COVER SHEET
Florida Keys Coastal Storm Risk Management Study
Final Integrated Feasibility Report and
Environmental Impact Statement
Monroe County, Florida

LEAD AGENCY:
Department of the Army
U.S. Army Corps of Engineers, Norfolk District

COOPERATING AGENCIES:
U.S. Environmental Protection Agency, Region 4; Florida Keys National Marine Sanctuary; National Oceanic and Atmospheric Administration Fisheries Division, Florida Department of Transportation

ABSTRACT:
The U.S. Army Corps of Engineers (USACE), Norfolk District and Monroe County propose to implement structural and non-structural measures to manage coastal storm risk in the Florida Keys, Florida. This plan will significantly add to the County's current efforts to promote resiliency and reduce the risks of coastal storm damage. The USACE has prepared an Environmental Impact Statement (EIS) to evaluate potential impacts of the proposed action in accordance with the requirements of the National Environmental Policy Act of 1969, as amended, the 1978 implementing regulations of the NEPA, the 40 Code of Federal Regulations 1500-1508, and other applicable state and federal laws and USACE policies. Four alternatives, including a Structural Only Alternative, a Nonstructural Only Alternative, a Combination Alternative, and the No Action/Future Without Project Alternative, were fully evaluated to determine the potential environmental, cultural, and socioeconomic impacts resulting from the proposed action. Resource areas evaluated in the EIS include land use and land cover, socioeconomics, transportation, water resources, wetlands, floodplains, special status species, wildlife, terrestrial habitat and vegetation, geology and soils, air quality, noise, recreation, utilities, aesthetics and visual resources, and cultural resources. Potential impacts are described in the EIS.

For further information and to submit comments, please contact the U.S. Army Corps of Engineers, Norfolk District:

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Florida Keys Coastal Storm Risk Management Feasibility Study Monroe County, Florida

Final Integrated Feasibility Report and Environmental Impact Statement

July, 2021

US Army Corps of Engineers®
Norfolk District

PERTINANT DATA

Recommended Plan Features

The recommended plan includes the following measures to reduce coastal storm risk and damage throughout the Florida Keys:

- Shoreline stabilization in six different locations along U.S. Route 1 (Overseas Highway) that were identified as having risk of damage due to erosion and/or wave energy during a storm event. These six rock revetment structures range in height from four to ten feet NAVD88 and were designed to reduce damage to a total of approximately 5,500 linear feet of roadway by stabilizing the shoreline and reducing the risk of washout.
- Dry floodproofing 53 critical infrastructure buildings that were identified at risk to damage from coastal storms. Dry floodproofing will reduce the damage caused by storm surge during storm events so that emergency and critical services can resume more quickly after a storm event.
- Nonstructural measures to reduce coastal storm damage by elevating 4,698 residential and dry floodproofing 1,052 nonresidential structures at risk throughout the Keys. Nonstructural measures are applied to a structure to reduce damage from flooding, which in the Keys would be caused by storm surge.

Recommended Plan Costs

First Cost

Civil Works WBS Number	Feature Description	Project First Cost[1] ($1,000s, Constant Dollar Basis)
6[2]	Fish & Wildlife Facilities	$362
16	Bank Stabilization	$14,437
18	Cultural Resource Preservation	$15,758
19	Buildings, Grounds, & Utilities	$1,561,036
	Construction Estimate Totals	$1,451,001
1	Lands and Damages	$50,305
30	Planning, Engineering, & Design	$230,781
31	Construction Management	$230,781
	Project Cost Total	$2,103,462

1. Includes 28% contingency, October 2020 Price Levels
2. This is the cost for environmental mitigation required for the U.S. Route 1 shoreline stabilization

Total Project Cost Apportionment

	Federal (65%)	Non-Federal (35%)	Total
Total Project Cost	$1,802,033,000	$970,326,000	$2,772,359,000
LERRD Credit	$0	$58,925,000	$58,925,000
Cash Contribution	$1,802,033,000	$911,401,000	$2,713,434,000
1. October 2020 price levels			

Recommended Plan Economics

Average Annual Benefits	Project First Costs	Annual O&M Costs	Total Average Annual Costs	Annual Net Benefits	BCR
$131,603,000	$2,103,462,000	$161,000	$85,557,000	$46,046,000	1.5
(1) Discount Rate: 2.5%, October 2020 Price Levels (2) Estimates rounded (3) The present value benefit estimate is with respect to the base year 2035 and the 50-year period of analysis (4) Reduction in damage estimates were generated utilizing the USACE high sea level change curve					

EXECUTIVE SUMMARY

This final integrated feasibility report and environmental impact statement documents the findings of the Florida Keys Coastal Storm Risk Management (CSRM) Study to date.

The Florida Keys are an important asset to the economic development of the United States because the islands are a major tourism destination that also hold unique environmental resources including the third largest coral reef in the world and 17 national and state parks. There is Federal interest in addressing the Keys' high levels of risk and vulnerability to coastal storms which are expected to be compounded by the combined effects of sea level change and climate change. The vulnerability of the Florida Keys to coastal storms was most recently exemplified by the significant damage sustained by Hurricane Irma in 2017.

States and territories with more than one flood-related major disaster declared pursuant to the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5121 et seq.) in calendar years 2014, 2015, 2016, or 2017 qualified for supplemental investigation funds for the initiation and completion of authorized flood and storm damage reduction studies appropriated by Public Law 115-123. High-priority studies were provided supplemental funding in 33 states and three territories which met the criteria due to impacts from Hurricanes Harvey, Irma, and Maria. Florida is one of the 33 states and the Florida Keys Coastal Storm Risk Management Study is one of 14 CSRM studies being conducted with supplemental funds in the State of Florida.

The purpose of the Florida Keys CSRM Study is to evaluate coastal storm risk and recommend a project for implementation that would reduce that risk throughout the study area. The study authority limits the study analysis to the effects of coastal storms that impact the Florida Keys. This includes storm surge, wave attack, and erosion with consideration of the effects of sea level change in the estimates of inundation and how it is expected to damage infrastructure. This study did not formulate plans to address the impacts of sea level rise or precipitation alone, which currently cause nuisance flooding at times outside of coastal storm events. Direct effects of wind associated with coastal storms were also not considered in the development of alternatives. Considering these limitations and the schedule and budget guidelines of the USACE SMART Planning process, the recommended plan is not an all-encompassing solution that would address all aspects of coastal storm risk in the Keys, but it is one important component of the larger ongoing effort by the non-federal sponsor, Monroe County, as well as the municipalities, local organizations, and state and federal government agencies that are all working to reduce risk and improve resiliency in the Florida Keys. Therefore, the goal of this study is to not only reduce coastal storm risk, but also build on resilience by implementing strategic approaches that are compatible with the work of others.

The recommended plan includes the following measures to reduce coastal storm risk and damage throughout the Florida Keys:

- Shoreline stabilization in six different locations along U.S. Route 1 (Overseas Highway) that were identified as having risk of damage due to erosion and/or wave energy during a storm event. These six rock revetment structures range in height from four to ten feet NAVD88 and were designed to reduce damage to a total of approximately 5,500 linear feet of roadway by stabilizing the shoreline and reducing the risk of washout.

- Dry floodproofing 53 critical infrastructure buildings that were identified at risk to damage from coastal storms. Dry floodproofing will reduce the damage caused by storm surge during storm events so that emergency and critical services can resume more quicklynafter a storm event.
- Nonstructural measures to reduce coastal storm damage to 4,698 residential and 1,052 nonresidential structures at risk throughout the Keys. Nonstructural measures are applied to a structure to reduce damage from flooding, which in the Keys would be caused by storm surge. The nonstructural measures in the recommended plan include elevation of residential structures and dry floodproofing of nonresidential structures. For the structures recommended for elevation and floodproofing, property owners may decide to participate in the project (or not) because the implementation of those nonstructural measures is completely voluntary.

The National Economic Development (NED) benefits generated by the recommended plan are expected to exceed the estimated project costs. The relationship between benefits and costs is expressed as a benefit cost ratio (BCR) as shown in Table 1. The recommended plan first cost and total project cost are estimated to be $2,103,462,000 and $2,772,359,000 respectively at October 2020 price levels. The estimated cost includes a 28 percent contingency, environmental mitigation, and preconstruction engineering and design costs. Project first cost is the constant dollar cost of the recommended plan at current price levels and is the cost used in the authorizing document for a project. Table 2 shows the project first cost summary. The total project cost is the constant dollar fully funded with escalation to the estimated midpoint of construction. The construction duration varies for the different elements of the recommended plan. The midpoint of construction is 2027 (Q2) for the U.S. Route 1 shoreline stabilization, 2026 (Q2) for the critical infrastructure floodproofing, 2030 (Q4) for the elevation of residential structures, and 2027 (Q3) for floodproofing of the nonresidential structures that are not critical infrastructure.

Table 1. Project Benefits and Costs

Average Annual Benefits	Project First Costs	Annual O&M Costs	Total Average Annual Costs	Annual Net Benefits	BCR
$131,603,000	$2,103,462,000	$161,000	$85,557,000	$46,046,000	1.5
1. October 2020 Price Levels 2. Discount Rate: 2.5%					

Table 2. First Cost

Civil Works WBS Number	Feature Description	Project First Cost[1] ($1,000s, Constant Dollar Basis)
6[2]	Fish & Wildlife Facilities	$362
16	Bank Stabilization	$14,437
18	Cultural Resource Preservation	$15,758
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30	Planning, Engineering, & Design	$230,781
31	Construction Management	$230,781
	Project Cost Total	$2,103,462

1. Includes 28% contingency
2. This is the cost for environmental mitigation required for the U.S. Route 1 shoreline stabilization

The total project cost is used in Project Partnership Agreements for the implementation of design and construction of a project. Total project cost is the cost estimate provided to the non-federal sponsor for their use in financial planning as it provides information regarding the overall non-Federal cost sharing obligation. The non-federal costs include the value of lands, easements, rights-of-way and relocations, and disposal/borrow areas (LERRDs). There are 14 parcels where an easement is needed or would be acquired in fee for environmental mitigation which is included in the LERRD cost. The project first cost and total project cost are shown in Table 3.

Table 3. Total Project Cost Apportionment

	Federal (65%)	Non-Federal (35%)	Total
Total Project Cost	$1,802,033,000	$970,326,000	$2,772,359,000
LERRD Credit	$0	$58,925,000	$58,925,000
Cash Contribution	$1,802,033,000	$911,401,000	$2,713,434,000

1. October 2020 price levels

Environmental Impacts and Mitgation

A public scoping meeting and several follow up public meetings were held throughout the study process. The most recent public meetings were held in July 2020 during the public review period for the Draft Feasibility Report and Environmental Impact Statement (EIS). Cooperating agencies were invited to participate in the development of this EIS; and consulting parties were invited to participate in the development of a Programmatic Agreement to address historic resources. Interagency coordination of the EIS occurred throughout the study process and is still ongoing.

There will be direct and indirect, temporary and permanent adverse effects on land use and socioeconomics that are moderate to significant. These effects include both adverse and beneficial effects, depending on perspective. There are approximately 4,698 residential homes recommended for elevation. Elevation could present a potentially significant temporary hardship for the low-income families, minorities, disabled and the elderly, because they will have to relocate temporarily during construction. However, the Proposed Action would also allow those affected by repetitive damage the benefit of greater resilience to flood damage associated with coastal storms. Approximately 1,052 nonresidential properties and 53 critical infrastructure facilities would be treated with floodproofing. There would be significant beneficial effects on land use, socioeconomics that are permanent, for those receiving elevations or floodproofing.

There would be minimal adverse effect on flood plains, as no new structures would be built in them. Minor beneficial permanent effects to the flood plain itself are possible, as elevation and wet proofing of existing structures could allow greater hydrologic access to the flood plains. The Study Area includes areas subject to the Coastal Barrier Resources Act (CBRA), which is regulated by the U.S. Fish and Wildlife Service (USFWS) and establishes unit areas and specifies for those areas certain restrictions on federal involvement in the development and/or improvements to buildings. Only one facility, a wastewater treatment facility, is within the Coastal Barrier Resources System (CBRS) unit mapping; however, as critical infrastructure, the USFWS has determined that it qualifies for an exemption from CBRA restrictions. The Proposed Action also will adhere to Executive Order 11988, which requires the federal government to avoid long and short-term adverse effects on flood plains.

Permanent direct and indirect moderately beneficial transportation, safety, and socioeconomic effects would result from the measures recommended for vulnerable sections of U.S. Route 1 to manage risk from erosional damage due to coastal storms. Minor temporary impacts for these measures would occur during construction. There would be permanent, moderate benefits because flood warning systems, land use planning, and emergency planning would help residents evacuate more effectively, orderly, and safely, reducing direct impacts on the traveling public.

There could be minor to moderate permanent adverse effects to any National Register of Historic Places (NRHP) eligible buildings that are subject to elevation or floodproofing; these impacts would be primarily in the NRHP listed Key West Historic District. No adverse effects on archeological resources are anticipated. Coordination pursuant to the National Historic Preservation Act (NHPA) has been concluded with the Florida State Preservation Officer (SHPO), Seminole Tribe of Florida, Miccosukee Tribe, the Seminole Nation of Oklahoma, and the Monroe County Historic Preservation Commission. A Regional Programmatic Agreement (PA) has been prepared to address adverse effects and mitigation and is included in Appendix E, Cultural Resources. USACE would be responsible for all activities related to identifying, assessing and mitigating impacts to historic properties.

Minor to moderate permanent and temporary adverse effects on threatened and endangered species are anticipated for the U.S. Route 1 shoreline stabilization. There would be modifications of up to 0.5 acre of American crocodile critical habitat; up to 0.5 acres of piping plover critical habitat; approximately 0.75 acres of Cape Sable thoroughwort critical habitat, and approximately 0.25 acres of loggerhead sea turtle critical habitat, including turtle nesting areas. Plant species surveys for the Cape Sable Thoroughwort, tree cactus, and Garber's spurge are expected to be necessary during the Preconstruction, Engineering, and Design (PED) phase. A Biological Assessment (BA) was prepared and is included in the Environmental Appendix. Pursuant to Section 7 of the Endangered Species Act (ESA), the U.S. Army Corps of Engineers (USACE) initiated formal consultation with the USFWS on April 30, 2020, with subsequent follow-up revisions and coordination, to address adverse effects and reasonable and prudent measures with respect to these species. Formal Section 7 consultation was concluded on April 12, 2021, with the issuance of a non-jeopardy Biological Opinion from USFWS. Coordination pursuant to the Fish and Wildlife Coordination Act (FWCA) also was completed during the NEPA process, pursuant to a Memorandum of Record between the USACE and the USFWS, culminating in a final letter from USFWS.

Permanent and temporary moderate adverse effects on land use, recreation, beaches, and upland nearshore vegetation would result from the proposed revetment approximately 1,500 linear feet along a narrow section of Long Key beach, in Long Key State Park shoreline, near its campground facility. Impacts on vegetated dune areas will be mitigated with a planting plan suitable to park management. In addition, there would be temporary, direct and indirect, adverse effects on the use of sections of the Overseas Trail, the public pier at Fiesta Key, Long Key State Park campground roadway, and Indian Key Fill beach access area, during an approximately four to five month construction window. However, there would be permanent beneficial effects due to erosion management.

There are no known hazardous materials locations within the proposed revetment areas. However, Phase 1 Environmental Site Assessments may be needed for the elevation of any affected structure constructed prior to 1978, with respect to asbestos-containing materials (ACM), lead-based paint (LBP), and polychlorinated biphenyls (PCBs). If any such contaminants are found, lawful demolition, removal, and disposal of such wastes would be followed.

There would be direct, permanent adverse impacts on approximately 10,250 square feet of sea purslane and sea oxeye-dominated herbaceous wetlands at West Summerland Key. Approximately 100-200 square feet of scrub/shrub wetlands are present at the proposed revetment site as well; however, it is anticipated that they would be avoided. Permanent wetland impacts would be mitigated, and thus would be minor. There would be direct and indirect, minor effects on hydrology, hydraulics, and bathymetry, wildlife, soils, and aesthetics. There will be minor to negligible impacts on geology and soils. Strict erosion and sediment control measures would be employed during construction, in accordance with the State of Florida's Erosion and Sediment Control Designer and Reviewer Manual, July 2013 (or most current version).

There would be no or negligible direct or indirect effect on marine mammals, essential fish habitat (EFH) or fisheries, benthics, submerged aquatic vegetation (SAV), water quality or navigation, because there will be no in-water impacts. The Proposed Action would have negligible temporary effects on air quality during construction due to emissions, and negligible permanent effects are anticipated. However, if in-water natural and nature-based features (NNBFs) are found to be feasible as part of the Proposed Action, then this finding will be modified.

Minor temporary impacts during construction for transportation, land use, noise, aesthetics, wildlife, recreation, and utilities are anticipated. Construction equipment will be visible at almost all locations and would create temporary noise and disturbance to wildlife and the public during construction. However, overall, the permanent effects on land use, recreation, transportation, safety, noise, and utilities are expected to be minimally adverse to mostly beneficial, because these resources would be enhanced through coastal storm risk management.

Issues Raised by the Agencies and the Public

Public comments mostly consisted of concerns as to which properties would be included in the nonstructural measures, and in particular, which ones would be acquired and demolished. However, further economic modeling and analysis completed after the release of the draft report determined that acquisition was no longer a cost-effective measure and the recommended plan does not include acquisition. In addition, elevations or floodproofing would be voluntary. Therefore, the project is not expected to generate public controversy, based on the comments received.

Few agency comments were received during the public comment period. The Florida Department of Environmental Protection (FDEP) indicated that based on the minimal environmental impacts, it had no objections to the project at this stage and, therefore, it is consistent with the Florida Coastal Management Program (FCMP). The FDEP will issue the Water Quality Certificate (WQC) during the permit process in PED. Coordination pursuant to ESA is ongoing with USFWS and will conclude prior to the signing of the (ROD). Coordination pursuant to the FWCA is currently being concluded.

The Environmental Protection Agency (EPA), Florida Department of Transportation (FDOT), South Florida Water Management Division (SFWMD), and the Florida Fish and Wildlife Conservation Commission, and the Advisory Council on Historic Properties (ACHP) all submitted comment letters. All comments have been addressed, and comment letters, response letters and other coordination correspondence are located in the Environmental Appendix, Appendix D.

Issues to Be Resolved:

There are no unresolved issues.

TABLE OF CONTENTS

Environmental Impact Statement (EIS) chapters are marked with an asterisk (*)

APPENDICES

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

ACM – Asbestos Containing Materials

ADCIRC – Advanced Circulation Model

ADM – Agency Decision Milestone

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

BCE – Before the Common Era (replaces B.C.)

BCR – Benefit-to-cost ratio

BFE – Base Flood Elevation

CAA – Clean Air Act

CBRA – Coastal Barrier Resources Act

CBRA – Coastal Barrier Resources System

CCCL – Coastal Construction Control Line

CE – Common Era (replaces A.D.)

CERCLA – Comprehensive Environmental Response, Compensation and Liability Information System

CoP – Community of Practice

CRS – Community Rating System

CSRM – Coastal Storm Risk Management

CWA – Clean Water Act

CZMA – Coastal Zone Management Act

DEM – Digital Elevation Model

DERM – Division of Environmental Resource Management

DO – Dissolved Oxygen

DPR – Florida Department of Environmental Protection, Division of Parks and Recreation

EALL – Expected Annual Life Loss

EIS – Environmental Impact Statement

EFH – Essential Fish Habitat

EO – Executive Order

EQ – Environmental Quality

ER – Engineering Regulation

ESA – Endangered Species Act

ESI – Environmental Sensitivity Index

FAAS – Focus Area Action Strategies

FAC – Florida Administrative Code

FCSA – Feasibility Cost Sharing Agreement

FDEP – Florida Department of Environmental Protection

FFE – Finished Floor Elevation

FDOT – Federal Department of Transportation

FEMA – Federal Emergency Management Agency

FIRM – Flood Insurance Rate Map

FIS – Flood Insurance Study

FKAA – Florida Keys Aqueduct Authority

FKEC – Florida Keys Electric Cooperative

FLKNMS – Florida Keys National Marine Sanctuary

FLMP – Florida Coastal Management Program

FMPA – Florida Municipal Power Agency

FONSI – Finding of No Significant Impact

FPL – Florida Power and Light

FWCAR – Fish and Wildlife Coordination Act Report

FWOP – Future Without Project

G2CRM – Generation II Coastal Risk Model

GIS – Geographic Information System

H&H – Hydrology and Hydraulics

HAPC – Habitat Areas of Particular Concern

HMGP – Hazard Mitigation Grant Program

IWR -- Institute for Water Resources

JD – Jurisdictional Determination

KEYS – Keys Energy Services

LBP – Lead Based Paint

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

LIDAR – Light Detection and Ranging

LPP – Locally Preferred Plan

MA – Model Area

MBTA – Migratory Bird Treaty Act

MHI – Median Household Income

MHW – Mean High Water

MSFCMA – Magnuson-Stevens Fishery Conservation and Management Act

MSL – Mean Sea Level

NAAQS – National Ambient Air Quality Standards

NACCS – North Atlantic Coast Comprehensive Study

NAD – North Atlantic Division

NAVD88 – North American Vertical Datum of 1988

NCA – Noise Control Act

NED – National Economic Development

NEPA – National Environmental Policy Act

NFIP – National Flood Insurance Program

NFS – Non-Federal Sponsor

NHPA – National Historic Preservation Act

NMFS – National Marine Fisheries Service

NNBF – Natural and Nature-Based Features

NOAA – National Oceanographic and Atmospheric Administration

NPDES – National Pollutant Discharge Elimination System

NPL – National Priorities List

NRHP – National Register of Historic Places

NWI – National Wetlands Inventory Project

OFW – Outstanding Florida Waters

OPA – Otherwise Protected Area

OSE – Other Social Effects

OSHA – Occupational Safety and Health Administration

PCB – Polychlorinated Biphenyls

PDRS – Post-Disaster Recovery Strategy

PDT – Project Delivery Team

PED – Preconstruction Engineering and Design

RCRA – Resource Conservation and Recovery Act

RED – Regional Economic Development

RER – Regulatory and Economic Resources

RMC – Risk Management Center

ROGO – Rate of Growth Ordinance

ROI – Region of Influence

RSLR – Relative Sea Level Rise

RSM – Regional Sediment Management

SACS – South Atlantic Coastal Study

SAD – South Atlantic Division

SAFMC – South Atlantic Fisheries Management Council

SAV – Submerged Aquatic Vegetation

SFWMD – South Florida Water Management District

SHPO – State Historic Preservation Office

SIP – State Implementation Plan

SLC – Sea Level Change

SLR – Sea Level Rise

TMDL – Total Maximum Daily Load

TSP – Tentatively Selected Plan

TSS – Total Suspended Solids

URA – Uniform Relocation Assistance and Real Property Acquisition Act (1970)

USACE – United States Army Corps of Engineers

USEPA – United States Environmental Protection Agency

USFWS – United States Fish and Wildlife service

USGS – United States Geological Survey

WASD – Water and Sewer Department

WMA – Wildlife Management Area

WQPP – Water Quality Protection Program

WRDA – Water Resources Development Act

WSEL – Water Surface Elevation

CHAPTER 1 INTRODUCTION

1.1 BACKGROUND

The Florida Keys are an important asset to the economic development of the United States because the islands are a major tourism destination that also hold unique environmental resources including the third largest coral reef in the world and 17 national and state parks. There is Federal interest in addressing the Keys' high levels of risk and vulnerability to coastal storms which is expected to be compounded by the combined effects of sea level change and climate change. The vulnerability of the Florida Keys to coastal storms was most recently exemplified by the significant damage sustained by Hurricane Irma in 2017.

States and territories with more than one flood-related major disaster declared pursuant to the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5121 et seq.) in calendar years 2014, 2015, 2016, or 2017 qualified for supplemental investigation funds for the initiation and completion of authorized flood and storm damage reduction studies appropriated by Public Law 115-123. High-priority studies of projects were provided supplemental funding in thirty-three states and three territories which met the criteria due to impacts from Hurricanes Harvey, Irma, and Maria. Florida is one of the 33 states and the Florida Keys Coastal Storm Risk Management Study is one of 14 CSRM studies being conducted with supplemental funds in the State of Florida.

1.2 STUDY AREA

The study area includes all land and water resources reasonably deemed to be within the vicinity of the Florida Keys, a 123 mile long chain of islands extending into the Gulf of Mexico from the southern tip of mainland Florida, provided they are located entirely within the jurisdictional boundary of Monroe County, FL. A map of the study area is shown in Figure 1-1.

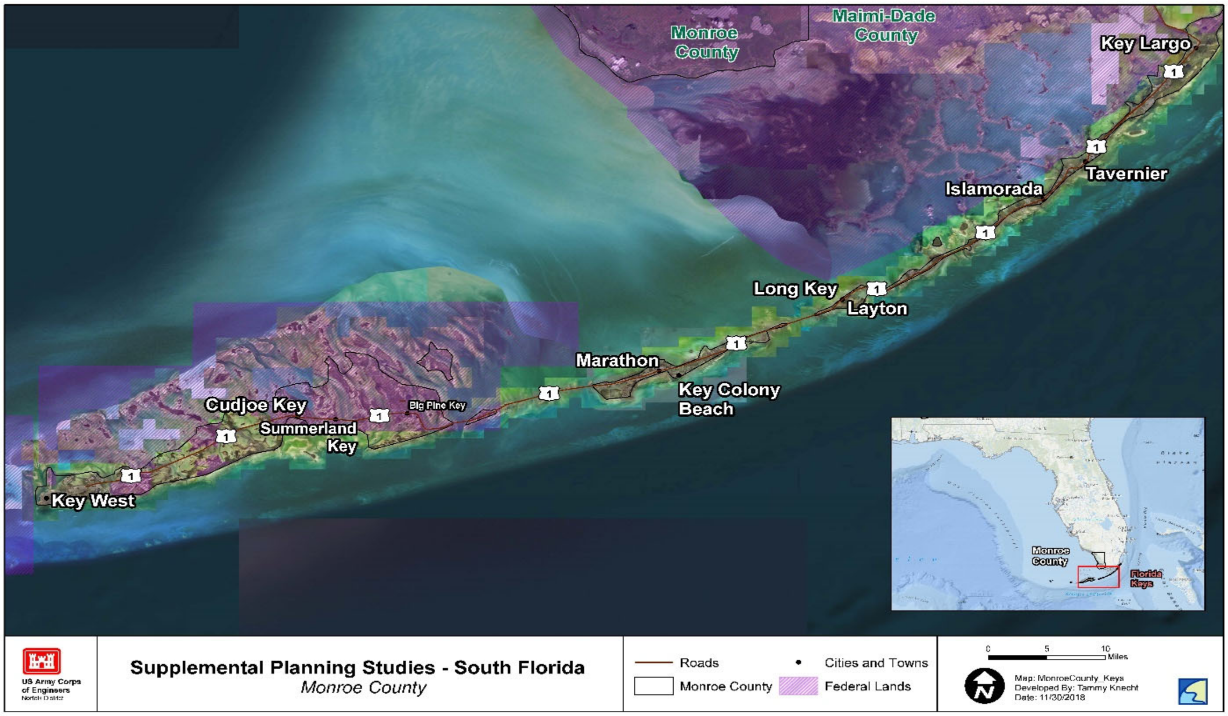


Figure 1-1: Study Area

1.3 PURPOSE AND NEED FOR THE PROPOSED ACTION

The purpose of the Florida Keys CSRM Study is to evaluate coastal storm risk and recommend a project for implementation that would reduce that risk throughout the study area. The study authority limits the study analysis to the effects of coastal storms that impact the Florida Keys. This includes storm surge with consideration for wave attack, erosion, and sea level change in the estimates of inundation and how it is expected to damage infrastructure. This study did not formulate plans to address the impacts of general sea level rise that is often referred to as “sunny day flooding” or precipitation. Direct effects of wind associated with coastal storms were also not considered in the development of alternatives. Due to the limitations of the study, this project is not an all-encompassing solution that would address all of the coastal storm risk in the Keys, but it is one important component of the larger effort by the non-federal sponsor, Monroe County, as well as municipalities, local organizations, and state and federal government agencies that are all working to reduce risk and improve resiliency in the Florida Keys. This study seeks to not only reduce coastal storm risk, but also build on resilience by implementing strategic approaches that are compatible with the work of others.

This study is needed to address the coastal storm risk that is inherent to the low lying chain of islands located in an area that regularly experiences significant coastal storm events such as hurricanes. As shown in Figure 1-2, the majority of the study area is within the 100 year (0.01 AEP) floodplain as defined on the current flood insurance rate map (FIRM). The most severe hurricane to hit the Keys since the 1960's was Hurricane Irma, which made landfall as a category four storm. Irma destroyed or badly damaged more than 4,000 homes throughout the Keys and left almost all homes and businesses without power, water, sewer, and phone service for varying intervals of time. The Florida Department of Transportation (FDOT) documented 68 segments of U.S. Route 1 that experienced erosion and/or washout of the slope, embankment, and/or roadway due to Hurricane Irma. The most severely damaged section of roadway was in Islamorada in a location known as Sea Oats Beach, where there was approximately 300 feet of roadway washout. Residents could not return to the Keys until the roadway had been repaired and critical utilities were back online which took a week for the southern islands in the Keys.

