Shoreline Stabilization for Erosion Control
Fort Raleigh National Historic Site
Floodplain Statement of Findings

Recommended:

Superintendent, Fort Raleigh National Historic Site — Date

Certification of Technical Adequacy and Service Wide Consistency:

Acting Chief, National Park Service Water Resources Division — Date

Approved:

Acting Regional Director, Interior Region 2 — Date

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SHORELINE STABILIZATION FOR EROSION CONTROL
FORT RALEIGH NATIONAL HISTORIC SITE

FLOODPLAIN STATEMENT OF FINDINGS

1. INTRODUCTION

Executive Order (EO) 11988, "Floodplain Management," and EO 13690, "Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input," require the National Park Service (NPS) and other federal agencies to evaluate the likely impacts of actions in floodplains. The objective of EO 11988 is to avoid, to the extent possible, the long-term and short-term adverse impacts associated with occupancy, modification, or destruction of floodplains and to avoid indirect support of development and new construction in such areas wherever there is a practicable alternative. EO 13690 was issued to establish a Flood Risk Management Standard for federally funded projects to improve the nation's resilience to floods and to ensure new federal infrastructure will last as long as intended. The National Park Service administers floodplain policy through Director's Order 77-2, *Floodplain Management* (DO 77-2), and Procedural Manual 77-2, *Floodplain Management* (PM 77-2).

It is NPS policy to preserve floodplain functions and values and minimize potentially hazardous conditions associated with flooding, including threats to human health and safety, risk to NPS capital investment, and impacts on natural and beneficial floodplain values. If a proposed action is found to be in, or possibly affecting a floodplain, and relocating the action to a non-floodplain site is considered not to be a viable alternative, then a formal Floodplain Statement of Findings (FSOF) must be prepared unless the action is considered excepted. The FSOF must (a) describe the rationale for selection of a floodplain site, (b) disclose the degree of risk associated with the chosen site (with respect to human life, health and safety, resource protection, and capital investment), and (c) explain strategies for mitigation of flood risk. The FSOF will be available for public review in coordination with the National Environmental Policy Act (NEPA) and other compliance procedures, as applicable. If public review is not provided through the NEPA process (e.g. environmental assessment), another opportunity for public review is required.

This Floodplain Statement of Findings provides:

1. A detailed justification for selecting a proposed action that would adversely impact the Federal Flood Risk Management Standard (FFRMS) floodplain (Section 2).
2. A detailed and comprehensive description of the flood hazard and risk associated with implementation of the proposed action (Section 3).
3. A thorough description of mitigation measures chosen to minimize or eliminate adverse floodplain impacts associated with the proposed action(s) (Section 4).

1.1 PREPARERS

In accordance with DO 77-2 and PM 77-2, this FSOF was prepared by Meaghan Johnson, Michael Flynn, and Byron Tsang. Meaghan Johnson is the Chief of Resource Management and Science, and Michael Flynn is the Physical Scientist and Certified Floodplain Manager (NC-17-0692) for the Outer Banks Group of Parks. Byron Tsang is an NPS aquatic resource professional, who is technically qualified to prepare this document. Byron is a Professional Wetland Scientist (PWS # 3832) with 15 years' experience in wetland and floodplain resource management. As the NPS Regional Wetland Ecologist for the Southeast Region, he is a technical authority and subject matter expert for issues pertaining to NPS wetland and floodplain management in National Park units. His specific areas of expertise include wetland hydrology and natural resource values, river and floodplain natural processes, coastal wetland environments, plant community ecology, natural species and invasive management, and ecological restoration in natural landscapes. He serves as the southeast region technical advisor for park projects and operations with regulatory obligations under Section 404 of the Clean Water Act, and NPS Wetland and Floodplain policies (DO 77-1 & 77-2).

1.2 LOCATION

Fort Raleigh National Historic Site (FORA) is located in Dare County, North Carolina, northwest of the city of Manteo on the northern end of Roanoke Island, an island within the Albemarle Sound. The 513-acre site was established on April 5, 1941, to preserve land declared to be of national significance as a portion of the colonial settlement or settlements established in America by Sir Walter Raleigh between 1581 and 1591 (NPS 2017). Residential developments are located east, west, and south of FORA with US Highway 64 running through the southern portion of the site. The proposed bank stabilization will be constructed entirely on NPS-owned (fee-simple) federal property. However, private in-holdings occur immediately adjacent to the proposed work area, and staging and equipment access may require temporary access through these neighboring lands.

