PUERTO RICO COASTAL STUDY

DRAFT INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

APPENDIX F
Planning Matrices and Tables

November 2020

US Army Corps
of Engineers
Jacksonville District

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1 RISK INFORMED DECISION FRAMEWORK & STUDY TIMELINE

Planning has always been about solving problems and making decisions under uncertainty. The risk management framework is a decision-making framework that allows USACE to remain efficient and effective for making decisions under uncertainty with today's complex challenges and limited resources. Since the inception of "SMART Planning" in 2011, where feasibility studies are required to be completed in 3 years and with $3M, USACE Planning has engaged in a significant transformation in the incorporation of risk-informed, decision-focused thinking into planning processes. 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 recommended plan.

Risk-informed planning embodies all the principles and tasks of the USACE risk management framework and the six-step planning process. This paradigm shift to explicitly assessing and managing risk is more important than ever in meeting the USACE Civil Works mission.

The study schedule and milestones are shown in **Table 1-1**. Key Milestones during the Feasibility Phase are described as follows:

- Alternatives Milestone Meeting (AMM): The Alternatives Milestone meeting marks the decision maker's agreement on a clear and logical formulation and evaluation rationale that indicates the study team is making appropriate risk-informed decisions and has a clear direction on next steps to complete the study. This milestone was achieved on December 13, 2018.
- Tentatively Selected Plan Milestone (TSP): At this milestone, the study team has completed the evaluation and comparison of a focused array of distinctly different strategies for achieving the water resources objectives in the study area and identified a TSP to carry forward. This milestone was achieved on July 17, 2020. At this point in the study, the TSP has been characterized to a level of detail consistent with an approximately 10% level of design for structural and nonstructural measures. During feasibility level design, the designs, cost estimates, and benefit analysis will be refined for both structural and nonstructural measures included in the TSP. Risk and uncertainty will also be evaluated to determine ranges of economic benefits and costs and project performance in order to meet the requirements of ER 1105-2-101. Before the release of the draft report, a sensitivity analysis will be completed to assess performance of the TSP under Sea Level Change (SLC) projections other than the USACE intermediate projection that was considered in the evaluation of the alternatives. The TSP will be evaluated at the USACE Low, USACE Intermediate, and USACE High SLC projections to determine how each scenario affects plan performance. In addition, the TSP will be evaluated for a period of 100 years to determine project performance over a 100-year period (vs. the 50-year period of analysis required for plan formulation purposes) at the USACE High rate of SLC.
- Release Draft Report for Public and Agency Review: This integrated draft feasibility report and EA documents the analysis that led to the selection of the TSP to a level of detail required for the release for concurrent public, technical, legal, and policy review.

- Agency Decision Milestone: The study team has also identified additional analysis that is needed following the release of the draft report to develop sufficient cost and design information for the final feasibility-level analysis and feasibility report/EA. The Feasibility Level Design becomes the agency recommended plan after the Agency Decision Meeting. This phase of the study includes development of the Final Draft Report and additional design of the recommended plan, approximately 35%, to reduce risk and uncertainty with cost data, engineering effectiveness, environmental impacts, and economic benefits.
- Final Report State & Agency Review: This integrated final feasibility report and EA documents the analysis that led to the selection of the recommended plan followed by final review and comment.
- Chief's Report: If the recommended plan is supported by USACE decisions makers, it will receive an approved Chief's Report recommending it for Congressional authorization construction.
- The plan will then need to receive 1. Congressional authorization and 2. Appropriations for construction, which would be cost shared as appropriate between USACE and DNER. Upon receipt of these items, the project will continue to the Preconstruction Engineering and Design (PED) phase where a more detailed analysis will be completed in order to develop plans and specifications needed to construct the project.

Table 1-1 Feasibility Study Schedule and Milestones

Alternatives Milestone	13 DEC 2018
Tentatively Selected Plan Milestone	17 JUL 2020
Draft Report Release – Start of Public/Concurrent Review	20 NOV 2020
Agency Decision Milestone	15 MAR 2021
District Engineer's Transmittal of Final Report Package	2 AUG 2021
Division Engineer's Transmittal of Final Report Package	1 OCT 2021
State & Agency (S&A) Review start	19 NOV 2021
Chief's Report Signed	8 FEB 2022

2 SUMMARY OF MANAGEMENT MEASURES

This Section presents some of the tables and matrices developed during the plan formulation analysis documented in Chapter 3 of the main report. Nonstructural flood risk management matrix user guide from the USACE National Nonstructural Committee are presented in **Table 2-1** and **Table 2-2**. **Table 2-3** presents the Matrix with complete structural and nonstructural measures evaluation and scores.