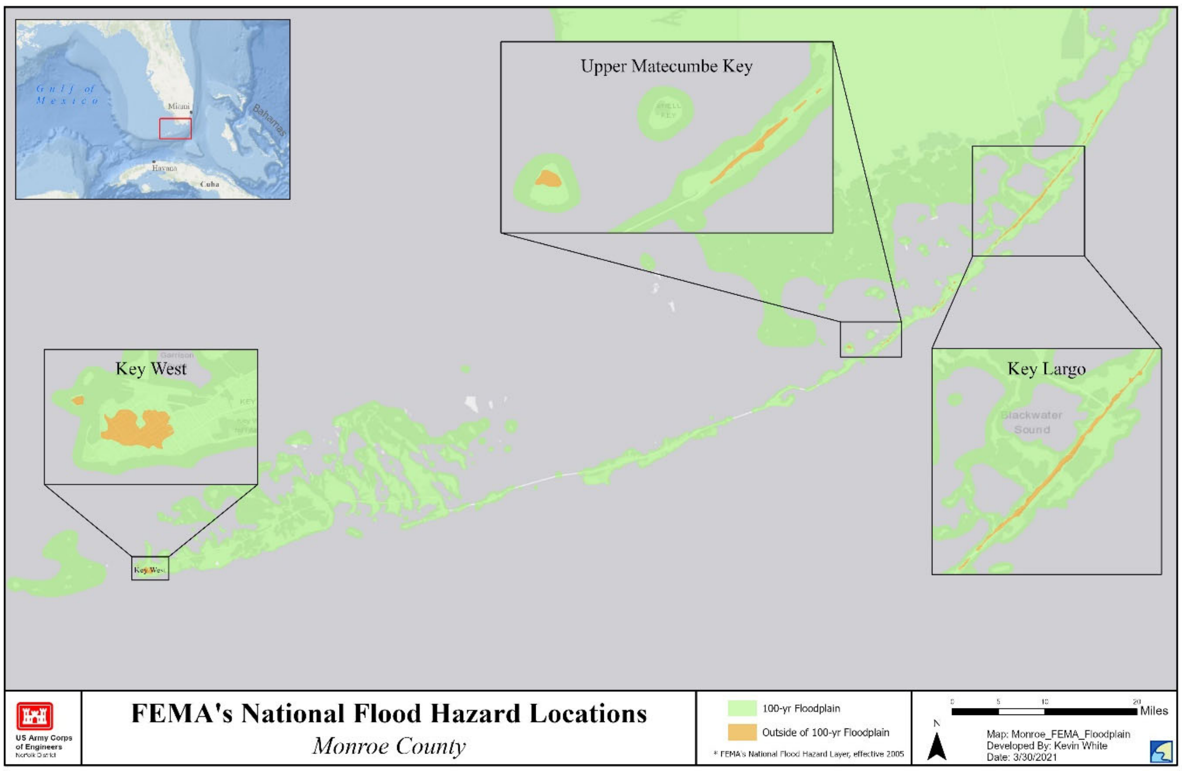


Figure 1-2: National Flood Hazard Locations in the Florida Keys (from the current FIRM effective 2005)

1.4 STUDY AUTHORITY

The study authority is Public Law 84-71, dated June 15, 1955 which authorizes an examination and survey of the coastal and tidal areas of the eastern and southern United States, with particular reference to areas where severe damages have occurred from hurricanes.

Per the Assistant Secretary of the Army for Civil Works (ASA(CW)) memorandum dated 9 August 2018, Subject: Policy Guidance on Implementation of Supplemental Appropriations in the Bipartisan Budget Act of 2018, for feasibility studies (including General Reevaluation

Studies), a new feasibility cost sharing agreement (FCSA) or an amendment to the existing FCSA is required to address use of Supplemental Investigations funds at 100 percent Federal expense. Additionally, this guidance states that studies funded by Public Law 115-123 will be undertaken in accordance with existing Civil Works policies and guidance and incorporate SMART Planning principles.

1.5 RISK INFORMED DECISION FRAMEWORK

This study is being completed using the USACE SMART Planning principles for civil works feasibility studies to ensure that the study results in a recommendation that is Specific, Measurable, Attainable, Risk informed, and Timely (SMART). USACE has adopted a risk informed planning initiative in support of the SMART Planning principle that requires study teams to balance the level of uncertainty and risk regarding level of detail of the study with the understanding that the level of detail required to make planning decisions increases over the course of the study. The USACE planning process has always been iterative, with teams repeating certain steps of the planning process as needed throughout the study. However, under risk informed planning, the need for multiple iterations of the entire planning process is emphasized, with the intent that the quality and quantity of information and analysis should increase with each iteration of the complete planning process. As the quantity and quality of the data used in the study analyses increases, the amount of uncertainty surrounding planning decisions should decrease with each iteration. Throughout the planning process, which is pictured in Figure 1-3, study teams are constantly identifying risk and uncertainty and then deciding which ones must be reduced or eliminated in order to make good planning decisions that will result in the selection of a plan with an acceptable level of risk and uncertainty.

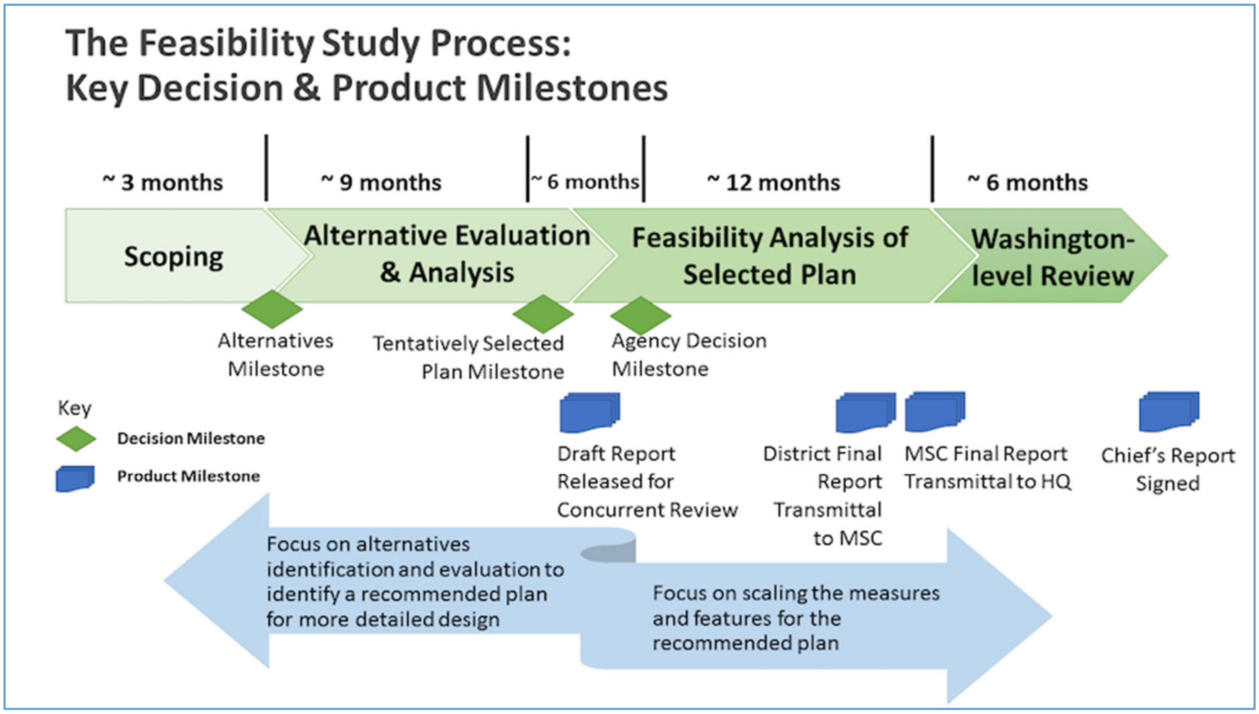


Figure 1-3: SMART Planning Process

Once the study is complete and the plan recommended to Congress in the Chief's Report has been authorized into law, additional and more detailed analysis will be completed prior to implementation of the project during the Preconstruction Engineering and Design (PED) phase. During PED, the approximately ten percent level of design developed during the study phase will be refined so that plans and specifications can be completed for project implementation. Table 10-3 in this report shows the draft implementation schedule.

1.6 COASTAL STORMS AND FLOODING

1.6.1 Describing Storms and Flood Levels

Floods are often defined according to their likelihood of occurring in any given year at a specific location. The most commonly used definition is the "100 year flood." This refers to a flood level or peak that has a 1 in 100, or one percent chance of being equaled or exceeded in any year (i.e., one percent annual exceedance probability or AEP). Therefore, the 100 year flood is also referred to as the "one percent flood," or as having a "recurrence interval" or "return period" of 100 years. A common misinterpretation is that a 100 year flood is likely to occur only once in a 100 year period. In fact, a second 100 year flood could occur a year or even a week after the first one. The term means that that the average interval between floods greater than the 100 year flood over a very long period (say 1,000 years) will be 100 years. However, the actual interval between floods greater than this magnitude will vary considerably. In addition, the probability of a certain flood occurring will increase for a longer period. For example, over the life of an average 30 year mortgage, a home located within the 100 year flood zone has a 26 percent chance of being flooded at least once. Even more significantly, a house in a 10 year flood zone is almost certain to be flooded at least once (96 percent chance) in the same 30 year mortgage cycle. The probability of flooding by various return period floods in any given year and over the life of a 30-year mortgage is summarized in Table 1-1.

Table 1-1. Flood Events by Various Return Periods

Return Period (years)	Chance of Flooding in Any Given Year	Annual Exceedance Probability (AEP)	Percent Chance of Flooding During A 30 Year Mortgage
10	10 in 100 (10%)		96%
50	2 in 100 (2%)		46%
100	1 in 100 (1%)	0.01	26%
500	0.2 in 100 (0.2%)		6%

Because of the potential confusion, recent USACE guidance documents and policy letters recommend use of the annual exceedance probability terminology instead of the recurrence interval or return period terminology. For example, one would discuss the “0.01 AEP” or “one percent chance exceedance flood,” as opposed to the “100 year flood.” This report uses AEP to reference storm events. For example, a 100 year return period would be described as the 0.01 AEP.

1.6.2 Coastal Storm History

Before official records were initiated, historical evidence shows Florida was impacted by storms prior to the 1900s (FEMA 2005). NOAA began weather records for the South Florida area in Key West as early as 1828 (NOAA 2020a). NOAA has three tide gages that may apply to the upper, middle, and lower Florida Keys: Virginia Key, established in 1994, near Miami; Vaca Key, established in 1970; and Key West, established in 1913, respectively. The highest recorded storm tide elevation for the period of record at Virginia Key is 3.8 feet, NAVD88 on September 10, 2017 (Hurricane Irma); 5.4 feet at Vaca Key in October 24, 2005 (Hurricane Wilma); and 3.2 feet at Key West also on October 24, 2005 (NOAA 2020b). Table 1-1 lists notable storm events with storm tide elevations and rainfall amounts collected at various locations within the Florida Keys (FEMA and USACE 1993; USACE 1998; FEMA 2005; MCWG 2015; NOAA 2020 a,b,c,d) (Table 1-2). The table shows a storm tide elevation of 15.3 feet, NAVD88 for Hurricane Andrew in 1992 at nearby Homestead, where surveys at Key Largo showed a lower storm tide elevation of 2.7 feet, NAVD88. The last hurricane event for the area with a comparable storm tide to Hurricane Andrew was the 1935 Labor Day Hurricane, with a storm tide elevation of 16.5 feet, NAVD88 at Lower Matecumbe Key.

Table 1-2: Historical Storm Events.

Storm Event	Location	Storm Tide Elevation, feet, NAVD88	Rainfall, inches
September 22 to October 4, 1929	Key Largo / Key West	7.4 / 4.7	2.9 (Key West Airport)
August 29 to September 10, 1935 (Labor Day Hurricane)	Key Largo / Lower Matecumbe Key / Key West	12.4 / 16.5 / 0.7	1.6 (Key West Airport)
September 12-19, 1945	Southern Biscayne Bay, Carrysfort Reef	12.1	0.2 (Key West)
September 19-25, 1948	Vaca Key / Key West	6.6 / 1.4	8.0 (Key West Airport)
Hurricane Donna, August 29 to September 13, 1960	Upper Matecumbe Key / Plantation Key / Key Largo / Key West	12.0 / 8.5 / 7.3 / 3.4	12.1 (Marathon Shores)
Hurricane Betsy, August 26 to September 12, 1965	Key Largo	7.4	10.5 (Big Pine Key) / 11.8 (Plantation Key)
Hurricane Andrew, August 24, 1992	Homestead, near Charles Deering Estate / Key Largo	15.3 / 2.7	2.0 (Cudjoe Key)
Hurricane Georges, September 1998	Cudjoe Ocean Shores	6.1	8.4 (Tavernier, Key West)
Hurricane Wilma, October 2005	Vaca Key / Key West	5.4 / 3.2	1.5 (Key Largo)
Hurricane Irma, September 2017	Big Pine Key	7.9	6 to 10 (across the Florida Keys)

Sources: FEMA and USACE 1993; USACE 1998; FEMA 2005; MCWG 2015; NOAA 2020 a,b,c,d

The Florida Keys were also impacted by Hurricanes Mitch (November 1998), Irene (October 1999), and Rita (September 2005), but the level of storm surge was less than five feet. While Hurricane Irene did not generate significant storm surge, it did produce a significant amount of rainfall in the Keys, with 8.59 inches of rainfall measured from Key West International Airport. However, the number of National Flood Insurance Program (NFIP) flood claims were less than 400 for each event: 41, 396, and 171, respectively. However, for Hurricanes Georges, Wilma, and Irma, the number of NFIP flood claims was over 3,000 for each event: 3,055, 4,070, and 3,163, respectively (MCWG 2015).

1.6.3 Sea Level Change in the Florida Keys

The NOAA gauge at Vaca Key was used to inform the rate of sea level change that was included in the study. Table 1-3 displays the date of the 6 highest peak water surface elevations on record, storm name and the peak water surfaces elevations by the NOAA gauges. The peak water surface elevations were measured by the NOAA – Key West and NOAA – Vaca Key tide gauge. Water surface elevations include the astronomical tide, storm surge and limited wave setup caused by breaking waves.

Table 1-3. Water Surface Elevations Recorded at the NOAA Gauge at Vaca Key & Key West

	Year	Storm Name	Peak Water Surface Elevations (in feet NAVD88) at Key West	Peak Water Surface Elevations (in feet NAVD88) at Vaca Key
1	1948	Unnamed Hurricane	1.27	N/A
2	1965	Hurricane Betsy	1.87	N/A
3	1992	Hurricane Andrew	1.27	N/A
4	1999	Hurricane Irene	1.29	1.01
5	2005	Hurricane Wilma	3.18	5.43
6	2017	Hurricane Irma	2.73	2.19

Hurricane Wilma is the second strongest storm recorded in the Atlantic Ocean basin. Wilma was a Category 3 hurricane (111-130mph) when it passed by Key West. This event created the largest water surface elevation ever recorded by the Vaca Key gauge. Hurricane Irma made landfall as a Category 4 hurricane at Cudjoe Key with maximum sustained winds at 130mph. Wind gusts were reported at Big Pine Key at 160 mph. The event produced the second largest water surface elevation on record for the Vaca Key gauge.

1.7 PRIOR USACE STUDIES, REPORTS, AND EXISTING PROJECTS

1.7.1 Prior Studies and Reports

There are some notable USACE studies and reports pertaining to coastal storm risk in the study area that have been completed to date:

- Beach Erosion Control Report on Cooperative Study of Key West, FLA, dated 23 October 1957
- Key West, FL., Beach Erosion Control Study Chief's Report, dated 27 June 1958
- Special Flood Hazard Information Report, Monroe County Keys, Florida, dated June 1972

- Plan of Study, Monroe County, Florida, Beach Erosion Control and Hurricane Protection Study, dated June 1976 (revised October 1977)
- Feasibility Report for Beach Erosion Control with Accompanying Environmental Impact Statement for Monroe County, Florida, dated February 1982 (revised April 1983)
- Monroe County, Florida Shore Protection Project General Design Memorandum with Environmental Assessment, dated October 1993
- Monroe County, Florida Shore Protection Project General Design Memorandum with Environmental Assessment, dated October 1999
- Florida Keys Carrying Capacity Study Socioeconomic Module Development for the Carrying Capacity/Impact Assessment Model, dated October 2002

In addition to the completed studies listed, the USACE South Atlantic Division is currently conducting the South Atlantic Coastal Study (SACS) which will conduct regional analyses of coastal risk and identify initial measures/costs that can address vulnerabilities with emphasis on regional sediment management (RSM) as an actionable strategy to sustainably maintain or enhance current levels of coastal storm risk management across 65,000 miles of tidally influenced coastline in the South Atlantic Division area of responsibility affected by sea level rise (SLR) where hurricane and storm damages are occurring, or are forecasted to occur. The goals of the SACS include:

1. Provide a common operating picture of coastal risk to provide decision-makers at all levels with a comprehensive and consistent regional assessment of coastal risk.
2. Identify high risk locations and focus current and future resources on the most vulnerable areas.
3. Identify and assess risk reduction actions that would reduce risk to vulnerable coastal populations.
4. Promote and support resilient coastal communities to ensure a sustainable coastal landscape system, considering future sea level rise scenarios and climate change, and provide information to stakeholders to optimize existing efforts to reduce risk.
5. Promote sustainable projects and programs by developing and providing consistent foundational elements to support coastal studies and projects and regionally managing projects through RSM and other opportunities.
6. Leverage supplemental actions so that multiple supplemental studies and construction efforts will inform and be informed by the SACS.

The SACS will ultimately result in the completion of Focus Area Action Strategies (FAAS) that will use SACS products in combination with other resources to develop actionable risk reduction strategies with stakeholders and serve as examples of how vulnerabilities in other high risk locations can be addressed. A FAAS will be developed for the area that includes the counties of Palm Beach, Broward, Miami-Dade, and Monroe. The Florida Keys CSRM feasibility study PDT has been coordinating closely with the SACS team to ensure that the two efforts are compatible.

1.7.2 Existing Projects

Key West Harbor is a Federal navigation project that provides approximately 23 miles of channel from the main ship channel and anchorage to Garrison Bight and Key West Bight. Garrison Bight forms part of the project for improving Key West Harbor and consists of approximately 3.75 miles of channel, a breakwater along the north side of the bight, and a 12 foot deep turning basin in the bight.

The Intracoastal Waterway, Miami to Key West, Florida provides a channel 7 feet deep and 35 feet wide from Miami to Cross Bank and a channel 7 feet deep by 90 feet wide from Miami to Key West. Finally, there are multiple Federal, state, local, and non-governmental environmental entities that have completed various ecosystem restoration projects within the study area and vicinity, such as coral reef and mangrove restoration.

1.8 PERTINANT STUDIES, PROJECTS, AND INITIATIVES COMPLETED BY THE NON-FEDERAL SPONSOR AND OTHERS

The non-federal sponsor, Monroe County, and other state and federal agencies, non-governmental groups, and other stakeholders all recognize that the Florida Keys are vulnerable to coastal storms and other problems that affect coastal communities, namely sea level change. Monroe County and others have been collectively working on various resilience studies and projects that aim to reduce the impacts that coastal storms will have on the Florida Keys now and in the future and also address the overall resiliency of the Islands so that they can continue to thrive.

1.8.1 Pertinent Work completed by the Non-Federal Sponsor

Monroe County has been working to adapt to the impacts of climate change and identify and reduce coastal storm risk in the Florida Keys. The County has completed various data collection efforts and studies on topics including sea level change, adaptation and mitigation methodologies, and comprehensive planning. The County has also engaged in efforts to improve their class rating in the FEMA Community Rating System and projects to improve county infrastructure to be more resilient to sea level rise. The County uses the Southeast Florida Regional Climate Change Compact Working Group sea level change projections to inform their studies and planning efforts. More information is provided on these projections in Section 2.23 of this report.

Studies and Reports

Several studies pertaining to coastal storm risk in the study area have been completed recently by Monroe County:

- GreenKeys (completed 2015). This was a two year study that resulted in Monroe County's plan for addressing climate change and sea level rise that is considered to be a blueprint for increased sustainability and resilience in the Keys. The GreenKeys study

generated sea level rise scenarios and a vulnerability analysis for roads, county buildings, habitat, and infrastructure.
- Roads Elevation Pilot Project Report (2016). The County conducted this technical analysis based on a data driven method to identify the appropriate design response to potential sea level rise effects on roadways for two communities, Twin Lakes and Big Pine Key, and ultimately recommended road elevation in both locations.
- Watershed Management Plan (2019). This was completed to meet the requirements to achieve a FEMA Community Rating System Class 4 status. The plan focuses on the assessment of storm water drainage systems that are vulnerable to climate change.
- 2030 Comprehensive Plan of Monroe County, Florida (adopted in April 2016 and effective in June 2016). The County is currently revising this plan to address state statutory requirements known as “Peril of Flood” for the conservation and coastal management element and to incorporate updated climate, energy, and sea level rise policies throughout the plan.
- A Repetitive Loss Analysis to identify mitigation strategies for homes at risk for repetitive flood loss (2019)
- A Countywide Roads Vulnerability Assessment/Elevation and Adaption Plan is currently underway for 300 miles of county roads (2019-current)

Projects and Initiatives

Monroe County has also initiated or completed the following projects and engaged in the following initiatives:

- Completed a greenhouse gas emission inventory and convened the Monroe County Green Building Task Force (2008)
- Joined the Southeast Florida Regional Climate Compact as a founding member (2009)
- Convened a Climate Change Advisory Committee and drafted the county’s first Climate Action Plan (2011)
- Created the County’s Office of Sustainability, including the position of County Sustainability Director (2012)
- Completed and formally adopted the GreenKeys Sustainability Action Plan, and in-depth five year work plan to guide the County’s response to sea level rise (2016)
- Achieved Class 5 in the FEMA Community Rating System, a move from the previous Class 10 rating (2016)
- Added policies to Comprehensive Plan to place disincentives on development in high-risk areas (2017)
- Adopted an Interim Design Criteria Resolution for Road Elevations that factor in SLR and future flood risk (2017)
- Incorporated SLR projections into new County facility construction (2018)
- Completed the Countywide Mobile LIDAR survey elevation data gathering effort (2019)
- Completed design work for the Roads Elevation Pilot Projects (2019)
- Completed requirements to achieve Class 4 rating in FEMA Community Rating System (2020, with submittal anticipated in 2021)

- Pursuing various disaster recovery program funding opportunities including the Community Development Block Grant Mitigation (CDBG-MIT) and disaster recovery funding to implement flood mitigation and sea level rise resiliency projects to address critical infrastructure vulnerabilities, build resiliency, reduce risk, and protect people and property (2020-current)

1.8.2 Pertinent Work completed by Florida Department of Transportation

U.S. Route 1 is a critical transportation route and the only evacuation route that leads northward to connect the Keys with mainland Florida. The Florida Department of Transportation (FDOT) is responsible for the maintenance and repair of U.S. Route 1 because it is a state roadway. FDOT maintains U.S. Route 1 and has made repairs required to return the roadway to the previous condition, but generally, has not and does not expect to receive the funding required to make significant improvements to the over 100 mile stretch of roadway known as the Overseas Highway that would reduce storm damage and/or the effects of sea level rise.

Studies and Reports

FDOT has recently completed the following relevant studies and reports:

- Study of Roadway Base Clearance for State Roads in Monroe County, Phase I-GIS Screening Report, November 2018. This report assessed the vulnerability of the road to sea level rise and did not recommend any projects but may be used to identify sites for projects in the future.
- Scoping Report, FM 443893-1, SR 5/US 1/Overseas Highway from MM 73.75 to MM 77.5 (Lower Matecumbe Key), (90050000 MP 14.063-14.072, 90060000 MP 0.000-3.741), Monroe County, FL, July 2019. This report recommends that the segment of U.S. ROUTE 1 at Sea Oats beach be elevated 1.7 feet and includes a schedule that estimates a contract letting date of January 26, 2022 for this work to be initiated.

Planned Projects

FDOT is currently making some targeted improvements in areas that were damaged by Hurricane Irma, most notably, revetment along some segments of roadway to reduce wave energy and erosion in areas exhibiting higher risk to damage by coastal storms. The PDT coordinated closely with FDOT to accurately capture where their projects will be completed and ensure that the revetment completed by FDOT prior to the base year for the economic analysis in this study have been included in the future without project conditions for this study.

The Scoping Report dated July 2019 recommended that the segment of U.S. ROUTE 1 at Sea Oats Beach, a stretch of roadway that is well known in the Keys to be vulnerable to the effects of coastal storms and sea level rise, should be elevated 1.7 feet. The estimated contract letting date is scheduled to take place prior to the base year for the economic analysis in this study, so this project has been included in the future without project conditions for this study.

The plan formulation appendix to this report, Appendix A, includes more detail on how projects completed by FDOT were considered in the analysis of measures to reduce coastal storm risk to U.S. Route 1.

1.8.3 Pertinent Work Completed by Other Stakeholders

There are many other stakeholders in the Florida Keys that have completed studies and projects that were reviewed by the PDT to discern the problems, opportunities, and future without project condition for this study. Important stakeholders include the five municipalities in the Keys; the City of Key West, City of Marathon, City of Key Colony Beach, City of Layton, and Village of Islamorada. There are also multiple state parks and state and federal environmental resource agencies. In addition to the various opportunities for agency and public coordination, the PDT also held numerous additional meetings with stakeholders as needed, especially in areas where the study recommendations could affect the area or operations of that stakeholder.

1.9 AGENCY, TRIBAL, AND PUBLIC COORDINATION

1.9.1 Interagency Coordination

Interagency coordination began with a kick-off planning charette on November 14, 2018. Over 30 federal, state, and local government officials, resource agencies, academics, and nonprofit organization members participated, with the goal of focusing the Florida Keys Coastal Storm Risk Management Study objectives and identifying solutions that would address flood risk in the Keys. During the workshop, workgroups were formed and conferred on these topics.
In addition, the following were invited to be cooperating agencies: U.S. Environmental Protection Agency (USEPA); U.S. Coast Guard; U.S. Navy; Federal Emergency Management Agency (FEMA); Florida Keys National Marine Sanctuary (FKNMS); National Oceanic and Atmospheric Administration’s National Marine Fisheries Division (NOAA) and National Marine Fisheries (NMFS); U.S. Fish and Wildlife Service (USFWS); National Park Service (NPS); Federal Highway Administration (FHWA); Florida Department of Transportation (FDOT); and Florida Department of Environmental Protection (FDEP). The following accepted the invitation: USEPA, FKNMS, NOAA PRD, and FDOT. FEMA is a participating agency.

Interagency meetings were held on January 7, 2019, February 12, 2019, March 21, 2019, and November 20, 2020. After further consideration of potential impacts, a Notice of Intent (NOI) to prepare an Environmental Impact Statement (EIS) was published in the Federal Register on November 8, 2019. Scoping letters were again sent to the interagency team. A follow-up interagency/cooperating agency meeting was held on November 20, 2019. Participants in the various meetings included: Monroe County, USEPA, FKNMS, NOAA PRD, NOAA NMFS, USACE Jacksonville and Norfolk Districts, FDOT, FDEP, and Florida Fish and Wildlife Conservation Commission (FWCC). An Interagency site visit was held to view the locations of the structural measures on December 11-12, 2019. Participants included team members or representatives from FKNMS, NOAA PRD, NOAA NMFS, USACE Jacksonville and Norfolk Districts, FDOT, FDEP (State Parks), and the City of Islamorada. Comment letters were received from FKNMS, NOAA PRD, NOAA NMFS, USEPA, FWCC.

Coordination under the U.S. Fish and Wildlife Coordination Act (FWCA) with the U.S. Fish and Wildlife Service (USFWS) was completed. Coordination under Section 7 of the Endangered Species Act concluded on April 12, 2021 with a non-jeopardy Biological Opinion. Coordination pursuant to the FWCA was concluded on April 14, 2021. All coordination materials are provided in **Error! Reference source not found.** Appendix, Appendix D.

Coordination under the NMFS under the Magnuson-Stevens Fishery Conservation and Management Act has been conducted. An Essential Fish Habitat Assessment was initially prepared; however, it was not needed, because after the Proposed Action was subsequently modified, the footprint is no longer in subaqueous areas. Consultation as required pursuant to Section 106 of the National Historic Preservation Act (NHPA) was completed with the signing of the Regional Programmatic Agreement on March 9, 2021, and the notification to the signatories and consulting parties on April 21, 2021, that the Regional PA is in effect for this project. All coordination pursuant to the NHPA are provided in the Cultural Resources Appendix, Appendix E.

The study team has coordinated with FDOT throughout the entire study, but increased the frequency of information sharing and level of collaboration following the September 2019 public meetings in Key Largo and Key West for the months leading up to identification of the TSP and TSP milestone meeting in January 2020. During this time, FDOT shared with the PDT a list of all the projects that will be completed along U.S. Route 1 as a result of damage that occurred during Hurricane Irma and all of the detailed plans and designs that they had available for those projects and these were reviewed by engineering team members. Once the PDT had refined the shoreline stabilization areas to be included in the TSP, a webinar was held with various FDOT staff and the PDT so that the proposed revetments could be discussed in detail and any remaining redundancies identified. During this webinar, there were also detailed discussions regarding the designs and construction schedules for the FDOT projects planned along U.S. Route 1. The PDT will continue to coordinate closely with FDOT for the remainder of the study.

A personal meeting was held in October 2018 with the Tribal Historic Preservation Officer (THPO) for the Seminole Tribe of Florida during which the basic scope and objective of the project was presented. Notices for the scoping meetings, along with brief project descriptions, were sent in November 2018 to the Deputy State Historic Preservation Officer (SHPO), THPOs for the Seminole Tribe of Florida and Miccosukee Tribe, the Chief of the Seminole Nation of Oklahoma, and the Monroe County Historic Preservation Commission. In October 2019 a draft of a project-specific programmatic agreement was sent to the SHPO. In January 2020 a form answering detailed questions about the project was completed and sent to the Advisory Council on Historic Preservation (ACHP) to inform their decision on participation in the development of the project-specific programmatic agreement. During the project it was determined that the project-specific programmatic agreement that was originally prepared would not be used but rather a regional programmatic agreement entitled, "*Programmatic Agreement Among the United States Army Corps of Engineers, the Florida State Historic Preservation Officer, the Bureau of Ocean Energy Management, and the Advisory Council on Historic Preservation Regarding Compliance with Section 106 of the National Historic Preservation Act During*

Implementation of the United States Army Corps of Engineers, Jacksonville District Operations, Navigation, and Shore Protection Programs". A copy of the regional programmatic agreement is provided in the Cultural Appendix. A summary of the coordination and consultation conducted for the regional programmatic agreement is provided in a Memorandum for the Record dated 9 February 2021 and is provided in the Cultural Appendix. Coordination was conducted with tribal governments, the ACHP, and SHPO to notify them that the regional programmatic agreement would be utilized for the Florida Keys Integrated Report and Environmental Impact Statement; a copy of this coordination is provided in the Cultural Appendix as well.