The FORA shoreline is estimated to have eroded a quarter mile or more since the late 16th century, resulting in loss of resources and site land (NPS 2017). Combating erosion along FORA's shoreline has been a management issue since FORA's creation in 1941. Despite several prior efforts to slow shoreline losses, erosion has continued at an estimated rate of 1 to 5 feet per year, impacting both cultural and natural resources at FORA as well as the adjacent, privately-owned property referred to as Elizabethan Gardens (Kirk 2018). In response, the NPS developed a plan for shoreline stabilization and erosion control, and an associated environmental assessment (EA) in 2025. The EA identified a preferred action alternative to include installation of a rock berm along a portion of the shoreline as described in section 1.3 PROPOSED ACTION, below.

The north end of Roanoke Island is predominately subject to normal wind driven tides of less than 1 foot, with weak influences of lunar tides due to the limited connectivity to Oregon Inlet. The north end of the island faces large fetches (i.e., area of wind-generated waves) to

the northerly direction, which exposes the shoreline to wave action from strong winds generated from low-pressure systems and extratropical storm events. These types of lower magnitude but higher frequency events result in shoreline erosion along the non-armored sections of shoreline that do recover under calmer conditions but exhibit an overall erosional trend. Typical flood events at the project location are caused by storm surge and wave action generated by tropical cyclones that traverse from southerly to northerly directions and push water from the Pamlico Sound into the more constricted basins of the Croatan, Roanoke, and Albemarle Sounds. Storm surge may reach 3 to 5 feet in amplitude and reach as high as 10 feet during major hurricanes (Riggs and Ames 2003). The higher magnitude but lower frequency events result in more severe bluff erosion. During normal rainfall events, surface water flows north into the immediately adjacent Albemarle Sound, or percolates through well-drained sandy soil to groundwater. Surrounding terrestrial land cover is naturally vegetated maritime forest. Inland areas not subject to bank erosion tolerate occasional inundation and are largely resilient against storm surge and other severe weather events.

FIGURE 1. Map of the Fort Raleigh National Historic Site located on Roanoke Island in North Carolina.

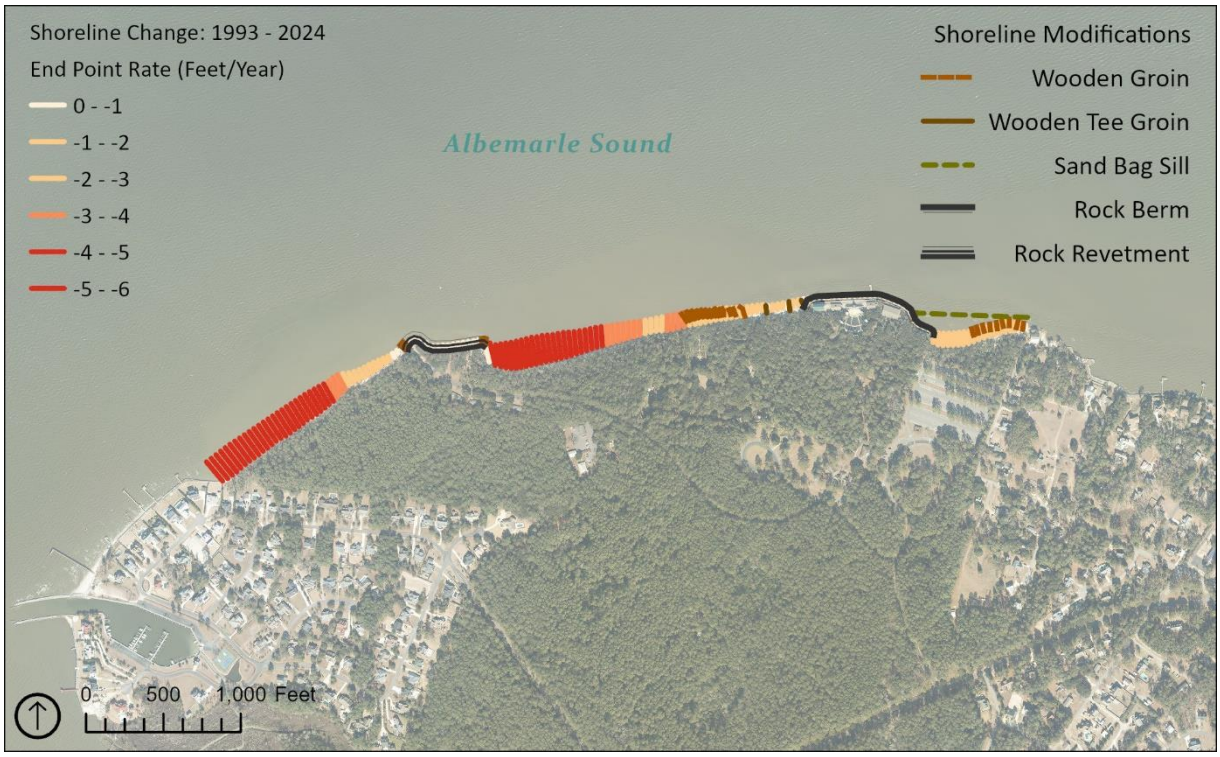

FIGURE 2. Map of the shoreline change rates and existing shoreline modifications at Fort Raleigh National Historic Site and Elizabethan Gardens.

