.

Structural Alternatives in Westerly: Upland mammals in the construction area may experience short-term impacts during construction activities of structural measures in the Westerly area. These impacts would be similar to those described in the Proposed Action section below.

Proposed Action: Upland mammals in the construction area may experience short-term impacts during construction activities. During construction, heavy machinery activity and increased noise levels may indirectly cause displacement of individuals near construction activities. Mammals are mobile species and will move to avoid the construction areas, thus minimizing the impacts of construction activities on them. Most mammals inhabiting the study area are accustomed to human activities and would likely return following the completion of construction. There will be no long-term impacts on upland mammals. There are no aquatic mammals in the project area and therefore, there will be no short or long term impacts to aquatic mammals.

6.5 Federal Threatened and Endangered Species

No Action Alternative: The project area will continue to be impacted by coastal storm events over the life of the project which may affect the habitat and food resources of some federally-listed threatened and endangered species. Storm related impacts may be detrimental or beneficial (e.g., loss of trees may negatively affect northern long-eared bat while piping plover may benefit from areas of sand deposition). However, the magnitude and location of impacts to mammals would be dependent on specific storm events.

Structural Alternatives in Westerly: There are four (4) federally protected animal species under the jurisdiction of the USFWS that have been identified as possibly being present along the coastal beach in the proposed project area: roseate tern (northeastern population), red knot, northern long-eared bat and piping plover. In addition, alternatives within the Westerly project area involve in-water work and as such, have the potential to impact aquatic species under the jurisdiction of the National Marine Fisheries Service (NMFS) including Atlantic sturgeon, sea turtles as well as large Atlantic whales. Coordination would need to be undertaken with both the USFWS and NMFS pursuant to the Endangered Species Act should structural measures be implemented.

Proposed Action: There are four (4) federally protected animal species under the jurisdiction of the USFWS that have been identified as possibly being present along the coastal beach in the proposed project area: roseate tern (northeastern population), red knot, northern long-eared bat and piping plover. There is no in-water work and therefore, no federally protected animal species under the jurisdiction of the NMFS will be impacted.

A finding of "no effect" for the following species:

Roseate Terns. The project area does not support suitable breeding habitat or feeding habitat for roseate terns. The proposed project involves modifications to buildings within the existing footprint of the structure. Therefore, no effect on roseate tern is anticipated.

Red Knot - The red knot, a federally threatened species, makes one of the longest yearly migrations of any bird to its Arctic breeding grounds. During migration, red knots concentrate in huge numbers at traditional staging grounds during migration. The upland properties associated with individual houses proposed for elevation or flood proofing do not provide suitable breeding or foraging habitat for red knot. Therefore, no effect on red knot is anticipated.

A finding of "may affect but is unlikely to adversely affect" for the following species:

Northern Long-Eared Bat – There have been no surveys conducted to determine the presence/absence of the NLEB in the project area and therefore, it is assumed that the NLEB is present and may utilize mature trees within the existing development and surrounding forest habitat for roosting. Individual trees may need to be removed as part of project activities to enable access for construction vehicles. The proposed project is not likely to adversely affect the threatened NLEB for the following reasons:

- No cutting of trees ≥ 3 inches diameter at breast height will occur from 15 April – 30 September as outlined in the July 7, 2015 USFWS guidance for federal agencies to minimize potential negative effects to the northern long-eared bat.

- Scheduling tree cutting activities outside the time of year restrictions will avoid impacts of greatest concern (e.g., direct roost disturbance).

Piping Plover

Piping plovers form nests (shallow depressions) in the sand on the high beach close to the dunes on wide open beaches and shorelines and feed in the intertidal zone at low tide. Project activities will involve elevating houses and flood proofing certain commercial structures within currently developed areas. None of the individual houses proposed for elevation are located within designated piping plover habitat in Westerly, Charlestown, South Kingstown or Narragansett. Therefore, no direct short or long term impacts to piping plover breeding or foraging habitat are anticipated.

However, there are three houses proposed for elevation located within 200, 500 and 900 feet of designated piping plover habitat (i.e., the beach located seaward of the Roger Wheeler State Park parking lot) and one house located within 200 feet of designated piping plover habitat on East Beach in the Watch Hill area of Westerly. Indirect impacts to piping plover may occur due to construction activities (e.g., construction noise, truck traffic, etc.). These potential impacts are not expected to be significant in consideration of on-going human related disturbances in the area associated with the Roger Wheeler State Park and East Beach, especially during the summer months (e.g., traffic, beach goers, swimming, etc.). Therefore, the proposed project may affect but is not likely to adversely affect this species because the effects to piping plover are expected to be insignificant or discountable.

The U.S. Fish and Wildlife Service concurred with this "unlikely to adversely affect determination" for the NLEB and piping plover in a letter dated December 14, 2017.

6.6 State Threatened and Endangered Species

No Action Alternative: The project area will continue to be impacted by coastal storm events over the life of the project which may affect the habitat and food resources of some state-listed threatened and endangered species. The magnitude and location of impacts to mammals would be dependent on specific storm events.

Structural Alternatives in Westerly: There are five state-listed rare species (3 plants and two birds) located in the Westerly project area. The beaches, marshes and salt and fresh water ponds in the area provide habitat for these species. Detailed survey information would be needed to determine species-specific impacts. In general, there is the potential for direct impacts to plants within the footprint of structural measures and also the potential for indirect impacts to plants and birds in the vicinity (e.g., shading, displacement, reduction in food resources, etc.).

Proposed Action: The closest distance to project activities for the nine state-listed species identified within a Natural Heritage Area polygon is seaside sparrow observed by the

Quonochontaug Breachway in Charlestown approximately 100 feet from a house proposed for elevation and tall wormwood which was located along the Weekapaug Breachway in Westerly approximately 200 feet from project activities. No direct impacts to protected species are anticipated because the work will be conducted within the footprint of an existing structure. Seaside sparrow may avoid the near project area during construction due to noise however, there is a large amount of habitat available in the general vicinity and therefore, this temporary impact is not considered to be significant.