1.9.2 Public Involvement

On December 3-4, 2018, the USACE held National Environmental Policy Act (NEPA) Open-House-Style Public Scoping meetings in the Cities of Islamorada and Key West. USACE staff were on-hand with storyboards to show the areas of the city to be addressed, to describe the potential measures, to answer questions, and to obtain public comments. Approximately 31 people attended, and eight public comments were submitted during and after the meeting.
On September 11-12, 2019, the USACE held Open House Style Public Meetings in Key Largo and Key West to update the public on the measures and the alternatives. The meeting was an open-house style forum including updated storyboards and a brief introduction to the study and status update by the Norfolk District at the midpoint of the meeting. Approximately 40 people and the media attended these meetings, and a total of 23 public comments were received. The public was again given the opportunity to comment after the NOI was published on November 8, 2019.

Prior to the September 2019 public meetings, a web-based GIS tool called Crowd Source Reporter was developed for the study to facilitate the communication of the proposed alternatives to the public and as an additional platform for the public and stakeholders to make comments with an option to reference them to a certain location on the map. All public comments and USACE responses from both of these meetings are included Environmental Appendix, Appendix D.

As mentioned earlier, on November 8, 2019, an NOI was published in the Federal Register to notify the public of the decision to prepare an EIS. A newspaper announcement was also run in The Citizen newspaper. The Crowd Source Reporter tool was reopened for public comments. No additional public comments were received.

CHAPTER 2 AFFECTED ENVIRONMENT*

2.1 LAND USE

Land use comprises the natural conditions and/or human-modified activities occurring at a particular location. Human-modified land use categories include residential, commercial, industrial, transportation, communications and utilities, agricultural, institutional, recreational, and other developed use areas. Figures 2-1 through 2-4 show land use in the Keys. State laws, management plans, and zoning regulations determine the type and extent of land use allowable in specific areas and often intend to protect specially designated or environmentally sensitive areas. Zoning requirements are regulations developed by the locality to control potential future development. Comprehensive plans evaluate long term demographic trends to identify how the region of analysis should be developed. Where zoning focuses on immediate trends in development, comprehensive plans are generally less regulatory in nature and often serve as guidance when current planning department is evaluating applications for development.

The Region of Influence (ROI) for land use consists of all areas directly and indirectly affected by the proposed structural and nonstructural measures, from Palo Alto Key (north Key Largo) extending southwest to Key West, Florida, including shoreline and adjacent wetlands. Monroe County has a 2030 Comprehensive Plan adopted on April 30, 2016, as well as a Rate of Growth Ordinance (ROGO), which governs growth and is explained further in this section. The aquatic environment surrounding the Keys falls within the boundaries of the Florida Keys National Marine Sanctuary (FKNMS), which is under the jurisdiction of the National Oceanic and Atmospheric Administration (NOAA 2019a).

2.1.1 Existing Conditions

Land Use in the Keys is similar throughout the Upper and Middle Keys (Figures 2-1 to 2-4). It is predominantly low and middle intensity development dispersed along population centers on US Route 1. Key Largo, Tavernier, Islamorada, and Marathon are large population centers. The developed landscape intensifies with more middle intensity development near Marathon. In the Lower Keys, Boca Chica Key and in particular, Key West, are large population centers, with an urban landscape of low, medium and high density development.

Population density of Monroe County, at 74.3 people per square mile (28.6/km2), is moderately lower than the U.S. as a whole, and substantially lower than the rest of Florida. However, in the Florida Keys portion of Monroe County, population density is 591 per square mile (227.3/km2). According to the U.S. Census Bureau, American Community Survey (2019), Monroe County has a population of approximately 74,228, and 32,839 households. However, these are the figures for permanent residency; the total population during peak season more than doubles, to a total population of approximately 155,000 (Monroe County, 2016). Monroe County experienced population increase of 1.6% between 2010 and 2019 (US Census, 2020).

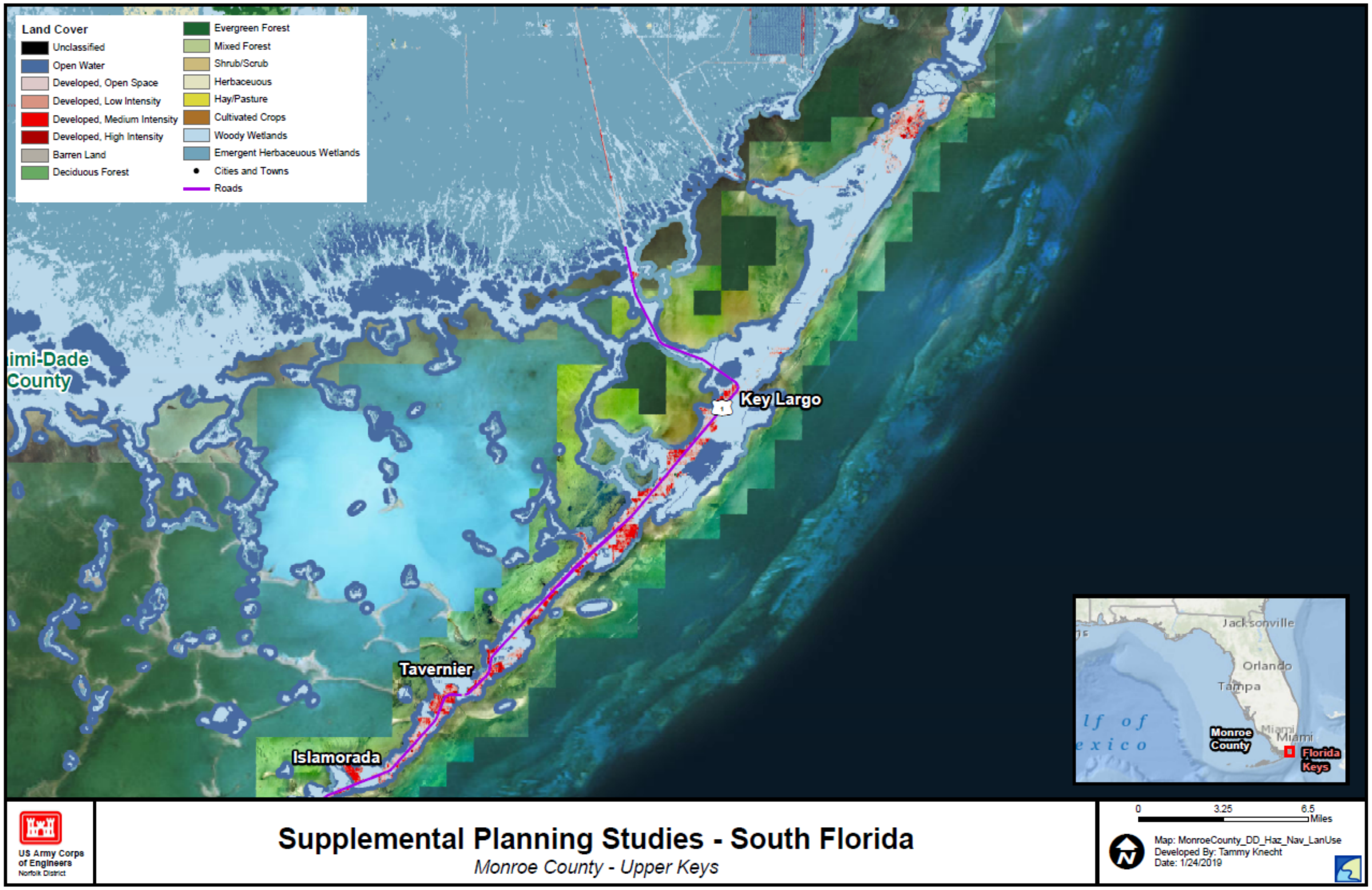


Figure 2-1. Land Use, Upper Keys

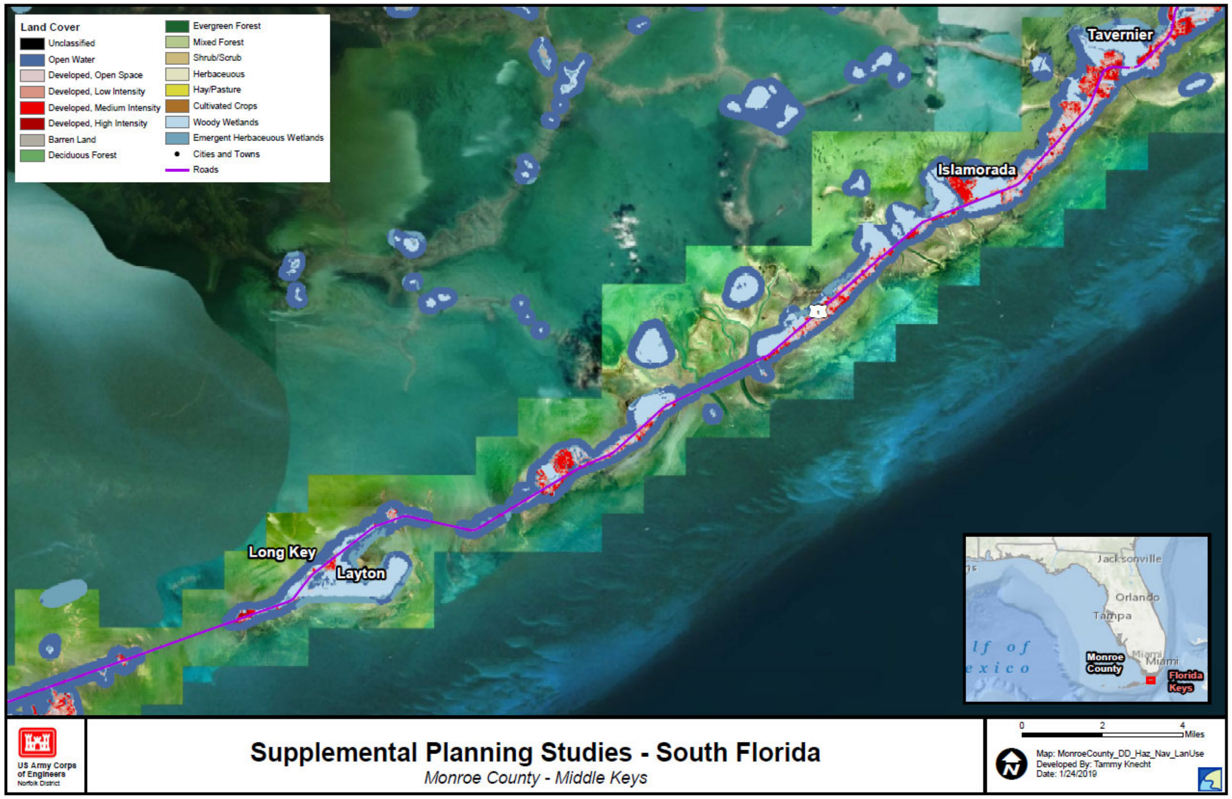


Figure 2-2: Land Use, Middle Keys

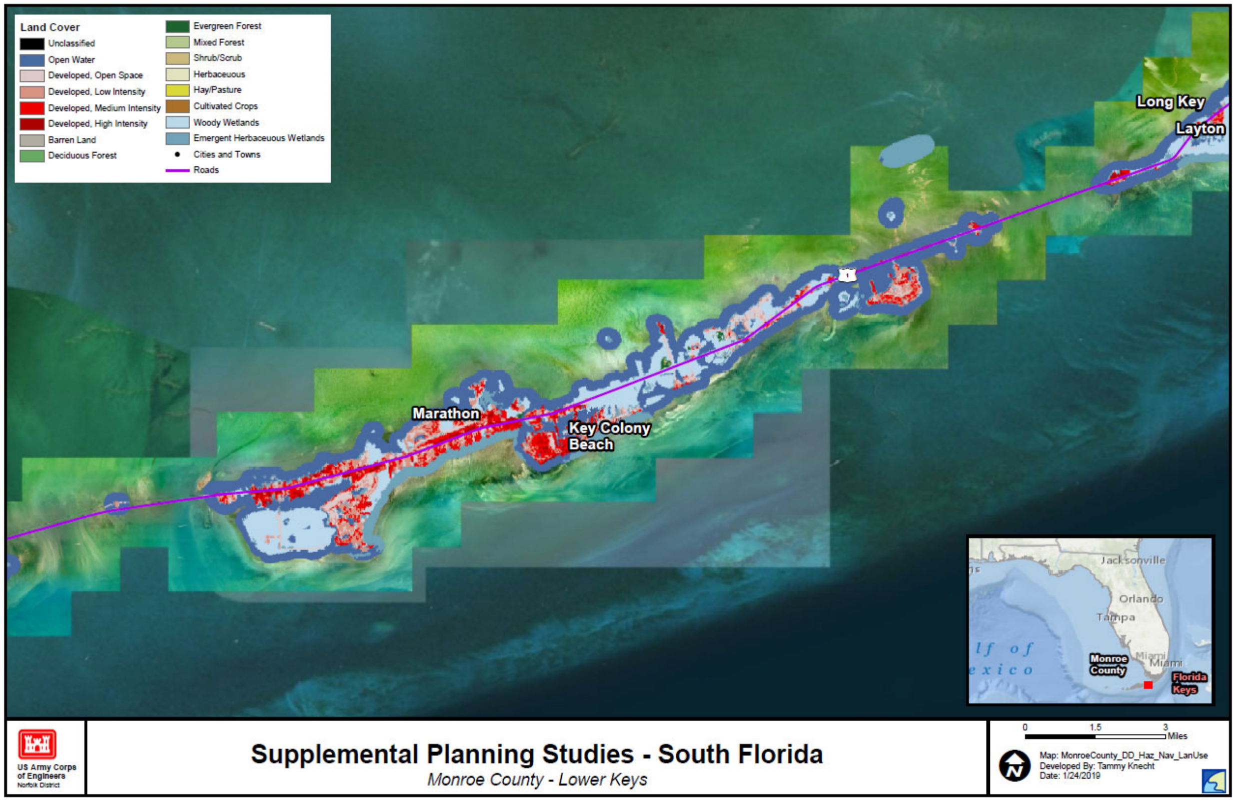


Figure 2-3: Land Use, Lower Keys

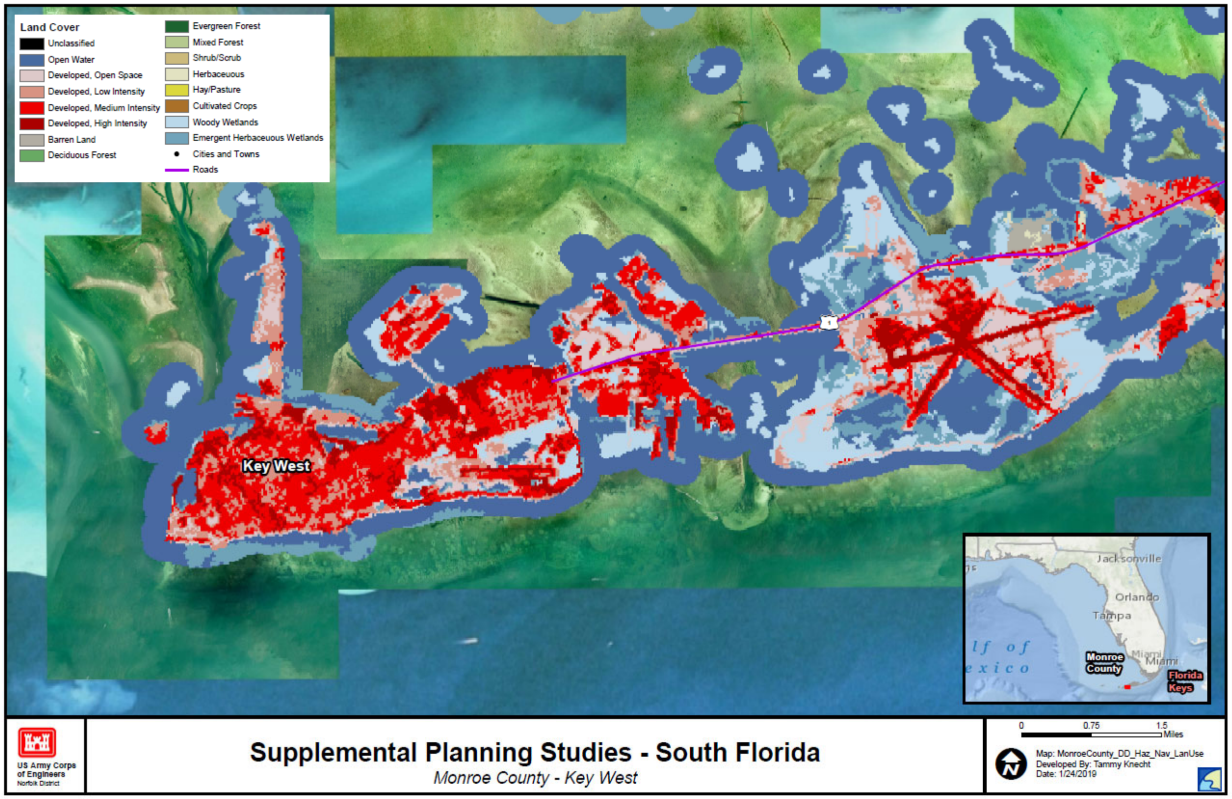


Figure 2-4: Land Use, Key West

More than 75 percent of land in the unincorporated Keys is set aside for conservation purposes. Of the developed land uses, residential is the largest land use category, representing approximately 6.8 percent of the land uses in the county, followed by military at 5.5 percent, utilities and rights-of-way at 4.4 percent, vacant at 3.2 percent, recreation at 1.8 percent and commercial at 1.2 percent (Monroe County, 2011).

A major land use in the Florida Keys is recreational and tourism. Monroe County has 11 state parks, including the Florida Keys Overseas Heritage Trail, which runs alongside U.S. Route 1. The Florida Keys Overseas Heritage Trail, a recreational trial and alternative transportation corridor that opened in 2011, is a 90-mile-long string of pathways, bridges, and green spaces abutting U.S. Route 1. The trail provides pedestrian and bicycle access to the scenic highway. It has the highest visitation of any state park in the Florida Keys. In 2015, it accounted for 38.5 percent of all state park visitation in the Florida Keys. State park visitation has been highly variable over the six-year period 2010-2015, ranging from a low of 2.1 million for all state parks in 2010 to a high of almost 4.6 million in 2013. This is discussed more in the recreation section of this document (Marine Sanctuary, 2019).

The ROI also contains military facilities: U.S. Navy facilities (Navy Air Station Key West on Boca Chica Key, lodging and task force areas in Key West), a U.S. Air Force Station in Summerland Key, and a U.S. Coast Guard Station in Marathon; however, those will not be included in the plan formulation, as federal lands can only be included in a Civil Works study on a reimbursable basis, upon request from the federal agency. If involvement has not been requested and such lands are within the study area, Civil Works funds may be used if including them in a project is more cost effective than excluding them. For this study, military installations did not request USACE include them on a 100 percent reimbursable basis and it was not more cost effective to include federal infrastructure in the recommended project.

Monroe County residential development is controlled by the Rate of Growth Ordinance (ROGO). The limit on the amount of residential development is based upon the ability to safely evacuate the Keys within 24 hours. Under ROGO, the state only allocates 197 housing units per year to the county for building permit issuance. Monroe County also adopted a Non-Residential Rate of Growth Ordinance in 2001 to “ensure a reasonable balance between the amount of future non-residential (primarily commercial) development and the needs of a slower growing residential population.” The Non-Residential Rate of Growth Ordinance attempts to maintain a ratio of approximately 239 square feet (22.2 m2) of nonresidential floor area for each new residential permit issued through the Residential Rate of Growth Ordinance. In addition, the municipal jurisdictions have building permit allocation systems that are similar to growth restrictions of the County; those and any other the growth management requirements specific to each would also apply. (Monroe County, 2011).

Of all the new single family housing growth in Monroe County since 1999, nearly 70 percent has been in non-homesteaded units. According to a population projection study in 2011, this is likely a function of both growth in seasonal population as well as permanent population loss, which may cause once permanently occupied existing units to become non-homesteaded (Monroe County, 2011).

Population projections for the functional population are also a driver for estimating future land uses. The functional population includes the number of permanent residents plus the number of seasonal residents in the Florida Keys on a given day. This number varies by season because of seasonal patterns of visitation. In addition, seasonal visitors are a classification used by the Monroe County Planning Department that ties population with demand for housing as well as for evacuation. Seasonal residents include visitors to Monroe County (including day visitors) and residents that are renting. The functional population projections are constrained by all the above noted constraints on growth and development (Leeworthy et al. 2010).

The functional population for Monroe County (unincorporated and incorporated areas) is important for planning roads, water supply, sewage treatment, and other infrastructure needs. One of the most important uses is for hurricane evacuation, which is a key element constraining growth in Monroe County. Most of the land that can be developed in Monroe County exists in the unincorporated areas, so the population projections are important in assessing the potential for growth in the development of those lands (Leeworthy et al. 2010).

2.2 SOCIOECONOMICS

Existing demographic and economic information was drawn from the U.S. Census Bureau, American Community Survey, and local planning agencies.

As mentioned earlier, based on the U.S. Census Bureau's American Community Survey, Monroe County had a total population of 74,228 and contained 32,839 households in 2019 (U.S. Census Bureau, 2019). However, during peak tourist seasons, the population more than doubles, to approximately 155,000 (Monroe County, 2016).

The impacts of implementing proposed project measures to various segments of the population is considered, especially with regard to the geographic distribution of these population elements and the impacts of the project measures in these areas. U.S. U.S. Census (2019) demographic and economic data on environmental justice was considered in evaluating these impacts.

Florida's reputation as a retirement haven is reflected by the over 65 population being higher than the national average at 17.8 percent, with Monroe County having 18.5 percent of its population over 65. Approximately 66 percent is white, 24 percent is Hispanic, 7 percent is black, 1 percent is Asian, with "other" making up 1 percent or less. Approximately 19% of the population of Monroe County is foreign-born, or about 90 percent of the rate of the State of Florida, at 21.1 percent (US Census, 2019).

Education levels are slightly above the state's average, with Monroe having 34.5 percent with a BA or more and Florida having 30.4 percent. The Median Household Income (MHI) for Monroe is $68,589, or approximately 20 percent higher than the State of Florida MHI of $59,227. The poverty incidence rate of Monroe County is 8.7 percent, which is about two-thirds the rate of the State of Florida, which is 12.7 percent (US Census, 2019). The poverty level, as defined by the US Department of Health and Human Services (2019), is $12,490 annual income for a single person and $25,750 for a household of four.

2.3 TRANSPORTATION

Transportation refers to the operational characteristics of the land transportation network, including the network's capacity to accommodate existing and projected future travel demand. Networks may encompass many different types of facilities that serve a variety of transportation modes, such as vehicular traffic, public transit, and non-motorized travel. Access to, within, and from the study area is provided via a network of freeways, arterial streets, connector streets, public transit services, and non-motorized transportation facilities (including bicycles, sidewalks, and pedestrian trails). However, it should be noted that recreational trails are covered under the recreation section of this document.

The ROI for transportation includes all roadways (freeways, major and minor arterial roads, collector roads, and neighborhood roads); air, bus routes, other mass transit, trails, and pedestrian sidewalks within the study area, that will be affected directly or indirectly by the project. It should be noted that navigation is covered in a separate section.

2.3.1 Existing Conditions

Roads

The spine or supporting structure of the Florida Keys is U.S. Route 1, or the Overseas Highway, which begins at Mile Marker 1 in Key West, Florida. Built upon the abandoned Florida East Coast Railroad footprint, US Route 1 is the only major artery transporting tourists and residents throughout the Keys and likewise serves as the only roadway evacuation route from the Keys during storm events. It spans 113 miles and has 42 overseas bridges connecting mainland or peninsular Florida with the Keys.

In 2017, a Travel Time and Delay Study was conducted by URS Consultants in order to model the Level of Service (LOS) on U.S. Route 1. Traffic counts were conducted in Big Pine Key, Marathon, and Islamorada. The average annual daily traffic at each location was 19,047; 34,609; and 23,043, respectively. The speed limit on U.S. Route 1 throughout the Keys is generally 45 mph, however, it increases to 55 mph on bridges and in less developed areas. In the most developed areas and in animal sanctuaries, the speed limit is 35 mph. The median overall speed during the 2017 study was 46.0 mph. The report found that U.S. Route 1 functions at a LOS rating of "C," which is defined by USDOT as "stable flow, at or near free flow. Ability to maneuver through lanes is noticeably restricted and lane changes require more driver awareness." This is considered an acceptable rating for urban and rural highways (URS, 2017).

Monroe County's 2030 Comprehensive Plan requires the County to complete a Transportation Strategy Master Plan, through its Long Range Transportation Plan, by May 2021, incorporating an intermodal transportation system and consideration of climate change implications (Monroe County 2016, 2030 Comprehensive Plan).

The Overseas Trail runs parallel to U.S. Route 1. The trail opened in 2011 and is a 90-mile-long string of pathways, bridges, and green spaces. The trail provides pedestrian and bicycle access to the scenic highway. Along most locations, it is separated from U.S. Route 1 by a narrow grass median; and over most of the bridges, it is within the bridge shoulder.

U.S. Route 1 is the only highway in Florida to be recognized as an “All-American Road” by the National Scenic Byways Program of the Department of Transportation’s Federal Highway Administration. The program is a grass-roots collaborative effort established to help recognize, preserve, and enhance selected roads throughout the United States. The U.S. Secretary of Transportation recognizes certain roads as All-American Roads or National Scenic Byways based on one or more archeological, cultural, historic, natural, recreational, and scenic qualities.

Evacuation

Because all land evacuation must occur on U.S. Route 1, Monroe County’s comprehensive emergency plan calls for a “Staged/Phased Evacuation.” This evacuation plan is intended to avoid unnecessary evacuation if some zones are expected to be affected and others are not. Residents must locate the zone they live in so that they will know when to leave if an evacuation becomes necessary.

Approximately 48 hours in advance of tropical storm winds, a mandatory evacuation of non-residents, visitors, recreational vehicles (RVs), travel trailers, live-aboard vessels (transient and non-transient), and military personnel from the Florida Keys shall be initiated. State parks and campgrounds should be closed at this time or sooner and entry into the Florida Keys by non-residents should be strictly limited. Approximately 36 hours in advance of tropical storm winds, a mandatory evacuation of mobile home residents, special needs residents, and hospital and nursing home patients from the Keys shall be initiated. Approximately 30 hours in advance of tropical storm winds, a mandatory phased evacuation of permanent residents by evacuation zone shall be initiated. Existing evacuation zones are as follows:

- Zone 1: Mile Marker (MM) 0 to MM 6
- Zone 2: MM 6 to MM 40
- Zone 3: MM 40 to MM 63
- Zone 4: MM 63 to the three-way stop at CR 905-A
- Zone 5: CR 905-A to mainland Monroe County, including Ocean Reef

(Monroe County, 2020).

Airports

In the Florida Keys, there are two commercial airports that contribute to the transportation infrastructure of Monroe County—Key West International Airport and Florida Keys Marathon International Airport. Both of these are critical to the regional economy and support health, welfare, emergency, and safety-related services. Both airports are located immediately adjacent to US Route 1 (Overseas Highway).

Key West International Airport encompasses 334 acres and provides services to visitors and residents traveling both nationally and internationally. It is located in the southeast quadrant of the City of Key West. Over 760,000 passengers fly into and out of Key West annually. Approximately 55,000 general aviation aircraft were operated out of the airport, which pumped more than 3 million gallons of aircraft fuel in 2017.

Aircraft size landing in Key West are restricted by the size of the sole runway (5,073 feet x 100 feet). The airport sits at an elevation of approximately 4 feet NAVD88 and is parallel to the South Roosevelt Boulevard immediately adjacent to the Atlantic Ocean. A recent upgrade to the airport elevated the runway six inches to accommodate sea level rise and in 2018, a new master planning document was approved by the BOCC for the expansion of the airport to accommodate expected increases in air traffic over the next ten years.

The other airport within the Study Area is the Florida Keys Marathon International Airport, located in Marathon, Florida and now owned by Monroe County. The Marathon Airport opened in 1943. It was built by the U.S. Navy as an auxiliary airfield for Naval Air Station Key West. It was deactivated as a military facility at the end of World War II and transferred to the Monroe County Board of County Commissioners for use as a civilian airport. This commercial service and general aviation airport is adjacent to Overseas Highway, covers 190 acres, and has one runway. For most of its existence, the County owned-and-operated airport has been a general aviation facility. It also has had scheduled passenger airline service for more than 25 years. Although currently no commercial carriers land in Marathon, there is a new U.S. Customs and Border Control Facility in the former commercial terminal to handle Immigration Customs issues.

2.4 NAVIGATION

Navigation refers to the use of waterways, either primarily for transportation or recreational purposes, by any type of vessel. Vessels include ships, barges, ferries, boats, sailboats, small craft, and the like. “Navigable Waters” are administratively defined as waters that have been used in the past, are now used, or are susceptible to use as a means to transport interstate or foreign commerce up to the head of navigation.

The ROI for navigation includes the navigable waterways and channels surrounding and within the study area limits that can be used by any type of vessel and would be affected by any of the structural or nonstructural measures.

2.4.1 Existing Conditions

Overall, the waters surrounding the Florida Keys are used regularly by commercial fisheries, commercial tourism, and private use watercraft. Boating is both a recreational activity and a method of transportation for residents and tourists of the Keys.

