PUERTO RICO COASTAL

DRAFT INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

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US Army Corps of Engineers ®
Jacksonville District

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DRAFT INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

INTRODUCTION

Hurricanes and coastal storms are responsible for significant damages to structures, property, and critical infrastructure due to wave attack, flooding, and erosion in Puerto Rico. These storm events threaten private and public property and critical infrastructure as well as recreational beach areas. The Puerto Rico Coastal Study began with the non-federal sponsor, the Department of Natural and Environmental Resources (DNER), bringing concerns about problems in the coastal areas of Puerto Rico to the U.S. Army Corps of Engineers (USACE), especially after Hurricane Maria (2017). In response to these problems, USACE initiated this study as a partial response to Section 204 of the Flood Control Act of 1970, Public Law 91-611. Title IV, Subdivision B of the Bipartisan Budget Act of 2018, P.L. 115-123 provides funding and allows the study to be conducted at full Federal expense.

This study investigates alternatives that address these vulnerabilities, as well as opportunities to maintain environmental habitat and recreation along specific areas of the Puerto Rico coastline.

PURPOSE AND NEED

This report is an interim response to the study authority. The purpose of this study is to determine whether there is economic justification and Federal interest in a plan to reduce the risk of damages to structures, properties and critical infrastructure as a result of erosion, wave attack, and flooding from coastal storms and hurricanes along specific areas of the Puerto Rico coastline. The study area is at risk of damages during coastal storms both now and as sea level changes. This vulnerability is evidenced by the extensive storm damages across the Commonwealth including but not limited to Hurricane Irma on September 6, 2017 (Presidential Disaster Declaration Federal Emergency Management Agency (FEMA)-4336-DR) and Hurricane Maria on September 20, 2017 (Presidential Disaster Declaration FEMA-4339-DR). Hurricane Irma caused minor flooding; however, wind damages were significant in Puerto Rico. Hurricane Maria caused extensive coastal storm surge, erosion, and stream flooding in many areas of Puerto Rico (FEMA, Puerto Rico Advisory Data and Products 2018). Other damaging storm events recorded in Puerto Rico include Hurricanes Hugo (1989), Georges (1998), Irene (2011), Matthew (2016), Irma (2017), and extra-tropical storm Riley (2018) and Fiona (2022).

PLAN FORMULATION

Study Scoping

Initially, the Puerto Rico Coastal Study assessed the shoreline problems along approximately 30 miles of coastline island-wide in order to provide possible Coastal Storm Risk Management (CSRM) alternatives to reduce risk to structures, property and critical infrastructure located in the municipalities of San Juan, Carolina, Vega Baja, Arecibo, Aguadilla, Aguada, Rincón, Añasco, Mayagüez, Cabo Rojo, Loiza, Luquillo, and Humacao. The initial scoping resulted in the following areas showing potential for Federal Interest: the San Juan (Condado, Ocean Park, Isla Verde, and Carolina) and Rincón coastlines; and a segment of the major hurricane/tsunami evacuation routes in Mayaguez (PR-102) and Humacao (PR-3). Further screening of the study areas eliminated the segments in Mayaguez (PR-102) and Humacao (PR-3) based on lack of potential for economic justification. As a result, the study concentrated on approximately 7

miles of coastline in the San Juan and Carolina municipalities and 2.4 miles of coastline in the Rincón municipality. The San Juan area fronts the Atlantic Ocean on the north coast of Puerto Rico, from El Boqueron to Boca de Cangrejos, and it is located in the municipalities of San Juan and Carolina, which are part of Metropolitan San Juan. For study purposes only, this study area will be referenced as the "San Juan Study Area" and it has been divided into four separable focus areas; Condado, Ocean Park, Isla Verde, and Carolina. The Rincón study area fronts the Atlantic Ocean on the west coast of Puerto Rico from Punta Ensenada to Corcega. The Rincón focus area was originally comprised of two planning reaches geographically separated by a stream, Rincón A lies north of Quebrada Los Ramos, and Rincón B lies south. Rincón A was not carried forward due to low erosion, as well as lack of ocean-front structures and critical infrastructure resulting in low economic justification.

Further investigations during the forecasting of existing and future without project conditions led to the screening out of the Carolina focus area due to the lack of potential for economic justification; therefore, modeling was performed only on the remaining focus areas of Condado, Ocean Park, Isla Verde and Rincón B, called Rincón for simplicity in this report.

A Draft Integrated Feasibility Report and Environmental Assessment was released for public and agency review in November 2020. After consideration of public and agency comments, as well as the need for updated environmental surveys, the Jacksonville District, with the support of the vertical team, made the decision to request more time and funding to allow the team to reassess technical and environmental aspects of the study area. The study team requested an additional 31 months and $3.3M, and this additional time and funding was approved in October 2021 which effectively restarted the study.

During plan formulation, the San Juan focus areas were divided into 4 planning reaches, shown in **Figure ES 1-1.** The study now focuses on the Ocean Park and Rincón planning reaches.

Figure ES 1-1. Planning Reaches in the Puerto Rico Coastal Study

OCEAN PARK PLANNING REACH

The Ocean Park planning reach is located within the municipality of San Juan, Puerto Rico. Important landmarks of interest in the study area include the Residencial Luis Llorens Torres, which has historically

been a community that has experienced economic challenges and which is the largest public housing community in Puerto Rico. Another key landmark is Barbosa Park, which is owned by the municipality of San Juan and is a recreational beach and park which are enjoyed by the community and some tourists. There are over 12 structures identified as critical infrastructure in the area, including police stations, fire stations, hospitals and shelters. The most widespread damages to structures, critical infrastructure and other assets are being caused by two points of coastal flooding which are coming from the ocean into low lying elevations at Barbosa Park and at the Marías skate park. The coastal flooding also causes road closures and difficulty for the economy to recover after storms in terms of schools, jobs and other businesses. The coastal flooding also creates a life safety hazard risk to the community.

RINCÓN

Rincón is a municipality of Puerto Rico, located on the north, westernmost tip of Puerto Rico. Historically the shoreline in southern Rincón reach was very wide; anecdotally it was wide enough to play a soccer game in years past. The shoreline has been a place of cultural identity and recreation for the community. The northern stretch of Rincón is known world-wide as a premiere surfing destination, hosting events and drawing in approximately 85,000 tourists per year to the municipality. The town of Stella (in the Pueblo barrio) is in the southern portion of the municipality of Rincón, which is one of the study areas. The town of Stella supports the northern portion of Rincón in tourism with hotels and restaurants, along with its sandy beaches, and relies on this income to sustain its economy. Stella has historically been a community that has experienced economic challenges, with 75% of the population meeting the low-income threshold. For reference, the national median income including mainland United States is 3 times that of the Rincón median income. The coastline of Rincón experiences erosion due to long-term sediment deficit, increased storm frequency, and infrastructure along the shoreline. Erosion has been further exacerbated by the construction of armoring along nearly the entire shoreline and has contributed to the severe sediment deficit partially caused by the excavation of beach and dune sediment from the coast for construction and other purposes. The erosion will become worse if storms are more frequent and intense, causing increased structure failures and potentially condemning of structures by the local government due to safety concerns. These failed structures, often left behind and unremoved, are very unsafe and create unsightly conditions that then continue to spread into the community. Further, the failed structures potentially increase erosion in the local area and prohibit natural beach recovery. Structure values in this area are noticeably much lower than in other parts of Puerto Rico compared to San Juan, and significantly lower than some comparable coastal communities in the mainland United States.

In the absence of a plan, structures[1] are expected to be completely lost to the ocean and/or condemned due to erosion, ultimately triggering forced relocations. Under devastating circumstances, property owners will be forced to move after their homes are condemned and large portions of the beach will be inaccessible due to the resulting safety issues with the remnants of the destroyed structures. Structures would become derelict and are unlikely to be removed which would further exacerbate wave energy,

[1] A structure refers to a single building which could have multiple property owners within. For example, a condominium complex with 20 units would be a single structure, but would have 20 unique property owners.

resulting in erosion on surrounding shorelines. Furthermore, residents are likely to relocate out of the area and potentially out of Puerto Rico, reducing not only the strength of the cultural identity of the community, but also reducing the tax base and impairing the economy.

PROBLEMS, OPPORTUNITIES, OBJECTIVES AND CONSTRAINTS

The main problems in the Ocean Park planning reach are coastal flooding, erosion and wave attack which cause damages to structures, property and critical infrastructure. The main problems in the Rincón planning reach are erosion and wave attack which cause damages to structures, property and critical infrastructure.

The overarching objective of this study is to provide resilience to affected communities within Puerto Rico with an emphasis on life safety. The study considered comprehensive effects under the four Planning and Guidelines (P&G) system of accounts, per the Assistance Secretary of the Army, Civil Works (ASA(CW)) 5 January 2021 memorandum. These four accounts are National Economic Development (NED), Environmental Quality (EQ), Regional Economic Development (RED), and Other Social Effects (OSE). This study developed the following objectives to address each of the identified problems and opportunities within all the planning reaches:

Ocean Park Planning Reach

- **Primary Objective:** Manage the risk of damages to structures, property and critical infrastructure as a result of coastal flooding, erosion, and wave attack caused by coastal storms, with an emphasis on maintaining life safety, within the study area over a 50-year period of analysis (2029 – 2078).(NED)
- **Secondary Objectives:**
    - Maintain recreational use of coastal and non-coastal areas. (NED)
    - Maintain environmental quality. (EQ)
    - Reduce disruptions to the economy after coastal storms. (RED)
    - Improve life safety during and after coastal flooding events. (OSE)

Rincón Planning Reach

- **Primary Objective:** Manage the risk of damages to structures, property and critical infrastructure as a result of erosion and wave attack caused by coastal storms, with an emphasis on maintaining life safety, within the study area over a 50-year period of analysis (2029 – 2078). (NED)
- **Secondary Objectives:**
    - Maintain recreational use of coastal areas. (NED)
    - Maintain environmental quality. (EQ)
    - Maintain or increase tourism, local property tax revenue and number of jobs . (RED)
    - Reduce risk of local communities abandoning the area. (OSE)

During the initial scoping, the density and type of properties were identified for both planning reaches, as well as the presence of critical Infrastructure like hospitals, fire stations, shelters, schools, utilities, and major evacuation routes. Managing the risk of damages to all of these assets is included under the main objective. Additionally, the study has proposed a plan consistent with Federal law and policy and will avoid

or minimize impacts to cultural resources, reef resources, submerged vegetation and critical infrastructure.

Structural management measures initially considered included: seawalls/floodwalls, revetments (rock), groins, and breakwaters.

Non-structural management measures initially considered included: relocation of critical infrastructure, wet floodproofing, elevation of structures, acquisition of structures and property, as well as measures that could be employed by the non-Federal sponsor to include a coastal regulatory program, re-zoning, improving public outreach, and improved evacuation plan and notification.

Natural and nature-based features initially considered included: beach with vegetated dune, vegetated dune, and artificial reefs.

During the plan formulation process, management measures were preliminarily screened against the four Federal accounts, planning objectives, and planning constraints using a qualitative assessment to first evaluate if they would address the primary objectives to reduce hazards in each reach. From this evaluation, the following measures were carried forward for each planning reach:

- Ocean Park – seawall/floodwall, beach with vegetated dune, acquisition
- Rincón – revetment (rock), groins, beach with vegetated dune, acquisition

The alternatives were evaluated and compared using planning criteria, environmental impact minimization and avoidance factors, and the USACE economic analysis.

THE TENTATIVELY SELECTED PLAN (TSP)

The TSP in Ocean Park is Alternative 2, which proposes a floodwall with rock armor for toe protection. This alternative would reduce the risk of coastal flooding entry at the most critical areas, Barbosa Park and the skate park (**Graphic Executive Summary Page 2)**. This alternative is preferred by the non-Federal sponsor. At Barbosa Park, the floodwall would be set back from the shoreline in place of the existing park access road. The floodwall would be aligned between the beach and the park in Barbosa Park, and would align landward of a block of existing townhomes, to tie into high ground. The townhomes currently have a seawall which appears to meet the required design elevation. Therefore they have reduced risk from coastal flooding under existing conditions, which will not be made worse from this project. The floodwall at Barbosa Park would have buried rock armoring and would have a small initial sand backfill seaward of it, in the form of a small, vegetated dune. This option would preserve the beach in front of the floodwall (approximately 1-3 feet high from ground elevation on average), and also allow public access over it to maintain existing accessibility to the beach park. In this area, it would be aligned along the shoreline and would have rock armoring for toe protection seaward of it. Access to Barbosa Park would be maintained along the side access roads. The existing sidewalk in the area would need to be removed during construction but would be relocated landward of the new floodwall. In the Barbosa Park location, some temporary easements would be required during construction and a permanent acquisition on one property would be required to provide necessary land to construct and maintain the floodwall. Approximately 6 removable floodgates are proposed to allow property access to current residents during non-flooding events. the floodgates would be installed prior to flooding events. In the skate park location, temporary easements would be required during construction and a permanent acquisition on three properties would be required to provide necessary land to construct and maintain the floodwall. Based

on this alternative's work limits, there would be no significant overlap with existing natural habitats. Avoidance planning was conducted to eliminate or minimize direct effects to aquatic habitats, and to maintain existing beach habitat conditions post construction. Prescribed conservation measures and monitoring would be implemented, and environmental mitigation would not be required. Ongoing coordination of study alternatives with the National Marine Fisheries Service (NMFS) and the US Fish and Wildlife Service (USFWS) indicate concurrence. This alternative has an estimated cost of $65,000,000 and delivers $2,816,000 in average annual NED benefits, $420,000 in average annual net benefits over a 50-year period of analysis with a benefit to cost ratio (BCR) of 1.2. Approximately 6,878 days of business disruption due to coastal flooding are reduced and life safety risk is reduced. Nearly 40% of the benefits would be gained by the most socially vulnerable populations by reducing coastal flooding damages to the Residencial Luis Llorens Torres community.

The TSP in Rincón is Alternative 4, which proposes acquisition. With this plan, high-risk structures along approximately 1.1 miles of shoreline would be included for acquisition and residents would be relocated. The structures would be demolished, and the land would be returned to its natural sandy state which may involve revegetation with native species. It would not require mitigation and additionally would re-establish 4.14 Average Annual Habitat Units (AAHU) within the acquisition footprint (eventually creating 17 acres of beach habitat for nesting sea turtles, shoreline birds, and other species.). The sandy shoreline would be allowed to naturally recover and would ensure that the tourism-based regional economy could thrive into the future by maintaining $3,372,000 Average Annual Equivalent units (AAEQ) worth of local tourism spending. It has an NED cost of $3,725,000 (AAEQ) with NED benefits of $1,013,000 (including increased recreation), negative net benefits of -$2,712,000 and a BCR of 0.27. It uses nature-based and non-structural solutions and is also supported by the Governor of Puerto Rico, the Mayor of Rincón, and the Secretary of DNER. This study would positively affect the city of Stella. This plan will be a model of coastal resiliency for Puerto Rico, allowing communities to prepare, absorb, recover and adapt, using best management practices for long-term sustainability of the shoreline. This is the most effective plan of all of the comprehensive plans considered. Since this plan deviates from the National Economic Development (NED) plan, a policy exception for this plan was approved by the Assistant Secretary of the Army, Civil Works (ASA, CW) on 8 May 2023. This approval letter can be found in **Appendix H, Pertinent Correspondence.**

SEA LEVEL CHANGE (SLC)

Following procedures outlined in ER 1110-2-8162 and EP 1100-2-1, low, intermediate, and high Sea Level Change (SLC) values were estimated over the life of the project using the official USACE sea level change calculator tool. For the future without-project conditions in San Juan study area, SLC could be expected to increase by increase by 0.59 ft (low), 1.25 ft (intermediate), and 3.33 ft (high) by year 2078 (50-year period of analysis). For the Rincón study area, sea level could be expected to increase by 0.54 ft (low), 1.19 ft (intermediate), and 3.28 ft (high) by year 2078 (50-year period of analysis) with respect to the above mentioned present local mean sea level tide datum. Future SLC is expected to exacerbate the impacts of coastal flooding and wave attack as those forces would be occurring at a higher starting water level in the future as sea level changes. The intermediate sea level change was chosen for plan formulation based on the study areas sensitivity to sea level change and critical flooding thresholds, with consideration of the 5-year average, the 19-year moving average, sea level change and relevant literature. The performance of the TSP was also evaluated under all three SLC curves. This approach has been coordinated with the Climate Preparedness and Resilience (CPR) Community of Practice (CoP). More information on the sea level change analysis can be found in **Appendix A, Engineering** and this information is also discussed in more detail in Chapters 2, 3, and 5 of this report.

ENVIRONMENTAL CONSIDERATIONS

The environmental quality account considers non-monetary effects on ecological, cultural, and aesthetic resources. Under this account, the preferred plan should avoid or minimize environmental impacts and maximize environmental quality in the project area to the extent practicable considering other criteria and planning objectives. More detailed descriptions of the analysis and impacts can be found in Chapter 4 of this report and in **Appendix G, Attachment 1**. For the purposes of alternatives analysis, all action plans were compared to the future without-project condition (i.e., NEPA No Action), which factors in 50 years of sea level change (to 2078). Effects for each alternative were evaluated and were carefully considered during plan formulation and for selection of the TSP. Mitigation is not expected for the TSP.

PLAN IMPLEMENTATION

For each of the alternatives included in the TSP, an Abbreviated Risk Analysis (ARA) was performed to assess the level of risk and to determine a reasonable contingency to be applied to each alternative. Based on the results of the ARA, an average contingency of 35-38% was assumed across all alternatives for the construction costs, PED, and S&A. For Lands and Damages and Real Estate administrative costs, a 30% contingency was assumed. **Table ES 1-1** presents the total project first cost for the Ocean Park Planning Reach, currently estimated to be $64,191,000 including contingency (FY23 price level). The estimated adjusted Federal cost after credit is applied from Section 1032 WRDDA 14 and credit is applied for Lands, easements, relocations, rehabilitations and disposal (LERRD) is $32,527,000 and non-Federal cost is $16,491,000. **Table ES 1-2** presents the total project first cost for the Rincón Planning Reach, currently estimated to be $110,830,000 including contingency (FY23 price level). For Rincón, it should be noted that the cost presented is based on the initial real estate appraisal for projected acquisitions. The gross real estate appraisal was completed, but it is still being finalized in the project cost and may result in up to a 20% cost increase. Updated costs will be presented in the Final Report. The estimated adjusted Federal cost after the waiver is applied pursuant to Section 1156 of the Water Resources Development Act of 1986, as amended, and after credit is applied for LERRD is $15,108,000 and non-Federal cost is $62,324,000.

Table ES 1-1 Ocean Park – Alternative 2 (Floodwalls)–- TSP Total Project First Cost (FY 23 Price Levels).

Item	Federal Share	Federal Cost	Non-federal Share	Non-federal Cost	Project First Cost
Construction (including demolition, grading, PED and Construction Management)	65.00%	$31,862,000	35.00%	$17,156,000	
Sidewalk relocation				$492,000	
Acquisition of structures and property		$0		$13,134,000	
RE Admin		$470,000		$1,075,000	
TOTAL		$32,332,000		$31,858,000	$64,191,000
LERRD Credit[2]				($14,702,000)	
Section 1032 of WRRDA 14 Waiver[3]		$665,000		($665,000)	
Adjusted Cost Share [4]				**$31,193,000**	
Non-Fed Cash Contribution[5]		**$32,527,000**		**$16,491,000**	

[2] This includes Lands, Easements, Relocations, Right-of-Way, Disposal (LERRD) plus non-federal administrative costs, applies to Table ES 1-2 as well.
[3] Reflects update to Section 1032 of WRDDA 14 waiver amount to $665,000 in November 2022, applies to Table ES 1-2 as well.
[4] Cost share is adjusted in the amount of $665,000 per Section 1156 of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2310), applies to Table ES 1-2 as well.
[5] Cost share cash contribution when both adjustments for $665,000 per Section 1156 of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2310), and LERRD credit, are applied. Applies to Table ES 1-2 as well.

Table ES 1-2 Rincón – Alternative 4 (Acquisition)- TSP Total Project First Cost (FY 23 Price Levels).

Item	Federal Share	Federal Cost	Non-federal Share	Non-federal Cost	Project First Cost
Construction (demolition, grading, PED, and Construction Management)	65%	$10,015,000	35%	$5,393,000	
Acquisition of structures and property		$0		$81,334,000	
RE admin		$4,428,000		$9,660,000	
TOTAL		**$14,443,000**		**$96,387,000**	**$110,830,000**
LERRD Credit (up to 35%)				($33,398,000)	
Section 1032 of WRRDA 14 Waiver		$665,000		($665,000)	
Adjusted Cost Share[6]		**$15,108,000**		**$62,324,000**	

[6] There are two potential paths for further adjustments that could be made to the cost share as shown. For the first path, per ER 1165-2-130 and under the project partnership agreement, there could be a reimbursement agreement to allow reimbursement to the non-federal sponsor for LERRDS in excess of the 35% cost share, after project completion and closeout, subject to federal appropriation of funds. For the second path, per ER 1165-2-131, the non-federal sponsor could request that the Federal government to acquire LERRDs. If either of these options is requested and approved, the cost share adjustments would be made.

VIEWS OF THE PUBLIC, AGENCIES AND STAKEHOLDERS

Stakeholders include of the communities in the municipalities of San Juan, Carolina and Rincón; the non-Federal sponsor Department of Natural and Environmental Resources (DNER), as well as Federal environmental agencies, state and local agencies, and Non-Governmental Organizations (NGO). Throughout the study, the team has met with affected communities, DNER, National Marine Fisheries Service (NMFS), the State Historic Preservation Office (SHPO), and U.S. Fish and Wildlife Service (USFWS).

A public scoping letter was sent in October 2018, which outlined the USACE Jacksonville District's intent to gather information to prepare an Environmental Assessment (EA) for evaluation of the feasibility of providing hurricane and storm damage reduction, and related purposes, to the Puerto Rico shoreline. The initial scoping period for the study was conducted from October 16 to November 16, 2018. Public and interagency meetings were held on November 6, 2018, in Aguadilla; November 8, 2018, in San Juan, Puerto Rico with participation from the DNER, USFWS, NMFS, Puerto Rico Planning Board (PRPB), Office of Permits General (OGPe), NGOs, Instituto de Cultura Puertorriqueña (ICP), and the public. An additional public meeting to provide study updates was held on June 18, 2019, in Rincón. On June 22, 2020, the team met via webinar to brief representatives of the municipalities of San Juan and Carolina, DNER, and environmental agencies on the alternatives and receive feedback. Public webinars were held in December 2020 to present the recommendations of the November 2020 Integrated Draft Report and Environmental Assessment.

The team has carefully considered input in recommending the tentatively selected plan. The team held open house meetings in both Rincón and Ocean Park in September 2022, where the team presented the focused array of alternatives and obtained feedback from members of the community and agencies. During this time, the team also met with the Secretary of DNER and her staff, as well as the Mayor of Rincón. The team continued to work on the study with those valuable insights, which lead to the final array of alternatives. The team then met with the Governor of Puerto Rico and the Secretary of DNER on 29 NOV 2022. At that meeting, the team recommended the potential TSP for consideration of support by DNER, the non-Federal sponsor. At that meeting, the Governor requested that his staff hold several meetings with landowners and USACE staff to present key technical information in order to gage feedback on the most likely set of alternatives to recommend as the TSP for each planning reach. A series of meetings were held by the Governor's staff on 12 December 2022 and 14 December 2022. A letter was sent on 27 December 2022 by the Secretary of DNER on behalf of the Governor of Puerto Rico, expressing his support of Ocean Park Alternative 2 and Rincón Alternative 4.

RESIDUAL RISK AND POTENTIAL ADAPTATION STRATEGIES

The USACE Climate Change Adaptation Goal is to minimize impacts from climate change and maximize resiliency in the coastal landscape. USACE describes resilience as "the ability to anticipate, prepare for, respond to, and adapt to changing conditions and to withstand and recover rapidly from disruptions with minimal damage." USACE Civil Works project designs should take into consideration how and if the design can be adapted to account for the effects of sea level change (SLC) and climate change 100 years after the project is constructed. These analyses and recommendations are primarily based on projected SLC and not future economic conditions that may affect project benefits.

Ocean Park

In Ocean Park, the study team has formulated alternatives for coastal flooding coming from the ocean side using the intermediate SLC curve. Some residual risks associated with this approach are the possibility of the SLC trends shifting towards the high SLC scenario and potential flooding from the back-bay under the high SLC scenario. Following a substantial analysis and coordination with the vertical team, USACE chose this formulation strategy due to the uncertainty of the high SLC and the potential exponential increase in inundation exposure from intermediate to high SLC. USACE noted higher inherent risk when formulating a coastal storm risk management (CSRM) plan using the high SLC scenario given the magnitude of the solution needed to buy down that risk (huge exposure area), thus inflating project costs. While a very costly CSRM solution may be justified for the high SLC scenario, that level of cost may not be justified under the intermediate or low SLC scenarios. Therefore, the current approach of formulating a TSP using the intermediate SLC scenario is a good compromise and provides options moving forward. Additionally, assessing damages at the high SLC scenario would necessitate compound flooding quantification and could require more than one study. Further, a much larger exposure/assessment area would have likely resulted (nearly island-wide) if the original study evaluated high SLC scenario vulnerability to areas regardless of economic value or intermediate SLC scenario exposure. If the high SLC were to occur, economic modeling indicates a large increase in damages and engineering modeling indicates an increase in flooding pathways within both the general study area along the coastline and in the adjacent back-bay areas. Back-bay flooding under the intermediate SLC scenario indicates the risk of coastal flooding is low and tolerable within the study area. However, the risk of flooding from the back-bay increases substantially under the high SLC scenario. To account for the possibility of the high SLC scenario, adaptation strategies are considered below. The formulation of alternatives based on the intermediate SLC curve with the inclusion of adaptation strategies, as needed, is an approach where there is a plan for each potential scenario to ensure resilience to the community.

Potential Adaptation Strategies for Ocean Park

In Ocean Park, adaptation will likely include a study to re-evaluate solutions rather than specific adaptable measures due to an increase in ocean-front and back-bay flooding pathways under the high SLC scenario in combination with the study area's topography and the extensive shoreline armoring that would be required under the high SLC scenario. The increase in flood pathways extends throughout the entire study area and includes flooding from the coastal and back-bay regions. Specific adaptable measures to the TSP would require elevating the TSP and extending the structures laterally to encompass the entire study area and potentially areas outside of the study area. This re-evaluation study will likely indicate that a full reformulation of solutions is required. Thresholds to determine when adaptation needs to take place will be established and included in the Final Report, based on increases in relative SLC over a specified period of time. It is recommended that should adaptations be considered within 50 years of project construction a post authorization study could be initiated with the USACE or a study could be initiated under Section 216 of the Flood Control Act of 1970 (Public Law 91-611). If adaptation is considered beyond a 50-year period after construction, the non-federal sponsor could initiate a study (with or without the USACE) to address problems.

During the PED Phase, the monitoring procedure for the project and adaptation strategies will be written in the OMRR&R manual. The OMRR&R manual will discuss the thresholds for adaption, with lead times required for each action. Once constructed, the project will be placed in the USACE's Comprehensive Evaluation of Projects with Respect to Sea-Level Change tool to provide additional forecast for potential

adaptation. The purpose of this tool is to inventory and assess the vulnerability of existing USACE projects to the effects of SLC and provide added benefits to other USACE activities.

Rincón

Preliminary modeling indicates there will be residual risk following project implementation primarily due to associated damages from continued beach erosion. First, there is residual risk related to potential future development within the newly restored project area, if not enforced. To mitigate this residual risk and ensure the project benefits are realized, it would be necessary to ensure that development and additional coastal armoring that may have an adverse effect on the newly restored natural areas is not allowed in the project area. To reduce this risk the non-federal sponsor should establish and enforce a coastal regulatory program to regulate current and future coastal development. This could be modeled after the Coastal Construction Control Line (CCCL) Program administered by the Florida Department of Environmental Protection (FDEP), which ensures the reasonable use of private property and protects the natural beaches and dunes.

Second, the TSP in Rincón recommends acquisition from R11-R19, rather than the full extent of R22. This is due to focusing the plan on the largest extent of structures that experience the most frequent damages. The area south of R19 generally contains large condos with robust armoring in the existing condition and several single-family units that are already condemned.

Third, residual risk remains if erosion continues beyond the acquired properties; the high SLC scenario could further exacerbate erosion damages within the study area. USACE formulated for the intermediate SLC curve and assessed the effectiveness of the TSP under high SLC. If a higher SLC scenario was realized increased erosion associated with higher SLC trends would further affect the structures within Rincón, which could undermine damage reduction benefits achieved under the intermediate SLC scenario. To mitigate this risk, it will be important to monitor erosion rates in conjunction with relative SLC trends over time for potential adaptation within the 100-year adaptation horizon. The formulation of alternatives based on the intermediate SLC curve with the inclusion of adaptation strategies, as needed, is an approach where there is a plan for each potential scenario to ensure resilience to the community.

Potential Adaptation Strategies for Rincón

In Rincón, adaptation could entail additional acquisition of structures, most vulnerable to erosion damages, beyond the TSP based on set thresholds and monitoring. Economic modeling indicates that approximately an additional 10 to 20 structures outside of the current acquisition footprint could be vulnerable to erosion within the 100-year adaptation horizon for the intermediate SLC curve and assuming the background erosion rates continue. Thresholds to determine when adaptation needs to take place will be established and included in the Final Report, based on erosion rates and/or increases in relative SLC over a specified period of time. To monitor the erosion rates within the potential project area the coastal regulatory program, developed by the non-federal sponsor, will provide a methodology to track erosion rates and the shoreline following construction completion through the 100-year adaptation horizon. Additionally, the non-federal sponsor should monitor the shoreline vegetation and replant, as needed, after storm events to further efforts to reduce the severity of erosional effects on the potential project area.

During the PED Phase, the monitoring procedure for the project and adaptation strategies, will be written in the OMRR&R manual. The OMRR&R manual will discuss the thresholds for adaption, with lead times required for each action. Once constructed, the project will be placed in the USACE's Comprehensive

Evaluation of Projects with Respect to Sea-Level Change tool to provide additional forecast for potential adaptation. The purpose of this tool is to inventory and assess the vulnerability of existing USACE projects to the effects of SLC and provide added benefits to other USACE activities.

Puerto Rico Coastal Study, Puerto Rico

INTRODUCTION

BACKGROUND

The Puerto Rico Coastal initial study area considered over 13 locations around the Puerto Rico coastline identified by the Department of Natural and Environmental Resources (DNER), the non-federal sponsor, as having coastal damages and warranting investigation under a feasibility study. The study now focuses on finding CSRM solutions in the Ocean Park and Rincón planning reaches. It is expected that storm-induced erosion, wave attack and coastal flooding will continue damaging properties and structures, along with critical infrastructure, as well as reducing beach habitat as well as community resilience during the 50-year period of analysis which will be further exacerbated by sea level rise.

STUDY AUTHORIZATION AND PROCESS

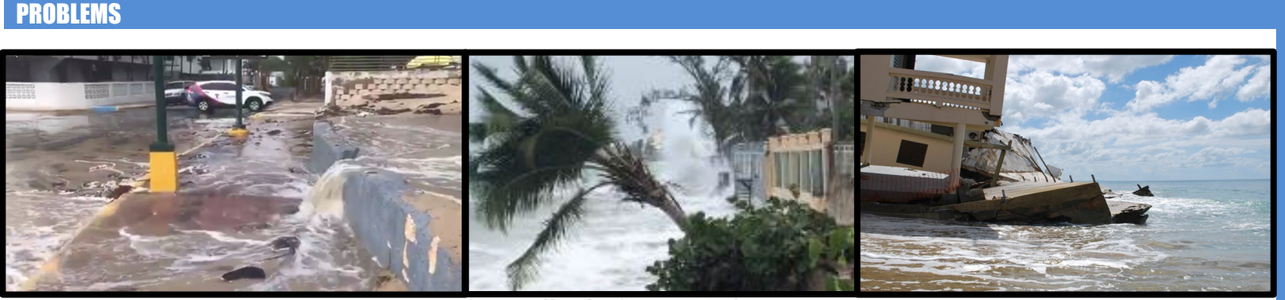
Authority for the Puerto Rico Coastal study is granted under Section 204 of the Flood Control Act of 1970, Public Law 91-611. Study funds were appropriated under Bipartisan Budget Act of 2018 Public Law 115-123. The Department of Natural and Environmental Resources (DNER) is the non-federal sponsor for this study.

STUDY SCHEDULE

STUDY INITIATION, PLANNING AND TECHNICAL ANALYSES, DRAFT REPORT PUBLIC RELEASE	PLAN FORMULATION ENGINEERING AND ECONOMIC MODELING	TENTATIVELY SELECTED PLAN MILESTONE	DRAFT REPORT AND EA ** PUBLIC, TECHNICAL, AND POLICY REVIEW	AGENCY DECISION MILESTONE	FINAL REPORT STATE AND AGENCY REVIEW	CHIEF OF ENGINEERS REPORT	PROJECT ENGINEERING AND DESIGN CONSTRUCTION
Oct 2018 to Nov 2020	Oct 2021*	Jan 2023	June 2023	Oct 2023	April 2024	May 2024	2024 through 2029***

*Additional Study Time Approved | ** National Environmental Policy Act Environmental Assessment | *** Contingent on Authorization, Appropriations & Real Estate Acquisition

PROBLEMS



Coastal flooding, Ocean Park

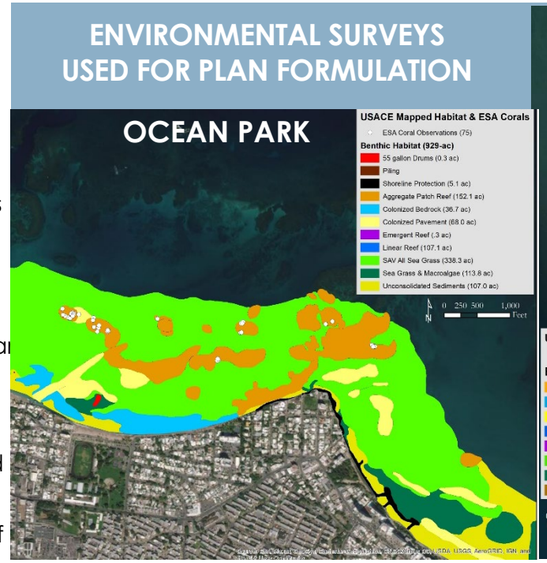
Wave attack, Ocean Park

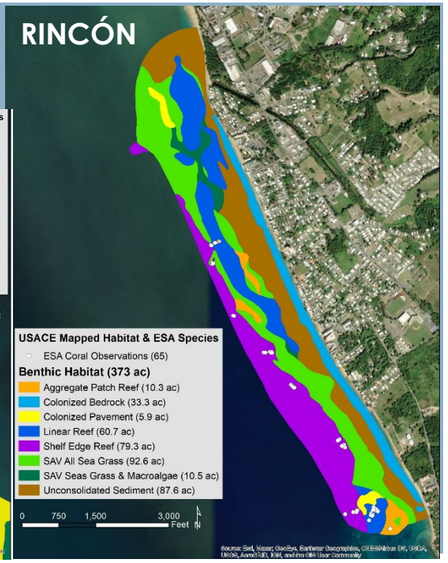
Severe erosion & wave attack, Rincon

ENVIRONMENTAL & CULTURAL RESOURCES

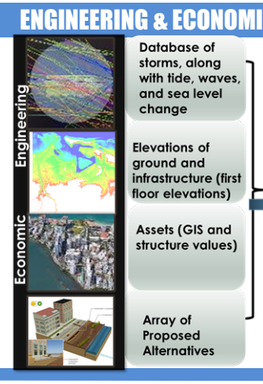
The National Environmental Policy Act (NEPA) is a federal law enacted in 1969. As required by NEPA, the Corps has assessed potential environmental effects of alternatives, to include cultural resources and the human environment as well as environmental justice considerations. The findings are explained in this report. Side scan sonar results are shown to the right. These surveys and subsequent data have helped to inform plan formulation, to avoid and minimize impacts, as well as understand potential environmental benefits of alternatives.

ENVIRONMENTAL SURVEYS USED FOR PLAN FORMULATION





ENGINEERING & ECONOMICS MODELING



The engineering analysis for this study considers the existing shoreline conditions and natural coastal processes in the study area, as well as sea level rise scenarios. The Beach-fx model is used to estimate the future damages from erosion to property and structures resulting from hurricanes and coastal storms. The G2CRM model is used to estimate damages to property, structures, and vehicles as a result of coastal flooding. The future without-project damages (FWOP) are used as the base condition against which potential alternatives will be compared. The difference between FWOP and Future with-Project (FWP) damages are used to determine primary CSRM benefits.

Plan Formulation Process

STUDY OBJECTIVES

Overall: Contribute to coastal resiliency in Puerto Rico

Primary Objectives:

Ocean Park Planning Reach

Manage the risk of damages to structures, property and critical infrastructure as a result of coastal flooding, erosion, and wave attack

Rincón Planning Reach

Manage the risk of damages to structures, property and critical infrastructure as a result of erosion and wave attack

Secondary objectives: Contribute to the comprehensive system of accounts, specific to each planning reach

1 EVALUATE AND COMPARE MEASURES

Initial criteria was ability of array of structural, non-structural and nature-based measures to effectively meet primary project objectives to reduce hazards in each reach

2 SCREEN MEASURES ✗

Measures that did not most effectively meet primary project objectives, or were redundant when compared to more cost-effective measures, were screened

3 CARRY FORWARD MEASURES ✓

SEAWALL/ FLOODWALL

ACQUISITION (NOT SHOWN)

ROCK REVETMENT

BEACH NOURISHMENT W/ VEGETATED DUNE AND/OR GROINS

4 FORMULATE ALTERNATIVES to reasonably maximize comprehensive benefits

Ocean Park Planning Reach

- Alt 1: No Action
- Alt 2: Floodwall
- Alt 3: Floodwall and Beach/Dune
- Alt 4: Floodwall
- Alt 5: Floodwall + Acquisition

Rincon Planning Reach

- Alt 1: No Action
- Alt 2: Revetment
- Alt 3: Beach/Dune with Groins
- Alt 4: Acquisition

5 EVALUATE & COMPARE ALTERNATIVES

Meet planning objectives

Primary and secondary

Long-term Considerations

Response/Ease of adaptability to sea level rise

Planning Constraints

Cannot violate Federal regulations or laws

Cannot incur greater life safety risk compared to FWOP

Evaluate comprehensive system of accounts

National Economic Development (NED)

Environmental Quality (EQ)

Other Social Effects (OSE)

Regional Economic Development (RED)

Ocean Park Tentatively Selected Plan – Alternative 2

- Floodwall at Barbosa Park & Skate Park
- Cost = $65M ($2.4M Average Annual Equivalent over 50-year period of analysis, AAEQ)
- Benefit to cost ratio (BCR) = 1.2

PROBLEMS ADDRESSED

- Key points of coastal flooding
- Coastal flooding risk reduced in area previously at risk

MEASURES TO REDUCE PROBELMS

- Floodwall with toe protection

KEY FEATURES

- Floodwall and toe protection (rock)
  - Barbosa Park = Length = ~1600 feet, EL = 7 feet PRVD02 (1.0 to 5.5 feet above existing grade)
  - Skate Park = Length = ~1200 feet, EL = 7 feet PRVD02 (1.0 to 4.5 feet above existing grade)

KEY BENEFITS

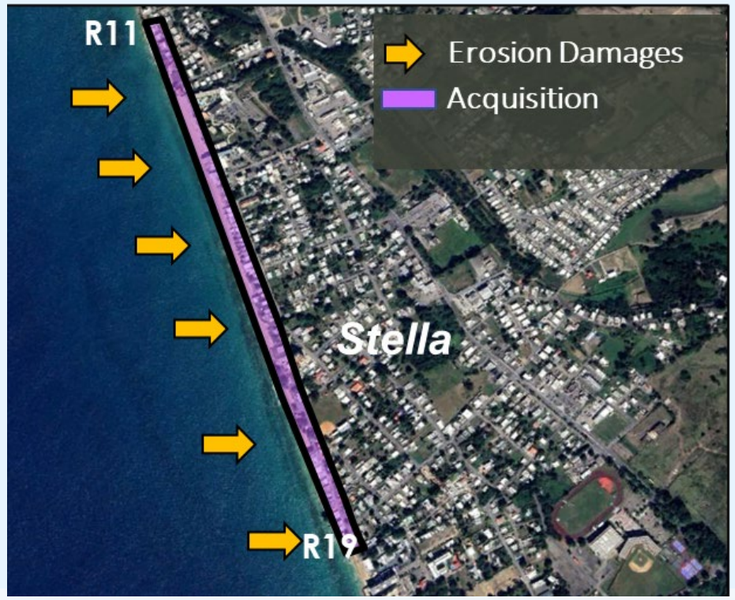
- Disproportionately positive effect on Residencial Luis Llorens Torres community
- Reduces 6685 days of business disruption attributed to coastal flooding
- Reduces risk to hundreds of structures, including 7 structures identified as critical infrastructure
- Reduces life loss attributed to coastal flooding
- No environmental mitigation anticipated
- Integrates into community landscape
- Preserves beach seaward of floodwall and will maintain access for beach and other recreation opportunities

CONCEPTUAL RENDERING OF TSP ALONG BEACH

Approx. 2 Ft high floodwall along beach in Barbosa Park will reduce coastal flooding, where access will be maintained for beach and other recreational opportunities

Rincón Tentatively Selected Plan – Alternative 4

- Acquisition
- Cost = $111M ($3.7M AAEQ)
- BCR = .27



PROBLEMS ADDRESSED

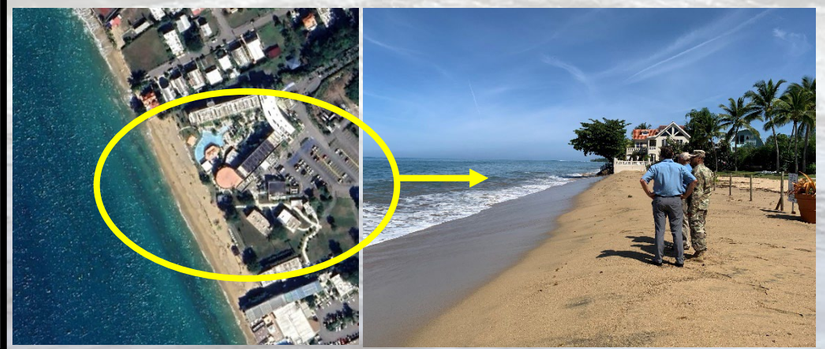
- Homeowners have time and incentive to move before structural failure of home due to erosion
- Coordinated effort to demolish structures and restore natural beach setback area, rather than ad hoc reactive approach as structures fail over time and devastation of community
- Natural beach restores and enhances habitat, revives cultural identify, and allows long-term coastal resilience

KEY FEATURES

- Acquisition of property and structures most vulnerable to damages
- After acquisition, homeowners would be relocated, and structures would be demolished
- Land would be graded to return it to natural sandy state; vegetation plantings will be included in the alternative to increase resiliency
- Formulated for no environmental impacts while also addressing reduction in storm damages

KEY BENEFITS

- This is the only plan to gain benefits comprehensively across the four accounts of benefits
- Positively affects city of Stella
- Increases beach related recreation by $496,000 (AAEQ)
- Maintains $3,372,000 AAEQ worth of local tourism spending
- Creates ~17 acres of beach habitat (estimated 4.14 AAHU)
- This is a non-structural/nature-based plan and is the most effective alternative



The Vision: The proposed plan is a reset of the Rincón coastline. Through the acquisition of vulnerable structures and properties, in concert with the establishment and enforcement of a coastal regulatory program, the newly established shoreline will function as a buffer to proactively reduce future damages and increase coastal resiliency into the future.

1 Introduction

Ocean Park Planning Reach

Rincón Planning Reach

1 INTRODUCTION*

1.1 INTRODUCTION

This U.S. Army Corps of Engineers (USACE) study evaluates alternatives and recommends a Federal project to reduce coastal flooding from storms and hurricanes within the San Juan Metro Area and Rincón area. This study is an interim response to the study authority, Section 204 of the Flood Control Act of 1970, Public Law 91-611, to determine Federal interest in a plan to reduce damages to structures and infrastructure along the ocean coast of the commonwealth of Puerto Rico. More specifically, this study assesses erosion, coastal flooding, and wave attack as well as the effects of sea level change on these problems under the Coastal Storm Risk Management (CSRM) mission. The study develops and evaluates CSRM alternatives to reduce risk to structures, property and critical infrastructure which are essential to the nation's economy and considers additional opportunities for recreation, environmental resources, regional economic development, and community resilience.

The non-Federal sponsor is the Puerto Rico Department of Natural and Environmental Resources (DNER), also known as (DRNA) for its Spanish name "Departamento de Recursos Naturales y Ambientales". A Feasibility Cost Sharing Agreement was executed on 9 October 2018.

1.2 USACE PLANNING PROCESS

Organization of this report follows Guidance from the USACE "Feasibility Report Format and Content Guide, October 2021". It also meets the requirements provided in Appendix G of Engineer Regulation (ER) 1105-2-100 (30 June 2004), documenting the iterative U.S. Army Corps of Engineers (USACE) Plan Formulation Process. The planning process consists of six major steps: (1) Specification of problems and opportunities; (2) Evidence Gathering, (3) Plan Formulation, (4) Evaluation of the effects of the alternative plans (5) Comparison of the alternative plans (6) Selection of the tentatively selected plan based upon the comparison of the alternative plans. Iterations of these steps are repeated with sponsor, stakeholder and USACE vertical team input, as problems become better understood and new information becomes available, as shown in **Figure 1-1.**

The evaluation and planning of coastal storm risk projects requires that risk management decisions are made despite significant uncertainty in factors such as storm occurrence and sea level change, to name just a few. The process emphasizes that study teams should use a reasonable level of detail to collect data and model alternatives to analyze and evaluate effectiveness in order to identify a USACE tentatively selected plan. Risk-informed planning embodies all the principles and tasks of the USACE risk management framework and the six-step planning process. The risk management framework is a decision making framework that allows USACE to remain efficient and effective in making decisions given uncertainty with today's complex challenges and limited resources.

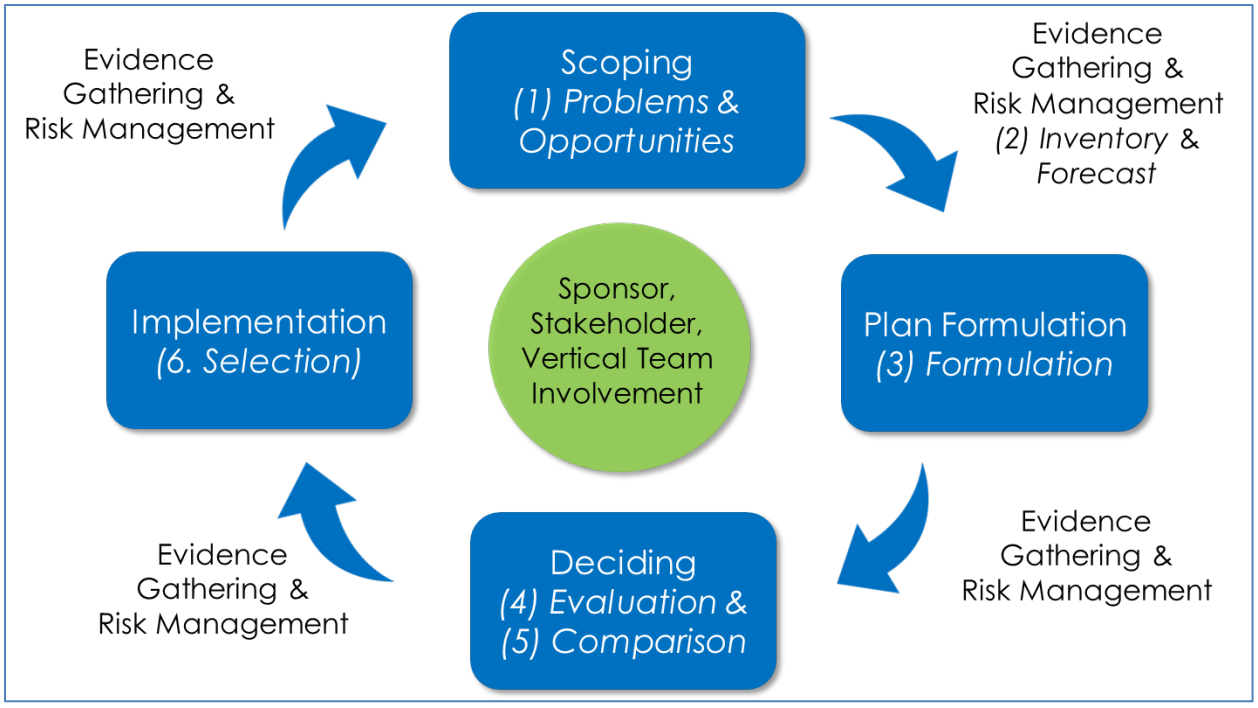


Figure 1-1. USACE Risk Informed Planning Process.

Each chapter in this report describes plan development as it progresses through the four integrated environments that shape a coastal storm risk management (CSRM) project: the built environment (upland development, etc.); the natural environment (species of concern and their habitat); the physical environment (currents, tides, sea level change, etc.), and the economic environment (vulnerability of built environment to damages). Concerns relative to plan formulation and National Environmental Policy Act (NEPA) review are summarized and encapsulated in the discussions of these four main environments.

The recommended format of an Environmental Assessment (EA) is provided in 40 CFR 1502.10 and has been integrated into the Feasibility Report. The basic table of contents for the report outlines how the EA format has been integrated into the planning process to develop a TSP that meets the requirements of both USACE Plan Formulation Policy and NEPA. Note that sections pertinent to the NEPA analysis are denoted with an asterisk.

1.3 STUDY AUTHORITY

Authority for this study is granted under Section 204 of the Flood Control Act of 1970, Public Law 91-611, which authorizes the Secretary of the Army, acting through the Chief of Engineers, to prepare plans for the development, utilization and conservation of water and related land resources of drainage basins and coastal areas in the Commonwealth of Puerto Rico.

> ***SEC. 204.*** *(a) The Secretary of the Army, acting through the Chief of Engineers, is authorized to cooperate with the Commonwealth Puerto Rico, political subdivisions thereof, and appropriate agencies and instrumentalities thereof, in the preparation of plans for the development,*

utilization, and conservation of water and related land resources of drainage basins and coastal areas in the Commonwealth of Puerto Rico, and to submit to Congress reports and recommendations with respect to appropriate participation by the Department of the Army in carrying out such plans. Such plans that may be recommended to the Congress shall be harmonious components of overall development plans being formulated by the Commonwealth and shall be fully coordinated with all interested Federal agencies.

(b) The Secretary of the Army, acting through the Chief of Engineers, shall consider plans to meet the needs of the Commonwealth for protection against floods, wise use of flood plain lands, improvement of navigation facilities, regional water supply and waste management systems, outdoor recreational facilities, the enhancement and control of water quality, enhancement and conservation of fish and wildlife, beach erosion control, and other measures for environmental enhancement.

Study funds are appropriated under Title IV, Subdivision B of the Bipartisan Budget Act (BBA) of 2018, P.L. 115-123.