Table 2-1 Nonstructural Flood Risk Management Matrix for Rincon Study Area

US Army Corps of Engineers

Nonstructural Flood Risk Management

National Nonstructural Committee

May 2019	NONSTRUCTURAL FLOOD RISK MANAGEMENT MATRIX	PHYSICAL NONSTRUCTURAL MITIGATION MEASURES									
		Elevation									
		Extend Foundation	Piers	Posts	Columns	Piles	Fill (Compacted)	Relocation	Acquisition	Dry Flood Proofing	Wet Flood Proofing
Flooding Characteristics	**Flood Depth**										
	Shallow (less than 3 ft)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Moderate (3 to 6 feet)	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
	Deep (6 to 12 feet)	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
	Very Deep (more than 12 feet)	N	N	N	N	N	N	Y	Y	N	N
	Flood Velocity										
	Low (less than 3 feet per second)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Moderate (3 to 6 feet per second)	N	Y	Y	Y	Y	Y	Y	Y	N	N
	High (more than 6 feet per second)	N	Y	N	N	Y	N	Y	Y	N	N
	Flash Flooding										
	Yes (less than 1 hour warning)	Y	Y	Y	Y	Y	Y	Y	Y	N	N
	No (more than 1 hour warning)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Debris / Ice Flow										
	Yes	N	Y	N	N	Y	Y	Y	Y	N	N
	No	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Site Characteristics	**Site Location**										
	Coastal Beach Front	N	N	N	N	Y	N	Y	Y	N	N
	Coastal Interior (Low Velocity)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Riverine Flood Plain	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Soil Type										
	Permeable	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
	Impermeable	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Building Characteristics	**Structure Foundation**										
	Slab on Grade (reinforced)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Crawl Space	N	N	N	N	N	Y	Y	Y	N	Y
	Basement	N	N	N	N	N	Y	Y	Y	N	Y
	Abandonment of Crawlspace / Basement	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Structure Construction										
	Concrete, Stone, or Masonry	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Metal	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Wood	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Overall Structure Condition										
	Excellent to Fair	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Fair to Poor	N	N	N	N	N	N	N	Y	N	N
Community (Project Area) Benefits	**Economics**										
	Insurance Premium Reduction (Residential)	Y	Y	Y	Y	Y	Y	Y	Y	N	N
	Insurance Premium Reduction (Non-Residential)	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
	Avoids Adverse Impact on Adjacent Property	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
	Reduction in Admin Costs of NFIP	N	N	N	N	N	Y	Y	Y	N	N
	Reduction in Emergency Costs	N	N	N	N	N	N	Y	Y	N	N
	Public Infrastructure Damage Reduced	N	N	N	N	N	N	Y	Y	N	N
	Intangible Benefits										
	Ecosystem Restoration Potential	N	N	N	N	N	N	Y	Y	N	N
	Recreation Potential	N	N	N	N	N	N	Y	Y	N	N
	Community (Project Are) Cohesion	Y	Y	Y	Y	Y	Y	N	N	Y	Y
	Flood Risk Eliminated	N	N	N	N	N	N	Y	Y	N	N

The US Army Corps of Engineers National Nonstructural Committee (NNC) is available to assist in any aspect of formulating and implementing nonstructural flood damage reduction measures and realizing the opportunities that exist with nonstructural.

For more information, please contact the NNC Chairman and committee members at: nnc@usace.army.mil
or visit the NNC website at: http://www.usace.army.mil/Missions/CivilWorks/ProjectPlanning/nnc/