Ports

The Port of Key West includes cruise berths at Mallory Square, the Navy's Outer Mole Pier, and a privately owned Pier B at the Weston Resort in downtown Key West. The city also maintains a domestic ferry terminal in the Key West Bight. These facilities constitute one of the busiest ports-of-call in the nation and one of the state's strongest and most sustained ferry port operations.

The Port of Key West is a major economic engine for the city and local businesses, bringing in almost a million total passengers per year resulting in a local business impact of approximately $85,000,000. Additionally, the Port of Key West supports cruise and ferry activities throughout the state, hosting cruise ships from Miami, Port Everglades, Canaveral, Tampa and Jacksonville as well as ferries from Fort Myers and Marco Island. The port provides 1,260 direct and indirect jobs to the citizens of Key West and contributes 15 percent of the city's total tax revenue. For a city with a total population of 22,000, these jobs represent a significant contribution to the overall economy (Florida Ports Council 2019).

Federal Channels

The waters around Key West draw tourists and residents for various recreational activities throughout the year. Within the ROI, the authorized federal navigation channels in the Upper and Middle Keys are the Intracoastal Waterway from Miami to Tavernier and the Key Largo Sound Channel (Figure 2-5). In the Lower Keys, Key West Harbor and Boot Key Harbor are federally maintained channels (Figures 2-5 to 2-8).

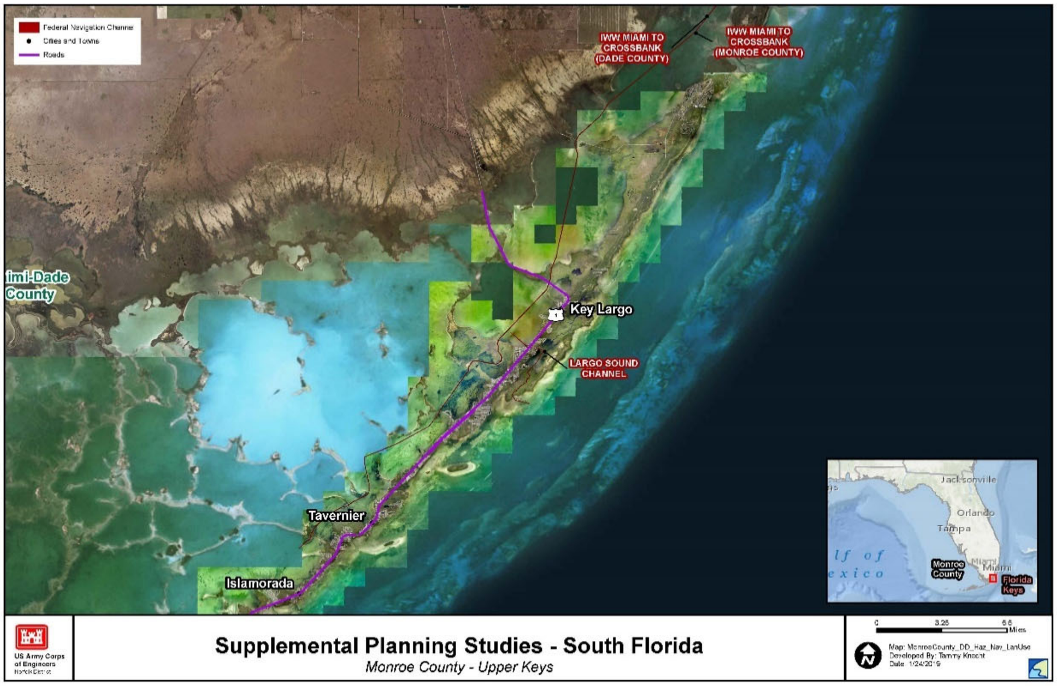


Figure 2-5: Federal Navigation Channels, Upper Keys

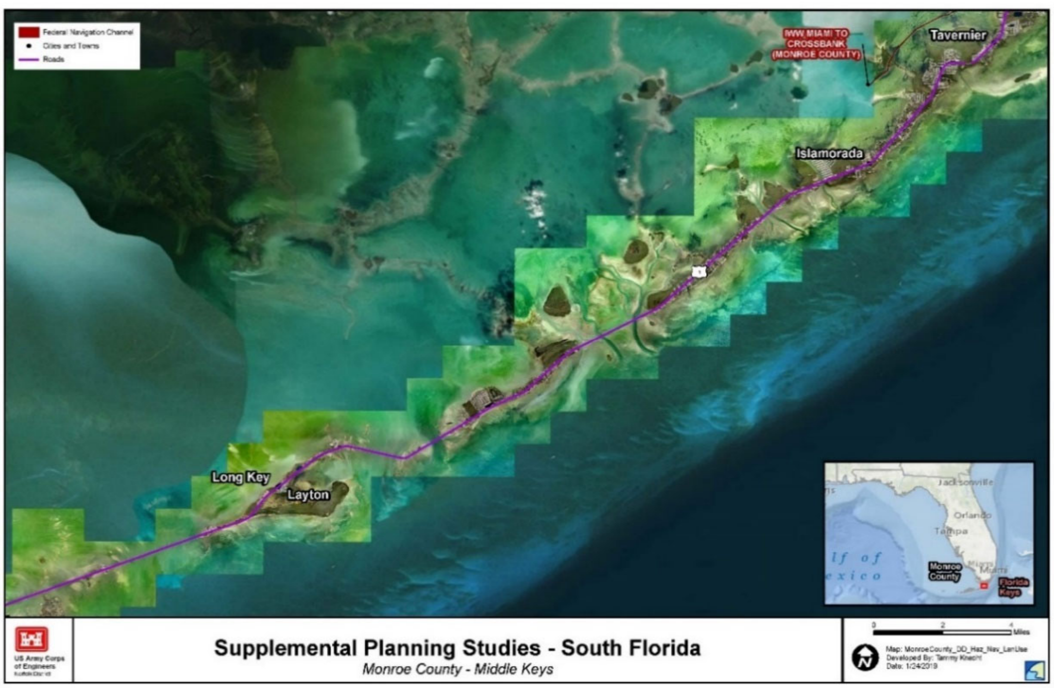


Figure 2-6: Navigation Channels, Middle Keys

Figure 2-7: Navigation Channels, Middle Keys

Figure 2-8: Federal Navigation Channels, Lower Keys

Non-Federal Channels
Kemp Channel is a marked channel located adjacent to Cudjoe Key, in the Lower Keys. It appears mostly to serve residents and visitors in the immediate area south of U.S. Route 1; there are no channel markers north of U.S. Route 1.

Toms Harbor Channel is a marked channel located adjacent to Duck Key, in the Middle Keys. Similarly, it appears to serve residents and visitors in the immediate area south of U.S. Route 1; there are no channel markers north of U.S. Route 1.

Within the vicinity of Indian Key in Islamorada there is a series of channels. The Lignumvitae Channel, the Indian Key Channel, and the Tea Table Channel are all marked, north and south of U.S. Route 1. There are also visible channels that parallel the south sides of Indian Key, though they are not marked.

Mooring Buoys
Mooring buoys, which are 18 inches in diameter with a blue stripe, have been used in the Keys since at least 1981, as an alternative to anchoring, which can break and damage the coral reef. There are over 490 mooring buoys available for use within the sanctuary on a first-come, first-served basis at no cost to the boater. Anchoring on living coral within the sanctuary in waters less than 40 feet and when the bottom is visible is prohibited (NOAA, 2019a). Other buoys used for marking zones such as Sanctuary Preservation Areas, Ecological Reserves, and Special-use Research only areas. These buoys are 30 inches in diameter and yellow and have no pick-up lines for the public to use for vessels. Spar buoys that are cylindrical, tall, and white with orange markings mark Wildlife Management Areas and sites on the Shipwreck Trail. A series of buoys are located along Oceanside Isle Channel, adjacent to Fiesta Key; and a series of buoys along on the north side of U.S, Route 1 adjacent to Indian Key in Islamorada.

2.5 GEOLOGY, TOPOGRAPHY, AND SOILS

Geological resources are defined as the topography, geology, mining resources, and soils of a given area. Topography describes the physical characteristics of the land such as slope, elevation, and general surface features. Geology refers to the earth's physical structure, underlying formations, and the processes that act upon it. Mining refers to the extraction of resources (e.g., gravel or sand). Soil refers to unconsolidated earthen materials overlaying bedrock or other parent material.

The ROI is all landforms of the Florida Keys along U.S. Route 1 and in existing development centers, from Palo Alto Key to Key West, that will be temporarily, permanently, directly, or indirectly disturbed or affected by any structural or nonstructural measures.

2.5.1 Existing Conditions

The Upper Keys extend from Virginia Key to Lower Matecumbe Key. The islands in the Upper Keys are long, narrow, and low-lying, with an average elevation of three to six feet (1-2 m). A few narrow channels connect Florida Bay to the Atlantic Ocean. The Middle Keys extend from Lower Matecumbe Key in Islamorada to the Seven Mile Bridge, which connects the City of Marathon to Little Duck Key. The Middle Keys are similar in size, elevation, and orientation to the Upper Keys; however, many wide channels separate each island. The Lower Keys extend from Little Duck Key to Key West. The Lower Keys are broad, and flat. They are separated by long narrow channels and are perpendicularly oriented as compared with the Middle and Upper Keys. Elevations in the study area range from eighteen feet above sea level at the highest point in Windley Key in the Upper Keys, to an average of three to five feet throughout the remainder of the Upper, Middle, and Lower Keys (NOAA, 2019a).

The Keys are a coral archipelago formed from a series of low limestone islands, within the South Atlantic Coastal Plain (NOAA 2019e). Two main geologic formations of the Pleistocene age are present in the study area – Miami Limestone and Key Largo Limestone. Miami Limestone is found on the mainland Florida peninsula and on the lower keys from Big Pine Key to Key West. It is highly karst and permeable containing fossils and composed of Ooids. The Ooids or grainstones are formed in a high energy environment and contains skeletal materials of corals, echnoids, mollusks and algae (Hailey et al, 2018). Throughout the Lower Keys, the exposed Miami limestone formation lies atop the Key Largo limestone formation. In the Lower Keys, the Miami limestone formation began forming in the late Pleistocene epoch when sea level conditions favored the accumulation of carbonate sand banks behind the outer reef (Clark, 1990).

At Big Pine Key, geologic formations transition to Key Largo Limestone, which is also permeable and karst. Key Largo Limestone is found throughout the Middle and Upper Keys, from Palo Alto Key to Big Pine Key. Both formations are part of the Biscayne Aquifer of the surficial aquifer system (Hailey et al, 2018). The last major drop in sea level exposed the ancient coral reefs which presently make up the Florida Keys. As sea level fluctuated during the Pleistocene Ice Ages the Key Largo limestone accumulated up to 200 feet thick**.** Intertidal erosion of the exposed Key Largo formation is a source of the sediment for the upper and middle Keys beaches (Clark, 1990).

The USGS soil survey identifies eight soils series within the Study Area: Bahiahonda, Cudjoe, Islamorada, Keylargo, Keyvaca, Keywest, Lignumvitae, and Matecumbe Series. Keyvaca and Keywest series are underlain by soft to hard, rippable oolitic limestone bedrock; the remaining series are underlain by soft to hard, rippable coral limestone bedrock. They include varying depths to bedrock, ranging from four inches (Keyvaca series) to 85 inches (Bahiahonda series) (USDA 1995).

Udorthents, or urban land complex, is also common in the Study Area. They consist primarily of crushed oolite limestone or coral rock limestone filled over top of the original soil material. In the Keys, up to 40 percent of the Udorthents areas are covered by houses and other urban structures (USDA, 1995).

2.6 HYDROLOGY, HYDRAULICS, AND BATHYMETRY

Hydrology is the science that deals with the properties, circulation, and distribution of water, its movement in relation to land, under the surface of the land, and in the atmosphere from the moment of precipitation until it returns to the atmosphere through evapotranspiration or is discharged into the ocean. Hydraulics is the science that deals with practical applications of runoff flowing through a channel. Collectively, hydrology and hydraulics are referred to as "H&H." Bathymetry, which is the configuration of the waterway bottom, influences H&H and where applicable, it will be discussed.

The ROI for H&H and bathymetry includes all areas within the study area to be directly filled, dredged, excavated, or otherwise temporarily or permanently converted to another use as a result of the construction of the structural and/or nonstructural measures, as well as all areas indirectly adversely affected by the structural and/or nonstructural measures, by means such as alteration in tidal flushing, sedimentation, currents, erosion, and/or changes in salinity. This would include water management operations in the Everglades National Park. It should be noted that sea level rise is discussed in the climate change section.

2.6.1 Existing Conditions

The nearshore areas of the Florida Keys are influenced by two main regional currents: the Gulf of Mexico Loop Current and the Florida Current. The variability of these currents in conjunction with local meteorology, tides, wind-driven currents, and surface runoff affects the circulation and nature of the Marine Sanctuary waters. Nearshore waters generally experience high variability in temperature, salinity, and other factors relative to the reef tract and deeper waters further offshore (NOAA, 2019a).

Due to erosion, all of the shorelines within the ROI have been impacted historically at least to some degree by artificial hardening, be it a seawall, riprap, scattered limestone rock, concrete block, or poured concrete. Generally, the beach shorelines within the ROI have been hardest-hit by erosion.

Clark (1990) notes that the primary causative factors for beach and dune erosion in Monroe County include periodic major storm events, onshore and longshore sediment budget deficits, historical development trends, and long-term sea level rise. Because of the nature of the carbonate sediment of the beaches in Monroe County, the sediment supply is affected by the chemical and biological processes of adjacent waters. Not well understood, Clark states, are the environmental influences of changing salinity, hydrostatic pressure, temperature, turbidity, organic and inorganic pollutants, and other marine environmental factors on the chemical and biological production of sediments for the natural nourishment of the beaches (Clark 1990).

Clark (1990) notes that at the same time, naturally occurring beach and dune formation is not common in the Keys. Compared to the Florida peninsula, there is very little natural quartz sand on the Keys; instead sand is of carbonate origin derived from the erosion of limestone, from aragonite particles precipitated from seawater, and from the fragmented remains of corals, cast-off shells, and calcareous algae (Clark 1990). However, several of the beaches on the Keys have been artificially nourished historically, and therefore do contain quartz sand.

Indian Key Fill

The shorelines between Upper and Lower Matecumbe Key in the City of Islamorada are known as Indian Key Fill; they were created by artificial fill material. Within this area, Clark (1990) had noted that between Upper and Lower Matecumbe Keys, the small Tea Table Key is bulkheaded and the Indian Key shoreline is mixed sand and gravel fill along U.S. Route 1; and that the Lower Matecumbe Key shoreline fronting the Florida Straits/Atlantic Ocean also has a mix of riprap, bulkheads, and natural rock shoreline. Today, an old cemented riprap wall is still in place along nearly the entire shoreline lengths of these three Indian Key Fill sections. Most of the shoreline lengths appear to be relatively stable due to the riprap wall, and in some cases, red mangroves along the shorelines. Shallow channels parallel their shorelines, which then intersect perpendicularly to the Tea Table, Indian Key, and Lignumvitae channels that pass underneath U.S. Route 1. Tidal flushing and circulation along these channels and riprap walls likely occurs regularly and effectively (Figure 2-9).

Figure 2-9: Shorelines along Indian Fill Key

Sea Oats Beach

Located in Lower Matecumbe Key in Islamorada, Sea Oats Beach is a 1.3 mile segment that was identified by the Florida DEP's (2019) *Strategic Beach Management Plan: Florida Keys Region* to be a critically eroded beach; and the erosion threatens both recreational interests and U.S. Route 1. In 2005, Hurricanes Rita and Wilma had caused moderate beach and dune erosion and flooding in this segment. FDEP (2019) also notes that Florida Department of Transportation (FDOT) had constructed a road shoulder stabilization project in 2008 that included an articulating block mattress and a dune system with sand fill and sea oats, but that in 2017 Hurricane Irma severely impacted this area again. The Hurricane Irma Storm Report (2017) considered this structure and system substantially destroyed. U.S. Route 1 was breached, and sand was washed into the roadway and other areas.

Sea Oats Beach (Figure 2-10) has a wide fetch facing the Florida Straits/Atlantic Ocean, and therefore is highly exposed to wave energy and erosion. The Florida DEP's (2019) Strategic Beach Management Plan calls for the initiation of a feasibility study to determine environmentally acceptable erosion control alternatives and monitoring. Currently, FDOT has developed a new roadway stabilization project along this area.

Figure 2-10: Sea Oats Beach. Facing south on left side; showing wide fetch across the Florida Straits, right side.

Fiesta Key

At the eastern end of Fiesta Key (Figure 2-11), adjacent to the bridge near Mile Marker 71, there is a steep fill slope that is heavily riprapped with coral rock on the south side of U.S. Route 1. This slope adjacent to the bridge approach is approximately 15 feet above mean sea level. Two other sections bordering the Florida Straits/Atlantic Ocean along the west end of Fiesta Key between Mile Markers 69 and 70, have been damaged by erosion, with sections of the U.S. Route 1 Overseas Trail washed out by Hurricane Irma, and there is scour along the banks immediately adjacent to the trail. However, these sections also have a mature wooded mangrove and buttonwood buffer seaward of them (Figure 2-11).

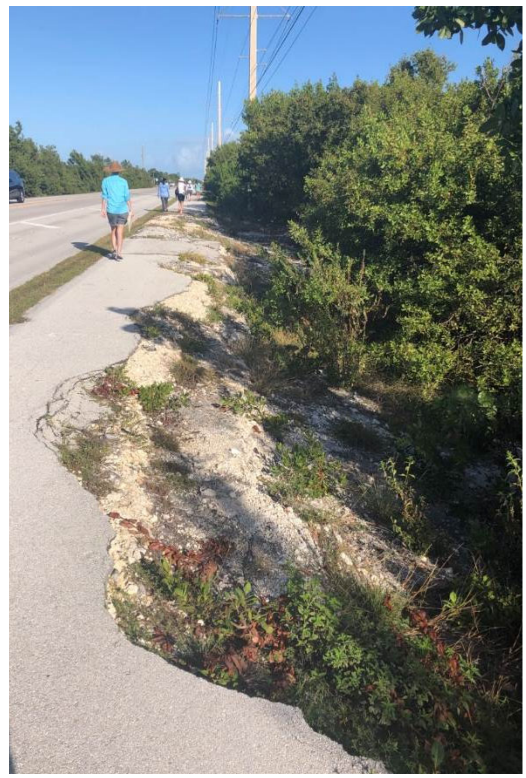


Figure 2-11: Fiesta Key. Near Mile Marker 70 at left, and near Mile Marker 69.5 at right, showing washouts of Overseas Trail.

Long Key State Park

Clark (1990) had noted that the western three quarters of Long Key has a west direction of longshore sediment transport; that critical erosion of 2,950 feet of shoreline exists along the camping and swimming areas within the State Recreation Area, and that at that time, park officials estimated that approximately 0.6 mile of the beach had been eroding as much as three feet per year since the park was opened in 1970 (Figure 2-12). A rock revetment was constructed along a limited segment of shoreline in 1976; however, Clark noted that erosion end effects are most apparent adjacent to the structure. Clark postulated that small tidal creeks, tidal lagoons, and a mangrove dominant shoreline fronting on the Florida Straits/Atlantic Ocean near the center of the island create a sediment budget deficit to the west, also affecting the shoreline campgrounds. This erosion was considered critical, due to the threat to the campground facilities (Clark 1990).

The FDEP's Strategic Beach Plan (2019) noted that the park was severely impacted by Hurricanes Georges and Irene in 1998 and 1999. Beach and dune restoration was considered necessary after these storms, and a feasibility study was initiated by the FDEP. However, in 2005, Hurricanes Rita and Wilma combined severely impacted the park again and damaged all the waterfront campsites and infrastructure. FDEP's Plan recommended construction of a beach restoration project that provides acceptable mitigation for sea grass beds and monitoring. Long Key State Park is currently working on a plan.

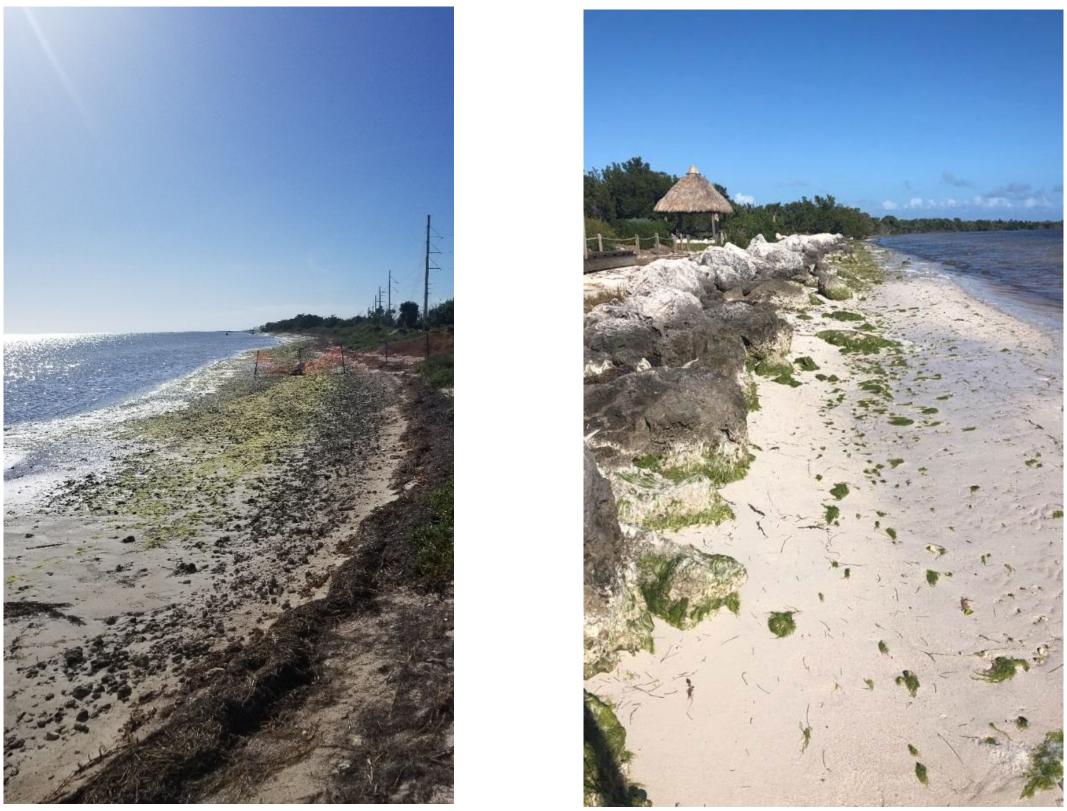


Figure 2-12: Long Key State Park. Facing south at left, and north at right. Remnants of the revetment are still present.

Duck Key

Two bridge approaches along Duck Key adjacent to Toms Harbor, at Mile Markers 60.5 and 62, are both armored with coral rock and/or poured concrete. Both locations also have a mature thicket of woody species (Figure 2-13 to 2-14). At Mile Marker 60.5, there is a mixed mangrove and buttonwood community. The areas with the widest mangrove buffer experienced no damage.

A metal corrugated bulkhead is present along the shoreline at Mile Marker 62. Seaward of the wall, the water is approximately 40 inches deep. Although the metal corrugated wall is old and somewhat damaged, it is still intact. Concrete and coral rubble are present behind and upslope of the wall also appear to be stable. Landward of the concrete and rubble is a mature buttonwood thicket. It does not appear that regular tides wash over the seawall.

Figure 2-13: Bridge approach near Duck Key, near Mile Marker 61.5

Figure 2-14: Bridge approach near Duck Key, Mile Marker 60.

Bahia Honda Key

The FDEP's Strategic Beach Plan (2019) states that the most significant carbonate beaches and dunes of the Lower Keys are on Bahia Honda Key, which is part of Bahia Honda State Park. The island has 11,900 feet of beach, south of U.S. Route 1, fronting the Straits of Florida. Sediment transport has been observed to occur primarily during storm events, with most of the material either being transported onshore or offshore (FDEP 2019).

FDEP (2019) notes that several attempts have been made to armor and fill the eroding areas since the early 1970's. The area was designated critically eroded and was estimated to have receded about five feet between 1971 and 1986. Erosion control efforts have included the riprap along the 400 to 500 feet of threatened roadway in the early 1970's, the 1988/89 construction of a 1,200 foot long limestone rock revetment, and substantial sea oats planting during the 1980s and 1990s.

FDEP (2019) indicated that Hurricane Georges, in 1998, caused major beach and dune erosion and severely damaged the park facilities, roadway and bridge. In 2005, Hurricanes Rita inflicted minor to moderate beach and dune erosion; and that same year, Hurricane Wilma caused moderate to major beach and dune erosion. Wilma also caused severe damage to the park's recreation facilities at the public beaches. Overwash sediments were returned to the beaches as part of the post-storm recovery operations. FDEP indicated that in 2005, a feasibility study was completed to investigate sand sources for State Parks in the Florida Keys, including Bahia Honda State Park. In 2017, Hurricane Irma caused major beach and dune erosion and severely damaged the park facilities, parking areas and roadway (FDEP 2019). The section of limestone rock revetment that washed out is within the ROI. These areas, including the Park's campground roadway and campground, remain closed to the public.

FDEP's Strategic Plan (2019) recommends maintaining a beach project consisting of sand trucked from approved upland borrow sites, placed in an alongshore berm configuration above mean high water, and stabilized with plantings of native vegetation, and monitoring.

Figure 2-15: Bahia Honda State Park looking west along the Mean High Water line, at left; looking west along the vegetated upland beach area at right.

West Summerland Key

This location has a concrete seawall along the shoreline, and water approximately 40 inches deep immediately seaward of it. The seawall is damaged but mostly intact. Water seeps behind the seawall and is sufficient to support what is now a mostly emergent wetland (Figure 2-16). Hurricane Irma washed over and through the seawall, damaged mangroves, and washing out the U.S. Route 1 Overseas trail.

Figure 2-16: West Summerland Key, showing existing concrete seawall and the wetland landward of it. Photo at right shows the base of the wall where water seeps behind the wall.

Cudjoe Key

This location is adjacent to the bridge approach that crosses Kemp channel (Figure 2-17). This is a steep slope approximately 15 feet high that contains scattered limestone rock and concrete, and has a mature, dense stand of mangroves along the shoreline growing among smaller sized limestone rock, with a mature, dense buttonwood community upslope. Nearshore areas are shallow and gravelly. There is minimal visible shoreline erosion or scour at the waterline. However, there is upland scour, perhaps caused both by runoff and storm events, along the upland slope adjacent to the U.S. Route 1 Overseas Trail.

Figure 2-17: Representative photos of the shoreline along the bridge approach at Cudjoe Key, adjacent to Kemps Channel.

Nonstructural Areas

The source of hydrology in the nonstructural areas is largely tidal and storm-related flooding of low-lying areas. Flooding has become increasingly problematic and is exacerbated by sea level rise.

2.7 WATER QUALITY

Water quality affects the ability of a water body to support life and also human activities such as recreation. Water quality describes the chemical and physical composition of water as affected by natural conditions and human activities. Impacts on water resources can also influence other issues such as land use, biological resources, socioeconomics, public safety, and environmental justice. This water quality analysis has been prepared considering the applicable federal and state regulations as discussed in the following sections.

2.7.1 Federal

Clean Water Act

The Clean Water Act (CWA) of 1972, as amended (33 USC §§ 1251 et seq.), is the primary federal law that protects the nation's waters, including lakes, rivers, and coastal areas. The CWA prohibits all unpermitted discharge of any pollutant into any jurisdictional waters of the U.S. The U.S. Environmental Protection Agency (USEPA) is responsible for administering the water quality requirements of the CWA. Section 303(d) of the CWA requires all states to identify waters that do not meet, or are not expected to meet, applicable water quality standards. In addition to the discharge restrictions, the CWA Section 404 requires a USACE issued permit for the dredging and/or filling of jurisdictional waters of the U.S. Areas meeting the "waters of the U.S." definition are under the jurisdiction of the USACE. Anyone proposing to conduct a project that requires a federal permit or involves dredge or fill activities that may result in a discharge to U.S. surface waters and/or waters of the U.S. is required to obtain a CWA Section 401 Water Quality Certification from the FDEP, verifying that project activities will comply with water quality standards.

Florida Keys National Marine Sanctuary (FKNMS) Program

In accordance with the standards set forth in title III of the Marine Protection, Research, and Sanctuaries Act of 1972, as amended, also known as the National Marine Sanctuaries Act (Act) the mission of the National Marine Sanctuary program (Program) is to identify, designate, and manage areas of the marine environment of special national, and in some cases international, significance due to their conservation, recreational, ecological, historical, research, educational, or aesthetic qualities. Public Law 101-605 established the FKNMS. The purpose of the FKNMS regulations are to implement the designations of the National Marine Sanctuaries by regulating activities affecting them, consistent with their respective terms of designation, in order to protect, preserve, and manage and thereby ensure the health, integrity and continued availability of the conservation, ecological, recreational, research, educational, historical, and aesthetic resources and qualities of these areas.

Rivers and Harbors Act

Section 10 of the Rivers and Harbors Act of 1899 (as amended; 33 USC § 403) regulates structures or work that would affect navigable waters of the U.S. Structures include any tidal gate, storm surge wall, pump intakes, or outlets that might be built as a result of recommendations of this study as well as piers, wharfs, bulkheads, etc. Work includes dredging, filling, excavation, or other modifications to navigable waters of the U.S. The USACE issues permits for work or structures in navigable waters of the U.S.

2.7.2 State

The determination whether the state's waters support their applicable designated uses as mandated by Section 305(b) of the Clean Water Act is made by FDEP and reported annually to USEPA based on monitoring data. There are six designated uses that may be applied to surface waters: aquatic life, fish consumption, shellfishing, recreation, public water supply, and wildlife. Water quality standards define the water quality needed to support each of these uses by establishing the numeric criteria for comparison of physical and chemical data. Section 303(d) of the CWA requires all states to identify waters that do not meet, or are not expected to meet, applicable water quality standards. If a waterbody contains more of a pollutant than is allowed by the water quality standards, it will not support one or more of its designated uses.