6.7 Essential Fish Habitat

No Action Alternative: The project area will continue to be impacted by coastal storm events over the life of the project which may affect the Essential Fish Habitat (EFH). However, the magnitude and location of impacts to EFH (e.g., nearshore areas, benthos, etc.) would be dependent on specific storm events.

Structural Alternatives in Westerly: Structural alternatives in the Westerly area would require an Essential Fish Habitat review under the Magnuson-Stevenson Act due to in-water work.

Proposed Action: There is no in-water work associated with the proposed project and therefore, no impact to EFH will occur.

6.8 Socioeconomics

No Action Alternative: The no action alternative may have short- or long-term impacts on socioeconomics. Flooding and storm related impacts may permanently impact existing homes. Households may not rebuild and leave empty lots or unrepaired homes.

Structural Alternatives in Westerly: The implementation of the proposed action may have positive short- and long-term socioeconomic impacts similar to those described in the Proposed Action section below.

Proposed Action: The implementation of the proposed action may have positive short- and long-term socioeconomic impacts. Protecting existing structures from flooding may help to preserve the area as an attractive coastal destination which should have positive socioeconomic impacts over the period of analysis. In the construction phase of the project, the introduction of construction workers into the community should result in their purchasing of supplies and food which may contribute to a minor, indirect temporary economic benefit to the local economy. The implementation of the plan is expected to have a direct positive impact on residential and commercial structures due to a reduction in future storm damage to existing properties, and the subsequent reduction in costs to repair such damages. Residential and commercial property values may increase in the project area due to the added coastal storm risk management of storm damages.

6.9 Environmental Justice

As stated in Section 3.9, none of the houses proposed for elevation are located within environmental justice populations.

No Action Alternative: The no action alternative will have neither short nor long-term impacts to an Environmental Justice Area.

Structural Alternatives in Westerly: The construction of structural measures in Westerly will have neither short nor long-term impacts to an Environmental Justice Area.

Proposed Action: The implementation of the proposed action will have no short-or long-term impacts on an Environmental Justice Area.

6.10 Cultural Resources

No Action Alternative: The no action alternative will not have short-term impacts to historic properties. However, one neighborhood in Narragansett, located on Arbeth and Champlin Avenues, MacAlder Street, and Succotash Road, contains 29 houses which could contribute to a historic district. Long-term impacts could effect this potentially significant area.

Structural Alternatives in Westerly: Construction of the floodwalls could potentially have a visual effect on the Matunuck Village Historic District in Westerly. Beach fill and the tide gate are unlikely to have an impact on historic properties.

Proposed Action: None of the buildings merit individual distinction for eligibility for the National Register of Historic Places. In South Kingstown, No. 392A Card's Pond Road is located in the Browning's Beach Historic District, which is listed in the National Register of Historic Places (National Register). The Rhode Island State Historic Preservation Officer (RISHPO), in a letter dated October 4, 2016, noted that based on alterations to No. 392A Card's Pond Road, the property should be considered a non-contributing resource of the Browning's Beach Historic District. The structure is not eligible for elevation in the LPP.

Based on coordination with RI SHPO, the only town with a potential for historic properties within the LPP is Narragansett, based on a review of all properties 50 years or older. One neighborhood could be potentially eligible for the National Register under Criterion A for its possible association with the early twentieth century development of the former fishing community of Jerusalem in Narragansett. The RI SHPO has requested that an architectural survey be completed for this area to determine if the neighborhood is eligible for the National Register. Continued coordination with the RISHPO is ongoing in order to comply with Section 106 of the National Historic Preservation Act, as amended. The architectural survey will be completed during PED. This project was coordinated with the Narragansett Tribal Historic Preservation Officer requesting consultation under Section 106 of the NHPA. No comments were received from the tribe.

6.11 Coastal Zone Management

No Action Alternative: The no action alternative will have neither short nor long-term impacts in terms of Coastal Zone Management policies.

Structural Alternatives in Westerly: A beach fill project was completed on Misquamicut Beach in 2015. It is likely that another beach fill project would be found to be consistent with the Rhode Island's Coastal Zone Management Policies should the project need be adequately justified. However, hard structures, such as the floodwall and tide gate, have many negative implications for the coastal zone. A Coastal Zone Management Consistency Determination would need to be prepared and a request for concurrence coordinated with the Rhode Island Coastal Resources Management Council (RICRMC). The construction of hard structures in the coastal zone are potentially controversial and generally discouraged by the environmental community.

Proposed action: USACE has determined that the proposed action is consistent to the maximum extent practicable with the relevant enforceable policies of the State of Rhode Island approved coastal zone program. A Coastal Zone Management Consistency Determination is provided in Appendix A2 along with RICRMC's preliminary concurrence.

6.12 Land Use and Zoning

No Action Alternative: The no action alternative may have short- and long-term impacts as storm damage and flooding will continue and possibly necessitate changes in land use as property is destroyed and land lost.

Structural Alternatives in Westerly: The construction of structural measures in Westerly will require some changes to land use zoning. The Misquamicut Beach is currently a state recreation area and likely would remain so after implementation of a beach fill project. However, the floodwalls and tide gate would require a change in land use and potentially zoning changes.

However, the implementation of the proposed coastal storm risk management measures is not expected to significantly induce future development in the adjacent residential areas, because most, if not all, of the developable areas are developed.
Proposed Action: Implementation of the proposed action will have no negative short- or long-term impacts to land use and zoning. The implementation of the proposed coastal storm risk management measures are not expected to significantly induce future development in the adjacent residential areas, because most, if not all, of the developable areas are developed.

6.13 Hazardous, Toxic, and Radioactive Waste

No Action Alternative: The project area will continue to be impacted by coastal storm events over the life of the project. As such, there is an on-going risk of impacts from HTRW due to infrastructure damage (spills, leaking pipes, etc.). However, the magnitude and location of HTRW damage would be dependent on specific storm events.

Structural Measures in Westerly: A detailed evaluation of the potential HTRW within the footprint of proposed structural measures would need to be conducted during the detailed phase of the project should structural measures be the preferred alternative. Remediation of HTRW, if found, would need to be accomplished to avoid short or long-term impacts to the environment from the implementation of the beach fill, floodwalls or tide gate alternatives.