US Army Corps of Engineers
National Nonstructural Committee

Table 2-2 Nonstructural Flood Risk Management Matrix for San Juan Study Area

US Army Corps of Engineers®

Nonstructural Flood Risk Management

National Nonstructural Committee

May 2019		PHYSICAL NONSTRUCTURAL MITIGATION MEASURES									
NONSTRUCTURAL FLOOD RISK MANAGEMENT MATRIX		Elevation									
		Extend Foundation	Piers	Posts	Columns	Piles	Fill (Compacted)	Relocation	Acquisition	Dry Flood Proofing	Wet Flood Proofing
Flooding Characteristics	**Flood Depth**										
	Shallow (less than 3 ft)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Moderate (3 to 6 feet)	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
	Deep (6 to 12 feet)	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
	Very Deep (more than 12 feet)	N	N	N	N	N	N	Y	Y	N	N
	Flood Velocity										
	Low (less than 3 feet per second)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Moderate (3 to 6 feet per second)	N	Y	Y	Y	Y	Y	Y	Y	N	N
	High (more than 6 feet per second)	N	Y	N	N	Y	N	Y	Y	N	N
	Flash Flooding										
	Yes (less than 1 hour warning)	Y	Y	Y	Y	Y	Y	Y	Y	N	N
	No (more than 1 hour warning)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Debris / Ice Flow										
	Yes	N	Y	N	N	Y	Y	Y	Y	N	N
	No	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Site Characteristics	**Site Location**										
	Coastal Beach Front	N	N	N	N	Y	N	Y	Y	N	N
	Coastal Interior (Low Velocity)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Riverine Flood Plain	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Soil Type										
	Permeable	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
	Impermeable	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Building Characteristics	**Structure Foundation**										
	Slab on Grade (reinforced)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Crawl Space	N	N	N	N	N	Y	Y	Y	N	Y
	Basement	N	N	N	N	N	Y	Y	Y	N	Y
	Abandonment of Crawlspace / Basement	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Structure Construction										
	Concrete, Stone, or Masonry	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Metal	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Wood	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Overall Structure Condition										
	Excellent to Fair	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Fair to Poor	N	N	N	N	N	N	N	Y	N	N
Community (Project Area) Benefits	**Economics**										
	Insurance Premium Reduction (Residential)	Y	Y	Y	Y	Y	Y	Y	Y	N	N
	Insurance Premium Reduction (Non-Residential)	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
	Avoids Adverse Impact on Adjacent Property	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
	Reduction in Admin Costs of NFIP	N	N	N	N	N	Y	Y	Y	N	N
	Reduction in Emergency Costs	N	N	N	N	N	N	Y	Y	N	N
	Public Infrastructure Damage Reduced	N	N	N	N	N	N	Y	Y	N	N
	Intangible Benefits										
	Ecosystem Restoration Potential	N	N	N	N	N	N	Y	Y	N	N
	Recreation Potential	N	N	N	N	N	N	Y	Y	N	N
	Community (Project Are) Cohesion	Y	Y	Y	Y	Y	Y	N	N	Y	Y
	Flood Risk Eliminated	N	N	N	N	N	N	Y	Y	N	N

The US Army Corps of Engineers National Nonstructural Committee [NNC] is available to assist in any aspect of formulating and implementing nonstructural flood damage reduction measures and realizing the opportunities that exist with nonstructural.

For more information, please contact the NNC Chairman and committee members at: nnc@usace.army.mil
or visit the NNC website at: http://www.usace.army.mil/Missions/CivilWorks/ProjectPlanning/nnc/

US Army Corps of Engineers
National Nonstructural Committee

Table 2-3. Screening of Management Measures Matrix

Rincon, Condado, Ocean Park, Isla Verde &Carolina focus areas
Non-Structural Measures

	MEASURES	50-YEAR PLANNING OBJECTIVES			PROJECT CONSTRAINTS	FOUR PRINCIPLES & GUIDELINES ACCOUNTS					
	RINCON & SAN JUAN FOCUS AREAS	Maximize Storm Damage Reduction to Infrastructure	Maintain Existing Recreation (Beach and Nearshore)	Maintain Environmental Quality/Maintain Beach/Dune Interaction	Avoid conflict with Federal and State Regulations	National Economic Development (NED)	Environmental Quality	Other Social Effects	Regional Economic Development (RED)	Total	Measure Carried Forward
	Nonstructural Measures (NS)										
NS-1	No-Action	No improvement	Erosion of existing beach will result in loss of recreation. No impact to nearshore recreation.	Erosion of existing beach will result in loss of beach habitat. Private shore protection measures will result is negative environmental impacts.	Consistent with Federal law.	No project cost. No damages prevented.	Possible loss of turtle nesting habitat due to decreased beach/dune width and private shore protection measures. Minimal change to other factors.	Moderate risk to loss of public facilities (parking, beach access, bathrooms, hospital and schools). Negative effect on community cohesion due to perceived inequality.	Loss of property value and tax value. Loss of other revenue related to existing beach as long -term erosion continues. Employment will be affected because hotels and commercial business provide the main source of income in the area.		No Action will be carried forward as the Future Without Project Condition
NS-2	Coastal Construction Control Line	Increasing construction standards could decrease damage to future Construction.	No impact to nearshore recreation. The erosion of the shoreline will continue resulting on potential loss of beach recreation.	The erosion of the shoreline will continue resulting on potential loss of beach/dune habitat	Implemented by the Commonwealth/local government and is consistent with Federal law.	Would impact future construction but doesn't reduce damages to existing inventory which NED calculation is based on for this study.	Possible loss of turtle nesting habitat due to decreased beach/dune. Minimal change to other factors.	Increased requirements/ restrictions on future construction will improve coastal planning and communities safety	This could help to promote building repairs and new construction .	9	Yes
		1	1	1	2	0	1	2	1		
NS-3	Moratorium on Construction	Doesn't provide damage reduction to current structure inventory but eliminate damages to future construction	The erosion of the shoreline will continue resulting on potential loss of beach recreation. No impact to nearshore recreation.	The erosion of the shoreline will continue resulting on potential loss of beach/dune habitat	Implemented by the Commonwealth/local government and is consistent with Federal law.	Would impact future construction but not reduce damages to existing inventory which NED calculation is based on for this study.	Possible loss of turtle nesting habitat due to decreased beach/dune width. Minimal change to other factors.	Moderate risk to loss of public facilities (parking, beach access, bathrooms). Negative effect on community cohesion due to perceived inequality.	Loss of property value and tax value. Loss of other revenue related to existing beach as long term erosion continues. Employment will be affected because hotels and commercial business provide the main source of income in the area.		
		1	1	1	2	0	1	0	0	6	No