Such waters are considered to have an "impaired" quality. An "impairment" refers to an individual parameter or characteristic that violates a water quality standard. A waterbody fails to support a designated use when it has one or more impairments. In most cases, a cleanup plan (called a "total maximum daily load") must be developed and implemented to restore impaired waters. The state creates total maximum daily loads (TMDLs) on a tributary level that indicate the total pollutants that a water body can assimilate and still meet water quality standards. Section 403.061(27), Florida Statutes, grants FDEP the authority to establish rules that provide for a special category of waterbodies within the state, to be referred to as "Outstanding Florida Waters (OFW)," which shall be worthy of special protection because of their natural attributes. Generally, OFW include Marine Sanctuaries. Aquatic Preserves, State Parks, Wildlife Refuges, and the like. Projects regulated by the Department or a Water Management District (WMD) that are proposed within an OFW must not lower existing ambient water quality, which is defined for purposes of an OFW designation as the water quality at the time of OFW designation or the year before applying for a permit, whichever water quality is better (FDEP 2020).

The importance of water quality was recognized in the 1990 authorizing legislative language for FKNMS, which established of a Water Quality Protection Program (WQPP) to be administered by the FDEP and USEPA. The purpose of the WQPP is to identify and implement priority corrective actions to address point and nonpoint sources of pollution in order to maintain the chemical, physical, and biological integrity of the sanctuary. The goal of the program is to restore and maintain balanced indigenous populations of corals, shellfish, fish, and wildlife and recreational activities in and on the water. The WQPP supports long term monitoring programs of water quality, coral reefs, and seagrass/benthic communities and selected special studies to address a variety of related topics. Research and monitoring projects are designed to quantify status and trends, answer resource management questions, and develop new scientific hypotheses for the FKNMS. Since 1995, the Water Quality Monitoring Project of the WQPP has conducted regular monitoring at more than 100 fixed stations throughout the sanctuary. A variety of physical and chemical parameters are sampled, including salinity, water temperature, total phosphorus (TP), total nitrogen (TN), dissolved oxygen (DO), dissolved inorganic nitrogen (DIN), and total organic carbon (TOC) (NOAA, 2019a).

In 2008, the Florida Keys Reasonable Assurance Documentation (FKRAD) to address nutrients was approved by the Florida Department of Environmental Protection (DEP or department) and was provided to the U.S. Environmental Protection Agency (EPA) in February 2009. The original FKRAD was based, partly, on compliance with Chapter 99-395, Laws of Florida (LOF), which mandated compliance with wastewater treatment requirements by June 2010 and an overall completion date of the management actions by 2020. However, in 2010, Chapter 2010-205, LOF, extended the wastewater treatment compliance date to December 2015 (FDEP 2018).

2.7.3 Existing Conditions

Water quality is generally good in the Florida Keys. However, nearshore water quality is impacted by stormwater runoff and wastewater. There are still onsite septic systems in portions of the Florida Keys, and older systems do not effectively remove nitrogen and phosphorus from effluent, which leads to eutrophication of nearshore waters. These are gradually being replaced by a county-wide sanitary sewer system. Stormwater runoff contributes to nearshore water quality degradation by carrying fertilizers, pesticides, contaminants, and pet waste into the water during rain events. Most of these pollutants are directly associated with coastal development (NOAA, 2019a).

The Marine Sanctuary waters are designated as OFW. However, currently, the Atlantic Ocean from Bahia Honda Key to Key West, is also on the 303(d) impaired waters list for total nitrogen levels. This waterbody is impaired for this parameter because the annual geometric means exceeded the criterion more than once in a three-year period during the verified period. This parameter is being added to the Verified List and the department is requesting USEPA add to the 303(d) List (FDEP, 2018b).

The Upper, Middle, and Lower Keys are on the 303(d) list for mercury in fish tissue. This is based on a Department of Health fish consumption advisory data from 2005-2008 for 76 King Mackerel with an average mercury concentration of 0.5 ppm. FDEP has adopted a USEPA approved mercury TMDL and is requesting USEPA remove it from the 303(d) List (FDEP, 2018).

The existing aquatic environment also includes the freshwater lens of groundwater found on land in a few of the larger Keys. These groundwater lens, which are in some cases used for water supply for irrigation, are regulated by the State.

2.8 FLOOD PLAINS

For the purpose of the following discussion, a flood plain is defined as any land area susceptible to being inundated by floodwaters from any source. The ROI is all flood plain areas within the

Florida Keys where flooding has occurred in the past or there is a potential for flooding, including tidal and/or rainfall events.

Executive Order 11988 – Flood Plain Management
Through Executive Order (EO) 11988, federal agencies are required to evaluate all proposed actions within the one percent annual chance flood plain or Base Flood Plain as defined by FEMA. Actions include any federal activity involving 1) acquiring, managing, and disposing of federal land and facilities, 2) providing federally undertaken, financed, or assisted construction and improvements, and 3) conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, and licensing activities. In addition, the FEMA 0.2 percent annual chance flood plain should be evaluated for critical actions or facilities, such as storage of hazardous materials or construction of a hospital.

USACE Engineering Regulation (ER) 1165-2-26
Engineering Regulation (ER) 1165-2-26 sets forth general policy and guidance for USACE implementation of EO 11988 as it pertains to the planning, design, and construction of Civil Works projects and activities under the Operation and Maintenance and Real Estate Programs. As shown in ER 1165-2-26 and in accordance with EO 11988, USACE uses an eight step process as part of the decision making for projects that have potential impacts to or are within the Base Flood Plain. The eight steps and project specific responses for EO 11988 are discussed further in chapter 9, Environmental Compliance.

Section 202(c) of Water Resources Development Act of 1996
Section 202(c) of WRDA 1996 provides that before the construction of any project for local flood damage reduction or hurricane or storm damage reduction that involves assistance from the Secretary of the Army, the non-federal interest must agree to participate in and comply with applicable federal flood plain management and flood insurance programs. It also requires non-federal interests to prepare a Flood Plain Management Plan designed to reduce the impacts of future flood events in the project area within one year of signing a Project Partnership Agreement (PPA) and to implement the plan not later than one year after completion of construction of the project.

More specifically, Section 202(c) requires that the non-federal interest shall prepare a plan designed to reduce the impacts of future flooding in the project area. It should be based on post-project flood plain conditions. The primary focus of the Plan should be to address potential measures, practices, and policies which will reduce the impacts of future residual flooding, help preserve levels of risk management provided by the USACE project and preserve and enhance natural flood plain values. In addition, the plan should address the risk of future flood damages to structures within the post project flood plain and internal drainage issues related to USACE levee/floodwall projects. Since actions within the flood plain upstream and downstream from the project area can affect the performance of a USACE project, the plan developed by the non-federal sponsor should not be limited to addressing measures solely within the immediate project boundaries. Monroe County has a Hazard Mitigation/Flood Plain Management Plan approved by FEMA in 2015. FEMA approvals are conducted on a five-year cycle, with the next review and approval in 2020 (MCWG 2015).

2.8.1 Existing Conditions

As with many coastal communities, Monroe County can be prone to flooding caused by coastal storm events. By having exposed waterfront areas, flat topography, land areas with low elevations, and populated and urbanized areas, the impacts to people, property, and the environment have been experienced from past storm events and continue to be a problem and concern. Section 1.6 of this report discusses the storm history of the Keys.

The Florida Keys are typically long, narrow, and low-lying islands. The average elevations of the various larger islands generally range from four to seven feet above sea level. Only one small area in the city of Key West, referred to as Solares Hill, is approximately 16 feet above sea level. Other relatively high areas are several coral ridges in Key Largo near mile marker 106. The entire mainland portion of Monroe County is within the Everglades National Park or the Big Cypress National Preserve and is virtually uninhabited, with only 14 residential buildings (MCWG 2015). In some areas that are low in elevation, Monroe County experiences nuisance type or minor flooding during a normal astronomical high tide, even on a sunny day when there is no storm or heavy rainfall. The extent and duration of flooding in some neighborhoods is significant and most notably in 2016 and again in 2019, when the tidal flooding was widespread throughout the County and lasted approximately 90 days or longer in at least one area in the Upper Keys. These tidal events can be heavily influenced by non-storm wind events extending their duration even longer. Water levels can be higher when the tide is highest during a Spring tide cycle, sometimes referred to as a King Tide, or an exceptionally high tide. While the flooding may not be life threatening, it can disrupt transportation and cause added public works expenses for the local community.

Severe or major flooding usually occurs during tidal storm events and/or from heavy rainfall, usually associated with tropical systems or just a heavy rainfall weather event. Flooding can be short term or long term in duration. For tropical events, peak tidal flooding will typically last during one astronomical tide cycle. For any coastal community with flat topography, low land elevations, and developed areas, flooding can be significantly worse when there is combined tidal and rainfall flooding, especially with respect to storm water drainage systems. Aside from tropical storms, rainfall events by themselves can cause flooding. With sudden and brief heavy downpours, drainage systems that are not designed to discharge the large amount of rainfall runoff can easily be overwhelmed. With the amount of impervious surface area, urban areas are most prone to flash flooding, where there is a large amount of rainfall in a short amount of time. Steady rainfall that occurs over a multi-day/week period or from back-to-back weather events can cause the ground to become over saturated and unable to absorb water, thus increasing the amount of rainfall runoff that may enter the drainage system and cause flooding. In some cases, standing water can last for days on properties, roadways, etc.

EO 11988 references the FEMA one and 0.2 percent annual chance flood plains. Monroe County participates in FEMA's NFIP. The effective FEMA Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRM) for Monroe County and incorporated areas are dated February 18, 2005. Generally, the majority of the Florida Keys are located within the effective one and 0.2 percent annual chance flood plains, except for one area in Key West and isolated high areas along U.S. Route 1 that are north of Islamorada as shown in Figures 2-18 and 2-19. The one percent annual chance flood plain is shown in blue color and the 0.2 percent annual chance flood plain is orange color. Because of the approximate 120 miles of linear distance covering the Florida Keys and due to map scale, no other effective FEMA FIRMs are shown, but they can be viewed online at FEMA's Map Service Center using the National Flood Hazard Layer Viewer (FEMA 2020). For comparison to historical data, the effective 2005 maximum FEMA one percent annual chance stillwater storm tide elevation ranges from 9.0 feet, NAVD88 (without the effects of wave setup) to 9.7 feet, NAVD88 (with the effects of wave setup) and the maximum one percent annual chance wave crest elevation is 15.8 feet, NAVD88.

The effective 2005 FIS and FIRMs are currently going through a revision and scheduled to be final in 2021-2022. The revision includes new coastal engineering (storm surge and wave height analyses) and more accurate topographic mapping. The coastal areas shown on the effective FIRMs, except for two site specific locations from submitted Letters of Map Revision, are based on an engineering analysis completed in 1988 and U.S. Geological Survey 7.5 Minute Quadrangle Topographic Mapping, where the topographic contour interval is five feet (FEMA 2005). With new engineering and more detailed and accurate topographic mapping, there could be significant changes with the revised coastal one and 0.2 percent annual chance flood elevations and flood plain mapping boundaries (Figures 2-18 and 2-19).

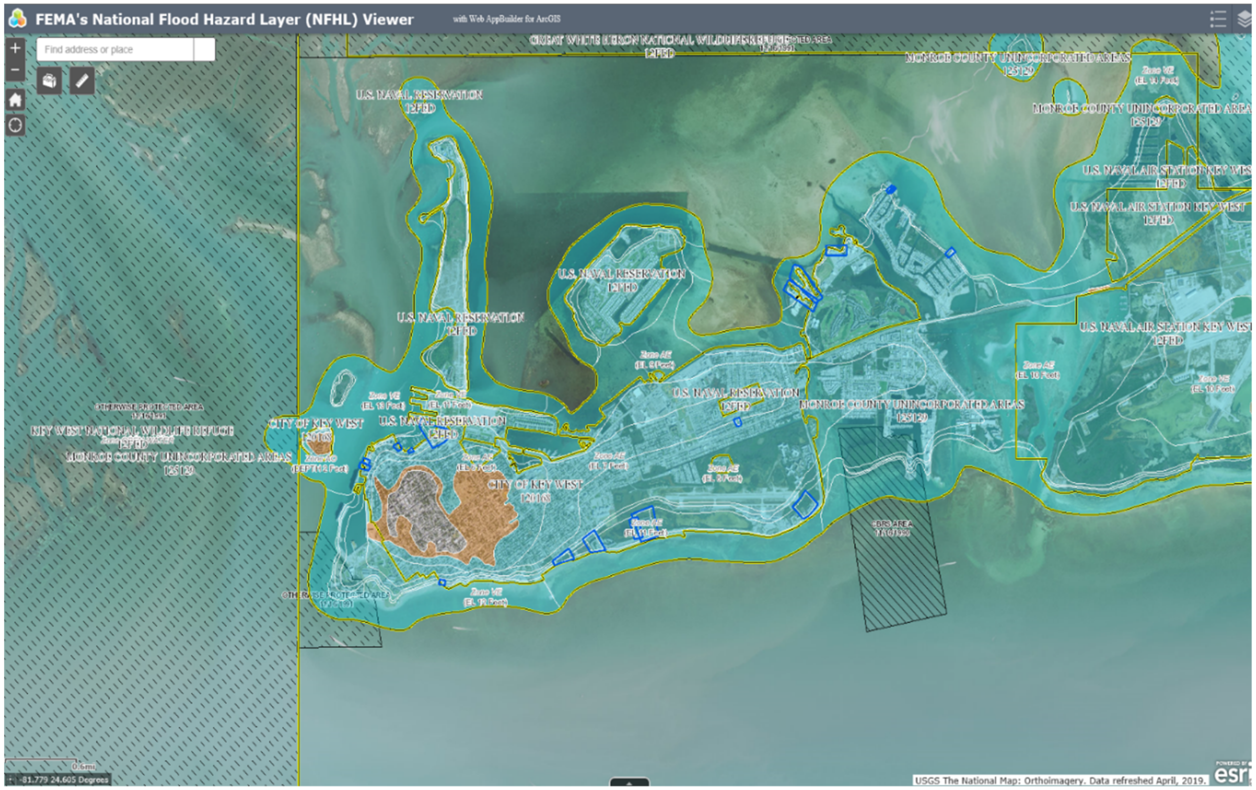


Figure 2-18: Effective 2005 FEMA 1 and 0.2 Percent Annual Chance Flood Plains – Key West (1 Percent Annual Chance Floodplain = Blue Color, 0.2 Percent Annual Chance Floodplain = Orange Color; FEMA Map Service Center, National Flood Hazard Layer

Viewer)

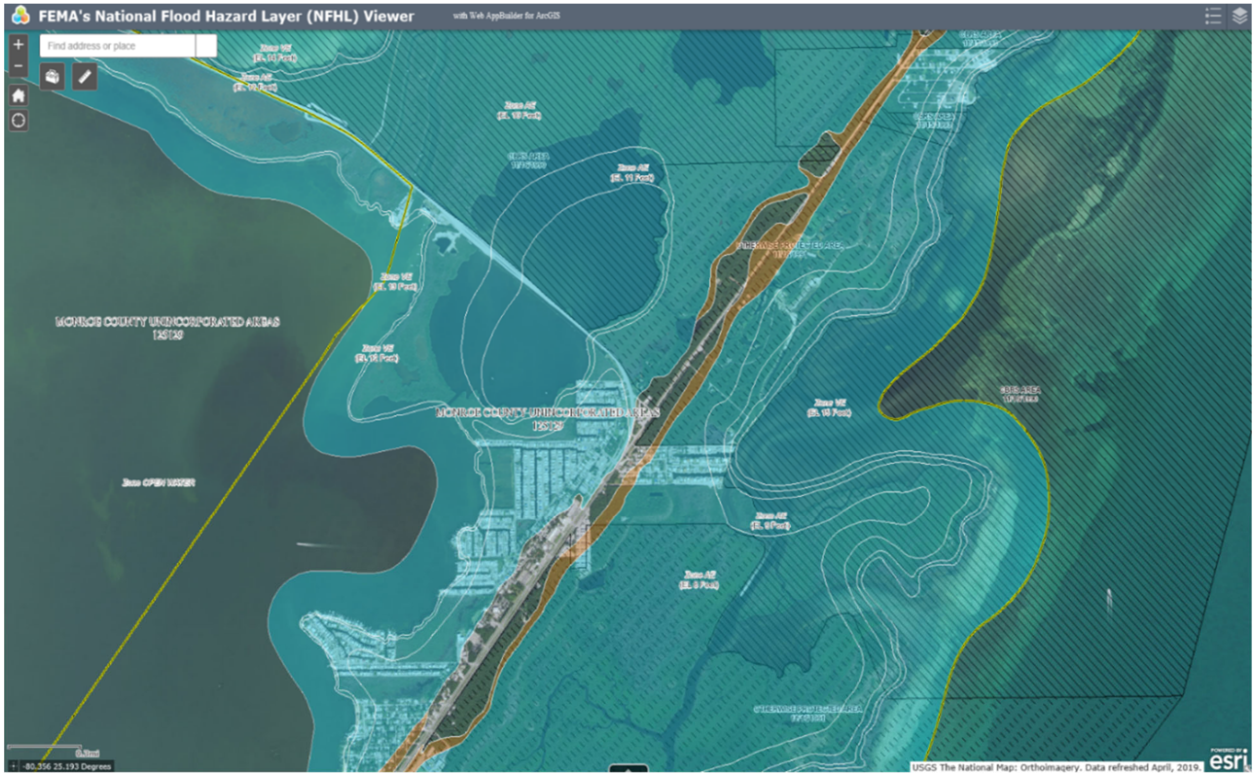


Figure 2-19: FEMA 1 and 0.2 Percent Annual Chance Flood Plains – Along U.S.-1, Near Key Largo (1 Percent Annual Chance Floodplain = Blue Color, 0.2 Percent Annual Chance Floodplain = Orange Color; FEMA Map Service Center, National Flood Hazard Layer Viewer)

Monroe County has an estimated permanent population of 74,228 (U.S. Census Bureau, 2019). Considering the additional seasonal population, the total population can increase to approximately 155,000 during the peak time of the year (Monroe County, 2016), noting that hurricane season is from June 1 to November 30 and the “off season” or when there is a lower seasonal population is generally late summer/early fall (Monroe County, 2021). There are approximately 54,000 housing units within Monroe County. Monroe County obtained FEMA Repetitive Loss data (2015), of which 916 properties were designated as Repetitive Loss properties, where 631 properties were within the unincorporated areas of Monroe County and 221 within the city of Key West (MCWG 2015). The Repetitive Loss information provides a good indication of areas that may be most vulnerable to flooding, where mitigation actions may be implemented. As defined by FEMA, a Repetitive Loss property is any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling ten year period, since 1978. A Repetitive Loss property may or may not be currently insured by the NFIP.

Even if an area only had one Repetitive Loss property from past flooding, there could be many others in that area that could be just as vulnerable if the water level was only a few inches higher. As such, unincorporated Monroe County recently completed a repetitive loss analysis looking at other properties located adjacent to or near designated FEMA Repetitive Loss properties within geographic areas or neighborhoods. Nearly 14,000 properties within the unincorporated areas within the County have flood insurance; the majority of the buildings are located in a coastal floodplain. Many were built before January 1975, when the County adopted its first flood plain regulations, which means they were likely built without any flood risk management considerations. Of the 14,000, approximately 4,500 structures were built before January 1975 and 9,500 after. The analysis identified over 9,500 properties that are potentially exposed to the same flood risk, referred to in the analysis as “repetitive loss properties in waiting.” Note, the draft analysis identified approximately 400 FEMA designated Repetitive Loss properties within unincorporated Monroe County, verses 631 in the 2015 Local Mitigation Strategy Update (Monroe County 2019). The reduction in number may be due to properties that have had flood mitigation measures implemented.

In addition to buildings being impacted by flooding, impacts to water supply, Monroe County is also greatly concerned with saltwater intrusion, sanitary and septic systems, oil/fuel/chemical facilities, gas/electrical/oil/chemical fires, stormwater systems, water quality, roadways and evacuation routes, other critical infrastructure, dangers of floating debris, shoreline erosion, natural habitat areas and animals, historic and cultural resources, life-safety (death from drowning or electrocution), etc. Continued sea level rise, when combined with a storm surge and/or rainfall events, will only make the flooding experienced so far only worse. The historic rate of sea level rise at the Virginia Key tide gage (1931-2018) is approximately 0.11 inches per year; Vaca Key (1971 to 2018) at 0.14, and Key West (1913 to 2018) at 0.09, or approximately one foot per 100 years for each of the gages (NOAA 2020b).

As discussed, while there can be direct impacts to buildings, infrastructure, the environment, life safety, etc. from flooding, indirect impacts also exist that could apply to an individual or to a larger community, and short term or long term depending on the situation. This could include loss of wages for homeowners, loss of revenue for businesses, loss of government tax revenue, the need for temporary housing, lower property values, increased travel time due to loss of transportation routes, increase in crime, mental and physical health issues, deaths, school closings, reduced tourism, business closings, foreclosures, bringing a non-compliant structure into compliance with local floodplain regulations if substantially damaged, etc. Direct and/or indirect impacts can be worse or prolonged if back-to-back floods occur. Before, during, and after a flood, local, state, and federal governments and citizens may have expenses to contend with that may not be covered by insurance or other means.

With respect to a substantially damaged structure mentioned above, a structure within the one percent annual chance flood plain, regardless of whether the structure has flood insurance, would not be in compliance with the requirements for lowest floor being elevated to or above the one percent annual chance flood plain (or floodproofed if nonresidential). In accordance with local flood plain regulations, if it is flooded or damaged by fire, wind, rain, or other natural or human induced hazard and the cost of restoring the structure to its before damaged condition would equal 50 percent of the market value of the structure before the damaged occurred, then the structure will be required to be brought into compliance. For a property owner who does not have proper insurance, it could be very costly to restore the structure and meet local flood plain regulations.

In addition, the effective 2005 FIRMs also show Coastal Barrier Resources System (CBRS) and Otherwise Protected Area (OPA) boundaries. The Coastal Barrier Resources Act (CBRA) was passed by Congress in 1982 to encourage conservation of hurricane prone, biologically rich coastal barriers. CBRA prohibits most new federal expenditures that encourage development or modification of coastal barriers. Therefore, most new or substantially improved residences, businesses, or other development in the CBRS are not eligible for certain federal funding and financial assistance, including coverage under the NFIP. Development can still occur within the CBRS, as long as private developers or other non-federal parties bear the full cost. More specifically, the NFIP cannot provide flood insurance coverage for structures built or substantially improved after the area is designated as a CBRS unit (initial designations went into effect on October 1, 1983). The NFIP may provide flood insurance for units built or substantially improved before the subject property was included in a designated CBRS unit. If an NFIP insured building within a designated CBRS unit is substantially improved or substantially damaged, the NFIP policy will be cancelled. NFIP flood insurance can be provided within CBRS units for new structures supporting conservation uses. Minimum NFIP flood plain management standards do not prohibit the rebuilding of substantially damaged buildings in CBRS units. However, such structures must meet the community's floodplain management regulations, and NFIP coverage is not available for such structures. Note, although shown on the effective FIRMs, CBRS, and OPA boundaries can change; the official and most up to date boundary information is maintained by the USFWS.

Flood mitigation activities are used to help reduce or eliminate the impacts from flooding. Monroe County has completed many activities in trying to address the many flooding problems and help its citizens. FEMA encourages communities to be proactive with flood mitigation activities by joining the Community Rating System (CRS). The CRS is a voluntary program for communities that participate in the NFIP to complete FEMA approved mitigation projects. In general, projects can include activities involving public information, mapping and regulations, flood damage reduction, and warning and response. Participation in CRS provides residents of those communities with flood insurance discounts. The discounts are based upon the CRS rating of the community from a Class 10 to a Class 1 with a five percent discount for each class obtained, ranging from ratings of Class 1, a 45 percent discount, to Class 9, a five percent discount. As of October 2019, the following CRS class ratings were earned: Islamorada – 6, Key Colony Beach – 7, Key West – 7, Layton - 6, Marathon – 6, and Monroe County – 5 (FEMA 2019). A listing of completed flood mitigation activities can be found in Monroe County's Hazard Mitigation Plan (MCWG 2015); some communities may have the information posted on their websites.

2.9 BEACHES AND TERRESTRIAL VEGETATION HABITAT

For the purpose of the following discussion, this section is intended to focus on terrestrial habitat above mean high water (MHW). However, due to the interconnectedness of ecosystems, there is some overlap with other sections.

The ROI is all areas within the Keys that will be temporarily or permanently filled, graded, cleared, excavated, or otherwise converted to another use as a result of the construction of the structural or nonstructural measures. It also includes all noise and disturbance effects indirectly adversely affected by the project, by means such as erosion, alteration of wildlife passage corridors, or changes in community type.

Section 307(c)(1) of the Coastal Zone Management Act (CZMA) requires that any federal agency that undertakes any development project in the coastal zone of a state shall insure that the project is, to the maximum extent practicable, consistent with the enforceable policies of the approved state management programs. It also requires that the federal agency shall complete and provide a federal consistency determination to the state that includes effects on wildlife. The Coastal Construction Control Line (CCCL) is defined by Florida Statutes as that portion of the beach and dune system subject to severe fluctuations based on a 100-year storm event and establishes the landward limit of jurisdiction of FDEP along sandy beaches of the state along the Gulf of Mexico, the Atlantic Ocean, and the Straits of Florida. Unless otherwise exempt, a permit is required from FDEP for construction and excavation activities seaward of the CCCL. The CCCL is not a seaward limit for construction of upland structures (as in a setback line), but is an area wherein special siting and design considerations are required to protect the beach and dune system, proposed or existing structures, adjacent properties, public beach access, native salt-tolerant coastal vegetation, and marine turtles. On sandy beach areas where no CCCL has been established pursuant to Section 161.053, Florida Statutes (F.S.), coastal construction is prohibited within 50 feet of the line of MHW unless authorized by waiver or variance of the setback requirements pursuant to Section 161.052, F.S (FDEP, 2020a). Pursuant to Section 161.55(4), F.S., all land area in the Florida Keys located within Monroe County shall be included in the coastal building zone.

2.9.1 Existing conditions

Beaches

Within the ROI, which includes shorelines within 100 feet of U.S. Route 1, three locations considered to be beach habitat are at Bahia Honda and Long Key State Parks and Sea Oats Beach. The beach berm, dune, and intertidal zones there tend to be very narrow. Although historically wider, they have been eroded more recently by storms and hurricanes. Therefore, the beach habitat quality and areas within the ROI are more limited in the amount of habitat they can provide than they were in the past.

Beach berms are dynamic and fragile ecosystems that host a wide diversity of species. The beach berm is considered to be any sandy areas within a ten foot (three meter) elevation range above mean high water (MHW). These ecosystems are dynamic systems that are formed and maintained naturally through the accretion and erosion of sediment from storm and wind events. Succession of vegetation occurs through disturbance, and recolonization of vegetation occurs through deposition of seeds that are transported through oceanic currents (NOAA, 2019a).

The wrackline is the area on the beach where organic material and other debris is deposited at high tide (Figure 2-20). Typical rack material includes uprooted seagrasses, algae, seeds, mangrove leaves and propagules, sponges, soft corals, and shells. Small crustaceans called amphipods feed among the seagrass wracklines, and shorebirds come along and forage on them. The foraging breaks down the seagrass in the wrackline, and the particles become nutrients for the dunes. The wrackline also helps stabilize the sand, which promotes dune life (Florida State Parks, 2020).

Figure 2-20: Rack Line at Bahia Honda State Park (l). Rack line and vegetated beach at Long Key State Park (r).

Within the beach berm zone are coastal dunes, which are typically found at an elevation of zero to four feet (1.2 meters) and adjacent to the intertidal zone. This area is primarily made up of sandy soils and is sparsely vegetated with species such as bay cedar (*Suriana maritima*), sea oats (*Uniola paniculata*), seashore dropseed (*Sporobolus virginicus*), beach panicum, and railroad vine (*Ipomoea pes-caprae*) (Long Key State Park, 2016). Sea lavender, a rare species, can also be found within this zone in these two state parks.

Dunes are a fragile habitat easily damaged by people and storms, the extent of which depends on dune size and profile, quantity and type of flora, beach characteristics, and surrounding water depth. The beach-dune interface is an important ecotone that produces sustained levels of biological activity (Liddle and Greig-Smith 1975, McDonnell 1981, Nickerson and Thibodeau, 1983).

Terrestrial vegetation

Other nearshore terrestrial species of vegetation that can be found along shorelines areas include seaside grape, buttonwood, (*Conocarpus erectus*), white mangrove (*Laguncularia racemosa*), and saltbush (*Baccahris hamifolia*).

Invasive plant species
Some of the more common invasive plant species that occur within the ROI include Brazillian pepper (*Schinus terebinthifolius*), seaside mahoe (*Taliparti tiliaceum*), and Australian pine (*Casuarina equestifollia*). Australian pines outcompete native vegetation due to the chemical properties in their fallen branches which suppress germination, and results in a monoculture (FDEP, 2016). Brazilian pepper can form dense forests that exclude all other plant life by producing a dense closed canopy that is considered to be poor habitat for native wildlife species and may negatively impact bird populations (Florida Fish and Wildlife Conservation Service, 2020)

2.10 WETLANDS

Wetlands are defined by CWA regulations as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (USEPA 2016). The two major categories of wetlands are tidal (subject to the ebb and flow of tide), and nontidal (freshwater). Wetlands may be forested, scrub/shrub, or emergent.

The ROI for wetlands includes all wetland areas within the study area to be directly filled, dredged, excavated, or otherwise temporarily or permanently converted to another use as a result of the construction of the measures, as well as all wetlands indirectly adversely affected by the project, by means such as alteration in tidal flushing, sedimentation, currents, erosion, changes in salinity, and community type. It should be noted that all wetlands within the ROI are tidal and brackish.