1.3 PROPOSED ACTION

The proposed action would include the installation of a rock berm and wooden walk-over along a 425-foot section of the FORA shoreline located between the Elizabethan Gardens and Waterside Theater that is tailored for appropriate protection of park archaeological resources and critical infrastructure (See FIGURE 3 and FIGURE 4, below). This berm would slow shoreline erosion while taking advantage of existing topography and accommodating current land use. The sound side toe of the rock berm would be placed along the mean high water shoreline with an elevation of 0.33 feet (NAVD88) as referenced to the tidal datum measured at the Oregon Inlet Marina, NC (Station 8652587) during the epoch from 1983-2001.

This section of rock berm would be approximately 425 feet long and tie into the existing rock berm in front of the Waterside Theater to the east and a rock berm that will be installed simultaneously by a third party on private land in front of the Elizabethan Gardens to the west. This project would be comparable to the existing rock berm along the Waterside Theatre which has stabilized the shoreline for over 40 years. In addition to matching existing adjacent shoreline protection structures, the proposed rock berm has been identified as the minimum necessary action to adequately mitigate shoreline erosion and prevent further loss of archeological resources and park facilities.

The rock berm will have a trapezoidal cross section and minor excavation and grading would be performed within the berm footprint to create a relatively uniform foundation. The intent of this design is to have minimal bluff excavation. The rock would be placed on geotextile fabric and not directly on native soil nor in the water. The berm would be 12-15 feet wide with a crest elevation of approximately 6 feet above the mean high water elevation, depending on site conditions (FIGURE 4). The cross-sectional detail displayed in FIGURE 4 represents the existing site conditions along the Elizabethan Gardens shoreline which are the most restrictive in terms of narrow beach width and proximity to the 8-12 feet high escarpment. The professional engineer that designed the Elizabethan Gardens berm anticipates the bluff will naturally slough into the angle of repose. Whereas, the installation of the berm along the section of FORA shoreline for this proposed project, will occur on a wider beach (approximately 30 – 40 feet from west to east) and where the bluff is still 8-12 feet high but transitions to a gentler slope from west to east. Temporary ponding on standing water on the landward side of the rock berm along the FORA section of the project area may occur during storm events or following heavy precipitation events until water levels subside.

The proposed project is being sponsored by a third party and will not require any federal funding for construction. While NPS would be responsible for maintenance of the rock berm along FORA property, maintenance costs are expected to be minimal based on the fact that no maintenance of the armor stone has been required on the rock berm that stabilizes the shoreline along the Waterside Theater since it was constructed in the 1980s. Periodic maintenance of the proposed wooden walkover is anticipated in response to general upkeep and period storm damage.

The 425 feet of berm on NPS property will be constructed concurrently with equivalent shoreline armoring along the shoreline of adjacent privately owned Elizabethan Gardens. This is being done to take advantage of available equipment and work crew schedules and will also avoid excess shoreline erosion or scour due to changes in sediment transport associated with construction of the berm on adjacent private land. The use of an existing access route that is located along the western boundary of Elizabethan Gardens was identified as being the proposed access route since it would have the least impact on resources within FORA. Specific impacts to the existing access route would entail the removal of 6 trees to widen the unpaved road and grading of the bluff to allow heavy equipment to access the shoreline, which would be backfilled after the project completion. Also, this access route is the preferred since it could be used to stabilize other sections of FORA shoreline from the Elizabethan Gardens to the Dough Cemetery.