Carried Forward Eliminated 2 Fully Meets Criteria 1 Partially Meets Crieria 0 Does Not Meet Criteria

Rincon, Condado, Ocean Park, Isla Verde & Carolina focus areas
Non-Structural Measures

	MEASURES	50-YEAR PLANNING OBJECTIVES			PROJECT CONSTRAINTS	FOUR PRINCIPLES & GUIDELINES ACCOUNTS					
	RINCON & SAN JUAN FOCUS AREAS	Maximize Storm Damage Reduction to Infrastructure	Maintain Existing Recreation (Beach and Nearshore)	Maintain Environmental Quality/Maintain Beach/Dune Interaction	Avoid conflict with Federal and State Regulations	National Economic Development (NED)	Environmental Quality	Other Social Effects	Regional Economic Development (RED)	Total	Measure Carried Forward
	Nonstructural Measures (NS)										
NS-4	Establish a No-Growth Program	Doesn't provide damage reduction to current structure inventory but eliminate damages to future construction	No impact to nearshore recreation. The erosion of the shoreline will continue resulting on potential loss of beach recreation.	The erosion of the shoreline will continue resulting on potential loss of beach/dune habitat	Implemented by the Commonwealth/local government and is consistent with Federal law.	Would impact future construction but doesn't reduce damages to existing inventory which NED calculation is based on for this study.	Possible loss of turtle nesting habitat due to decreased beach/dune width. Minimal change to other factors.	Loss of property value and tax value. Moderate risk to loss of public facilities (parking, beach access, bathrooms). Negative effect on community cohesion due to perceived inequality.	Loss of property value and tax value. Employment will be affected because hotels and commercial business provide the main source of income in the area.		
		1	1	1	2	0	1	0	0	6	No
NS-5	Relocation of Structures	Relocating existing at risk-structures would reduce Damages. Likely to be high cost	Eventual narrowing of beach could cause loss of beach recreation. No impact to nearshore recreation.	Relocation could reduce private shore protection measures and maintain beach/dune interaction. But erosion will produce eventual narrowing of beach/dune system which would limit or eliminate interaction	Consistent with Federal law.	Costs undetermined at this stage. Likely to be high cost, and more property would need to be acquired as sea level rises.	Eventual narrowing of beach/dune system would limit or eliminate habitat. No impact to nearshore habitat. Minimal change to other factors.	Moderate risk to loss of public facilities (parking, beach access, bathrooms, hospital, schools). Negative effect on community cohesion due to perceived inequality.	Loss of property value and tax value. Loss of other revenue related to existing beach as long -term erosion continues.		
		1	1	1	2	0	1	0	0	6	No
NS-6	Flood Proofing of Structures (Dry)	Waterproofing structures at risk only works up to 3 feet.	No impact to nearshore recreation. Eventual narrowing of beach could cause loss of beach recreation.	The erosion of the shoreline will continue resulting on potential loss of beach/dune habitat	Consistent with Federal law.	Costs undetermined at this stage. Unlikely to achieve needed benefits	Eventual narrowing of beach/dune system would limit or eliminate habitat. No impact to nearshore habitat. Minimal change to other factors.	Unlikely to help most of the communities, therefore might lack of support	This could help to promote building repairs and construction business during implementation.		
		1	1	1	2	1	1	0	1	8	No

Rincon, Condado, Ocean Park, Isla Verde &Carolina focus areas
Non-Structural Measures