Proposed Action: There will be neither short nor long-term impacts from HTRW. The presence of HTRW will be assessed for each structure proposed for elevation or flood proofing during the design phase of the project. Measures will be undertaken to secure the site (e.g., disconnect utilities, avoid underground tanks, etc.) prior to the commencement of construction activities. Therefore, no short or long-term impacts will occur from implementation of the proposed action.

6.14 Aesthetic and Scenic Resources

No Action Alternative: The no action alternative may have negative short- and long-term impacts as flooding and storm related impacts may permanently impact existing homes. Households may not rebuild and leave empty lots or unrepaired homes which may impact the aesthetic and scenic resources in the area.

Structural Alternatives in Westerly: The construction of structural measures will have negative short and long-term impacts to aesthetics and scenic resources. Over the short-term, there will be an increase in construction equipment and vehicles in the area which is generally not considered visually appealing. The long-term impacts of the proposed action will be permanent views of floodwall and tide gate infrastructure not in keeping with the visual attributes of the coast.

Proposed Action: Implementation of the proposed action will have negative short-term impacts to aesthetics and scenic resources. Over the short-term, there will be an increase in construction equipment and vehicles in the area which is generally not considered visually appealing. The long-term impacts of the proposed action will be positive due to a reduction in future storm damage to existing properties.

6.15 Recreation

No Action Alternative: The project area will continue to be impacted by coastal storm events over the life of the project which may impact recreational resources. However, the magnitude and location of damage and the effects on the recreational value or use in the area would be dependent on specific storm events.

Structural Measures in Westerly: The implementation of structural measures in Westerly may have short-term impacts on recreation due to construction related disturbances (e.g., noise, increased traffic, etc.). No long-term impacts to recreation are anticipated.

Proposed Action: The implementation of the proposed action will have no short-term or long-term impacts to recreation because structure elevations and flood proofing are located on private property and beaches will be accessible during and after construction.

6.16 Air Quality

No Action Alternative: The project area will continue to be impacted by coastal storm events over the life of the project. However, Washington County in Rhode Island is in attainment with the National Ambient Air Quality Standards (NAAQS). Air quality of a significant magnitude would not be expected after storm events.

Structural Measures in Westerly: Impacts to air quality from the construction of structural measures in Westerly would be similar to impacts for the Proposed Action described below.

Proposed Action: Washington County in Rhode Island is in attainment with the National Ambient Air Quality Standards (NAAQS) for all six criteria pollutants. As such, a general conformity review is not required. The Locally Preferred Plan will produce temporarily localized emission increases from the diesel powered construction equipment working onsite.

The localized emission increases from the diesel powered equipment will last only during the project's construction period and then end when the project is over, thus any potential impacts will be temporary in nature. A Record of Non-Applicability is provided in Appendix A4.

6.17 Greenhouse Gases (GHGS)

No Action Alternative: The project area will continue to be impacted by coastal storm events over the life of the project. However, a significant increase in the amount Green House Gases (GHGs), as a result of the increased use of diesel-fueled engines (which emits CO_2), is not expected under the No Action Alternative.

Structural Measures in Westerly: The impact on GHG emissions from the construction of structural measures in Westerly would be similar to those described for the Proposed Action section below.

Proposed Action: The primary GHG emitted by diesel-fueled engines is CO_2. The project is estimated to generate a total of 11,304 metric tons of CO_2 (see EPA Greenhouse Gas Equivalent Calculator, www2.epa.gov/energy/greenhouse-gas-equivalencies-calculator, website accessed August 8, 2016). The GHG emissions associated with the project are temporary and insignificant compared to the total of 10,000,000 metric tons of CO_2 generated in Rhode Island (2013 period) (Rhode Island State Energy Profile http://www.eia.gov/state/print.cfm?sid=ri [Website access August 8, 2016]).

6.18 Noise

No Action Alternative: Under the no action alternative there may be negative short-term impacts from noise due to construction activities associated with storm and flooding damage repairs.

Structural Measures in Westerly: There would be negative short-term impacts from noise due to use of construction equipment with the construction of structural measures in Westerly. There will be no long-term impacts.

Proposed action: With implementation of the proposed action, there would be negative short-term impacts from noise due to use of construction equipment. There will be no long-term impacts.

Chapter 7: Cumulative Impacts*

The Council on Environmental Quality defines "cumulative impact" as the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. The following section describes past, present and future Federal and local projects in the South County area which represents prior work that was conducted in the study area.

The study area is on the south coast of Rhode Island and includes about 28 miles of moderately developed coast in the rapidly growing towns of Westerly, Charlestown, South Kingstown, and Narragansett. Not surprisingly, due to its beautiful landscape and ocean nexus, Washington County was the third fastest growing region in New England with a population increase of 20% in the 1990's (Bobrowski *et al.* 2001). Increasing development is associated with a broad range of direct impacts to natural resources such as increased impervious areas, septic system installation, pollutant laden runoff and a decrease in vegetated buffer zones for riparian and coastal waters. Some of secondary impacts that have occurred in the project area as a result of anthropomorphic changes, as listed in the Rhode Island's Salt Pond Region Special Area Management Plan (RICRMC 1999), include eutrophication of poorly flushed waters (Lee and Olsen 1985), closure of shellfishing areas (RIDEM 1996), elevated concentrations of total nitrogen beneath densely developed areas (Olsen and Lee 1984, Lee and Ernst 1996), sedimentation of settling substrate for shellfish and lobsters (Ganz 1997) and the loss of 30.4% of eelgrass in Ninigret Pond between 1960 and 1992 (Short *et al.* 1996).

Individual Federal and local projects that have been constructed in the South County area include the following (see Section 1.6 for detailed information):

<u>Sand Hill Cove Beach, Narragansett</u>. This beach erosion control project consisted of widening the beach by 65 feet, constructing five stone groins and a steel bulkhead.

<u>Misquamicut Beach, Beach Erosion Control Project</u>. This beach erosion control project involved the placement of approximately 90,000 cubic yards of a suitable sand fill along 3,250 feet of shoreline.