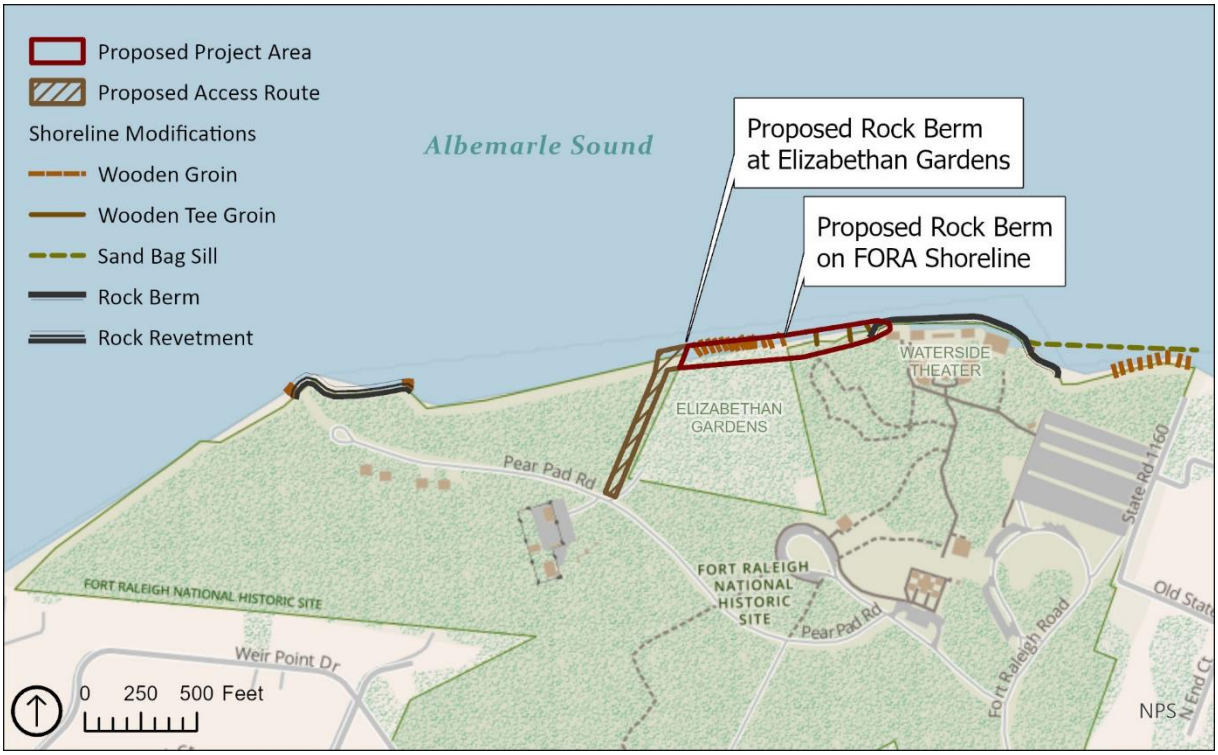

FIGURE 3. Project location map of the proposed project to stabilize the shoreline along Elizabethan Gardens and a section of the shoreline at the Fort Raleigh National Historic Site.

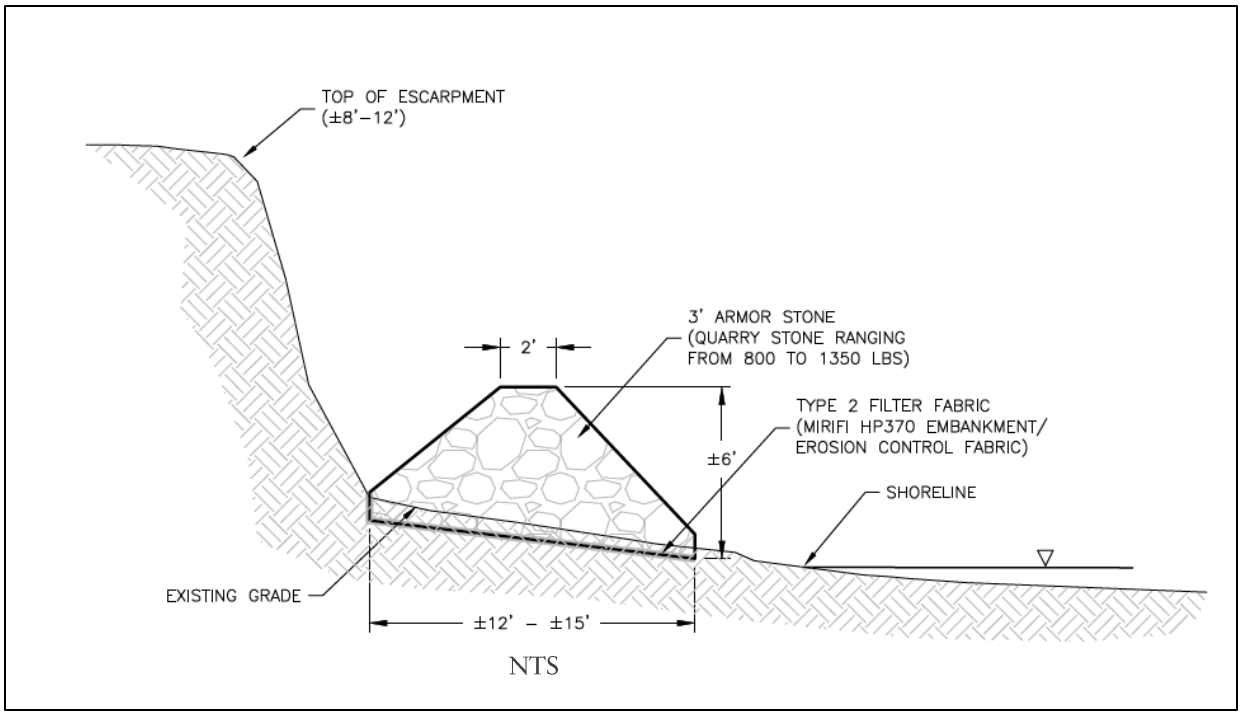

FIGURE 4. Cross-section detail of the proposed rock berm design to stabilize the section of shoreline at Elizabethan Gardens and extend east to the Waterside Theater along the shoreline of the Fort Raleigh National Historic Site.