2.10.1 Existing Conditions

Forested and Scrub/Shrub wetlands: Mangroves
Mangroves grow along more than 1,800 miles of shoreline within FKNMS. In the Florida Keys, the red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), and white mangrove *Laguncularia racemosa*) tend to dominate wetland landscapes. These forests help stabilize coastlines and help reduce erosion from storm surge, currents, waves, tides, and hurricane damage. They also slow down and filter runoff, assisting in keeping waters clean and clear (NOAA 2019a).

Mangrove wetlands are highly valuable and high functioning wetlands. They range from tall, coastal forest to low, dense scrub communities, with each variety providing different physical habitats, niches, microclimates, and food sources for a diverse assemblage of animals. Most red mangrove dominated wetlands are flooded at least two times per day. The roots of these trees are either fully submerged in water or inundated daily with the tidal cycle. They are important habitat for wildlife, both above and below the water. The prop roots of the red mangrove serve as nursery areas for many commercially and recreationally important fish and shellfish aquatic species. Above the water, they are critical nesting, resting, and feeding sites for many birds including wading birds like great white herons and reddish egrets, magnificent frigatebirds, white crowned-pigeon, osprey, bald eagles, resident and migratory songbirds, hawks, and falcons. The black and white mangrove species are found further up-slope in coastal wetlands (NOAA, 2019a). Buttonwood trees (Conocarpus erectus) are sometimes intermingled with black and/or white mangrove species; however, usually buttonwood is found slightly upslope, and near the transitional wetland/upland border.

Since the 1940s, when dredge and fill operations began in the Florida Keys, mangrove forests have suffered significant losses. Approximately 60 percent of shallow water mangroves in the Upper Keys were lost between 1965 and 1985 due to construction of marinas, airports, and seawalls; dredging of channels; and other commercial and residential construction. Mangrove forests in the Florida Keys have most recently been impacted by the high winds, storm surge, and hypersalinity caused by Hurricane Irma. While some recovery has occurred, mangrove forest recovery can take 10 to 15 years (NOAA, 2019a).

Within the ROI, mangrove fringed wetland shorelines can be found on Cudjoe Key, Spanish Harbor Key, Duck Key, Fiesta Key, and Indian Key (Figures 2-21 to 2-23). These locations all had mature mangroves estimated to be at least 15-30 years old. Within the ROI, most of the mangroves were healthy and mature; in many cases, they were growing and even thriving among old concrete blocks, rocks, and existing riprap or seawalls.

Figure 2-21: Mangrove wetlands within the ROI, growing among concrete at Cudjoe Key.

Figure 2-22: Representative Photos of mixed mangrove wetlands within the ROI.

Herbaceous wetlands

The only other wetland community type in the ROI are a few herbaceous wetland communities dominated by sea purslane (*Sesuvium portulacastrum*) and sea oxeye (*Borrichia frutescens*). These communities can be found landward of the existing seawalls at West Summerland Key and Indian Key. Specifically, at West Summerland Key, landward of an existing concrete seawall, there were several dead and few live mangroves standing, but the herbaceous community of these two species was thriving and young mangrove shoots were coming up.

Figure 2-23: Herbaceous Wetlands at West Summerland Key. U.S. Route 1 at top left.

2.11 BENTHICS AND SUBMERGED AQUATIC VEGETATION

Benthos include organisms living near, in, or on the bottom sediments of the various bodies of water included in the study area. They include highly and semi-motile forms capable of relocating short distances in response to changes in their environment, and sessile invertebrates that remain in place all their adult lives, such as corals. The benthic habitat within the Florida Keys includes both estuarine and marine hydrologic regimes and is a uniquely productive resource that supports both sensitive, diverse biological systems and a booming commercial and recreational fishery.

The ROI for benthic habitat and submerged aquatic vegetation (SAV) is the intertidal and submerged lands from Palo Alto Key to Key West extending approximately 120 miles, that are to be directly filled, dredged, excavated, or otherwise temporarily or permanently converted to another use as a result of the construction of the measures, as well as all such areas indirectly adversely affected by the project, by means such as alteration in tidal flushing, sedimentation, currents, erosion, changes in salinity, and community type.

These areas may include unconsolidated substrate (sand or mud), red mangrove fringes, hardbottom, and seagrass beds. The ROI includes Critical Habitat for Elkhorn and Staghorn corals, which are further discussed in the Special Status Species section. However, as the structural measures are shoreline stabilization, the ROI footprint would be nearshore and relatively limited.

2.11.1 Existing Conditions

Unconsolidated Substrate: Beaches, Sandflats, and Mudflats

In the Florida Keys, common types of unconsolidated substrates include coralgal, marl, mud, mud/sand, sand, or shell. Unconsolidated sediments can come from organic sources, such as decaying plant tissues (e.g., mud) or from recent or fossilized calcium carbonate depositions of plants or animals (e.g., coralgal, marl, and shell substrates). Infaunal organisms in subtidal zones can be substantial, making these areas important feeding grounds for many bottom-feeding fish. Common infaunal organisms can include mollusks, isopods, amphipods, and an assortment of crabs. The intertidal and supratidal zones are extremely important feeding grounds for many shorebirds and invertebrates (FNAI 2010).

Tidal flats are non-vegetated areas of sand or mud that are tidally submerged and protected from wave action. They provide habitat for a host of marine and terrestrial species throughout the year. Tidal flats provide essential foraging habitat for wading and shorebirds that hunt small fish, crustaceans, and marine invertebrates during low tide cycles (NOAA, 2019a).

Red Mangrove Habitat

As mentioned in the wetland section, red mangroves occur within the ROI. They assist in trapping and cycling various organic materials, chemical elements, and important nutrients throughout the interconnected reef-seagrass-mangrove system. Detritus from mangrove leaves are an important part of the food web that supports decomposers and consumers. In addition, mangrove roots provide nearshore attachment surfaces for various marine organisms, many of which filter water and trap and cycle nutrients. Mangrove prop roots also provide cover used by commercially and recreationally important reef fishes and crustaceans (NOAA, 2019a).

Consolidated Substrate: Hardbottom and Corals

Shallow hardbottom communities are found throughout nearshore environments within the Florida Keys, on both the ocean and bay side, and can be found in up to 30 percent of the nearshore environment of the Florida Keys (Bertelsen et al. 2009). Hardbottom communities can form on solid rock or on low-relief limestone substrates covered with a layer of sediment and sparse seagrass (FNAI 2010).

Hardbottom communities close to shore typically have low species diversity, but can support gorgonians, algae, sponges, and a few stony coral species. These habitats provide important cover and feeding areas for many fish and invertebrates (Florida Museum, 2019). Hardbottom communities are often divided into two types:

- Nearshore restricted hardbottom communities have limited water movement. This bottom community typically is dominated by algae including epilithic algae that attaches itself directly to the limestone bottom as well as drift algae. Algae are at the bottom of the food chain and provide a primary food source for a variety of organisms including invertebrates, fishes, and even the endangered green sea turtle (Chelonia mydas).
- Nearshore high-velocity hardbottom communities are exposed to strong currents. Gorgonians, easily recognized with their rod-like appearance and flexibility, and sponges can dominate these communities (Florida Museum, 2019).

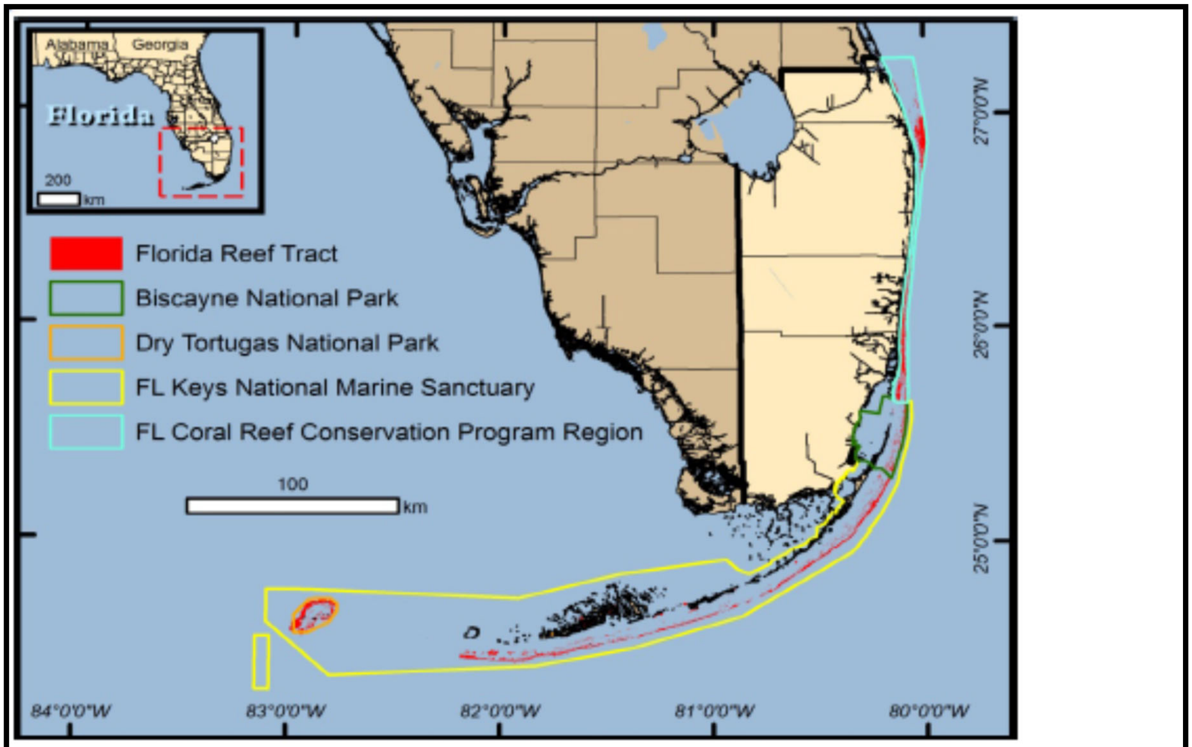
Although biodiversity of visible organisms on hardbottom may be low compared with patch reefs and deep water reefs, it is much higher on nearshore reefs than on sandy bottom. The term nearshore reefs is meant here to include all solid physical substrate below the mean high water line (MHW) and seaward of Atlantic Ocean or Gulf of Mexico shoreline which may be vulnerable to fill deposition and turbidity (loss of light penetration through the water column) associated with beach nourishment. The zone has been defined by the FDEP as the area landward of the 4 meter (13.1 foot) depth contour (U.S Fish and Wildlife, 1999).

Hardbottom habitat can be easily degraded through siltation, sedimentation, or placement of fill; and is also sensitive to water quality changes associated with thermal stress, salinity changes, and harmful algal blooms.

Corals

Corals and coral reefs in the Florida Keys depend on the Florida Current to bring the warm, low-nutrient waters that corals require to live. Reefs are well developed seaward of the Upper Keys and Lower Keys, but are absent or poorly developed near the wider channels in the middle Keys, where conditions for optimal growth are adversely affected by water quality variations. The Florida Tract Reef is well offshore of the Keys, but there are many patch reefs throughout the Marine Sanctuary, and the Marine Sanctuary is also working to create and enhance reefs (NOAA, 2019a).

The ROI is limited to shorelines and nearshore areas and does not include any known coral reefs or patch reefs. However, as mentioned, it is within the Critical Habitat for Elkhorn and Staghorn Coral, both federally endangered species that are discussed under the Special Status Species section. Also, nearshore hardbottom habitat may include individual corals. Sedimentation, overturned coral colonies, and scouring all have a negative impact on corals and coral reef habitat. Many of the indirect impacts to coral can be derived from declining water quality and clarity (Figure 2-24).



Credit: Florida Department of Environmental Protection Coral Reef Conservation Program (DEP, CRCP)

Figure 2-24: Federally Protected Waters within the Florida Keys.

Seagrasses/SAV

Seagrass occurs throughout the soft-bottom, shallow-water areas within the Marine Sanctuary wherever water quality allows adequate light penetration to enable photosynthesis. Seagrass communities provide a range of ecosystem services, including stabilizing the bottom through their dense roots and rhizomes, and helping to maintain water clarity by trapping fine sediments and other particles in their leaves and root systems. There are both sparse and continuous seagrass beds mapped throughout the FK waters.

Seagrass beds have declined in abundance and distribution and species composition has shifted in some nearshore areas due to water quality degradation and through the direct loss of habitat related to dredging, infilling, coastal development, and boating impacts (e.g., propeller scars and groundings (NOAA, 2019a).

Within the footprint of the ROI, which is limited to nearshore areas, there is no observable seagrass. It is present farther offshore, and includes turtle grass (*Thalassia testudinum*), the dominant seagrass community; shoal grass *(Halodule wrightii*); and manatee grass *(Syringodium filiforme*).

2.12 FISH AND FISHERY RESOURCES

Fish and fishery resources exist in the Marine Sanctuary waters within the Upper, Middle, and Lower Keys. The Upper Keys extend from Virginia Key to Lower Matecumbe Key, the Middle Keys extend from Lower Matecumbe Key to the Seven Mile Bridge, and the Lower Keys extend from Little Duck Key to Key West.

The ROI includes all nearshore environment areas that would be affected temporarily or permanently by structural or nonstructural measures; typically, in areas channelward of mean high water (MHW).

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. §§ 1801 et seq.) governs the management of marine fisheries in U.S. federal waters to the 200-mile nautical limit. The 1996 amendments to the MSA, or the Sustainable Fisheries Act, identified fish habitat as a vital component to fisheries management and set forth a mandate for NOAA's National Marine Fisheries Service (NMFS) and regional Fisheries Management Councils to designated Essential Fish Habitat (EFH) for species managed under federal fishery management plans. The MSA defines Essential Fish Habitat as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Habitat Areas of Particular Concern (HAPCs) are subsets of EFH that identify sensitive and high priority EFH conservation areas which support vital ecological functions for designated species. Consultation with NOAA Fisheries is required by the MSA for proposed Federal actions that may adversely affect EFH by reducing the quality and/or quantity of EFH through direct, indirect, or cumulative impacts. An EFH Assessment containing further information is provided in the Environmental Appendix (Appendix D).

The South Atlantic Fishery Management Council (SAFMC) currently manages eight fisheries along the Atlantic Coast within the 200 nautical mile limit extending from North Carolina to Key West. The eight fisheries managed under existing Fishery Management Plans include: snapper grouper, Caribbean spiny lobster (*Panulirus argus*), coastal migratory pelagics (mackerel and cobia), coral and live bottom habitat; dolphin and wahoo; golden crab, and Sargassum.

2.12.1 Existing Conditions

The diverse assemblage of fishes found in the Florida Keys region is vital to the health of the marine ecosystem which supports commercial and recreational fishing as well as various ecotourism activities. Tropical and subtropical fish utilize coral reef, shallow bank, seagrass, and mangrove habitats as nursery and spawning grounds throughout the region. Fishes and marine invertebrates depend on healthy habitats throughout their lives for survival, and they are vulnerable to habitat degradation and other anthropogenic impacts associated with overexploitation, climate change, and poor water quality.

Aquatic Preserves are designated as Outstanding Florida Waters under 62-302.700 Florida Administrative Code (FAC) and provide protection to Florida's valuable aquatic natural resources and cultural heritage. There are 41 aquatic preserves in Florida; however, Lignumvitae Key, which functions as nursery habitat and EFH for species managed by the SAFMC, is the only designated aquatic preserve in the ROI.

Snapper and Groupers

Snappers (family *Lutjanidae*) and groupers (family *Serranidae*) comprise an ecologically important complex of reef fishes with commercial and recreational value in the region. The life history characteristics of these slow growing, late maturing, and long lived species increase their vulnerability to overexploitation with long-term sustainability a concern due to slow recovery times. Methods to prevent overfishing and rebuild stocks include the use of protected areas and stringent harvest regulations established by the SAFMC under the Snapper-Grouper Fishery Management Plan for the South Atlantic Region. These fishes utilize inshore and offshore habitats throughout their life cycle (Ault et al. 2005), with the majority of eggs/larvae dispersing and settling into nearshore environments.

Hogfish (Lachnolaimus maximus)

An economically important reef fish, hogfish are found in tropical and subtropical waters of the Atlantic Ocean, Gulf of Mexico, and Caribbean. In 2017, the SAFMC designated a distinct hogfish stock for the Florida Keys/East Florida. Hogfish rely on reef habitat for protection from predators and for feeding on benthic invertebrates.

Following a 30-40 day pelagic larval phase, hogfish settlement occurs nearshore in shallow seagrass, reef, or estuarine habitats. Hogfish eventually move offshore and onto reef habitats. As protogynous hermaphrodites, hogfish begin life as females and eventually mature into males (McBride and Johnson 2007). In the Florida Keys, the hogfish spawning season typically peaks between December and April. Hogfish form social groups called harems, where one male will protect and spawn with a group of females within his territory. Due to their life history characteristics and history of overfishing, hogfish are vulnerable to overharvesting.

Marine Invertebrates: Caribbean Spiny Lobster and Shrimp Species

The Caribbean spiny lobster (*Panulirus argus*) is widely distributed from North Carolina to Brazil, with the commercial fishery and the majority of the recreational fishery occurring off of South Florida and primarily in the Florida Keys (GMFMC 2017).

Caribbean spiny lobsters utilize mangrove, shallow hardbottom, seagrass, and reef habitats of the Florida Keys. Larvae, which may originate elsewhere in the Caribbean, are transported by ocean currents to the hardbottom habitats of the Florida Keys where postlarvae settle nearshore often in hardbottom habitat covered by red macroalgae where they feed on invertebrates. Caribbean spiny lobsters emerge from the macroalgae and seek protection in crevices under sponges, octocorals, and corals, and also within dissolved limestone burrows and seagrass blowouts after reaching a carapace length of approximately 15-20 millimeters (mm). Larger juveniles migrate to patch reef and offshore reef systems, and both male and female lobsters travel from their shelters to foraging grounds on a daily basis. Caribbean spiny lobsters are also an important prey species in the Florida Keys seagrass ecosystem.

The shrimp fishery represents one of the most important commercial fisheries in the Florida Keys. The various federally managed species that comprise the fishery include: brown shrimp (*Farfantepenaeus aztecus*), white shrimp (*Litopenaeus setiferus*), pink shrimp (*Farfantepenaeus duorarum*), royal red shrimp (*Hymenopenaeus robustus*), and rock shrimp (*Sicyonia brevirostris*). Various protection measures implemented by SAFMC and the Gulf of Mexico Fishery Management Council include: closed areas in federal waters, the use of bycatch reduction devices, and the prohibition on rock shrimp trawling in Oculina coral areas. Pink shrimp, brown shrimp, and white shrimp can be found in shallow environments while royal red and rock shrimp generally occur in deeper waters. Adult pink shrimp spawn off of the Dry Tortugas, and larvae are transported to shallow-water estuaries where they spend the majority of their lifecycle. Postlarval pink shrimp spend from two to seven months in Florida Bay's seagrass nursery grounds before moving back into the Gulf of Mexico off the Dry Tortugas where they are the dominant species within the Dry Tortugas shrimping grounds (SAFMC 2019).

2.12.2 Habitats

The following section focuses on the primary habitats designated as EFH in the ROI.

Hardbottom

Nearshore environments on the Atlantic Ocean side of the Florida Keys are characterized by shallow hardbottom communities which serve as critical nursery areas for many commercially important fishes and invertebrates, such as the Caribbean spiny lobster. These communities support various sponge species, stony corals, macroalgae, sea fans, and branching gorgonians. Stony coral cover is generally low with sponges as the dominant invertebrates providing shelter and habitat for nearshore marine organisms. Hardbottom habitats are sensitive to water quality changes resulting from thermal stress and harmful algal blooms, and they are easily degraded from sedimentation and fill impacts due to their proximity to land.

Mangroves

Mangrove communities are characterized by three species in the Florida Keys, the red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), and white mangrove (*Laguncularia racemosa*). Mangrove roots are inundated daily by tides and their elevation ranges from shallow submerged land to approximately four inches above sea level. Red mangroves are an essential feature of the Florida Keys ecosystem and provide ecosystem services including: trapping and cycling organic materials and nutrients, serving as a carbon sink (living plant material and soil/peat layers in the mangrove substrate) and also as a source of carbon in the food web, and shoreline protection through buffering wave action and storm surge. Mangrove communities are among the most biologically productive ecosystems in the world (Lugo and Snedaker 1974) and are vital to the marine environment.

Coral Reef

Corals reefs are formed by reef-building (stony) corals, calcareous marine algae, and other invertebrates that create or produce structures consisting of calcium carbonate, or limestone. Over time, the structures fuse together to form large expanses of reef tract elevation off of the seafloor and that can also serve as wave-attenuating structures. Coral reefs create habitat for a myriad of organisms by providing food sources and shelter. The Florida Reef Tract, which extends from the Dry Tortugas in the west to St. Lucie inlet off of the southeast coast of the Florida peninsula, is the most extensive living coral reef ecosystem in North American waters. Hard coral species that characterize the Florida Reef Tract include elkhorn coral (*Acropora palmata*), staghorn coral (*Acropora cervicornis*), mountainous star coral (*Orbicella faveolata*), brain corals (*Pseudodiploria strigosa*, *Diploria labyrinthiformis*, *Pseudodiploria clivosa*, and *Colpophyllia natans*), mustard hill coral (*Porites astreoides*), finger coral (*Porites porites*), starlet coral (*Siderastrea siderea*), and lettuce corals (*Agaricia agaricites*). Coral reefs are vulnerable to drastic and extended sea water temperature fluctuations which contribute to coral bleaching and disease susceptibility.

2.13 SPECIAL STATUS SPECIES

2.13.1 Federally Listed Species and Critical Habitat

In reference to the Endangered Species Act of 1973, as amended, an “endangered species” is defined as any plant or animal species in danger of extinction throughout all or a substantial portion of its range. A “threatened species” is any species likely to become an endangered species in the foreseeable future throughout all or a substantial part of its range. “Proposed Species” are animal or plant species proposed in the Federal Register to be listed under Section 4 of the ESA. “Candidate species” are species for which the FWS and NMFS have sufficient information on their biological status and threats to propose them as endangered or threatened under the ESA. “Critical habitat” is designated per 50 CFR parts 17 or 226 and defines those habitats that are essential for the conservation of a federally threatened or endangered species and that may require special management and protection. The ESA provides for the conservation of species that are endangered or threatened throughout all or a significant portion of their range and the conservation of habitats upon which they depend. The law also prohibits any action that causes a "taking" of any listed species of endangered fish or wildlife unless otherwise authorized by the USFWS.

2.13.2 State Listed Species

Federally listed species are included on the Florida Endangered and Threatened Species List as “Federally designated Endangered, Federally designated Threatened, Federally designated Threatened Due to Similarity of Appearance,” or “Federally designated Non-Essential Experimental Population” species. Additional species specifically designated by the Florida Fish and Wildlife Commission are included on the Florida Endangered and Threatened Species List as State designated Threatened species and are listed in the Florida Administrative Rule 68A-27.003.

2.13.3 Marine Mammals

In reference to the Marine Mammal Protection Act of 1972, as amended, a marine mammal refers to a species found in the U.S. that is classified into one of the following four distinct groups: cetaceans (whales, dolphins, and porpoises), pinnipeds (seals, sea lions, and walruses), sirenians (manatees and dugongs), and marine fissipeds (polar bears and sea otters). For this project, only sirenians have the potential to occur in the Action Area.

The Marine Mammal Protection Act of 1972, as amended (MMPA) prohibits, with certain exceptions, the “take” of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S. (NOAA, 2019a). All marine mammals in the U.S. are afforded protection under the MMPA.

The term “take” per the MMPA is defined as harass, hunt, capture, or kill, or attempt to harass, hunt, capture or kill any marine mammal. For most activities, “harassment” refers to the act of pursuit, torment, or annoyance which:

- Has the potential to injure a marine mammal or a marine mammal stock in the wild which is referred to as Level A Harassment; or
- Has the potential to disturb a marine mammal or marine mammal stock in the wild by disrupting behavioral patterns that include but are not limited to the following: migration, breathing, nursing, breeding, feeding, or sheltering which is referred to as Level B Harassment.

2.13.4 Migratory Birds

Migratory birds are defined as those described by the USFWS in the 50 CFR 10.13 and consists of species that that belongs to a family or group of species in the United States as well as Canada, Japan, Mexico, or Russia. Most birds native (naturally occurring) to the U.S. belong to a protected family and are protected by the Migratory Bird Treaty Act (MBTA). A species qualifies for protection under the MBTA if it meets one or more of the following four criteria:

(1) It (a) Belongs to a family or group of species named in the Canadian convention of 1916, as amended in 1996; (b) specimens, photographs, videotape recordings, or audiotape recordings provide convincing evidence of natural occurrence in the United States or its territories; and (c) the documentation of such records has been recognized by the American Ornithologists Union or other competent scientific authorities.

(2) It (a) Belongs to a family of group of species named in the Mexican convention of 1936, as amended in 1972; (b) specimens, photographs, videotape recordings, or audiotape recordings provide convincing evidence of natural occurrence in the United States or its territories; and (c) the documentation of such records has been recognized by the AOU or other competent scientific authorities.

(3) It is a species listed in the annex to the Japanese convention of 1972.

(4) It is a species listed in the appendix to the Russian convention of 1976.

The MBTA and Executive Order 13186 (EO) requires agencies to protect and conserve migratory birds and their habitats. Any activity that results in the take of migratory birds or eagles is prohibited unless otherwise authorized by the USFWS (FWS IPaC, 2019). The USFWS National Bald Eagle Management Guidelines (2007) provide general recommendations for land management practices that will benefit bald eagles, describe the potential for various human activities that disturb bald eagles, and encourage land management practices that benefit bald eagles.

The ROI (or Action Area per 50 Code of Federal Regulation (CFR) 402.02 with respect to federally listed threatened and endangered species), is defined as those areas that have the potential to be directly or indirectly impacted by an alternative as it pertains to Special Status Species. The terms ROI and Action Area will be used interchangeably in this section.

The ROI includes the limits of physical disturbance of the habitat caused by construction, maintenance, and operations of the potential structural and nonstructural project features as well as the extent of hydraulic and water quality impacts that have the potential to impact special status species. The ROI is also defined by the extent of noise impacts as they pertain to special status species.

Lists of the state and federally listed species, marine mammals, and migratory birds were compiled that have the potential to occur in the ROI based on the following sources:

- Official Species List correspondence by the USFWS on December 17, 2019 (provided in the Environmental Appendix, Appendix D);
- Official Species List correspondence provided by the NMFS, on December 3, 2019 (provided in Appendix D);

- Florida Fish and Wildlife Conservation Commission's Statewide Atlas of Sea Turtle Nesting Occurrence and Density http://ocean.floridamarine.org/SeaTurtle/nesting/FlexViewer/
- Information, Planning, and Conservation Database (U.S. Fish and Wildlife Service 2019);
- Florida Administrative Rule 68A-27.003 (Effective Date: February 17, 2020); and the
- Florida Fish and Wildlife Commission (FWC) Bald Eagle Locator (FWC 2016-2017).\
- Florida Fish and Wildlife Conservation Commission's Statewide Eagle Nest Locator http://myfwc.maps.arcgis.com/apps/webappviewer/index.html?id=253604118279431984e8bc3ebf1cc8e9

Nesting Buffers to estimate potential impacts to nesting bald eagles (*Haliaeetus leucocephalus*) were calculated in accordance with the USFWS National Bald Eagle Management Guidelines (2007). To avoid disturbing bald eagles, a nest buffer is recommended between the human activity and the nest where applicable. Human impacts are considered detrimental to nesting success within the primary buffer and within the secondary buffer human impacts are thought to impact the quality of the primary buffer. The primary buffer is a distance of 330 feet from the nest and the secondary buffer is a distance of 660 feet from the nest. Human activities that are considered detrimental to breeding activities (e.g. development, logging, use of toxic chemicals, etc.) are to be limited within the primary buffer and those that could impact the integrity of the primary buffer are restricted within a secondary buffer (e.g. developments, roadways, etc.). Per the Management Guidelines, a nest buffer of 2,640 feet is recommended from the nest for loud, disturbing noises such as those caused by blasting and other loud, intermittent noises.

2.13.5 Existing Conditions

Federally Listed Species and Critical Habitat

Table 2-1 provides the federally listed species that have the potential to occur in the ROI and also designated critical habitats located in the ROI. For a detailed description of federally listed species and designated critical habitat please refer to the Biological Assessment provided in Appendix D. Maps of the designated critical habitats in the ROI are provided in the Biological Assessment provided in Appendix D.

Table 2-1: Federally Listed Species With the Potential to Occur in the ROI and Critical Habitat

Taxonomic Category/Common Name	Scientific Name	Federal Status	Critical Habitat
Birds			
Piping Plover^	*Charadrius melodus*	T	Y
Red knot^	*Calidris canatus rufa*	T	N
Fish			
Nassau grouper	*Epinephelus striatus*	T	N
Smalltooth sawfish (U.S. DPS)	*Pristis pectinata*	E	Y*

Oceanic whitetip shark	*Carcharhinus longimanus*	T	N
Giant manta ray	*Manta birostris*	T	N
Invertebrates			
Pillar coral	*Dendrogyra cylindrus*	T	N
Rough cactus coral	*Mycetophyllia ferox*	T	N
Lobed star coral	*Orbicella annularis*	T	N
Boulder star coral	*Orbicella franksi*	T	N
Mountainous star coral	*Orbicella faveolata*	T	N
Elkhorn coral	*Acropora palmata*	T	Y
Staghorn coral	*Acropora cervicornis*	T	Y
Mammals			
West Indian manatee^	*Trichechus manatus*	T	Y
Reptiles			
American alligator^	*Alligator mississippiensis*	SAT	N
American crocodile^	*Crocodylus acutus*	T	Y
Hawksbill sea turtle	*Eretmochelys imbricata*	E	Y*
Leatherback sea turtle	*Dermochelys coriacea*	E	Y*
Loggerhead sea turtle (Northwest Atlantic Ocean DPS)	*Caretta caretta*	T	Y
Green sea turtle (North and South Atlantic DPS)	*Chelonia mydas*	T	Y*
Kemp's Ridley sea turtle	*Lepidochelys kempii*	E	N
Plants			
Cape Sable Thoroughwort^	*Chromolaena frustrata*	E	Y
Garbers spurge	*Chamaesyce garberi*	T	N
Tree cactus	*Pilosocereus robinii*	E	N
DPS = Distinct Population Segment; E = Endangered; T = Threatened; Y = Yes; N = No; SAT = threatened due to similarity of appearance; Species classification is reported as it pertains to the DPS/Action Area; *Critical Habitat designated but is not located in the ROI/Action Area; ^Species under the jurisdiction of the USFWS; remaining species are under the jurisdiction of the NMFS			

Source: (U.S. Fish and Wildlife Service 2019; National Oceanic and Atmospheric Administration 2019).