<u>Ninigret Pond, Habitat Restoration Project</u>. This restoration project restored eelgrass to the flood tidal shoal of Ninigret Pond. About 40 acres of the flood tidal shoal were dredged to a depth of 0.75 meters (2.5 feet) below Mean Low Water. About 200,000 cubic yards of dredged sand was pumped directly to East and Charlestown beaches for disposal.

Bulkheads and Groins. There are a number of existing bulkheads and groins located within the project area built mainly for the purpose of shoreline erosion management. Rock revetments are located along approximately 23% of the beach front properties within Westerly and 31% in the Matunuck area of South Kingstown. Other than that, the shoreline consists of sandy barrier beaches.

It is expected that developmental pressure will continue in the coastal region of Rhode Island into the future. The Rhode Island's Salt Pond (1999) Region Special Area Management Plan (SAMP) provides a regulatory framework and land-use policies established to protect natural resources in the salt pond region with special emphasis safeguarding water quality. The SAMP is part of the Rhode Island Coastal Resources Management Council's (RICRMC), ongoing responsibility under both the Rhode Island General Laws 46-23 and the Coastal Zone Management Act (CZMA) (16 U.S.C. §§ 1451-1464). The future cumulative activities associated with the Pawcatuck Coastal project includes elevating a total of 247 structures (49 in Westerly; 45 in Charlestown; 72 in South Kingstown and 81 in Narragansett) and flood proofing a total of 21 commercial structures (6 in Westerly; 4 in South Kingstown and 11 in Narragansett).

The proposed structure elevations and flood proofing will be accomplished within the footprint of existing structures and as such, no additional permanent cumulative impacts to the coastal community are anticipated as a result of the proposed project. There are potential short-term negative construction impacts (i.e., noise, dust) and potential short-term positive socio-economic impacts (e.g., local employment, workers soliciting local businesses). Specifically, construction would have a positive benefit by reducing costs resulting from storm and water damage. However, these impacts are not cumulatively significant when added to past measures.

There are no anticipated cumulative impacts to fish and wildlife, or Federal and/or State threatened and endangered species. This project will be coordinated with the appropriate state and federal agencies to ensure no significant impacts occur and shall be conducted in a manner consistent with federal, state and local laws and regulations.

Chapter 8: Coordination & Compliance with Environmental Requirements*

8.1 Compliance Summary

Table 24. Summary of Primary Federal Laws and Regulations

Item	Citation	Compliance
Clean Air Act	42 U.S.C. §§ 7401 et seq.	A Record of Non-Applicability (RONA) is provided in Appendix A4
Clean Water Act	33 U.S.C. 1251 et seq.	There is no in-water work. A Clean Water Act (Section 401) Water Quality Certificate is not required.
Coastal Barrier Resources Act of 1982	16 U.S.C. 3501 et seq.	No work will be conducted within any designated Coastal Barrier Resources Act unit under the recommended Locally Preferred Plan (LPP).
Coastal Zone Management Act	15 CFR § 930 Subpart C – Consistency for Federal Agency Activities	A conditional Coastal Zone Management Consistency Determination concurrence from the RI CRMC is provided in Appendix A2. A final consistency review will be conducted following Headquarters approval of the project.
Endangered Species Act of 1973	16 U.S.C. 1531 et seq.	The USFWS concurred with the Corps' "unlikely to adversely affect" determination for Piping Plover and Northern Long-eared Bat in a letter dated December 14, 2017
Environmental Justice in Minority and Low Income Populations	Executive Order 12898	USACE performed an analysis and has determined that a disproportionate negative impact on minority or low-income groups in the community is not anticipated; a full evaluation of Environmental Justice issues is not required.
Fish and Wildlife Coordination Act	16 U.S.C. 661 *et seq*.	The USFWS provided a final comments pursuant to the Fish and Wildlife Coordination Act in a letter dated December 14, 2017
Magnuson-Stevens Act Fishery Conservation and Management Act	16 U.S.C. 1855(b)(2)	No in-water work. An EFH Assessment is not required.
National Environmental Policy Act of 1969	42 U.S.C. 432 *et seq*.	The circulation of the Draft EA fulfills requirements of this act.
National Historic Preservation Act of 1966	16 U.S.C. 470 et seq.	Continued coordination and consultation with the Rhode Island State Historic Preservation Officer is required in order to comply with Section 106 of the National Historic Preservation Act, as amended and implementing regulations 36 CFR 800. Correspondence included in Appendix A3.
Protection of Wetlands	Executive Order 11990	Circulation of this report for public and agency review fulfills the requirements of this order.
Protection of Children from Environmental Health Risks and Safety Risks	Executive Order 13045	Implementation of this project will reduce environmental health risks. Circulation of this report for

		public and agency review fulfills the requirements of this order.

8.2 Compliance with Executive Order (EO) 11988

Executive Order 11988 requires that Federal agencies avoid, to the extent possible, adverse impacts associated with the occupancy and modification of floodplains and to avoid support of floodplain development wherever there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities."

The Water Resources Council Floodplain Management Guidelines for implementation of EO 11988, as referenced in ER 1165-2-26, requires an eight-step process that agencies should carry out as part of their decision-making on projects that have potential impacts to, or are within the floodplain. The eight steps and project-specific responses to them are summarized below.

EO 11988 Step	Project-Specific Response
Determine if a proposed action is in the base floodplain (that area which has a one percent or greater chance of flooding in any given year).	The proposed action is within the base floodplain.
If the action is in the base floodplain, identify and evaluate practicable alternatives to the action or to location of the action in the base floodplain.	Practicable measures and alternatives were formulated and evaluated against USACE guidance, including nonstructural measures such as buy-outs (land acquisition and demolition of structures).
If the action must be in the floodplain, advise the general public in the affected area and obtain their views and comments.	The Draft Integrated Feasibility Report and Environmental Assessment were released for public review, and coordination with agency officials and the public have been held throughout the study.
Identify beneficial and adverse impacts due to the action and any expected losses of natural and beneficial floodplain values. Where actions proposed to be located outside the base floodplain will affect the base floodplain, impacts resulting from these actions should also be identified.	The anticipated impacts associated with the Selected Plan are summarized in Chapter 6 of this report. The project would not alter or impact the natural or beneficial floodplain values.