	MEASURES	50-YEAR PLANNING OBJECTIVES			PROJECT CONSTRAINTS	FOUR PRINCIPLES & GUIDELINES ACCOUNTS					
	RINCON & SAN JUAN FOCUS AREAS	Maximize Storm Damage Reduction to Infrastructure	Maintain Existing Recreation (Beach and Nearshore)	Maintain Environmental Quality/Maintain Beach/Dune Interaction	Avoid conflict with Federal and State Regulations	National Economic Development (NED)	Environmental Quality	Other Social Effects	Regional Economic Development (RED)	Total	Measure Carried Forward
	Nonstructural Measures (NS)										
NS-7	Flood Proofing of Structures (Wet)	In combination with other measures, this could reduce damages to infrastructure by taking them to higher elevations. However, most homes are concrete block on grade and this type of measure is not practical or realistic for homes.	Loss of beach recreation as beach/dune system continue eroding. No impact to nearshore recreation.	The erosion of the shoreline will continue resulting on potential loss of beach/dune habitat	Consistent with Federal law.	Costs undetermined at this stage. Applying this to entire study area is not feasible. Cost almost certainly outweigh benefit	Possible loss of turtle nesting habitat due to decreased beach/dune width and private shore protection measures. Minimal change to other factors.	Increased requirements/ restrictions on future construction are typically unfavorable.	Loss of property value and tax value. Loss of other revenue related to existing beach as long -term erosion continues.		
		1	1	1	2	1	1	0	0	7	No
NS-8	Condemnation of Structures and Land Acquisition	Removing damageable elements doesn't reduce the risk to adjacent infrastructure. There is some risk transfer to the second row.	Loss of beach recreation as beach/dune system continue eroding. No impact to nearshore recreation.	The erosion of the shoreline will continue resulting on potential loss of beach/dune habitat	Consistent with Federal law.	Costs undetermined at this stage. Applying this to entire study are is not feasible because cost almost certainly outweigh benefit. This analysis will be done to address residual damages.	Creation of natural area/habitat would improve environment.	Moderate risk to loss of public facilities. Negative effect on community cohesion due to perceived inequality. Shorefront property owners would present high opposition.	Minimal increase with creation of parkland and eco-tourism benefits.		
		1	1	1	2	2	1	0	1	9	Yes
NS-9	Improved Hurricane Evacuation Plan	Hurricane evacuation plan improvements will help to reduce evacuation times, identify vulnerable population and account for shelters as well as enforce protocols to reduce risk to the population	Loss of beach recreation as beach/dune system continue eroding. No impact to nearshore recreation.	Erosion conditions will continue at natural rates. Eventual narrowing of beach/dune system	Implemented by the Commonwealth/ Local government and is consistent with Federal law.	Would reduce the risk of life loss to the population but doesn't reduce the damages to existing inventory which NED calculation is based on for this study	Eventual narrowing of beach/dune system would limit or eliminate habitat. No impact to nearshore habitat. Minimal change to other factors.	Hurricane Evacuation Plan improvement will help understanding of timing, need and risk prevention	Loss of property value and tax value. Improving safety procedures will prevent life losses.		
		1	1	1	2	0	1	2	1	9	Yes

Rincon, Condado, Ocean Park, Isla Verde & Carolina focus areas
Structural Measures

	MEASURES	50-YEAR PLANNING OBJECTIVES			PROJECT CONSTRAINTS	FOUR PRINCIPLES & GUIDELINES ACCOUNTS					
	RINCON & SAN JUAN FOCUS AREAS	Maximize Storm Damage Reduction to Infrastructure	Maintain Existing Recreation (Beach and Nearshore)	Maintain Environmental Quality/Maintain Beach/Dune Interaction	Avoid conflict with Federal and State Regulations	National Economic Development (NED)	Environmental Quality	Other Social Effects	Regional Economic Development (RED)	Total	Measure Carried Forward
	Structural Measures (S)										
S-1	Seawalls	Would maximize storm damage reduction where constructed.	Steepening of beach profile and/or wave reflection may effect beach and nearshore recreation.	wave reflection and erosive effects will narrow the existing beach, potentially eliminating beach/dune interaction.	Consistent with Federal law.	Costs undetermined at this stage, but it has Potential to have moderate cost and high benefits.	Negative effects due to increase of erosion in front of the seawall, reducing sea turtle nesting habitat and wildlife habitat. Only protects the structures but it is detrimental to habitat.	Supported by individual homeowners but little support from the general public when implemented at large scale. Properties adjacent to seawalls could be negatively affected.	Moderate increase to RED through Protection of property value and tax value.		
		2	1	0	2	1	0	1	2	9	Yes
S-2	Revetments	Would maximize storm damage reduction where constructed	Sloped construction causes revetments to take up more beach width than seawalls. Potential loss of beach recreation fronting structures.	Would eliminate beach/dune interaction. Could be implemented on specific locations like headlands where no other measures are feasible	Consistent with Federal law.	Costs undetermined at this stage, but it has Potential to have moderate cost and high benefits.	Negative effects to sea turtle nesting habitat and wildlife habitat due to steep revetments (steeper than 1 to 2). Only protects structures but it is detrimental to habitat.	Supported by individual homeowners but little support from the general public when implemented at large scale.	Moderate increase to RED through Protection of property value and tax value.		
		2	1	0	2	1	0	1	2	9	Yes
S-3	Beach/Dune Nourishment	Continuous nourishment along constructible lengths of shoreline would maximize storm damage reduction.	Beach recreation would be maintained or improved. Nearshore recreation such as surfing and fishing could be impacted for a short period of time after initial nourishment and periodic renourishments.	Beach/dune interaction would be maintained. Could result in impacts to nearshore hardbottom habitat, depending on berm width.	Supported by Federal law except in CBRA zone.	Costs undetermined at this stage, but it has Potential to have moderate cost and high benefits.	Empirical evidence indicates potential negative effects to benthic invertebrates and nearshore habitat are for short periods of time, with habitat recovering within one year. Coral reefs nearby might be negatively impacted. Positive impact to sea turtle nesting habitat.	Protection of public facilities (parking, beach access, bathrooms, hospital and schools). Supported by majority of community.	Significant increase to RED through improvement of tourism/ beach economy. Protection of property value and tax value. Hotels and commercial business provide the main source of income in the area.		
		2	2	1	2	1	1	2	2	13	Yes