1.4 STUDY AREA (PLANNING AREA)

The Puerto Rico Coastal Study initial study area considered over 13 locations around the island coastline identified by the Department of Natural and Environmental Resources (DNER), the non-Federal sponsor, as having coastal damages and warranting investigation via a feasibility study. These areas were identified as San Juan, Vega Baja, Arecibo, Aguadilla, Aguada, Rincón, Anasco, Mayaguez, Cabo Rojo, Loiza, Luquillo, and Humacao. It should be noted that there were originally four planning reaches under analysis at the re-initiation of this study in October 2021: Rincón, Condado, Ocean Park and Isla Verde, shown in **Figure 1-2.** However, two of those reaches, Isla Verde and Condado, were removed from further analysis, leaving the remaining analysis to focus on the Ocean Park planning reach and the Rincón planning reach. This chapter focuses on the existing conditions for the Ocean Park and Rincón planning reaches only. However, four places can be referenced for additional information on the reaches that were removed from further analysis. First, **Appendix F, Plan Formulation** provides the background on the all the reaches originally under study. Second, **Appendix A, Engineering** can be referenced for physical conditions in the four planning reaches. Third, the economics portion of Chapter 2 and associated **Appendix D, Economics**, discusses the economic results of modeling that contributed to removal of Condado, and Isla Verde planning reaches from this study. Fourth, **Chapter 3** briefly discusses the rationale for removing these reaches from further analysis.

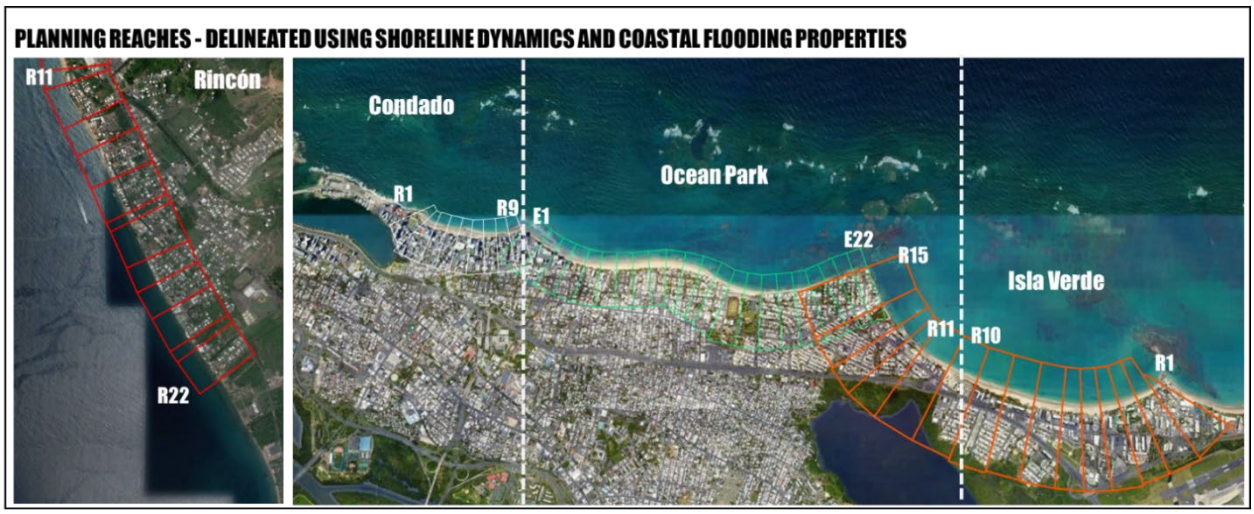


Figure 1-2. The Four Planning Reaches.

1.5 BACKGROUND AND HISTORY

This island wide CSRM study began with the DNER bringing concerns about problems in the coastal areas of Puerto Rico to the USACE. Originally, the Puerto Rico Coastal study was scoped to assess shoreline erosion along the coastline of the entire island with exception of the coastline of San Juan Metropolitan Area, which was being analyzed under a separate "San Juan Metro Area CSRM" feasibility study. A scoping meeting, as required under the National Environmental Policy Act (NEPA), was held in San Juan on November 8, 2018, where the study team presented the general study scope and requested feedback from communities. During that process, several communities expressed concerns of back bay flooding in the Cataño municipality, as well as the Condado Lagoon area within the San Juan municipality. As a result, the Puerto Rico Coastal study adopted the San Juan Metro Area coastline as part of the study area, to allow the San Juan Metro Area CSRM study to focus solely on back bay flooding. A brief description of the scope of the San Juan Metro Area CSRM study is provided in section 1.7.1 under related USACE and NEPA studies. See **Appendix F, Plan Formulation,** for **a** more detailed account of how the study reaches of focus were identified.

Initially, the Puerto Rico Coastal Study assessed the shoreline problems along approximately 30 miles of coastline island wide. The initial scoping resulted in the following areas being the most vulnerable areas with the most potential for Federal Interest: the San Juan (Condado, Ocean Park, Isla Verde, and Carolina) and Rincón coastlines; and segments of the major hurricane/tsunami evacuation routes in Mayaguez (PR-102) and Humacao (PR-3). Further investigations during the forecasting of existing and future without project conditions led to the screening out of all focus areas with the exception of Rincón, Condado, Ocean Park, and Isla Verde due to the lack of potential for economic justification.

A Draft Integrated Feasibility Report and Environmental Assessment was released for public and agency review in November 2020. After consideration of public and agency comments, as well as the need for updated environmental surveys, the Jacksonville District, with the support of the vertical team, made the decision to request more time and funding to allow the team to reassess technical and environmental aspects of the study area. The study team requested an additional 31 months and $3.3M, and this

additional time and funding was approved by the Assistant Secretary of the Army, Civil Works (ASA, CW) on October 20, 2021, which effectively restarted the study.

Post exception, the study delineated new planning reaches and focused on re-modeling remaining planning reaches of Condado, Ocean Park, Isla Verde, and Rincón. Modeling showed little to no damages or associated risk in Condado and Isla Verde planning reaches. The study now focused on finding CSRM solutions in the Ocean Park and Rincón planning reaches.

Figure 1-3. Planning Reaches in the Puerto Rico Coastal Study.

1.6 PURPOSE AND NEED*

Puerto Rico is an archipelago located between the Caribbean Sea and the North Atlantic Ocean, east of the Dominican Republic and west of the U.S. Virgin Islands. The archipelago of Puerto Rico is composed of 143 islands, with three main inhabited islands, Puerto Rico, Vieques, and Culebra. The most inhabited of the three, Puerto Rico, has a land area of 3,515 square miles, almost three times the size of Rhode Island. The Puerto Rico vicinity map is shown in **Graphic Executive Summary Page 1.** Puerto Rico has approximately 800 miles of shoreline distributed in 44 coastal municipalities. The beaches are one of the principal economic engines of the hotel/tourism industry and are a very important source of recreation for the Puerto Rican population. Over 24% of the 800 miles of coastline are occupied or developed. The analysis conducted by the Puerto Rico Coastal Zone Management Program using the 2010 Census data shows that 56% of the population (2,317,189 people) live in the coastal municipalities. Today, more than half of the population lives in the San Juan Metropolitan Area. The metropolitan municipalities, like San Juan and Carolina, are where activities and services are concentrated: Puerto Rico's main seaport and airport; the most important healthcare center in Puerto Rico and the Caribbean (Centro Médico) and the major universities. Government services are also highly concentrated in San Juan. The coastal zone of Condado, Ocean Park, Isla Verde, and Carolina is where most hotels are located. Most businesses and other forms of economic activity are located in the coastal zone as well (Puerto Rico Climate Change Council (PRCCC) 2013).

Erosion, coastal flooding, and wave attack damage is evident in many urban, commercial, and Industrial areas. Even though the vulnerability of these public and private assets, critical infrastructure, and coastal

habitat have been identified by several entities in Puerto Rico, including the DNER, the adaptation and protection strategies have been implemented on a case by case basis, and do not comprehensively address the problems. As is typical on the Caribbean Islands, Puerto Rico can be impacted by frequent winter storms (northeasters) as well as tropical storms and hurricanes. Some of the most damaging storm events recorded include Hurricanes Hugo (1989), Georges (1998), Irene (2011), and Matthew (2016). More recently, the area has been affected by Hurricane Irma on September 6, 2017 (Presidential Disaster Declaration FEMA-4336-DR) and Hurricane Maria on September 20, 2017 (Presidential Disaster Declaration FEMA-4339-DR). Hurricane Irma caused minor flooding; however, wind damages were significant in Puerto Rico. Hurricane Maria caused extensive coastal storm surge, erosion, and stream flooding in many areas of Puerto Rico (FEMA, Puerto Rico Advisory Data and Products 2018). After Hurricane Maria in 2017, the country turned its attention to Puerto Rico due to the massive devastation that occurred island wide. As a result of this Hurricane and several more historical storm events (Riley 2018 and Fiona 2022), Puerto Rico coastal areas have experienced erosion and infrastructure damage prompting Federal and local government assistance. As described in the Coastal Engineering Handbook for best practices in Puerto Rico (Department of Natural and Environmental Resources of Puerto Rico and Tetra Tech, Inc 2019), Puerto Rico faces multiple coastal management challenges, including increasing development pressures, land-based sources of pollution, wetlands and coral reef degradation, dune systems alteration, beach erosion and coastal hazards, among others.

1.7 PROBLEMS AND OPPORTUNITIES

PROBLEMS AND EXISITING CONDITIONS– OCEAN PARK

The Ocean Park planning reach is located in the municipality of San Juan, Puerto Rico. Important landmarks of interest in the study area include the Residencial Luis Llorens Torres, a community which has historically experienced economic challenges and which is the largest public housing community in Puerto Rico. Another key landmark is Barbosa Park, which is owned by the municipality of San Juan, and it is a recreational beach and park which are enjoyed by the community and some tourists. There are over 12 structures identified as critical infrastructure in the area, including police stations, fire stations, hospitals and shelters. The most significant and widespread damages to structures, critical infrastructure and other assets are being caused by two points of coastal flooding which are coming from the ocean into low lying elevations at Barbosa Park and at the Marías skate park. The coastal flooding also causes road closures and difficulty for the economy to recover after storms in terms of schools, jobs, and other businesses. This area in Barbosa Park becomes routinely flooded due to coastal storms, bringing sand and debris which impacts local recreation. The coastal flooding also creates a life safety hazard risk to the community.

PROBLEMS AND EXISTING CONDITIONS – RINCÓN

The Rincón planning reach, where the town of Stella is most affected, exhibits erosion and wave attack, causing severe damage to structures and property. Stella is a community which has historically experienced economic challenges, where 75% of the population is low income. The value of structure damages were modeled as a little over $1M, which is very low for the amount of damages they are experiencing. This is due to very low structure values compared to many other study areas. Homes have been built too close to the beach in some cases, and hard armoring in other areas have exacerbated erosion to the point that where there used to be a healthy beach, there is now hardly anything left. Generations of families have lived in this community. They can remember playing on the beach, the sense

of well-being the beach provided to the community, and the community's dependance on it for the local income to the regional economy. In the absence of an actionable plan, individual property owners along the shoreline will attempt to reduce risk locally with low-cost, ad hoc solutions such as rock, gabions (metal meshes containing rocks), or seawalls, incurring repeated expense and probable failure due to erosion , as well as loss of habitat, recreation, and tourism. As erosion progresses without a plan in place, structures will experience repeated severe damages and some will structurally fail, crumbling into the ocean, and leading to condemnation by local government due to safety issues. Homeowners cannot sell their homes at this point, and they will have no choice but to abandon their condemned structures, at a huge loss to themselves and to the community. Those structures more often than not are left in place, which create unsightly conditions and are already causing a blight condition, where the community begins to decline. This existing and future without project condition is a far cry from coastal resilience. The problems in each reach will continue to be exacerbated in the future with sea level change.

OPPORTUNITIES

In addition to reducing the problems described above, there are opportunities that may result from implementation of a Federal project, including:

- Maintain existing coastal (beach) related recreation and tourism: this area depends heavily on tourism, as well as aesthetic quality and cultural identity of community. (OP/R)
- Maintain or restore habitat and environmental resources: beaches, small dunes, and reef complexes serve as habitat for nesting sea turtles, native shore birds, and nearshore manatee, corals, fishes, and marine invertebrates. (OP/R)
- Maintain existing non-coastal recreation in Barbosa Park. (OP)
- Improve access to roads after coastal flooding events for critical economic functions such as jobs, schools, etc. (OP)
- Improve overall community resilience within the San Juan Metropolitan Area. (OP)
- Improve overall community resilience within the Rincón area.®)
- Improve overall resilience over the island of Puerto Rico. (OP/R)

*OP - Applies to Ocean Park Planning Reach; R- Applies to Rincón Planning Reach

1.8 OBJECTIVES AND CONSTRAINTS

Ocean Park Planning Reach

- **Primary Objective:** Manage the risk of damages to structures, property and critical infrastructure as a result of coastal flooding, erosion, and wave attack caused by coastal storms, with an emphasis on maintaining life safety, within the study area over a 50-year period of analysis (2029 – 2078).(NED)
- **Secondary Objectives:**
  - Maintain recreational use of coastal and non-coastal areas. (NED)
  - Maintain environmental quality. (EQ)
  - Reduce disruptions to the economy after coastal storms . (RED)
  - Improve life safety during and after coastal flooding events. (OSE)

Rincón Planning Reach

- **Primary Objective:** Manage the risk of damages to structures, property and critical infrastructure as a result of erosion and wave attack caused by coastal storms, with an emphasis on maintaining life safety, within the study area over a 50-year period of analysis (2029 – 2078). (NED)
- **Secondary Objectives:**
  - Maintain recreational use of coastal areas. (NED)
  - Maintain environmental quality. (EQ)
  - Maintain or increase tourism, local property tax revenue and number of jobs. (RED)
  - Reduce risk of local communities abandoning the area. (OSE)

The planning constraints for this study area are the same general constraints as for all studies, which is to avoid conflict with Federal regulations, as stated in Federal law, USACE regulations and policies, as well as executive orders. There are no specific constraints associated with this study.

1.9 STUDY SCOPE

The study was approved for additional time and funding in October 2021 through the 3x3 policy exception request and was scoped to formulate solutions to reduce the risk coastal flooding, erosion and wave attack within the study areas In concert, the study team was charged to evaluate the cost of implementing those solutions; their comprehensive impacts and comprehensive contributions to NED, EQ, RED and OSE; their ability to avoid constraints; their contribution to life safety; and their adaptability to sea level change. The planning reaches were re-assessed with additional modeling information for Ocean Park planning reach and Rincón planning reach. sea level change. The team used appropriate planning models (Beach-fx and Generation 2 Coastal Storm Risk Model (G2CRM)), in concert with relevant structure inventory data, coastal storm data, physical conditions, existing socio-economic data, Geographic Information Systems (GIS), and recent environmental surveys. The team followed the USACE 6-step planning process and coordination with the sponsor, communities and other Federal and state agencies, to complete the analysis and tentatively selected plan recommendations which are outlined in this report and associated appendices.

1.10 RELATED DOCUMENTS*

Summaries of prior studies relevant to this project are as follows:

1.10.1 RECENT RELATED USACE STUDIES

- U.S. Army Corps of Engineers (USACE). 2018. Section 14 Integrated Feasibility Report and Environmental Assessment, Loiza, Puerto Rico. The report recommends placement of a continuous rock revetment along approximately 1,050 feet of shoreline in front of a public road, head start public school, and community center to provide emergency shoreline protection at Loiza. Elevation of the revetment crest is 8.9-ft Puerto Rico Vertical Datum of 2002 (PRVD02).

- U.S. Army Corps of Engineers (USACE), FEMA, National Oceanic and Atmospheric administration (NOAA). 2018. Puerto Rico Vulnerability Study. This is part of the Hurricane Evacuation Study for Puerto Rico. The vulnerability study is the final report in a four-phase series of reports to analyze evacuation behavior, shelters, hazards and vulnerability in Puerto Rico.
- U.S. Army Corps of Engineers (USACE). 2018. San Juan Harbor Navigation Improvements Feasibility Study and Environmental Assessment, San Juan, Puerto Rico. Chief's Report signed August 2018. The TSP includes deepening of channels with associated channel widening and turning basins. It provides average annual benefits of $75,269,000, average annual costs of $15,172,000, and a benefit-to-cost ratio of 5.0. These improvements are currently under construction.
- U.S. Army Corps of Engineers (USACE). 2021. South Atlantic Coastal Study (SACS). The SACS 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 incorporates wherever possible sustainable coastal landscape systems that considers future sea level and climate change scenarios.
- U.S. Army Corps of Engineers (USACE). 2021. San Juan Metro Area Coastal Storm Risk Management Study, Puerto Rico, Integrated Feasibility Report and Environmental Assessment. The report and subsequently approved Chiefs Report (September 2021) recommended a plan to address coastal flooding (combined effects of tide, storm surge, wave influence, and sea level change (SLC) rather than inland rainfall and stormwater runoff) caused by coastal storms and hurricanes along the back bay areas in the San Juan Metro Area, comprised of the municipalities of San Juan, Cataño, Guaynabo, and Toa Baja. The study team completed a final report which can be found in the following link: www.saj.usace.army.mil/SanJuanMetro
- USACE. 2022. *Submerged Aquatic Vegetation & Benthic Resource Survey Rincón & San Juan, Puerto Rico*. USACE Project Number W912EP22F0060. This survey and mapping were required to garner detailed information on hardbottom, SAV, EFH, and ESA Corals for avoidance planning, impact assessment, and residual environmental quality benefits.

1.10.2 RELATED NON-FEDERAL STUDIES

Many studies and reports relevant to San Juan and Rincón coastline have been completed by non-Federal interests. A list of the most relevant ones is provided in the references of this report.

- Coastal Engineering Handbook, Puerto Rico. 2019. This handbook was produced by Tetra Tech for DNER as a means to provide best practices in coastal areas of Puerto Rico.

- Arrecife Condado Artificial Reef Project San Juan, PR. 2019. This project was recently permitted for the purpose of altering wave energy in critical locations along the seaward shoreline of Condado where high wave energy causes damage and life safety hazards. The proposed Project includes the installation of a shore parallel multi-segmented artificial reef, covering approximately 500 linear meters in front of the Condado Beach area. The submerged artificial reef will consist of three individual segments, approximately 170 meters (m) in average length.

2 Existing and Future Without- Project Conditions

Ocean Park Planning Reach

Rincón Planning Reach

2 EXISTING AND FUTURE WITHOUT-PROJECT CONDITIONS

This chapter describes conditions as they currently exist, and as they are projected to exist if a Federal project is not implemented within the Ocean Park and Rincón planning reaches. Information gathered in this step helps to describe the problems and opportunities and forecast future conditions. The future without-project (FWOP) condition is the most likely condition of the study area without construction of a Federal project over 50 year period of analysis. The future without-project (FWOP) condition is also the no-action alternative for the purposes of the National Environmental Policy Act (NEPA) process, and this report uses both terms interchangeably.

2.1 PERIOD OF ANALYSIS

The period of analysis for this study for both planning reaches is currently assumed to be 50 years, from 2029 to 2078. This assumes the base year is 2029, which is when any potential projects would begin accruing benefits, as a basis of comparison for the future without-project and future with-project conditions.

2.2 GENERAL SETTING IN OCEAN PARK AND RINCÓN PLANNING REACHES*

Please reference the **Graphic Executive Summary Page 2** for visual information to support the discussions below.

OCEAN PARK PLANNING REACH

The Ocean Park planning reach is located in the municipality of San Juan, Puerto Rico. Important landmarks of interest in the study area include the Residencial Luis Llorens Torres, which is the largest public housing community in Puerto Rico. Another key landmark is Barbosa Park, which is owned by the municipality of San Juan, and it is a recreational beach and park which are enjoyed by the community and some tourists. It is bounded by a sidewalk and a small access road. The large recreational park includes a track, various sports fields, as well as a police station. There is a low wall on the beach already but there are several gaps in it where water is able to enter, and additionally, flooding overtops it routinely, causing flooding and sand on the road with even just small high frequency storms. Another reference point of interest is the Marías skate park. This area is actually on a series of undeveloped privately owned parcels, where a skateboard park has been informally set up and is used by the community. It is used as a reference point throughout the report.

The Ocean park planning reach extends from E1 to E22 and R15 to R11, as shown on **Figure 2-1**. It is characterized by development on sandy beaches, with seasonal shifting of sand between the west and eastern boundaries. There are 12 structures identified as critical infrastructure in the area, including police stations, fire stations, hospitals and shelters. The most significant and widespread damages to structures, critical infrastructure and other assets are being caused by two points of coastal flooding which are coming from the ocean into low lying elevations at Barbosa Park and at the Marías skate park. The coastal flooding also causes road closures and difficulty for the economy to recover after storms in terms of schools, jobs and other businesses. The coastal flooding also creates a life safety hazard risk to the community.

Based upon the results of draft final benthic habitat and species mapping and characterization surveys, the San Juan study area provides diverse aquatic habitats. In general, the ecology of the study area is healthy and diverse, with some issues of habitat degradation likely due to continuing poor water and sediment quality inputs. The existing nearshore supports an ever shifting diverse physical and biological nearshore aquatic grassland and coral reef system; however, the shoreline has been modified in the past. ESA coral species were located and identified, being found on the outer Patch Reef well offshore. Beach habitat has been consistent over recent time based on aerial observations; however, conditions for nesting sea turtles, native shore birds, and native vegetation have been limited by natural and human disturbance such as storms, residential and recreational activities on/near the beach including native vegetation clearing, lighting, and noise. Sea turtles have nested at a few locations within the San Juan study area in the past, and information provided by NMFS and USFWS acknowledges a likely potential for Leatherback and Hawksbill Sea Turtle nesting habitat under certain wider beach and native vegetation conditions.

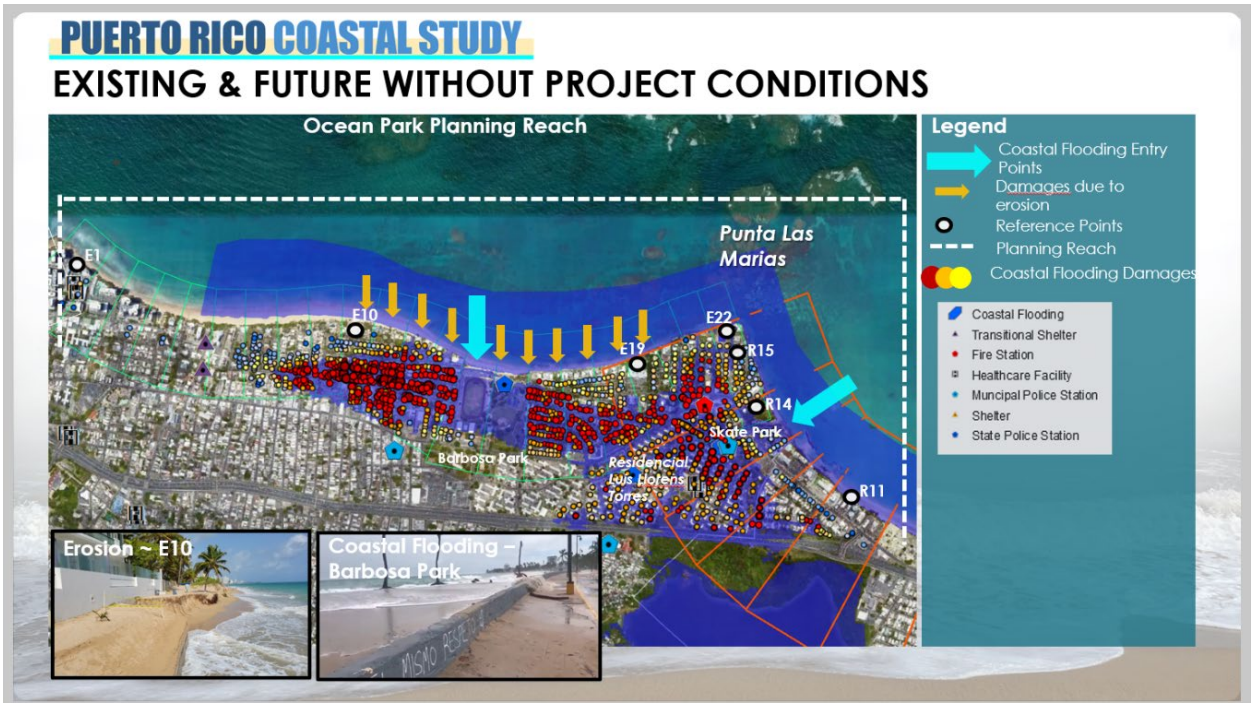


Figure 2-1. Existing and Future Without Project Conditions – Ocean Park Planning Reach.

RINCÓN

Rincón is a municipality of Puerto Rico, located on the north, westernmost tip of Puerto Rico. Historically the shoreline in the southern Rincón reach was very wide; anecdotally it was wide enough to play a soccer game. The shoreline has been a place of cultural identity and recreation for the community. The northern stretch of Rincón is known world-wide as a premiere surfing destination, hosting events and drawing in approximately 85,000 tourists per year to the municipality. The Rincón study area extends from reference point R11 to R22, as shown in **Figure 2-2**. The town of Stella (in the Pueblo barrio) is in the southern portion of the municipality of Rincón, which is one of the areas under study within the Puerto Rico study.

The town of Stella supports the northern portion of Rincón in tourism with hotels and restaurants, along with its sandy beaches, and relies on this income to sustain its economy. In Stella,75% of the population meeting the low-income threshold. For reference, the national median income including mainland United States is 3 times that of the Rincón median income. Structures were built along the shoreline, some with appropriate set back distances to allow natural coastal processes but most were built too close and have negatively impacted sediment transport and beach stability. Erosion has been further exacerbated by the construction of armoring along nearly the entire shoreline and has contributed to the severe sediment deficit partially caused by the excavation of beach and dune sediment from the coast for construction and other purposes. The erosion will worsen if storms are more frequent and intense, causing increased structure failures and condemnations by the local government due to safety concerns. These failed and condemned structures, which are often left behind and unremoved, are very unsafe and create unsightly conditions, that then continue to spread into the community. Further, the failed structures increase erosion in the local area and prohibit natural beach recovery. Historically, there have been accounts of sea turtle nesting in the area. Benthic species of significance exist in the nearshore and beyond. Structure values in this area are noticeably much lower than in other parts of Puerto Rico compared to San Juan, and significantly lower than some comparable coastal communities in the mainland United States.

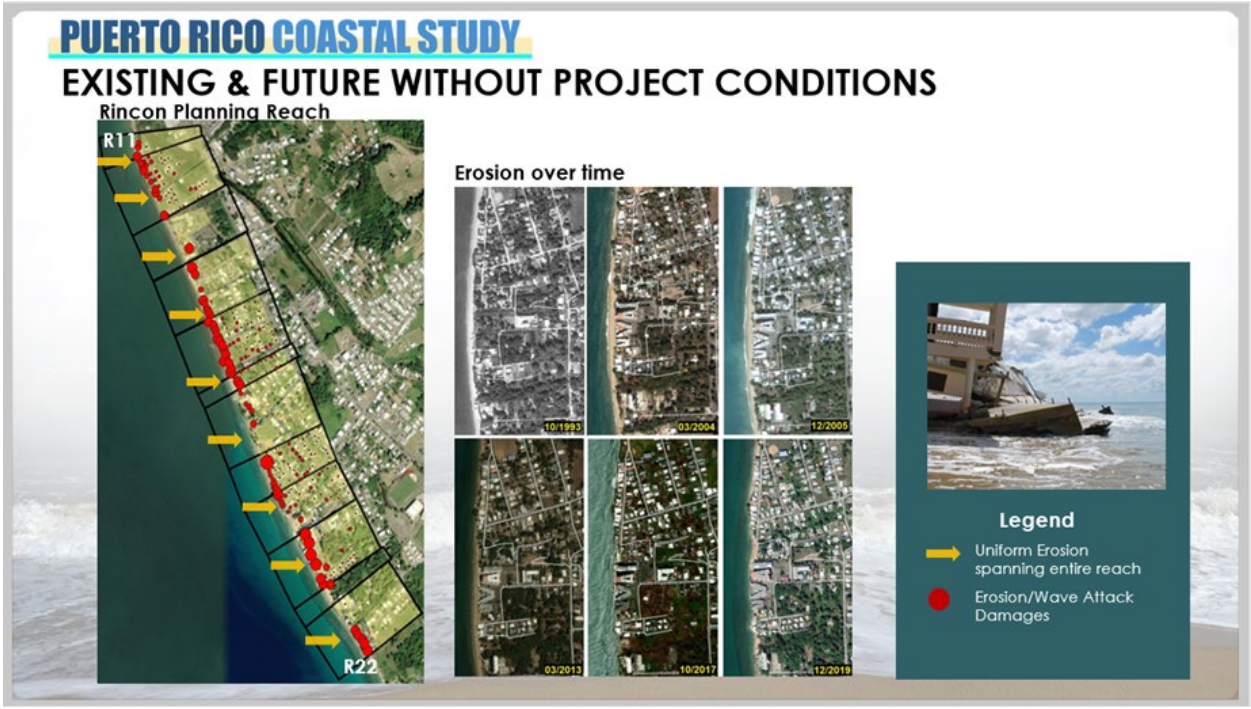


Figure 2-2. Existing and Future Without Project Conditions – Rincón Planning Reach.

In the absence of a plan, structures[7] are expected to be completely lost to the ocean and/or condemned due to erosion, ultimately triggering forced relocations. Under devastating circumstances, property owners will be forced to move after their homes are condemned and large portions of the beach will be inaccessible due to the resulting safety issues with the remnants of the destroyed structures, as seen in the photos included herein. Structures would become derelict and are unlikely to be removed which would further exacerbate wave energy, resulting in erosion on surrounding shorelines. Furthermore, residents are likely to relocate out of the area and potentially out of Puerto Rico, reducing not only the strength of the cultural identity of the community but also reducing the tax base and impairing the economy.

The effect of the beach erosion is four-fold. First, the long-term erosion, exacerbated by the extensive shoreline armoring along this stretch of beach, contributes to catastrophic damages to homes, causing structural failure and causing them to literally crumble into the ocean, as described earlier. This current practice of continued shoreline armoring and structure abandonment is a far cry from the goals of coastal resiliency. Second, erosion removes the available beach which affects the town's ability to utilize it in support of tourism. Third, residents have lived in this community for generations and the presence of dilapidated and condemned structures across the entire shoreline affects not only the safety of enjoying the beach but also accessibility to it, affecting their quality of life and mental well-being. Fourth, this community does not have the financial resources to easily relocate to a new home at their own expense if they cannot sell their home, nor remove derelict structures at their own expense. Once a structure fails, it is abandoned and most often remains. This degrades the aesthetic of this historically economically disadvantaged community, adversely affects recreation, tourism, critical habitats, and causes health and safety concerns. The degraded condition can cause a decline in tourism, not just in the immediate area but across all of Rincón. The result of these effects directly impacts the entire town of Stella and most certainly ensures a demise of the town's historical and cultural identity. The loss of the heart of Stella would be a loss for Commonwealth of Puerto Rico as well as the United States.

In general, the ecology of the study area is healthy and diverse. The existing nearshore supports an ever shifting diverse physical and biological nearshore aquatic grassland and coral reef system; however, the shoreline has been modified in the past. ESA coral species were located and identified, being found on the Shelf Edge Reef well offshore. The natural sand source and aggradation of beach is ephemeral over time. Natural conditions for nesting sea turtles would be fleeting, which is the nature of the beach. Leatherback Sea Turtle nesting was recorded in the past when a wide enough beach would form. In general, conditions for nesting sea turtles, native birds, and native vegetation have been removed or are limited by human disturbance via residential and recreational activities on or near the beach, including encroachment, clearing, lighting, and noise. The USACE survey and USFWS information indicates that the species and relative abundance of native sponges present provide a source of food for adult sea turtles.

[7] A structure refers to a single building which could have multiple property owners within. For example, a condominium complex with 20 units would be a single structure, but would have 20 unique property owners.

There are also extensive sea grass beds that were found to be providing the Antillean Manatee with a food source.

The following sections describe the existing and FWOP conditions of the natural, physical, built, and economic environments in additional detail for both reaches.

2.3 NATURAL(GENERAL) ENVIRONMENT*

2.3.1 WATER QUALITY

The Puerto Rico Department of Natural and Environmental Resources (DNER), through the promulgation of the Puerto Rico Water Quality Standards Regulation (2019), has designated the waters of these reaches as “Class SB”, where “Class SB” are coastal and estuarine waters intended for uses where the human body may come in direct or indirect contact with the water (such as swimming or fishing) and for use in propagation and preservation of desirable species. The turbidity standard for Class SB waters in Puerto Rico is not to exceed 10 nephelometric turbidity units (NTU), except by natural phenomena. The following sub-sections describe water quality for each of the focus areas.

OCEAN PARK PLANNING REACH

EXISTING CONDITION

Ocean waters in this planning reach are typically considered of good quality and designated as Class SB for full body contact, aquatic species support, and food harvesting. Main impairments to water quality include river discharges and San Juan Bay waters laden effluent and storm water runoff, which contribute to degradation of water quality along the coastal waters of the San Juan study area once they leave the Bay after rain events, tropical storms or hurricanes (Figure 2-3). Shoreline erosion and aggradation of longshore drift sands and shell hash are persistent throughout this planning reach and do not contribute to water quality degradation. Since this material is moving and has a low embeddedness, it likely supports water quality with denitrification by microbes. Fine silt and organic material stemming from anthropogenic sources were identified by benthic surveys in 2022 as driving impairment to coastal water quality.

FUTURE WITHOUT-PROJECT CONDITION

It is anticipated that water quality would remain the same or become slightly more impaired than the existing condition. It is possible efforts would be made during the next decade to abate/curtail anthropogenic sources of nutrient, chemical, and temperature type pollutions.

RINCÓN PLANNING REACH

EXISTING CONDITION

Ocean waters in this planning reach are typically considered of good quality and designated as Class SB for full body contact, aquatic species support, and food harvesting. Main impairments to water quality include Rio Añasco discharges and point source laden effluent and storm water runoff, which contribute to degradation of water quality along the coastal waters of the Rincón study area after rain events, tropical storms or hurricanes (Figure 2-4). Shoreline erosion and aggradation of longshore drift sands and shell

hash are persistent within this planning reach and do not contribute to water quality degradation. Since this material is moving and has a low embeddedness, it likely supports water quality with denitrification by microbes. Fine silt and organic material stemming from anthropogenic sources were identified by benthic surveys in 2022 as driving impairment to coastal water quality.

FUTURE WITHOUT-PROJECT CONDITION

It is anticipated that water quality would remain the same or become slightly more impaired than the existing condition. It is possible efforts would be made during the next decade to abate/curtail anthropogenic sources of nutrient, chemical, and temperature type pollutions. There could be adverse effects, temporary or permanent, from buildings/structures falling into the ocean, depending on what the contents of the building/structure was.

Figure 2-3. October 2004 Google Earth Aerial with Hurricane Jeanne storm water discharges along the San Juan Study Area from Boca del Morro and El Boquerón to the West and Boca de Cangrejos to the east

Figure 2-4. October 2004 Google Earth Aerial after Hurricane Jeanne with nearshore turbidity along the Rincón Study Area.

2.3.2 SHORELINES AND VEGETATION

OCEAN PARK PLANNING REACH

EXISTING CONDITIONS

Ocean Park study area contains a central beach approximately 1.1 miles long and roughly 280 feet wide at the widest part of the beach. There are sparse small foredunes with some tropical coastal vegetation (coconut palm, sea grape, Hibiscus, tropical almond). Barbosa Park is the only undeveloped stretch of coastline amid homes and condominiums. Bedrock is exposed in headland reaches, and in some areas outside of the headland as well. The shoreline upland of the beaches is residential.

FUTURE WITHOUT-PROJECT CONDITION

It is anticipated that shoreline and native vegetation would remain relatively the same. Shoreline erosion and aggradation of longshore drift sands and shell hash are persistent within this planning reach and would continue to support dynamic pocket beaches are small foredunes. Some portions of the shoreline with revetment would likely remain stable while poorly constructed or outdated stabilization will likely fail. Reaches with exposed bedrock would remain naturally stable.

RINCÓN PLANNING REACH

EXISTING CONDITION

The Rincón focus area contains wider beaches and elevated berm crests to the north and narrower beaches with abandoned homes, some physically in the water to the south. The southern portion of Rincón, which includes Stella and Corcega, generally consists of coastline with minimal to no dry beach. There is high extent of coastal structures like riprap and seawalls protecting homes and hotels. The upland of the immediate shoreline is residential. Native vegetation is not present along this shoreline reach. Bedrock is exposed along the shoreline as well, which also limits sandy beach formation.

FUTURE WITHOUT-PROJECT CONDITION

It is anticipated that the shoreline would continue to erode landward until a dynamic equilibrium is met. The portions of the shoreline with riprap and seawalls would likely remain stable for a while, but ultimately protection and structures will likely succumb to the erosive hydrodynamics in this planning reach. Natural beach formation would continue to be ephemeral . Shoreline habitat is very limited or highly impaired within the study reach due to encroachment of structures into the natural shoreline zone.

2.3.3 SUBMERGED AQUATIC VEGETATION

A team of marine scientists composed of qualified coral biologists and benthic ecologists experienced with coastal habitats occurring throughout Puerto Rico conducted *in situ* identifications of submerged resources (see **Appendix G, Attachment 5**). SAV resources were delineated, mapped, and assessed within the San Juan (**Figure 2-4)** and Rincón (**Figure 2-5**) study areas. The benthic resource surveys were conducted during three separate field efforts occurring from 17 July to 9 October 2022.

OCEAN PARK PLANNING REACH

EXISTING CONDITION

Delineated SAV habitat covered 452.8 acres of the surveyed area, with 339.3 acres consisting of continuous seagrass habitat (Figure 2-4). This habitat was characterized by continuous seagrass growth and varying density macroalgal growth. A total of six (6) species of seagrass were identified within the San Juan survey area including: *Halophila decipiens, Halophila engelmannii*, *Halophila stipulacea*, *Halodule wrightii, Syringodium filiforme,* and *Thalassia testudinum*. The majority of these seagrass habitats had dense growth and appeared to be generally healthy, mature, well-established beds. The remaining 113.4 acres of SAV habitat was comprised solely of macroalgae. These macroalgal communities typically had a mix of the following species: *Halimeda* spp., *Udotea* spp., and *Caulerpa* spp. SAV habitats were observed in water depths that ranged from 5 to 25 feet and were also observed growing immediately adjacent to the base of patch reefs and other hardbottom habitats. In some areas, seagrass was observed mixed with sand veneered hardbottom and growing in small sand patches between hardbottom outcrops.

Based on data collected using the percent cover method, SAV resources accounted for 79.8% of the 140 meters^2 sampled in San Juan. Coral, sponges, and other sessile invertebrates accounted for remaining 20.2%. Although the SAV was comprised of both seagrasses and macroalgae, the macroalgal cover was low and accounted for 4.6% of SAV percent cover. Predominate macroalgae genera observed during the San Juan survey included *Halimeda* spp., *Caulerpa* spp., and *Gracilaria* spp. Seagrass accounted for the

remaining 75.2% of SAV resources. Six (6) species of seagrass were identified in the San Juan survey area including: *Syringodium filiforme*, *Halophila stipulacea*, *Thalassia testudinum*, *Halophila decipiens*, *Halodule wrightii*, and *Halophila engelmannii*. Each species was assessed for percent cover, density (shoots/10-cm^2), frequency of occurrence, blade length, canopy height, and visible health including: the presence of flowering, epiphytes, sedimentation, and drift algae. Average percent cover for seagrasses delineated during the Preliminary Visual Reconnaissance included the following: *Syringodium filiforme* with the highest average percent cover of 33.9%, followed by *Halophila stipulacea* (11.9%), *Thalassia testudinum* (11.5%), *Halophila decipiens* (9.2%), *Halodule wrightii* (8.5%), and *Halophila engelmannii* (0.2%).

Although quantitative data for *Halophila decipiens* and *Halophila engelmannii* was collected at one sample site (SJ_SAV-03), these species were observed throughout the San Juan survey area in delineated seagrass habitats. Data collected for each seagrass species was representative of delineated seagrass habitat in San Juan. In areas where seagrass was observed density was generally high. *Halophila decipiens* had the greatest density range of 2-37 shoots/10-centimeter^2, followed by *Halophila stipulacea* (2-26 shoots/10-centimeter^2), and *Syringodium filiforme* (2-26 shoots/10-centimeter^2). *Halophila engelmannii* (2-8 shoots/10-centimeter^2) had the lowest density of seagrasses sampled in San Juan.

FUTURE WITHOUT-PROJECT CONDITION

It is anticipated that SAV and macroalgae beds within the San Juan study area would remain relatively the same. There is potential for some species to be impacted by fine sedimentation and poor water quality, while other hardier species become more dominant. If hardbottom habitats were to become permanently silted in, more SAV beds may form.

RINCÓN PLANNING REACH

EXISTING CONDITION

Overall, SAV habitat covered 103.5 acres of the survey area, 92.9 acres consisting of continuous seagrass habitat. This habitat was characterized by continuous seagrass growth and varying density macroalgal growth (Figure 2-5). *Halophila decipiens, Halophila engelmannii*, *Halodule wrightii*, and *Syringodium filiforme* were the dominant seagrass species observed in these habitats. The remaining 10.5 acres of SAV habitat was compromised solely of macroalgae. Typical species observed in macroalgal habitat included *Halimeda* spp., *Udotea* spp., and *Caulerpa* spp. SAV habitats were mainly observed farther offshore in deeper water (20 to 40 feet) and were also found to be growing within small sand patches within hardbottom habitat. In some cases, seagrass was growing over sand veneered hardbottom in areas with high levels of sedimentation covering portions of the reef.

Based on the estimated percent cover data, SAV resources accounted for 46.4% of the 67 meters^2 sampled, with substrate and other sessile invertebrates accounting for 52.3% and 1.3%, respectively. Densities of macroalgae were lower with 5.1% of cover. The most dominate macroalgae genera observed were *Dasya* and *Dictyota*. Seagrass accounted for the remaining 41.3% of SAV resources observed. Although only three (3) of the six (6) species known to occur in Puerto Rico were recorded during quantitative data collection, *Syringodium filiforme* was also observed elsewhere in the survey area. *Halophila decipiens* had the highest average percent cover of 39.9%, followed by *Halophila engelmannii*

(0.9%), and *Halodule wrightii* (0.5%). *Halophila decipiens* also had the greatest density, which ranged from 17-66 shoots/10-cm^2.

FUTURE WITHOUT-PROJECT CONDITION

It is anticipated that SAV and macroalgae beds within the Rincón study area would remain relatively the same. There is potential for some species to be impacted by fine sedimentation and poor water quality, while other hardier species become more dominant. If hardbottom habitats were to become permanently silted in, more SAV beds may form.

2.3.4 HARBOTTOM HABITAT

A team of marine scientists composed of qualified coral biologists and benthic ecologists experienced with coastal habitats occurring throughout Puerto Rico conducted *in situ* identifications of submerged resources (see **Appendix G, Attachment 5**). Hardbottom habitat and other important marine resources were delineated, mapped, and assessed within the San Juan (Figure 2-4) and Rincón (Figure 2-5) study areas. The benthic resource surveys were conducted during three separate field efforts occurring from 17 July to 9 October 2022.

OCEAN PARK PLANNING REACH

EXISTING CONDITION

Mapped hardbottom within the San Juan study area includes aggregate patch reef (152 acres), colonized bedrock (37 acres), colonized pavement (68 acres), emergent reef (0.3 acres), and linear reef (107 acres) **(Figure 2-5**). The dominant biota observed across all habitats was macroalgae, turf algae, crustose coralline algae, and sponges. Scientists identified, measured, and recorded 294 octocorals and 918 stony corals at eight (8) sample sites in San Juan. The average number of octocorals recorded in each 1-meter$_2$ sample quadrat was 5.25 colonies. The average number of octocorals in San Juan was 4.9 colonies/1-meter$_2$ sample quadrat. The average number of stony corals recorded in each 1-meter$_2$ sample quadrat was 16.4 colonies. **Appendix G, Attachment 5, Table 12** lists the different genera/species of corals identified and their relative abundances. *Porites astreoides* was the most abundant coral species (363 colonies) totaling 30.0% of observed corals, followed by *Siderastrea radians* (191 colonies; 15.8%), *Porites porites* (185 colonies; 15.3%), and *Gorgonia* sp. (151 colonies, 12.5%). When stony coral colony counts are presented by habitat type, aggregate patch reefs had the highest numbers of corals (942 colonies, 77.7%), followed by linear reefs (207 colonies, 17.1%) and colonized pavement (63 colonies, 5.2%).

Although there were signs of various stress indicators and numerous dead coral colonies observed within hardbottom habitat in San Juan, most living corals appeared to have healthy tissue and generally in good condition. The average percent live tissue for stony corals measured in San Juan was 95.4% which was the same value for stony corals surveyed in Rincón. There were symptoms of various stress responses observed on stony corals throughout the San Juan survey area. Stress indicators observed during the survey included extended polyps, excess mucus, endolithic borers, predation, macroalgal overgrowth, and bleaching.

Macroalgae had the highest average percent cover (33.5%) for all of the sample sites in San Juan. When average macroalgae percent cover was presented by habitat type, aggregate patch reef had the highest (36.1%) followed by linear reef (34.1%), and colonized pavement (22.5%). Stony corals were observed in

all hardbottom habitats and had an average percent cover of 5.8% for the entire San Juan survey area. When stony coral cover was presented by habitat type, patch reefs had the highest average stony coral percent cover (7.5%), followed by linear reefs (5.0%) and colonized pavement (2.1%). Octocorals had the lowest average percent cover (1.7%) for the entire San Juan survey area. Sponges had an average percent cover of 9.5% for all of the sample sites in San Juan. When average sponge percent cover was presented by habitat type, colonized pavement (17.6%) had the highest cover, followed by linear reef (12.2%), and aggregate patch reef (5.0%). Other biota observed during surveys were anemones, bivalves, bryozoans, corallimorphs, crustose coralline algae, cyanobacteria, echinoderms, hydroids, millepora, sessile worms, tunicates, turf algae, and zoanthids.

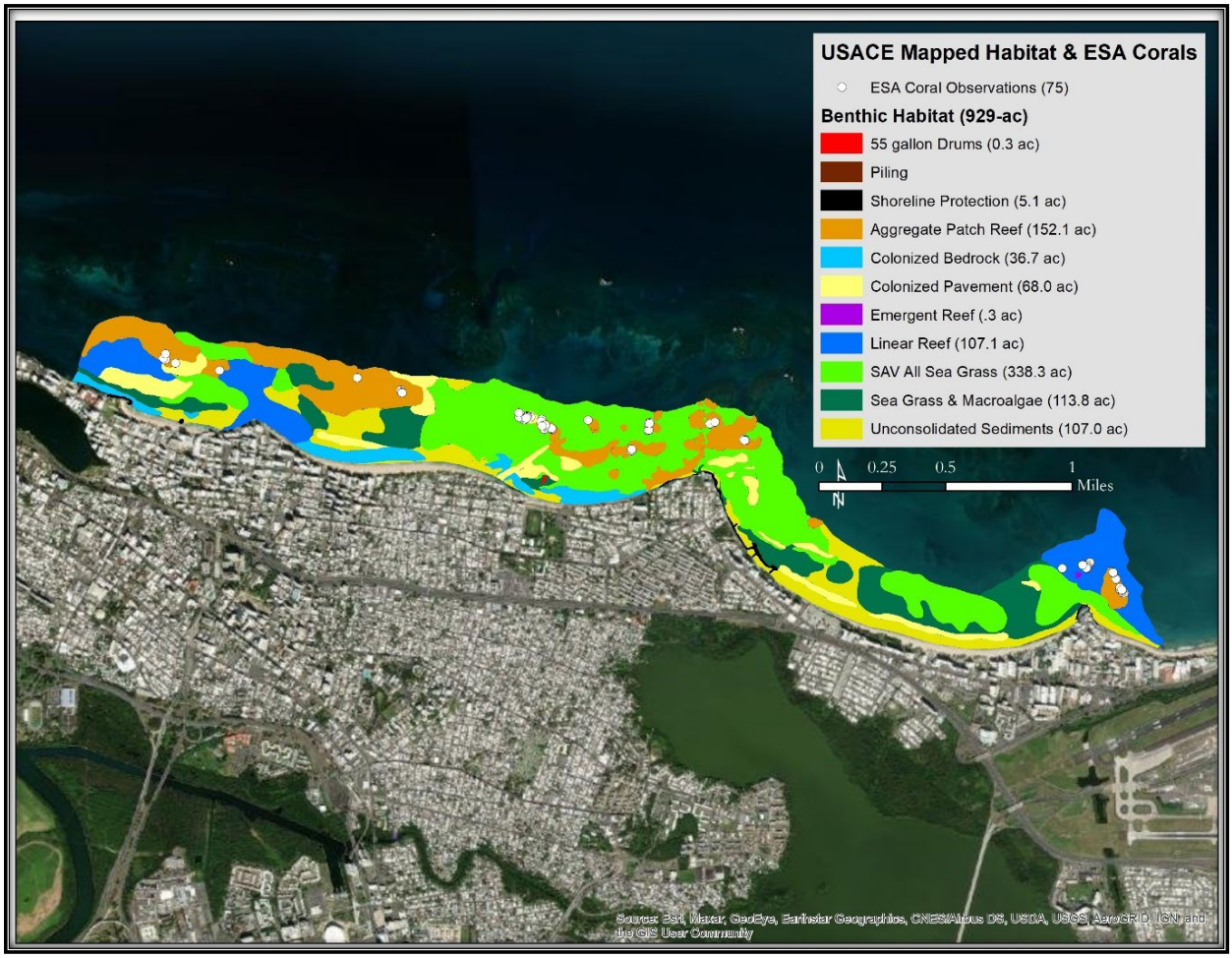


Figure 2-5. San Juan Study Area Benthic Habitat & ESA Species Mapping, USACE 2022.

FUTURE WITHOUT-PROJECT CONDITION

Overall, surveyed hardbottom habitats were diverse and healthy in 2022. Descriptions and results show that poor water quality, anthropogenic sedimentation, and physical disturbance are the three main future threats to declining habitat. These conditions also slow or limit recovery after natural disturbance by storms, herbivory/predation, and general habitat mosaic shifts. Global-wide issues of acidification and

aerial deposited pollution also contributes to declining habitats. Should these effects continue to carry on into the future, it is anticipated that hardbottom habitats within the San Juan study areas would decline.

RINCÓN PLANNING REACH

EXISTING CONDITION

Mapped hardbottom habitat within the Rincón study area includes aggregate patch reef (10 acres), colonized bedrock (33 acres), colonize pavement (6 acres), linear reef (61 acres), and shelf edge reef (79 acres) (**Figure 2-5**). The dominant biota observed across all habitats was turf algae, sponges, macroalgae, and stony corals. Scientists identified, measured, and recorded 210 octocorals and 746 stony corals at six (6) sample sites in Rincón. The average number of octocorals recorded in each 1-meter^2 sample quadrat was 4.9 colonies. The average number of stony corals recorded in each 1-meter^{2}sample quadrat was 17.3 colonies. Appendix G, Attachment 5, **Table 5** lists the different genera/species of corals identified and their relative abundances. *Porites astreoides* had the greatest number of corals (178) representing 18.6% of all corals surveyed, followed by *Siderastrea radians* (113 colonies, 11.8%), *Siderastrea siderea* (92 colonies, 9.6%), and *Pseudodiploria strigosa* (79 colonies, 8.3%). When stony coral colony counts are presented by habitat type, shelf-edge reefs have the highest average number of corals (184), followed by linear reefs (161), and colonized bedrock (128).

Although there were signs of various stress indicators and numerous dead coral colonies observed within hardbottom habitat in Rincón, most living corals appeared to have healthy tissue and generally in good condition. The average percent live tissue for stony corals measured at Rincón was 95.4%. Stress indicators on corals were observed throughout the Rincón survey area. Stress indicators observed during the benthic resource survey included extended polyps, excess mucus, endolithic borers, predation, macroalgal overgrowth, and bleaching.