If the action is likely to induce development in the base floodplain, determine if a practicable non-floodplain alternative for the development exists.	The project will not encourage development in the floodplain because all properties available for development have been developed. The project provides benefits solely for existing development.
As part of the planning process under the Principles and Guidelines, determine viable methods to minimize any adverse impacts of the action including any likely induced development for which there is no practicable alternative and methods to restore and preserve the natural and beneficial floodplain values. This should include reevaluation of the "no action" alternative.	The project would not induce development in the floodplain. Chapter 4 of this report summarizes the alternative identification, screening and selection process. The "no action" alternative was included in the plan formulation phase.
If the final determination is made that no practicable alternative exists to locating the action in the floodplain, advise the general public in the affected area of the findings.	The Final Integrated Feasibility Report and Environmental Assessment will document the final determination.

Recognizing the Federal government's commitment to ensure no inducement of development in the floodplain pursuant to Executive Order 11988, this project will identify in the Project Partnership Agreement (PPA) the need for the non-Federal sponsor to develop a floodplain management plan and a requirement for the sponsor to certify that measures are in place to ensure that the project does not induce development within the floodplain.

8.3 List of Environmental Assessment Report Preparers

Individual	Responsibility
Judith Johnson	Biologist; NEPA
Kathleen Atwood	Archaeologist: NHPA, SEC. 106

Chapter 9: Plan Implementation

The implementation process would carry the plan that is recommended through pre-construction engineering and design (PED), including development of plans and specifications, and construction. Funding by the Federal Government to support these activities would have to meet the requirements of Public Law 113-2 or traditional civil works budgeting criteria.

9.1 Consistency with Public Law 113-2

This final feasibility report has been prepared in accordance with the Disaster Relief Appropriations Act of 2013, Public Law 113-2. Specifically, this section of the report addresses:

- the specific requirements necessary to demonstrate that the project is technically feasible, economically justified and environmentally complaint;
- the specific requirements necessary to demonstrate resiliency, sustainability and consistency with the North Atlantic Coast Comprehensive Study (NACCS);
- and the costs and cost-sharing to support a Project Partnership Agreement (PPA).

Economics Justification and Environmental Compliance. The prior sections of this report demonstrate that the LPP is technically feasible. It also identifies the plan to be economically justified for the authorized period of Federal participation. The final Environmental Assessment has been prepared to meet the requirements of NEPA and demonstrates that the plan is compliant with environmental laws, regulations, and policies and has effectively addressed any environmental concerns of resource and regulatory agencies.

Resiliency and Consistency with the NACCS. The North Atlantic Coast Comprehensive Study (NACCS) was released in January 2015 and provides a risk management framework designed to help local communities better understand changing flood risks associated with climate change and to provide tools to help those communities better prepare for future flood risks. In particular, it encourages planning for resilient coastal communities that incorporate, wherever possible, coastal landscape systems that take into account future sea level and climate change scenarios (USACE, 2015).

The process used to identify the LPP was a risk management approach that included evaluation of the benefits and costs of an array of alternative solutions both structural and nonstructural and took into account storm data, climate change and rising sea levels consistent with NACCS. The LPP structure elevation and flood proofing project represents a solution that reduces flood risk to many property owners and improves resiliency to the study areas following coastal storm events. Of the estimated $531,372,000 in total damages in the study area, the proposed LPP eliminates $236,556,000 of those damages or 45% of the total by applying nonstructural flood risk management measures to only 7% of the properties in the study area.

9.2 Cost Sharing and Non-Federal Sponsor Responsibilities

Cost Apportionment. The details of cost of apportionment of the NED and LPP plans are shown in Table 25 and discussed below. The apportionment is based on the Total Project (aka Fully Funded) Cost of each escalated to the midpoint (November 2023) of construction. See Appendix E for details.

Table 25. Cost Apportionment of the NED Plan and LPP Plans (Fully Funded)

	NED Plan			LPP		
	Total	Federal Share	Non-Federal Share	Total	Federal Share	Non-Federal Share
Construction	$66,456,000	$45,533,000	$20,923,000	$46,556,000	$31,932,000	$14,624,000
Lands & Damages	$4,504,000	$81,000	$4,423,000	$3,211,000	$58,000	$3,153,000
Planning, Engineering & Design	$6,108,000	$4,185,000	$1,922,000	$4,262,000	$2,924,000	$1,338,000
Construction Management	$8,379,000	$5,741,000	$2,638,000	$5,687,000	$3,901,000	$1,786,000
Total Project Cost	$85,446,000	$55,540,000	$29,906,000	$59,716,000	$38,815,000	$20,901,000

In accordance with the cost share provisions in Section 103 of the Water Resources Development Act (WRDA) of 1986, as amended (33 U.S.C. 2213), the Federal and non-Federal shares are as follows: The Federal share of the Total Project Cost for the LPP is estimated to be $38,815,000and the non-Federal share is estimated to be $20,901,000, which equates to 65% Federal and 35% non-Federal. The non-Federal costs include the value of lands, easements, rights-of-way, relocations, and dredged or excavated material disposal areas (LERRD) currently estimated to be $3,153,000.

OMRR&R costs associated with a nonstructural plan such as this are considered 'de-minimis' (periodic surveillance by the non-Federal sponsor). An average annual cost of $100 per structure has been included in the annual cost calculations. The property owner is ultimately responsible for maintenance of the project.

9.3 Design and Construction Considerations

Preconstruction, Engineering and Design. Since the Pawcatuck River Coastal Storm Risk Management feasibility study was funded under the Public Law 113-2 response to Hurricane

Sandy, there may be funding under the same appropriation to initiate the Pre-Construction Engineering and Design (PED) efforts for this project upon successful completion of a Chief's Report. A Design Agreement (DA) could then be executed between USACE and RICRMC. PED is cost shared 65% Federal and 35% non-Federal. Construction of the project will occur after Congress has authorized the project and provided sufficient funds through the normal budgeting process. If funding allows, a portion of the construction may be implemented under Section 103 of the Continuing Authorities Program.

Draft Schedule. The draft schedule for plan implementation was developed for planning and cost estimating purpose. See Appendix E, Cost Engineering, for more detail on the proposed construction schedule. The construction duration for the LPP was estimated at five years. No cutting of trees ≥ 3 inches diameter at breast height will occur from 15 April – 30 September to minimize potential negative effects to the northern long-eared bat.