1.4 DETERMINATION OF ACTION CLASS AND REGULATORY FLOODPLAIN

Following PM 77-2, three action classes were considered when establishing the regulatory floodplain:

1. Class I Actions include location or construction of administrative, residential, warehouse, and maintenance buildings; non-excepted parking lots; or other manufactured features which by their nature entice or require individuals to occupy the site, are prone to flood damage, or result in impacts on natural floodplain values.
2. Class II Actions include any activity for which even a slight chance of flooding is too great, such as construction of schools, medical facilities, emergency services, hazardous material storage, and records/collections storage.
3. Class III Actions include any action that involves human occupation or substantial human exposure in high hazard areas, such as drainages subject to flash flooding.

This project constitutes a Class I Action.

Proposed actions on federal lands must comply with the FFRMS, which amends the definition of the regulatory floodplain (as defined in EO 11988) to include additional flood resiliency measures and are designed to ensure that Federal investments are resilient to current and future flooding, including changes such as sea-level rise and more frequent and extreme rainfall.

The FFRMS identifies and describes three specific approaches for determining the vertical flood elevation and the corresponding horizontal extent of the floodplain. The NPS must use one of the following methods to determine this flood resiliency standard for any action is a Federally funded project.

- Climate-Informed Science Approach (CISA) - The elevation and flood hazard area that results from using the best-available, actionable, hydrologic and hydraulic data and methods that integrate current and future changes in flooding (e.g. due to increasing severity and frequency of precipitation, sea level rise, tidal cycles, land use change). This is the preferred approach where data are available and actionable, which currently applies to many coastal settings.
- Freeboard Value Approach (FVA) - The elevation and flood hazard area that results from adding an additional 2 feet to the base flood elevation (BFE) for non-critical actions (class I) and by adding an additional 3 feet to the BFE for critical actions (class

II). The BFE is the area subject to flooding by the 1-percent annual chance (100-year) flood.

- 0.2-Percent Annual-Chance Flood Approach (0.2PFA) - The area subject to flooding by the 0.2 percent annual-chance (500-year) flood.

A Climate-Informed Science Approach (CISA) establishing FFRMS flood elevations is employed for this proposed action. Therefore, the regulatory floodplain for the proposed action is the floodplain informed by a climate-informed science using best available climate and sea level rise predictions for the area. Data sources considered for this determination were FEMA Flood Insurance Rate Map (FIRM) and NOAA Coastal Management Sea Level Rise and Coastal Flooding Impacts Viewer (updated 2016 for North Carolina).

The primary flood hazard at the project location is coastal flooding and inundation associated with storm surge and sea level rise. The FFRMS Floodplain Determination Job Aid (2024) was used to determine the elevation and extent of the regulatory floodplain based on the Simplified CISA (Coastal Only). According to the current FEMA FIRM Panel 9871 dated June 19, 2020, which includes the project area, the open water area of the Albemarle Sound adjacent to the shoreline is identified as Zone AE, which is subject to inundation by the 1% annual chance flood (100-year flood), and has a base flood elevation of 6 feet (NAVD88). The proposed berm is designed for a 50-year service life. The NOAA Coastal Management Sea Level Rise and Coastal Flooding Impacts Viewer (updated 2016 for North Carolina) predicts 2.72 feet of sea level rise for the year 2080 using the intermediate scenario. Therefore, the CISA regulatory floodplain at the project location is 9 feet NAVD88; calculated as the 6 feet BFE plus 3 feet for predicted sea level rise (2.72 feet rounded to the nearest foot).

2. JUSTIFICATION FOR USE OF THE FLOODPLAIN

The FORA shoreline is estimated to have eroded a quarter mile or more since the late 16th century, resulting in loss of resources and site land (NPS 2017). Combating erosion along FORA's shoreline has been an ongoing management issue since FORA's creation in 1941. Past efforts to address shoreline erosion included the following actions (Binkley 2003):

- 1940s – jetties with pilings
- 1950's – breakwater, wooden groin field, and sill (breakwater)
- 1960's – wood groins and sandbag sill (breakwater)
- 1979-1980 – rock berm and riprap revetment
- 2009 – rock riprap placement (adjacent private land)

Erosion of the bank provides the primary source of sediment to the littoral system (Eshleman and York 2011). The use of a rock berm and rock revetment effectively stabilized the shoreline along the Waterside Theater and Dough Cemetery, respectively; however, the efforts disrupted sediment transport along the shoreline. Although the orientation of northern Roanoke Island upon which FORA is located allows for littoral drive in both easterly and westerly directions, depending on the dominant wind and wave direction, shoreline erosion has continued at an estimated rate of 1 to 5 feet per year, which impacts

both cultural and natural resources at FORA as well as Elizabethan Gardens (Kirk 2018). This shoreline protection project must be located in the floodplain to achieve the stated goal of preventing further degradation.