Macroalgae was observed on all hardbottom habitats and had an average percent cover of 12.9% for the entire Rincón survey area. When macroalgal cover was presented by habitat type, the highest average percent cover occurred on shelf edge reefs (16.4%) and linear reefs (13.4%). The most dominate macroalgae genera observed in the Rincón survey area were *Amphiroa* spp., *Dictyota* spp., *Gelidium* sp., and *Halimeda* spp. Stony corals were observed in all hardbottom habitats and had an average percent cover of 12.4% for the entire Rincón survey area. When stony coral cover was presented by habitat type, shelf edge reefs and linear reefs had a similar average percent cover of 14.3% and 14.2%, respectively. Octocorals had the lowest percent cover (3.6%) for the entire Rincón survey area. When octocoral cover was presented by habitat type, linear reefs had the highest percent cover (4.6%). Other biota observed during BEAMR surveys were anemones, bivalves, bryozoans, corallimorphs, cnidarians, crustose coralline algae, cyanobacteria, echinoderms, hydroids, millepora, sessile worms, tunicates, and turf algae.

FUTURE WITHOUT-PROJECT CONDITION

Overall, surveyed hardbottom habitats were diverse and healthy in 2022. Descriptions and results show that poor water quality, anthropogenic sedimentation, and physical disturbance are the three main future threats to declining habitat. These conditions also slow or limit recovery after natural disturbance by storms, herbivory/predation, and general habitat mosaic shifts. Global-wide issues of acidification and aerial deposited pollution also contributes to declining habitats. Should these effects continue to carry on into the future, it is anticipated that hardbottom habitats within the Rincón study areas would decline.

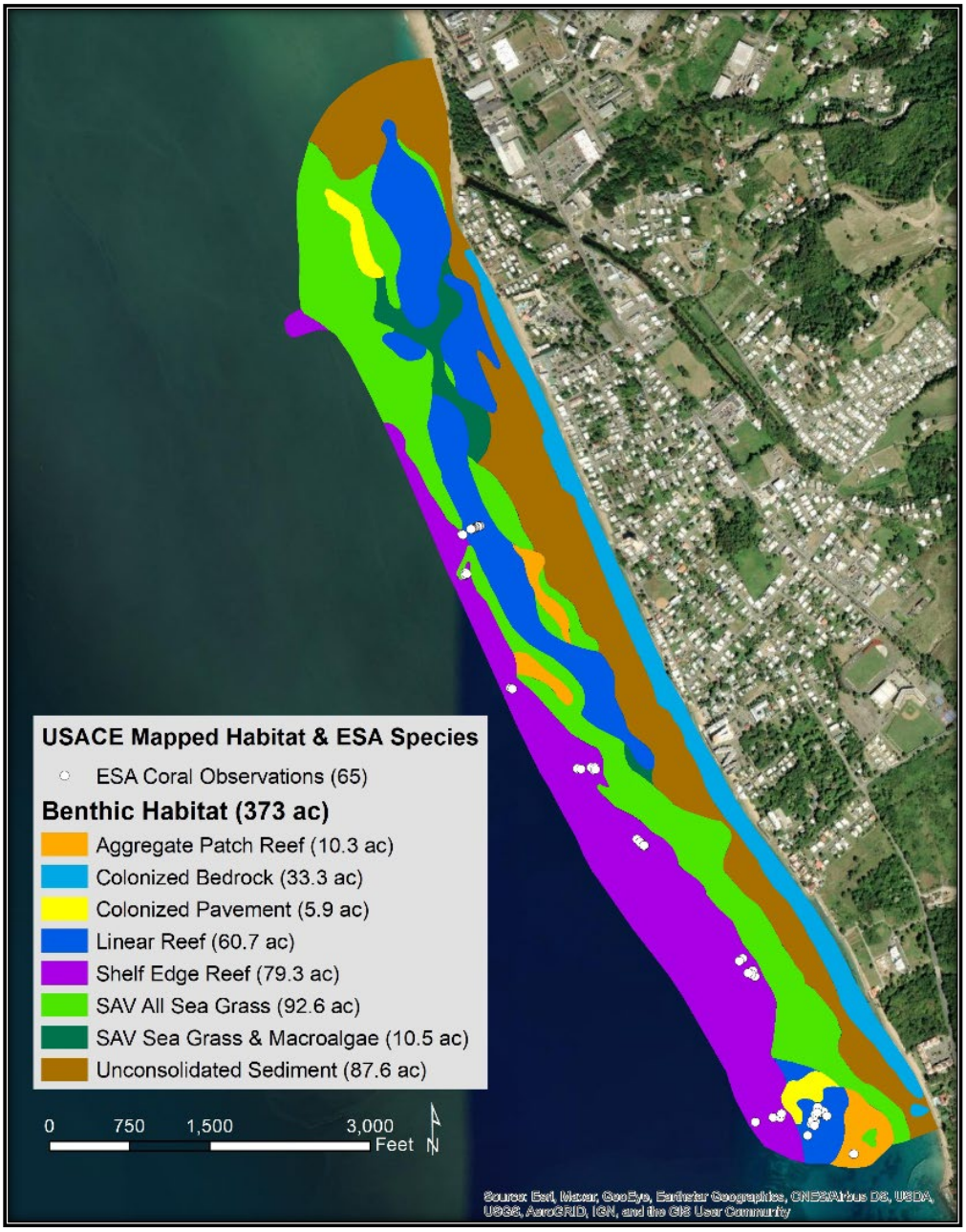


Figure 2-6. Rincón Study Area Benthic Habitat & ESA Species Mapping, USACE 2022

2.3.5 ESSENTIAL FISH HABITAT

The Essential Fish Habitat (EFH) provisions of the Magnuson-Stevens Fishery Conservation & Management Act are intended to protect those waters and substrates necessary to fish for spawning, breeding, feeding, and growth to maturity. If a proposed action potentially affects EFH, then consultation with NMFS is

required. The EFH consultation ensures the potential action considers the effects on important habitats and supports the management of sustainable marine fisheries.

OCEAN PARK AND RINCÓN PLANNING REACHES

EXISTING CONDITION

In the Caribbean waters under the jurisdiction of the U.S., EFH is identified and described based on areas where the life stages of 17 managed species of fish and marine invertebrates occur. Fifteen of the 17 managed species have been documented in the study area (See Appendix G, Attachment 4 for designated EFH area and list of species). NOAA's Fishery Management Plan (FMP) habitat specifies EFH for the Spiny Lobster, Queen Conch, reef fish, and all corals. EFH for this study includes all waters and substrates (coral reef, submerged aquatic vegetation, hard bottom, and unconsolidated sediment) that are necessary for the reproduction, feeding, and growth of marine species.

Surveyed habitats in the San Juan and Rincón study area likely support a high fish species richness and abundance because they provide diverse spawning substrates, food, and refuge. Mapped EFH within the San Juan study area includes aggregate patch reef (152 acres), colonized bedrock (37 acres), colonize pavement (68 acres), emergent reef (0.3 acres), linear reef (107 acres), submerged aquatic vegetation (338 acres), submerged aquatic vegetation mixed with macroalgae (114 acres), and unconsolidated sediment (107 acres) (**Figure 2-4**). Mapped EFH within the Rincón study area includes aggregate patch reef (10 acres), colonized bedrock (33 acres), colonize pavement (6 acres), linear reef (61 acres), shelf edge reef (79 acres), submerged aquatic vegetation (93 acres), submerged aquatic vegetation mixed with macroalgae (11 acres), and unconsolidated sediment (88 acres) (Figure 2-5). Many of these habitats are integral to producing healthy populations of commercially and recreationally important species. Specific management species surveys were not conducted, but Spiny Lobster, Squirrel Fish, Peacock Flounder, and other non-management species were observed.

FUTURE WITHOUT-PROJECT CONDITION

Overall, surveyed essential fish habitats were diverse and healthy in 2022. Descriptions and results show that poor water quality, anthropogenic sedimentation, and physical disturbance are the three main future threats to declining habitat. These conditions also slow or limit recovery after natural disturbance by storms, herbivory/predation, and general habitat mosaic shifts. Global-wide issues of acidification and aerial deposited pollution also contributes to declining habitats. Should these effects continue to carry on into the future, it is anticipated that EFH within the study areas would decline.

2.3.6 THREATENED & ENDANGERED SPECIES

OCEAN PARK AND RINCÓN PLANNING REACHES

The U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) have responsibilities under the Endangered Species Act of 1973 (ESA) to protect certain species. There are many threatened and endangered (T&E) species known to occur in and near the study areas. Accordingly, the USACE is working with USFWS Field Office in Boqueron, Puerto Rico, as well as the NMFS Southeast Regional Office in St. Petersburg, Florida to focus on the species listed in (Table 2-1 and Table 2-2). This list includes the Federally listed T&E species that could be present in the area based upon their geographic

range. However, the actual occurrence of a species in the area would depend upon the availability of suitable habitat, the season of the year relative to a species' temperature tolerance, migratory habits, and other factors. Biological Assessments (BA) have been drafted for these T&E species and TSP effects determinations (Appendix G, Attachment 4).

Table 2-1. ESA Species Under Jurisdiction of the National Marine Fisheries Service

Common Name	Scientific Name	Status
Sea Turtles		
Loggerhead Sea Turtle	*Caretta caretta*	T
Hawksbill Sea Turtle	*Eretmochelys imbricata*	E
Leatherback Sea Turtle	*Dermochelys coriacea*	E
Green Sea Turtle	*Chelonia mydas*	T
Fish		
Nassau Grouper	*Epinephelus striatus*	T
Scalloped Hammerhead Shark	*Sphyrna lewinii*	E
Giant Manta Ray	*Manta birostris*	T
Invertebrates		
Elkhorn Coral	*Acropora palmata*	T
Staghorn Coral	*Acropora cervicornis*	T
Pillar Coral	*Dendrogyra cylindrus*	T
Lobed Star Coral	*Orbicella annularis*	T
Mountainous Star Coral	*Orbicella faveolata*	T
Boulder Star Coral	*Orbicella franksi*	T
Rough Cactus Coral	*Mycetophyllia ferox*	T
Queen Conch	*Strombus gigas*	C*
Acroporid Coral Designated Critical Habitat		

*Candidate

Table 2-3. ESA Species Under Jurisdiction of the US Fish & Wildlife Service

Common Name	Scientific Name	Status
Nesting Sea Turtles		
Loggerhead Sea Turtle	*Caretta caretta*	T
Hawksbill Sea Turtle	*Eretmochelys imbricata*	E
Leatherback Sea Turtle	*Dermochelys coriacea*	E
Green Sea Turtle	*Chelonia mydas*	T
Mammal		
Antillean Manatee	*Trichechus manatus manatus*	T

2.3.6.1.1 FISHES

EXISTING CONDITION

There are three focus species of fishes considered for the study area: Scalloped Hammerhead Shark, Giant Manta Ray, and Nassau Grouper. Of the three listed fish species, Nassau Grouper are most likely to occur in the vicinity of the project. However, in the late 1980s Nassau Grouper reached commercial extinction and a fishery moratorium was implemented in the 1990s, but commercial fishing continued in Florida and the U.S. Atlantic (including Puerto Rico) despite initial moratoriums (Frias-Torres 2008). The Scalloped Hammerhead Shark and Giant Manta Ray are migratory species commonly found offshore in the open ocean and outer continental shelf. See Appendix G, Attachment 4 for species descriptions.

FUTURE WITHOUT-PROJECT CONDITION

It is anticipated that recovery efforts would be made for these species, especially in terms of overfishing and bycatch. In terms of the study area, it is anticipated that these three species would remain stable in their exiting conditions.

2.3.6.1.2 SEA TURTLES

EXISTING CONDITION

Four different sea turtle species could occur in the study area, Loggerhead, Leatherback, Hawksbill, and Green. Of the four species, the Hawksbill and Green are the most common in San Juan Bay. Although sandy beach habitat occurs within San Juan Bay along La Esperanza and in Condado Lagoon, DNER has not documented nesting there (Carlos Diez, Puerto Rico Department of Natural and Environmental Resources, San Juan, Puerto Rico, personal communication, July 12, 2016). Sea turtle nesting is limited to the sandy beaches along the north coast of Puerto Rico adjacent to San Juan Bay. Green and Hawksbill Sea Turtle foraging habitat occurs in San Juan Bay. Leatherback were noted to nest on beaches near Rincón; however, the existing hydrodynamics along this reach of coast is not conducive to beach formation due to the proximity of underlying bedrock and encroaching structures. See Appendix G, Attachment 4 for species descriptions.

FUTURE WITHOUT-PROJECT CONDITION

It is anticipated that recovery efforts would be made for these species where feasible along Puerto Rico's coastlines, especially in terms of nesting habitat and bycatch. In terms of the study area, it is anticipated that these four species would remain stable in their exiting conditions, which has a high level of foraging and sheltering habitats, but limited nesting habitat

2.3.6.1.3 ANTILLEAN MANATEES

EXISTING CONDITION

The Antillean manatee inhabits the coastal waters of Puerto Rico and has been documented both feeding and traveling in San Juan Bay and along the north coast of San Juan. Manatee sightings in Rincón are fewer though both habitat and Manatee population increase south of the Rincón study area (Atkins 2011); however, manatee were observed feeding over SAV beds in Rincón during 2022 benthic surveys. Seagrass beds in the bay and backreef zones provide suitable foraging habitat. See Appendix G, Attachment 4 for species description.

FUTURE WITHOUT-PROJECT CONDITION

It is anticipated that recovery efforts would be made for these species, especially in terms of physical contact with marine vessels and machinery, and SAV foraging habitats. In terms of the study area, it is anticipated that these three species would remain stable in their exiting conditions.

2.3.6.1.4 CORALS & DESIGNATED CRITICAL HABITAT

EXISTING CONDITION

To perform an effects determination for *Acropora* DCH, a solid basis in the spatial extent and quality of study area habitats and species is required. Hardbottom habitat and ESA corals were delineated, mapped, and assessed within the San Juan (Figure 2-4) and Rincón (Figure 2-5) study areas. Surveyed habitats that qualify as Acropora DCH within the San Juan study area includes aggregate patch reef (152 acres), colonized bedrock (37 acres), colonize pavement (68 acres), emergent reef (0.3 acres), and linear reef (107 acres) (Figure 2-4). Mapped *Acropora* DCH within the Rincón study area includes aggregate patch reef (10 acres), colonized bedrock (33 acres), colonize pavement (6 acres), linear reef (61 acres), and shelf edge reef (79 acres) (Figure 2-5).

San Juan – There was a total of twenty-one (21) ESA listed corals identified and measured during surveys in San Juan, which accounted for 2.3% of all stony corals sampled. Nineteen (19) were *Orbicella faveolta* and two (2) were *Orbicella annularis*. Numerous dead *Acropora palmata* colonies were observed during the San Juan survey. Although the colonies were dead and fully encrusted with macroalgae, some of the colonies still retained coral structure including branching. It is difficult to determine from simple observations how long these corals have been dead, but their presence indicates this may still be viable habitat for *Acropora palmata*. Appendix G (Attachment 5, Table 15) lists the sites where the ESA corals were located. Twenty (20) of these colonies were located on patch reef habitat (Figure 2-4). Although none were observed during this benthic resource survey, other biological monitoring studies have documented *Dendrogyra cylindicus* on hardbottom habitat offshore Isla Verde, Puerto Rico (Rivera 2014). Maximum dimensions of the ESA listed corals ranged from 14 to 448 centimeters, with an average maximum dimension of 142.7 centimeters. The average percent live tissue of ESA corals was only 68.1%, which may indicate corals are experiencing levels of stress that are impacting their health. Although no ESA listed corals were observed at the sites with high levels of sedimentation, 57.1% had sediment

indicators present. ESA listed corals were often some of the largest corals observed during the San Juan survey. A larger sized coral colony provides more surface area and may have an increased susceptibility to sediment deposition. The most prominent signs of stress in ESA listed corals were algal overgrowth (90.5% of colonies) and endolithic borers (71.4% of colonies). For more details, see Attachment 5.

Rincón – A total of 33 ESA listed corals were identified during surveys in Rincón, which accounted for just 4.4% of all stony corals. Twenty-five (25) were *Orbicella faveolta*, seven (7) were *Dendrogyra cylindricus*, and one (1) was *Acropora cervicornis*. Appendix G (Attachment 5, Table 8) lists the sites where ESA listed corals were observed. Twenty-six (26) of the ESA listed corals were observed on linear reef habitats (Figure 2-5). Many of the ESA listed stony corals were first observed during mapping efforts. The maximum dimensions of ESA listed corals ranged from 7.7 to 285 centimeters, with an average maximum dimension of 50.5 centimeters. The average percent live tissue of ESA corals was 84.8%, which supported in situ observations that corals appeared to be in relatively good health. Although no ESA corals were observed at sites with high levels of sedimentation, 15.2% of ESA listed corals observed in the Rincón survey area had visible sediment indicators. ESA listed corals were often some of the largest corals observed during the Rincón survey. A larger coral colony size provides more surface area and may be more susceptible to sediment deposition. The most prominent signs of stress in ESA corals were algal overgrowth (48.5% of colonies), endolithic borers (42.4% of colonies), and partial bleaching/paling (30.3%). For more details, see Attachment 5.

FUTURE WITHOUT-PROJECT CONDITION

It is anticipated that poor water quality and human induced sedimentation would continue to result in negative effects to listed corals, such as bleaching, disease, and low reproduction/recruitment rates. Sedimentation could smother these listed coral species, especially Orbicella, Mycetophyllia, and Dendrogyra, because they cannot shed the sediment like the fanlike species (Acropora; mucus sloughing). It is possible efforts would be made during the next decade to abate/curtail anthropogenic sources of nutrient, chemical, and temperature type pollutions.

2.3.7 SEABIRDS AND SHOREBIRDS

OCEAN PARK AND RINCÓN PLANNING REACHES

EXISTING CONDITION

The sandy and rocky shorelines and nearshore coastal waters within the San Juan and Rincón study areas are utilized by many species of seabirds and shorebirds for resting and feeding. According to the Puerto Rico Breeding Bird Atlas (Castro-Prieto, J. et al. 2020), about 58 species of birds are found within the San Juan Bay area, 44 of which are sea birds, waterfowl or wading birds. The brown pelican (*Pelecanus occidentalis*) is a permanent resident which feeds throughout the San Juan and Rincón study areas. Numerous gulls, terns, and frigate birds use the beaches for roosting and feeding. Native bird habitat is generally limited within the two specific planning reaches as the reaches have been modified mostly for human uses.

FUTURE WITHOUT-PROJECT CONDITION

It is anticipated native seabirds, shorebirds, and other native bird species and populations would remain relatively like the existing condition.

2.3.8 INVASIVE SPECIES

OCEAN PARK AND RINCÓN PLANNING REACHES

EXISTING CONDITION

Invasive species can adversely impact native plant and animal populations by disrupting natural ecosystem functions. Islands have long been considered particularly vulnerable to biotic invasions. The 1,032 species of alien plants reported for Puerto Rico and Virgin Islands (PRVI) represent about a third of total plant diversity on these islands (DRNA 2015). Some aquatic invasive species that may occur in the project area include:

- Freshwater Plants
    - *Phragmites australis* (Common reed)
    - *Melaleuca quinquenervia* (Bottlebrush tree)
    - *Casuarina equisetifolia* (Australian pine)
- Freshwater Animals
    - *Iguana* (Green iguana)
    - *Cherax quadricarinatus* (Australian red claw crawfish)
- Marine/Estuarine Animals
    - *Pterois volitans* (Red lionfish)
    - *Oreochromis aureus* (Blue tilapia)
    - *Petrolisthes armatus* (Green porcelain crab)
    - *Perna viridis* (Asian green mussel)
    - Phyllorhiza punctata (Australian spotted jellyfish)
- Dune Plants
    - *Crinum asiaticus* (Asiatic swamp lily)
    - Dactyloctenium aegyptium (Egyptian grass)
    - *Scaevola taccada* (Beach naupaka)
    - Yucca aloifolia (Dagger plant)
    - *Cocos nucifera* (Coconut palm)
    - Casuarina equisetifolia (Australian pine)
    - Terminalia catappa (Almond tree)
    - Hibiscus mutabilis (Sea hibiscus)
- Marine/Estuarine Plants
    - *Halophila stipulacea* (Mediterranean seagrass)

Species can be introduced by a variety of different mechanisms; however, most estuarine and marine species introductions are associated with shipping (Ruiz et al. 2000). Commercial shipping is the primary direct mechanism related to this project. Presently, the largest single source of shipping-related introductions is ballast water (Carlton 1985, Lavoie et al. 1999). Ballast water is pumped into the hull of a vessel to stabilize the vessel and keep it upright while carrying cargo. This water can be discharged at the

receiving port as the cargo is loaded or unloaded. Each vessel may take on and discharge millions of gallons of water. Ballast water taken on in foreign ports may include an abundance of aquatic plants, animals, and pathogens not native to Puerto Rico. If discharged into state waters, these foreign species may become problematic.

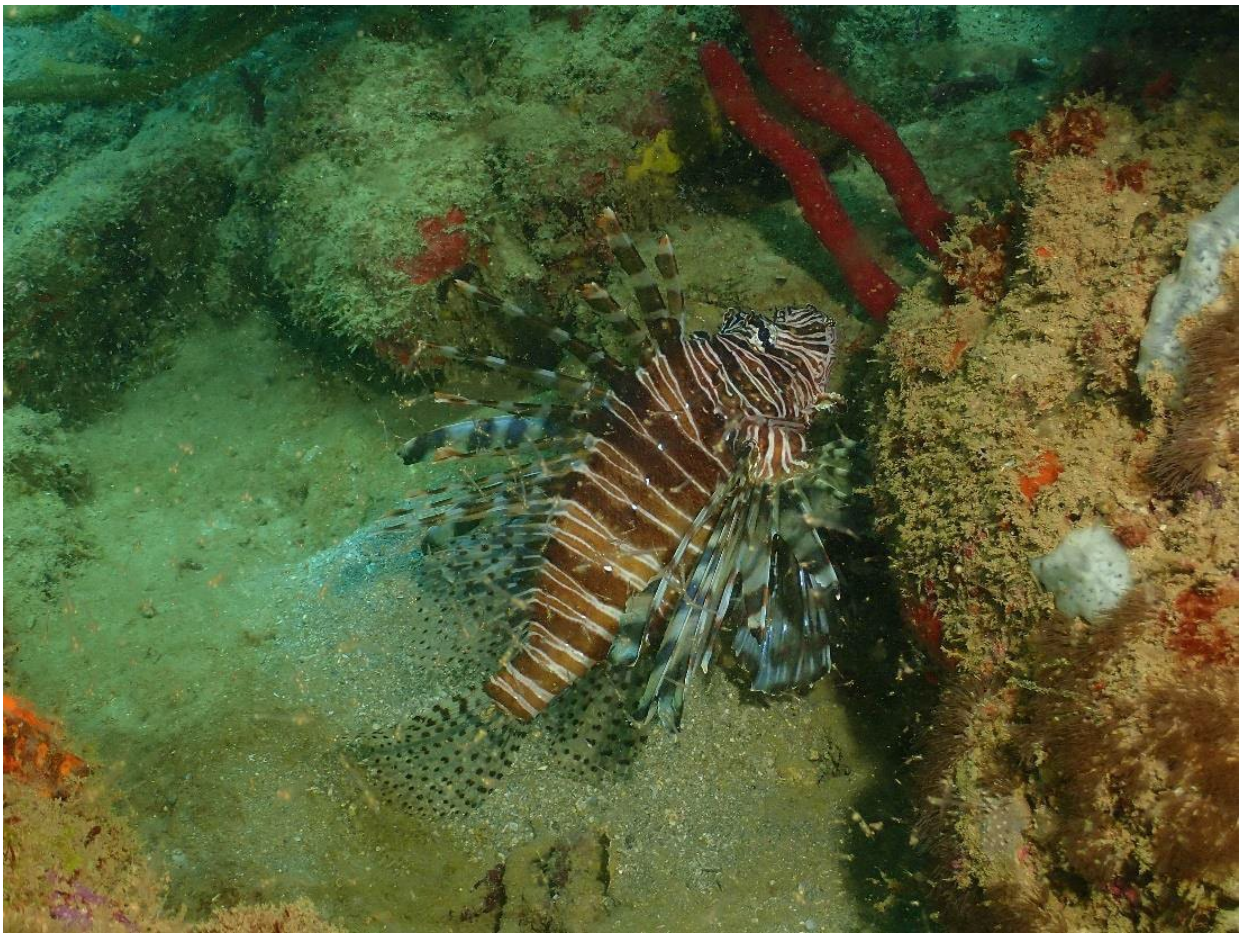


Figure 2-7. A Red Lionfish (*Pterois volitans*) observed on a linear reef, Rincón

In addition to ballast water discharge, another important source for the introduction of nonindigenous plants and sessile animals are hitchhikers that get stuck to land-based machinery or grow on the outside of boats. Commercially available ornamental plants that get tossed into the wild, fragment, or spread seed are also a prevalent source of infestation, especially to native shoreline and upland plant communities.

FUTURE WITHOUT-PROJECT CONDITION

In the future without-project condition, the potential will continue to exist for introduction of invasive species due to the mechanisms discussed above. Recent Federal regulations require the shipping industry to implement better controls to prevent the introduction of invasive species through the ballasts of vessels (USCG 2012). These regulations should decrease the rate at which invasive species are introduced to the study area. The USCG will continue to monitor, enforce, and revise regulations related to the discharge of ballast water while vessels are in port according to the USCG Ballast Water Management

Final Rule Published 23 March 2012. Other safeguards and preventative measures could be implemented for ornamental and landscape plants sales and distribution.

2.3.9 AIR QUALITY

OCEAN PARK AND RINCÓN PLANNING REACHES

EXISTING CONDITION

Puerto Rico is a United States territory with commonwealth status. The USEPA, Region 2 and the Puerto Rico EQB regulate air quality in Puerto Rico. The Clean Air Act (CAA) gives USEPA the responsibility to establish the primary and secondary National Ambient Air Quality the basis of the severity of the pollution problem, nonattainment areas are categorized as marginal, moderate, serious, severe, or extreme. Each state has the authority to adopt stricter standards; however, Puerto Rico has accepted the United States Federal Standards. USEPA regulations designate Air-Quality Control Regions (AQCRs) in violation of the NAAQS as nonattainment areas. USEPA regulations designate AQCRs with levels below the NAAQS as attainment areas. Maintenance AQCRs are areas previously designated nonattainment areas that have subsequently been designated attainment areas for a probationary period through implementation of maintenance plans. On the basis of the severity of the pollution problem, nonattainment areas are categorized as marginal, moderate, serious, severe, or extreme. Each state has the authority to adopt stricter standards; however, Puerto Rico has accepted the United States Federal Standards. USEPA regulations designate Air-Quality Control Regions (AQCRs) in violation of the NAAQS as nonattainment areas. USEPA regulations designate AQCRs with levels below the NAAQS as attainment areas. Maintenance AQCRs are areas previously designated nonattainment areas that have subsequently been designated attainment areas for a probationary period through implementation of maintenance plans. The San Juan and Rincón study areas are located within the Puerto Rico AQCR which is comprised of the entire Commonwealth of Puerto Rico, including Vieques, Culebra, and surrounding islands (40 CFR 81.77). Puerto Rico has adopted the NAAQS established by the USEPA and has developed a State Implementation Plan under the CAA that incorporates permitting and regulatory requirements for stationary and mobile sources of air pollution. All areas within the AQCR are in attainment or unclassifiable (due to lack of data) for NAAQS for the following criteria pollutants: ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, PM2.5, and lead (USEPA 2008).

Due to their locations, the San Juan and Rincón study areas experience nearly constant onshore trade winds and sea breezes. These areas are surrounded by the municipalities of San Juan, Guaynabo, Cataño, Ocean Park, Carolina and Rincón. The Guaynabo non-compliance was due to pollution from power plants, industrial facilities, motor vehicles, and major San Juan emitters. In 2010 the municipality of Guaynabo became compliant air quality standards. In 2011 USEPA provided a grant to the Polytechnic University of Puerto Rico in the amount of $886,095 to install pollution-reduction technology on 72 heavy-duty trucks and replace 10 old heavy-duty trucks with 2010 or newer lower emissions diesel trucks in the Port of San Juan. These upgrades reduced the air emissions of fine particles (particulate matter, (PM)), nitrogen oxides (NOx), and carbon monoxide from diesel engines operating in the port. The municipality of Guaynabo is identified as being in moderate non-attainment of the NAAQS for particulate matter with a diameter of 10 micrometers or less (USEPA 2008).

The Puerto Rico Electric Power Authority (PREPA) owns and operates two power plants in the vicinity. The San Juan Power Plant located in the area of the bay and the Palo Seco Power Plant located in Cataño just

outside the entrance of the Bay. In order to comply with upcoming Mercury and Air Toxics Standards (MATS) administered by the USEPA and to reduce cost of electricity production in Puerto Rico, PREPA is preparing to convert a number of the power generation units at its San Juan and Palo Seco Power Plants to burn natural gas as the primary fuel instead of Bunker C and Diesel (No. 6 and No. 2 type) fuel oil.

FUTURE WITHOUT-PROJECT CONDITION

It is anticipated that no change to the existing air quality would be expected. Ambient air quality conditions in the San Juan and Rincón study areas would more than likely remain the same.

2.3.10 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

OCEAN PARK AND RINCÓN PLANNING REACHES

EXISTING CONDITION

The San Juan and Rincón study areas are highly developed. No hazardous or toxic materials or waste have been identified within the project footprint. No known hazardous, toxic, or radioactive waste has been encountered or released in the project area. Sediments from the San Juan Harbor navigation channel typically have traces of heavy metals, Polychlorinated biphenyls (PCBs), pesticides, Polycyclic Aromatic Hydrocarbons (PAHs), and petroleum products, at low levels that do not affect the sediment quality or the water quality in the project area.

FUTURE WITHOUT-PROJECT CONDITION

No significant effects to or from hazardous and toxic materials are anticipated from the FWOP condition.

2.3.11 NOISE

OCEAN PARK AND RINCÓN PLANNING REACHES

EXISTING CONDITION

Noise is often defined as any sound that is undesirable because it interferes with communication, is intense enough to damage hearing, diminishes the quality of the environment, or is otherwise annoying. Response to noise varies by the type and characteristics of the noise source; distance from the source; receptor sensitivity, and time of day. Noise can be intermittent or continuous, steady or impulsive, and it may be generated by stationary or mobile sources. Noise is described by a weighted sound intensity (or level), which represents sound heard by the human ear and is measured in units called decibels (dB). The potential impacts of underwater sounds associated with dredging operations have come under increasing scrutiny by regulatory agencies.

San Juan bay has functioned as an international harbor since pre-colonial times. Over the last 300 years, San Juan Harbor has evolved to accommodate the growing shipping industry as larger vessels continued to arrive. At the same time, recreational and other commercial boat traffic and industrial noise has continued to increase. Several sources of ambient noise are present in San Juan Bay. The ambient noise level of an area includes sounds from both natural (wind waves, fish, tidal currents, mammals) and artificial (commercial and recreational vessels, dredging, pile driving, etc.) sources. Tidal currents produce

hydrodynamic sounds, which are most significant at very low frequencies (< 100 Hz). Vessel traffic, including vessels passing the immediate study area, generate sounds that can travel considerable distances, in frequencies ranging from 10 to 1000Hz. Sea state (surface condition of the water characterized by wave height, period, and power) also produces ambient sounds above 500 Hz. As a commercial and industrial area, San Juan Bay experiences a wide range of noise from a variety of industrial activities. Biological sounds associated with mammals, fishes, and invertebrates can also generate broadband noise in the frequency of 1 to 10 kHz with intensities as high as 60 to 90 dB.

San Juan Harbor has the typical noise characteristics of a busy harbor including recreational and commercial vessel traffic, dredging vessels and dock side facilities. Noise sources for vessels include cranes, whistles and various motors for propulsion. Dockside noise sources include cranes, trucks, cars, and loading and unloading equipment. In addition to the noise in the water/marine environment, noise can impact the human environment. Background noise exposures change during the course of the day in a gradual manner, which reflects the addition and subtraction of distant noise sources. Ambient noise represents the combination of all sound within a given environment at a specified time. Humans hear sound from 0-140 dB. Sound above this level is associated with pain.

High intensity sounds can permanently damage fish hearing (Nightingale and Simenstad 2001). These sounds have been documented to be continuous and low frequencies (< 1000 Hz) and are within the audible range of listed species of both whales (7Hz–22 kHz) and sea turtles (100-1000Hz) (Clarke et al. 2002).

Noise has been documented to influence fish behavior. Fish detect and respond to sound by utilizing cues to hunt for prey, avoid predators, and for social interaction. Fish produce sound when swimming, mating, or fighting and also noise associated with swimming. Fish use a wide range of mechanisms for sound production, including scraping structures against one another, vibrating muscles, and a variety of other methods. Sounds produced by spawning fishes, such as sciaenids, are sufficiently loud and characteristic for them to be used by humans to locate spawning locations.

Relative to exposure to anthropogenic noise, NOAA guidelines define two levels of harassment for marine mammals: Level A based on a temporary threshold shift (190 dB for pinnipeds and 180 dB for cetaceans), and Level B harassment with the potential to disturb a marine mammal in the wild by causing disruption to behavioral patterns such as migration, breeding, feeding, and sheltering (160 dB for impulse noise such as pile driving and 120 dB for continuous noise such as vessel thrusters) (http://www.nwr.noaa.gov/Marine-Mammals/MM-sound-thrshld.cfm). According to Richardson et al. (1995) the following noise levels could be detrimental to marine mammals:

Prolonged exposure of 140 dB re 1 µPa/m (continuous man-made noise), at 1 km can cause permanent hearing loss. Prolonged exposure of 195 to 225 dB re 1 µPa/m (intermittent noise), at a few meters or tens of meters, can cause immediate hearing damage.

At the time this document was prepared, NOAA had released a draft report that provides guidance for assessing the effects of anthropogenic sound on marine mammal species under the jurisdiction of NMFS (NOAA 2013). The guidance will replace the current thresholds used by NOAA and described above. NOAA compiled, interpreted, and synthesized best available science to update the threshold levels for temporary and permanent hearing threshold shifts. Different target species for protection have widely divergent tolerance levels for sounds (owing to different hearing sensitivities, hearing integration times, etc.). Due to the complexity and variability of marine mammal behavioral responses, NOAA will continue

to work over the next years on developing additional guidance regarding the effects of anthropogenic sound on marine mammal behavior (http://www.nmfs.noaa.gov/pr/acoustics/guidelines.htm).

FUTURE WITHOUT-PROJECT CONDITION

The San Juan study area is within an urban setting and noises related to beach recreation, recreational and commercial vessel traffic, dredging vessels, and dock side facilities would continue similar to the existing conditions. The Rincón study area is within a smaller urban setting though noises related to beach recreation, water sports, and recreational and commercial vessel traffic, would also continue similar to the existing conditions.

2.3.12 COASTAL BARRIER RESOURCES

OCEAN PARK AND RINCÓN PLANNING REACHES

EXISTING CONDITION

The Coastal Barrier Resources Act (CBRA) was enacted by Congress in 1982. The CBRA was implemented to prevent development of coastal barriers that provide quality habitat for migratory birds and other wildlife and spawning, nursery, nesting, and feeding grounds for a variety of commercially and recreationally important species of finfish and shellfish. As a deterrent to development, Federal insurance is not available for property within designated high-hazard areas. These high-hazard areas are called Coastal Barrier Resources System (CBRS) units.

CBRS units are areas of fragile, high-risk, and ecologically sensitive coastal barriers. Development conducted in these areas is ineligible for both direct and indirect Federal expenditures and financial assistance. Along with CBRS units are otherwise protected areas (OPAs). OPAs are national, state, or local areas that include coastal barriers that are held for conservation or recreation. The only Federal funding prohibition within OPAs is Federal flood insurance.

There are three CBRS units located near, but not in the study area including San Juan, PR-87 Punta Vacia Talega and PR-87P Punta Vacia Talega OPA approximately 13-19 km east and PR-86P Punta Salinas OPA approximately 6 km west (**Figure 2-7**). In addition, unit PR-72 Rio Guanajibo occurs approximately 11 miles south and unit PR-75 Espinar occurs approximately 11 miles north of the Rincón study area (**Figure 2-8**).

FUTURE WITHOUT-PROJECT CONDITION

The CBRS units and OPAs do not fall within the study area. The CBRS units and OPAs would continue to be protected from development under the CBRA in the FWOP condition pending no changes in the current regulations.

Figure 2-8. West San Juan Bay and Condado Lagoon Vicinity Coastal Barrier Resource System Units.

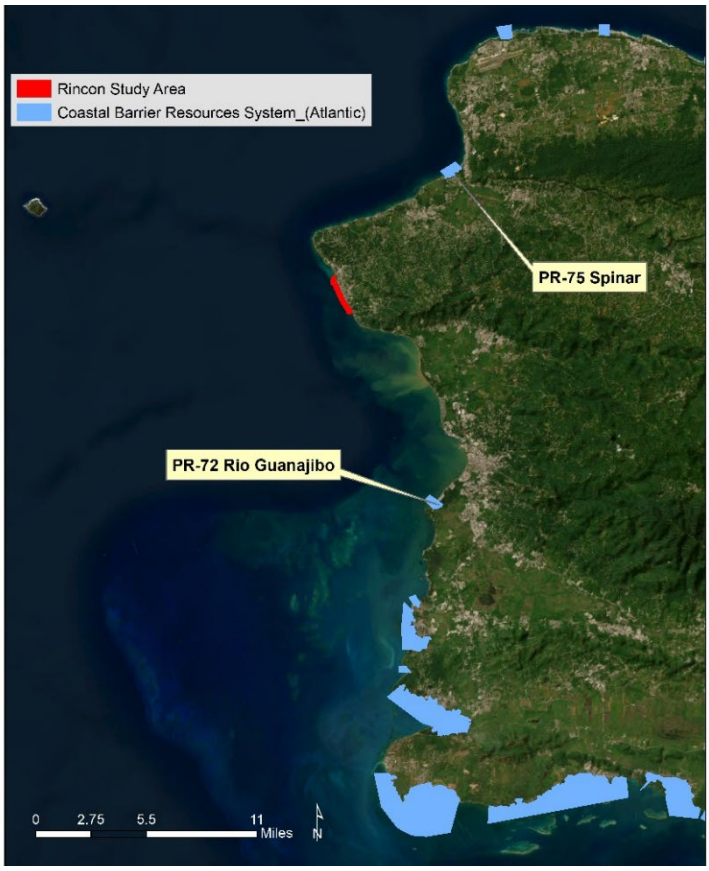


Figure 2-9. Rincón Vicinity Coastal Barrier Resource System Units.

2.3.13 CULTURAL RESOURCES AND HISTORIC PROPERTIES

OCEAN PARK AND RINCÓN PLANNING REACHES

EXISTING CONDITIONS

Cultural resources include prehistoric and historic sites, structures, districts, or any other physical evidence of human activity considered important to a culture, a subculture, or a community for scientific, traditional, religious, or any other reason. Several Federal laws and regulations protect these resources, including the National Historic Preservation Act of 1966 (NHPA)(Public Law 89-665), the Archaeological and Historic Preservation Act of 1974 (Public Law 93-291; 16 U.S.C. 469-469c), and the Archaeological Resources Protection Act of 1979 (16 U.S.C. §§470aa-470mm; Public Law 96-95, as amended). Additionally, NEPA requires that Federal agencies consider the "unique characteristics of the geographic area such as proximity to historic or cultural resources" and "the degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historical resources" (40 CFR 1508.27[b]). Documentation of historic properties and cultural resources is important for this project, as the cultural resources in the Rincón and San Juan area are significant to the history of Puerto Rico, the broader Caribbean, the United States, and world in general. The area is rich in precolonial and historic human activity, with the potential for significant resources from the last several thousand years.

The analysis of impacts to cultural resources relies on existing information primarily from documents prepared by the Puerto Rico State Historic Preservation Officer (SHPO), GIS data of resources from SHPO, and properties listed in the National Register of Historic Places (NRHP). The area of potential effects (APE) for cultural resources is defined as the areas where structural measures are implemented, and non-structural measures are applied to historic properties as defined in 36 C.F.R. §800.16(l). An effect is an alteration to any characteristic which qualifies a historic property for inclusion in or eligibility for the NRHP (36 CFR 800.16(i)). Effects may be direct or indirect. Examples of effects include visual intrusions, alterations of setting, noise, vibrations, viewsheds, and physical impacts. Indirect effects may occur where the actions enable other effects, which may be later in time or removed by distance. These may include increased development or changes in land use that may reasonably be associated with an action.

The proposed project includes measures along the shoreline of Ocean Park in the San Juan Metropolitan area and in the Rincón area. The background of these geographically and historically distinct areas will be reviewed in turn. Due to history, location, and the complexity of the archaeology in Puerto Rico, the island has been one of the central locations of archaeological research in the Caribbean. Though competing schema exist of how the islands was settled and occupied, there is broad agreement people have occupied Puerto Rico for several thousand years. The material traces of these groups include a variety of types of archaeological sites, including dense middens, panels of petroglyphs in stone, stone-lined plazas, and artifact scatters. During the subsequent colonial period, notable types of sites range from archaeological evidence of small households to large haciendas, the material traces of the development of various industries, distinctive Puerto Rican architecture, and historic districts from the Spanish colonial period through the twentieth century.

The Ocean Park planning area is located immediately east of the Islet of San Juan. San Juan has been a significant port dating back to the end of the fifteenth century and the European exploration and settlement of the New World. Christopher Columbus landed on the west coast of Puerto Rico at Boquerón

Bay in 1493, naming the area San Juan Bautista. At this time, the indigenous population measured approximately 60,000 people, who are collectively identified by archaeologists as Taíno based on shared cultural traits. Spanish colonization of the island did not occur until 1508 when Juan Ponce de León established a permanent settlement south of San Juan Bay with the permission of the Taíno chiefdom of Guainía (Jiméz de Wagenheim 1998).

The Spanish subjection and maltreatment of the indigenous population led to a Taíno revolt in 1511. However, due to military subjugation, disease, and abuse from the Spanish, the native population was reduced by 75 percent in 1515. In order to replace the native workforce of the island's gold mines, the Spanish began importing enslaved Africans and indigenous people from nearby islands (Jiméz de Wagenheim 1998).

By 1521, the islet adjacent to *Puerto Rico* became the central Spanish settlement of San Juan and the island itself had come to be called Puerto Rico. Through the second half of the sixteenth century, San Juan became increasingly strategic for the export of sugarcane and ginger, and as a military outpost for Spain's colonial empire. In order to reinforce the military defenses of Puerto Rico, the Santa Catalina fortress (present-day *La Fortaleza*) was built, and construction began on *El Morro* Castle. The city was fortified well enough to rebuke the attack of Sir Francis Drake in 1595. George Clifford, 3rd Earl of Cumberland, attacked and took the city in 1598; however, Spanish forces arrived shortly to rescue the island from the British. In 1625 Dutch forces attacked the city of San Juan, but the Spanish repelled the forces from *El Morro*. After this attack, the Spanish began improving their waterside fortifications, including the initial construction of the City Wall in 1634 (Krivor 2017).

During the beginning of the nineteenth century, Spain loosened its grip on Puerto Rico resulting in increased trade with foreign nations. Native Puerto Ricans (*Criollos*) sought political autonomy and gradually transformed the island to a sugarcane and coffee plantation-based economy (Jiméz de Wagenheim 1998). As Puerto Rico engaged in the global economy, San Juan was the center of economic development. The areas east of the San Juan islet remained relatively undeveloped, as these were outside of the protective walls and administrative hub.

The Spanish American War led to changes in the study area. The region from Condado to Carolina was generally undeveloped during the Spanish colonial period. The San Juan region experienced rapid development after the Spanish American War ended in July 1898 with the cession of Puerto Rico to the United States. Within a decade of American control, streets were laid out in Condado, and the land was sold for development (López Martínez 2008). In 1919 the first major tourist hotel, the Condado Vanderbilt Hotel, was constructed in Condado. Additional hotels followed, and the stretch of coastline from Condado to Carolina became a prominent area for both housing and tourism.

Cultural resources recorded in the San Juan study area include those related to the precolonial inhabitants of Puerto Rico and the rich twentieth architectural heritage. Previous efforts to identify these resources have documented prehistoric archaeological sites along the coast in neighboring Carolina, both submerged and in the dune environment. There are archaeological sites located near the project reaches, and the potential exists for additional sites within the APE. Extensive sand mining has occurred across these reaches, potentially removing unknown archaeological sites. Though the development and storm damage likely have disturbed archaeological sites across these reaches, the potential remains for additional unrecorded resources. This includes submerged prehistoric archaeological sites and shipwrecks.

Located west of the Ocean Park Planning Reach, the Condado Vanderbilt Hotel is listed on the NRHP (NRHP Reference Number 08001110). This historic property is linked to the development of the Puerto Rican tourism industry in the twentieth century. The hotel remains operational, having been renovated. The areas south of this reach include neighborhoods developed in the twentieth century, many with shared unique architecture and atmosphere.

The Rincón Planning Reach is along the western shore of Puerto Rico, starting approximately two miles south of Punta Higuero. In an examination of Puerto Rican archaeology, Irving Rouse (1952) posited the Rincón area was sparsely populated prior to European conquest due to the lack of a clear embayment and the force of the prevailing winds. Based on the early chronicles at the time of European colonization, Rouse places Rincón as part of the Aymamón region at contact and ruled by a cacique of the same name. Subsequent researchers place this as part of Puerto Rico as the Yagüeca region ruled by Urayoan (Alegría 1999).

The western coast of Puerto Rico was an important stopping point for early European exploration of the Caribbean, as it provided a crucial location for topping off fresh water supplies. However, there is no evidence for development of Rincón for some time. Eighteenth century maps of Spanish settlements and infrastructure in this region do not map the town of Rincón in 1737 or 1791. A single structure is mapped inland in the 1737 map. Abbad y Lasiera (1866) reported on the conditions in Puerto Rico from 1773-1783. He provides little information on the Rincón. It is listed as one of the ports on the western side of Puerto Rico, associated with the river. He notes the settlement of Santa Rosa de Rincón was founded in 1772 (other sources provide 1770) along the river, with 11 houses and a church. He notes the area is poor and has no defense against *corsarios* (pirates).

During the nineteenth century, Rincón remained a remote settlement of Puerto Rico due to a lack of a deep-water port and limited transportation options. The SHPO site file notes two haciendas and a central (sugar processing factory) in the municipality, providing evidence of the agricultural past in Rincón. Rincón was better connected to the rest of Puerto Rico during the boom in railroad building during the late nineteenth century.

In his review of the region up to the time, Rouse (1952) reports a major shell midden site named Rincón 1, measuring two acres in size on Punta Ensenada, north of the study area. This site was visited by archaeologists in the early twentieth century, with Ostiones, Santa Elena, Cuevas, and Capá styles of pottery documented in museum collections (Rouse 1952: 398). The location of this site, as recorded in the Puerto Rico SHPO site file with the added name of Fussá I, is located within a developed residential portion of the town of Rincón. After Rouse's observations, the SHPO file on Rincón suggests archaeologist forgot about the region ("la región pasó prácticamente al olvido") for some time, until work was completed in the 1970s and 1980s. At this point, additional efforts were conducted at Fussá I and a portion of the site with petroglyphs (Fussá II) was recorded. The archive of papers presented at the International Association of Caribbean Archaeology from 1931 to 2011 has two papers including reference to Rincón, both only mentioning the existence of the petroglyphs without additional details. In addition to the archaeological sites, other cultural resources have been identified and recorded in the site files. Inland, near the study area, there are remnants of the historic coastal railroad infrastructure and a hacienda.

The NRHP includes two historic properties in the Rincón municipality. Faro de Punta Higuero (NRHP Reference Number 81000560) was listed on the NRHP in 1981 as part of the nomination of multiple lighthouses across Puerto Rico. The lighthouse was originally built in 1892, subsequently repaired in 1921

after a 1918 earthquake, and then replaced in 1922. The later construction incorporated elements from the original facility. The area is currently a park.

The second historic property is the Boiling Nuclear Superheater (BONUS) Reactor Facility (NRHP Reference Number 7001194), listed in the NRHP in 2007 as a district comprised on 6 buildings. This decommissioned nuclear reactor complex was constructed in 1960-1963 as an experimental facility and prototype. It is one of two boiling-water superheater reactors constructed in the United States and was the first nuclear plant built in Latin America. The reactor was used to produce electricity until 1968 and was decommissioned between 1969 and 1970. It was later turned into a museum but was shuttered due to potential exposure to radiation.

Though neither historic property is located near the measures proposed in this report, other unrecorded resources may exist. Though the proposed project is located on a highly eroded beach, which limits potential impacts to archaeological sites, cultural resources may be present in the area.

FUTURE WITHOUT-PROJECT CONDITION

Without the project, the current laws and regulations governing cultural resources in Puerto Rico would still apply and protect cultural resources. Without additional shoreline protection, storms may damage the cultural resources along the coast. Erosion could potentially impact archaeological sites located inland.

2.3.14 ENVIRONMENTAL JUSTICE

EXISTING CONDITION

This study considered impacts under Executive Order 128981 "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" (1994), which directs each Federal agency to avoid disproportionately high and adverse human health or environmental effects on low-income and minority populations. Federal agencies must conduct their programs, policies, and activities that substantially affect human health or the environment to avoid excluding persons or populations and avoid subjecting persons or populations to discrimination because of their race, color, or national origin. The team also took the analysis one step further and compared alternatives to each other based on the percentage of benefits accruing to these historically economically disadvantaged communities in line with current administration's Justice40 Initiative[8], as well as the Comprehensive Documentation of Benefits in Decision Documents (ASA,CW, 2021). In order to perform this analysis, it was necessary to first understand

[8] **Executive Order 14008, Tackling the Climate Crisis at Home and Abroad**. Section 223 of EO 14008 established the Justice40 Initiative, which directs 40% of the overall benefits of certain Federal investments – including investments in clean energy and energy efficiency; clean transit; affordable and sustainable housing; training and workforce development; the remediation and reduction of legacy pollution; and the development of clean water infrastructure – to flow to disadvantaged communities (DACs).

the communities in each planning reach. The description and identification of the communities in this section is the basis for that comparison and the primary tool used for this identification was the Environmental Protection Agency's (EPA) EJScreen Tool and income/employment data from the American Community Survey (ACS).

Each census tract within Ocean Park planning reach was found to be an economically disadvantaged community. On average, 54% of the residents are considered low income and 46% live below poverty level. The median income averages $25,948 with census tract 13.02 the lowest at only $3,157. Additionally, there is a significant amount of public housing located within the planning reach, such as the Residencial Luis Llorens Torres which is the largest public housing complex in the entire Caribbean. Residencial Luis Llorens Torres spans across census tracts 13.01 and 13.02 and 99% of the residents are considered low income. See **Figure 2-10** for data on each Ocean Park census tract used in the assessment.