Table 26. FSP Implementation Schedule

Pawcatuck River, Rhode Island Coastal Storm Risk Management Project	
Implementation Schedule	Date
Submission of Chief's Report	
Chief Signs Report	Sep-18
Design Agreement (DA)	
DA Execution	Apr-19
Pre-Construction Engineering & Design	
Plans & Specifications;	Jul 20
Real Estate Acquisition	TBD Pending Congressional Authorization and Appropriation
Contract Award	TBD Pending Congressional Authorization and Appropriation
Construction	
Construction complete	TBD Pending Congressional Authorization and Appropriation

9.4 Real Estate Requirements

USACE projects require the non-Federal sponsor provide lands, easements, rights-of-way and relocations, and disposal/borrow areas (LERRDs) for a project. There are approximately 268 residential and commercial structures eligible for participation. The nonstructural elevation and flood proofing measures will be offered to owners of structures that have been determined to be eligible and that have voluntarily consented to grant a temporary work area easement for construction, staging and storage and a permanent easement limiting alteration of the elevated structure for human habitation below the targeted first floor elevation for each structure in the case of elevation. The non-Federal sponsor will also be required to provide temporary relocation assistance benefits to tenants occupying eligible structures. Further discussion of the potential real estate requirements are detailed in the Real Estate Report (Appendix F).

9.5 Views of Non-Federal Sponsors and Other Agencies

The non-Federal sponsor's support for the TSP was confirmed through a Letter of Support dated December 13, 2016 following Public and Agency reviews (see Appendix G). Since that time, the non-Federal sponsor has confirmed through an updated Letter of Support dated October 19, 2017 that they wish to implement an LPP that consists of elevating 247 residential structures and flood proofs another 21 commercial structures. The proposed LPP costs less than the NED Plan. An exemption waiver was obtained from the Assistant Secretary of the Army for Civil Works on June 15, 2018.

9.6 Public Access

Public access is not a requirement for this nonstructural plan.

Chapter 10: Local Cooperation Requirements

The non-Federal Sponsor, has indicated their support for the LPP. A coordinated DA package will be prepared subsequent to the approval of the Chief's Report.

Federal implementation of the LPP will be subject to the non-Federal agreeing to comply with applicable Federal laws and policies, including but not limited to:

a. Provide a minimum of 35 percent of initial project costs assigned to coastal storm risk management, and as further defined below:

(1) Provide, during design, 35 percent of design costs allocated to coastal storm risk management in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;

(2) Provide, during construction, any additional amounts necessary to make its total contribution equal to 35 percent of project costs assigned to coastal storm risk management;

b. Once eligible properties have been identified, the non-federal sponsor will be required to obtain temporary work area easements for construction, staging and storage, in accordance with construction requirements. The non-Federal sponsor will also be required to obtain permanent easements limiting alteration of the elevated or flood proofed structure for human habitation below a height corresponding to the targeted first floor elevation for each structure in the case of elevation. The easement shall be recorded by the non-Federal sponsor in the public records of the county in which the property is located prior to commencement of the nonstructural improvements on the property;

c. Participate in and comply with applicable Federal floodplain management and flood insurance programs; comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12); and publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the flood risk management features;

d. Operate, maintain, repair, replace, and rehabilitate the completed project, or functional portion of the project, at no cost to the Federal government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal government;

e. For so long as the project remains authorized, ensure continued use of the elevated or flood proofed structure in a manner consistent with which the Federal participation is based;

f. Hold and save the United States free from all damages arising from the initial construction, periodic nourishment, operation, maintenance, repair, replacement, and rehabilitation of the project, except for damages due to the fault or negligence of the United States or its contractors;

g. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal government determines to be necessary for the initial construction, operation and maintenance of the project;

h. Assume, as between the Federal government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way required for the initial construction, or operation and maintenance of the project;

i. Agree, as between the Federal government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and, to the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA;

Chapter 11: Recommendations

In making the following recommendations, I have given consideration to all significant aspects in the overall public interest, including environmental, social and economic effects, engineering feasibility and compatibility of the project with the policies, desires and capabilities of the State of Rhode Island and other non-Federal interests.

I recommend that the Locally Preferred Plan for coastal storm risk management in the Pawcatuck River watershed, Rhode Island, as fully detailed in this Integrated Feasibility Report and Environmental Assessment, be authorized for construction as a Federal project, subject to such modifications as may be prescribed by the Chief of Engineers.

The recommendations contained herein reflect the information available at this time and current departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of highest review levels within the Executive Branch. Consequently, the recommendations may be modified (by the Chief of Engineers) before they are transmitted to the Congress as proposals for authorization and implementing funding. However, prior to transmittal to Congress, the partner, the State, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

Date: ______________

____
William M. Conde
Colonel, U.S. Army
District Engineer

Chapter 12: References

Atlantic Sturgeon Status Review Team (ASSRT) 2007. (Acipenser oxyrinchus oxyrinchus) Prepared by the Atlantic Sturgeon Status Review Team for the National Marine Fisheries Service National Oceanic and Atmospheric Administration. February 23, 2007. Updated with corrections on July 27, 2007.

Boothroyd, J.C., B.A. Oakley, and C. Trokosky. 2009. Benthic Geologic habitats of the Watch Hill-Misquamicut shoreface, Rhode Island. Prepared for US Army Corps of Engineers. Concord, MA 28 February 2009.

Bobrowski, Mark and Andrew Teitz. 2001. Model Zoning Ordinances. South County Watersheds Technical Planning Assistance Project. April 2001 http://www.dem.ri.gov/programs/bpoladm/suswshed/pdfs/modords.pdf [Website accessed August 1, 2016]

Cornell Lab of Ornithology Lab. 2017. Ebird.org website http://ebird.org/ebird/eBirdReports?cmd=Start [website accessed 31 October 2017].