Rincon, Condado, Ocean Park, Isla Verde &Carolina focus areas
Structural Measures

	MEASURES	50-YEAR PLANNING OBJECTIVES			PROJECT CONSTRAINTS	FOUR PRINCIPLES& GUIDELINES ACCOUNTS					
	RINCON & SAN JUAN FOCUS AREAS	Maximize Storm Damage Reduction to Infrastructure	Maintain Existing Recreation (Beach and Nearshore)	Maintain Environmental Quality/Maintain Beach/Dune Interaction	Avoid conflict with Federal and State Regulations	National Economic Development (NED)	Environmental Quality	Other Social Effects	Regional Economic Development (RED)	Total	Measure Carried Forward
	Structural Measures (S)										
S-4	Groins/T-Groins	In combination with beach nourishment, groins could be used at hotspots to stabilize fill and maximize storm damage reduction.	In combination with beach nourishment, beach recreation would be maintained. Periodic renourishments should be reduced due to stabilization effects of groins.	Beach/dune interaction would be maintained.	Supported by Federal law except in CBRA zone.	Costs undetermined at this stage, but it has Potential to have moderate cost and high benefits.	Periodic renourishments could be reduced due to stabilizing effect of groins. Coral reefs nearby might be negatively impacted. Positive impact to sea turtle nesting habitat when implemented with beach nourishment, but groin could be possible entrapment hazard for hatchling sea turtles.	Protection of public facilities (parking, beach access, bathrooms, hospital, schools). Supported by majority of community.	Moderate increase to RED through improvement of tourism/ beach economy. Protection of and tax value.		
		2	1	2	2	1	1	1	1	11	Yes
S-5	Perched beach*	Constructed in select locations, in combination with beach nourishment and a submerged shore parallel structure, could maximize storm damage reduction.	In combination with beach nourishment, beach recreation would be maintained. Reef construction could maintain or improve nearshore recreation such as surfing, fishing, and diving.	Beach/dune interaction would be maintained.	Supported by Federal law except in CBRA zone.	Costs undetermined at this stage, but the cost would likely be excessive	Reef construction on a large beach area could carry significant impacts since the hard structure would be located in the surf zone, where high amount of hardbottoms exist	Protection of public facilities (parking, beach access, bathrooms, hospital, schools).	Significant increase to RED through improvement of tourism/ beach economy. Protection of property value and tax value.		
		2	1	2	2	1	2	1	2	13	Yes
S-6	Nearshore Placement	Could provide moderate storm damage reduction dependent on migration of fill.	Beach recreation could be maintained or improved dependent on fill migration. Nearshore recreation such as surfing and fishing could be impacted Coral reefs nearby might be negatively impacted.	Beach/dune interaction would be maintained, but Coral reefs nearby might be negatively impacted.	Supported by Federal law except in CBRA zone.	Costs undetermined at this stage.	Empirical evidence indicates potential negative effects to benthic invertebrates and nearshore habitat are for short periods of time, with habitat recovering within one year. Volume of sand needed to provide significant benefits could have negative impact to sea turtle nesting habitat dependent on migration of fill.	Minimal protection of public facilities (parking, beach access, bathrooms).	Minimal protection of property value and tax value.		
		1	1	1	2	1	0	1	1	8	No

* Further screened out. The cost would likely be excessive. Groins could provide similar benefits for less cost and environmental impacts.