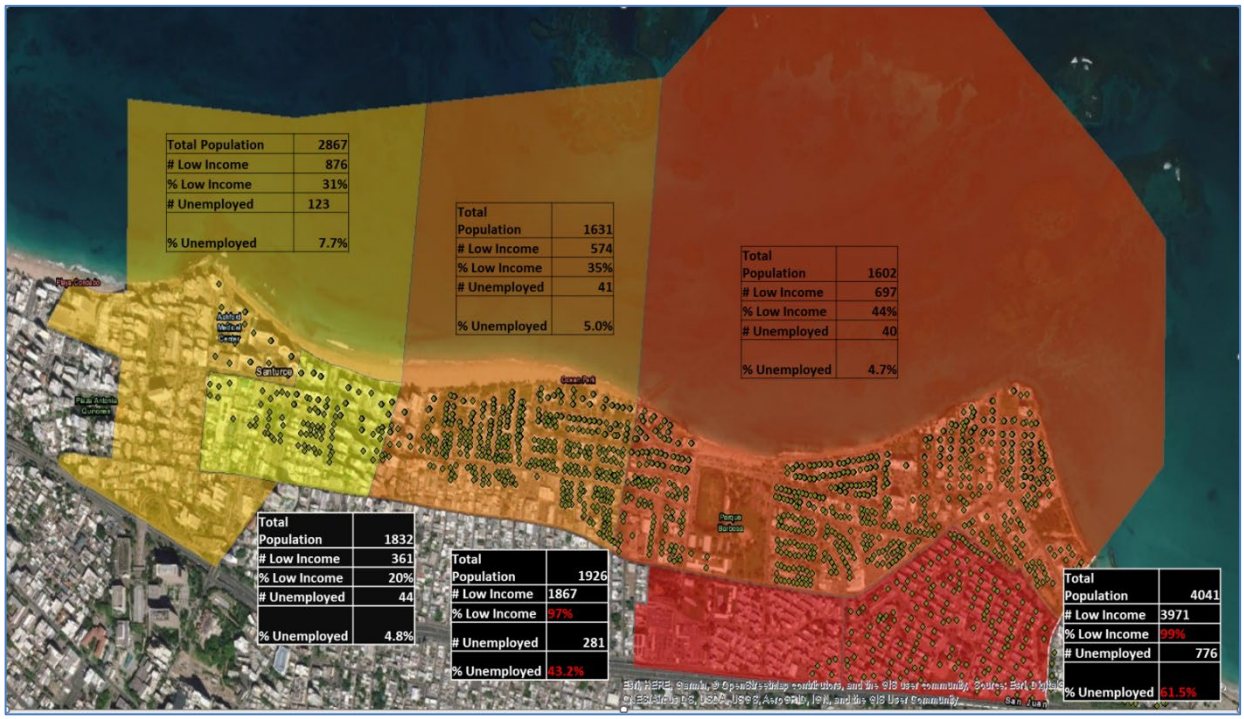


Figure 2-10: Communities in Ocean Park.

**Heat map coloring based on percent of population considered low income. Small green points on map represent assets included in the modeling domain, more discussion on this in the FWOP condition below.*

Similarly, the entirety of the Rincón planning reach was determined to be a community experiencing economic challenges. This planning reach, which contains the barrio of Stella, was almost entirely represented by a single census tract. The unemployment rate of 4.6% is not particularly high compared to the US, but the median income of $29,769 is slightly less than half that of the US. The percent of population living below poverty in Stella is 38.2% and those considered low income represent 75.4%, putting this census tract in the 97th percentile of low income. See **Figure 2-11** for statistics representing the assessment.

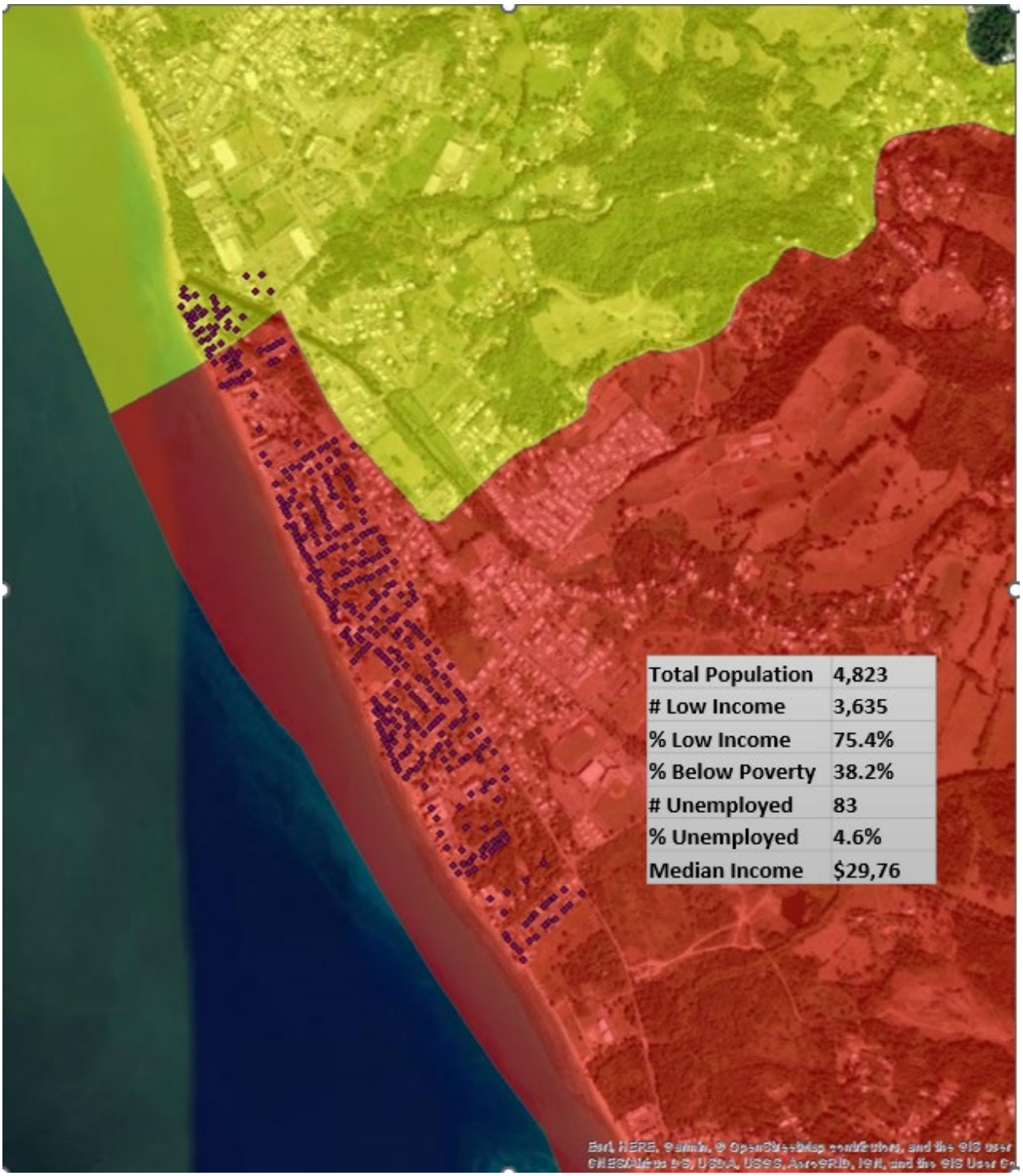


Figure 2-11: Rincón (Stella) Communities.

2.3.15 AESTHETICS AND RECREATION

OCEAN PARK PLANNING REACH

EXISTING CONDITION

San Juan is the capital and most populous municipality in the Commonwealth of Puerto Rico. The coastal environment provides opportunities for swimming, boating, and fishing.

A key recreational landmark is Barbosa Park (also known as Último Trolley), which is owned by the municipality of San Juan. It consists of a recreational beach and park which are enjoyed by the community and tourists. It is bounded by a sidewalk and a small access road. The large recreational park includes a track, various sports fields, as well as a police station. Overtopping of the existing wall from coastal storms wall occurs routinely, causing flooding both in the park and on access roads, which adversely impacts recreational opportunities.

FUTURE WITHOUT-PROJECT CONDITION

The municipality of San Juan has plans to enhance features of Barbosa Park. Coastal flooding will continue to impact recreational opportunities after coastal storms.

RINCÓN PLANNING REACH

The Rincón municipality is significant to the nation with its rich historical and cultural heritage, environmental resources, and tourism. In 2018, the Rincón population was estimated to be 15,000. Tourism is a vital part of the Rincón economy and an important consideration. Almost all of the tourism industry in Rincón could be described as coastal tourism. Tourists venture to Puerto Rico's western, most remote coast to enjoy passive uses of the coast such as surfing, fishing, snorkeling, and scuba diving.

Historically the shoreline in the southern Rincón reach was very wide; anecdotally it was wide enough to play a soccer game. The shoreline has been a place of cultural identity and recreation for the community. The northern stretch of Rincón is known world-wide as a premiere surfing destination, hosting events and drawing in approximately 85,000 tourists per year to the municipality. The town of Stella (in the Pueblo barrio) is in the southern portion of the municipality of Rincón. The town of Stella supports the northern portion of Rincón in tourism with hotels and restaurants, along with its sandy beaches, and relies on this income to sustain its economy.

As erosion continues, the beach is lost and with it, the recreational use along the coast. Additionally failed and condemned structures, which are often left behind and unremoved, are very unsafe and create unsightly conditions, that then continue to spread into the community. Further, the failed structures increase erosion in the local area and prohibit natural beach recovery. Structure values in this area are noticeably much lower than in other parts of Puerto Rico compared to San Juan, and significantly lower than some comparable coastal communities in the mainland United States.

FUTURE WITHOUT-PROJECT CONDITION

In the absence of a plan, structures[9] are expected to be completely lost to the ocean and/or condemned due to erosion, ultimately triggering forced relocations. Under devastating circumstances, property owners will be forced to move after their homes are condemned and large portions of the beach will be inaccessible due to the resulting safety issues with the remnants of the destroyed structures, as seen in the photos included herein. Structures would become derelict and are unlikely to be removed which would further exacerbate wave energy, resulting in erosion on surrounding shorelines. Furthermore, residents are likely to relocate out of the area and potentially out of Puerto Rico, reducing not only the strength of the cultural identity of the community but also reducing the tax base and impairing the economy.

2.4 PHYSICAL ENVIRONMENT

Both Ocean Park (in San Juan) and Rincón planning reaches are subject to frequent storm events. Adjacent properties to the shoreline can be categorized as urban and include residential, commercial, and recreational properties. Potential sources of sand that could be used to construct potential alternatives are also considered part of the physical environment. Many factors influence the coastal processes characteristic to the San Juan and Rincón shorelines, including winds, tides, waves, storm effects, and sea level change. There are no other Federal projects influencing the coastal processes in these study areas. The role of each of these factors and their contribution to coastal damages are briefly described in this section.

2.4.1 SEA LEVEL CHANGE

The full analysis of the sea level change existing and future conditions is documented in Section 2.2.3 of the **Appendix A, Engineering**

Relative Sea Level (RSL) refers to local elevation of the sea with respect to land, including the lowering or rising of land through geologic processes such as subsidence and glacial rebound. It is anticipated that the global mean sea level will rise within the next 100 years. To incorporate the direct and indirect physical effects of projected future Sea Level Change (SLC) on design, construction, operation, and maintenance of USACE coastal projects, the climate assessment for Relative Sea Level Change (RSLC) follows the USACE guidance of Engineering Regulation, (ER) 1100-2-8162 (USACE 2019) and Engineering Pamphlet (EP) 1100-2-1 (USACE 2019). Three scenarios are required by ER 1100-2-8162 guidance: A Baseline (or “Low”)

[9] A structure refers to a single building which could have multiple property owners within. For example, a condominium complex with 20 units would be a single structure, but would have 20 unique property owners.

scenario, representing the minimum expected SLC; an Intermediate scenario; and a High scenario representing the maximum expected SLC.

EXISTING CONDITIONS

Historical Sea Level Change Trends

Based on historical sea level measurements taken from NOAA gauge 9755371 San Juan Bay, PR, and NOAA gauge 9759110 Magueyes Island, PR, USACE determined the historic sea level change rates for San Juan and Rincón areas.

NOAA Station 9755371 showed a Mean Sea Level (MSL) trend from 1962 to 2020 of 2.09 mm/yr. (0.00686 ft/yr.) +/- 0.37 mm/yr. (0.00121 ft/yr.) at 95 percent confidence. At gauge 9759110, the MSL trend from 1955 to 2020 is 1.90 mm/yr. (0.00623 ft/yr.) +/- 0.30 mm/yr. (0.00098 ft/yr.) at 95 percent confidence.

FUTURE WITHOUT-PROJECT CONDITION

Four dates are important when projecting SLC for a given study area under this guidance: the project "base" year: (1) 1992 is the mid-point of the referenced epoch (1983-2001) and is the MSL elevation of zero in which the SLC values are relative to, (2) the year that the project's construction is assumed to be completed, (3) the end of the economic period of analysis which is 50 years following construction completion, and (4) the project's adaptation horizon, which is 100 years following construction completion to adapt to climatological changes. The base year for this study is 2029, the 50-year economic period of analysis is through 2078, and the 100-year adaptation horizon is through 2128. Following procedures outlined in ER 1110-2-8162 and EP 1100-2-1, low, intermediate, and high SLC values were estimated over the life of the project using the official USACE sea level change calculator tool.

Sea Level Change Projections for San Juan, Puerto Rico

Based on USACE guidance and the historic local MSL trends in San Juan, three curves were developed for the San Juan study area projected to the 2128 (100-yr) adaptation horizon. The USACE low SLC curve extrapolates the USACE linear trend. The regional USACE linear trend for San Juan (SLC Calculator) projected to 0.59 ft by 2078 and 0.93 ft by 2128 (relative to 1992 MSL) using NOAA's MSL trend. The USACE intermediate curve (NRC I) projects 1.25 ft by 2078 and 2.58 ft by 2128. The USACE high curve (NRC III) estimates 3.33 ft by 2078 and 7.79 ft by 2128. This information is displayed in **Figure 2-12.**

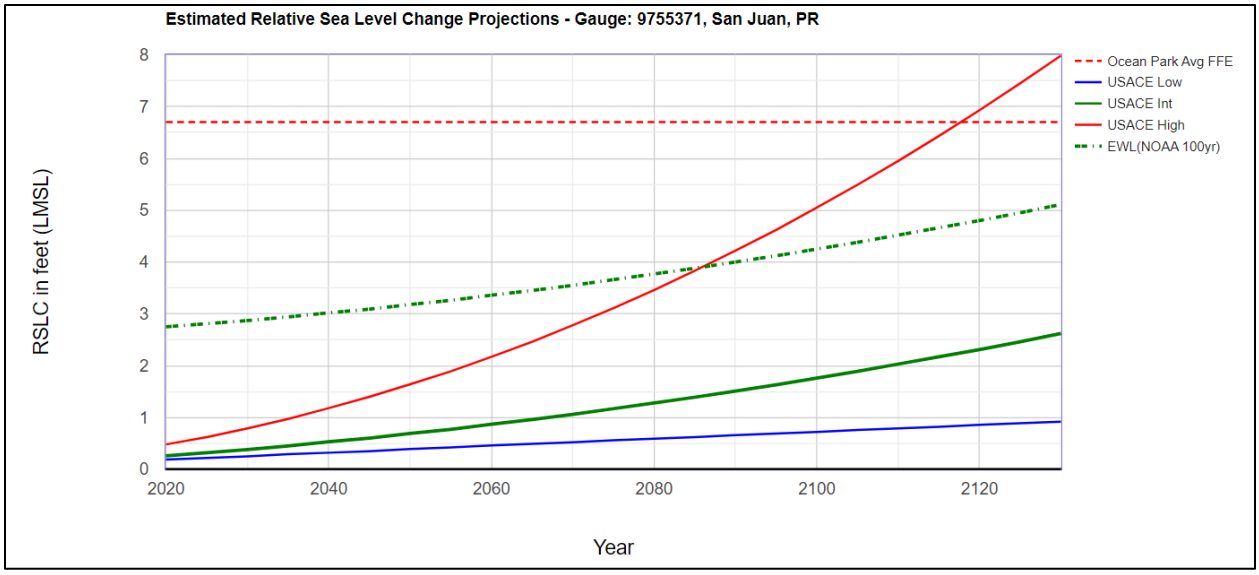


Figure 2-12. SLC Projections for San Juan, Puerto Rico

Sea Level Change Projections for Rincón, Puerto Rico

Three curves were projected to the 2128 (100-yr) adaptation horizon for the Rincón study area. for the regional USACE linear trend for the Rincón area projects to 0.54 ft by 2078 and 0.85 ft by 2128, the USACE intermediate projects to 1.19 ft by 2078 and 2.49 ft by 2128, and the USACE high curve projects to 3.28 ft by 2078 and 7.70 ft by 2128. Figure 2-13 displays this information graphically.

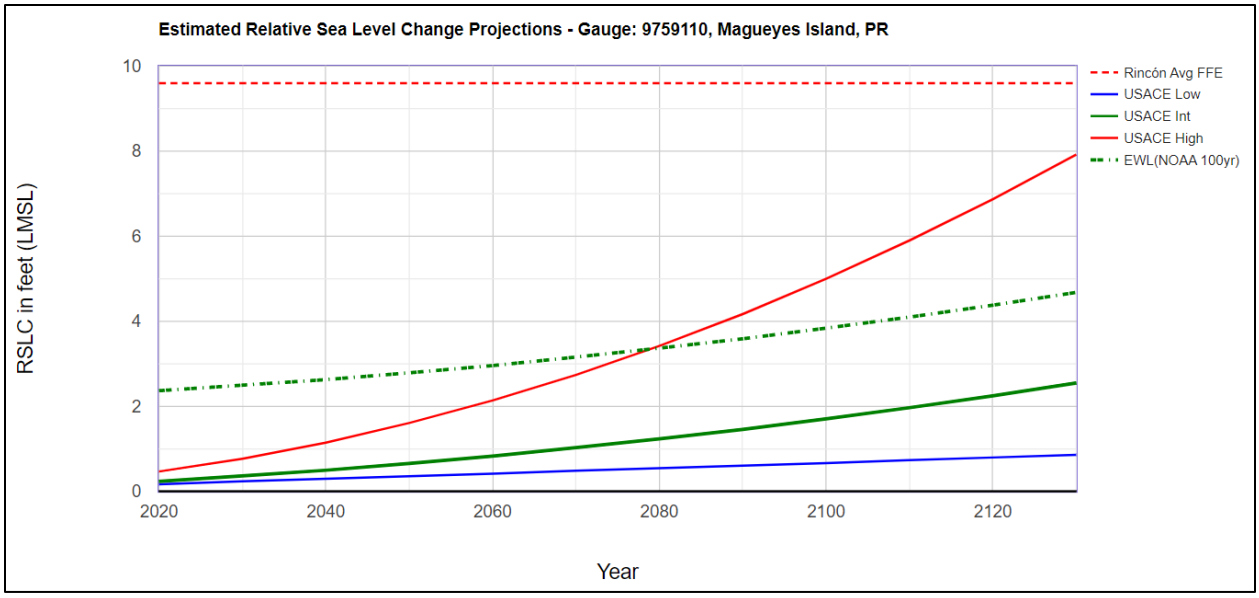


Figure 2-13. SLC Projections for Rincón, Puerto Rico

2.4.2 STORM INTERACTIONS WITHIN THE PHYSICAL ENVIRONMENT

2.4.3 STORM EFFECTS

EXISTING CONDITIONS

The San Juan and Rincón study areas are located in a region of considerable hurricane activity, resulting in relatively frequent hurricane impacts. Puerto Rico coastline is generally influenced by tropical systems during the summer and fall months (hurricane season) and by nor'easters during the late fall, winter, and spring months. Although hurricanes typically generate larger waves and storm surge, northeasters can have a greater cumulative effect on the area due to longer storm duration and greater frequency of event occurrence.

Figure 2-14 shows an example of the tropical storm sampling via the NOAA Hurricane Data's 2nd Generation (HURDAT2) sampling tool on the interactive hurricane tracker website. A 200-kilometer (roughly 125 miles) selection radius centered on San Juan yielded a total of 143 storms that passed through the area from 1851 to 2020. A total of 131 tropical storms passed through the Rincón project area with the same sampling method. The 200-kilometer radius was chosen because a tropical disturbance passing within this radial area would likely produce damages along the shoreline. Stronger storms can produce significant damage to the coastline from greater distances.

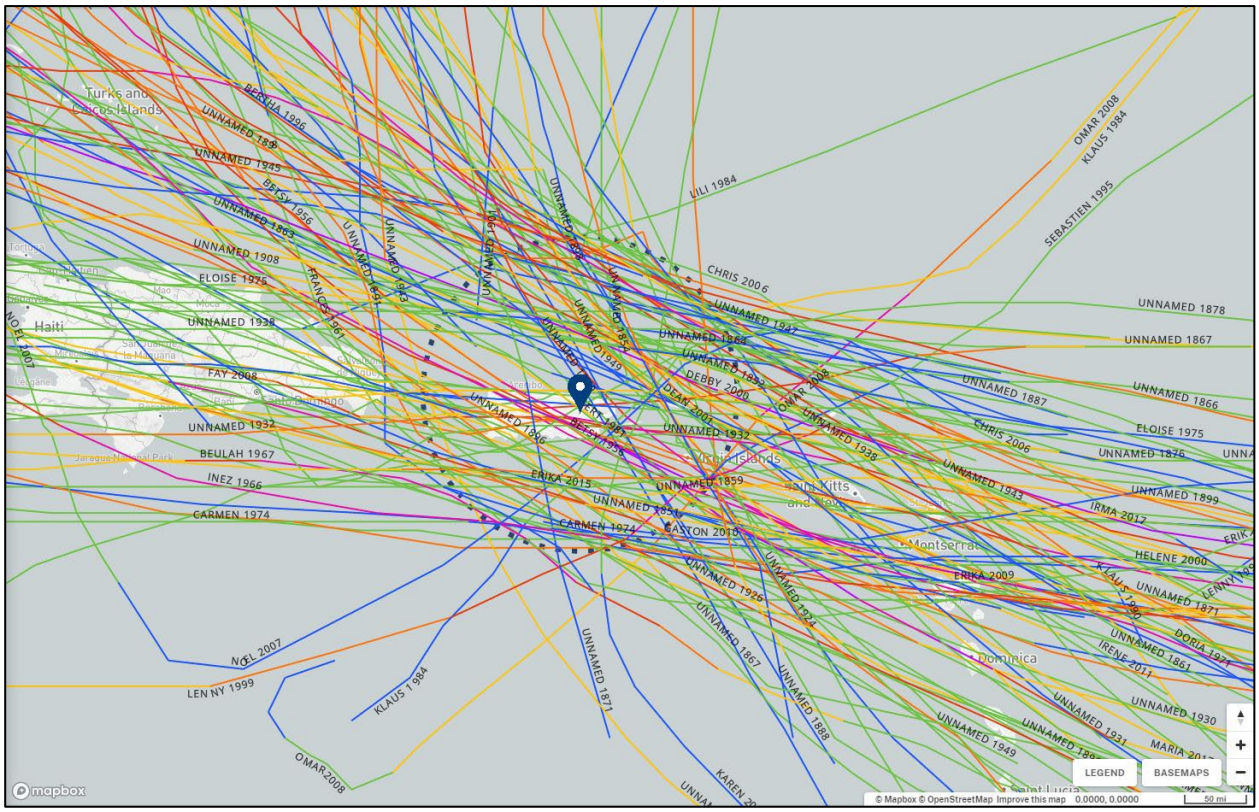


Figure 2-14. Example of Sampling Tropical Storm Rates (NOAA, 2021b)

At least 16 major hurricanes have severely damaged properties and infrastructure in Puerto Rico since late 1893. Following is a summary of the most damaging storm events recorded:

- Earlier historic records for Puerto Rico indicate that six hurricanes and storms with significant effects occurred in Puerto Rico between 1893 and 1956. The San Roque Hurricane of August 1893 caused significant damages to agriculture and port business. The San Ciriaco Hurricane of August 8, 1899 is considered the worst natural disaster in Puerto Rico's history. This great hurricane killed more than 3,300 people, left 25 percent of the island's population homeless, destroyed more than $7 million worth of the coffee, sugarcane and plantain crops (over $225 million in 2012 dollars) (Bush 1995). Since then, several other hurricane events have affected the island, with the San Felipe Hurricane in 1928 leaving no area of the island untouched (Bush 1995). Two hurricanes, San Nicolas in 1931 and San Ciprian in 1932, passed directly over the San Juan metropolitan area. The San Ciprian Hurricane crossed Puerto Rico with winds estimated at 120 miles per hour and caused 225 deaths and losses of $30 million. In September 1956, Hurricane Santa Clara, also known as Betsy, caused 9 deaths and losses estimated at $25 million.

- Hurricane Hugo (1989) passed over the island of Puerto Rico with estimated winds of 140 mph. Hurricane Marilyn (1995) and Hurricane Hortensia (1996) caused severe floods and landslides.

- Hurricane Georges (1998) has been one of the most severe events in terms of wind effects letting long lasting impacts to agriculture and infrastructure. After hurricane Georges (1998) the National Weather Service reported enormous damage to Puerto Rico's utility infrastructure. Electricity was lost to 96% of the island's 1.3 million customers, while water and sewer service was lost to 75% of the islands 1.83 million customers. An estimated $1.6 Billion in damages was caused to municipalities and $233 million in damages to commonwealth agencies. Thus, the total damage in Puerto Rico was estimated at $1.9 billion (National Weather Servive 2012) (FEMA 2012).
- The center of the Tropical Storm Irene (2011) passed through the northeast of Puerto Rico and became a hurricane while moving through the North of Puerto Rico. Winds of hurricane intensity remained on the waters, but the effect of the tropical storm winds and the rains affected a large part of the island. It took more than seven months to the island to recover from the heavy rains, flooding, landslides, and mudslides left by the hurricane. The Government of Puerto Rico and the Federal Emergency Management Agency cited the approval of more than $83.9 million in Federal grants for disaster aid (FEMA 2012).
- In September 2016, Hurricane Matthew generated several cyclonic storm surges that severely impacted the infrastructure of the west coast of Rincón, exposing the municipality's vulnerability (Aponte-Bermúdez, et al. 2017). **Figure 2-17** presents evidence of damages to the Rincón Ocean Club 2, located at Corcega beach in Rincón[10].
- The 2017 Atlantic hurricane season has been the most active in modern history. During 2017, Puerto Rico's coastal communities, critical infrastructure as well as coastal and marine habitats were severely impacted by the devastating power of hurricanes Irma (September 6, 2017) and hurricane Maria (September 20, 2017). **Figure 2-16** presents some damages to infrastructure caused by Hurricane Maria in San Juan Metropolitan area. Hurricane Maria was the second hurricane classified by the National Oceanic and Atmospheric Administration's National Weather Service (NOAA-NWS) as a category five

[10] Figure 1-3 was downloaded from article: Impacto de la erosion costera a la infraestructura de Rincón, Puerto Rico, page 27, Aponte-Bermúdez, et al. 2017

in September 2017, approximately two weeks after Hurricane Irma had affected the northern coast of the Island. Hurricane Maria devastated Puerto Rico's infrastructure, resulted in dozens of deaths, loss of homes, industries, business, and affected the livelihoods of thousands of Puerto Ricans. Response and recovery efforts were initiated and continue after the Presidential disaster declaration was issued on September 20th, 2017. During Hurricane Maria, damages along the coast of Rincón were attributable to the coastal erosion, storm surge, and wave energy. The storm surge overwash and waves were high enough to cause structural damage to upland development and inland flooding. Although most of these structures had sheet piling and/or rock revetment protection, the strong waves pounded the section of coast, causing severe damage to the slab foundation and structure body of the coastal infrastructure. Most of Rincón's coast lost a significant amount of sediment, leaving most of it without a dry sand beach, thus affecting the coast's capacity to withstand another major storm. Extensive debris still remains along the upper reach of the beach affecting beach aesthetics and tourism (U.S. Fish and Wildlife Service, Caribbean Landscape Conservation Cooperative 2019). Figure 2-15a) shows an aerial view of four condominium complexes at Corcega beach[11] in Rincón from 18 JAN 2017, and b) to f) present images of the same structures damaged by Hurricane Maria. Coastal erosion on the north coast of Puerto Rico was exacerbated not only by cumulative wave action associated with hurricanes Irma and Maria but also to the 5-day high energy wave action from Winter Storm Riley in March 2018. **Figure 2-18** shows flooding caused by winter storm Riley at the Ocean Park area in San Juan. shows flooding caused by winter storm Riley at the Ocean Park area in San Juan.

- During the month of August 2019, the Ocean Park coastline in the San Juan Municipality experienced one of the most severe erosion events on the past four decades. Between July and August 2019, researchers in the area documented approximately 91-foot-wide loss of beach and significant vertical loss of sand in some areas of Ocean Park. **Figure 2-19** shows beach erosion and exposed seawalls foundations. Analysis of historical data and the effects of the energy deficit of the North and Northwest during the winter 2018-2019 suggest that the transport of the bottom sediment (Offshore-Onshore) or the sediment from the west to the east on the beaches of Ocean Park did not occur and that this sediment was therefore not available in the nearby coastal area to be deposited by the low-energy swell associated with the summer. Analysis of historical data and the effects

[11] Figure 1-5 a) was downloaded from article: Impacto de la erosion costera a la infraestructura de Rincón, Puerto Rico, page 27, Aponte-Bermúdez, et al. 2017

of the energy deficit of the North and Northwest during the winter 2018-2019, suggest that the transport of the bottom sediment (Offshore-Onshore) or the sediment from the west to the east on the beaches of Ocean Park did not occur and that this sediment was therefore not available in the nearby coastal area to be deposited by the low-energy swell associated with the summer.

Figure 2-15. a) Damages to the Rincón Ocean Club 2 condominium caused by Hurricane Matthew, September 2016. b) Close view of failed seawall and exposed foundation

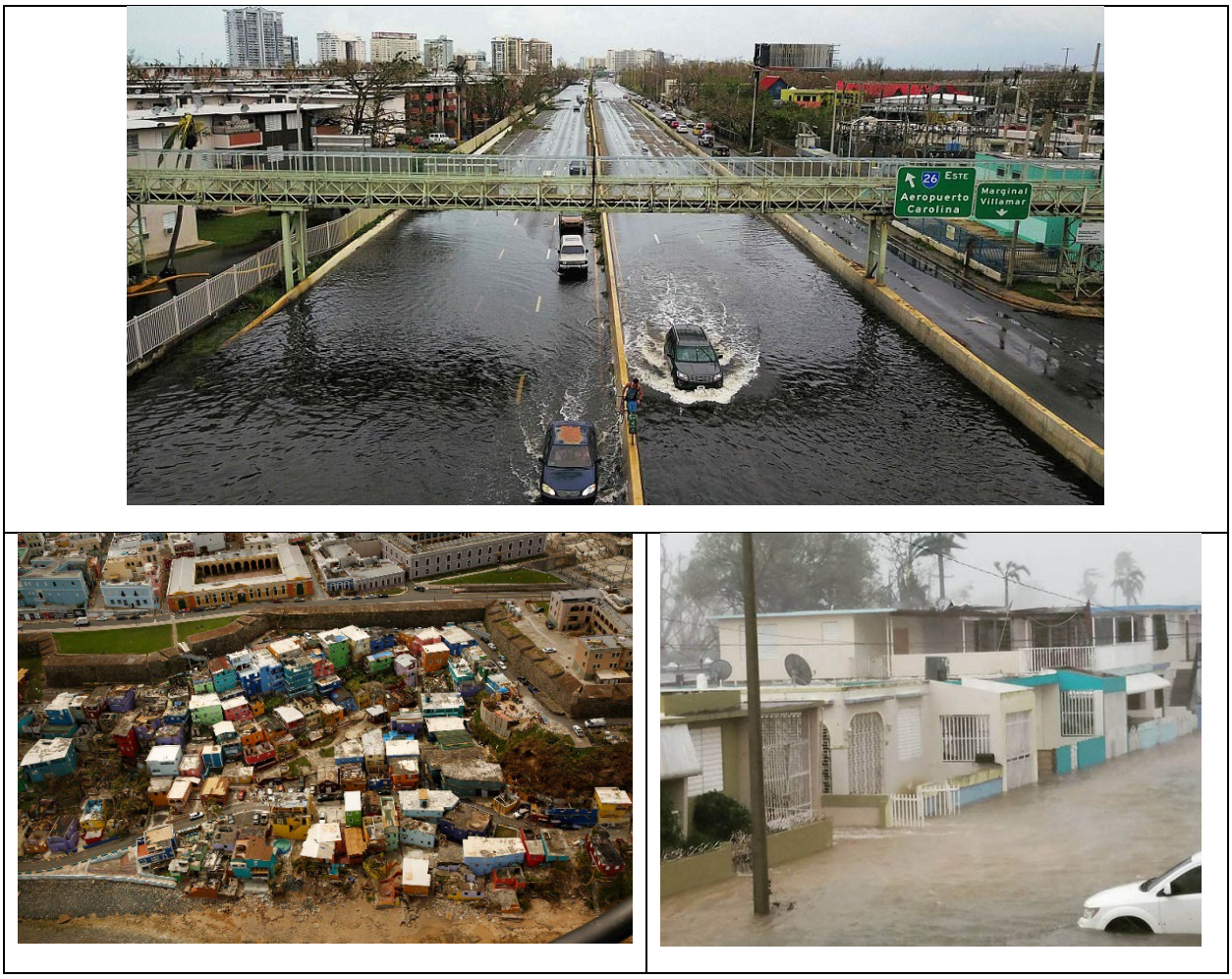


Figure 2-16. Damages due to Hurricane Maria in San Juan Metropolitan Area

Figure 2-17. Severe damage to properties generated by Hurricane Maria in Rincón

Figure 2-18. Flooding caused by winter storm Riley at the Ocean Park area in San Juan

Figure 2-19. Severe erosional event in Ocean Park, San Juan, August 2019

FUTURE WITHOUT-PROJECT CONDITION

Future SLC is expected to exacerbate the impacts of coastal flooding and wave attack as those forces would be occurring at a higher starting water level in the future as sea level changes. This will result in storm effects reaching further inland. An increase in storm events will likely also have detrimental impacts on coastal flooding, beach erosion and wave attack.

2.4.4 SHORELINE CONDITIONS AND EROSION RATES

EXISTING CONDITIONS

The following brief discussions are subsets of more detailed conditions, which can be found in **Appendix A, Engineering.**

The Ocean Park planning reach extends from Punta Piedrita east about 2.5 miles to west of Punta Las Marías. Punta Piedrita and Punta Las Marías are both part of a headland system, where there is little to no dry beach during most parts of the year, which is a typical condition of seasonal beaches. The central beach spans approximately 1.1 miles where the widest part of the beach is roughly 280 ft wide. Sparse dunes with upland vegetation along 0.2 miles of the central beach range from 10-15 ft above MSL. The middle section of this focus area includes a public park (Barbosa Park, known as the Ultimo Trolley), which is historically known to experience extensive coastal inundation driven by large waves and storm surge. The entire planning reach includes a mixture of single-family homes, condominiums, commercial structures, and hotels.

The Rincón planning reach extends from Quebrada Los Ramos, reference R11 (**Figure 1-2)**, south to include Stella about 1.4 miles to R22, ending at Corcega. It is characterized by narrower beaches with damaged/abandoned homes, some physically in the water, to the south (Corcega). This area is a mixture of single-family homes, condominiums, commercial structures, and hotels. Seawalls, revetments, and non-engineered armoring front a majority of the homes and hotels in this focus area.

Long-term shoreline changes (erosion or accretion) for a particular area is best defined by continuously repeated (i.e., yearly, every five years, every decade, etc.) topographic and bathymetric surveys collected in the same location. However, such data were not available for the study areas. Due to the lack of repeated physical survey data, a combination of referenced work, USACE LiDAR, historical aerials, and Google Earth Imagery were used to define the long-term erosion in Rincón and Ocean Park planning reaches.

Long-term shoreline response (erosion or accretion) in San Juan is generally minor compared to Rincón. San Juan results indicate no change at headlands over the past 90 years and minimal shoreline erosion in much of the pocket beach centers. **Table 2-2** presents the long-term erosion rates by modeling reach for Ocean Park (positive values denote accretion and negative values denote erosion). For Rincón planning reach, the overall long-term erosion rates used in the modeling effort is shown as the average in **Table 2-3,** where positive values denote accretion and negative values denote erosion.

Table 2-2. Long-Term Erosion Rates by Modeling Reach in Ocean Park planning reach.

Project Segment	Model Reach	Historical Background Change Rate (ft/yr.)	Storm Induced Change Rate (ft/yr.)	Calibrated Beach-*fx* Applied Erosion Rates (ft/yr.)
Ocean Park	E01	-0.24	-1.419	1.207
	E02	-1.34	-1.449	0.071
	E03	-2.44	-1.449	-1.020
	E04	-2.25	-1.927	-0.342
	E05	-0.05	-2.118	2.015
	E06	-0.05	-2.118	2.015
	E07	-0.69	-0.83	0.168
	E08	-1.34	-0.83	-0.568
	E09	-1.40	-0.263	-1.137
	E10	-1.39	-0.362	-1.031
	E11	-1.11	-0.366	-0.760
	E12	-0.79	-0.366	-0.426
	E13	-0.73	-0.366	-0.379
	E14	-0.73	-0.362	-0.368
	E15	-0.73	-0.362	-0.368
	E16	-1.43	-0.362	-1.159
	E17	-1.30	-0.362	-0.966
	E18	-1.89	-0.362	-1.626
	E19	-2.53	-0.362	-2.259
	E20	-1.15	-0.362	-0.875
	E21	-0.57	-0.362	-0.235
	E22	0	-0.263	0.263

Table 2-3. Long-Term Erosion Rates by Modeling Reach in Rincón planning reach.

Project Segment	Model Reach	Historical Background Change Rate (ft/yr.)	Storm Induced Change Rate (ft/yr.)	Calibrated Beach-*fx* Applied Erosion Rates (ft/yr.)
Rincón	R11	-2.063	-10.227	-2.261
	R12	-2.067	-9.575	-2.234
	R13	-2.203	-10.227	-2.299
	R14	-1.999	-10.227	-2.242
	R15	-1.993	-9.575	-2.209
	R16	-1.874	-9.575	-1.804
	R17	-1.947	-10.227	-2.227
	R18	-1.946	-9.575	-2.183
	R19	-2.542	-9.575	-2.753
	R20	-2.868	-9.575	-2.985
	R21	-2.601	-9.575	-2.767
	R22	-2.218	-10.227	-2.306

FUTURE WITHOUT-PROJECT CONDITION

The natural shoreline should experience similar rates of erosion and accretion in the future without-project condition as described in the existing conditions section above. Existing armor (seawall, revetment, etc.) in some of the reaches is preventing erosion from proceeding landward from the armored point extending landward. However, in 2018, the DNER issued a directive prohibiting permits to build new seawalls, and revetments of any kind that may affect sandy beaches and beach dynamics, particularly on highly visited touristic-recreational and/or sea turtle nesting beaches. Therefore, in the future without-project condition, erosion would be expected to increase if revetments fail and cannot be replaced.

The natural shoreline around Ocean Park planning reach will continue to experience seasonal shifts in sand. The Rincón planning reach will continue experiencing erosion due to coastal processes. In the future without-project condition damages will continue to occur due to storms, and sea level change.

2.4.5 WINDS

EXISTING CONDITIONS

The study area lies within the tropical trade wind zone, resulting in moderate winds from a prevailing easterly direction all year long. Increased north-northeast winds during fall, winter, and spring seasons

primarily occur from Extra Tropical (ET) cyclones in the mid- to northern-Atlantic Basin. Extreme conditions from tropical systems generally impact the island in the summer and fall months.

For the San Juan study area two stations were used to assess the general wind climate. The National Data Buoy Center (NDBC) Station #41053 located just off the San Juan coastline (18° 28.4' N, 66° 5.9' W) which contains wind data from 2010-2021, and the USACE Wave Information Study (WIS) Station #61019 (approximately 37 miles north of San Juan at 19° 0.0' N, 66° 0.0' W) which is the closest WIS station to the San Juan study area with record from 1980-2020.

Records from WIS station #61019 show that the prevailing wind direction is from the east (about 66.6% of occurrence at an average speed of 15.9 mph). Approximately 94% of the WIS wind records from 1980-2020 were from the northeast (NE) to southeast (SE) quadrants. Average wind speeds during this time top out around 16.4 miles per hour (mph) from the east-NE quadrant.

For the Rincón study area, records from NDBC station PTRP4 (2012-2021) located 1.7 mi NE of the Rincón study area at 18° 22.0' N, 67° 15.1' W show that the prevailing winds (like San Juan) are from the eastern quadrant, where 79.2% of the wind records come from the NE to SE directions.

Appendix A, Engineering provides the full wind analysis.

FUTURE WITHOUT-PROJECT CONDITION

The future without-project conditions of winds are similar to the existing conditions described above.

2.4.6 WAVES

EXISTING CONDITIONS

The wave energy dissipation that occurs as waves directly impact coastal structures is often a principal cause of infrastructure damage. Wave height, period, and direction, in combination with tides and storm surge, are the most important factors influencing the behavior of the shoreline.

The San Juan study area is exposed predominantly to short period wind-waves with periodic exposure to longer period storm swells. Most of the San Juan study area is protected by offshore reefs, which dissipate some of the ocean-driven waves. Periodic damage to upland development is partially attributable to large storm waves produced primarily by extra tropical storms during the late fall, winter, and early spring months and tropical disturbances during the summer and early fall months.

General wave information for the San Juan study area was obtained from the USACE WIS hindcast database for the Atlantic Ocean, WIS station 61019 located approximately 37.0 miles north of San Juan at 19° 0.0' N, 66° 0.0' W (1980 – 2020). Records show that average wave heights range from 5.9 ft to 7.8 ft. Wave directions are generally from the east (63.7% of occurrence) and northeast quadrants (30.1% of occurrence). A seasonal breakdown of wave heights show that higher wave heights are more frequent in the late fall, winter, and early spring months (November through March) and tend to originate from the northeast and east quadrants. These larger wave heights (average range from 6.8 ft to 7.8 ft) can be attributed to the ET storms that drive large waves towards the study area. Late spring, summer, and early fall waves (April through October), are smaller and originate predominantly from the east (average range from 5.3 ft to 6.1 ft).

A seasonal breakdown of percent occurrence by wave period demonstrates that long period, storm-generated swells are common throughout the year. The late fall, winter, and spring months (November to April) have slightly larger periods indicating the influence of ET storms throughout the months of November through April. None of the dominant wave periods are less than 8.0 seconds.

General wave information for the Rincón study area were obtained from the NDBC Gauge 41115, located approximately 3.5 miles NW of the Rincón study area at 18° 22.6' N, 67° 16.8' W (2011-2021). Records show that average wave heights range from 1.9 ft to 4.1 ft. Wave directions are predominantly from the NNE (90.9% of the records). A seasonal breakdown of wave heights show that higher wave heights are more frequent in winter to spring months (November through March), which can be attributed to the ET storms that drive large waves towards the study area.

Appendix A, Engineering provides additional detail on waves.

FUTURE WITHOUT-PROJECT CONDITION

Future SLC is expected to exacerbate the impacts of coastal flooding and wave attack as those forces would be occurring at a higher starting water level in the future as sea level changes.

2.4.7 ASTRONOMICAL TIDES

EXISTING CONDITIONS

The Puerto Rico Vertical Datum of 2002 (PRVD02) is the official vertical datum of Puerto Rico and will be used as the referenced datum for water level criteria in this study.

San Juan Tides

Tides in San Juan, Puerto Rico are affected by mixed, semidiurnal tidal fluctuations of the Atlantic Ocean with two high and two low tides that occur at different elevations per tidal day. For the San Juan study area, tidal datums were acquired from the NOAA tide station 9755371 (San Juan, La Puntilla) located in the San Juan Bay. The NOAA gauge contains astronomical tide data from November 1977 to present. The mean tide range, the difference between Mean High Water (MHW) and Mean Low Water (MLW), equals 1.11 ft and the spring tide range, the difference between Mean Higher High Water (MHHW) and Mean Lower Low Water (MLLW) is 1.57 ft.

Rincón Tides

Water levels in the Rincón study area are mainly affected by wind and semi-diurnal tidal fluctuations of the Mona Passage connecting the Atlantic Ocean and Caribbean Sea basins. Tidal datums in the Rincón study area vicinity were gathered using NOAA's Mayagüez, Puerto Rico Station 9759394. Elevations from that gauge, which are referred to PRVD02 from the tidal epoch period of 1983 – 2001, are based on a 2-year analysis period ranging from May 2015 – April 2017. The mean tide range equals 1.04 ft and the spring tide range is 1.37 ft.

The **Appendix A, Engineering** provides additional detail on tides.

FUTURE WITHOUT-PROJECT CONDITION

Future SLC is expected to exacerbate the impacts of coastal flooding, tides will produce higher water levels in the future as sea level changes.

2.4.8 BEACH SEDIMENT CHARACTERISTICS

EXISTING CONDITIONS

Historical records indicate that the size and height of dunes along the north coast of Puerto Rico is inadequate in many places to protect human life and coastal property; in part, as a result of decades of massive sand extraction. In 1947, the Beach Erosion Control Study for Punta Las Marías, San Juan, Puerto Rico (U.S. Army Corps of Engineers 1947) documented the removal of sand for commercial purposes. For almost 35 years, large quantities of sand were removed for construction purposes from two locations along the shore of Ocean Park and Isla Verde. The largest borrow pit, about 500 feet in length, was located about one-half mile east of Punta del Medio. At that time, residents of this vicinity attributed erosion of their beach to the removal of sand from this pit. A smaller pit was located about 0.7 mile west of Punta del Medio. It was reported that the volume of sand removed from the beach sometimes amounted to 2,000 cubic meters (about 2,600 cubic yards) a day. The Carolina beach is also of special interest because of massive sand extraction in the 1950's for airport construction and the intense erosion reported during 1960-1980 (Island Resources Foundation, Virgin Islands 1983). This practice has been officially discontinued, but the negative impacts to the beach and dune system hasn't been mitigated or repaired.

No beach nourishments have been conducted at any of the beaches in the study areas and as previously described, the beach has been altered from its natural state through sand mining in the past. The existing beaches of San Juan and Rincón were sampled by the USACE team in 2019 to characterize the beach sediments and assess compatibility with the potential sand source material.

The beach composite sample for Ocean Park planning reach was classified as clean, poorly graded, fine-grained quartz sand (SP) with a mean grain size of or 0.21 mm, and a standard deviation of 0.86 phi. The average percentage of fines passing the #230 sieve is 2.29. The average visual shell percentage is 20%, with a range from 8.7% through 43.8%. The typical moist Munsell Color value is 6 and color is described as light brownish gray.

The beach composite sample for Rincón planning reach was classified as clean, poorly-graded, fine-grained quartz sand (SP) with a mean grain size of or 0.34 mm, and a standard deviation of 0.97 phi. The average percentage of fines passing the #230 sieve is 0.85%. The average visual shell percentage is 27%, with a range from 8.7% through 38%. The typical moist Munsell Color value is 5 and color is described as grayish brown.

More details can be found in **Appendix B, Geotechnical.**

FUTURE WITHOUT-PROJECT CONDITION

Without implementing a Federal project, it is expected that the future without-project conditions of the sand composition of the existing beach will be similar to the existing conditions described above.

2.4.9 SAND SOURCE INVESTIGATION

EXISTING CONDITIONS

For San Juan and Rincón study areas, several offshore sand sources and upland sand mines were investigated during the preparation of this feasibility study. The following discussion gives a brief summary of the investigations for some of the key sand sources identified. All investigation can be found in greater detail in the **Appendix B, Geotechnical**. Puerto Rico has no specific requirements for the beach fill quality. However, from an environmental and sustainability point of view the sand placed on the beach should have less than 5% silt, be similar to the sand of the existing beach and free of foreign matter, like rock, debris, and toxic material. The sand sources which are discussed can be referenced in **Figure 2-21.**

Ocean Park planning reach

- **Upland Sand Mines:** The Concretos de Puerto Rico, Inc was investigated, located in Juncos, approximately 30 miles south of San Juan. The Concretos upland sand mine is equipped to produce customized beach compatible sand and has sufficient volume for a 50-year project available.
- **Offshore:** Loiza unverified offshore sand sources - The Loiza unverified offshore sand sources are located approximately 15 miles east of San Juan in water depths of 20-40 feet, likely in the vicinity of submerged environmental resources. At this time Loiza 1&2 are not considered to be viable sand sources for this project.

Rincón planning reach

- **Nearshore:** The Bajo Blanco nearshore sand shoal (Rincón) is located 25 nautical Miles south of Rincón. The Bajo Blanco sand shoal has an estimated volume of 300,000+ CY of sand. Even though the available data shows that the sand deposits from Bajo Blanco are beach compatible, its use as sand source may be deemed unfeasible because of its close proximity to the shoreline and the Tres Palmas Marine preserve.
- **Offshore:** The Cabo Rojo sand source is approximately 1-2 Miles offshore. The material is deemed beach compatible, with no adverse effect on the beach even though the composition is 100% carbonate while the receiving beach has only 30% carbonate. It has beach compatible sand and is 400,000 square yards with a conservatively estimated sand thickness of 6-8 feet resulting in a volume 3 million cubic yards.

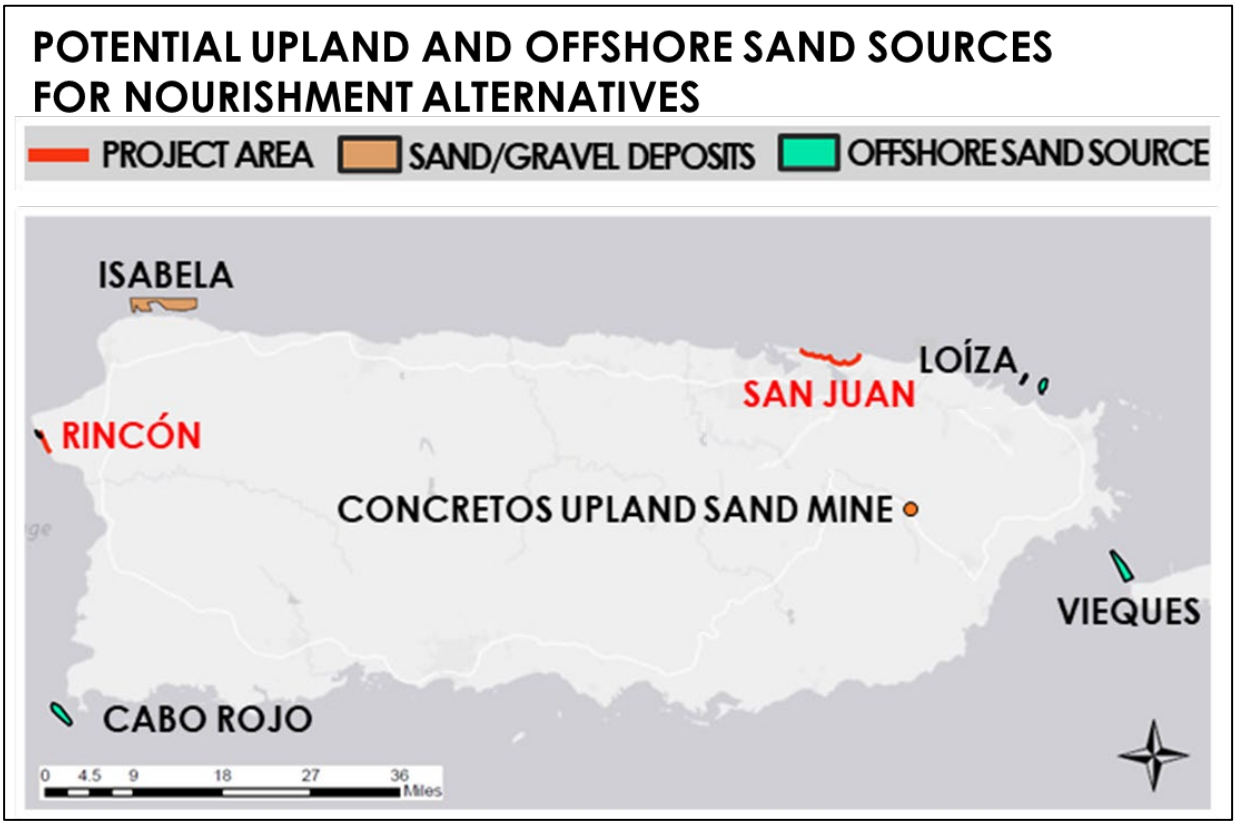


Figure 2-20. Potential Upland and Off-shore Sand Sources Location.

FUTURE WITHOUT-PROJECT CONDITION

In the future, it is possible that these sand sources could be mined by another agency or for another Federal project. However, at this time, there are no construction plans by any agency to use them.