Cowardin, L., V. Carter, F. Golet and E. LaRose, Classification of Wetlands and Deepwater Habitats of the United States, Office of the Biological Services, Fish and Wildlife Service, Department of the Interior, FWS/OBS-79/31 Dec. 1979

Dillingham, T.P., R. Abrams, A. Desbonnet, and J.M. Willis. 1993. The Pawcatuck River Estuary and Little Narragansett Bay: An Interstate Management Plan. Prepared for the Rhode Island Coastal Resources Management Council and Connecticut Department of the Environment, Long Island Sound Program.

Ernst, Nick. 2015. Telecom on June 12, 2015 between Nick Ernst, former piping plover coordinator at the Rhode Island National Wildlife Refuge and Kathleen Atwood, U.S. Army Corps of Engineers regarding 2014-2015 piping plover monitoring at Misquamicut Beach.

Federal Emergency Management Agency. 2016. Rhode Island Hurricane Evacuation Study Technical Data Report. Region 1, Boston, Massachusetts.

Ganz, Arthur R. 1997. Environmental concerns for Breachway and Channel Siltation: Winnapaug (Brightman) Pond, Quonochontaug Pond, Ninigret (Charlestown) Pond, Washington County, R.I. 1997. Rhode Island Division of Fish and Wildlife.

Hermes, O.D., Gromet, L.P., and Murray, D.P., comps., 1994, Bedrock geologic map of Rhode Island: Rhode Island Map Series No. 1, University of Rhode Island, Kingston, scale 1:100,000.

Kenney, Robert D. and Kathleen J. Vigness-Raposa. 2010. Marine Mammals and Sea Turtles of Narragansett Bay, Block Island Sound, Rhode Island Sound, and Nearby Waters: An

Analysis of Existing Data for the Rhode Island Ocean Special Area Management Plan. University of Rhode Island, June 22, 2010.

Komar, P.D. 1998. Beach Processes and Sedimentation, 2nd Edition. Upper Saddle River, New Jersey.

Kleinert, Ryan. 2015. Email communication dated June 15, 2015 from Ryan Kleinert, piping plover coordinator at the Rhode Island National Wildlife Refuge, regarding piping plover monitoring at Misquamicut Beach. Mr. Kleinert noted that the monitoring did identify tracks and foraging of several adult plovers, but no nesting birds were identified.

Lee, V. and S. Olsen. 1985. Hurricanes and flood hazards in the salt pond region. Mar. Tech. Report. Coastal Resources Center, Kingston, R.I.

Lee, Virginia and Laura Ernst. 1996. Cumulative and secondary impact study of the Rhode Island salt ponds, research notes, University of Rhode Island, Coastal Resources Center, Narragansett, R.I.

Massachusetts Natural Heritage and Endangered Species Program (MA NHESP). 2007. Roseate Tern (*Sterna dougallii*) fact sheet. Prepared by C. S. Mostello.

Masterson, J.P., Sorenson, J.R., Stone, J.R., Moran, S.B., Hougham, A., 2007, Hydrogeology and simulated ground-water flow in the Salt Pond region of southern Rhode Island: U.S. Geological Survey, Scientific Investigations Report 2006–5271, 56 p.

National Oceanic and Atmospheric Administration (NOAA). 2011. National Oceanic and Atmospheric Administration Tidal Current Tables 2011, East Coast of North and South America Including Greenland. National Ocean Service, U.S. Department of Commerce, Washington, D.C.

Nisbet, I. C. T. 1980. Status and trends of the roseate tern *Sterna dougallii* in North America and the Caribbean. Unpubl. Report, U.S. Fish and Wildlife Service, Newton Corner, MA. x and 131 pp.

Olsen, S. and V. Lee. 1984. The Salt Pond Region Special Area Management Plan. Rhode Island Coastal Resources Management Council, Wakefield, R.I. Pawcatuck Watershed Partnership. 1998. The Pawcatuck Watershed Report, p. 13

Pawcatuck Watershed Partnership. 1998. The Pawcatuck Watershed Report.

Rhode Island Coastal Resources Management Program (RICRMP). 1996. [On-line] http://www.crmc.ri.gov/regulations/RICRMP.pdf [Website assessed November 30, 2015].

Rhode Island Coastal Resources Management Program (RICRMP). 1999. Rhode Island’s Salt Pond Region: A Special Area Management Plan (Maschaug to Point Judith Ponds) for the Towns of Westerly, Charlestown, South Kingstown and Narragansett. April 12, 1999.

Rhode Island Coastal Resources Management Program (RICRMP). 2016. Restoring Coastal Habitat for Rhode Island's Future. http://www.edc.uri.edu/restoration/html/tech_sci/socio/intro.htm [Website assessed July 28. 2016)

Rhode Island Department of Environmental Management (RIDEM). 1996. Areas Closed to Shellfishing (map). Department of Environmental Management, Division of Fish, Wildlife and Estuarine resources.

Rhode Island, Department of Environmental Management (RIDEM) 2009. State of Rhode and Providence Plantation Water Quality Regulations. Amended December, 2009. Rhode Island Department of Environmental Management.

Rhode Island Department of Environmental Management (RIDEM) 2011. Rhode Island Statewide TMDL for Bacteria Impaired Waters – Pawcatuck River Segment 18C Water Summary. June 2011. Website accessed November 9, 2015. http://www.dem.ri.gov/programs/benviron/water/quality/swbpdf/paw18c.pdf

Rhode Island Geographic Information Systems (RIGIS). 1993 Wetland shape files http://www.edc.uri.edu/rigis/data/data.aspx?ISO=biota[website [website accessed November 16, 2015]

Rhode Island Statewide Planning Program. 2009. Ocean State Outdoors: Rhode Island's Comprehensive Outdoor Recreation Plan. Prepared by Rhode Island Statewide Planning Program and Rhode Island Department of Environmental Management June 2009

Rhode Island Geographic Information Systems (RIGIS). 2015. U.S. Fish and Wildlife Service National Wetland Inventory. July 2015

Rhode Island Geographic Information Systems (RIGIS). 2016. Natural Heritage Areas. Email dated September 29, 2016 from Paul Jordan, Supervising GIS Specialist, Rhode Island Department of Environmental Management.

Rhode Island Historical Preservation Commission. 1981. Historic and Architectural Resources of Charlestown, Rhode Island.