State Listed Species

Federally listed species are also designated as state listed species in Florida. Therefore, all of the endangered and threatened species provided in Table 2-2 are also designated as state listed species with the same respective listing classification.

Additional species listed by the FWC are included on the Florida Endangered and Threatened Species List as State designated Threatened species. The ROI provides habitat for several state listed species (Table 2-2) besides those already described in Table 2-1.

Table 2-2: Additional State Listed Species with the Potential to Occur in the ROI

Taxonomic Category/Common Name	Scientific Name	State Status
Birds		
Black skimmer	*Rynchops niger*	T
Florida burrowing owl	*Athene cunicularia floridana*	T
Least tern	*Sternula antillarum*	T
Little blue heron	*Egretta caerulea*	T
Reddish egret	*Egretta rufescens*	T
Roseate spoonbill	*Platalea ajaja*	T
Tricolored heron	*Egretta tricolor*	T
Snowy plover	*Charadrius nivosus*	T
White-crowned pigeon	*Patagioenas leucocephala*	T
Reptiles		
Florida Keys mole skink	*Plestiodon egregius egregious*	T
Key ringneck snake	*Diadophis punctatus acricus*	T
Rim rock crowned snake	*Tantilla oolitica*	T
Fish		
Key silverside	*Menidia conchorum*	T

Source: (Florida Fish and Wildlife Conservation Commission, 2019)

Marine Mammals

In addition to the federally listed marine mammals described in Table 2-1, bottlenose dolphins (*Tursiops truncatus*) are known to commonly occur in the ROI (FWC, n.d.). Bottlenose dolphins are blue-gray on top with lighter coloration on their sides and bellies and are typically six to 12 feet long. Common prey items of the bottlenose dolphin include a variety of fish species such as mullet (*Mugil cephalus*), sheepshead (*Archosargus probatocephalus*), pinfish (*Lagodon rhomboides*), flounder (*Paralichthys lethostigma*), and marine invertebrates. They are known to inhabit inshore as well as offshore areas. Other non-federally listed dolphins and whales have the potential to occur in the ROI but occurrences would be unlikely based on their preferential breeding and foraging habitats.

Species Protected under the Migratory Bird Treaty Act of 1918 and Executive Order 13186

Migratory birds nest throughout North America, some as far north as the Arctic. In late summer and fall, they migrate south for the winter. Some winter in the southern United States, Mexico, the Caribbean or Central America while others go as far as South America. Then, each spring they return north to their breeding grounds. In addition to the already described federally listed piping plover and red knot, additional migratory bird species with the potential to occur in the ROI are provided in Table 2-3.

Table 2-3: Migratory Birds with the Potential to Occur in the ROI (USFWS 2020)

Common Name	Scientific Name
American Kestrel	*Falco sparverius paulus*
American Oystercatcher	*Haematopus palliatus*
Audubon's Shearwater	*Puffinus lherminieri*
Bald Eagle	*Haliaeetus leucocephalus*
Black Scoter	*Melanitta nigra*
Black Skimmer	*Rynchops niger*
Black-whiskered Vireo	*Vireo altiloquus*
Bonaparte's Gull	*Chroicocephalus philadelphia*
Bridled Tern	*Onychoprion anaethetus*
Brown Pelican	*Pelecanus occidentalis*
Clapper Rail	*Rallus crepitans*
Common Ground-dove	*Columbina passerina exigua*
Common Loon	*Gavia immer*
Common Tern	*Sterna hirundo*
Cory's Shearwater	*Calonectris diomedea*
Double-crested Cormorant	*Phalacrocorax auritus*
Dunlin	*Calidris alpina arcticola*
Great Black-backed Gull	*Larus marinus*
Great Shearwater	*Puffinus gravis*
Herring Gull	*Larus argentatus*
King Rail	*Rallus elegans*
Least Tern	*Sterna antillarum*
Lesser Yellowlegs	*Tringa flavipes*
Magnificent Frigatebird	*Fregata magni cens*
Mangrove Cuckoo	*Coccyzus minor*
Nelson's Sparrow	*Ammodramus nelsoni*
Northern Gannet	*Morus bassanus*
Parasitic Jaeger	*Stercorarius parasiticus*
Pomarine Jaeger	*Stercorarius pomarinus*
Prairie Warbler	*Dendroica discolor*
Prothonotary Warbler	*Protonotaria citrea*
Razorbill	*Alca torda*
Red-breasted Merganser	*Mergus serrator*

Common Name	Scientific Name
Reddish Egret	*Egretta rufescens*
Ring-billed Gull	*Larus delawarensis*
Roseate Tern	*Sterna dougallii*
Royal Tern	*Thalasseus maximus*
Ruddy Turnstone	*Arenaria interpres morinella*
Semipalmated Sandpiper	*Calidris pusilla*
Short-billed Dowitcher	*Limnodromus griseus*
Short-tailed Hawk	*Buteo brachyurus*
Smooth-billed Ani	*Crotophaga ani*
Sooty Tern	*Onychoprion fuscatus*
Surf Scoter	*Melanitta perspicillata*
Swallow-tailed Kite	*Elanoides forficatus*
Whimbrel	*Numenius phaeopus*
White-crowned Pigeon	*Patagioenas leucocephala*
Willet	*Tringa semipalmata*
Wilson's Plover	*Charadrius wilsonia*
Wilson's Storm-petrel	*Oceanites oceanicus*
Yellow Warbler	*Dendroica petechia gundlachi*

Species Protected under the American Bald and Golden Eagle Act of 1972

Once federally listed as endangered, the bald eagle (*Haliaeetus leucocephalus)* has made a remarkable comeback. It is currently protected under the American Bald and Golden Eagle Act, and the MBTA. Bald eagles breed throughout much of Canada and Alaska, in addition to scattered sites across the lower 48 states, from California to the southeastern U.S. coast and Florida. Wintering covers most of the contiguous U.S., with some year-round distribution in the northwest. A large raptor, the bald eagle has a wingspread of about seven feet. Adults have a dark brown body and wings, white head and tail, and a yellow beak. Juveniles are mostly brown with white mottling on the body, tail, and undersides of wings.

Bald eagles typically breed and winter in forested areas adjacent to large bodies of water. However, such areas must have an adequate food base, perching areas, and nesting sites. Throughout its range, it selects large, super-canopy roost trees that are open and accessible. Nests are constructed from an array of sticks placed in an interwoven pattern. Other materials added as fillers may include grasses, mosses, even corn stalks. Per the Florida Fish and Wildlife Commission Bald Eagle Locator Database (FWC 2016-2017), there are no known bald eagle nesting territories in the ROI (Figure 2-25).

Figure 2-25: Bald Eagle Nesting Locations (FFWC 2016-2017)

2.14 WILDLIFE AND TERRESTRIAL HABITAT

For the purpose of the following discussion, this section is intended to focus on wetland and terrestrial wildlife species and habitat for invertebrates, amphibians, reptiles, resident birds, and mammals; however, due to the interconnectedness of ecosystems, there is some overlap with other sections. Threatened and endangered species and migratory birds are discussed more in the Special Status Species Section; and aquatic species are discussed in the fisheries and benthics sections.

The ROI is all areas within the Keys that are temporarily or permanently filled, graded, cleared, excavated, or otherwise converted to another use as a result of the construction of the structural or nonstructural measures. It also includes all noise and disturbance effects indirectly adversely affected by the project, by means such as erosion, alteration of wildlife passage corridors, or changes in community type.

The Fish and Wildlife Coordination Act requires the USACE to coordinate with the USFWS and the Florida Fish and Wildlife Conservation Commission (FWCC) on water resources related projects to obtain their views toward preservation of fish and wildlife resources and migration of unavoidable impacts.

2.14.1 Existing conditions

The Keys have a rich abundance of wildlife and unique ecosystems, as well as many federal and state wildlife refuges and Wildlife Management Areas (WMA). Much can and has been written about the wildlife throughout the Keys; however, discussion herein is limited to within the ROI.

Within the ROI for nonstructural measures such as those specifically limited to enhancement and protection of existing buildings and critical infrastructure in urbanized and suburbanized areas, it is presumed that wildlife habitat and species would be limited. However, the locations of structural measures are shorelines. Shorelines along the Keys contain habitat for a wide variety of wildlife species.

Mangrove Communities
Mangrove communities are thought to be among the most biologically productive ecosystems in the world (Lugo and Snedaker 1974). As mentioned previously, these forests are a primary component of the estuarine and marine environment, providing an important detrital source and essential nutrients for the food web; important habitat for tree-dwelling, intertidal, and subtidal organisms; nursery areas for juvenile fish and crustaceans and other invertebrates; nesting sites; cover and foraging sites for migratory birds; and habitat for some reptiles and mammals (NOAA, 2019a).

Mangrove tree canopies serve as rookeries, for herons, reddish egrets, and brown pelicans (*Pelecanus occidentalis*), and oceanic birds such as magnificent frigatebirds Red-bellied woodpeckers (*Melanerpes carolinus*), red-winged blackbirds (*Agelaius phoeniceus*), gray kingbird (*Tyrannus dominicensis*), black-whiskered vireo (*Vireo altiloquus*), white-eyed vireo (*Vireo griseus*), white-crowned pigeon, and mangrove clapper rail (*Rallus longirostris*) are some of the more common resident breeding birds in the Keys. Mangrove and shallow water habitats are important foraging and loafing areas for several species of wading birds and migratory shorebirds. Bird species known to nest in the Keys include great white heron, great blue heron (*Ardea herodias)*, great egret, reddish egret, tricolored heron, little blue heron, green heron (*Butorides virescens*), yellow-crowned night-heron (*Nyctanassa violacea*), and the white ibis (*Eudocimus albus*) (NOAA, 2019a).

Beach Community Habitats
Beach berms are dynamic and fragile ecosystems that host a wide diversity of species. The beach berm zone includes coastal dunes, which typically are found at an elevation of zero to four feet (1.2 meters) and adjacent to the intertidal zone. Dunes are a fragile habitat easily damaged by humans and storms, the extent of which depends on dune size and profile, quantity and type of flora, beach characteristics, and surrounding water depth (Liddle and Greig-Smith 1975, McDonnell 1981, Nickerson and Thibodeau, 1983).

These ecosystems are created and maintained naturally through the accretion and erosion of sediment from storm and wind events. These areas are primarily made up of sandy soils and is sparsely vegetated with species such as bay cedar (*Suriana maritima*), sea oat (*Uniola paniculata*), and seashore dropseed (*Sporobolus virginicus*). Succession of vegetation occurs through disturbance, and recolonization of vegetation occurs through deposition of seeds that are transported through oceanic currents. Wider and less disturbed beach berms can support terrestrial invertebrates, neotropical migrant and resident passerine and raptor species, reptiles, and small mammals; breeding and nectaring plants for imperiled butterfly species; refuge for eastern diamondback rattlesnakes (*Crotalus adamanteus*) and the Florida Keys mole skink (*Plestiodon egregius egregius*); and nesting habitat for green (*Chelonia mydas*), loggerhead (*Caretta caretta*), and hawksbill (*Eretmochelys imbricata*) sea turtles (NOAA, 2019a). The beach-dune interface is an important ecotone that produces sustained levels of biological activity.

The beach berm, dune, and intertidal zones within the ROI tend to be very narrow. Although historically wider, they have been impacted more recently by erosion and in particular, by storms and hurricanes. The ROI focuses on the narrowest locations, and those closest to U.S. Route 1. Therefore, the beach habitat quality and areas within the ROI are some of the more limited in the amount of wildlife habitat they can provide, compared with less disturbed and wider beach berm habitats.

Invasive plant species that occur within the ROI include Brazillian pepper, seaside mahoe, Australian pine. Two key invasive animal species within the ROI are Green iguana (*Iguana iguana*) and spiny-tailed iguana (*Ctenosaura* spp.).

2.15 CULTURAL RESOURCES

Several federal laws and regulations have been established to manage cultural resources, including the National Historic Preservation Act (NHPA) of 1966, the Archeological and Historic Preservation Act of 1974, the American Indian Religious Freedom Act of 1978, the Archeological Resource Protection Act of 1979, and the Native American Graves Protection and Repatriation Act of 1990. In addition, DoDI 4710.02, *Department of Defense Interactions with Federally-Recognized Tribes* (2006), governs DoD interactions with federally-recognized tribes and EO 13175, *Consultation and Coordination with Indian Governments* (2000), charges federal departments and agencies with regular and meaningful consultation with Native American tribal officials in the development of policies that have tribal implications. In order for a cultural resource to be considered significant, it must meet one or more of the following criteria for inclusion on the National Register of Historic Places (NRHP):

“The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and: 1) that are associated with events that have made a significant contribution to the broad patterns of our history; or 2) that are associated with the lives or persons significant in our past; or 3) that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or 4) that have yielded, or may be likely to yield, information important in prehistory or history" (36 CFR 60.4).

Geographic Information System (GIS) files maintained on historic properties, surveys, and evaluations are kept by the Florida Division of Historic Resources (FDHR). Data on Monroe County was downloaded from the FDHR on November 5, 2018. Separate files are kept on cultural resource surveys, archaeological sites, buildings, districts and landscapes, bridges, churches, objects, and cemeteries. These include the status of National Register of Historic Places evaluations, periodicity, and many other attributes along with location and extent. This information was used to characterize the potential cultural resources in the Area of Potential Effects and determine potential impacts to cultural resources in the Environmental Consequences Section.

2.15.1 Existing Conditions

Historic and Prehistoric Context

Although evidence is growing that North America may have been inhabited thousands of years earlier, the earliest well documented inhabitation of South Florida was by the Clovis Culture of the Paleo Indian Period about 11,500 years ago. At that time, the transition from the Pleistocene or Ice Age to the Holocene or recent period was underway, with sea levels vastly lower. This meant the coastline was many miles away, with the west coast being up to 100 miles past its present location. What is now the Everglades was an arid sandy area (McCally 1999). This period was characterized by widely scattered camps as the people pursued large game. Around 11,000 years ago Pleistocene fauna like saber-toothed cats and giant ground sloths died out (Fiedel 2009). The Paleo-Indians had focused on hunting these large mammals and as the climate became warmer and wetter, adapted by ever broadening their subsistence base with plants, aquatic resources, and smaller game. This change in culture is referred to as the Archaic Period which lasted between 7000 and 1500 BCE, and is subdivided into the Early, Middle and Late Archaic Periods. Through the Archaic Period material culture became increasingly sophisticated as shown by the discovery of a variety of textiles at the Windover Site, a burial ground in what had been a lake dating to the Middle Archaic. The Archaic Period is followed by the Transitional Period from 1500 to 500 BCE. Corresponding to the Woodland Period in the northeast, south Florida has the Glades period from 500 BCE to the Historic Period, and like the Woodland it is divided into early, middle and late subperiods. Unlike native peoples in the northeast, the south Florida tribes did not practice maize agriculture, and yet developed complex societies based on hunting, gathering, and fishing. The two main groups were the Calusa on the southwest coast, and the Tequesta on the southeast coast.

Recorded Historic Resources in Monroe County

There are 54 NRHP listed properties in Monroe County (Figure 2-26). Among these are the Key West Historic District, the 1733 Spanish Plate Fleet shipwrecks, and several Indian mounds. Archaeological surveys number 179 and have resulted in 486 recorded sites (Figure 2-27). Of these 100 were recommended as eligible, 134 as not eligible, 68 needed more information, one was considered likely eligible, and no recommendation was recorded on 180 of them. Historic architecture survey has covered 5214 buildings with 162 considered eligible, 4807 ineligible, and 249 had either no recommendation or insufficient information. The historical significance of bridges linking the Keys is reflected in the evaluation of 28 bridges as eligible for listing.

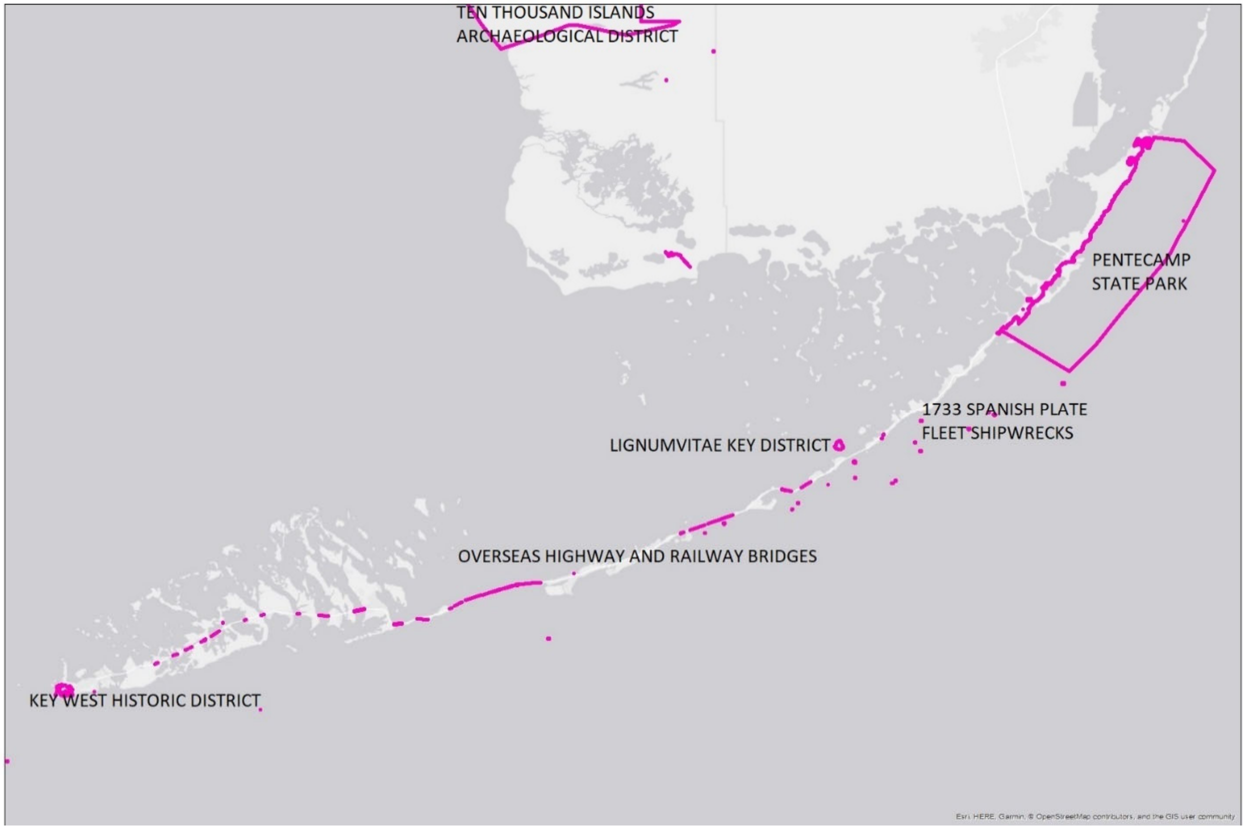


Figure 2-26: NRHP Listed Properties in Monroe County (larger districts labeled, most archaeological sites not shown) (Florida Department of Historic Resources 2018).

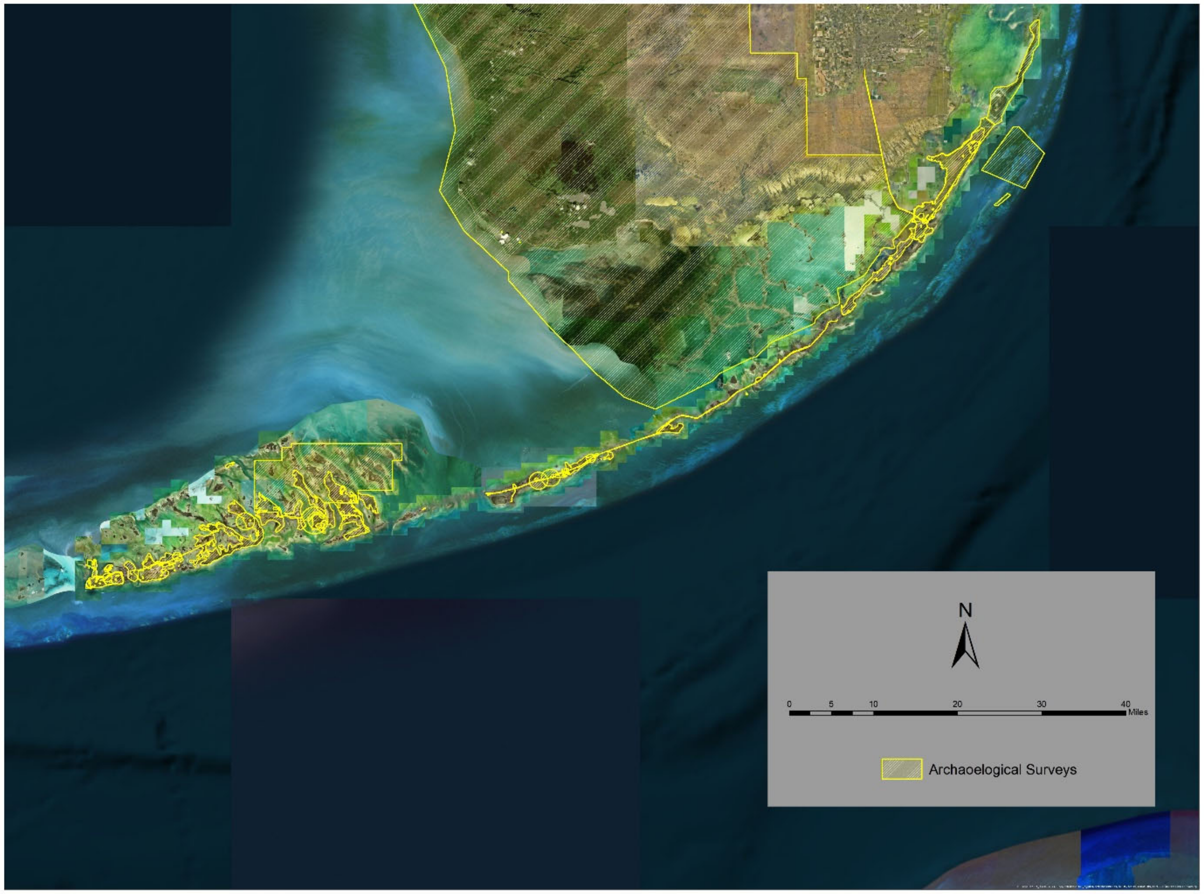


Figure 2-27: Archaeological Surveys in Monroe County (Florida Department of Historic Resources 2018)

2.16 RECREATION

Recreational facilities are defined as those amenities that provide for relaxation, rest, exercise, activity, enjoyment, education, or opportunities for leisure and community support that enrich the quality of life. These include, but are not limited to, parks, wildlife refuges, trails, boat ramps, piers, beaches, and marinas. Recreational areas may include any type of activity in which residents or visitors may participate. Activities include hiking, bike riding, boating, fishing, swimming, sunbathing, picnicking, wildlife viewing, or participation in sports.

The ROI is defined as all recreational lands and facilities within Florida Keys that would be affected either directly or indirectly by the project. This includes recreational areas where structure or fill is temporarily or permanently graded, cleared, excavated, or otherwise converted to another use as, or that will result in limited recreational use, as a consequence of the construction of the measures. It also includes areas indirectly and/or temporarily adversely affected by the project, such as by means of construction activities.

2.16.1 Existing Conditions

The share of the Monroe County economy accounted for by recreating visitors accounted for 59.9 percent of output/sales in 2007-2008. For income, recreating visitors accounted for 43.8 percent in 2007-08, while for employment recreating visitors accounted for 55.3 percent of all full-time and part-time jobs in 2007-08. In 2013, domestic leisure/recreation visitors spent 15.98 million person-days in the Florida Keys. This increased to 16.22 million in 2014 and to 16.52 million in 2015, with international visitors making up 20 percent of the 20.57 million total in 2015 at 4.05 million estimated person-days (NOAA, 2019a). The Keys are a popular tourist attraction for charter fishing, snorkeling, diving, wildlife watching, camping, and biking, as well as for their rich historical heritage, dining, and nightlife.

Monroe County has 11 state parks, including the Florida Keys Overseas Heritage Trail, which passes through most of the ROI. The trail opened in 2011 and is a 90 mile long string of pathways, bridges, and greenspaces that parallel U.S. Route 1. The trail provides pedestrian and bicycle access to the scenic highway. Along most locations, it is separated from U.S. Route 1 by a narrow grass median; and over most of the bridges, it is within the bridge shoulder. It has the highest visitation of any state park in the Florida Keys. In 2015, it accounted for 38.5 percent of all state park visitation in the Florida Keys (NOAA, 2019a). However, many sections of the trail along the shoreline and roadway were washed out by Hurricane Irma in 2017, and remain in need of repair. FDOT has plans to repair the damaged sections of trail and banks.

The two state parks within the ROI are Bahia Honda and Long Key State Parks. Bahia Honda was ranked third in state park visitation from 2010-2015, accounting for 19 percent of all state park visitation in the Keys, and almost 15 percent of all state and national park visitation (NOAA, 2019a). However, both state parks were damaged by Hurricane Irma. Specifically, both parks' campgrounds and shorelines within the ROI sustained erosion damage, including washouts of riprap, mangrove areas, and park campground access roadways immediately landward. At this time, both roadways and campgrounds remain closed to the public while repairs are planned.

Recreational fishing, boating, wildlife watching, swimming, and wading occur throughout the Keys, including along shorelines adjacent to U.S. Route 1. Indian Fill Key, located between Upper and Lower Matecumbe Key (Sites 11-13), is one of few locations along the Keys that has free public access to the shorelines, and is therefore heavily used by the public, particularly on holidays and weekends. A boat ramp is located on Indian Key on the north side of U.S. Route 1, and channels deep enough for recreational boating parallel the shorelines of those sites. Currently the City of Islamorada and FDOT are working to prepare a long term lease that will govern safe and orderly public use of the area.

A long public pier is located along Fiesta Key, parallel to U.S. Route 1. It is heavily used for fishing, walking, bird watching, and other activities.

2.17 AESTHETICS

Visual resources are the natural and man-made features that comprise the visual qualities of a given area, or “viewshed.” These features form the overall impression that an observer receives of an area or its landscape character. Topography, water, vegetation, man-made features, and the degree of panoramic view available are examples of visual characteristics of an area.

Monroe County’s 2030 Comprehensive plan (Objective 301.6) indicates that it:

- shall provide a transportation system that facilitates scenic corridor enhancement and beautification within the Florida Keys;
- shall continue to ensure that development along the U.S.1 Florida Keys Scenic Highway Corridor provides the landscaping and setbacks necessary to minimize impacts on the visual environment;
- supports the Vision, Goals, Objectives, and Strategies of the Florida Scenic Highway Corridor Management Plan and the recommendations of the *Florida Scenic Highway Interpretive Master Plan* in its transportation planning. (Ord. 022-2009). (Monroe County, 2016).

The ROI for aesthetics (visual resources) is the residential, recreational, transportation corridors and tourist sites from Palo Alto Key (North Key Largo) to Key West, Florida, in which temporary or permanent, structural or nonstructural measures that would change the viewshed could occur.

2.17.1 Existing Conditions

The visual experience in any locale is dependent upon the pattern of the land (i.e., the topography), the pattern of water bodies, vegetation, and manmade development. Within the ROI, the topography is relatively flat decreasing in elevation moving westward from the Upper Keys to the Lower Keys. Viewers can generally see long distances from the locations that are only slightly higher than the surrounding area, particularly from the high rise bridges of U.S.

Route 1 (Figures 2-28 and 2-29). The predominant visual experiences for residents and tourists of the Florida Keys are the natural vistas of Florida Bay, the Gulf of Mexico, and the Atlantic Ocean from U.S. Route 1 intermingled with small towns. Scenic resources include large swaths of mangrove forests, uninhabited islands with diverse species, beaches, long stretches of open ocean, bays, busy marinas, bridges and residential and hotel development. Clearly, the aesthetics of the Florida Keys is an important part their appeal for both visitors and residents.

U.S. Route 1, the Overseas Highway, is the only highway in Florida to be recognized as an “All-American Road” by the National Scenic Byways Program of the Department of Transportation’s Federal Highway Administration. The program is a grass-roots collaborative effort established to help recognize, preserve, and enhance selected roads throughout the United States. The U.S. Secretary of Transportation recognizes certain roads as All-American Roads or National Scenic Byways based on one or more archeological, cultural, historic, natural, recreational, and scenic qualities.

The Florida Keys National Marine Sanctuary (FKNMS) surrounds the Florida Keys archipelago, reaching into the Atlantic Ocean, the Florida Bay, and the Gulf of Mexico.

Figure 2-28: Aerial View of the Florida Keys.

Figure 2-29: Aerial View of Key West

In contrast to the lesser developed keys, in Key West the vista changes to more urbanized landscape with an historic City Center that overlooks open ocean with recreational marinas and hotels. Fort Zachary Taylor National Monument on the southern tip of Key West provides visual access to sights and sounds of this maritime setting reinforcing the historic visual and natural character of the keys. The US Naval Air Station Key West (NAS Key West) is also a large part of the visual environment of Key West. It is located on Boca Chica Key four miles east of the Central Business District of Key West. NAS KEY West's national security mission supports operational and readiness requirements for Department of Defense, Department of Homeland Security, National Guard units, federal agencies, and allied forces.