The Elizabethan Gardens intends to construct a rock berm along the section of shoreline owned by Roanoke Island Historical Association (RIHA) in 2026. This project entails working in coordination with the Elizabethan Gardens to install a rock berm contiguously from the western edge of the existing rock berm at the Waterside Theater along the approximately 425-foot section of FORA shoreline and the entire length of the Elizabethan Gardens, which necessitates working within the floodplain of the Albemarle Sound. If a rock berm is not installed within this FORA section, it will leave this area of shoreline more vulnerable to erosion between the rock berms. Numerous archeological resources have been found within this section of shoreline, and landward of this area is the Thomas Hariot Trail and critical infrastructure which includes buildings and the septic system for the Waterside Theater complex.

3. DETAILED FLOOD HAZARD AND FLOOD RISK ANALYSIS

3.1 DESCRIPTION OF SITE-SPECIFIC FLOOD HAZARD

NOAA Applied Climate Information System (ACIS) data for Dare County NC indicate average annual rainfall of 50–76 inches with heaviest rainfall occurring in summer months (May through August). However, with the project location immediately adjacent to open ocean, surface water can readily run off the site under normal circumstances. Because storm surge depth and velocity vary by storm intensity, FEMA flood data do not include coastal flood depth and velocity data at this location. However, background data is available via detailed capstone research project conducted by students enrolled in the U.S. Naval Academy examined site conditions including topography, average wind speed and direction, wave heights, and sea level rise in an effort to evaluate the effectiveness of various approaches to shoreline stabilization (U.S. Naval Academy 2014). Typical wave heights reach 1 to 3 feet, and storm surge may reach 3 to 5 feet in amplitude and reach as high as 10 feet during major hurricanes (US Naval Academy 2014; Riggs and Ames 2003). The higher magnitude but lower frequency events result in more severe bluff erosion.

The proposed cross-section is designed by a professional engineer that has integrated local knowledge of the environment and performance of similarly designed and constructed shoreline stabilization structures within the region (e.g. NC Aquarium on Roanoke Island) to withstand wave energy and storm surge events and therefore mitigate shoreline and bluff erosion, which are the principal concern at this site compared to flood inundation.