2.5 BUILT ENVIRONMENT

2.5.1 EFFECTS OF OTHER COASTAL STORM RISK MANAGEMENT (CSRM) AND NAVIGATIONPROJECTS

EXISTING CONDITIONS

OTHER CSRM PROJECTS

To date, no other Coastal Storm Risk Management projects have been constructed along the San Juan and Rincón study areas.

OTHER NAVIGATION PROJECTS

San Juan Harbor is a Federal navigation project located about 3 miles west of the San Juan study area. There is no evidence that San Juan Bay inlet or the navigation project affect sediment transport processes in the study area.

FUTURE WITHOUT-PROJECT CONDITION

The future without-project conditions of other CSRM and navigation projects are similar to the existing conditions described above.

2.5.2 EXISTING STRUCTURES AND CRITICAL INFRASTRUCTURE

EXISTING CONDITIONS

The critical infrastructure around the island includes power plants, hospitals, airports, seaports, schools, bridges, roads, shelters and government buildings. Information used to identify the presence of critical infrastructure includes the 2018 Vulnerability Analysis Report, which is part of the Puerto Rico Hurricane Evacuation Study (HES) prepared by the USACE, FEMA and the National Hurricane Center. The Puerto Rico HES Vulnerability Report identifies and map the people and infrastructure exposed to hurricane-induced storm surge. This Vulnerability Report incorporates information from the previous Hurricane Evacuation Study efforts; the 2014 Behavioral Study, the 2015 Shelter Assessment, and the 2016 Hazard Analysis. Critical infrastructure data were captured in years 2016 and 2017 (before the devastating 2017 hurricanes of Irma and Maria) and were provided by the FEMA Caribbean Area Division (FEMA CAD).

In the Ocean Park planning reach, there are 12 structures identified as critical infrastructure, which include police stations, fire stations, hospitals, temporary shelters..

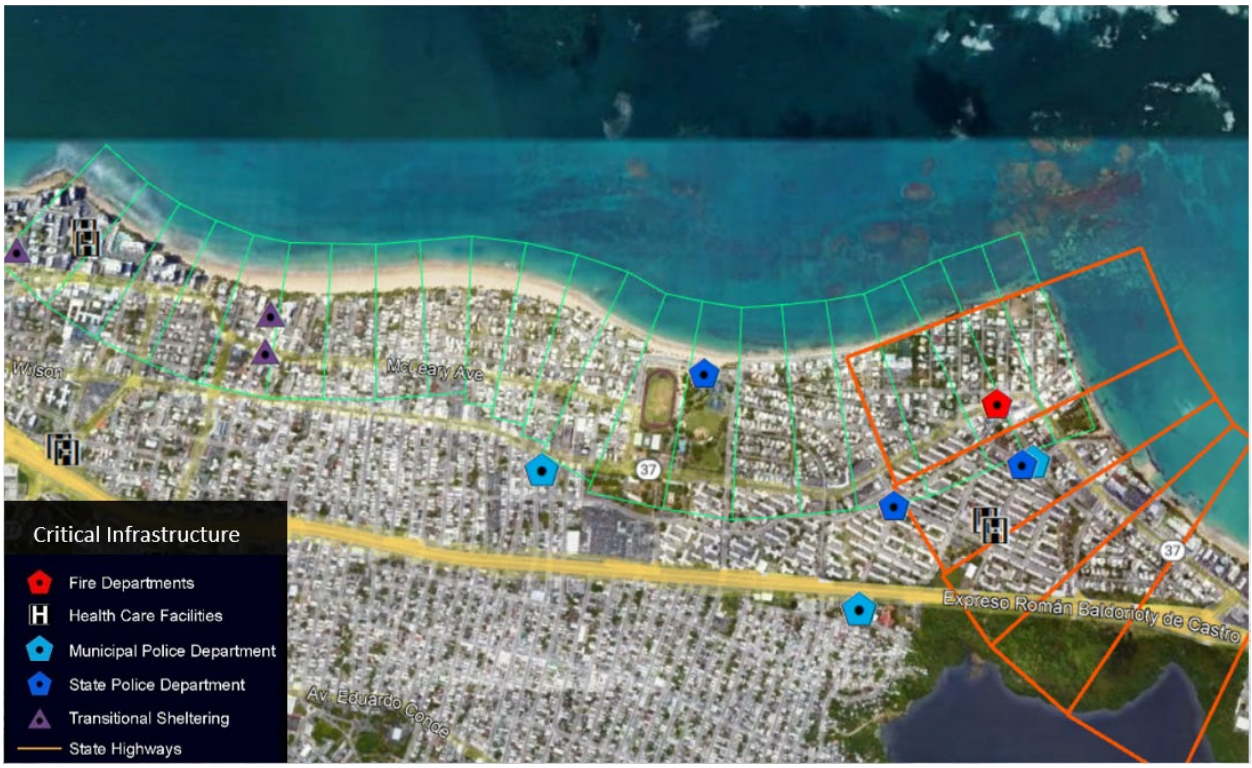


Figure 2-21. Critical Infrastructure within the Ocean Park Planning Reach.

The Rincón planning reach structure inventory does not contain any critical infrastructure on which the area depends, such as hospitals or emergency services. The existing medical centers, fire departments and shelters are located further inland at higher elevations.

FUTURE WITHOUT-PROJECT CONDITION

In the future without-project condition coastal flooding and wave attack would continue to occur, and future increase in sea levels will result in storm effects reaching further inland.

2.5.3 HURRICANE EVACUATION ROUTES

EXISTING CONDITIONS

PR Highway 187, PR Highway 37, and the expreso Loiza PR 26, are the main evacuation routes for the San Juan Metro area. However, these highways are set back from the shoreline making them less susceptible to storm damages. The Puerto Rico Highway and Transportation Authority (PRHTA) maintains these roads and has not expressed interest or need for a Federal project to protect these roads from coastal storm damages.

FUTURE WITHOUT-PROJECT CONDITION

It is assumed that the PRHTA will continue to maintain these roads and they will continue to be effective evacuation routes.

2.5.4 LIFE SAFETY

EXISTING CONDITIONS

There is an existing Puerto Rico Evacuation Plan, in the report titled the "Puerto Rico Hurricane Evacuation Study Vulnerability Analysis", prepared for the Federal Emergency Management Agency (FEMA) in October 2018. In it, evacuation zones are identified as well as shelters. It is assumed that the recommendations in it will be carried out by government officials prior to hurricanes and storm events. It is also assumed that evacuation orders would be in place as required, and to increase life safety and reduce the risk of life loss. Modeling indicates there is currently risk of life loss associated with coastal flooding in the Ocean Park planning reach.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

In the future, it is assumed that prior to hurricanes and storm events, evacuation orders would be in place as required, and followed by communities to increase life safety and reduce the risk of life loss. The non-Federal sponsor may or may not pursue measures such as local outreach and evacuation plan/notification improvement in order to ensure that residents continue to understand evacuation plans, receive notification of evacuation orders, and follow evacuation orders. Modeling indicates there would continue to be the risk of life loss associated with coastal flooding in the Ocean Park planning reach.

2.5.5 COASTAL ARMORING

The traditional response to coastal hazards in Puerto Rico, has been to implement vertical or sloping (revetment-type) coastal structures to protect individual properties. The large number of vertical structures has resulted in negative effects on both the Ocean Park and Rincón Planning Reaches as well as on adjacent coastal areas. The lack of a programmatic approach to shoreline management and protection in Puerto Rico, as well as poorly designed or maintained coastal features, have resulted in extensive adverse effects (e.g., shoreline erosion and inundation) and constant repairing and replacement of failed structures. The most common coastal structures in the focus areas are seawalls and stone revetments. Section 1.2 of The **Engineering Appendix, A** presents a detailed description of the existing coastal features in San Juan and Rincón. Overall, structure inventory at the headlands in San Juan (Punta Piedrita, Punta Las Marías) generally consists of seawalls and rock revetments. The San Juan pocket beaches contain a mixture of coastal protection, but the predominant type is seawall. Specific to Rincón, property owners have implemented unplanned or unproperly designed coastal armoring, commonly referred as manmade protection structures, which don't provide adequate level of protection. The southern part of Rincón study area is characterized for high extent of coastal structures like stone revetments and seawalls protecting private property. Further explanation of the modeling assumptions relevant to coastal armoring is provided in the **Economics Appendix, D. and** present an overview of the existing coastal protection in the Ocean Park and Rincón planning reaches.

2.6 ECONOMIC ENVIRONMENT

The **Appendix D, Economics** fully covers the economic investigations, the modeling efforts, and the benefits evaluations. This section summarizes the existing conditions and the future without project conditions (FWOP) analyses, and includes the results for the 4 planning reaches (Rincón, Condado, Ocean Park and Isla Verde) which were assessed at the resumption of the study in October 2021. This information is important to explain why Condado and Isla Verde planning reaches were removed from further analysis in this study. The benefits assessed under the Future with Project condition (FWP) will be presented in Chapter 3.

- **Existing Conditions:** Includes an assessment of socio-economic conditions, spatial organization of the study area, and an inventory of the coastal infrastructure within the study area.
- **Future Without Project Condition (FWOP):** The FWOP is a forecast of the economic conditions and structure values located within the project area that are subject to the risks associated with coastal processes and coastal storms. The FWOP is the basis for alternative comparison in order to obtain the benefits from any potential Federal project.
- **Coastal Storm Risk Management (CSRM) Benefits:** The benefits are estimated through the future without-project and future with-project condition analysis using Beach-fx and Generation II Coastal Risk Model (G2CRM), while also accounting for risk and uncertainty. Discussion of the ongoing FWP condition will address the management measures and alternative plans evaluated (see Chapter 3).

EXISTING CONDITIONS

Information on the existing economic conditions along the Condado, Ocean Park, Isla Verda, and Rincón planning reaches was collected for economic modeling purposes (Beach-fx and G2CRM). The Carolina focus area appeared to not have the potential for economic justification needed to be moved forward into modeling.

2.6.1 SOCIO-ECONOMIC CONDITIONS

Data from the 5-year 2018 American Community Survey was collected at the census tract level within San Juan and Rincón focus areas. There are approximately 8,000 people living within the Condado, Ocean Park and Isla Verde (census tracts 10, 11, and 12) directly impacted by the proposed alternatives. The average unemployment rate is 8% and average income is $69,576. On average, 17% of the residents live below poverty level.

The socio-economic characteristics of the Rincón Municipality are significantly different from those found in San Juan. The Rincón planning reach impacts primarily census tract 9596. There are about 6,800 people living within Rincón (census tract 9596) directly impacted by the proposed alternatives. Though the unemployment of 8% is similar to the census tracts in San Juan, the level of poverty and median wage is considerably different. The percent of population living below poverty in Rincón, 41%, is over twice that of the average population living in poverty in the San Juan census tracts (17%). The average income in Rincón ($27,432) is less than one-third that of the entire United States' average income ($84,938).

2.6.2 DATA COLLECTION

Economists and real estate specialists have collected and compiled detailed structure information for the four planning reaches (Rincón, Condado, Ocean Park, and Isla Verde). In total, 2,800 assets were collected for economic modeling using Beach-fx and G2CRM.

Real estate professionals from the USACE Savannah District, using geo-spatial parcel data from Puerto Rico's Centro de Recaudación de Ingresos Municipales (Municipal Revenues Collection Center or CRIM), provided detailed data on each structure including geographic location, structure type, foundation type, construction type, number of floors, depreciated replacement value, and approximate foundation height[12].

The study area consists of 25 profiles, and 51 model reaches, and over 100 lots for economic modeling and reporting purposes. This hierarchical structure is depicted as follows:

- **Profiles:** Coastal surveys of the shoreline modified by USACE SAJ Coastal Engineering personnel to apply coastal morphology changes to the model reach level. Specific details can be found in the Engineering Appendix (A).
- **Beach-fx Model Reaches:** Quadrilaterals parallel with the shoreline used to incorporate coastal morphology changes for transfer to the lot level. Each model reach is separately subjected to environmental forcing irrespective of neighboring reaches.
- **Lots:** Quadrilaterals encapsulated within reaches used to transfer the effect of coastal morphology changes to the damage element.
- **Damage Elements:** Represent a unit of coastal inventory in the existing condition and a store of economic value subject to losses from wave-attack, inundation, and erosion damages.

2.6.3 STRUCTURE INVENTORY

The economic value of the existing structure inventory represents the depreciated replacement costs of damageable structures (i.e., damage elements or assets) and their associated contents along the coastline. Real Estate professionals from the USACE Savannah District worked together with economists and planners to provide economic valuations for all of the 2,800 damageable structures and their contents. These damage elements have an overall estimated value of $3.5B (FY23). Content values were established as a ratio to overall structure value. When applicable, content-to-structure ratios were based off the USACE IWR 2012 "*Nonresidential Flood Depth-Damage Functions Derived from Expert Elicitation"* report. Many items in the structure inventory had a content to structure value ratio (CSVR) of 0% (e.g.,

[12] Estimated foundation height was used to establish a structure's first-floor elevation.

roads, dune walks, parking lots). It is also important to note that content valuation considers only those contents anticipated to be at risk from flood, wave, and erosion and, specifically in cases of high-rise structures, may not include total contents. As a result, the average CSVR across the entire study area is roughly 20%. The overall distribution of value by planning reach is summarized in **Table 2-3**.

Table 2-4. Distribution of Structures & Structure Value by Planning Reach

Planning Reach / Model Domain	Most-Likely Structure and Content Value	Most-Likely Average First-Floor Elevation
Condado	**$ 577,820,703**	**16.7**
Isla Verde	**$ 939,282,473**	**10.0**
Ocean Park (First Row)	**$ 228,569,985**	**9.1**
Rincón	**$ 79,450,490**	**9.6**
Ocean Park (Upland)	**$ 1,135,621,653**	**6.6**
Total	**$ 2,960,745,304**	**10.4**

2.6.4 BEACH-FX AND G2CRM MODEL SET-UP

The **Appendix A, Engineering** and the **Appendix D, Economics** provide a complete description of the model set-up and use. Data on historic storms, beach survey profiles, and private, commercial, and public structures within the project area is used as input to the models. The models are then used to estimate future damages resulting from hurricanes and coastal storms. The future structure inventory and values are the same as the existing condition. This approach neglects any increase in value accrued from future development. Using the existing inventory is considered preferable due to the uncertainty involved in projections of future development.

The future without-project damages are used as the base condition against which potential alternatives will be compared. The difference between FWOP and FWP damages are used to determine primary CSRM benefits.

2.6.5 BEACH-FX AND G2CRM MODEL ASSUMPTIONS

Each planning reach (Rincón, Condado, Ocean Park, and Isla Verde) was modeled separately, resulting in four separate modeling databases. This was required due to the complexity of the shoreline shape as well as the differences in the coastal processes subjected to each individual planning reaches. This section describes some key assumptions relevant to the timeframe and discount rate. The rest of the modeling assumptions, such as rebuilding, damage functions, and coastal armoring, are fully explained in **Appendix D, Economics.**

TIMEFRAME AND DISCOUNT RATE

- **Start Year:** The year in which the simulation begins for G2CRM is 2022 in order to capture risk from storms and the associated changes in dynamic inventories between current conditions and the base year. For Beach-Fx the start year was set to 2028. This year

determines the starting shoreline position which will be impacted by standard erosion and storm forces throughout the period of analysis. It is also the starting point for the sea-level rise projections. The reason 2028 was selected was to ensure that, if necessary, hard structures that would come online in the base year, such as break waters, could most accurately be modeled.

- **Base Year**: The year in which the benefits of a constructed Federal project would be expected to begin accruing is 2029.
- **Period of Analysis**: 50 years, from 2029 to 2078.
- **Discount Rate:** 2.25% FY2022 Federal Water Resources Discount Rate. During the development of this report and appendices the FY23 Discount Rate of 2.5% was released. The economic analysis for the FWOP, NED, and TSP will be updated using the updated Discount Rate for release of the final report.
- **Iterations:** The number of iterations run within Beach-fx was decided based on model run time and model stabilization. FWOP simulations were run using 100 iterations in Beach-Fx and 300 iterations in G2CRM. For the preliminary array of alternatives in Beach-Fx, 25 iterations were run for comparison purposes. Once the array of alternatives was whittled down to a final array 100 iterations were run to ensure model convergence.

2.6.6 FUTURE WITHOUT PROJECT CONDITION (FWOP) – BEACH-FX AND G2CRM

This section contains a brief summary of the FWOP damages results per every planning reach (Rincón, Condado, Ocean Park and Isla Verde). **Appendix D, Economics**, contains the full analysis of the FWOP damages, which include the descriptive statistics, damage distribution by structure category and type, spatial distribution of damages, damage distribution by damage driving parameter, temporal distribution of damages, emergency clean-up and evacuation costs, sea level change scenarios, and conclusions.

A brief summary of the models used for each planning reach, driven by the primary damage driver, are listed below, and graphically displayed in **Figure 2-23** and **Figure 2-24**:

- **Rincón (R11 to R22)**- Beach-fx was the primary model due to erosion and wave attack. G2CRM was used but concluded low inundation.
- **Condado (R1 to R10)** – Beach-Fx was the primary model due to erosion and wave attack. G2CRM was used but concluded low inundation
- **Ocean Park (R1 to R22, R15 to R11)** – G2CRM was the primary model due to significant inundation damages. The front row of structures were not modeled due to overlap with Beach-fx, but all other assets in the model domains were included in the model. Beach-fx was the secondary model and was used to model the front row structures due to erosion and wave attack.
- **Isla Verde (R10 to R1)** – Beach-fx was the primary model due to erosion and wave attack. G2CRM was used but concluded low inundation.

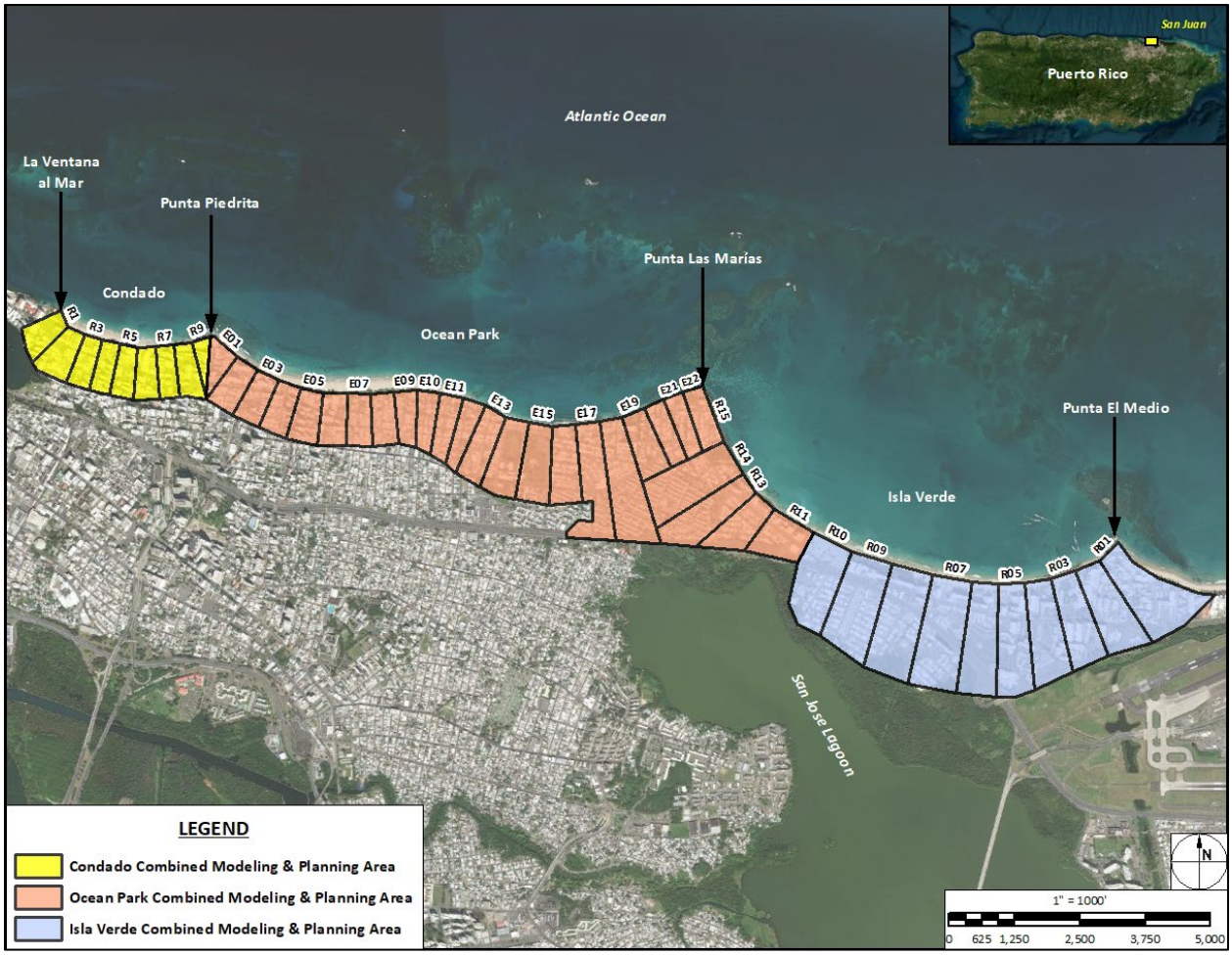


Figure 2-22. Planning Reaches and modeling domains in San Juan.

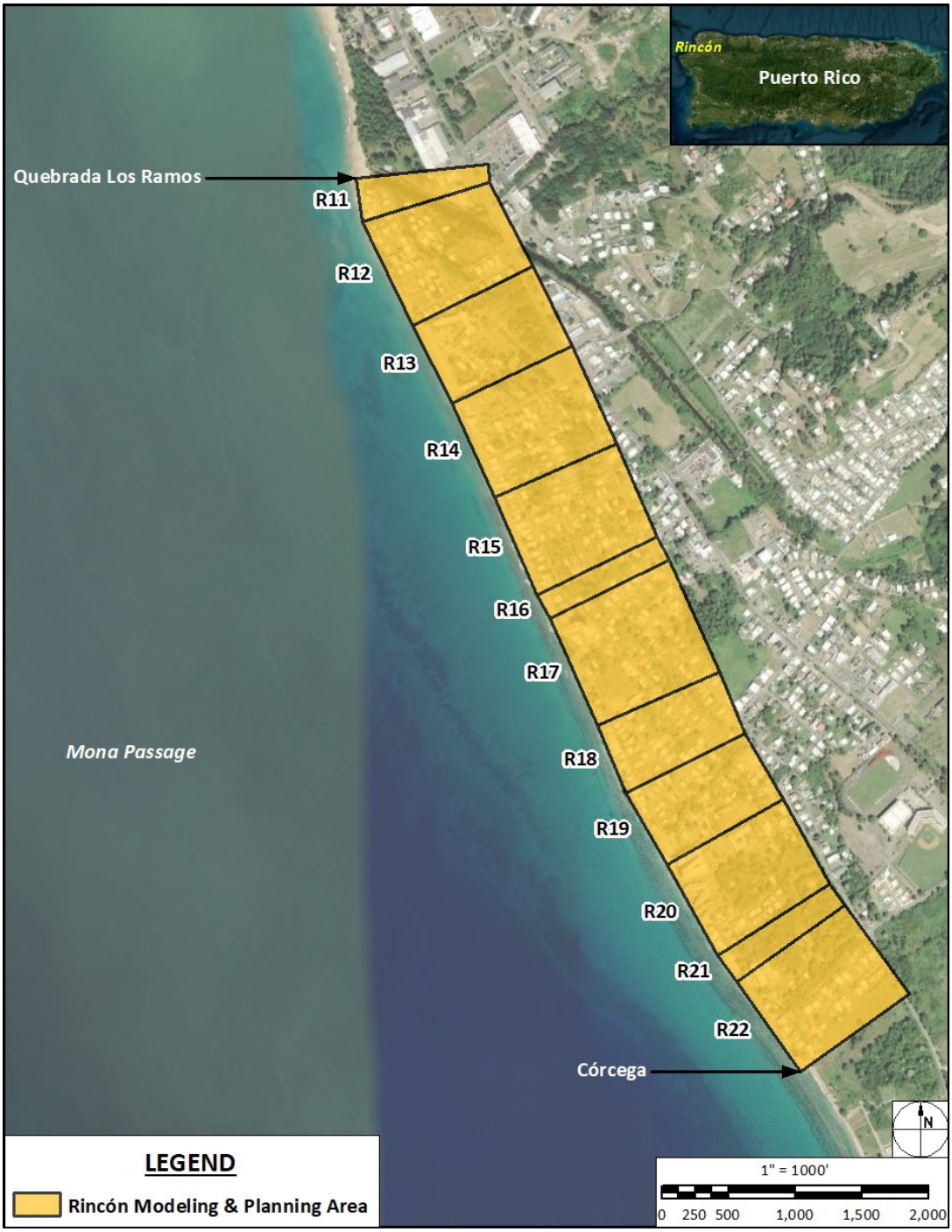


Figure 2-23. Planning Reach and modeling domain in Rincón.

2.6.7 OCEAN PARK FUTURE WITHOUT PROJECT CONDITION (FWOP) OVERALL SUMMARY

Ocean Park is the only planning segment where both Beach-Fx and G2CRM were utilized for plan formulation decisions. Ocean Park has by far the largest amount of damages estimated in the FWOP condition. This is a large focus area and is densely populated with a contingent of single-family and multi-family homes. Many of the structures within Ocean Park have very low first floor elevations (FFE) and make this focus area extremely vulnerable to inundation in the future if no action is taken. Many of these structures are not up to current code (i.e., they are non-conforming structures) due to their FFE positioned below base flood elevation (BFE) in this high-hazard zone.

Average Annual Equivalent damages (AAEQ) per the FWOP model results:

- Mean First-Row Damages (Beach-Fx): $1,461,000 (AAEQ)
- Mean Upland Damages (G2CRM, includes ERCE): $2,960,000 (AAEQ)
- Total Average Damages: $4,421,000

Analysis of Damages:

- **Spatial Distribution of Damages**: The large public space, Barbosa Park, is located in reaches E14 and E15. There is a medical complex, with hospitals and doctor's offices, in the west in reaches E01 to E02. However, damages are very low in reaches E01-E06, accounting for only 2% of total damages. 96% of those damages arise from armor build or repair costs. Moving towards the center of the model domain and just west of Barbosa Park are reaches E07 to E13. This group of reaches has around a third of total damages in the FWOP condition. These damages are primarily to structures and contents, accounting for around 86% in this group of reaches. There are no first-row structures located in Barbosa Park so damages therein are zero. However, this area is a major point of recreational value. To the east of Barbosa are reaches E16 to E22 where the remaining two-thirds of damages occur. As in the reaches just to the west of Barbosa, the damages here are primarily structure and content based, accounting for 91% of the damages. This area is heavily armored in the existing condition with robust seawalls so armor repair or new build costs only account for 9% of the damages.
- **Damages by Damage Driving Parameter**: Overall, FWOP damages in Ocean Park are largely driven by flooding (75%) with wave damages next (13%) and lastly erosion (9%), and armor repair costs (3%).
- **Temporal Distribution of Damages**: Damages are somewhat evenly distributed throughout the period of analysis. The damages are somewhat higher in the later years as inundation and wave levels increase and the impact of cumulative erosion occurs. The drop off in damages near the very end of the period of analysis represents the fact that many of the first-row structures are damaged beyond the 50% threshold and are removed from the inventory.

- **Emergency Clean-up and Evacuation Cost (ERC&E)**: Ocean Park has some of the highest estimated ERC&E damages in the FWOP condition. This is again a result from the structures being mostly residential in nature which increases evacuation risk, which was estimated at $71,000 (AAEQ) in the FWOP. It is also a function of the density of structures in this focus area and each commercial and residential structure is at risk of incurring emergency clean-up costs, which is estimated at $279,000 (AAEQ) for a total combined ERC&E cost of $350,000.
- **Damages in Sea-Level-Rise Scenarios**: Damages in the SLC scenarios show similar patterns as the other focus areas. Damages only increase 13% from the baseline to the intermediate scenario, which emphasizes the high vulnerability of Ocean Park even if the baseline SLC scenario continues into the future. Again, though, damages escalate very quickly in the high SLC scenario and shows an 120% and 94% increase from the baseline and intermediate respectively. All the San Juan focus areas demonstrate an increased vulnerability in the future if sea-level rise begins to track the USACE high curve.
- **Ocean Park FWOP Conclusion**: Total FWOP damages including ERC&E costs are estimated at $4,421,000 AAEQ . There are a total of 7,239 business disruption days. Ocean Park is relatively more vulnerable due to the many structures with low First Floor Elevation (FFE's) and a lower ground-surface elevation across the entire planning reach. Damages in the FWOP increase dramatically in the high SLC scenario but are also very high in the baseline condition indicating a high level of vulnerability for Ocean Park. Based on the FWOP results, the Ocean Park planning reach will move forward for formulation and evaluation of alternatives.

2.6.8 RINCÓN FUTURE WITHOUT PROJECT CONDITION (FWOP) OVERALL SUMMARY

The Rincón planning reach extends from R11 to R22.

Average Annual Equivalent damages (AAEQ) per the FWOP model results:

- Mean Structure, Content, Armor Damage: $1,010,900 (AAEQ)
- Average ERC&E Costs: $0 (AAEQ)

Analysis of Damages:

- **Damage Distribution by Structure Category and Type:** The majority of the damage is structural in nature. Structure damages account for 75%; content damages are 19% of the damages; and armor/repair cost are 7% of the total damages for the FWOP.
- **Spatial Distribution of Damages**: FWOP damages are generally consistent across reaches except for model reach R18 which accounts for 28% of all damages. Most important is the fact that the first row of structures across all reaches are exposed to high levels of risk in

the future. Most of these structures face future a situation where erosion causes enough damage where rebuilding becomes non-feasible, leading to condemnation by local government due to safety reasons.

- **Damages by Damage Driving Parameter**: Damages are largely driven by flood and erosion damage. Erosion: 88%, Inundation: 5%, Wave Attack: 0%, Armor Repair Cost: 6%.
- **Temporal Distribution of Damages**: FWOP damages occur early in the period of analysis. The severity of erosion, which leads to condemnation of the structure by local government (due to structural failure from erosion), peaks in the years between 2037 and 2047. Once structures are condemned they are not subject to repetitive damages, which accounts for the lower risk of damages towards the end of the life cycle.
- **Emergency Clean-up and Evacuation Cost (ERC&E)**: Emergency clean-up and evacuation (ERC&E) costs were not computed for Rincón since flood damages were almost non-existent. Erosion damages do cause debris that requires removal (and thus incurs a cost), however, the evidence in Rincón suggests that in the FWOP the municipality will not remove this debris. This is apparent based on condemned structure debris from Hurricane Maria still in place and is a large portion of the Other Social Effects (OSE) discussion.
- **Damages in Sea-Level-Rise Scenarios**: From the low to intermediate SLC scenario damages have an increase of roughly 14.0% in AAEQ damages. From the intermediate to high scenario damages spike showing an increase of 46%, or roughly $462,000 in AAEQ damage. From the low to high scenario damages increase by 67%. There is very little shift in what drives the damages from the low to the intermediate scenario. In the high sea level change scenario flooding is more of a risk since second row and beyond structures become inundated.
- **Rincón FWOP Conclusion:** FWOP damages are largely driven by erosion damage and are estimated to be $1,010,900 (AAEQ). The majority of the damage is structural in nature. Residential structures account for 64% of all damages with additional repair costs associated with residential armor. Damages in the FWOP increase significantly in the high sea level change scenario. Although the damages are lower relative to the Ocean Park planning reach, this reach is being carried forward for further analysis to better understand if there are potential alternatives whose benefits would outweigh the costs.

2.6.9 CONDADO FUTURE WITHOUT PROJECT CONDITION (FWOP) OVERALL SUMMARY

The Condado planning reach extends from reference R1 to R9. Initial modeling indicated Condado was at very low risk from CSRM damages. After careful consideration and support by the non-federal sponsor, due to this low risk, this planning reach was not carried forward for further analysis. Therefore, the modeling detailed in this report will not be as detailed as other model segments. Damages per the Condado FWOP model results which contributed to these conclusions are as follows:

Average Annual Equivalent damages (AAEQ) per the FWOP model results:

- Mean Structure, Content, Armor Damage: $89,000 (AAEQ)
- Average ERC&E Costs: $0 (AAEQ)

Analysis of Damages:

- **Damage Distribution by Structure Category and Type**: Structure damages account for 23% and Content damages are 13% of the damages, or $20,000 AAEQ, for the FWOP. All structure and content damages are isolated to Reach R02 and primarily attributed to a single structure located on the berm at a very low elevation. The damages occur primarily from wave and inundation. Armor damages are responsible for 77% of FWOP damages, or $68,000 AAEQ. Monetary costs resulting from emergency clean-up efforts and emergency evacuation are responsible for 0% of FWOP damages.
- **Spatial Distribution of Damages**: The Condado modeling area is made up of nine Modeling Reaches and three Planning Reaches. The Planning Reaches (West Headland, Pocket Beach, Punta Piedrita Headland) are areas with distinct engineering characteristics and areas that are separable in their potential for project implementation. The western headland is characterized by a rocky outcropping and heavy existing armor. Early engineering assessments concluded technical feasibility of measures in this area would be difficult due to the need to tie into existing structures on private property as well as the challenges presented by the offshore environment. Additionally, early modeling results indicated an extremely low chance of implementing a cost-effective measure (Damages about $185,000 AAEQ). Therefore, more detailed modeling excluded the Western Headland. Condado Pocket Beach represents the sandy pocket beach where there are many high-rise hotels very near MHW and the presence of armoring is very minimal in the existing condition. Damages in Condado Pocket Beach ($575,000 AAEQ) are the highest total as well as the highest per linear foot ($286 AAEQ). Punta Piedrita Headland is the eastern headland and is also characterized by a rocky outcropping, damages are about $194,000 AAEQ. However, unlike the West Headland, Punta Piedrita Headland is a relatively smaller reach and damages are high in this area per linear foot ($192).
- **Damages in Sea-Level-Rise Scenarios**: The change in damages from the low curve to the intermediate curve has a relatively muted impact, with an estimated increase of only 14%, all of which comes from increases in armor costs. The similarity in structure and content damages results from the fact that a single structure drives the results and therefore damages are heavily reliant on the point in time when the single structure is condemned. Under the high scenario damages increase dramatically as the risk from coastal storms is transmitted into the upland and the impacts from erosion are more acute. FWOP damage goes from $89,000 in the intermediate scenario to $1,793,000 in the high scenario. In the high, 92% of damages are from structure and contents and 91% of those damages are attributable to a single high-value structure. The remaining 8% are for armor repair costs,

of which 55% are attributable to the same single property. It is important to note that ER 1105-2-100, under the section header "Specific Policies", states that, "The Corps will not participate in structural flood damage reduction for a single private property."

- **Condado FWOP Conclusion**: Total damages in the intermediate SLC FWOP condition are $89,000 AAEQ, representing a very low level of estimated risk to infrastructure. Most of the structure and content damages are attributed to a single private structure and the majority of overall damages come from coastal armor construction or repair to a limited spatial extent. Storm risks increase dramatically in the high sea level change scenario as the impacts from erosion increase greatly. Over 90% of all damages in the high scenario accrue to a single private structure. Due to very low risk of damages in this area, and almost all benefits potentially benefiting a single user, this planning reach is removed from further analysis in this study.

2.6.10 ISLA VERDE FUTURE WITHOUT PROJECT CONDITION (FWOP) OVERALL SUMMARY

The Isla Verde planning reach extends from R10 to R1. Early modeling of Isla Verde planning reach indicated very low FWOP damages, estimates at $318,000 AAEQ. After careful consideration and support by the non-Federal sponsor, due to this low risk, this planning reach was not carried forward for further analysis. Moreover, some portion of the actual Isla Verde community was included in the Ocean Park planning reach (R15 to R11) due to the nature of flooding that overlaps in these communities. Therefore, the G2CRM model was the primary model for steering plan formulation and used for those affected areas in Isla Verde, which were included in the Ocean Park planning reach. Thus, this section on Isla Verde, with specific respect to the Beach-Fx modeling, will not have as detailed a description of damages as the previous modeled areas have.

The Isla Verde planning reach was modeled in two different ways. The first way was to include the entire structure inventory in the Beach-Fx model in order to gauge the risk directly related to coastal storm risk from all parameters (i.e., flood, wave, erosion). Separately, the assets that overlapped with the G2CRM Ocean Park inventory were removed and then only the first-row structures were analyzed in order to gauge risk in the same manner as the Ocean Park planning reach. Average FWOP damages for the entire Isla Verde segment in the intermediate are $318,000 (AAEQ).

Average Annual Equivalent damages (AAEQ) per the FWOP model results:

- Mean Structure, Content, Armor Damage: $318,000 (AAEQ)
- Average ERC&E Costs: No modeling of the ERC&E was performed for Isla Verde

Analysis of Damages:

- **Spatial Distribution of Damages**: The Isla Verde modeling area is made up of fifteen Modeling Reaches and three Planning Reaches. The planning reaches are characterized by headland points in the east and west (Punta El Medio and Punta Las Marías) and a wide

sandy pocket beach between the headlands (Isla Verde Pocket Beach). FWOP damages are the lowest of all the focus areas, and as a result, the PDT concluded early on that no-action was the most likely outcome. Based on that decision, the Isla Verde economic analysis will not have as detailed a description of damages as the previous focus areas have. Punta Las Marías reach (East side) damages are around $37,000 AAEQ, Isla Verde Pocket Beach damages are $154,000 AAEQ, and the Punta El Medio (West side) damages are $30,000 AAEQ.

- **Damages in Sea-Level-Rise Scenarios**: Under low SLC, damages were $133,000 AAEQ; under intermediate SLC, damages were $318,000 AAEQ, under high SLC, damages were $2,544,000 AAEQ. It is important to note that 60% of all damages in the high sea level change scenario come from a single reach (R08). Approximately 17% of the damages come from flooding in reaches R11-R15 which is part of the Ocean Park planning reach G2CRM modeling domain and those problems were addressed there for plan formulation purposes.
- **Isla Verde FWOP Conclusion**: Early modeling of Isla Verde planning reach indicated very low FWOP damages, estimates at $318,000 AAEQ. After careful consideration and support by the non-federal sponsor, due to this low risk, this planning reach was not carried forward for further analysis. Moreover, some portion of the actual Isla Verde community was included in the Ocean Park planning reach (R15 to R11) and those flooding problems will be addressed in the study in that reach.

2.6.11 LAND LOSS DAMAGES IN THE FUTURE WITHOUT PROJECT BY PLANNING REACH

Appendix D, Economics, describes the methodology used for estimating land loss. The FWOP land loss was estimated for each applicable pocket beach since these are the only areas not currently armored or armored in the future subject to land loss. For this study, the only reach where land loss is a significant factor across the period of analysis is the Ocean Park Pocket Beach. Over the 50-years approximately 250,000 square feet of land is estimated to be lost in this planning reach which, in FY22 dollars is valued at approximately $17M. The average annual equivalent losses are approximately $561,000 (FY22 discount rate).

3 Plan Formulation & Evaluation

Ocean Park Planning Reach

Rincón Planning Reach

3 PLAN FORMULATION

3.1 PLANNING FRAMEWORK

The purpose of this feasibility study is to develop an implementable and acceptable plan to change the future condition and address specific problems and opportunities[13] in the study area.

Using the initial inventory and forecast of information, or evidence gathering within Chapter 2 as baseline conditions, this chapter explores possible solutions using the USACE plan formulation process.

The Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, established by the U.S. Water Resources Council on March 10, 1983, have been developed to guide the formulation and evaluation studies of the major Federal water resources development agencies. These principles and guidelines are commonly referred to as the "P&G," and will be cited throughout the plan formulation sections of this report.

Benefits and effects of all four accounts (P&G 1983) were considered during the plan formulation process and are summarized below. Per guidance in the memorandum from the Assistant Secretary of the Army, Civil Works (ASA, CW), dated 5 January 2021, Comprehensive Documentation of Benefits in Decision Document, this analysis identifies, analyzes, and maximizes all benefits in the National Economic Development (NED), Environmental Quality (EQ), Regional Economic Development (RED), and Other Social Effects (OSE). This analysis qualitatively describes the impacts associated with the RED, EQ and OSE accounts to include impacts to life safety and local and regional economies and NED benefits are quantified to the fullest extent reasonably possible.

1. National Economic Development (NED) account: Includes consideration of a measure's potential to meet the planning objective to reduce storm damages, as well as decrease costs of emergency services, lower flood insurance premiums, and considers project costs. Costs and benefits used to fully evaluate the NED objective are not calculated at this stage; however, estimates can be made to gauge the overall cost-effectiveness of a measure for this initial screening. Effects of sea-level change and a measure's adaptability to such change were considered under the National Economic Development (NED) account.
2. Environmental Quality (EQ) account: Considers ecosystem restoration, water circulation, noise level changes, public facilities and services, aesthetic values, natural resources, air and water

[13] A problem is an existing undesirable condition to be changed. An opportunity is a chance to create a future condition that is desirable.

quality, cultural and historic preservation, and other factors covered by the National Environmental Policy Act (NEPA).

3. Other Social Effects (OSE) account: Includes considerations for the preservation of life, health, and public safety; community cohesion and growth; tax and property values; and the displacement of businesses and public facilities. For evaluation purposes, the OSE account is inclusive of the planning objectives to maintain a safe evacuation route, and the planning constraint to avoid conflict with legal requirements.
4. Regional Economic Development (RED) account: Considers the potential impacts on the local economy including employment, income, and sales volume.

The NED plan must also be evaluated in consideration of the P&G criteria of completeness, effectiveness, efficiency, and acceptability. Each alternative plan is formulated in consideration of these four criteria:

1. Completeness: Extent to which the plan provides and accounts for all necessary investments or actions to ensure realization of the planning objectives
2. Effectiveness**:** Extent to which the plan contributes to achieving the planning objectives
3. Efficiency: Extent to which the plan is the most cost-effective means of addressing the specified problems and realizing the specified opportunities, consistent with protecting the nation's environment
4. Acceptability**:** Workability and viability of the alternative plan with respect to acceptance by Federal and non-federal entities and the public, and compatibility with existing laws, regulations, and public policies.

The overarching objective was to formulate plans to contribute to coastal resiliency in Puerto Rico. The overall planning strategy was to formulate comprehensives plans for each planning reach to focus on the key measures to reduce coastal storm risk first, and then focus on configuring and refining those measures into alternatives to gain comprehensive benefits towards community resiliency. Following the Assistant Secretary of the Army (ASA,CW) directive from 5 January 2021, the team then identified an NED plan, comprehensive benefits plan, and/or a Locally Preferred Plan (LPP). Due to the nature of these very different study areas, in terms of geographical distances, different problems, and different coastal dynamics, a tentatively selected plan was recommended for each planning reach, as a stand-alone project.

Appendix F, Plan Formulation, gives a full account of the plan formation analysis that occurred during the study. This section in the report gives an abbreviated overview, and **Appendix F** can be referred to more in-depth discussions. A graphic depiction of the plan formulation process for this study can be found on **Graphic Executive Summary Page 1**.

3.2 KEY ASSUMPTIONS

SEA LEVEL CHANGE

- Following procedures outlined in ER 1110-2-8162 and EP 1100-2-1, low, intermediate, and high Sea Level Change (SLC) values were estimated over the life of the project using the official USACE sea level change calculator tool. For the future without-project conditions in the San Juan study area, SLC could be expected to increase by 0.59 ft (low), 1.25 ft (intermediate), and 3.33 ft (high) by year 2078 (50-year period of analysis). For the Rincón study area, sea level could be expected to increase by 0.54 ft (low), 1.19 ft (intermediate), and 3.28 ft (high) by year 2078 (50-year period of analysis) with respect to the above mentioned present local mean sea level tide datum. Future SLC is expected to exacerbate the impacts of coastal flooding and wave attack as those forces would be occurring at a higher starting water level in the future as sea level changes. The intermediate sea level change was chosen to use for plan formulation based on the study areas sensitivity to sea level change and critical flooding thresholds, with consideration of the 5-year average, the 19-year moving average, the sea level change tracker, and relevant literature. The performance of the TSP was also evaluated under all three SLC curves. This approach has been coordinated with the Climate Preparedness and Resilience (CPR) Community of Practice (CoP). More information on the sea level change analysis can be found in **Appendix A, Engineering** and this information is also discussed in more detail in Chapter 2 and 5 of this report.

3.3 SCREENING OF PLANNING REACHES

This section discusses planning reaches, relative to existing conditions and future without project considerations presented in Chapter 2.

- **Ocean Park FWOP Conclusion (E1 to E15 R15 to R11)**: Total FWOP damages including emergency clean-up and evacuation cost **(**ERC&E) costs are estimated at $4,421,000. Ocean Park is relatively more vulnerable due to the many structures with low First Floor Elevation (FFE's) and a lower ground-surface elevation across the entire focus area. Damages in the FWOP increase dramatically in the high SLC scenario but are also very high in the baseline condition indicating a high level of vulnerability for Ocean Park. Based on the FWOP results, the Ocean Park planning reach was carried forward for formulation and evaluation of alternatives.
- **Rincón FWOP Conclusion (R11 to R22):** FWOP damages are largely driven by erosion damage and are estimated to be $1,010,900 (AAEQ). The majority of the damage is structural in nature. Residential structures account for 64% of all damages with additional repair costs associated with residential armor. Damages in the FWOP increase significantly in the high sea level change scenario. Although the damages are lower

relative to the Ocean Park planning reach, this reach was carried forward for further analysis to better understand if there are potential alternatives whose benefits would outweigh the costs.

- **Condado FWOP Conclusion (R1 to R10)**: Total damages in the intermediate SLC FWOP condition are $89,000 AAEQ, representing a very low level of estimated risk to infrastructure. Most of the structure and content damages are attributed to a single private structure and the majority of overall damages come from coastal armor construction or repair to a limited spatial extent. Storm risks increase dramatically in the high sea level change scenario as the impacts from erosion increase greatly. Over 90% of all damages in the high scenario accrue to a single private structure. After careful consideration and support by the non-federal sponsor, due to this low risk, this planning reach was not carried forward for further analysis. As a note, coastal flooding in the backbay areas in the Condado community was addressed in the San Juan Metro Area Coastal Storm Risk Management Study (CSRM). The study recommended an elevated living shoreline to reduce risk of coastal flooding in the Condado area. The project was authorized in September 2021 and is expected to be constructed by 2029. Both the San Juan Metro Area CSRM and Puerto Rico Coastal Study work in concert to improve coastal resilience in Puerto Rico.
- **Isla Verde FWOP Conclusion (R10 to R1)**: Early modeling of Isla Verde planning reach indicated very low FWOP damages, estimates at $318,000 AAEQ. After careful consideration and support by the non-federal sponsor, due to this low risk, this planning reach was not carried forward for further analysis. Moreover, some portion of the actual Isla Verde community was included in the Ocean Park planning reach (R15 to R11) and those flooding problems will be addressed in the study in that reach.

3.3.1 MEASURES OVERVIEW

Management measures are specific structural or nonstructural actions that would take place at geographical locations within the project areas. Structural, non-structural, and natural and nature-based features measures were considered to address problems and to realize the opportunities and planning objectives listed above.

Structural management measures initially considered included: seawalls/floodwalls, revetments (rock), groins, and breakwaters.

Non-structural management measures initially considered included: relocation of critical infrastructure, wet floodproofing, elevation of structures, acquisition of structures and property, as well as measures that could be employed by the non-federal sponsor to include coastal regulatory program, re-zoning, improving public outreach, improved evacuation plan and notification.

Natural and nature-based features initially considered included: beach with vegetated dune, vegetated dune, and artificial reefs.

During the plan formulation process, management measures were preliminarily screened against the four Federal accounts, planning objectives, and planning constraints using a qualitative assessment to first evaluate if they would address the primary objectives to reduce hazards in each reach. From this evaluation, the following measures were carried forward for each planning reach:

- Ocean Park – seawall/floodwall, beach with vegetated dune, acquisition
- Rincón – revetment (rock), groins, beach with vegetated dune, acquisition

3.3.2 THE FOCUSED ARRAY OF ALTERNATIVES

Using the key information as described above in concert with ground elevations and key hazards leading to the highest risk of damages, the focused array of alternatives was formulated and is provided below.

Additionally, all alternatives sufficiently met the completeness, effectiveness, efficiency and acceptability criteria below, as required by USACE policy in ER 1105-2-100.

- Completeness: Completeness is the extent to which the alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planning objectives, including actions by other Federal and non-federal entities. For each alternative, ability of the alternative to provide a complete response to the problem was considered.
- Effectiveness: Effectiveness is the extent to which the alternative plans contribute to achieve the planning objectives. For each alternative, ability of the alternative to a be an efficient solution to meet project objectives was considered.
- Efficiency: Efficiency is the extent to which an alternative plan is the most cost effective means of achieving the objectives. For each alternative, ability of the alternative to a be cost effective solution was considered.
- Acceptability: Acceptability is the extent to which the alternative plans are acceptable in terms of applicable laws, regulations and public policies. For each alternative, ability of the alternative be acceptable was considered.

All floodwall/seawall alternatives in the focused array include inland hydrology measures to allow for outflow of rainfall runoff. The no-action alternative is also carried forward into the final array. Although this alternative does not include any Federal action or risk reduction from hazards as outlined within this study, it provides a comparison for all other alternatives.

Although the key objectives are generally the same in each planning reach, it is important to note that the planning reaches represent very different and unique communities in Puerto Rico. While each planning reach has been defined as a separate unit, the goal is to provide a cohesive storm risk reduction plan for the communities at risk in Puerto Rico, focusing on Ocean Park Planning Reach to improve resilience in the San Juan Metro Area and improving resilience within the entirety of Stella and in the municipality of Rincón.

Each of the alternatives listed below is described further in the subsequent text. Rationale for how each alternative is conceptually considered and how it was further refined for floodwall and beach nourishment alternatives towards the final array is presented further in **Appendix F, Plan Formulation.**

Table 3-1. Focused Array of Alternatives.

Alternative	Description
Ocean Park Planning Reach	
Alternative 1	**No Action**
Alternative 2	**Floodwall with toe protection (E13 to E15, R14)**
Alternative 3	**Floodwall with toe protection (E13 to E15, R14) + beach nourishment with vegetated dunes (E10-E19)**
Alternative 4	**Floodwall (up to E10-E19) + R14**
Alternative 5	**Floodwall with toe protection (E13 to E15, R14) + Acquisition**
Rincón Planning Reach	
Alternative 1	**No Action**
Alternative 2	**Revetment (Rock) R11 to R22**
Alternative 3	**Beach Nourishment with vegetated dunes (R11 to R22) plus groins**
Alternative 4	**Acquisition (R11 to R22)**

3.3.3 FINAL ARRAY OF ALTERNATIVES

This section discusses the final array of alternatives. Details on the engineering modeling and preliminary design assumptions for all alternatives at this stage of the final array can be found in **Appendix A, Engineering** and a more detailed account of the plan formulation can be found in **Appendix F, Plan Formulation.**

OCEAN PARK PLANNNG REACH

Many alternatives were evaluated, with the primary goal of reducing coastal flooding, which makes up the majority of the forecasted FWOP damages in this planning reach. Consideration was also given to addressing erosion and wave attack, although these processes account for a much smaller amount of FWOP damages. The final array of alternatives includes no action, floodwalls at Barbosa Park and the skate park, a floodwall with beach nourishment/vegetated dune, an extended floodwall to reduce erosion, and a floodwall with acquisition of structures and property.

A brief description is outlined below, where **Figure 3-1** can be referenced for a visual representation.

- Alternative 1 would be no action, where coastal flooding continues to occur in the areas shown.