Rincon, Condado, Ocean Park, Isla Verde &Carolina focus areas
Structural Measures

	MEASURES	50-YEAR PLANNING OBJECTIVES			PROJECT CONSTRAINTS	FEDERAL OBJECTIVES					
	SAN JUAN & RINCON FOCUS AREAS	Maximize Storm Damage Reduction to Infrastructure	Maintain Existing Recreation (Beach and Nearshore)	Maintain Environmental Quality/Maintain Beach/Dune Interaction	Avoid conflict with Federal and State Regulations	National Economic Development (NED)	Environmental Quality	Other Social Effects	Regional Economic Development (RED)	Total	Measure Carried Forward
	Structural Measures (S)										
S-7	Breakwater	As a stand alone measure could improve damage reduction, but it would be more effective in combination with beach nourishment to stabilize fill and maximize storm damage reduction.	Overall beach recreation could be maintained even though nearshore recreation such as surfing could be negatively impacted. Breakwater could serve as reef habitat and could maintain or improve nearshore recreation such as fishing, and diving.	Beach/dune interaction would be maintained.	Supported by Federal law except in CBRA zone.	Costs undetermined at this stage, but it has Potential to have moderate cost and high benefits.	Reef could serve as mitigation for periodic beach nourishment impacts to nearshore habitat in portions of the study area. Emerged breakwaters have potential negative impacts to sea turtle nesting activities and hatchling entrapment.	Protection of public facilities (parking, beach access, bathrooms, hospital and schools). Supported by majority of community.	Moderate increase to RED through improvement of tourism/beach economy. Moderate protection of property value and tax value.		
		1	2	2	2	1	1	2	1	12	Yes
S-8	Dunes and Vegetation	Could improve storm damage reduction as a stand-alone measure.	Beach recreation could be maintained. No impact to nearshore recreation.	Beach/dune interaction would be maintained or improved.	Supported by Federal law except in CBRA zone.	Costs undetermined at this stage, but it has Potential to have moderate cost and high benefits.	Dune creation improves dune habitat and potentially beach habitat for sea turtle nesting. No impact to nearshore habitat	Minimal protection of public facilities (parking, beach access, bathrooms, hospital and schools). Supported by majority of community.	Moderate increase to RED through improvement of tourism/beach economy. Moderate protection of property value and tax value.		
		1	1	2	2	1	2	1	1	11	Yes

3 COMPARISON AND EVALUATION OF ALTERNATIVES UNDER PLANNING CRITERIA

Criteria to evaluate the array of alternatives consisted of evaluations under the four P&G accounts, the required evaluation criteria of completeness, efficiency, effectiveness and acceptability, and the risk based on resilience and residual damages. The main report presents the full analysis for this evaluation and the results (Matrix labeled as Table 3-11). This section only contains the Other Social Effects matrices used to feed the main report matrix.

- 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. This evaluation was conducted taking into consideration the OSE factors listed in ER 1105-2-100. The planning metrics developed by the Institute of Water Resources (Applying Other Social Effects in Alternative Analysis, 2013) were used as a guidance. OSE matrixes with the criteria and evaluations are shown in **Table 3-1** to **Table 3-4**.

Table 3-1. Rincon OSE Evaluation of Preliminary Alternatives

RINCON B - Social Factor and Metrics	Alt 2 -Revetment		Alt 3 -"Beach nourishment - 75' berm&dune"		Alt 4 -Breakwaters		Alt 5 -Beach nourishment 25' berm + breakwaters	
	D	E	D	E	D	E	D	E
Mental Health	1	2	2	2	1	2	2	2
Physical Health	2	2	2	2	2	2	2	2
Physical Safety	2	2	2	3	2	2	2	3
Regional Healthcare	0	2	0	2	0	2	0	2
Economic Vitality								
Business Climate	1	2	3	2	1	2	2	2
Employment Opp	1	2	2	2	1	2	1	2
Financial Impacts	-1	2	2	2	0	2	-1	2
Municipal Services	-1	2	-1	1	-1	2	-1	1
Community Cohesion	0	2	0	2	0	2	0	2
Community Facilities	0	2	0	2	0	2	0	2
Identity								
Cultural Identity	-1	0	1	0	0	0	1	0
Community Identity	-1	1	2	1	1	1	1	1
Social Vulnerability and Resiliency								
Residents of Study Area	2	2	2	2	2	2	2	2
Socially Vulnerable Groups	2	2	2	2	2	2	2	2
Participation								
Public Participation	0	0	0	0	0	0	0	0
Leisure and Recreation								
Recreational Activities	-1	0	2	0	1	0	2	0
Total Daily and Event Score	***6***	***25***	***21***	***25***	***12***	***25***	***15***	***25***
Total Overall Score	***31***		***46***		***37***		***40***	

Notes:

Impacts are measured in comparison to the Without-Project Alternative

D = Impacts to daily lifes (no flooding); E= Impacts during a flood event

Scores can range from -3 (significant negative impact) to +3 (significant beneficial impact)

No more than 25 percent of the metric scores for an alternative should be either -3 or +3