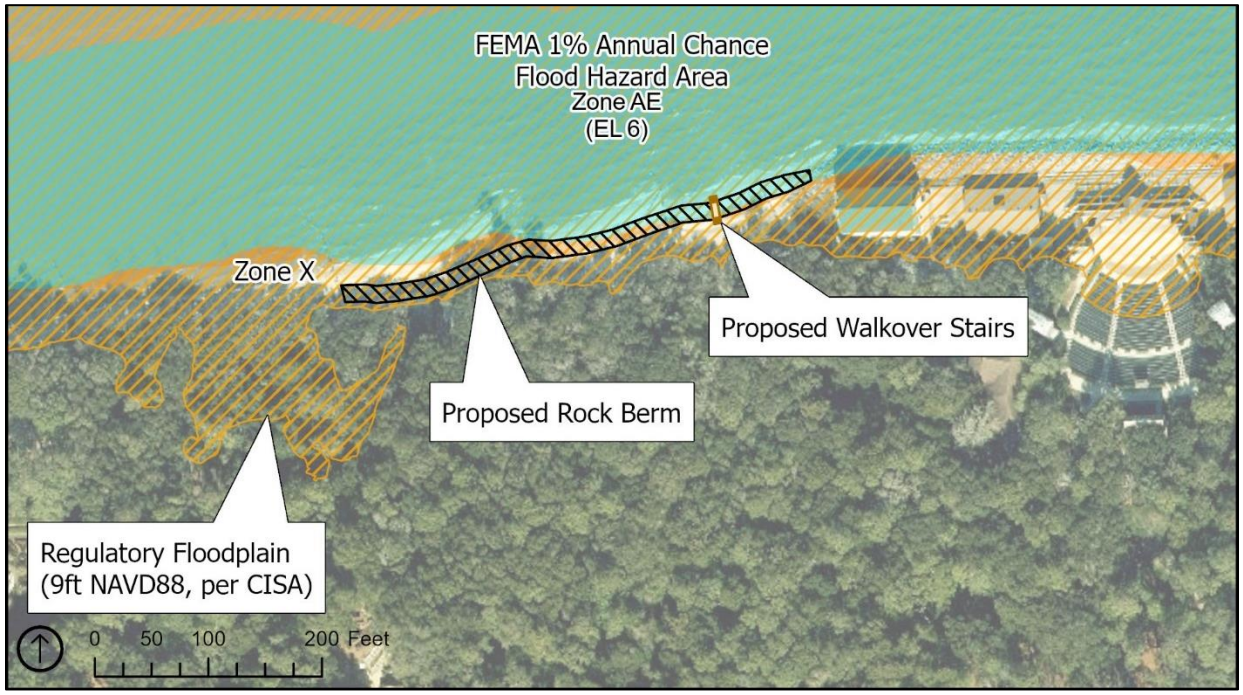

FIGURE 5. Proposed project area with rock berm location in relation to FEMA Special Flood Hazard Areas and Regulatory Floodplain (9 ft NAVD88, using climate-informed science approach).

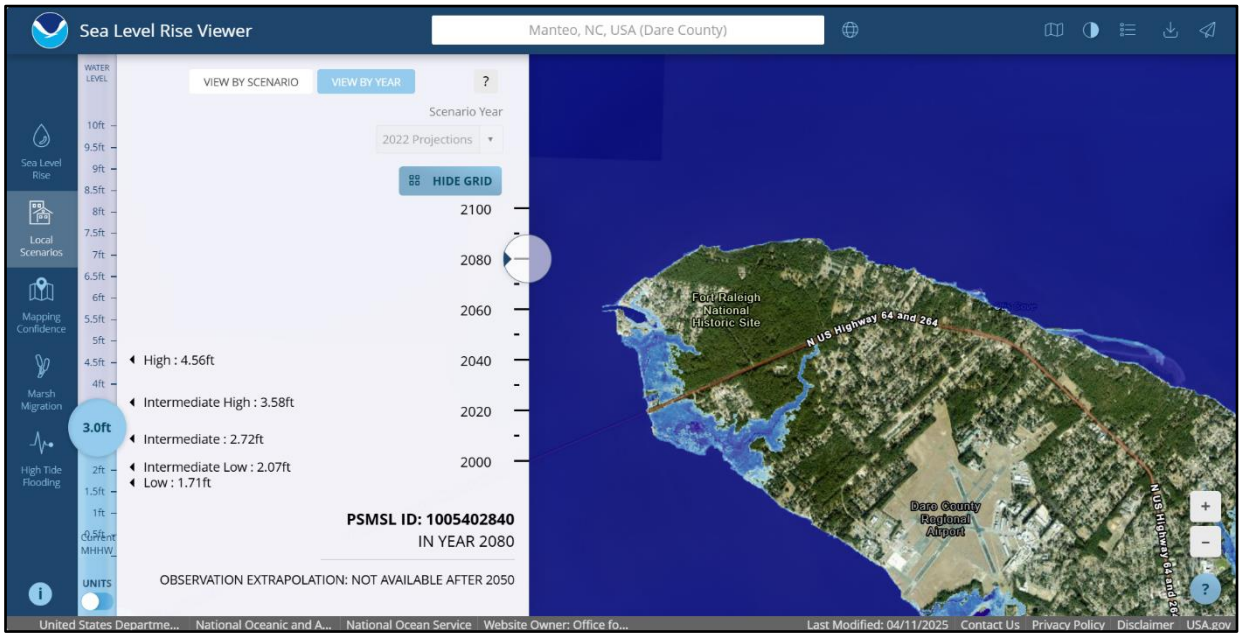

FIGURE 6. NOAA Sea Level Rise viewer showing local scenario for Manteo, NC. Extrapolated sea level rise data for 2080 predict sea levels will be 2.72 feet higher than current using the intermediate scenario. A rise of 3.0 feet is displayed in the map indicated by blue shaded areas.

3.2 DESCRIPTION OF SITE-SPECIFIC FLOOD RISK

As a result of anticipated environmental trends, continued loss of shoreline due to erosion is expected to progress and floodplain topography and location will change in response to sea level rise and increased frequency of coastal flooding.

The proposed action would have permanent direct impacts on 0.08 acres of the regulatory floodplain due to permanent fill placement for the rock berm (see FIGURE 5). Lateral scour at the project's western terminus would be limited, and measures, including toe protection, are incorporated into the project design to prevent adverse effects until future stabilization measures are constructed to complete stabilization contiguously to the Dough Cemetery. The eastern terminus of the project would tie into existing stabilization along the shoreline of the Waterside Theater. The proposed cross-section is designed to withstand wave action and storm surge events accounting for sea level rise for its full 50-year service life and aligns with the existing rock berm (and other stabilization structures designed by the professional engineer that have been constructed within the region), and would function as a protective structure, stabilizing the shoreline, reducing erosion, and attenuating wave energy, which all help to preserve FORA's coastal resources and ecosystems.