- Alternative 2 reduces the coastal flooding with two floodwalls at 7 ft elevation PRVD02, located at Barbosa Park and the skate park.
- Alternative 3 is the same as Alternative 2 but also introduces a nature-based feature which is a beach and vegetated dune, as shown in yellow and orange, to not only reduce risk of damages due to coastal flooding but also to reduce risk of damages due to erosion.
- Alternative 4 is the same as Alternative 2 but also introduces a structural measure which is an extended floodwall to reduce not only damages due to coastal flooding but also due to erosion.
- Alternative 5 is the same as Alternative 2, but also introduces a non-structural measure and nature-based feature which is acquisition of structures and property to the west of Barbosa Park and restoration of those parcels to a natural beach.

Table 3-2. Final Array of Alternatives for Ocean Park Planning Reach.

Alternative	Description
Ocean Park Planning Reach**	
Alternative 1	**No Action**
Alternative 2	**Floodwall with toe protection* (E13 to E15, R14)**
Alternative 3	**Floodwall with toe protection* (E13 to E15, R14) + beach nourishment with vegetated dune**(E10-E19) (***10' Berm with Dune 12' and 20' Wide, nourished every 5 years***)**
Alternative 4	**Floodwall with toe protection* (up to E10-E19***) + R14**
Alternative 5	**Floodwall with toe protection* (E13 to E15, R14) + Acquisition**

*Floodwall would be at an elevation of 7-foot (PRVD02) for all floodwall alternatives shown above. Floodwall construction for Ocean Park Alts 2, 3, 4 and 5 would also require toe protection which is assumed to be rock armoring.

**Elevations of dunes are referenced at PRDV02

***Floodwall construction for alternatives west of E13 would require small initial sand fill for construction feasibility in those areas.

****The floodwall would tie into high ground for all ocean park alternatives, causing them to be constructed slightly beyond the reference points.

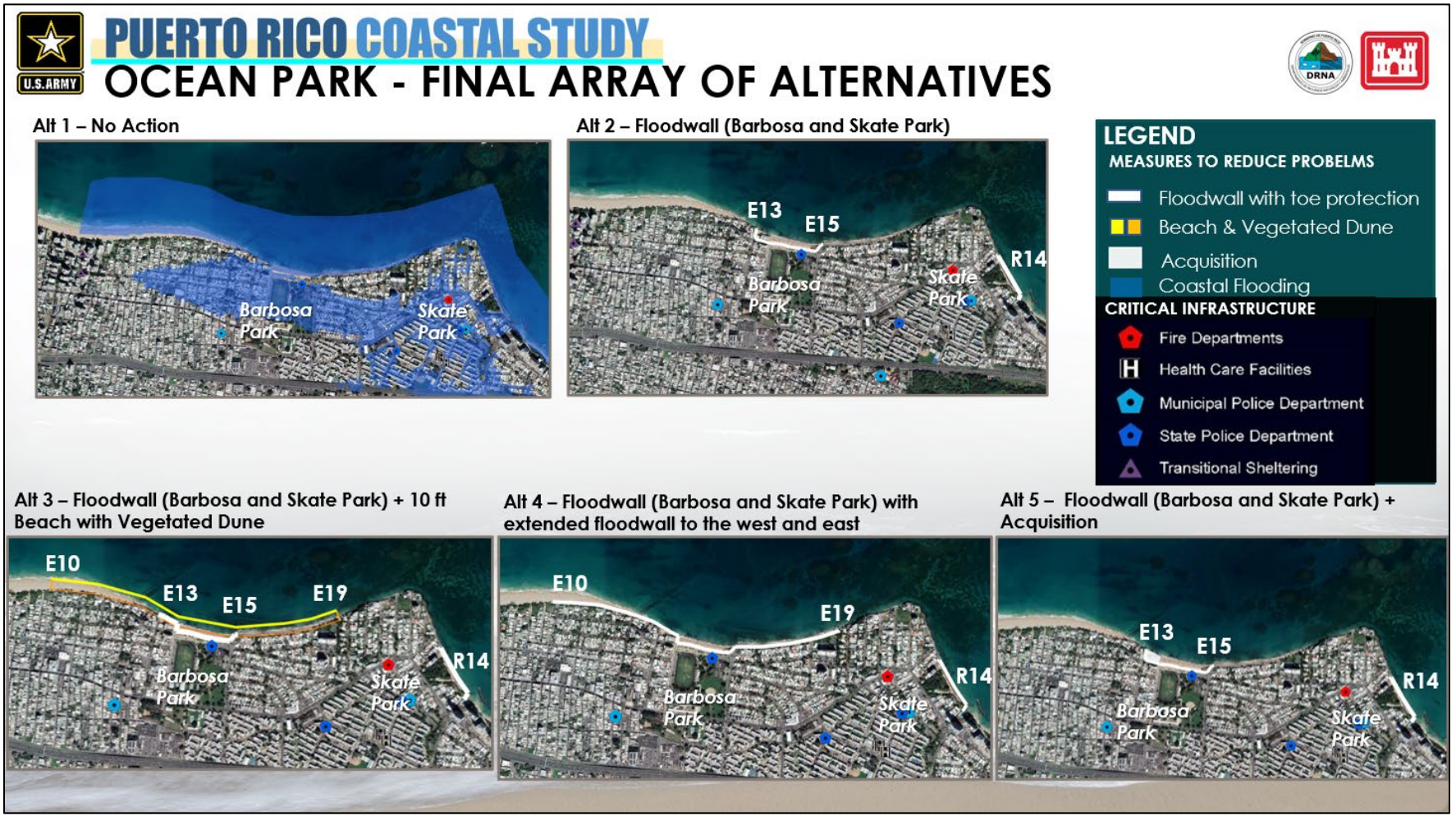


Figure 3-1. Final Array of Alternatives for Ocean Park Planning Reach.

RINCÓN PLANNING REACH

Many alternatives were evaluated, with the primary goal of reducing erosion and wave attack, which make up the majority of the forecasted FWOP damages in this planning reach.

A brief description is outlined below, where **Figure 3-2** can be referenced for a visual representation.

- Alternative 1 is the no action plan. In absence of an actionable plan, individual property owners along the shoreline will likely attempt to reduce risk locally with low-cost, ad hoc solutions such as rock, gabions (metal meshes containing rocks), or seawalls, incurring repeated expense and in many cases, structural failure and condemnation by local government due to safety reasons. Residents will be forced to move, likely out of the area and potentially out of Puerto Rico, reducing not only the strength of the cultural identity of the community but also reducing the tax base and impairing the economy.
- Alternative 2 is rock revetment along approximately 1.3 miles of shoreline, which would stop the line of erosion and reduce the risk of erosion related damages to structures
- Alternative 3 is beach nourishment (10 ft-berm) with small, vegetated dunes and approximately 12 groins along approximately 1.3 miles of shoreline. This would add sand back to this location and to the system. The area would be expected to retain sand for roughly 5 years in combination with the groins before requiring periodic nourishment and would continue on that average cycle for a 50-year period.
- Alternative 4 is acquisition. With this plan, high-risk structures along approximately 1.1 miles of shoreline would be included for acquisition and residents would be relocated. The structures would be demolished, and the land would be returned to its natural sandy state which would include revegetation with native species.

Table 3-3. Final Array of Alternatives for Rincón Planning Reach.

Alternative	Description
Rincón Planning Reach	
Alternative 1	**No Action**
Alternative 2	**Revetment (Rock) R11 to R22**
Alternative 3	**Beach Nourishment with vegetated dunes (R11 to R22) plus groins**
Alternative 4	**Acquisition (R11 to R19)**

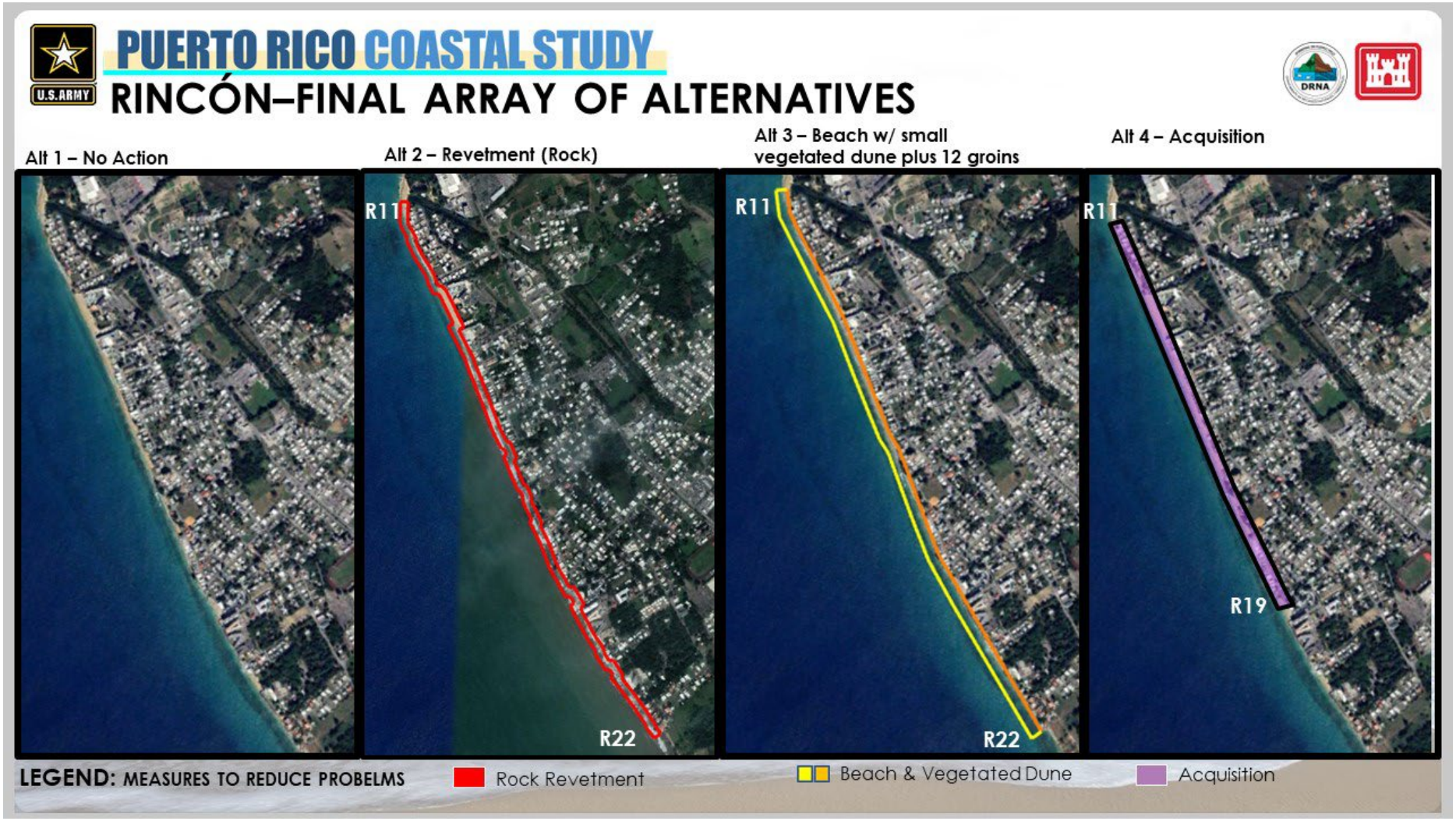


Figure 3-2. Final Array of Alternatives for Rincón Planning Reach.

3.4 EVALUATION OF THE FINAL ARRAY OF ALTERNATIVES

In this stage of the planning process (steps 4 and 5), the focused array of alternatives were qualitatively and quantitatively evaluated against criteria under integrated secondary planning objectives which represented the 4 P&G account (NED, EQ, OSE, RED). Then, the team identified the NED Plan, comprehensive benefits plan and ultimately arrived at a selection of the Tentatively Selected Plan (TSP).

The overarching objective was to formulate plans to contribute to coastal resiliency in Puerto Rico. The overall planning strategy was to formulate comprehensives plans for each planning reach to focus on the key measures to reduce coastal storm risk first, and then focus on configuring and refining those measures into alternatives to gain comprehensive benefits towards community resiliency. Following the Assistant Secretary of the Army ASA, CW directive from 5 January 2021, the team then identified an NED plan, comprehensive benefits plan, and/or a Locally Preferred Plan (LPP). Due to the nature of these very different study areas, in terms of geographical distances, different problems, and different coastal dynamics, a tentatively selected plan was recommended for each planning reach, as a stand-alone project.

Measures that met criteria to be carried forward were combined using the combinability thought process as described earlier, as well as refined geographical elevation information, existing site conditions, and professional engineering judgment as to the most feasible combinations per reach. The P&G four accounts (OSE, EQ, NED, RED) were integrated into the secondary planning objectives during plan formulation of the alternatives, and are discussed below. More in-depth analysis can be found in **Appendix D, Economics**.

3.5 NATIONAL ECONOMIC DEVELOPMENT

Alternatives were evaluated for their ability to maximize primary objectives, reducing risk of damages under the coastal storm risk management mission area. Alternatives were also evaluated for their contribution to recreation under this account.

3.6 OTHER SOCIAL EFFECTS

Key areas of focus were considered in the Other Social Effects (OSE) account. In this account, life safety considerations were paramount, and the robustness of measures in terms of life safety considerations were most fully considered. Life safety was considered as the most paramount criteria in areas where life safety was assessed to be high risk. Other focus areas of consideration included design heights, which looked at the most realistic scenarios in terms of water level under annual exceedance probabilities and public acceptability of height of structures. Available land was another key focus area. In an urban setting, available land is important and as such, the footprints of various measures would need were therefore considered.

LIFE SAFETY CONSIDERATIONS

There is an existing Puerto Rico Evacuation Plan, and in the future in absence of a Federal project, it is assumed that the Evacuation Plan will be carried out by government officials. It is also assumed that evacuation orders would be in place as required and followed by communities prior to hurricanes and storm events to increase life safety and reduce the risk of life loss.

When considering potential alternatives and the effects they may have after construction, however, the assumptions when comparing the future without-project condition to the future with-project condition

may change. Building new features to reduce damages to structures will reduce the risk of damage to structures and should also increase life safety as well; however, evacuation plans and evacuation orders should still be followed. However, if evacuation plans are not followed, in the case of failure of a structure, water piled behind the structure would have the potential to put life safety at risk. This risk was carefully considered during the plan formulation process. In areas where life safety may be at a higher risk due to factors such as low lying elevations, structures on grade (rather than raised), and existing waterways in the area, certain measures are lower risk than others. For any floodwalls/seawalls, inland hydrology features would have to be implemented as associated features to ensure that rainfall runoff would continue to drain properly through the new feature to ensure continued life safety. Life safety due to coastal flooding was a key point of analysis in Ocean Park.

DESIGN HEIGHT CONSIDERATIONS

The team performed due diligence to ensure that likely scenarios were forecast during preliminary design, to provide reasonable assurance that the top of the feature would not be overtopped. To produce risk-based design elevations for the desired measures the study team followed ECB 2019-15 and ER 1105-2-101. ER 1105-2-101 states the assurance, also known as conditional non-exceedance probability, is based on the uncertainty in the flow and stages associated with a given exceedance probability event. This study utilized the 90% Confidence Intervals (CI) from Federal Emergency Management Administration (FEMA) to incorporate the total water level uncertainty. To represent the design elevation, the study used the 90% CI of the 1% AEP event with mean higher high water (MHHW) and the intermediate sea level Change (SLC) out to the end of the assumed period of analysis (2079). The team analyzed the stage-damage output from the future without-project (FWOP) G2CRM model runs to confirm that the design elevations would provide sufficient damage reduction to each planning reach. The team assumed the average design elevation to be between 6.5 to 8.5 feet PRVD02 during this stage of the planning process. To incorporate sea level change, the intermediate curve was chosen for plan formulation, based on trends for 5-year and 19-year MSL moving average. Sensitivities for the high SLC curve were conducted and are discussed in the risk and uncertainty section of the main report.

PUBLIC ACCEPTABILITY

Public acceptability was an important consideration within the communities in the study area. One aspect of this is the height of the feature. The team performed due diligence, as discussed earlier to provide reasonable assurance that the top of the feature would not be overtopped. However, the team also took into account existing community features as much as possible and kept public acceptability and aesthetics of the viewshed in mind. Another key aspect of public acceptability, as discussed in Chapter 2, is that many of the reaches in the study area offer important opportunities for community gathering and recreation. Maintaining access to those opportunities were also kept in mind during formulation.

URBAN SETTING AND LAND CONSIDERATIONS

Several alternatives have wide variations in terms of the bottom width, or footprint they would require, translating to needed land in a higher urban setting. Available land and avoidance of excessive land acquisition was considered with along with several other factors as mentioned during plan formulation.

3.7 ENVIRONMENTAL QUALITY CONSIDERATIONS

The environmental quality account considers non-monetary effects on ecological, cultural, and aesthetic resources. Under this account, the preferred plan should avoid or minimize environmental impacts and

maximize environmental quality in the project area to the extent practicable considering other criteria and planning objectives. For the purposes of alternatives analysis, all action plans were compared to the future without-project condition (i.e., NEPA No Action), which factors in 50 years of sea level change (to 2079). Effects for each alternative were evaluated and were carefully considered during plan formulation and for selection of the tentatively selected plans for both Ocean Park and Rincón.

Similar to the land considerations discussed above, effects to environmental resources in the area were also dependent in some cases on the footprint of the various alternatives, with tradeoffs as well in some cases. During plan formulation throughout the alternatives analysis, creation of habitat, avoidance of impacts to habitat, as well as loss of habitat (resulting in mitigation) were accounted for, factored into plan selection, and are documented in this report. In both Ocean Park and Rincón, environmental resources are offshore, indicated by recently obtained environmental surveys. Information from these surveys allowed full consideration of the effects of each alternative, which are discussed in Chapter 4.

3.8 ECONOMIC CONSIDERATIONS

The national economic development (NED) is considered in terms of the function of the feature and how well it will reduce the risk of damages to structures, thus providing monetary savings or benefits to the nation when compared to the costs of constructing and maintaining the feature. Recreation is important within each planning each, and both maintaining and improving recreation while reducing damages from coastal storms was a very important consideration during plan formulation. Similarly, regional economic development (RED) is considered in terms of how the feature may contribute to the local economy. In both reaches, evaluating contributions to tourism was a key part of the evaluation.

4 Environmental Effects & Consequences

Ocean Park Planning Reach

Rincón Planning Reach

4 ENVIRONMENTAL EFFECTSAND CONSEQUENCES *

This section is the evaluation and rationale of environmental effects that would result from the final array of alternatives and implementing the TSP. Resource category descriptions in Chapter 2 provide information on existing conditions as well as effects resulting from the "no-action alternative," or the "Future Without-Project Conditions."

4.1 FINAL ALTERNATIVE ARRAY COMPARISON

The following presents the effects assessment results utilized to support screening of the final array of study alternatives. Direct permanent and temporary effects of the final array are fully described in Appendix G, Attachment 1. Temporary effects were not assessed quantitatively with the Habitat Equivalency Analysis (HEA) tool, as existing land use and ecosystem conditions would return as construction is completed or shortly thereafter. Permanent effects were assessed with the HEA tool to determine how much compensatory mitigation would be needed, or if there would be residual EQ benefits for a given alternative. Indirect effects were discussed as necessary. **Table 4-1** provides a summary of effects.

Table 4-1. Summary of Effects to Resources for the Final Array of Alternatives

	Ocean Park					Rincon			
Resource Category	**Alt-1 (NA)**	**Alt-2 (Floodwall)**	**Alt-3 (Floodwall & Nourishment)**	**Alt-4 (Extended Floodwall)**	**Alt-5 (Floodwall & Acquisition)**	**Alt-1 (NA)**	**Alt-2 (Revetment)**	**Alt-3 (Nourishment w/Groins)**	**Alt-4 (Acquisition)**
Air Quality									
Water Quality									
Shorelines & Native Vegetaion									
SAV									
Hardbottom Habitat									
Essential Fish Habitat & Nassau Grouper DCH									
ESA Species & Critical Habitat									
Corals, Queen Conch, & *Acropora* DCH									
Fishes									
Sea Turtles									
Antillean Manatee									
Sea Birds & Shore Birds									
Coastal Barrier Resources									
Invasive Species									
Environmental Justice									
HTRW									
Cultural Resources									
Aesthetics & Recreation									
Noise									

beneficial effects
nuetral effects
temporary adverse effects
premanent adverse effects

4.2 EFFECTS OF THE TENTATIVELY SELECTED PLAN

The following section focuses on anticipated changes to the existing environment including direct, indirect, and cumulative effects as a result of the TSP, or the Future With-Project Conditions. The TSP includes Alternative 2 for Ocean Park and Alternative 4 for Rincón:

- Barbosa Park, Ocean Park, San Juan: Floodwall and stone toe protection (1,600 LF); Nearly all of this feature would be placed on old infrastructure and above Mean High Water (MHW). This area would be covered with beach quality sand to maintain aesthetics and habitat.
- The Skate Park, Ocean Park, San Juan: Floodwall and stone toe protection (1,200 LF); Nearly all of this feature would be placed on old shoreline protection and unconsolidated sediments already affected by old and existing shoreline protection. Landward would be covered with beach quality sand to maintain grade, aesthetics, and habitat.
- Stella, Rincón: Acquisition of vulnerable structures and properties. Overtime this would create about 17-acres of shoreline habitat and recreation space.

Temporary and permanent effects of the TSP are fully disclosed in this section and further detailed in **Appendix G, Attachment 1, Attachment 2** 404(b)(1) determination, and **Attachment 4 ESA biological assessments.**

4.2.1 WATER QUALITY

Minor, short-term effects to water quality are expected from the TSP for Ocean Park. These effects include localized increases in turbidity stemming from removal of debris and old shoreline structures, and placement of new clean materials. Turbidity increases are expected to be less of that induced by natural storms and wind driven waves. No effects are expected from the TSP at Rincón. A Section 404(b)(1) analysis (Appendix G, Attachment 1) was conducted in which significant or long-term effects were not determined. It was determined that compensatory mitigation (40 C.F.R. § 230.93) would not be implemented for this action with regards to Clean Water Act compliance. A Water Quality Certification (WQC) in Accordance with Section 401 of the Clean Water Act, as amended, will be obtained and the conditions of this certification will be adhered to as a commitment of the construction of this project.

4.2.2 SHORELINES & VEGETATION

Minor, temporary effects are expected from shoreline modification at Ocean Park. Temporary disturbance to the areas that will receive the floodwall measures stem from removing old infrastructure, debris, and grading slopes. It is anticipated after the floodwalls and toe stone are in place, covered/backfilled with beach sand, and cleaned up there would not be much difference from the existing shoreline conditions in terms of habitat and recreation. No effects to native vegetation or important habitat patches of vegetation are expected from the TSP at Ocean Park. Beneficial, long-term effects to shorelines and vegetation are expected from the TSP at Rincón. The restoration of parcels from residential to natural area would eventually provide 17 acres of beach, small foredune, and vegetation habitat, and beach recreational opportunities.

4.2.3 SUBMERGED AQUATIC VEGETATION

The USACE has completed surveys for submerged aquatic vegetation (SAV), which is provided in **Appendix G, Attachments 5**. In summary, the USACE has determined that there would be no effect to SAV for Barbosa

Park and the Skate Park, Ocean Park and Stella, Rincón. This is based on the alternatives primarily being upland, placed on old infrastructure/shoreline protection, or in unconsolidated sediments. Detailed mapping and surveys conducted in 2023 show that both study areas are highly diverse in SAV habitat and species. This same mapping shows that the TSP does not overlap with SAV habitats or would not cause disturbance to associated species.

4.2.4 HARDBOTTOM HABITAT

The USACE has completed surveys and Biological Assessment for hardbottom habitat, coral species, and other associated biota, which is provided in Appendix G, Attachments 4 and 5. The Mitigation Analysis (Appendix G, Attachment 3) provides further detail on the effects to hardbottom habitat. In summary, the USACE has determined that there would be no long-term adverse effect to hardbottom habitat for Barbosa Park and the Skate Park, Ocean Park and Stella, Rincón. This is based on the alternatives primarily being upland, placed on old infrastructure/shoreline protection, or in unconsolidated sediments. Detailed mapping and surveys conducted in 2022 show that both study areas are highly diverse in hardbottom habitat and species. This same mapping shows that the TSP at Barbosa Park does overlap 0.1 acres of colonized bedrock at this level of design, which is anticipated to be both temporary effects and ultimately avoided with plan refinements made during the design phase. In addition, this area of colonized bedrock is frequently covered by drifting sands, creating a naturally shifting benthic community and coral absent zone.

4.2.5 ESSENTIAL FISH HABITAT

The Essential Fish Habitat (EFH) provisions of the Magnuson-Stevens Fishery Conservation & Management Act are intended to protect those waters and substrates necessary to fish for spawning, breeding, feeding, and growth to maturity. If a proposed action potentially affects EFH, then consultation with NMFS is required. The EFH consultation ensures the potential action considers the effects on important habitats and supports the management of sustainable marine fisheries. Consultation was initiated for this study as it was anticipated in-water alternatives would impart adverse effects to EFH, however, the reassessment of alternatives during second iteration of this study has tentatively selected a plan that does not affect EFH. EFH consultation will be concluded in response to this document.

The USACE has completed surveys and Biological Assessment for EFH and managed species, which is provided in Appendix G, Attachments 4 and 5. The Biological Assessment provides further detail on effects determinations. EFH for this study includes all waters and substrates (coral reef, submerged aquatic vegetation, hard bottom, and unconsolidated sediment) that are necessary for the reproduction, feeding, and growth of marine species. In the Caribbean waters under the jurisdiction of the U.S., EFH is identified and described based on areas where the life stages of 17 managed species of fish and marine invertebrates occur. Fifteen (15) of the 17 managed species have been documented in the study area and are listed in the following table.

Table 4-2. Managed Species Documented in the San Juan & Rincón Study Area

Species	Common Name	SPAG*	FMP
Chaetodon striatus	Banded Butterflyfish		Reef Fish - aquarium trade
Epinephelus guttatus	Red Hind		Reef Fish
Cephalopholis fulva	Coney		Reef Fish
Lutjanus analis	Mutton Snapper	X	Reef Fish
Lutjanus apodus	Schoolmaster	X	Reef Fish
Lutjanus griseus	Gray Snapper		Reef Fish
Ocyurus chrysurus	Yellowtail Snapper	X	Reef Fish
Haemulon plumieri	White Grunt		Reef Fish
Balistes vetula	Queen Triggerfish		Reef Fish
Sparisoma viride	Stoplight Parrotfish	X	Reef Fish
Holocentrus adscensionis	Squirrelfish		Reef Fish
Malacanthus plumieri	Sand Tile Fish		Reef Fish
Panulirus argus	Spiny Lobster		Spiny Lobster
Strombus gigas	Queen Conch		Queen Conch
Cnidarians	All Corals		Coral

Source: Rivera, 2015; CSA Architects & Engineers, 2014; ERM, 2013; Glauco A. Rivera & Associates, 2011. *SPAG: Potential Spawning Aggregation site in San Juan Bay (Ojeda et. al. 2007).

In summary, USACE has determined that there would be no effect to EFH for Barbosa Park and the Skate Park, Ocean Park and Stella, Rincón. This is based on the alternatives primarily being upland, placed on old infrastructure/shoreline protection, or in unconsolidated sediments. Detailed mapping and surveys conducted in 2022 show that both study areas are highly diverse in EFH habitat and species. This same mapping shows that the TSP does not overlap with these essential fish habitats or would not cause disturbance to managed species.

4.2.6 THREATENED & ENDANGERED SPECIES

The USACE has completed surveys and Biological Assessment for ESA species, which is provided in Appendix G, Attachments 4 and 5. The Biological Assessment provides further detail on effects determinations per species. In summary, the USACE has determined that the TSP would have no effect on the Scalloped Hammerhead Shark, Nassau Grouper,, Giant Manta Ray, Elkhorn, Staghorn, Pillar, Rough Cactus, Lobed Star, Mountainous Star, Boulder Star Corals, Acropora and coral designated critical habitat (DCH), and the Antillean Manatee. The USACE has determined the TSP may affect but would not likely adversely affect (MANLAA) nesting Loggerhead, Hawksbill, Leatherback,Green Sea Turtles and Queen Conch. Conservation measures for nesting Sea Turtles and Antillean Manatee would be utilized during construction at Barbosa Park and the Skate Park. Best management practices to protect water quality and habitat would be utilized during construction at Ocean Park and Stella. The TSP for Stella would provide 17 acres of additional nesting Sea Turtle beach and dune habitat. Study area T&E species under jurisdiction of the NMFS and the USACE effects determinations for these species are summarized in **Table 4-3**. ESA Species & Effect Determination Under NMFS Jurisdiction, and USFWS jurisdictional species in **Table 4-4**.

Table 4-3. ESA Species & Effect Determination Under NMFS Jurisdiction

Common Name	Scientific Name	Status	Determination
Sea Turtles			
Loggerhead Sea Turtle	*Caretta caretta*	T	NE
Hawksbill Sea Turtle	*Eretmochelys imbricata*	E	NE
Leatherback Sea Turtle	*Dermochelys coriacea*	E	NE
Green Sea Turtle	*Chelonia mydas*	T	NE
Fish			
Nassau Grouper	*Epinephelus striatus*	T	NE
Scalloped Hammerhead Shark	*Sphyrna lewinii*	E	NE
Giant Manta Ray	*Manta birostris*	T	NE
Invertebrates			
Elkhorn Coral	*Acropora palmata*	T	NE
Staghorn Coral	*Acropora cervicornis*	T	NE
Pillar Coral	*Dendrogyra cylindrus*	T	NE
Lobed Star Coral	*Orbicella annularis*	T	NE
Mountainous Star Coral	*Orbicella faveolata*	T	NE
Boulder Star Coral	*Orbicella franksi*	T	NE
Rough Cactus Coral	*Mycetophyllia ferox*	T	NE
Queen Conch	*Strombus gigas*	C*	MANLAA
***Acropora* and Coral Designated Critical Habitat**			**NE**

*Candidate

Table 4-4. ESA Species & Effect Determination Under USFWS Jurisdiction

Common Name	Scientific Name	Status	Determination
Nesting Sea Turtles			
Loggerhead Sea Turtle	*Caretta caretta*	T	MANLAA
Hawksbill Sea Turtle	*Eretmochelys imbricata*	E	MANLAA
Leatherback Sea Turtle	*Dermochelys coriacea*	E	MANLAA
Green Sea Turtle	*Chelonia mydas*	T	MANLAA
Mammal			
Antillean Manatee	*Trichechus manatus manatus*	T	NE

4.2.7 SEABIRDS AND SHOREBIRDS

Minor, temporary effects are expected from shoreline modification at Ocean Park. Temporary disturbance to the areas that will receive the floodwall measures stem from removing old infrastructure, debris, and grading slopes include noise and visual disturbance. It is anticipated after the floodwalls and toe stone are in place, covered/backfilled with beach sand, and cleaned up there would not be much difference from the existing shoreline conditions in terms of bird habitat. No effects to native vegetation or important bird habitat or vegetation are expected from the TSP at Ocean Park. Beneficial, long-term effects to birds are expected from the TSP at Rincón. The restoration of parcels from residential to natural area would eventually provide 17 acres of beach, small foredune, and vegetation habitat.

4.2.8 INVASIVE SPECIES

No effects from invasive species are anticipated from the TSP. The contract set of plans and specifications would include measures to clean construction equipment before mobilization to the site, which would reduce the potential for the introduction and spread of invasive plant and invertebrate species.

4.2.9 AIR QUALITY

Construction equipment is typically powered by diesel engines. Depending on the size, type, age, and condition of the equipment, various emissions can be expected for the duration of the operation. The project area is compliant with Puerto Rico air quality standards. The proposed construction would occur in areas that experience nearly constant trade winds and sea breezes. In the long term, post construction, air quality is expected to remain as described in the FWOP condition.

The TSP has been analyzed for conformity applicability pursuant to regulations implementing Section 176c of the Clean Air Act. It has been determined that the activities proposed under this proposed project would not exceed de minimis (a level of risk too small to be concerned with) levels of direct or indirect emissions of a criteria pollutant or its precursors and are exempted by 40 CFR Part 93.153. For these reasons a conformity determination is not required for this proposed project.

4.2.10 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

Using an EPA web mapper (https://www.epa.gov/superfund/search-superfund-sites-where-you-live), the proposed project is not expected to encounter HTRW. No HTRW would be released in the project area during or after construction. The project should not impact existing sediment conditions. None of the

construction areas would be affected by HTRW. The proposed project would not change or affect the ability for Federal regulations, U.S. Customs, and Port Security to continue to address the transportation of any HTRW. It is anticipated additional investigations would be conducted in PED prior to construction to ensure no HTRW exists within the project area.

4.2.11 NOISE

IMPACTS OF CONSTRUCTION NOISE ON MARINE LIFE

NMFS is currently developing guidelines for determining sound pressure level thresholds for fish and marine mammals, based on existing studies, the NMFS current thresholds for determining impacts to marine mammals is between 180 and 190 dB re 1 uPa for potential injury to cetaceans and pinnipeds respectively, and 160 dB re 1 uPa for behavioral disturbance/harassment from an impulsive noise source, and 120 dB re 1 uPa from a continuous source. Reine et al (2012) found that the 120 dB re 1uPa proposed threshold was exceeded by ambient noises in their study area. It is unlikely that underwater sound from conventional land-based construction operations can cause physical injury to marine mammals and fish species. Some temporary loss of hearing could occur if the animal remains in the immediate vicinity of construction for lengthy durations, although the risk of this outcome is low. Fish and marine mammals would likely respond to construction by using avoidance techniques. Avoidance is defined as an effect that causes the animal to not occupy an area that is periodically or infrequently occupied. Construction is likely to cause avoidance due to noise (and increased turbidity and other temporary water quality changes). Therefore, construction activities would likely cause the temporary displacement of fish and marine mammals as a response to the noise.

In the long term, construction of the TSP is not anticipated to significantly affect ambient noise levels in the project areas.

IMPACT OF CONSTRUCTION NOISE ON THE HUMAN ENVIRONMENT

There would be a temporary increase in the ambient noise level during the construction phase of the project. The construction would be within 150m of sensitive receptors. However, since construction should not occur in one position for any extended period of time, there will be no disproportionate adverse impact on any communities. Noise generated by this project would not be substantially different from other ambient noise levels of an active harbor and metropolitan area.

4.2.12 COASTAL BARRIER RESOURCES

No effects to coastal barrier resources are expected from the TSP at Ocean Park, San Juan and Stella, Rincón. The TSP does not overlap with coastal barrier resources as described in the Affected Environment Chapter 2. These resources are geographically distant from the project area and no features are to be constructed within the CBRS Units.

4.2.13 CULTURAL RESOURCES AND HISTORIC PROPERTIES

Analysis of potential impacts to historic and cultural resources considered both direct and indirect effects. Direct effects may result from physically altering, damaging, or destroying all or part of a historic or cultural property, or changing the character of physical features within the property's setting that contribute to its historic significance. An effects analysis focuses on the characteristics of a historic property that qualify it

for inclusion in the NRHP and assesses the potential to alter historically significant characteristics and diminish the integrity of a historic property. There may also be cultural resources of value which are not eligible for inclusion in the NRHP. The APE for direct affects was defined as being within and adjacent to the proposed alternatives, as well as staging and work areas.

Indirect effects are reasonably foreseeable effects caused by an undertaking that may occur later in time, be farther removed in distance or be cumulative. In the case of the alternatives, these may include increased development associated with the protection afforded by the alternatives and increased pedestrian traffic along the floodwalls. As discussed in Chapter 2 of this document, there are cultural resources and historic properties recorded near the proposed project and additional resources may be present.

FUTURE WITH-PROJECT

Though background research documented no cultural resources and historic properties within the area of potential effects (APE), a full inventory has not yet been conducted due to project features that will continue to be refined during the pre-construction engineering and design (PED) phase. As such a final APE cannot be defined prior to the completion of this study. Each of the alternatives has the potential to affect cultural resources. The direct footprint of construction may disturb archaeological sites, be a visual intrusion in historic districts, or alter the appreciation of historic structures. The potential exists for archaeological sites in submerged areas, shipwrecks, and additional visual intrusion altering the character of historic districts or structures. The conceptual nature of the plans, lack of clear staging and access areas, and planning timeline prevent a full identification of and effects to historic properties and therefore make a determination of effects. The improvement of resiliency of these areas may serve to protect cultural resources, such as historic structures, as well as the continued use of areas.

Due to limited project designs during the feasibility stage, it is not possible to effectively conduct fieldwork to identify and evaluate cultural resources or to determine the effects of the TSP on historic properties. The TSP has the potential to reduce risk to cultural resources in both reaches but may lead to development. Cultural resources potentially threatened by increase development would continue to be protected by local laws and regulations. Additional impacts resulting from the execution of the TSP are also a potential and will be assesses as project designs are refined and optimized.

Consultation with SHPO and coordination with the ICP and interested parties is ongoing, including review of the APE prior to TSP and SHPO concurrence on the use of a programmatic agreement (PA). These efforts are ongoing. In consultation with SHPO, pursuant to 54 USC 306108, 36CFR 800.4(b)(2), and 36 CFR 800.14(b)(1)(ii), USACE is deferring final identification and evaluation of historic properties until after project approval, when additional funding and design details are available. A PA will be used to ensure compliance with Section 106 of the NHPA. The PA will allow the USACE to complete the necessary archaeological surveys during the PED phase of the project, when a final APE can be established based on the final design, and it will also allow for the identification of historic properties, assessment of effects, and inclusion of measures to avoid, minimize, and mitigate effects to historic properties to be completed after project features have been clearly defined and sited. A draft PA and relevant correspondence are included as **Appendix G** to this report. The current draft will also be provided to the SHPO and the ICP for review during the draft release of this report. The PA will be executed prior to the issuance of a FONSI.

4.2.14 AESTHETIC RESOURCES

The proposed project, during construction, could alter the aesthetic resources of Condado, Ocean Park, and Rincón, and increase recreational opportunities. Although the definition of aesthetics is fluid (see Section 2.2.18), for the purposes of the present evaluation, the principal aesthetic "targets" include the visual perception of Puerto Rico's land- and seascapes, historic features, and certain architecture. The degree to which any adverse feature affects aesthetics is frequently based on scale, position, and proximity relative to the viewer. Temporary impacts to recreational activities during construction and a temporary reduction in the aesthetic appeal during construction are anticipated. However, the CSRM measures could also enhance local aesthetic in the long-term.

As a public safety measure, boating would be prohibited near the operating construction equipment. Recreational access to these areas would return to pre-construction conditions following completion of the project. Although short-term impacts could occur, no long-term adverse effects are anticipated. Information would be provided to the USCG so they could issue a "Notice to Mariners" prior to initiation of construction and for each major change in the construction activities. This would alert public boaters of areas to avoid and the possibility of limited and restricted access. No significant adverse impacts to recreational boating are expected from the proposed project.

4.2.15 ENVIRONMENTAL JUSTICE

The USACE collected and analyzed information to consider the potential impacts of the proposed action on minority and low-income populations. The information and analyses presented below demonstrates that the proposed action complies with Executive Order 12898 and would not cause disproportionately high and adverse impacts to minority or low-income populations.

The CSRM areas of interest is bordered by numerous historically economically disadvantaged communities. Possible factors that could impact these communities include those resulting directly from the construction of the project and the secondary effects that could occur as a result of the shoreline improvements. These factors include, but are not limited to the following:

- Construction equipment through neighborhoods
- Noise from construction
- Air emissions from construction
- Affects to subsistence fishermen
- Increasing exposure to contaminants
- Decreasing water quality

Further, the TSP in Ocean Park is shown to have a large positive impact on historically economically disadvantaged communities as evident in the fact that nearly 40% of the benefits accrue to the most socially vulnerable, many of which are in the 99th percentile of low income. In Rincón, a primary factor driving selection of the TSP were the OSE benefits accruing to the historically economically disadvantaged communities (Reference **Figure 5-1)**.

4.2.16 CONSTRUCTION RELATED IMPACTS

The proposed action consists of a collection of key structural, non-structural and natural features in specific locations in order to increase storm resiliency and flooding within the Ocean Park, San Juan and Stella,

Rincón areas. As such, the construction and operational activities are within the shallow waters of coastal Puerto Rico. The construction and operational work areas are located near residential communities, schools, and hospitals which are situated near the coastal areas of the bay. Impacts from noise, air, and other inconveniences are not likely to significantly impact identified communities. Compared to most large, entirely land-based projects, there is little potential for direct adverse impacts to minority populations, low-income populations, the elderly, or children. The result of the project would provide a benefit to the identified communities, as it will reduce flooding and provide benefits to the coastal communities, such as recreational opportunities. Recreational opportunities include improved access to the coastline, increased natural recreational areas, and improved wildlife and natural communities. As indicated in previous sections of this document, during construction there would be temporary and minor impacts resulting from increase turbidity (decreased water quality) from in-water work. These impacts will be temporary and minor and will not disproportionately impact low-income, minority, juvenile, or elderly populations. Additionally, the potential exists for subsistence fishing along the coast; however, these practices will not be significantly impacted by the proposed project due to the impacts being temporary. The project is likely to increase availability of locations for the local population to fish. No significant impacts to fish populations are expected to result from the construction of the project. In summary, there will not be a disproportionately high or adverse impact on low-income or minority populations resulting from the construction of the project.

4.2.17 PUBLIC ENGAGEMENT DURING CONSTRUCTION

An important component of any project is informing the public at all stages of the project (i.e., planning, design, construction, and maintenance). USACE engaged in public outreach efforts through the media and public information meetings during the feasibility phase (planning phase). USACE will provide a contact information link on the public website for anyone with concerns about, or related to, the project.

4.3 CUMULATIVE EFFECTS

4.3.1 CUMULATIVE EFFECTS ANALYSIS

NEPA, as implemented by Council on Environmental Quality (CEQ) regulations (40 CFR §§ 1500 -1508), requires Federal agencies, including the USACE, to consider cumulative impacts in rendering a decision on a Federal action under its jurisdiction. According to 40 CFR § 1508.7, a *cumulative impact* is the impact on the environment that results from the incremental impact of the proposed project when added to other past, present, and reasonably foreseeable future actions regardless of the agency (Federal or non-federal) or person that undertakes such other actions; cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Due to the small spatial extent, short duration of project effects, and little to no change in land use, no significant cumulative effects are anticipated

5 Plan Comparison & Selection

Ocean Park Planning Reach

Rincón Planning Reach

5 PLAN COMPARISON AND SELECTION

5.1 PLAN COMPARISON

OCEAN PARK PLANNNG REACH

An extensive analysis of all effects, both positive and negative, under NED, EQ, RED and OSE was conducted during the study. The discussions below capture both the qualitative and quantitative results of the analysis. **Figure 5-1** displays the quantitative analysis. Chapter 4 of this report assesses environmental quality effects for each of the alternatives in detail, as required under NEPA. The sections that follow here include the results of that analysis.

Alternative 1 is the no action plan. In the absence of an actionable plan, coastal flooding will continue to occur routinely during minor and major storm events. Life safety from coastal flooding will continue to be at risk, road access to critical infrastructure will be limited or non-accessible, and homes, business buildings and other structures and property will be damaged.

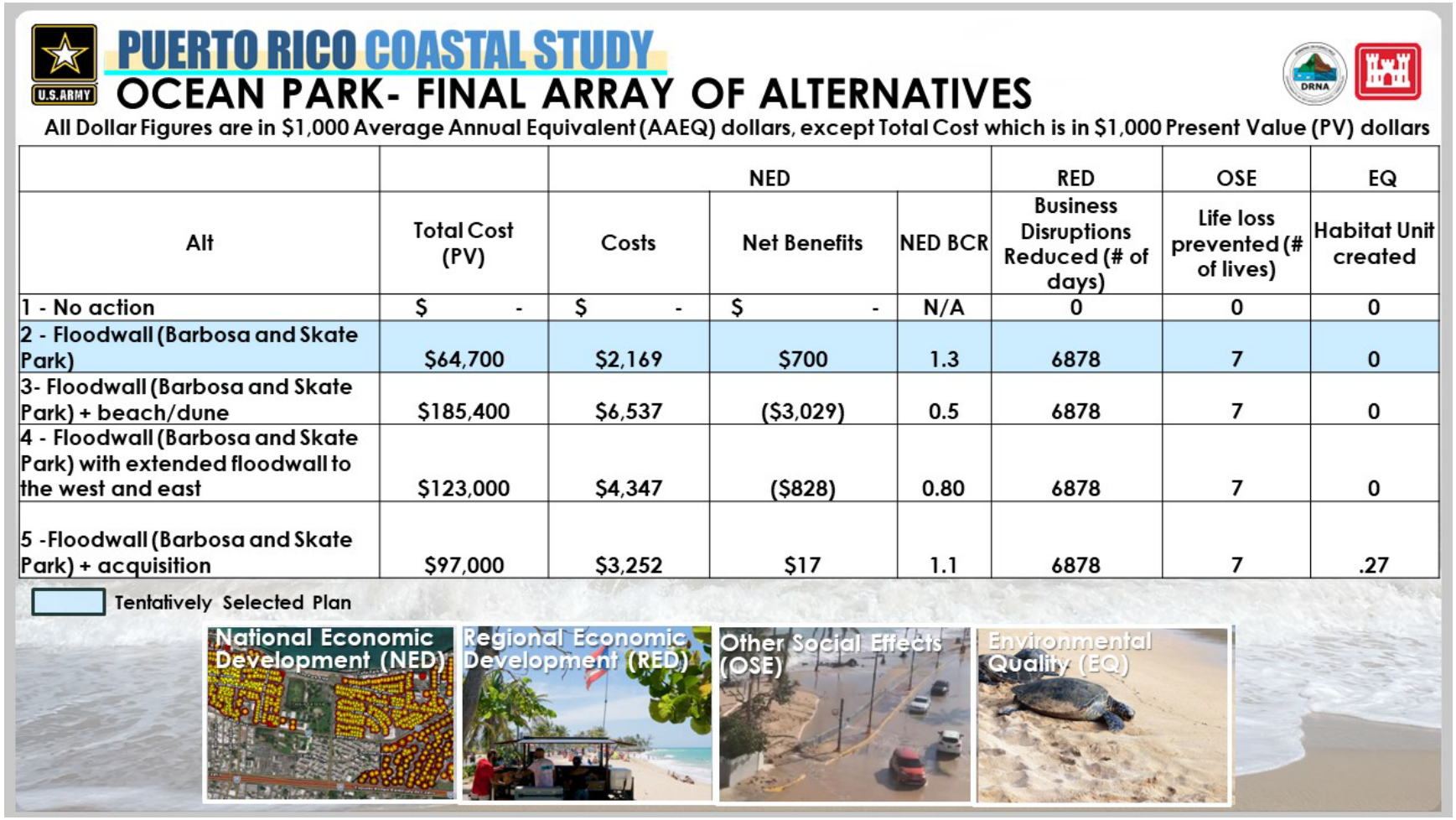
Alternative 2 is a floodwall with rock armor toe protection. This alternative would reduce the risk of coastal flooding entry at the most critical areas, Barbosa Park and the "skate park". This alternative is preferred by the non-federal sponsor. At Barbosa Park, the floodwall would be set back from the shoreline in place of the existing park access road. The floodwall would be aligned between the beach and the park in Barbosa Park, and would align landward of a block of existing structures, to tie into high ground. Those structures currently have a seawall at a higher elevation than what is proposed and already have reduced risk from coastal flooding. In short, this plan would not induce additional flooding for those properties. The floodwall at Barbosa Park would have buried rock armoring and would have a small initial sand backfill seaward of it, in the form of a small, vegetated dune. This option would preserve the beach in front of the floodwall (approximately 1-3 feet higher than ground elevation on average), and also allow public access over it to maintain existing accessibility to the beach park. In this area, it would be aligned along the shoreline and would have rock armoring for toe protection seaward of it. Access to Barbosa Park would be maintained along the side roads (Calle Soldado Serrano to the west and Avenida Las Americas to the east). The existing sidewalk in the area would need to be removed during construction but would be re-constructed landward of the new floodwall. In the Barbosa Park location, some temporary easements would be required during construction and a permanent acquisition of one property would be required to provide necessary land to construct and maintain the floodwall. Approximately six removable floodgates are proposed to allow property access to current residents during non-flooding events and would be installed by the non-federal sponsor prior to flooding events. In the skate park location, some temporary easements would be required during construction and a permanent acquisition on three properties would be required to provide necessary land to construct and maintain the floodwall. Based on this alternative's work limits, there would be no significant overlap with existing natural habitats. Avoidance planning was conducted to eliminate or minimize direct effects to aquatic habitats, and to maintain existing beach habitat conditions post construction. Prescribed conservation measures and monitoring would be implemented, and environmental mitigation would not be required. Ongoing coordination of study alternatives with the NMFS and USFWS indicate concurrence. This alternative has an estimated cost of $65,000,000 and delivers $2,869,000 in average annual NED benefits, $700,000 in average annual net benefits over a 50-year period of analysis with a benefit to cost ratio (BCR) of 1.3. Approximately 6,878 days of business disruption due to coastal flooding are reduced and life safety risk is

reduced. Nearly 40% of the benefits would be gained by the most socially vulnerable populations by reducing coastal flooding damages due to the Residencial Luis Llorens Torres community. This benefit applies to the subsequent alternatives as well.

Alternative 3 proposes the same floodwalls as in Alternative 2. This alternative would reduce the risk of coastal flooding entry at the most critical areas, Barbosa Park and the skate park. A natural and nature-based feature of beach nourishment (10-ft berm) with vegetated dunes and would add sand back to this location and to the system to address erosion. The area would be expected to retain sand for roughly 5 years before requiring periodic nourishment and would continue on that average cycle for a 50-year period. This alternative is similar to what many other projects ultimately decide on as the least cost and full comprehensive benefits plan. However, in this case, sand is extremely scarce, and the closest feasible option is still approximately 10 miles away at an upland mine. Further, due to the significant benthic resources in the area, placement of sand would incur direct impacts to nearshore corals, sponges, and SAV, resulting in mitigation between 17 and 50 acres of mixed hardbottom and SAV habitats. This alternative has an estimated cost of $185,400,000, $3,328,000 in average annual NED benefits and has negative average annual net benefits of -$3,029,000 over a 50-year period of analysis with a BCR of 0.5. Approximately 6,878 days of business disruption due to coastal flooding are reduced and life safety risk is reduced.

Alternative 4 proposes the same floodwalls as in Alternative 2. This alternative would reduce the risk of coastal flooding entry at the most critical areas, Barbosa Park and the skate park. This alternative would extend the floodwall west and east to reduce the risk of not only coastal flooding but also erosion in the surrounding areas. The extended floodwalls would require some small sand fill to be feasible for construction due to limited existing land in those areas and would include toe protection in the form of rock armoring seaward of the floodwall. This plan would require environmental mitigation for a low acreage of lost beach and nearshore coral reef habitat. This alternative has an estimated cost of $123,000,000, $3,519,000 in average annual NED benefits and has negative net benefits of -$828,000 over a 50-year period of analysis with a BCR of 0.8. Approximately 6,878 days of business disruption due to coastal flooding are reduced and life safety risk is reduced.

Alternative 5 proposes the same floodwalls as in Alternative 2. This alternative would reduce the risk of coastal flooding entry at the most critical areas, Barbosa Park and the skate park. The floodwall would be aligned between the beach and the park in Barbosa Park and would align landward of a block of existing structures. This alternative varies from Alternative 2 in that the block of structures and property would be acquired and relocated with subsequent demolition and grading of the land to its natural beach state. This alternative has an estimated cost of $97,000,000 and delivers $3,269,000 in average annual NED benefits, $17,000 in net average annual benefits, including recreation benefits of $360,000, over a 50-year period of analysis with a BCR of 1.1. Approximately 6,878 days of business disruption due to coastal flooding are reduced and life safety risk is also reduced. This plan would not require environmental mitigation and is also the only plan to create habitat units (0.27 Average Annual Habitat Units, or AAHU) by increasing about 1.1-acre of beach habitat for nesting Sea Turtles and shoreline birds.