Rhode Island Historical Preservation. 1991. Historic and Architectural Resources of Narragansett, Rhode Island.

Rhode Island Historical Preservation. 1981. Historic and Architectural Resources of South Kingstown, Rhode Island.

Rhode Island Historical Preservation. 1978. Historic and Architectural Resources of Westerly, Rhode Island.

Rhode Island Historical Preservation and Heritage Commission. 2002. Native American Archaeology in Rhode Island.

Rhode Island. 2016. Rhode Island Geography: The Land Geography and Landforms of Rhode Island. http://www.ereferencedesk.com/resources/state-geography/rhode-island.html [website accessed May 13, 2016].

Salt Pond Coalition. 2016. Website accessed May 13, 2016 http://www.saltpondscoalition.org/PageWinnapaug.html.

Short, F.T., D.M. Burdick, S. Granger and S.W. Nixon. 1996. Long-term decline in eelgrass, Zostera marina L., linked to increased housing development. Seagrass Biology: Proceedings of an International Workshop, Rottnest Island, Western Australia. pp 291-298.

University of Rhode Island Cooperative Extension (URI) 2003. Westerly Source Water Assessment. April 2003.

U.S. Army Corps of Engineers (USACE) 1994. Shore Protection and Flood Damage Reduction Reconnaissance Report, Misquamicut Beach, Westerly, Rhode Island. US Army Corps of Engineers, New England Division, Waltham, MA, January 1994.

U.S. Army Corps of Engineers (USACE). 2000. Raritan Bay & Sandy Hook Bay, Combined Flood Control and Shore Protection Project, Port Monmouth, New Jersey. NY.

U.S. Army Corps of Engineers (USACE). 2002. Rhode Island South Coast Habitat Restoration Feasibility Report and Environmental Assessment. Prepared by the USACE New England District, Concord, Massachusetts.

U.S. Army Corps of Engineers (USACE). 2014. Environmental Assessment for Beach Erosion Control Project Report on Misquamicut Beach, Westerly, Rhode Island. Prepared by the USACE New England District, Concord, Massachusetts. January 2014.

U.S. Army Corps of Engineers (USACE). 2015. Raritan Bay & Sandy Hook Bay, Highlands, New Jersey. Coastal Storm Risk Management Draft Integrated Feasibility Report and Environmental Assessment. July 2015

U.S. Army Corps of Engineers (USACE). 2015b. Sediment Survey in Support of Project Design. Pawcatuck River Coastal Storm Risk Management Feasibility Study, Pawcatuck, Rhode Island. November 2015.

U.S. Census Bureau. 2015. United States Census [On-line] [multiple years]. http://quickfacts.census.gov/qfd/states/44/4476820.html [Website assessed November 30, 2015].

U.S. Department of Agriculture (USDA). 1981. Soil Survey of Rhode Island. Soil Conservation Service in cooperation with Rhode Island Agricultural Experiment Station.

U.S. Environmental Protection Agency. 1978. Protective Noise Levels. Office of Noise Abatement and Control, Washington, D.C

U.S. Environmental Protection Agency (USEPA). 1988. Sole Source Aquifers [On-line]. Available: http://www3.epa.gov/region1/eco/drinkwater/solepawc.html. [Website accessed November 2015]

U.S. Environmental Protection Agency (USEPA). 2014a. Waterbody Quality Assessment Report – Winnapaug Pond (RI0010043E-09). http://ofmpub.epa.gov/tmdl_waters10/attains_waterbody.control?p_au_id=RI0010043E-09&p_cycle=2010&p_state=RI&p_report_type= [Accessed November 2015]

U.S. Environmental Protection Agency (USEPA). 2014b. Waterbody Quality Assessment Report – Little Maschaug Pond (RI0010043L-18). http://ofmpub.epa.gov/waters10/attains_waterbody.control?p_au_id=RI0010043L-18&p_cycle=2014 [Website accessed November 2015]

U.S. Fish and Wildlife Service (USFWS). 1998. Roseate Tern Recovery Plan - Northeastern Population. First Update. Hadley, MA. 75 pp.

U.S. Fish and Wildlife Service (USFWS). 2010. Caribbean Roseate Tern and North Atlantic Roseate Tern (*Sterna dougallii dougallii*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Southeast Region, Boquerón, Puerto Rico and Northeast Region, Concord, New Hampshire.

U.S. Fish and Wildlife Service (USFWS). 2015a. Species Profile for Northern long-eared bat (*Myotis septentrionalis*). Environmental Conservation Online System (ECOS). Website accessed September 17, 2015. http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A0JE

U.S. Fish and Wildlife Service (USFWS). 2015b. Letter dated July 7, 2015 providing regional guidance to federal agencies on Endangered Species Act compliance for the norther long-eared bat. U.S. Fish and Wildlife Service, New England Field Office.

U.S. Environmental Protection Agency (USEPA). 2016a. EPA Green Book Non-Attainment Areas. https://www3.epa.gov/airquality/greenbook/hindex.html [Website accessed August 2, 2016].

U.S. Environmental Protection Agency (USEPA). 2016b. Green House Gas Emissions. https://www3.epa.gov/climatechange/ghgemissions/[Website accessed August 2, 2016].

U.S. Fish & Wildlife Service. 2016. Information, Planning and Conservation website (IPaC). https://ecos.fws.gov/ipac/ [Website accessed August 2, 2016].

U.S. Fish & Wildlife Service. 2015. Planning Aid Letter dated August 12, 2015 for the Pawcatuck River, Rhode Island Coastal Storm Risk Integrated Feasibility and Environmental Assessment. Prepared for: USACE, New England District

Washington County Regional Planning Council. 2003. South County Greenspace Protection Strategy. Spring 2003.

Westerly, Town of. 2014a. Town of Westerly, Rhode Island Water Supply System Management Plan Executive Summary. May 2013. Final Submission November 2014.

Westerly, Town of. 2014b. Annual Water Quality Report. Water testing preformed in 2014. Presented by the Westerly Water Department. PWS ID#: RI 1559512

Westerly, Town of. 2009. Comprehensive Plan, Town of Westerly, Rhode Island. A Plan for Conservation and Development. December 2009 [Adopted February 8, 2010].