Potential Risk to Human Health and Safety

The project would protect NPS property farther inland outside of the regulatory floodplain by reducing wave energy and erosion forces of the shoreline. There is no expected change in risk to human health or safety resulting from the proposed project, given expected wave heights of 1 to 2 feet, risk to visitors at the project site during the design storm would be significant; however, the site will be closed during adverse weather conditions.

The NPS Outer Banks Group maintains a Severe Weather Action Plan which includes storm safety measures for FORA. This plan includes seasonal pre-storm prep and emergency preparation and evacuation procedures as early as 96 hours ahead of anticipated storm events. Additionally, Manteo/Dare County Regional provides flood warning forecasts to the public through the National Oceanic and Atmospheric Administration (NOAA) weather radio, commercial radio, TV stations, and local emergency agencies.

Potential Risk to Property

The proposed project has been designed to withstand wave energy and storm surge events accounting for sea level rise for its full 50-year service life. The purpose of the project is to protect existing FORA property from flood risks associated with future shoreline and bluff erosion rather than inundation since most of the park is located at elevations that are not subject to coastal inundation during storm events.

Some long-term, permanent, adverse impacts to flood risk may occur because of changes to natural longshore sediment transport caused by the proposed rock berm. Adjacent non-stabilized floodplain areas to the west could be starved of sediment from local erosion that feeds sand to these areas. In turn, this could accelerate erosion along the shoreline, increasing

risk to coastal infrastructure, facilities and resources. Lateral scour and erosion at the western terminus of this project is expected to be relatively localized and would occur within 10 to 15 feet of the base of the proposed shoreline stabilization structures and are not expected to significantly affect adjacent existing floodplains. Additionally, the NPS plans to mitigate this effect by constructing shoreline stabilization contiguously to the Dough Cemetery.

Potential Risk to Floodplain Values

Natural floodplain values contribute to ecosystem quality and include, but are not limited to, coastal habitat, soils, vegetation, flood attenuation, sedimentation processes, and ground water recharge. Periodic disturbance of natural floodplain soils and geomorphic and vegetation attributes by floods also contributes to ecosystem quality. The proposed project would result in the permanent loss of 0.08 acre of unconsolidated shoreline due to placement of riprap. This impact has been reduced to the minimum necessary to adequately protect the shoreline and nearby park facilities and cultural resources from future erosion. The proposed rock berm will be placed above the high tide line to avoid impacts to sensitive tidal wetlands. In terms of coastal floodplain processes, the berm would not introduce new flow boundaries or adversely affect storm surge, wave reflection, wave focusing, or regional erosion rates. Additionally, by slowing shoreline erosion, the proposed project would reduce flood risk to upland maritime forest areas which cannot easily be replaced or restored due to slow forest growth.

4. FLOODPLAIN IMPACT MITIGATION MEASURES

The proposed project is not expected to result in risk to human health or safety. While the proposed rock berm is being funded by a third party and requires no NPS investment, it will be constructed on NPS land and would be maintained by NPS as park property. The berm has been designed to withstand coastal wave action and reduce the bluff erosion caused by flooding for a 50-year service life, taking into account expected sea level rise. Construction of the proposed berm will result in permanent loss of shoreline habitat and associated floodplain function at the 0.08 acre site. These losses have been reduced to the greatest extent practicable and are necessary to achieve adequate protection of cultural resources and park facilities. Vegetation clearing for construction access would be minimized wherever possible and would be scheduled to avoid seasonal impacts to protected tree-roosting bat species. Disturbed areas would be returned to pre-existing contours (where applicable) and seeded with NPS-approved vegetation per NPS standards.

Potential downdrift erosion to the Elizabethan Gardens shoreline could occur while the revetment-armored adjacent properties would not be impacted. To mitigate downdrift at Elizabethan Gardens, FORA will collaborate with the landowner and/or the state through cooperative agreements to take the necessary actions outside NPS property to determine the best course of action at the Elizabethan Gardens shoreline.

5. SUMMARY

The National Park Service has determined the proposed action to construct a rock berm to prevent ongoing and future shoreline erosion at Fort Raleigh National Historic Site is necessary and consistent with Executive Order (EO) 11988, Floodplain Management and Director's Order 77-2: Floodplain Management. The proposed action is a Class I action which would require the location or construction of facilities within the regulatory floodplain which are prone to flood damage. Mitigation measures against flood risks include use of flood resilient materials and best available construction standards to minimize storm damage and facilitate fast and simple repairs, reduction of the impact to the minimum necessary for adequate shoreline protection, and revegetation of disturbed areas post-construction to restore temporary impacts to natural resource functions of the coastal floodplain to the extent possible.

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