		NED			RED	OSE	EQ
Alt	Total Cost (PV)	Costs	Net Benefits	NED BCR	Business Disruptions Reduced (# of days)	Life loss prevented (# of lives)	Habitat Unit created
1 - No action	$ -	$ -	$ -	N/A	0	0	0
2 - Floodwall (Barbosa and Skate Park)	$64,700	$2,169	$700	1.3	6878	7	0
3- Floodwall (Barbosa and Skate Park) + beach/dune	$185,400	$6,537	($3,029)	0.5	6878	7	0
4 - Floodwall (Barbosa and Skate Park) with extended floodwall to the west and east	$123,000	$4,347	($828)	0.80	6878	7	0
5 -Floodwall (Barbosa and Skate Park) + acquisition	$97,000	$3,252	$17	1.1	6878	7	.27

Figure 5-1. Average Annual Costs and Comprehensive Benefits for the Final Array of Alternatives.

RINCÓN PLANNING REACH

An extensive analysis of all effects, both positive and negative, under NED, EQ, RED and OSE was conducted during the study. The discussions below capture both the qualitative and quantitative results of the analysis. can be referenced for a brief overview of the analysis in quantitative terms. Chapter 4 of this report assesses environmental quality effects for each of the alternatives in detail, as required under NEPA. The sections that follow here include the results of that analysis.

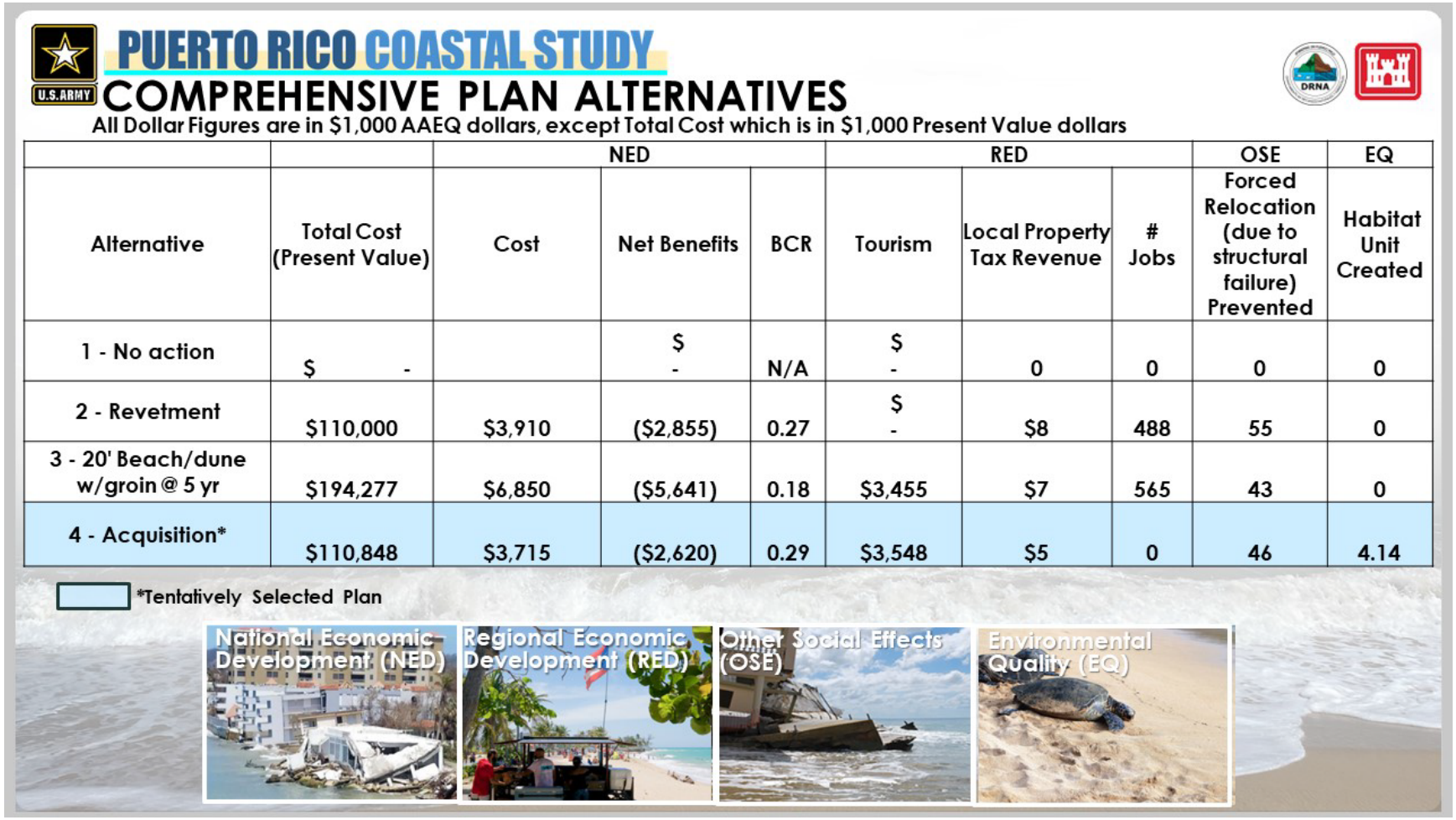
Alternative 1 is the no action plan. In absence of an actionable plan, individual property owners along the shoreline will likely attempt to reduce risk locally with low-cost, ad hoc solutions such as rock, gabions (metal meshes containing rocks), or seawalls, incurring repeated expense and probable failure of structures with likely condemnation by local government due to safety reasons. Approximately 60 structures are projected to structurally fail, and become condemned. Condemned structures would likely become derelict and are unlikely to be removed which would further exacerbate erosion on surrounding shorelines. Residents will be forced to move, likely out of the area and potentially out of Puerto Rico, reducing not only the strength of the cultural identity of the community but also reducing the tax base and impairing the economy. Structures would become derelict and are unlikely to be removed which would further exacerbate erosion on surrounding shorelines. This is identified as the NED plan by default.

Alternative 2 is rock revetment along approximately 1.3 miles of shoreline would stop the line of erosion Alternative 2 proposes a substantial rock revetment along approximately 1.3 miles of shoreline to stop the line of erosion and greatly reduce risk to the structure inventory. However, this alternative with a large rock footprint spanning the entire shoreline incurs great losses for the community as it ensures permanent loss of any remaining existing sandy beach, which are described further below. While this plan would incur permanent loss of sandy beaches, as well as species that require them, it would also displace and have direct impacts to hardbottom habitats, thus requiring extensive compensatory mitigation. All of these losses would negatively affect the community in terms of aesthetics of the beach and access to the beach in a community where the sandy shores have been part of the cultural identity. It would also pose a systemic risk to the tourism industry with adverse impacts to adjacent beaches up and down the coast, which, if lost, would permanently impair the local economy. It is strongly opposed by the non-federal sponsor and the community and did not receive coastal zone management consistency determination from the Puerto Rico Planning Board when proposed as the Tentatively Selected Plan in the November 2020 Draft Report Release. This plan currently has an estimated cost of $110,000,000 (FY23). It has an NED cost of $3,910,000 (AAEQ), NED benefits of $1,055,000, with negative net national economic development (NED) benefits of -$2,855,000, and a benefit-to-cost ratio (BCR) of 0.27.

Alternative 3 proposes beach nourishment (10-ft wide berm) with small, vegetated dunes and approximately 12 stone groins along approximately 1.3 miles of shoreline which would add sand back to this location and to the system. The area would be expected to retain sand for roughly 5 years before requiring periodic nourishment and would continue on that average cycle over the 50-year period of analysis. This alternative is similar to what many other projects ultimately decide on as the least cost and full comprehensive benefits plan. However, in this case, sand is extremely scarce, and the closest feasible borrow option is approximately 25 to 30 miles offshore. This results in a cost higher than any of the other alternatives. Due to the significant benthic resources in the area, placement of sand and the pipeline corridors would likely adversely affect nearby corals and sponges identified in the recent environmental surveys, resulting in the need for extensive compensatory mitigation. This plan currently has an estimated

cost of $194,000,000. It has an NED cost of $6,850,000 (AAEQ), NED benefits of $919,000 (AAEQ) with negative net NED benefits of -$5,641,000 (AAEQ), and a BCR of 0.18.

Alternative 4 is acquisition. With this plan, high-risk structures along approximately 1.1 miles of shoreline would be included for acquisition, and residents would be relocated following guidelines under the Uniform Relocation Assistance and Real Property Acquisition Act of 1970 (URA) (Public Law 91-646, as amended, (42 U.S.C. 4630 and 4655)). It is currently estimated that there could be approximately 115 acquisitions, within approximately 60 structures, which were identified based on their vulnerability to erosion and impact to the shoreline. After relocations and acquisitions are complete, the structures would be demolished, the land would be graded and returned to its natural sandy state which would involve some revegetation with native species. It would not require compensatory mitigation and would instead re-establish 4.14 AAHU within the acquisition footprint (eventually creating 17 acres of beach habitat for nesting Federally listed sea turtles and shore birds, and other species). The sandy shoreline would be allowed to naturally recover and would support the tourism-based regional economy into the future by maintaining $3,548,000 (AAEQ) worth of local tourism spending. It has an NED cost of $3,715,000 (AAEQ) with NED benefits of $1,095,000, including $496,000 AAEQ in increased recreation, negative net benefits of -$2,620,000 and a BCR of 0.29. This is the most effective plan of all the comprehensive plans considered and it is supported by the Governor of Puerto Rico, DNER, and the Mayor of Rincón.



		NED			RED			OSE	EQ
Alternative	Total Cost (Present Value)	Cost	Net Benefits	BCR	Tourism	Local Property Tax Revenue	# Jobs	Forced Relocation (due to structural failure) Prevented	Habitat Unit Created
1 - No action	$ -		$ -	N/A	$ -	0	0	0	0
2 - Revetment	$110,000	$3,910	($2,855)	0.27	$ -	$8	488	55	0
3 - 20' Beach/dune w/groin @ 5 yr	$194,277	$6,850	($5,641)	0.18	$3,455	$7	565	43	0
4 - Acquisition*	$110,848	$3,715	($2,620)	0.29	$3,548	$5	0	46	4.14

Figure 5-2. Average Annual Costs and Comprehensive Benefits for the Final Array of Alternatives.

5.2 IDENTIFICATION OF THE NED PLAN

The following discussions explain the rationale, in concert with the earlier discussions, for identification of the NED plan and total benefits plan for Ocean Park and Rincón.

- Ocean Park Alternative 2 –This is a very streamlined engineering solution to reduce coastal flooding risk in the Ocean Park Planning Reach, which included the Ocean Park and communities in Isla Verde , which includes the Marías Skate Park. This would add overall resilience to the entire San Juan Metropolitan Area and Puerto Rico. This plan is the NED plan.
- Ocean Park Alternative 5 – This alternative is the same as alternative 2, but it would include acquisition of the entire block of structures and properties west of Barbosa Park. This would be combined with nature based features, to add additional recreation, environmental habitat, and resilience to the San Juan Metropolitan Area and Puerto Rico. This would involve significant acquisitions of homes and property within that block, and is understood to be a large loss to the homeowners in this area. This plan could be a locally preferred plan.
- Rincón Alternative 4 – This alternative proposes acquisition along 1.1 miles of shoreline in the Stella community within the Rincón municipality. This is an extreme and bold plan, to address the devasting and very immediate effects erosion is having on the community. This plan would involve extremely significant acquisitions of homes and property and is understood to be a large immediate loss to the homeowners along the ocean-fronting shoreline. However, this would give those homeowners options and incentives to proactively relocate to new safe homes before structures fail completely. It would also revive the rest of the community and allow a long term management of the shoreline for resilience of the coastline and community into the long-term future. This plan is the most effective plan but it has a benefit to cost ratio less than 1.0 and requires a policy exception with approval by the Assistant Secretary of the Army, Civil Works, ASA,CW.
- Rincón Alternative 1 –This alternative is the no action plan. Although this is not recommended by the team, it is the most likely option since none of the other alternatives are policy compliant with a benefit to cost ratio at or above 1.0. Any alternative other than this one in Rincón would need to have a policy exception approved by the ASA,CW to move forward.

5.3 PLAN SELECTION

As discussed in the previous sections, the alternatives were evaluated and compared using planning criteria, environmental minimization and avoidance factors, and the USACE economic analysis.

Consideration and care was taken by the team in the recommending the tentatively selected plan. The team held open house meetings in both Rincón and Ocean Park in September 2022, where the team presented the focused array of alternatives and obtained feedback from members of the community and other agencies. During this time, the team also met with the Secretary of DNER, and her staff, as well as the Mayor of Rincón. The team continued to work on the study with those valuable insights, which lead to the final array of alternatives.

The team then met with the Governor of Puerto Rico and the Secretary of DNER of 29 NOV 2022. At that meeting, the team recommended the above mentioned potential TSPs for consideration of support by DNER, the non-Federal sponsor.

At that meeting, the Governor requested that his staff hold several meetings with landowners, with USACE staff to present key technical information, in order to gage feedback on the most likely set of alternatives to recommend as the TSPs for each planning reach.

A series of meetings were held by the Governor's staff on 12 December 2022 and 14 December 2022. A letter was sent on 27 December 2022 by the Secretary of DNER on behalf of the Governor of Puerto Rico, expressing his support of Ocean Park Alternative 2 and Rincón Alternative 4.

With consideration of the technical analysis and feedback as described above, Ocean Park Alternative 2 (Floodwall) and Rincón Alternative 4 (Acquisition), were selected as the TSPs. These plans were then further developed by the team and more detailed information can be found in **Appendix A, Engineering and Chapter 6 of the Main Report.**

5.4 DEVIATIONS FROM THE NED PLAN

Since Rincón Alternative 4 (Acquisition) deviates from the National Economic Development (NED) plan, a policy exception for this plan was requested, and approved by the Assistant Secretary of the Army, Civil Works (ASA, CW) on 8 May 2023.

6 The Tentatively Selected Plan

Ocean Park Planning Reach

Rincón Planning Reach

6 THE TENTATIVELY SELECTED PLAN

Due to the nature of these very different study areas, in terms of geographical distances, different problems, and different coastal dynamics, a tentatively selected plan was recommended for each planning reach, as a stand-alone projects. As such, this section is broken out by planning reach for ease of viewing and reference.

6.1 OCEAN PARK PLANNING REACH

6.1.1 OVERVIEW

The tentatively selected plan (TSP) for the Ocean Park planning reach is Alternative 2, which is floodwall construction along two low-lying areas – Barbosa Park and along the eastern portion of Punta Las Marías, in the vicinity of the Marías Skate Park. A conceptual rendering is shown in **Figure 6-1**. Key summary details are shown in **Figure 6-2** and are described the following sections, relative to engineering, economics, environmental, and real estate considerations.

This plan would reduce the risk of coastal flooding entry at the most critical areas, Barbosa Park and the Marías skate park. At Barbosa Park, the floodwall would be set back from the shoreline in place of the existing park road. The floodwall would be aligned between the beach and the park in Barbosa Park, and would align landward of a block of existing structures, to tie into high ground. The townhomes currently have a seawall which appears to meet the required design elevation. Therefore they have reduced risk from coastal flooding under existing conditions, which will not be made worse from this project. The floodwall at Barbosa Park would have buried rock armoring and would have a small initial sand backfill seaward of it, in the form of a small, vegetated dune. This option would preserve the beach in front of the floodwall (approximately 1-3 foot above high ground elevation on average), and also allow public access over it to maintain existing accessibility to the beach park. In this area, it would be aligned along the shoreline and would have rock armoring for toe protection seaward of it. Access to Barbosa Park would be maintained along the side access roads. The existing sidewalk in the area would need to be removed during construction but would be re-constructed landward of the new floodwall. In the Barbosa Park location, some temporary easements would be required during construction and a permanent acquisition on one property would be required to provide necessary land to construct and maintain the floodwall. Approximately 6 removable floodgates are proposed to allow property access to current residents during non-flooding events, and would be placed by the non-federal sponsor, prior to flooding events. Further details will be outlined in the Operation, Maintenance, Repair, Replacement, Rehabilitation (OMRR&R) Manual.

In the skate park location, some temporary easements would be required during construction and a permanent acquisition on three properties would be required to provide necessary land to construct and maintain the floodwall. Based on this alternative's work limits, there would be no significant overlap with existing natural habitats. Avoidance planning was conducted to eliminate or minimize direct effects to aquatic habitats, and to maintain existing beach habitat conditions post construction.

Prescribed conservation measures and monitoring would be implemented, and environmental mitigation would not be required. Ongoing coordination of study alternatives with the NMFS and USFWS indicate concurrence.

Figure 6-1. Conceptual Rendering of proposed floodwall and new sidewalk in Barbosa Park, looking west to east.

Figure 6-2. Tentatively Selected Plan Summary – Ocean Park planning reach

6.1.2 COMPREHENSIVE BENEFITS

After the TSP was selected for Ocean Park, there were minor modeling refinements and cost updates to include costs for OMRR&R and interest during construction (IDC).

Comprehensive benefits for the TSP are summarized in **Table 6-1**. This plan has an estimated cost of $65,000,000 and delivers $2,396,000 in average annual NED benefits, $420,000 in average annual net benefits over a 50 year period of analysis with a benefit to cost ratio (BCR) of 1.2. Approximately 6,878 days of business disruption due to coastal flooding are reduced and life safety risk is reduced. More than 40% of the benefits would be gained by the most socially vulnerable populations by reducing coastal flooding damages to the Residencial Luis Llorens Torres community.

Table 6-1. Summary of Comprehensive Benefits for Ocean Park Planning Reach.

National Economic Development	NED Primary Benefits	$ 2,816,000
	NED Cost	$ 2,396,000
	NED Primary Net-Benefits	$ 420,000
	NED Primary BCR	1.2
	Recreation Benefits	TBD
	NED Net-Benefits With Recreation	TBD
	NED BCR with Recreation	TDB
Regional Economic Development	Business Interruptions Prevented	6,878
Other Social Effects	Percent of Benefits Accruing to Historically Economically Disadvantaged Communities	42%

6.1.3 CONCEPTUAL ENGINEERING DETAILS OF THE TENTATIVELY SELECTED PLAN

The following discussions are an excerpt from Appendix A, Engineering, which can be referenced for more details. The TSP for the Ocean Park planning reach includes floodwall construction along two low-lying areas – Barbosa Park and along the eastern portion of Punta Las Marías. The intent of the walls is to reduce the large-scale flooding from coastal storms predicted to compound in the low-lying interior areas of San

Juan. The walls also provide a secondary benefit of mitigating shoreline erosion and associated damages landward of the floodwalls.

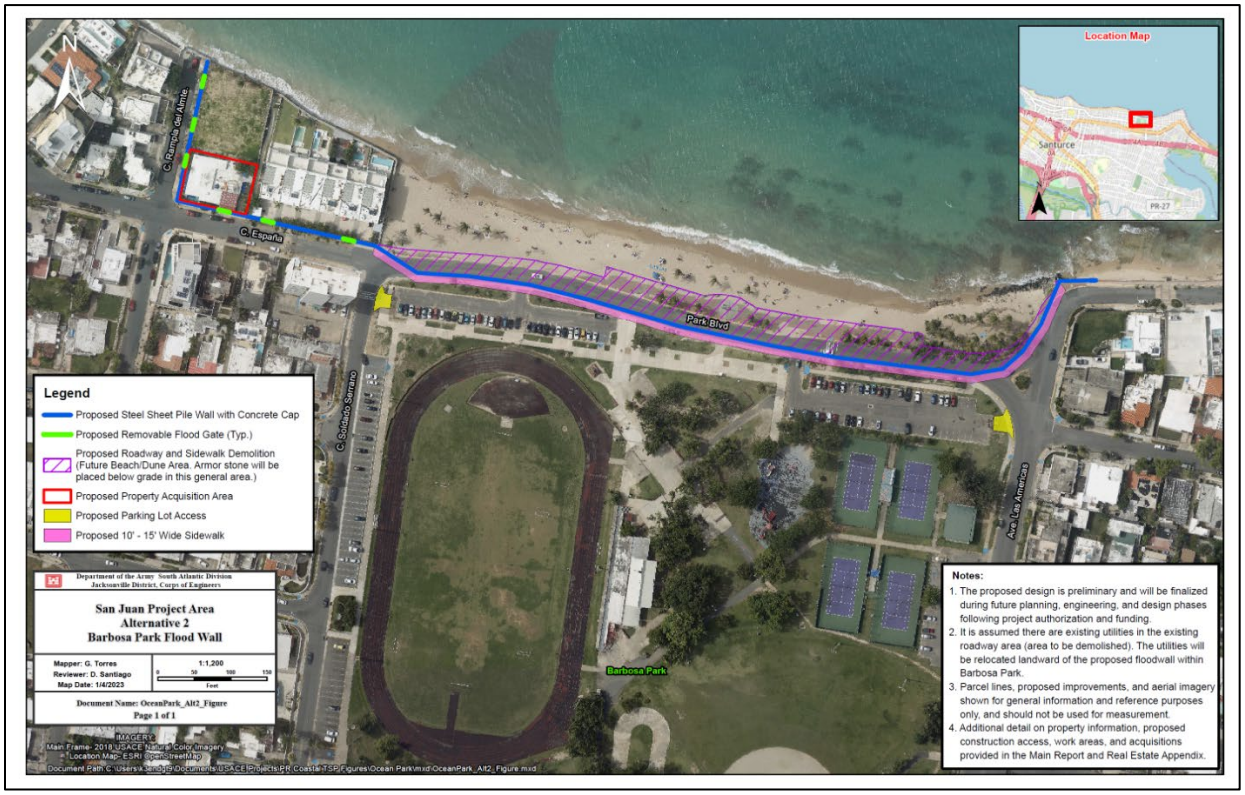


Figure 6-3. TSP – First Floodwall in Barbosa Park (Alternative 2).

The first proposed floodwall alignment in the Barbosa Park area is shown in **Figure 6-3** , and should be referenced for the following discussions. One key item of note is that the floodwall would be aligned in the general vicinity of the eastbound lane of Park Boulevard. The proposed TSP includes removal of the existing roadway and sidewalks along the northern portion of Barbosa Park and installing the floodwall within the landward portion of the existing roadway (Park Blvd). Utilities within the existing road footprint will be relocated landward of the proposed wall alignment and a new sidewalk (similar to the existing sidewalk) will be constructed immediately landward of the wall. The removed roadway and sidewalk infrastructure will be replaced with beach-quality sand and a small dune feature (approximately 12,000 cubic yards (CY) total) to provide increased recreational beach area and reduce the potential for adverse impacts to the coastal system from the wall. The dune feature will provide approximately three feet of cover above the rock armor. The sand placement is not anticipated to impact nearshore resources due to the placement location along the upper beach area and the small volume of sediment. The sidewalk along the landward side of the proposed wall will provide similar recreation opportunities and connectivity as the existing sidewalk currently provides; however, it will be set back further landward from the increased beach area. The two parking areas along the northern limit of Barbosa Park will remain and additional access points to those parking areas will be provided from the adjacent streets (Calle Coldado Serrano and Av. Las Americas).

Along the eastern limit of Barbosa Park, the floodwall will tie-in with higher elevation topography and/or existing structures meeting the intended design elevation (roughly 7 ft-PRVD02) near the existing rock and seawall fronting Park Blvd. Along the western limit of Barbosa Park and extending farther west, the floodwall will run along the northern road right of way (ROW) of Calle Espana and the eastern road ROW of Calle Rampla del Almte. The preliminary floodwall alignment is along the edge of the road right of way in the vicinity of the existing sidewalks, immediately adjacent to the current private property. The floodwall will include removable flood gates to provide access to the existing parcels (two per parcel, similar number of accesses to existing conditions) and are anticipated to generally consist of engineered planks that will slide and lock into a structural anchor (jamb) on either side of the wall. The removable flood gates are currently proposed to be approximately 15 ft wide x 4 ft high and will only be installed during major storm events. The non-Federal sponsor (NFS) will be responsible for deploying/operating the flood gates. Final engineering designs and details will be determined during PED.

The second proposed floodwall alignment is shown in **Figure 6-4**. It would be aligned along the east side of Punta Las Marías, which is primarily within the Parque de Patinetas de Punta Las Marías (Marías Skate Park). The return wall extensions to the north and south would tie into existing upland areas meeting the intended design elevation of approximately 7 ft-PRVD02. The floodwall is currently proposed to be placed immediately seaward of the existing concrete seawall along the waterfront properties and will extend north to Calle Inga and south to encompass the small public accessway.

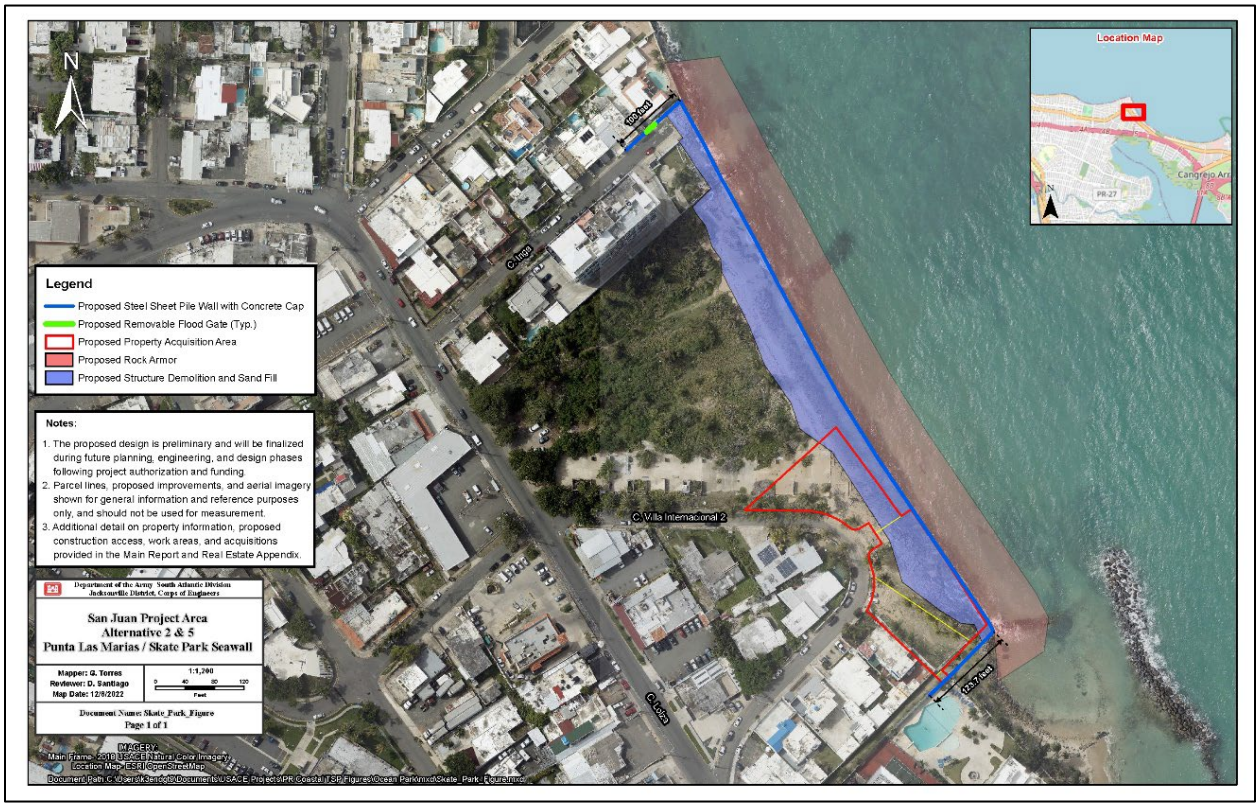


Figure 6-4. Second Floodwall in vicinity of Marías Skate Park. (Alternative 2).

Both floodwalls as described earlier are designed with a crest height of approximately 7 ft-PRVD. Both floodwalls include an engineered foundation to reduce settlement, inhibit scour and foundation failure, and rock armor protection to reduce reflected wave energy. The team also included project features to

maintain accessibility for Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) and inherently maintain existing public access. Additional typical cross sections for each floodwall location are provided below.

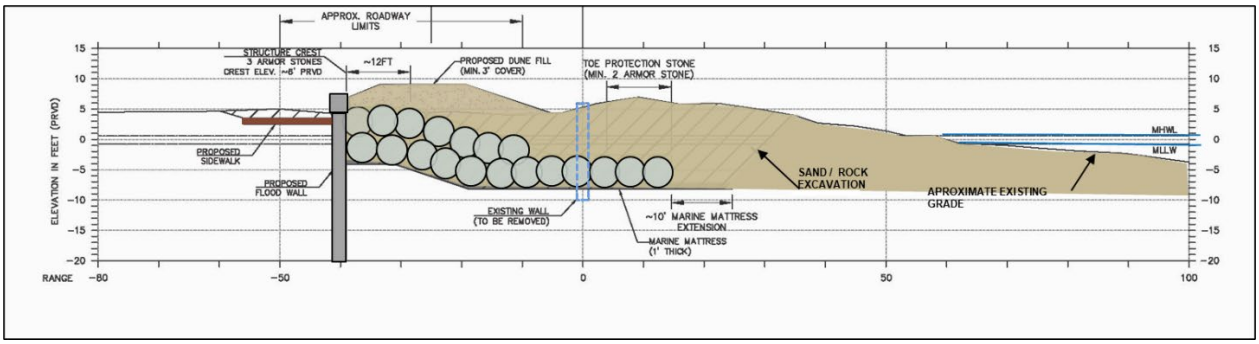


Figure 6-5. Typical Floodwall and Rock Armor Protection along Barbosa Park.

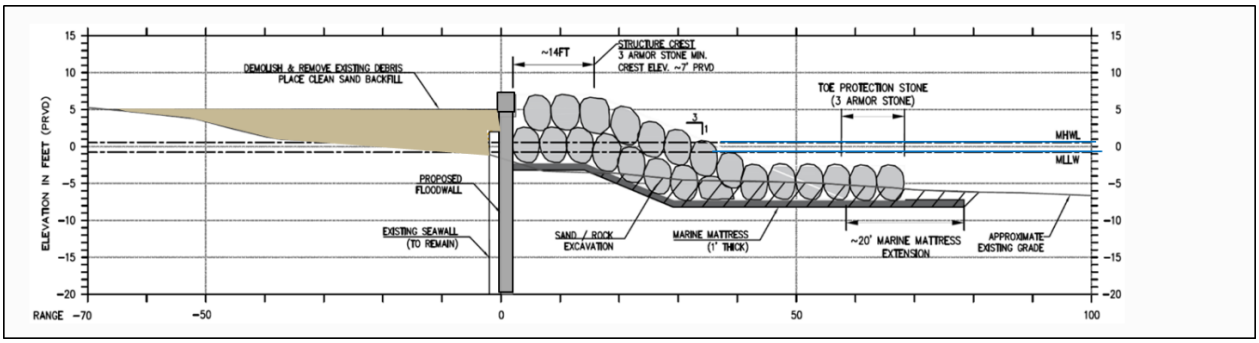


Figure 6-6. Typical Floodwall and Rock Armor Protection along the Marías Skate Park.

6.1.4 OPERATION AND MAINTENANCE

Operation and Maintenance (also known as Operation, Maintenance, Repair, Replacement, Rehabilitation, or OMRR&R) includes all activities which are not related to the initial construction, and are borne 100% by the non-Federal sponsor, as the non-Federal sponsor will have the primary responsibility for operating and maintaining the project. The monitoring and inspection procedures for the constructed project will be written in an OMRR&R Manual and provided to the non-federal sponsor prior to completion of construction. More information can be found in **Appendix A, Engineering.**

Operations and maintenance costs for the tentatively selected plans were based on costs for similar existing structures for labor and materials to perform yearly inspections, small repairs, and potentially replacing gates or equipment during the 50-year period of analysis. Costs were then adjusted based on the length, type of measure, and additional labor/material costs as deemed necessary for different structural measures. After computation of the total costs, they were annualized using the FY2023 discount rate of 2.50% for a 50-year period of analysis. The annual average costs for OMRR&R are estimated to be a total of approximately $7.8M over the 50-year period of analysis, or $202,000 per year over a 50-year period of analysis. A summary of OMRR&R activities can be found in **Table 6-2.**

Table 6-2. Overview of operation and maintenance.

Measure	General Action	Approximate Frequency
Managed Coastal Retreat	Routine Inspections**	Yearly
Floodwall/Seawall	Routine Inspections (Full System)	Yearly or As Needed
	Post-Storm Inspections	As Needed
	Sheet Pile Wall Maintenance	Every 5 - 10 Yrs
	Concrete Cap Maintenance	Every 5 - 10 Yrs
	Flood Gate Repairs and/or Replacement	Two times in the project life
	Rock Armor Surveys and/or Detailed Inspections	Every 10 Yrs
	Rock Armor Repair	Once in the project life

6.1.5 SEA LEVEL CHANGE CONSIDERATIONS

Ocean Park Alternative 2 provides a robust level of damage reduction in the low and intermediate sea level change scenarios. Benefits for the high sea level change scenarios were not computed since the compound flooding from the back-bay area makes residual risk with a project in place unquantifiable in the current effort[14]. However, there would be some level of benefits since a significant amount of risk associated with overtopping of surge from the coast would be reduced. In the intermediate and low sea level change scenarios, damages are reduced by 91% and 95% with benefits of $2,816,000 and $692,000 (AAEQ) respectively. Further discussions can be found in the section titled "Residual Risk and Potential Adaptation Strategies" in this chapter.

Table 6-3. TSP effectiveness under sea level change scenarios.

SLC Scenario	FWOP Damages (AAEQ)	Alt 2 - Floodwall Damages (AAEQ)	NED Benefits (AAEQ)	Damages Reduced
Base	$ 764,000	$72,000	$ 692,000	91%
Intermediate	$ 2,960,000	$144,000	$ 2,816,000	95%

6.1.6 LANDS, EASEMENTS, RIGHTS OF WAY, RELOCATIONS AND DISPOSAL AREAS (LERRDS)

The following information is an abbreviated description. More detailed information including proposed required temporary and permanent easements can be found in **Appendix E, Real Estate.** This section

[14] Residual risk can be quantified and benefits could be produced if the portion of risk attributable specifically to the back-bay was known. In order to measure that risk the current study would need a significant expansion of scope.

discusses lands, easements, rights of way, relocation, and disposal areas (LERRD) anticipated, identified or estimated at this time, that appear to be required for construction, operation and maintenance of the proposed tentatively selected plan, including estimated acreage, estates, ownerships, and preliminarily and roughly estimated values and identified assumptions. The Puerto Rico Department of Natural and Environmental Resources is the non-Federal sponsor (NFS) for the study and will provide the LERRDs.

The following project features have related real estate requirements that are necessary to provide adequate construction room to build proposed shore protection management features and secure lands needed for Operations and Maintenance (O&MMR):

Floodwall and Seawall - The team determined the implementation of either floodwalls or seawalls at various locations within each model area using design elevations and local geology. Total area consists of 13.80 acres. In addition, there will be a requirement for a Flood Protection Levee Easement to be acquired by the NFS over six privately-owned parcels. Easements that will be required for floodwall and floodgates are discussed further in **Appendix E, Real Estate**.

Sidewalks – Sidewalks will be removed landward of the existing floodwall in the Barbosa Park area and reconstructed landward of the new floodwall. The sidewalk relocation will be within public lands (municipality owned), no private land acquisitions will be required.

Utilities – Utilities along the road in Barbosa Park are expected to not be affected. It is anticipated that utilities will need to be disconnected prior to construction and reconnected after construction. A small cost is included in the cost estimate for this. The proposed design included a preliminary review of known utilities in the proposed project area in the Ocean Park Reach; however, unknown utilities may exist. Utility surveys will be performed during PED to document the presence of existing utilities that may affect the proposed design and/or need to be relocated.

Staging/Work Areas - Five staging and storage areas have been identified for the Project, comprising a total of 2.64 acres. The required real estate interests are Temporary Work Area Easements. Of the five staging areas, three are owned by municipalities and two by private owners, so the NFS will have to acquire the easements.

Disposal – At this feasibility phase, no disposal area for ground or marsh material has been determined as required. If later during the Planning, Engineering and Design (PED) phase, it's determined that disposal of material is needed, local landfill will be identified for this purpose. Lands would not need to be acquired by the NFS.

Borrow Area/Sand Sources - Offshore sand sources and upland sand mines were identified for both study areas. Puerto Rico has no specific requirements for the beach fill quality. However, from an environmental and sustainability point of view, the sand placed on the beach should be similar to the sand of the existing beach and free of foreign matter, like rock, debris, toxic material. Near shore and offshore sand sources are on submerged lands owned or controlled by the NFS. If upland sand sources (privately owned sand mines) are used, sand material will be purchased from the mine. No lands will need to be acquired by the NFS.

Road Access – Road access would be over public roads and highways. Land will not be needed to be acquired by the NFS.

Operation and Maintenance – After construction is completed, O&M of the Project features will be conducted within lands owned or controlled by the NFS.

6.1.7 COST

An Abbreviated Risk Analysis (ARA) was performed to assess the level of risk and to determine a reasonable contingency for the TSP. Based on the results of the ARA, an average contingency of 35-38% was assumed for the construction costs, PED and S&A. For Lands and Damages, and Real Estate administrative costs, a 30% contingency was assumed. Table 6-4 presents the total project first cost for the Ocean Park Planning Reach, currently estimated to be $64,191,000 including contingency (FY23 price level). The estimated adjusted Federal cost after credit and LERRD credit is applied from Section 1032 WRDDA 14 is $32,527,000 and non-Federal cost is $16,491,000.

Table 6-4. Ocean Park – Alternative 2 (Floodwall) - TSP Total Project First Cost (FY 23 Price Levels).

Item	Federal Share	Federal Cost	Non-federal Share	Non-federal Cost	Project First Cost
Construction (including demolition, grading, PED and Construction Management)	65.00%	$31,862,000	35.00%	$17,156,000	
Sidewalk relocation				$492,000	
Acquisition of property and land		$0		$13,134,000	
RE Admin		$470,000		$1,075,000	
TOTAL		$32,332,000		$31,858,000	$64,191,000
LERRD Credit[15]				($14,702,000)	
Section 1032 of WRRDA 14 Waiver[16]		$665,000		($665,000)	
Adjusted Cost Share [17]				**$31,193,000**	
Non-Fed Cash Contribution[18]		**$32,527,000**		**$16,491,000**	

[15] This includes Lands, Easements, Relocations, Right-of-Way, Disposal (LERRD) plus non-federal administrative costs, applies to Table ES 1-2 as well.
[16] Reflects update to Section 1032 of WRDDA 14 waiver amount to $665,000 in November 2022.
[17] Cost share is adjusted in the amount of $665,000 per Section 1156 of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2310).
[18] Cost share cash contribution when both adjustments for $665,000 per Section 1156 of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2310), and LERRD credit, are applied.

6.2 RINCÓN PLANNING REACH

6.2.1 OVERVIEW

The proposed TSP for the Rincón planning reach is for acquisition of the most vulnerable structures and property. Key summary details and reference graphics are shown in **Figure 6-7** and are described the following sections, relative to engineering, economics, environmental, and real estate considerations.

The majority of acquired structures are single-family homes (65%), followed by multi-family homes (28%), and then hotels[19] (7%). This is the only plan to gain benefits holistically across all four Principles & Guidelines P&G accounts[20].

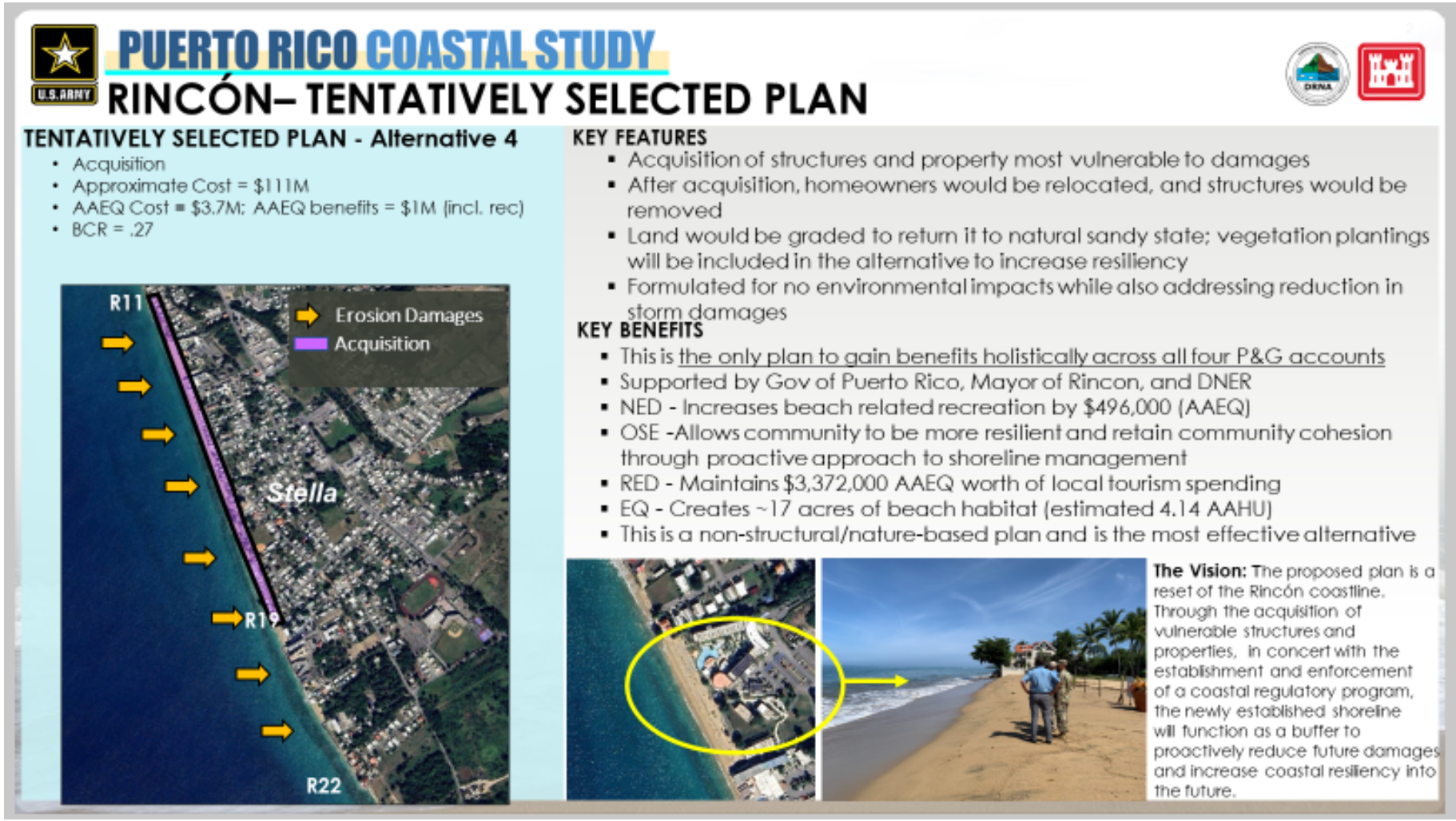
This plan currently has an estimated cost of $110,848,000 (FY23). This plan currently includes an estimated 115 acquisitions of individual property units. These units are within severely vulnerable structures, which are those most at risk to structural failure due to erosion in the FWOP, and residents would be relocated. The structures would be demolished, and the land would be returned to its natural sandy state which may involve revegetation with native species. Remaining structures would then have an appropriate be set back distance from coastal processes, allowing the municipality and non-Federal sponsor to manage the shoreline in a comprehensive manner. It is estimated that there would be residual risk following project implementation. First, it would be necessary to ensure that development is prevented on the newly restored land, which will be achieved when the land is purchased. At the moment of acquisition, the lands will have a restrictive easement to prohibit future development. In addition, these lands will become part of the "Maritime Terrestrial Zone", which converts lands to Public Domain Lands. Second, it will be extremely important to monitor the shoreline for potential future erosion and necessary adaptation if certain triggers are met. Several options could be employed. One option the team is considering is recommending the sponsor establish, maintain and enforce a coastal regulatory program, similar to the state of Florida's coastal construction control line program, to continue to manage the shoreline into the 100-year adaptation horizon. This proactive program could also mitigate the risk of second-row structures in the future. The TSP in Rincón recommends acquisition of vulnerable structures and property from R11-R19, rather than the full extent of R22. This is due to focusing acquisition on the largest extent of structures that experience the most frequent

[19] The number of hotels being acquired are not a large overall percentage of hotels in the Municipality of Rincón and, therefore, will not have a materially adverse impact on the local economy.

[20] Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, established by the U.S. Water Resources Council on March 10, 1983, have been developed to guide the formulation and evaluation studies of the major Federal water resources development agencies. These principles and guidelines are commonly referred to as the "P&G"

damages. Large condos are located south of this area with robust armoring in the existing condition. Some single-family units south of the condos are already condemned and a few others would likely experience damages. These outcome risks are summarized in the risk and uncertainty section of this paper. This is the only plan that would essentially give the town of Stella in the southern stretch of Rincón a second chance to reset the shoreline and implement best practices to sustain it into the future.

Figure 6-7. Tentatively Selected Plan Summary – Rincón planning reach



6.2.2 COMPREHENSIVE BENEFITS

After the TSP was selected for Rincón, there were minor modeling refinements and cost updates to include costs for OMRR&R and interest during construction (IDC).

Comprehensive benefits for the TSP are summarized in **Table 6-5.** This plan has an NED cost of $3,725,000 (AAEQ) with NED benefits of $1,095,000 (including increased recreation), negative net benefits of $2,712,000 and a BCR of 0.27. It would result in approximately 115 acquisitions (within approximately 60 structures) along the shoreline in Stella, proactively preventing 82% of the structural failures that are projected to occur in the future-without project condition. These acquisitions could also prevent harm to nearby properties and adjacent shorelines incurred from the induced erosional effects of destroyed structure remnants. The plan does not require mitigation but would instead accrue 4.14 average annual habitat units for shoreline species within the acquisition footprint (eventually creating 17 acres of beach habitat).

The sandy shoreline would be allowed to naturally recover and would support the tourism-based regional economy into the future by maintaining $3,372,000 (AAEQ) worth of local tourism spending. Most notably, this plan sustains community cohesion by allowing the community of Stella to thrive rather than submit to decline with the renewal of a beach and removal of unsafe and unsightly structures, stopping and reversing the spread of decline in the community.

This plan allows the southern part of Rincón to remain connected culturally and economically to the northern part of Rincón. With the exception of a positive benefit-to-cost ratio, this plan is consistent with Executive Orders and Administration priorities of coastal resilience.

It uses nature-based and non-structural solutions and is also supported by the Governor of Puerto Rico, the Mayor of Rincón, and the Secretary of DNER. This study would positively affect the town of Stella, which is a historically economically disadvantaged community.

This plan will be a model of coastal resiliency for Puerto Rico, and the Nation, allowing vulnerable communities to prepare, absorb, recover and adapt, using best management practices for long-term sustainability of the shoreline. This is the most effective plan of all of the comprehensive plans considered. Since this plan deviates from the National Economic Development (NED) plan, a policy exception for this plan was approved by the Assistant Secretary of the Army, Civil Works (ASA, CW) on 8 May 2023.

Table 6-5. Comprehensive Benefit Summary – Rincón.

National Economic Development	NED Primary Benefits (AAEQ)	$ 587,000
	NED Cost (AAEQ)	$ 3,725,000
	NED Primary Net-Benefits (AAEQ)	$ (3,138,000)
	NED Primary BCR	0.16
	Recreation Benefits (AAEQ)	$ 426,000
	NED Net-Benefits with Recreation (AAEQ)	$ (2,712,000)
	NED BCR with Recreation	0.27
Regional Economic Development	Tourism Expenditures Maintained (AAEQ)	$ 3,372,000
Other Social Effects	First-Row Condemnations [21]Avoided	82%
	Total Condemnations Avoided	53%

6.2.3 CONCEPTUAL ENGINEERING DETAILS OF THE TENTATIVELY SELECTED PLAN

The proposed TSP is for acquisition of the most vulnerable structures along the southern coastline of Rincón, shown in **Figure 6-8.** The intent of the TSP is to acquire vulnerable properties along the Rincón shoreline to reduce future economic damages to upland property, structures, and infrastructure. The acquired properties would be reestablished as natural coastline (beach) that would support environmental enhancement, public recreation, and future economic growth and stability. Removing large segments of structures and/or coastal armoring that encroach into the coastal system would also increase shoreline stability by allowing the shoreline/beach to naturally respond to storm events (i.e., the

[21] Due to structural failure from erosion and subsequent actions by local government for safety reasons

increased erosion due to coastal armoring and the presence of structures projecting into the coastal system adversely affecting cross-shore and long-shore sediment transport would be greatly reduced or eliminated).

Specifically, the TSP for Rincón includes acquisition of approximately 60 structures[22], resulting in an estimated 115 acquisitions[23] of individual property units along the Rincón shoreline. The parcels currently estimated for acquisition were selected based on numerous factors, including but not limited to, predicted structure damage(s) from planning models, their physical location in relation to the existing water line, potential impacts to natural coastal processes (at present and into the future), and environmental resources. In general, structures that are not setback from the shoreline have and will continue to experience increased damages, were shown to have an adverse effect on the coastal system, and are recommended to be included for acquisition.

[22] A structure refers to a single building which could have multiple property owners within. For example, a condominium complex with 20 units would be a single structure, but would have 20 unique property owners.

[23] The 115 properties are units within the individual structures subject to severe damage. A single structure can contain multiple units of property. This number is approximate and is subject to change with future refinement.

Figure 6-8. Estimated location of acquisition - TSP for Rincón planning reach (Alternative 4)

6.2.4 SEA LEVEL CHANGE CONSIDERATIONS

It is important to note that modeling assumptions did change between the FWOP and FWP Acquisition scenario. It was assumed that if acquisitions are implemented in order to restore the shoreline, no future armoring (e.g., seawalls, rip rap, revetments) would be placed along the shoreline. The acquisition footprint was based on the intermediate SLC scenario, rather than the high. Therefore, there are additional damages in the high SLC FWP scenario without armoring than in the high FWOP. This indicates that if evidence shows sea levels are trending towards the high curve, the acquisition plan would need to be adapted and the footprint for asset purchases would need to be extended.. This is not an indication that the TSP induces damages but is rather a function of utilizing the same assumptions for the FWP condition in each of the SLC scenarios. Further discussions can be found in the section titled "Residual Risk and Potential Adaptation Strategies" in this chapter.

Table 6-6. TSP effectiveness under sea level change scenarios.

SLC Scenario	FWOP Damages (R11-R19)	Acquisition Damages	Benefits	% Damage Reduction
Low	$ 702,000	$92,000	$ 610,000	87%
Intermediate	$ 847,000	$260,000	$ 587,000	69%
High	$ 997,000	$1,095,000	$ (98,000)	N/A

6.2.5 LANDS, EASEMENTS, RIGHTS OF WAY, RELOCATIONS AND DISPOSAL AREAS (LERRDS)

The following information is an abbreviated description. More detailed information including proposed required temporary and permanent easements can be found in **Appendix E, Real Estate.** This section discusses lands, easements, rights of way, relocation, and disposal areas (LERRD) anticipated, identified or estimated at this time, that appear to be required for construction, operation and maintenance of the proposed tentatively selected plan, including estimated acreage, estates, ownerships, and preliminarily and roughly estimated values and identified assumptions. The Puerto Rico Department of Natural and Environmental Resources is the non-federal sponsor (NFS) for the study and will provide the LERRDs.

The following project features have related real estate requirements that are necessary to provide adequate construction room to build proposed shore protection management features and secure lands needed for Operations and Maintenance (O&MRRR).