Table 3-2. Condado Pocket Beach OSE Evaluation of Preliminary Alternatives

CONDADO POCKET BEACH Social Factor and Metrics	Alt 2 -Revetment		Alt 3 -Beach nourishment		Alt 4 -Breakwaters		Alt 5 -Beach nourishment + breakwaters	
	D	E	D	E	D	E	D	E
Health and Safety								
Mental Health	1	2	2	2	1	2	2	2
Physical Health	2	2	2	2	2	2	2	2
Physical Safety	2	2	2	2	2	2	2	3
Regional Healthcare	0	2	0	2	0	2	0	2
Economic Vitality								
Business Climate	1	2	3	2	1	2	3	2
Employment Opp	1	2	2	2	1	2	2	2
Financial Impacts	-1	2	0	2	0	2	1	2
Municipal Services	-1	2	-1	1	-1	2	-1	2
Social Connectedness								
Community Cohesion	0	2	0	2	0	2	0	2
Community Facilities	0	2	0	2	0	2	0	2
Identity								
Cultural Identity	-1	0	1	0	0	0	1	0
Community Identity	-1	1	1	1	1	1	1	1
Social Vulnerability and Resiliency								
Residents of Study Area	2	2	2	2	2	2	2	3
Socially Vulnerable Groups	2	2	2	2	2	2	2	3
Participation								
Public Participation	0	0	0	0	0	0	0	0
Leisure and Recreation								
Recreational Activities	-1	0	1	0	1	0	2	0
Total Daily and Event Score	***6***	***25***	***17***	***24***	***12***	***25***	***19***	***28***
Total Overall Score	***31***		***41***		***37***		***47***	

Notes:

Impacts are measured in comparison to the Without-Project Alternative

D = Impacts to daily lifes (no flooding); E= Impacts during a flood event

Scores can range from -3 (significant negative impact) to +3 (significant beneficial impact)

No more than 25 percent of the metric scores for an alternative should be either -3 or +3

Table 3-3. Ocean Park OSE Evaluation of Preliminary Alternatives

OCEAN PARK POCKET BEACH Social Factor and Metrics	Alt 2 -Revetment		Alt 3 -Beach nourishment		Alt 4 -Breakwaters		Alt 5 -Beach nourishment + breakwaters	
	D	E	D	E	D	E	D	E
Health and Safety								
Mental Health	1	2	2	2	1	2	3	3
Physical Health	2	2	2	2	2	2	2	2
Physical Safety	2	2	2	3	2	2	3	3
Regional Healthcare	0	2	0	2	0	2	0	2
Economic Vitality								
Business Climate	1	2	3	2	1	2	3	2
Employment Opp	1	2	2	2	1	2	2	2
Financial Impacts	-1	2	2	2	0	2	2	2
Municipal Services	-1	2	-1	1	-1	2	-1	2
Social Connectedness								
Community Cohesion	0	2	0	2	0	2	0	2
Community Facilities	0	2	0	2	0	2	0	2
Identity								
Cultural Identity	-1	0	1	0	0	0	2	0
Community Identity	-1	1	2	1	1	1	2	1
Social Vulnerability and Resiliency								
Residents of Study Area	2	2	2	2	2	2	2	3
Socially Vulnerable Groups	2	2	2	2	2	2	2	3
Participation								
Public Participation	0	0	0	0	0	0	0	0
Leisure and Recreation								
Recreational Activities	-1	0	2	0	1	0	3	0
Total Daily and Event Score	***6***	***25***	***21***	***25***	***12***	***25***	***25***	***29***
Total Overall Score	***31***		***46***		***37***		***54***	

Notes:

Impacts are measured in comparison to the Without-Project Alternative

D = Impacts to daily lifes (no flooding); E= Impacts during a flood event

Scores can range from -3 (significant negative impact) to +3 (significant beneficial impact)

No more than 25 percent of the metric scores for an alternative should be either -3 or +3

Table 3-4. Punta Piedrita and Punta Las Marias Headlands OSE Evaluation of Preliminary Alternatives

PUNTA PIEDRITA AND PUNTA LAS MARIAS HEADLANDS Social Factor and Metrics	Alt 2 -Revetment	
	D	E
Health and Safety		
Mental Health	1	2
Physical Health	2	2
Physical Safety	2	2
Regional Healthcare	0	2
Economic Vitality		
Business Climate	1	2
Employment Opp	1	2
Financial Impacts	-1	2
Municipal Services	-1	2
Social Connectedness		
Community Cohesion	0	2
Community Facilities	0	2
Identity		
Cultural Identity	-1	0
Community Identity	-1	1
Social Vulnerability and Resiliency		
Residents of Study Area	2	2
Socially Vulnerable Groups	2	2
Participation		
Public Participation	0	0
Leisure and Recreation		
Recreational Activities	-1	0
Total Daily and Event Score	***6***	***25***
Total Overall Score	***31***	

Notes:

Impacts are measured in comparison to the Without-Project Alternative

D = Impacts to daily lifes (no flooding); E= Impacts during a flood event

Scores can range from -3 (significant negative impact) to +3 (significant beneficial impact)

No more than 25 percent of the metric scores for an alternative should be either -3 or +3