Acquisition/Building Removal or Relocation. Buildings may be removed from vulnerable areas by acquisition , subsequent demolition, and relocation of the residents. Often considered a drastic approach to storm damage reduction, property acquisition and structure removal are usually associated with frequently damaged structures. Implementation of other measures may be effective but if a structure is subject to repeated storm damage, this measure may represent the best alternative to eliminating risks to the property and residents. Removal of a structure requires acquisition of the entire property, demolition of the structure, removal of debris, excavation of underground utilities (if warranted), and

restoration of the site to natural conditions. Acquired properties are usually deed restricted from further development.

The total area for the acquisition is 17.06 acres, and the real estate interests required are Fee Interest and Restrictive Easements. Properties to be acquired are mostly by private owners, so the NFS will be responsible for acquiring these real estate interests.

Staging/Work Areas - Five staging and storage areas have been identified for the Project, comprising a total of 2.64 acres. The required real estate interests are Temporary Work Area Easements. Of the five staging areas, three are owned by municipalities and two by private owners, so the NFS will be responsible for acquiring the easements.

Disposal – At this feasibility phase, no disposal area for ground or marsh material has been determined as required. If later during the Planning, Engineering and Design (PED) phase, it's determined that disposal of material is needed, local landfill will be identified for this purpose. Lands would not need to be acquired by the NFS.

Borrow Area/Sand Sources - Offshore sand sources and upland sand mines were identified for both study areas. Puerto Rico has no specific requirements for the beach fill quality. However, from an environmental and sustainability point of view, the sand placed on the beach should be similar to the sand of the existing beach and free of foreign matter, like rock, debris, toxic material. Near shore and offshore sand sources are on submerged lands owned or controlled by the NFS. In case upland sand sources (privately owned sand mines) are used, sand material will be purchased from the mine. No lands will need to be acquired by the NFS.

Road Access – Road access would be over public roads and highways. Land will not be needed to be acquired by the NFS.

Zoning - The lands subject to acquisition, at the moment of acquisition will have a restrictive easement to prohibit future development. In addition, these lands will become part of the "Maritime Terrestrial Zone", which converts lands to Public Domain Lands.

Operation and Maintenance – After construction is completed, O&M of the Project features will be conducted within lands owned or controlled by the NFS.

6.2.6 COST

An Abbreviated Risk Analysis (ARA) was performed to assess the level of risk and to determine a reasonable contingency for the TSP. Based on the results of the ARA, an average contingency of 35-38% was assumed for the construction costs, PED and S&A. For Lands and Damages, and Real Estate administrative costs, a 30% contingency was assumed. **Table 6-7** presents the total project first cost for the Rincón Planning Reach, currently estimated to be $110,830,000 including contingency (FY23 price level). For Rincón, it should be noted that the cost presented is based on the initial real estate appraisal for projected acquisitions. The gross real estate appraisal was completed but is still being finalized in the project cost, and may result in up to a 20% cost increase. Updated costs will be presented in the Final Report. The estimated adjusted Federal cost after the waiver is applied pursuant to Section 1156 of the

Water Resources Development Act of 1986, as amended, is $15,108,000 and non-Federal cost is $62,324,000.

Table 6-7. Rincón – Alternative 4 Acquisition- TSP Project First Cost (FY 23 Price Levels).

Item	Federal Share	Federal Cost	Non-federal Share	Non-federal Cost	Project First Cost
Construction (demolition, grading, relocation, PED, and Construction Management)	65%	$10,015,000	35%	$5,393,000	
Acquisition of structures and property		$0		$81,334,000	
RE admin		$4,428,000		$9,660,000	
TOTAL		**$14,443,000**		**$96,387,000**	**$110,830,000**
LERRD Credit (up to 35%) [24]				(33,398,000)	
Section 1032 of WRRDA 14 Waiver[25]		$665,000		($665,000)	
Adjusted Cost Share[26]		**$15,108,000**		**$62,324,000**	

[24] This includes Lands, Easements, Relocations, Right-of-Way, Disposal (LERRD) plus non-federal administrative costs.
[25] Reflects update to Section 1032 of WRDDA 14 waiver amount to $665,000 in November 2022.
[26] Adjusted cost share when both adjustments for $665,000 per Section 1156 of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2310), and LERRD credit, are applied. There are two potential paths for further adjustments that could be made to the cost share as shown. For the first path, per ER 1165-2-130 and under the project partnership agreement, there could be a reimbursement agreement to allow reimbursement to the non-federal sponsor for LERRDS in excess of the 35% cost share, after project completion and closeout. For the second path, per ER 1165-2-131, the non-federal sponsor could request that the Federal government acquires LERRD. If either of these options is requested and approved, the cost share adjustments would be made.

6.2.7 VIEWS OF THE NON-FEDERAL SPONSOR

The DNER is the non-federal sponsor for this study. They have been an integral part of the study team throughout the feasibility study process. DNER supports both of the tentatively selected plans. A letter of support from DNER on behalf of the Governor of Puerto Rico was received on 27 December 2023, which can be referenced in **Appendix H, Pertinent Correspondence**.

6.2.8 RESILIENCY

The second objective of this study speaks to resilience. In EP 1100-1-2 USACE Resilience Initiative Roadmap 16 Oct 17, USACE has identified four key principles of resilience from the many definitions of resilience that exist. These principles – Prepare, Absorb, Recover, and Adapt – exemplify the temporal aspects and actions that are inherent to the process of building community resilience capacity.

Prepare: The report communicates the results of analyses, which will help communities anticipate future coastal flooding elevations with sea level change.

Absorb: The tentatively selected plans offers solutions that will reduce damages, meaning fewer damages for the communities to absorb.

Recover: The tentatively selected plans reduces damages and also reduces the risk to safety of the communities during coastal flooding events through features that will reduce the risk of flooding in roads and safety problems that can arise from standing water, and allowing quicker recovery before, during and after storms.

Adapt: This report offers recommendations for monitoring to inform when adaptations to features in the TSP may need to occur and to what extent. The ability of the project to adapt into the future was assessed through the analysis of varying rates of sea level change as well as an assessment of project performance out to 2129. The USACE Climate Change Adaptation Goal is to minimize impacts from climate change and maximize resiliency in the coastal landscape. The current conceptual design takes into consideration the effects of sea level change as part of the design. The tentatively selected plans design takes into consideration how and if the design can adapt to the effects of sea level change and climate change 100 years after the project is constructed and what adjustments can be made to the design to assure that the project can adapt into the future.

6.3 FEDERAL IMPLEMENTATION RESPONSIBILITIES

USACE is responsible for budgeting for the Federal share of future Federal construction projects. Federal funding is subject to budgetary constraints inherent in the formation of the national civil works budget in a given fiscal year. USACE would perform the necessary preconstruction engineering and design (PED) needed prior to construction and would follow the items of local cooperation as outlined in **Chapter 8, Recommendations**. Cost sharing of PED and initial construction will be in accordance with WRDA 1986, as amended, subject to the availability of appropriations.

6.4 NON-FEDERAL IMPLEMENTATION RESPONSIBILITIES

The non-Federal sponsor for the CSRM project will be DNER. A list of items of local cooperation are included in **Chapter 8, Recommendations.** The non-Federal sponsor shall provide lands, easements, and rights-of-way and bear a portion of the administrative costs associated with land requirements. The non-Federal project sponsor will be responsible for all costs of operation, maintenance, repair, rehabilitation, and replacement of project features. Section 402 of the 1986 Water Resources Development Act, as amended (33 USC 701b-12), states that "Before construction of any project for local flood protection, or any project for hurricane or storm damage reduction, that involves Federal assistance from the Secretary, the non-Federal interest shall agree to participate in and comply with applicable Federal floodplain management and flood insurance programs." The non-Federal sponsor and communities must be enrolled in, and in compliance with, the National Flood Insurance Program (NFIP) to receive Federal funding for a recommended storm damage reduction project.

The PR Planning Board (PRPB) runs the National Flood Insurance Program in PR, and manages all PR riverine and coastal flood plains through PRPB Regulation 13. The non-Federal sponsor and communities must be enrolled in, and in compliance with, the National Flood Insurance Program (NFIP) to be eligible for Federal cost-sharing of a recommended coastal storm risk reduction project. Based on information from the PR Planning Board, DNER and communities are enrolled in the NFIP and are in compliance with this regulation.

6.5 RISK AND UNCERTAINTY

Risk and uncertainty is inherent within the feasibility phase during planning, and has been addressed and managed in several ways during the process.

Engineering: A Qualitative Risk Assessment (QRA) was conducted to ensure life safety guidelines were met. The QRA concluded that the proposed TSPs maintain life safety and do not incur additional life safety risk.

The rate of sea level change under low, intermediate and high curves is calculated in this study using best available data and trend analysis. However, the actual sea level change rate which will occur is uncertain. The design accounts for this uncertainty both in design height, and with adaptation triggers, which should be monitored and evaluated after the project is constructed. These considerations are discussed in **Appendix A, Engineering.**

Additional surveys and analysis are recommended prior to the Final Report and during PED to continue to reduce risk and uncertainty prior to project construction. These are described further in **Appendix A, Engineering.**

Economic Modeling: G2CRM and Beach-fx models incorporate risk and uncertainty to determine an optimized plan under many future scenarios. There is some uncertainty in the population data as the sources used to collect the information were not up to date. There is some uncertainty when accounting for repetitive damages in the model. Assumptions were used based on observed human behavior within these communities. More information on model assumptions and uncertainties can be found in **Appendix D, Economics**

Real Estate: There is inherent uncertainty in the amount time it will take to complete relocations and acquisitions, specifically in the Rincón area due to the large number of relocations and acquisitions that are currently estimated.

Cost: An abbreviated cost and schedule risk analysis (CSRA) has been completed, which addresses risks to project implementation and construction. Based on the results of the analysis, a risk-based contingency value of $13.5M (37%) has been added to the Ocean Park project. In addition to this, $4M (40%) contingency has been added for real estate relocation and acquisition features. Based on the results of the analysis, a risk-based contingency value of $4M (35%) has been added to the Rincón project. In addition to this, $27.2M (40%) contingency has been added for real estate relocation and acquisition features. In the future, the risks will continue to be assessed and managed in during the remainder of the feasibility phase prior to the final report, and into the design and construction phase of the project.

6.6 RESIDUAL RISK & POTENTIAL ADAPTATION STRATEGIES

The USACE Climate Change Adaptation Goal is to minimize impacts from climate change and maximize resiliency in the coastal landscape. USACE describes resilience as "the ability to anticipate, prepare for, respond to, and adapt to changing conditions and to withstand and recover rapidly from disruptions with minimal damage." USACE Civil Works project designs should take into consideration how and if the design can be adapted to account for the effects of sea level change (SLC) and climate change 100 years after the project is constructed. These analyses and recommendations are primarily based on projected SLC and not future economic conditions that may affect project benefits.

Ocean Park

In Ocean Park, the study team has formulated alternatives for coastal flooding coming from the ocean side using the intermediate SLC curve. Some residual risks associated with this approach are the possibility of the SLC trends shifting towards the high SLC scenario and potential flooding from the back-bay under the high SLC scenario. Following a substantial analysis and coordination with the vertical team, USACE chose this formulation strategy due to the uncertainty of the high SLC and the potential exponential increase in inundation exposure from intermediate to high SLC. USACE noted higher inherent risk when formulating a coastal storm risk management (CSRM) plan using the high SLC scenario given the magnitude of the solution needed to buy down that risk (huge exposure area), thus inflating project costs. While a very costly CSRM solution may be justified for the high SLC scenario, that level of cost may not be justified under the intermediate or low SLC scenarios. Therefore, the current approach of formulating a TSP using the intermediate SLC scenario is a good compromise and leaves the PDT with no regrets moving forward. Additionally, assessing damages at the high SLC scenario would necessitate compound flooding quantification and could require more than one study. Further, a much larger exposure/assessment area would have likely resulted (nearly island-wide) if the original study evaluated high SLC scenario vulnerability to areas regardless of economic value or intermediate SLC scenario exposure. If the high SLC were to occur, economic modeling indicates a large increase in damages and engineering modeling indicates an increase in flooding pathways within both the general study area along the coastline and in the adjacent back-bay areas. Back-bay flooding under the intermediate SLC scenario indicates the risk of coastal flooding is low and tolerable within the study area. However, the risk of flooding from the back-bay increases substantially under the high SLC scenario. To account for the possibility of the high SLC scenario, adaptation strategies are considered below. The formulation of alternatives based on the intermediate SLC curve with the inclusion of adaptation strategies, as needed, is an approach where there is a plan for each potential scenario to ensure resilience to the community.

Potential Adaptation Strategies for Ocean Park

In Ocean Park, adaptation will likely encompass a study to re-evaluation problems and solutions rather than specific adaptable measures due to an increase in ocean-front and back-bay flooding pathways under the high SLC scenario in combination with the study area's topography and the extensive shoreline armoring that would be required under the high SLC scenario. The increase in flood pathways extends throughout the entire study area and includes flooding from the coastal and back-bay regions. Specific adaptable measures to the TSP would require elevating the TSP and extending the structures laterally to encompass the entire study area and potentially areas outside of the study area. This re-evaluation study will likely indicate that a full reformulation of solutions is required. Thresholds to determine when adaptation needs to take place will be established and included in the Final Report, based on increases in

relative SLC over a specified period of time. It is recommended that should adaptations be considered within 50 years of project construction a post authorization study could be initiated with the USACE or a study could be initiated under Section 216 of the Flood Control Act of 1970 (Public Law 91-611). If adaptation is considered beyond a 50-year period after construction, the non-federal sponsor could initiate a study (with or without the USACE) to address problems.

During the PED Phase, the monitoring procedure for the project and adaptation strategies will be written in the OMRR&R manual. The OMRR&R manual will discuss the thresholds for adaption, with lead times required for each action. Once constructed, the project will be placed in the USACE's Comprehensive Evaluation of Projects with Respect to Sea-Level Change tool to provide additional forecast for potential adaptation. The purpose of this tool is to inventory and assess the vulnerability of existing USACE projects to the effects of SLC and provide added benefits to other USACE activities.

Rincón

Preliminary modeling indicates there will be residual risk following project implementation primarily due to associated damages from continued beach erosion. First, there is residual risk related to potential future development within the newly restored project area, if not enforced. To mitigate this residual risk and ensure the project benefits are realized, it would be necessary to ensure that development and additional coastal armoring, that may have an adverse effect on the newly restored natural areas, is not allowed in the project area. To reduce this risk the non-federal sponsor should establish and enforce a coastal regulatory program to regulate current and future coastal development. This could be modeled after the Coastal Construction Control Line (CCCL) Program administered by the Florida Department of Environmental Protection (FDEP), which ensures the reasonable use of private property and protects the natural beaches and dunes.

Second, the TSP in Rincón recommends acquisition from R11-R19, rather than the full extent of R22. This is due to focusing the plan on the largest extent of structures that experience the most frequent damages. The area south of R19 generally contains large condos with robust armoring in the existing condition and several single-family units that are already condemned by local government due to safety reasons.

Third, residual risk remains if erosion continues beyond the acquired properties; the high SLC scenario could further exacerbate erosion damages within the study area. USACE formulated for the intermediate SLC curve and assessed the effectiveness of the TSP under high SLC. If a higher SLC scenario was realized, increased erosion associated with higher SLC trends would further affect the structures within Rincón, which could undermine damage reduction benefits achieved under the intermediate SLC scenario. To mitigate this risk, it will be important to monitor erosion rates in conjunction with relative SLC trends over time for potential adaptation within the 100-year adaptation horizon. The formulation of alternatives based on the intermediate SLC curve with the inclusion of adaptation strategies, as needed, is an approach where there is a plan for each potential scenario to ensure resilience to the community.

Potential Adaptation Strategies for Rincón

In Rincón, adaptation could entail additional acquisition of structures, most vulnerable to erosion damages, beyond the TSP based on set thresholds and monitoring. Economic modeling indicates that approximately an additional 10 to 20 structures outside of the current acquisition footprint could be vulnerable to erosion within the 100-year adaptation horizon for the intermediate SLC curve and assuming the background erosion rates continue. Thresholds to determine when adaptation needs to take place will be established and included in the Final Report, based on erosion rates and/or increases in relative

SLC over a specified period of time. To monitor the erosion rates within the potential project area the coastal regulatory program, as recommended to be developed by the non-federal sponsor, will provide a methodology to track erosion rates and the shoreline following construction completion through the 100-year adaptation horizon. Additionally, the non-federal sponsor should monitor the shoreline vegetation and replant, as needed, after storm events to further efforts to reduce the severity of erosional effects on the project area.

During the PED Phase, the monitoring procedure for the project and adaptation strategies, will be written in the OMRR&R manual. The OMRR&R manual will discuss the thresholds for adaption, with lead times required for each action. Once constructed, the project will be placed in the USACE's Comprehensive Evaluation of Projects with Respect to Sea-Level Change tool to provide additional forecast for potential adaptation. The purpose of this tool is to inventory and assess the vulnerability of existing USACE projects to the effects of SLC and provide added benefits to other USACE activities.

7 Environmental Compliance

Ocean Park Planning Reach

Rincón Planning Reach

7 ENVIRONMENTAL COMPLIANCE*

This chapter discusses the status of coordination and compliance of the tentatively selected plan (TSP) with environmental requirements. Additionally, it shows how the TSP meets USACE Environmental Operating Principles.

7.1 SCOPING

The NEPA scoping period for the study was initiated by letter dated October 16, 2018. Public and interagency meetings were held November 6 and 8, 2018 in Aguadilla and San Juan (respectively). Comments and feedback received were primarily concerning protection of sea turtles, manatees, coral reefs/benthic resources, and fish habitat; ensuring public safety; and preservation and enhancement of recreation and tourism. Pertinent correspondence associated with this NEPA scoping process is included in **Appendix H**.

7.2 COOPERATING AGENCIES

This proposed project has been coordinated with the following agencies, among others: USFWS, NMFS, U.S. Environmental Protection Agency (EPA), SHPO, Department of Natural and Environmental Resources, Puerto Rico Environmental Quality Board and OGPe. The EPA by electronic correspondence dated November 13, 2018, indicated they will be a Participating Agency under NEPA and E.O. 13807 ("One Federal Decision"). USFWS by letter dated November 15, 2018, indicated they will not be able to be a cooperating agency for the NEPA process; however, the USFWS will provide technical assistance regarding possible impacts to fish and wildlife resources. The NMFS by letter dated December 21, 2018, accepted USACE's invitation to participate as a cooperating agency. As a cooperating agency, NMFS will provide comments on the draft IFR/EA and participate in teleconferences during study development. Correspondence from all Federal and State agencies in included in **Appendix H.**

7.3 LIST OF RECIPIENTS

The NOA of the draft IFR/EA and Draft FONSI will be mailed/emailed to those listed in **Appendix H**. Electronic distribution (email and webpage) of these documents will also occur.

7.4 COMMENTS RECEIVED AND RESPONSE

Comments received during scoping and public meetings are discussed in Section 6.1 above and included in **Appendix H**. Comments received in response to release of this draft IFR/EA will be discussed here and included in **Appendix H** as well.

7.5 ENVIRONMENTAL COMMITMENTS

USACE shall comply with the terms and conditions resulting from ESA consultations with the USFWS and NMFS, and the Water Quality Certification issued by DNER.

SEA TURTLES IN THE WATER

- The contractor shall instruct all personnel associated with the project of the potential presence of these species and the need to avoid collisions with them. All construction personnel are responsible for observing water-related activities for the presence of sea turtles.

- The contractor shall be responsible for insuring sea turtle nesting monitoring and avoidance activities are conducted. Prior to the start of any work on the beach each morning the contractor shall coordinate with the sea turtle nest monitor to ensure all nests are marked for avoidance.

- The contractor shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing sea turtles, which are protected under the Endangered Species Act of 1973.

- Siltation barriers shall be made of material in which a sea turtle cannot become entangled, be properly secured, and be regularly monitored to avoid protected species entrapment. Barriers may not block sea turtle entry to or exit from the area.

- All vessels associated with the construction project shall operate at no wake/idle speeds at all times while in the construction area and while in water depths where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will preferentially follow deep-water routes (e.g., marked channels) whenever possible.

- If a sea turtle is seen within 100 yards of the active construction or vessel movement, all appropriate precautions shall be implemented to ensure its protection. These precautions shall include cessation of operation of any moving equipment closer than 50 feet of a sea turtle. Operation of any mechanical construction equipment shall cease immediately if a sea turtle is seen within a 50-ft radius of the equipment. Activities shall not resume until the sea turtle has departed the project area of its own volition.

- Any collision with and/or injury to a sea turtle shall be reported immediately to the National Marine Fisheries Services Protected Resources Division (727-824-5312) and the local authorized sea turtle stranding/rescue organization.

MANATEES

- All vessels associated with the construction project shall operate “t "Idle Speed/No Wake” at all times while in the immediate area and while in water where the draft of the vessel provides less than a 4-foot clearance from the bottom. All vessels will follow routes of deep water whenever possible

- Siltation or turbidity barriers shall be made of material in which manatees cannot become entangled, shall be properly secured, and shall be regularly monitored to avoid manatee entanglement or entrapment. Barriers must not impede manatee movement

- All on-site project personnel are responsible for observing water-related activities for the presence of manatee(s). All in-water operations, including vessels, must be shut down if a manatee(s) comes within 50 feet of the operation. Activities will not resume until the manatee(s) has moved beyond the 50-foot radius of the project operation, or until 30 minutes elapses if the manatee(s) has not reappeared within 50 feet of the operation. Animals must not be herded away or harassed into leaving

- Any collision with or injury to a manatee shall be reported to Department of Natural and Environmental Resources Law Enforcement (787-724-5700) and the USFWS Caribbean Ecological Services Field Office (787-851-7297).

- Temporary signs concerning manatees shall be posted prior to and during all in-water project activities. All signs are to be removed by the contractor upon completion of the project. Example awareness signs are located here: https://www.fws.gov/caribbean/es/documents/ManateeSignsLetreros.pdf.

WATER QUALITY

- The Contractor shall monitor water quality (turbidity) at the construction sites, as required by the 401 Water Quality Certification.

- If turbidity values at the construction site exceed permitted values, the Contractor shall suspend all construction activities. Construction shall not continue until water quality meets state standards.

OTHER

- Migratory birds (adult birds, eggs and chicks) shall be protected during construction activities.

- The USACE is currently developing a PA with SHPO and other interested parties that will be used to ensure compliance with Section 106 of the National Historic Preservation Act of 1966 (NHPA) (Public Law 89-665). The PA will allow the USACE to complete the necessary archaeological surveys during the PED phase of the project, and it will also allow any additional inventories and

mitigation to be completed after measures have been clearly defined and sited. Consultation and coordination with all interested parties is ongoing and will be finalized prior to project implementation.

- The environmental resources within the project boundaries and those affected outside the limits of permanent work would be protected during the entire period of work.

- An oil spill prevention plan shall be required.

7.6 COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS

7.6.1 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) OF 1969 (PUBLIC LAW 91-190)

Environmental information on the project has been compiled in this draft IFR/EA. This draft IFR/EA will be coordinated with interested stakeholders for review and comment. The project is anticipated to be in compliance with the National Environmental Policy Act.

7.6.2 ENDANGERED SPECIES ACT OF 1973 (PUBLIC LAW 93-205)

In summary, the USACE has determined that the TSP would have no effect on the Scalloped Hammerhead Shark, Nassau Grouper, Giant Manta Ray, Elkhorn, Staghorn, Pillar, Rough Cactus, Lobed Star, Mountainous Star, Boulder Star Corals, DCH for *Acropora* corals, and the Antillean Manatee. The USACE has determined the TSP may affect but would not likely adversely affect (MANLAA) nesting Loggerhead, Hawksbill, Leatherback,Green Sea Turtles, and Queen Conch. Conservation measures for nesting Sea Turtles and Antillean Manatee would be utilized during construction at Barbosa Park and the Skate Park. Best management practices to protect water quality and habitat would be utilized during construction at Ocean Park and Stella. The TSP for Stella would provide 17 acres of additional nesting Sea Turtle beach and dune habitat. Consultation with both the USFWS and NMFS resumed 31 January 2022 with the study restart. Pertinent correspondence can be found within **Appendix H**. The TSP is anticipated to be in full compliance with the Endangered Species Act pending review and concurrence by the NMFS and USFWS. A compiled Biological Assessment was provided to support this document in **Appendix G, Attachment 4**. A specific Biological Assessment for Sea Turtles and Manatee was provided to the USFWS along with this document.

7.6.3 FISH & WILDLIFE COORDINATION ACT OF 1958 (PUBLIC LAW 85-425)

In accordance with an interagency agreement between the USFWS and USACE, coordination with the USFWS shall be conducted through the NEPA process and the Endangered Species Act. The USFWS Coordination Act Report would be provided in response to this Environmental Assessment and supporting Biological Assessments. The TSP is anticipated to be in full compliance with the Act.

7.6.4 NATIONAL HISTORIC PRESERVATION ACT OF 1966 (*INTER ALIA*) (PUBLIC LAW 89-665)

The TSP will comply with Section 106 of the National Historic Preservation Act through a PA executed as part of this study. USACE has initiated consultation, consulted on a tentative APE prior to determination of a TSP, and received concurrence on the development of a programmatic agreement with SHPO. Pursuant to 54 USC 306108, 36 CFR 800.4(b)(2), and 36 CFR 800.14(b)(1)(ii), the PA will defer final identification and evaluation of historic properties until after project approval, additional funding becomes available, and prior to construction. A draft programmatic agreement has been provided to SHPO and the ICP and is included as an **Appendix G, Attachment 6** to this report.

7.6.5 ARCHAEOLOGICAL RESOURCES PROTECTION ACT OF 1979, AS AMENDED (54 USC § 312501-312508: PRESERVATION OF HISTORICAL AND ARCHAEOLOGICAL DATA)

This Act applies to Federally owned and tribally owned lands, including Reservation lands. This Act is not applicable because the TSP does not occur on Federally or tribally owned lands and will not affect such lands.

7.6.6 ARCHAEOLOGICAL AND HISTORIC PRESERVATION ACT (PUBLIC LAW 93-291 AND 16 USC § 469-469C)

The potential for the TSP to effect historic properties will be considered as part of the PA established to comply with the NHPA (see 6.6.4). This will also provide compliance with this act.

7.6.7 ANTIQUITIES ACT OF 1906, AS AMENDED (PUBLIC LAW 59-209; 54 USC § 320301-320303: MONUMENTS, RUINS, SITES, AND OBJECT OF ANTIQUITY AND 18 USC 1866 (B): HISTORIC, ARCHEOLOGIC, OR PREHISTORIC, ITEMS AND ANTIQUITIES)

This Act applies to Federally owned lands. This Act is not applicable because the TSP does not occur on Federally or tribally owned lands and will not affect such lands.

7.6.8 NATIVE AMERICAN GRAVES PROTECTION AND REPATRIATION ACT OF 1990 (PUBLIC LAW 101-601 AND 25 USC § 3001 ET SEQ)

This Act applies to Federally owned lands, including Reservation lands. The TSP does not occur on Federally or tribally owned lands and Native American graves are unlikely to be present within the project area.

7.6.9 AMERICAN INDIAN RELIGIOUS FREEDOM ACT OF 1978 (PUBLIC LAW 95-341 AND 42 USC §§ 1996 AND 1996A)

The TSP will not affect American Indian religious properties and is compliant with this Act.

7.6.10 EXECUTIVE ORDER (E.O.) 11593 PROTECTION AND ENHANCEMENT OF THE CULTURAL ENVIRONMENT

The potential for the TSP to effect historic properties will be considered as part of the PA established to comply with the NHPA (see 6.6.4). This will also provide compliance with this act.

7.6.11 THE ABANDONED SHIPWRECK ACT OF 1987, AS AMENDED (PUBLIC LAW 100-298 AND 43 USC § 2101-2106)

The TSP will not affect submerged resources and is compliance with this Act.

7.6.12 CLEAN WATER ACT OF 1972 , AS AMENDED (PUBLIC LAW 95-217)

A Section 401 water quality certification application will be submitted to DNER, and USACE will obtain this certification prior to construction. All Commonwealth water quality requirements would be met. A Section 404(b)(1) evaluation is included in this report as **Appendix G, Attachment 2**. The TSP is in full compliance with this Act.

7.6.13 CLEAN AIR ACT OF 1972, AS AMENDED (PUBLIC 88-206, 42 U.S.C. 7401 ET SEQ.)

The short-term impacts from construction equipment associated with the project would not significantly impact air quality. No air quality permits would be required for this project. The study areas are designated as an attainment area for Federal air quality standards under the Clean Air Act. Because the project is located within an attainment area, USEPA's General Conformity Rule to implement Section 176(c) of the Clean Air Act does not apply and a conformity determination is not required.

7.6.14 COASTAL ZONE MANAGEMENT ACT OF 1972 (PUBLIC LAW 92-583; 16 USC 1451, ET SEQ.)

A Federal consistency determination (CD) in accordance with 15 CFR 930 Subpart C is included in this report as **Appendix G, Attachment 3**. The USACE CD determined the proposed activity is consistent to the maximum extent practicable with the enforceable policies of the Puerto Rico Coastal Management Program. The CD will be submitted to the PRPB, and Commonwealth concurrence is anticipated after public review of the draft IFR/EA. The TSP is in compliance with this Act.

7.6.15 FARMLAND PROTECTION POLICY ACT OF 1981 (PUBLIC LAW 97-98)

No prime or unique farmland would be impacted by implementation of this project. This Act is not applicable to the project.

7.6.16 WILD AND SCENIC RIVER ACT OF 1968 (PUBLIC LAW 90-542)

No designated Wild and Scenic River reaches would be affected by project related activities. This Act is not applicable to the project.

7.6.17MARINE MAMMAL PROTECTION ACT OF 1972 (PUBLIC LAW 92-522)

USACE does not anticipate the take of any marine mammal during any activities associated with the project. Trained observers will monitor construction activities to ensure appropriate actions are taken to avoid adverse effects to listed and protected marine mammal species during project construction. The TSP is in compliance with this Act.

7.6.18 ESTUARY PROTECTION ACT OF 1968 (PUBLIC LAW 116-337)

In the Estuary Protection Act Congress declared that many estuaries in the United States are rich in a variety of natural, commercial, and other resources, including environmental natural beauty, and are of immediate and potential value to the present and future generations of Americans. This Act is intended to protect, conserve, and restore estuaries in balance with developing them to further the growth and development of the Nation. The nearby, inshore San Juan Bay Estuary is of national significance but would not be affected by the proposed action, therefore, the TSP is consistent with the Act.

7.6.19 FEDERAL WATER PROJECT RECREATION ACT OF 1965 (PUBLIC LAW 89-72)

The project is consistent with the principles of the Federal Water Project Recreation Act, (Public Law 89-72) as amended.

7.6.20 MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT OF 1976 (PUBLIC LAW 109-479)

Pursuant to the 2019 EFH Finding between USACE and NMFS, USACE's Notice of Availability of the draft IFR/EA will initiate consultation under the Magnuson-Stevens Fishery Conservation and Management Act. Consultation was resumed 31 January 2022 with study restart. In summary, the USACE has determined that there would be **no effect** to EFH or managed species for Barbosa Park and the Skate Park, Ocean Park and Stella, Rincón. This is based on the TSP primarily being upland, placed on old infrastructure/shoreline protection, or in unconsolidated sediments. Detailed mapping and surveys conducted in 2022 show that both study areas are highly diverse in EFH habitat and species. This same mapping shows that the TSP does not overlap with these essential fish habitats or would not cause disturbance to managed species. The TSP is anticipated to be in compliance with the Act.

7.6.21 COASTAL BARRIER RESOURCES ACT AND COASTAL BARRIER IMPROVEMENT ACT OF 1990 (PUBLIC LAW 97-348)

The Coastal Barrier Resources Act (CBRA) and the Coastal Barrier Improvement Act of 1990 (CBIA) limit Federally subsidized development within the CBRA Units to limit the loss of human life by discouraging development in high risk areas, to reduce wasteful expenditures of Federal resources, and to protect the natural resources associated with coastal barriers. The TSP would not affect the three CBRS Units located near San Juan, PR-87 Punta Vacia Talega and PR-87P Punta Vacia Talega OPA and PR-86P Punta Salinas OPA or Rincón, PR-72 Rio Guanajibo and PR-75 Espinar. This TSP is in compliance with the Act.

7.6.22 RIVERS AND HARBORS ACT OF 1899 (33 USC 401, ET SEQ.)

The proposed work in not anticipated to obstruct navigable waters of the United States. The proposed action will be subject to public notice and other evaluations normally conducted for activities subject to the Act. The TSP is in compliance with this Act.

7.6.23 MIGRATORY BIRD TREATY ACT AND MIGRATORY BIRD CONSERVATION ACT OF 1918 (16 USC 701, ET SEQ.)

Migratory birds would be minimally affected by construction of the TSP. USACE will include standard migratory bird protection requirements in the project plans and specifications and will require the Contractor to abide by those requirements. Construction activities will be monitored at dawn or dusk daily during the nesting season to protect nesting migratory birds. If nesting activities occur within the construction area, appropriate buffers will be placed around nests to ensure their protection. The TSP is in compliance with these Acts.

7.6.24 UNIFORM RELOCATION ASSISTANCE AND REAL PROPERTY ACQUISITION POLICIES ACT OF 1970 (PUBLIC LAW 91-646)

The purpose of Public Law 91-646 is to ensure that owners of real property to be acquired for Federal and Federally assisted projects are treated fairly and consistently and that persons displaced as a direct result of such acquisition will not suffer disproportionate injuries as a result of projects designed for the benefit of the public as a whole.

While one of the alternatives considered during plan formulation included the acquisition of real property, this is not part of the TSP. Therefore, this project does not involve any real property acquisition or displacement of property owners or tenants. Therefore, this Act is not relevant to this project.

7.6.25 E.O. 11990, PROTECTION OF WETLANDS

No wetlands would be affected by the TSP. The project is in compliance with the goals of this Executive Order.

7.6.26 E.O. 11988, FLOOD PLAIN MANAGEMENT

To comply with EO 11988, the policy of USACE is to formulate projects that, to the extent possible, avoid or minimize adverse effects associated with the use of the floodplain and avoid inducing development in the floodplain unless there is no practicable alternative. No activities associated with this project are located within a floodplain, which is defined by EO 11988 as an "area which has a one percent or greater chance of flooding in any given year." The project is located within the Coastal High Hazard Area (CHHA), as defined by EO 11988 as an "area subject to inundation by one-percent-annual chance of flood, extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area subject to high velocity wave action from storms." The project shoreline is significantly developed, and further development is anticipated to be minimal, particularly at Stella in Rincón.

CSRM projects are inherently located in coastal areas and are often located in CHHAs based on the problems the project is seeking to alleviate. The primary objective of this study is to reduce residential structure damage. There is no practicable alternative that could be located outside of the CHHA that would achieve this objective.

For the reasons stated above, the TSP is in compliance with EO 11988, Floodplain Management.

Executive Order 11988 requires Federal agencies avoid, to the extent possible, the long- and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect 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 flood plains in carrying out its responsibilities."

The Water Resources Council Floodplain Management Guidelines for implementation of EO 11988, as referenced in USACE 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.

1. **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. However, the project is designed to reduce damages to existing structures located landward of the proposed project.

2. **If the action is in the base flood plain, identify and evaluate practicable alternatives to the action or to location of the action in the base flood plain.** Chapters 3 discusses the process of screening and analyzing both measures and alternatives. Nonstructural, structural, and NNBF measures were all considered in the process.

3. **If the action must be in the floodplain, advise the general public in the affected area and obtain their views and comments.** An Environmental Assessment (EA) is being developed concurrently with the study. During this process the local stakeholders and the general public have been afforded the opportunity to review and comment on the study recommendations.

4. **Identify beneficial and adverse impacts due to the action and any expected losses of natural and beneficial flood plain values. Where actions proposed to be located outside the base flood plain will affect the base flood plain, impacts resulting from these actions should also be identified.** The anticipated impacts and environmental compliance associated with the TSP are summarized in Chapter 7. The project is not expected to alter or impact the natural or beneficial flood plain values

5. **If the action is likely to induce development in the base flood plain, determine if a practicable non-flood plain alternative for the development exists**. The project provides benefits primarily for existing and previously approved development and is not likely to induce significant development. Nonstructural components of the project, and real estate requirements required for construction of the project will reduce the level of development that is at risk. The acquisition in Stella, Rincón would reduce development.

6. **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 flood plain values. This should include reevaluation of the "no action" alternative.** The project is not expected to induce development in the flood plain. The TSP will impact not impact natural or beneficial flood plain values. Due to the built-out level of the city the impact to natural floodplains is considered minimal. Chapter 3 of this report summarizes the alternative identification, screening and selection process. The "no action" alternative was included in the plan formulation phase.

7. **If the final determination is made that no practicable alternative exists to locating the action in the flood plain, advise the general public in the affected area of the findings.** The Draft Integrated Feasibility Report and EA will be provided for public review. Public meetings will be scheduled during the public review period. Comments received will be addressed and, if appropriate, incorporated into the Final Report.

8. **Recommend the plan most responsive to the planning objectives established by the study and consistent with the requirements of the Executive Order. T**he TSP is the most responsive to all of the study objectives and the most consistent with the executive order

7.6.27 E.O. 12898, ENVIRONMENTAL JUSTICE

On February 11, 1994, the President of the United States issued Executive Order 12898, *Federal Actions to Address Environmental Justice Populations and Low-Income Populations*. The Executive Order mandates that each Federal agency make environmental justice part of the agency mission and to address, as appropriate, disproportionately high and adverse human health or environmental effects of the programs and policies on minority and low-income populations.

Any potential adverse effects of the proposed action would be more likely to affect those of higher socio-economic status, such as large watercraft owners or those living in the coastal area surrounding the project. The beneficial effect of a wider, more sustainable beach would benefit all members of the public

who are able to obtain transportation to access the beach. The storm damage reduction benefits are primarily benefitting the landowners in this area. There are no disproportionate adverse impacts to minority or low income implementation of the project. **See Appendix D** for the Environmental Justice analysis.

7.6.28 E.O. 13045, DISPARATE RISKS INVOLVING CHILDREN

On April 21, 1997, the President of the United States issued Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks*. The Executive Order mandates that each Federal agency make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children and ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

As the TSP does not affect children disproportionately from other members of the population, the proposed action would not increase any environmental health or safety risks to children.

7.6.29 E.O. 13089, CORAL REEF PROTECTION

The EO refers to "those species, habitats, and other natural resources associated with coral reefs." Coral reefs are not anticipated to be affected by construction activities. The USACE has completed surveys and Biological Assessment for hardbottom habitat, coral species, and other associated biota, which is provided in Appendix G, Attachments 4 and 5. The EFH Analysis (Appendix G, Attachment 4) provides further detail on the effects to hardbottom habitat. In summary, the USACE has determined that there would be no long-term adverse effect to hardbottom habitat for Barbosa Park and the Skate Park, Ocean Park and Stella, Rincón. This is based on the alternatives primarily being upland, placed on old infrastructure/shoreline protection, or in unconsolidated sediments. Detailed mapping and surveys conducted in 2022 show that both study areas are highly diverse in hardbottom habitat and species. This same mapping shows that the TSP at Barbosa Park does overlap 0.1 acres of colonized bedrock at this level of design, which is anticipated to be both temporary effects and ultimately avoided with plan refinements made during the design phase. In addition, this area of colonized bedrock is frequently covered by drifting sands, creating a naturally shifting benthic community and coral absent zone. The TSP is anticipated to be in compliance with this EO.

7.6.30 E.O. 13112, INVASIVE SPECIES

The proposed action will require the mobilization of construction equipment from other geographical regions. Construction equipment has the potential to transport species from one region to another, introducing them to new habitats where they are able to out-compete native species. The TSP's contract specifications would include measures to clean construction equipment before mobilization to the construction sites, which would reduce the potential for the introduction and spread of invasive species.

7.6.31 ENVIRONMENTAL OPERATING PRINCIPLES

- Foster sustainability as a way of life throughout the organization.

The proposed project formulated measures and alternatives by considering sustainable measures that would mimic the existing site conditions to every extent possible, both when considering structural, non-structural and natural and nature-based features. Measures were formulated and combined into alternatives with long term adaptability and resilience in mind, to reduce the risk of damages from storm surge combined with sea level change.

1. **Proactively consider environmental consequences of all USACE activities and act accordingly.**

Each measure and subsequently each alternative considered both positive and negative effects in the environmental quality account. Effects were avoided and minimized by considering footprints of measures and choosing measures that would have minimal impacts to resources.

2. **Create mutually supporting economic and environmentally sustainable solutions.**

The above description in number 2 demonstrates how environmental effects were considered during the formulation process and in some areas will create additional habitat. The TSP will support the San Juan and Rincón areas by providing a comprehensive plan to allow communities experience less damages from storms and hurricanes and recover faster after storms. Additionally, several of the features (beach, dune, native vegetation) bring in recreational elements which can bring communities together, as well as potentially support tourism, therefore strengthening the economy, community and environment together.

3. **Continue to meet our corporate responsibility and accountability under the law for activities undertaken by USACE, which may impact human and natural environments.**

This report includes all information necessary to document how the project meets USACE's corporate responsibility and accountability requirements for actions that may impact human and natural environments.

4. **Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs.**

The team is involved throughout the study process to ensure that environmental considerations are considered for the life of the project.

5. **Leverage scientific, economic and social knowledge to understand the environmental context and effects of USACE actions in a collaborative manner.**

The entire Project Delivery Team understands the need to consider the environment during its decision-making process and worked collaboratively with agencies to foster education and sharing of policies and best management practices.

6. **Employ an open, transparent process that respects views of individuals and groups interested in USACE activities.**

The actions taken to involve the public, resource agencies, and NGOs who may be interested in the project are outlined in Section 7.1 through 7.4 of this report.

8 District Engineer Recommendation

Ocean Park Planning Reach

Rincón Planning Reach

8 DISTRICT ENGINEER RECOMMENDATION

Due to the nature of these very different study areas, in terms of geographical distances, different problems, and different coastal dynamics, a tentatively selected plan was recommended for each planning reach, as a stand-alone project.

The tentatively selected plan for the Ocean Park planning reach includes construction of two floodwalls over a length of 1600 feet in the Barbosa Park area and 1200 feet in the vicinity of Marías skate park to reduce coastal flooding in San Juan as a result of hurricanes and storms. This plan also includes features to integrate it into the community and maintain recreation as well as aesthetic qualities. This plan has an estimated cost of $65,000,000 and delivers $2,816,000 in average annual NED benefits, $420,000 in average annual net benefits over a 50-year period of analysis with a benefit to cost ratio (BCR) of 1.3. Approximately 6,878 days of business disruption due to coastal flooding are reduced and life safety risk is reduced. Nearly 40% of the benefits would be gained by the most socially vulnerable populations by reducing coastal flooding damages due to the Residencial Luis Llorens Torres community.

The tentatively selected plan for the Rincón planning reach is for acquisition of vulnerable structures along approximately 1.1 miles of shoreline. It uses nature-based and non-structural solutions to proactively prevent 82% of the first-row structural failures that are projected to occur in the future-without project condition. The sandy shoreline would be naturally restored and would support the tourism-based regional economy into the future by maintaining $3,372,000 (AAEQ) worth of local tourism spending. Most notably, this plan sustains community cohesion by allowing the community of Stella to thrive rather than submit to decline with the renewal of a beach and removal of unsafe and unsightly structures, stopping and reversing the spread of decline in the community. The plan does not require mitigation but would instead re-establish 4.14 average annual habitat units for shoreline species within the acquisition footprint (eventually creating 17 acres of beach habitat). This study would positively affect the town of Stella, which is identified as a historically economically disadvantaged community. This plan currently has an estimated cost of $110,848,000 (FY23). It has an NED cost of $3,725,000 (AAEQ) with NED benefits of $1,013,000 (including increased recreation), negative net benefits of -$2,712,000 and a BCR of 0.27. Since this plan deviates from the National Economic Development (NED) plan, a policy exception for this plan was approved by the Assistant Secretary of the Army, Civil Works (ASA, CW) on 8 May 2023.

Both TSPs are supported by the Governor of Puerto Rico and Secretary of DNER. Both of these plans will contribute to coastal resiliency for Puerto Rico, and the Nation, in order to prepare, absorb, recover and adapt, using best management practices for long-term sustainability of Puerto Rico's shorelines.

The residual risks in Rincón are a tolerable risk. To mitigate those risks, I recommend that the first, it would be necessary to ensure that development is prevented on the newly restored land which will have a restrictive easement to prohibit future development at the time of acquisition. Second, I recommend that DNER and the Rincón municipality actively monitor the shoreline for potential future erosion and necessary adaptation if certain triggers are met, to continue to manage the shoreline into the 100-year adaptation horizon and also mitigate the risk of other structures in the future.

The residual risk of potential for the high sea level change scenario in Ocean Park is a tolerable risk. To mitigate this risk, I recommend that DNER and the municipality of San Juan actively monitor sea level change and follow recommendations in the report if certain triggers are met. In addition to mitigate this risk, I echo the recommendation expressed in the San Juan Metro Area CSRM report, in recommending

that that "reaches 4 through 6" (Cano Martin Pena, Los Corozos and San Jose Lagoon, Torrecilla Lagoon) should be evaluated under a separate study in order to adequately address both storm surge and precipitation (compound flooding) holistically, using the same study authority that is used for this study.

I have given consideration to all significant aspects in the overall public interest including engineering feasibility, economic, social, cost and risk analysis, and environmental effects. The Tentatively Selected Plans described in this draft report provides the optimum solution for coastal storm risk management benefits within the study area that can be developed with the framework of the formulation concepts.

8.1 ITEMS OF LOCAL COOPERATION

Federal implementation of the project for coastal risk management is subject to the non-Federal sponsor agreeing to perform, in accordance with applicable Federal laws, regulations, and policies, the required items of local cooperation for the project, including but not limited to the following:

a. Provide 35 percent of construction costs, as further specified below:
    (1) Provide, during design, 35 percent of design costs in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;
    (2) Provide all real property interests, including placement area improvements, and perform all relocations determined by the Government to be required for the project;
    (3) Provide, during construction, any additional contribution necessary to make its total contribution equal to at least 35 percent of construction costs;

b. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) that might reduce the level of coastal storm risk reduction the project affords, hinder operation and maintenance of the project, or interfere with the project's proper function;

c. Inform affected interests, at least yearly, of the extent of risk reduction afforded by the project; participate in and comply with applicable Federal floodplain management and flood insurance programs; prepare a floodplain management plan for the project to be implemented not later than one year after completion of construction of the project; 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 the project;

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

e. Give the Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project to inspect the

project, and, if necessary, to undertake work necessary to the proper functioning of the project for its authorized purpose;

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

g. Perform, or ensure performance of, any investigations for hazardous, toxic, and radioactive wastes (HTRW) that are determined necessary to identify the existence and extent of any HTRW regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9601-9675, and any other applicable law, that may exist in, on, or under real property interests that the Federal government determines to be necessary for construction, operation and maintenance of the project;

h. Agree, as between the Federal government and the non-Federal sponsor, to be solely responsible for the performance and costs of cleanup and response of any HTRW regulated under applicable law that are located in, on, or under real property interests required for construction, operation, and maintenance of the project, including the costs of any studies and investigations necessary to determine an appropriate response to the contamination, without reimbursement or credit by the Federal government;

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

j. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended, (42 U.S.C. 4630 and 4655) and the Uniform Regulations contained in 49 C.F.R Part 24, in acquiring real property interests necessary for construction, operation, and maintenance of the project including those necessary for relocations, and placement area improvements; and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

8.2 DISCLAIMER

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 higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to higher authority as proposals for authorization and implementation funding. However, prior to transmittal to higher authority, the sponsor, the states,

interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

JAMES L. BOOTH
Colonel, EN
Commanding[27]

[27] Final Report will have signature by the Commander.

9 List of Preparers

Ocean Park Planning Reach

Rincón Planning Reach

9 LIST OF PREPARERS

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10 References and Acronyms

Ocean Park Planning Reach

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10 REFERENCES AND ACRONYMS

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10.2 LIST OF ACRONYMS

AAEQ: Average Annual Equivalent

ASA(CW): Assistant Secretary of the Army for Civil Works

BCR: Benefit-cost ratio

BMP: Best Management Practices

CBIA: Coastal Barrier Improvement Act

CBRA: Coastal Barrier Resources Act

CBRS: Coastal Barrier Resources System

CCCL Coastal Construction Control Line

CFR: Code of Federal Regulations

CG: Construction General

CSRA: Cost and Schedule Risk Analysis

CSRM: Coastal Storm Risk Management

cy: cubic yards

CZMA: Coastal Zone Management Act

DEIS: Draft Environmental Impact Statement

DNER: Department of Natural and Environmental Resources

DoD: Department of Defense

EA: Environmental Assessment

ECL: Erosion Control Line

EFH: Essential Fish Habitat

EIS: Environmental Impact Statement

EQ: Environmental Quality

FCCE: Flood Control and Coastal Emergencies

FDEM: Florida Division of Emergency Management

FDEP: Florida Department of Environmental Protection

FMP: Fishery Management Plan

FONSI: Finding of No Significant Impact

FWC: Florida Fish and Wildlife Conservation Commission

FWOP: Future Without-Project

FWP: Future With-Project

FY: Fiscal Year

GHG: Green House Gas

HTRW: Hazardous, Toxic or Radioactive Waste

ICP: Instituto de Cultura Puertorriqueña

IDC: Interest During Construction

IPR: In Progress review

LERRD: Lands, Easements, Rights-of-Way, Relocations and Disposal

m: meters

MCACES - Micro-Computer Aided Cost Estimating System

MHW: Mean High Water

MLW: Mean Low Water

MLLW: Mean Lower Low Water

MOU: Memorandum of Understanding

MSC: Major Subordinate Command

MSFCMA: Magnuson-Stevens Fishery Conservation and Management Act

MSL: Mean Sea Level

MTZ: Maritime Terrestrial Zone

NAGPRA: Native American Graves Protection and Repatriation Act

NAVD88: North American Vertical Datum of 1988

NED: National Economic Development

NEPA: National Environmental Policy Act

NGO: Non-governmental Organizations

NHC: National Hurricane Center

NHPA: National Historic Preservation Act

NGVD29: National Geodetic Vertical Datum of 1929

NMFS: National Marine Fisheries Service

NOA: Notice of Availability

NOAA: National Oceanic Atmospheric Administration

NOI: Notice of Intent

NOS: National Ocean Service

NRHP: National Register of Historic Places

OCS: Outer Continental Shelf

OMRR&R: Operation, Maintenance, Rehabilitation, Repair and Replacement

OPA: Other Protected Areas

OSE: Other Social Effects

PBO: Programmatic Biological Opinion

P3BO: Programmatic Piping Plover Biological Opinion

PCA: Project Cooperation Agreement

PDT: Project Delivery Team

PED: Preconstruction Engineering and Design

PGL: Policy Guidance Letter

PIR: Project Information Report

PPA: Project Partnership Agreement

PRHTA: Puerto Rico Highway and Transportation Authority

PRVD02: Puerto Rico Vertical Datum of 2002

PV: Present Value

RED: Regional Economic Development

ROM: Rough Order of Magnitude

RSL: Relative sea level

SHPO: State Historic Preservation Office

S&A: Supervision and Administration (Construction Management)

SLC: Sea Level Change

SPBO: Statewide Programmatic Biological Opinion

TCM: Travel Cost Method

T.S.: Tropical Storm

TSP: Tentatively Selected Plan

UDV: Unit Day Value

USACE: United States Army Corps of Engineers

USC: United State Code

USFWS: United States Fish and Wildlife Service

VT: Vertical Team

WIS: Wave Information Study

WRDA: Water Resources Development Act

WRRDA: Water Resources Reform and Development Act