2.18 HAZARDOUS, RADIOACTIVE, OR TOXIC WASTES (HRTW)

Hazardous materials include, but are not limited to, hazardous and toxic substances (biological, chemical, and/or physical) and waste, and any materials that pose a potential hazard to human health and the environment due to their quantity, concentration, or physical and chemical properties. Hazardous wastes are characterized by their ignitability, corrosivity, reactivity, and toxicity. Hazardous materials and wastes, if not controlled, may either (1) cause or significantly contribute to an increase in mortality, serious irreversible illness, or incapacitating reversible illness, or (2) pose a substantial threat to human health or the environment.

The following analysis of hazardous materials and wastes includes a description of existing contamination and the risk of exposure to hazardous materials and waste related to the contamination and to routine use, storage, and transportation of hazardous materials, along with the associated regulatory framework.

The primary relevant federal regulations include those promulgated under the Resource Conservation and Recovery Act (RCRA) of 1974 and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980.
The state rules regarding asbestos adopt existing federal Occupational Safety and Health Administration (OSHA) and USEPA regulations and apply them to all public facilities in which activities involving the disturbance or removal of asbestos containing material (ACM) may occur. The USEPA maintains guidance on management inspection of facilities that may have lead-based paint (LBP). The TDSHS regulates LBP inspection, remediation, and management. The state rules regarding LBP adopt existing OSHA and USEPA regulations and apply them to all public facilities in which activities involving the disturbance or removal of LBP may occur.

The ROI for hazardous materials and wastes is defined as all areas to be disturbed temporarily or permanently or otherwise converted to another use, in order to install the structural or nonstructural measures.

2.18.1 Existing Conditions

There are no Superfund National Priorities List (NPL) sites within the Florida Keys. There are no known contaminated sites within the structural or nonstructural project components. No areas of potential contamination were observed during site visits for the revetment sites in December 2019. However, the structures to be demolished, elevated, wet floodproofed or dry floodproofed could contain ACM or LBP if they were constructed before 1978.

2.19 SAFETY

The safety resource examines those elements of the study area that might be at risk of harm from a flood event, as well as the emergency response systems in place to respond to such events. Intense, heavy rainfall and tidal flooding that has the ability to cause property damage and destruction, life threatening injuries, and the possibility of loss of life for those affected. An occupational health and safety plan will also need to be implemented for the personnel that will be constructing, operating, and maintaining the project features within the study area.

The FEMA Disaster Operations Legal Reference Version 2.0, describes the legal authorities for FEMA's readiness, response, and recovery activities. The FEMA Public Assistance Program is the largest grant program that provides emergency assistance, such as debris clearance and protective measures as well as permanent restoration of community infrastructure. The FEMA Public Assistance reimbursement process is a significant undertaking as it requires coordination across all departments within a community to provide proper documentation on damage as well as repairs completed to infrastructure and public facilities (Monroe County, 2019c).
The FEMA Hazard Mitigation Program can be used to strengthen community infrastructure and public facilities so it is rebuilt in a way that mitigates future risk from storms (Monroe County, 2019c).

The Robert T. Stafford Disaster Relief and Emergency Assistance Act, PL 100-707, signed into law November 23, 1988 and amended the Disaster Relief Act of 1974, PL 93-288, constitutes the statutory authority for most Federal disaster response activities especially as they pertain to FEMA and FEMA programs.

According to the Draft Monroe County Post-Disaster Recovery Strategy for Hurricane Irma (November 2019):

- "The 2015 Monroe Countywide Local Mitigation Strategy (LMS) recognizes future scenarios for increased flood risk due to sea level rise and describes the risk and vulnerability of the communities in detail. Its first and foremost strategy is to promote public health, safety, and general welfare.
- In 2016 the County began its implementation of the GreenKeys Sustainability and Resilience Plan, which outlines specific actions for long-term flood mitigation.
- Monroe County adopted goals, objectives, and policies into the comprehensive plan to provide a proactive policy structure to consider new vulnerabilities.
- The Monroe Countywide Post-Disaster Recovery Strategy identifies goals, strategies, and projects for redevelopment following Hurricane Irma. A full list of roles and responsibilities is detailed in the Monroe County Comprehensive Emergency Management Plan."

2.19.1 Existing Conditions

Coastal Flooding

The Florida Keys are situated within estuarine and marine environments, between the Florida Bay and the Atlantic Ocean. The Keys are located in a low-lying physiographic region, which presents additional challenges in flood mitigation because drainage gradients are limited and nearly all portions of the Keys are below an elevation ten feet. Close proximity to water paired with low drainage gradients results in a significant percentage of the Keys being susceptible to flooding from high tides, exceptionally high tides, hurricanes, and other storm events. The intensity of this flooding ranges from nuisance flooding, typically associated with high and exceptionally high tides, to severe, albeit less frequent flooding from hurricanes.

Numerous secondary roadways are low-lying and flood on an occasional or even regular basis. However, U.S. Route 1 (the Overseas Highway), being the sole roadway route connecting the island chain, is crucial for evacuation, rescue, recovery providers, and suppliers. If this area were inundated or washed away, no resources could be brought into the Keys south of this area to Key West by land.

Hurricane Damage and Safety

Hurricane Irma struck the Florida Keys on September 10, 2017, as a Category 4 storm. It had maximum sustained winds of 132 mph and storm surge up to eight feet in the hardest hit areas in the Lower and Middle Keys. Due to the linear geography of the island chain, some parts of the Keys were hit harder than others. The eye of the storm made landfall over Cudjoe Key (Cangialosi, et al, 2017). According to the Monroe County Medical Examiner, in the Florida Keys, three victims drowned during the hurricane. Another 14 people died due to hurricane related causes, such as being unable to obtain life-saving medical treatment. There were more than 40 injuries reported after the storm. Irma destroyed or badly damaged more than 4,000 homes and 1,800 boats, and left almost all homes and businesses without power, water, sewer, and phone service for varying intervals of time (Monroe County, 2019d).

While no part of the island chain was spared, the Middle and Lower Keys were hit the hardest. Over two years later, the Keys continue to recover and rebuild. The Monroe County Post-Disaster Recovery Strategy (PDRS) is being developed to guide long term recovery and resilience efforts following this storm, to help the community learn from its experiences from this event, and to prepare for the future. Hurricane Irma illuminated the vulnerability of this island chain. When the debris was cleared, homes built to new codes were found to have withstood wind impacts stood as a prime example of wind mitigation in action as well as a sound investment. However, the impacts from flooding could have been much worse. As the Florida Keys plans for the future, it will be important to consider not only current flooding vulnerability but how these vulnerabilities can be further exacerbated by sea level rise (Monroe County 2019c).

Hurricane Irma dramatically demonstrated the benefit of investment in a hardened infrastructure. Despite the 130 mph winds, the county did not have substantial structural damage to roads, bridges, and water or wastewater systems. While these systems experienced intermittent outages and limitations immediately following the storm, they were able to be restored efficiently. The primary roadway system, water, and wastewater systems remained largely resilient, but portions of U.S. Route 1 did washout causing tremendous issues and holding up return access by residents to their homes and businesses until FDOT provided needed repairs. The electrical grid and the communications system, however, remain highly vulnerable to wind and storm surge (Monroe County 2019d).

The need to continue to build redundancy and resilience within the communications systems, power utility infrastructure and within public safety critical infrastructure facilities became evident after Irma. The immediate response capability was hampered within the public and private sectors by a lack of communications. Similarly, the Emergency Operations Center and the Sheriff's Office facilities displayed weaknesses in supporting continued operations. Long term recovery efforts focus on enhancing, hardening, and replacing these vital, life-saving infrastructure components and public facilities (Monroe County 2019c).

2.20 UTILITIES

This section focuses on the following major utilities and associated infrastructure within the Study Area: potable water, wastewater, and stormwater, power, and telecommunication. Potable water is suitable for drinking or use for cooking without risk of illness and has typically been through treatment that includes filtration and disinfection to ensure its safe use. Wastewater generated from residential and commercial sources has been adversely affected in quality by human use and is treated at a wastewater treatment plant to reduce contamination to acceptable level prior to its release into the environment. Stormwater runoff is a type of non-point source pollution because the discharge to receiving waters comes from diffuse sources.

Regional utilities occurring within the study area are discussed below. Potential impacts and mitigation measures related to implementation of the Proposed Action are assessed based on their impacts to the existing utility infrastructure. The ROI for utilities is all utilities within the study area in Monroe County and its bordering waterways that have the potential to be impacted temporarily or permanently by structural and/or nonstructural measures.

Surface Water Quality Standards are defined in Chapter 62-302 of the FAC and establish the water quality standards for surface waters for designated use classifications throughout the state of Florida. Regulations relating to stormwater discharge are contained in Section 62-25 of the FAC. Subsection 403.0885 of the Florida Statutes authorizes FDEP to establish a state National Pollutant Discharge Elimination System (NPDES) permitting program in accordance with Section 402 of the Clean Water Act. Chapter 9.5, Land Development Regulations, of the Monroe County Code of Ordinances is the primary Monroe County ordinance that controls stormwater (Monroe County 2001). Section 9.5-293 of the Monroe County Code of Ordinances establishes criteria and guidelines for surface water management and requires the development of a stormwater management plan for all development.

The South Florida Water Management District is one of five regional management districts in the state of Florida and is responsible for the management and protection of water resources and ecosystems from Orlando to the Florida Keys.

2.20.1 Existing Conditions

The major utilities within the study area include buried potable, wastewater, and stormwater infrastructure, and buried and aboveground power transmission lines and associated infrastructure. Other underground telecommunication utilities such as fiber optic cables are also present within the Study Area.

Water and Wastewater

The Florida Keys Aqueduct Authority (FKAA) is the water service provider for the Florida Keys and delivers approximately 17,000,000 gallons per day of potable drinking water to Florida Keys residents (FKAA 2018). Treated water is primarily sourced from the Biscayne Aquifer, however it is also supplemented by the Floridian Aquifer. The J. Robert Dean Water Treatment Plant and wellfield is located west of Florida City on the mainland near Everglades National Park. The FKAA wellfield contains high quality groundwater from the Biscayne Aquifer. Following treatment, the water is pumped to the Florida Keys through a 130-mile-long transmission main utilizing 800 horsepower electric motors to pump the water south (FKAA 2018). Booster pump stations are located in Key Largo, Long Key, Marathon, Ramrod Key, and Stock Island to maintain adequate pressure. For emergency situations, the FKAA has the capacity to supply additional water from two seawater plants, one located in Marathon and one in Stock Island. Water supply cisterns capturing rainwater and small groundwater lenses on larger islands area also used, and some are permitted by the South Florida Water Management Division (SFWMD).

The FKAA also provides central wastewater services to seven regions of the Florida Keys and utilizes advanced technologies to ensure nutrient and pollutant removal. Reclaimed water, or recycled water, which is safe for non-potable (non-drinking) uses, is also available to several of the Florida Keys and provides a safe and cost efficient alternative for freshwater supply conservation (FKAA 2018).

Wastewater Service Areas not currently under FKAA jurisdiction include the City of Key West, Key West Resort Utilities, City of Marathon, the Village of Islamorada, and the Key Largo Wastewater Treatment District. The Richard A. Heyman Environmental Pollution Control Facility is a wastewater treatment plant located in Key West. It was constructed in 1989, and the sewer collection systems operations and maintenance are contracted to Operations Management, Inc. (OMI). Wastewater is treated and discharged into a deep injection well located onsite. Wastewater from Islamorada is conveyed through a transmission main installed adjacent to U.S. Route 1 to the Key Largo Wastewater Treatment Facility (Islamorada 2016).

Stormwater

Throughout the Florida Keys, the major stormwater management systems are associated with roads and highways; however, other stormwater management systems exist and include both structural and nonstructural controls as Best Management Practices (BMPs) (Monroe County 2001). Examples of stormwater BMPs recommended as suitable for the Florida Keys in the Monroe County Stormwater Management Master Plan include: 1) structural BMPs such as buffer strips; water quality inlets, porous pavement, and vegetated swales and 2) nonstructural

BMPs such as land use planning, low impact development, and impervious area reduction (Monroe County 2001).

The City of Key West has developed a storm water capital plan to address and improve storm water drainage and to minimize/eliminate contaminant discharges to nearshore waters (City of Key West 2019). Stormwater runoff currently drains through 63 outfalls that release into nearshore waters; however, the City of Key West continues to reduce stormwater runoff through the installation of well systems that coincide with the construction of intersection improvements (Key West 2019). In 2005, the City of Marathon created a stormwater utility collecting non-ad valorem assessments to manage the infrastructure and improvements.

Power

The Florida Keys Electric Cooperative (FKEC), is a not-for-profit electric utility that services approximately 33,000 accounts from the Monroe-Dade County line to the Seven Mile Bridge. Within the existing territory, six substations, and over 800 miles of power lines are maintained (FKEC 2011). The FKEC also maintains a 130,000 kilo-volt transmission line, which brings power to the Florida Keys from the mainland. The FKEC purchases almost all of its energy needs from Florida Power and Light (FPL) which serves more than five million accounts throughout the state of Florida. Additional contributions to the FKEC power supply come from generators in Marathon and FKEC’s two solar arrays located in Marathon and Crawl Key.

Keys Energy Services (KEYS) is the public power utility servicing the lower Florida Keys. KEYS provides electricity from Key West to the Seven Mile Bridge and provides service to approximately 28,000 customers (KEYS 2019). The majority of the Florida Keys’ power supply is imported from the mainland because it is less expensive than local generation. Local power generation is a back-up supply used only in emergency situations. The Florida Municipal Power Agency (FMPA), in partnership with numerous municipalities, including Key West will expand the Florida Municipal Solar Project to include Phase II which will consist of two 74.5 megawatt solar farms in Alachua County and Putnam County (FMPA 2019). The KEYS is one of the utilities that will be receiving power from Phase II expected to be completed in 2023 (FMPA 2019).

Telecommunication utilities and associated infrastructure, such as fiber optic cabling and cellular communication towers, are present throughout the Florida Keys allowing residential and commercial access to services for purchase such as high speed internet and wireless communications.

2.21 AIR QUALITY

Air quality is the degree to which the ambient air concentration is contaminated with any one or more pollutant that has been scientifically proven to be a health concern. The USEPA has identified six criteria pollutants (ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter, and lead) as causing detrimental health effects when their concentrations in the ambient air are found above the thresholds that have been established at levels that are known to be safe. The USEPA has established National Ambient Air Quality Standard (NAAQS) for each criteria pollutant, which represents the maximum allowable atmospheric concentrations to ensure protection of public health and welfare.

2.21.1 Criteria Pollutants

Ozone

Ozone (O_3), forms through a series of complex chemical reactions involving Volatile Organic Compounds (VOCs) and oxides of nitrogen (NO_x) in the presence of sunlight. Ground level ozone concentrations vary depending on the weather conditions and is more readily formed on warm, sunny days when the air is stagnant. A health-based air quality standard has been established by the USEPA for ozone. The Florida Department of Environmental Protection, in cooperation with several county air pollution control agencies, monitors ozone air quality in Florida's major urban areas.

Carbon Monoxide Carbon monoxide (CO) is a colorless, odorless gas produced by the incomplete combustion of fossil fuels. Sources of carbon monoxide affecting outdoor air include motor vehicles and machinery that burns fossil fuels. Harmful health effects can result from exposure to large amounts of CO which reduces oxygen transport through the bloodstream.

Nitrogen Dioxide

Nitrogen dioxide (NO_2) is a primary component of nitrogen oxides (NO_x) and is produced when fuel is burned in motor vehicles, power plants, industrial boilers, and other sources. Exposure to elevated levels of nitrogen dioxide can irritate the respiratory system and can increase a person's susceptibility to respiratory infections and diseases.

Sulfur Dioxide

Sulfur dioxide (SO_2) is produced by power plants and other industries that burn fossil fuels containing sulfur, such as coal and oil. Exposure to sulfur dioxide can have harmful health effects particularly on the human respiratory system.

Particulate Matter

Particle pollution, also known as particulate matter (PM), is the general term used for a mixture of solid particles and liquid droplets found in the air and is made up of a number of components, including acids (such as sulfates and nitrates), organic chemicals, metals, soil or dust particles, and allergens (such as fragments of pollen or mold spores). $PM_{2.5}$ describes fine particles that are 2.5 micrometers in diameter or less in size (such as those found in smoke and haze) and pose the greatest health threat. PM_{10} or coarse particles describe particles that are greater than 2.5, but less than or equal to ten micrometers in diameter.

Fine particles can result directly from emissions of fuel combustion from motor vehicles, power generation, and industrial facilities, as well as from residential fireplaces and wood stoves. Coarse particles are generally emitted from sources such as vehicles traveling on unpaved roads, materials handling, crushing and grinding operations, and windblown dust. Their chemical and physical compositions vary depending on location, time of year, and weather.

Lead

Sources of lead (Pb) sources in the air may include incinerators, utilities, lead-acid battery manufacturers, and lead-producing plants. Levels of lead in the air have decreased by 98 percent between 1980 due to the removal of lead from motor vehicle gasoline and other regulatory efforts by the USEPA (USEPA 2017).

Greenhouse Gas Emissions

Greenhouse gases (GHGs) are gases that trap heat in the atmosphere. Major GHGs include carbon dioxide, methane, nitrous oxide, and various synthetic chemicals. These emissions occur from natural processes and human activities. The accumulation of GHGs in the atmosphere can influence the earth's temperature. Predictions of long term environmental impacts due to global climate change include sea level rise, changing weather patterns with increases in the severity of storms and droughts, and changes to local and regional ecosystems including the potential loss of species.

The ROI for air quality is all of The Florida Keys, from Key Largo south to Key West. The USEPA establishes air quality control regions which delineate areas, either intrastate or interstate, that share a common airshed. Monroe County is part of the Southeast Florida Intrastate Air Quality Control Region.

To protect the overall health and wellbeing of the public and to address air pollution problems, Congress established the Clean Air Act of 1970 (amended 1990), which requires the USEPA to set and implement the NAAQS for the six criteria pollutants with the potential for harmful health effects. The USEPA is required to designate geographical areas as either attainment or nonattainment for the criteria pollutants. Areas in attainment meet or exceed the NAAQS, whereas areas in non-attainment do not meet the NAAQS. States are required to develop a general plan to attain and maintain the NAAQS in all areas of the country, and a specific state implementation plan (SIP) to re-attain the standards for each area designated nonattainment for a NAAQS. According to the plans that are outlined in the SIP, states and local agencies are given delegated authority to implement the regulations in order to control emissions sources of criteria pollutants.

In accordance with Chapter 403 of the Florida Statutes, FDEP's Division of Air Resource Management is responsible for the protection and management of Florida's air resource, including air quality monitoring, permitting, and compliance. FDEP manages a Title V air operation permit program which is approved by the USEPA. In general, Title V permits are issued to facilities that are considered a major stationary source or air pollution. Non-title V permits are also issued by FDEP for facilities with minor sources of air pollution.

2.21.2 Existing Conditions

Florida's air quality has improved over the last two decades with monitored levels of criteria pollutants declining since 2000 and currently the lowest on record. Although there are 99 monitoring sites located throughout Florida, there are no air quality monitoring sites in Monroe County.

Monroe County is currently in attainment for all NAAQS criteria pollutants. According to FDEP's map of active air-permitted facilities which shows the locations of all active facilities with current air permits in Florida, there are only two Title V Facilities located in Monroe County, Stock Island Power Plant located on Stock Island, and the Charles A. Russell Generation Facility in Marathon (DEP 2019). Numerous non-title V permitted facilities also exist throughout Monroe County.

2.22 NOISE

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air, and are sensed by the human ear as well as most fauna. Noise is generally defined as loud, unpleasant, unexpected, or undesired sound that is typically associated with human activity and that interferes with or disrupts normal activities of humans and wildlife. The human environment is generally characterized by a certain consistent noise level that varies by area. This is called ambient, or background, noise. Although exposure to high noise levels has been demonstrated to cause hearing loss, the principal human response to environmental noise is annoyance. The response of individuals to similar noise events is diverse and influenced by the type of noise; perceived importance of the noise and its appropriateness in the setting; time of day and type of activity during which the noise occurs; and sensitivity of the individual. Wildlife near areas of human activity and associated noise react similarly. Boating noise can carry for long distances underwater and disrupt the behavior of aquatic life for considerable distances from the source, depending on the size of and noise produced by marine engines
Changes in noise are typically measured and reported in units of decibels (dBA), a weighted measure of sound level. The A-weighted sound level (dBA) is a single number measure of sound intensity with weighted frequency characteristics that corresponds to human subjective response to noise (FHA, 2001). Noise ranging from about ten dBA for the rustling of leaves to as much as 115 dBA, the upper limit for unprotected hearing exposure established by OSHA, is common in areas where there are sources of industrial operations, construction activities, and vehicular traffic (CHC, 2020)

Table 2-4: Common Sounds and their Noise Levels

Outdoor	Sound level (dBA)	Equivalent
Snowmobile	100	Subway train
Tractor	90	Garbage disposal
Noisy restaurant	85	Blender
Downtown (large city)	80	Ringing telephone
Freeway traffic	70	TV audio
Normal conversation	60	Sewing machine
Rainfall	50	Refrigerator
Quiet residential area	40	Library

Source: Center for Hearing and Communication, 2020.

The impact analysis of the Proposed Action is focused upon potential noise increases at sensitive noise receptors resulting from the construction and operation of the various project components. Noise sensitive receptors are buildings or parks where quiet forms a basic element of their purpose; residences and buildings where people normally sleep (e.g., homes, hotels, hospitals), where nighttime noise is most annoying; and institutional land uses (e.g., schools, libraries, parks, churches) with primarily daytime and evening use. Because noise levels at sensitive receptors are reduced by obstructions (such as sound walls) lying between them and the noise source, special emphasis is placed on sensitive receptors having a direct line of sight to the Proposed Action construction sites and facilities.

Section 4(b) of the Noise Control Act (NCA) of 1972 (42 USC §§ 4901-4918) directs federal agencies to comply with applicable federal, state, and local noise requirements with respect to the control and abatement of environmental noise. Congress defined environmental noise in the NCA of 1972 to include the intensity, duration, and character of sounds from all sources. Applicable federal guidelines for noise regulation derive from the USDOT or, more specifically, the Federal Transit Administration and the FHWA. In addition, Monroe County has its own noise ordinance.

The ROI for noise analysis includes all structural and nonstructural area footprints, plus a buffer including all areas within 500 feet.

2.22.1 Existing Conditions

The main source of noise within the ROI of all of the proposed structural project components is traffic noise from U.S. Route 1. All of the structural project components are within 100 feet of U.S. Route 1. There is occasional navigation traffic nearshore and within existing federal and local navigation channels; however, this is a minimal source of noise. Sites 3 (Bahia Honda State Park), Site 6 (Long Key State Park) are noise sensitive receptors, by virtue of their being parks for recreational use. Site 10 (Sea Oats Beach) is adjacent to noise sensitive receptors that include homes and commercial businesses within 500 feet of the structural project components. Sites 11-13 constitute noise sensitive receptors by virtue of their use for recreation by the public.

The Cities of Key West and Marathon and Boca Chica Key have commercial and/or military airports with light air traffic and are within or adjacent to the nonstructural project component areas. These areas also include residential communities and commercial uses, and therefore, have noise levels are typical of such land uses.

2.23 CLIMATE CHANGE

Global climate change is a transformation in the average weather of the Earth, which is measured by changes in temperature, wind patterns, and precipitation. Emission of greenhouse gases above natural levels is suggested to be a significant contributor to global climate change. Greenhouse gases are known to trap heat in the atmosphere and regulate the Earth’s temperature. These gases include water vapor, carbon dioxide, methane, nitrous oxide, ground level ozone, and fluorinated gases such as chlorofluorocarbons, and hydrochlorofluorocarbons. Increasing temperatures are contributing to melting glaciers and sea level rise. The ROI for climate change includes the entire study area.

2.23.1 Existing Conditions

The threat of sea level rise profoundly affects the Florida Keys. Figure 2-30 shows the projected increase in water surface elevation for the historic, intermediate, and high rates of future sea level rise at the NOAA Vaca Key Gage from year 1992 to 2134. The USACE high curve was used for this project. The USACE high curve and projections from the SE FL regional Climate Compact are compared in the Hydraulics, Hydrology & Coastal Sub-Appendix.

8723970, Vaca Key, FL
User Defined Rate: 0.01201 feet/yr
All values are expressed in feet relative to NAVD88

Year	USACE Low	USACE Int	USACE High
1992	-0.82	-0.82	-0.82
1995	-0.78	-0.78	-0.78
2000	-0.72	-0.72	-0.70
2005	-0.66	-0.65	-0.60
2010	-0.60	-0.57	-0.48
2015	-0.54	-0.50	-0.35
2020	-0.48	-0.41	-0.19
2025	-0.42	-0.33	-0.02
2030	-0.36	-0.24	0.17
2035	-0.30	-0.14	0.38
2040	-0.24	-0.04	0.61
2045	-0.18	0.07	0.86
2050	-0.12	0.18	1.12
2055	-0.06	0.29	1.41
2060	-0.00	0.41	1.71
2065	0.06	0.53	2.03
2070	0.12	0.66	2.37
2075	0.18	0.79	2.73
2080	0.24	0.93	3.11
2085	0.30	1.07	3.50
2090	0.36	1.21	3.92
2095	0.42	1.36	4.35
2100	0.48	1.51	4.80
2105	0.54	1.67	5.27
2110	0.60	1.84	5.76
2115	0.66	2.00	6.27
2120	0.72	2.17	6.79
2125	0.78	2.35	7.34
2130	0.84	2.53	7.90
2134	0.89	2.68	8.36

Figure 2-30 Estimated Relative Sea Level Change at the Vaca Key Gauge

Sea level change could have a significant effect on the land of the Florida Keys, as the average elevation of the larger islands range from four to seven feet (1.2 to 2.1 meters) above current sea levels. Already, tidal flooding inundates many areas of the Keys during extreme high tides (UCS, 2015). Several times a year, exceptionally high tides can cause coastal flooding. With the increase in sea level projected for the Keys by 2045, high tides on top of these normal tidal variations will reach farther inland and cause more frequent flooding.

The flooding will worsen as the sea level rises, which will threaten the county's primary economic driver: a $2.2 billion tourism industry that attracts approximately 3 million people to the Keys each year (Monroe County 2014). Flooding would also worsen along portions of the transportation network, some of which already experiences coastal flooding from exceptionally high tides and heavy rain events. Moreover, the intrusion of salt water that can accompany rising sea levels will threaten the region's unique ecosystems. Also, storms in combination with higher seas can flood larger areas, putting more residential and commercial property at risk (UCS, 2015).

As sea level rise increasingly inundates coastal areas, there also is the potential for degradation of natural resources and loss of their services to the surrounding environment. SFRCC (2015) notes:

> Ecosystems will transition either by retreat and migration, adaptation, or elimination of functions and certain species. Shallow water habitats may transition to open water, forcing ecological changes in coastal wetlands and estuaries affecting nesting, spawning, and feeding locations and behavior. Intrusion of saltwater inland, into inland water bodies and within the aquifer is negatively impacting freshwater resources, and these impacts will worsen or accelerate with further sea level rise. Inundation of shorelines will increase the extent and severity of beach erosion at 11 previously stable coastal areas. In combination, these impacts will cascade throughout the region's ecosystems even if they are not immediately adjacent to open water areas.

With its low lying, elevation specific vegetation, the lower Florida Keys will have dramatic terrestrial impacts even at low (one foot/0.3 meter) levels of sea level rise. LaFever et al. (2007) found that various sea level rise scenarios (one to three feet/0.3-0.9 meters estimated by IPCC 2001) resulted in loss of both coastal and upland vegetation structure as sea level rise strained the ability of vegetation to migrate vertically. A recent Florida International University research study also found that South Florida mangrove forests would not be able to adapt effectively to current sea level rise projections (Meeder and Parkinson, 2018). Upland communities are expected to decrease in area extent and fragment based on small differences in elevation. With the loss of both waterholes and freshwater marshes, the loss of freshwater would be an important limiting factor for many terrestrial wildlife species (NOAA, 2019a).

Yet USC (2015) notes that some of the coastal vulnerability can be reduced and investing in coastal preparedness measures can go a long way toward protecting the infrastructure, private property, and livelihood of Keys residents. During the past decade, Monroe County has taken a leading role in the regional effort to combat climate change and adapt to rising seas. The County is continuing its coordination and activities with the SFRCCC. In 2016, the County set priorities, a work plan, and implementation strategies, which can be found at its Green Keys website. The Green Keys Sustainability Action Plan identifies the County's vulnerabilities to sea level rise and climate change and provides a comprehensive five year roadmap on how best to proactively deal with these issues that likely will worsen in the future. This study also aims to address the coastal storm damage associated with climate change.

CHAPTER 3 PLANNING CONSIDERATIONS

3.1 PROBLEMS AND OPPORTUNITIES

3.1.1 Problems

The overarching problem to be addressed by this study is that coastal storm events cause damage to the natural and built environment in the Florida Keys as a result of storm surge inundation, wave action, and erosion. There are several more specific risk drivers and issues within this problem:

- Structures (commercial and residential) in the Florida Keys are vulnerable to damage from inundation caused by storm surge.
- Critical infrastructure in the Florida Keys including fire stations, airports, hospitals, etc. are vulnerable to damage from inundation caused by storm surge.
- Critical transportation routes and U.S. Route 1 specifically are vulnerable to damage from wave energy and erosion caused by coastal storms. In previous storm events and most recently when Hurricane Irma hit the Keys, there were instances of roadway damage contributing to a delay in the timely return of residents back into the Keys once the evacuation order was lifted after the storm.
- Inundation caused by storm surge limits or in some locations prevents vehicle travel on U.S. Route 1, the only evacuation route out of the Florida Keys northward toward mainland Florida, during and immediately before and/or after a coastal storm event. In previous storm events and most recently when Hurricane Irma hit the Keys, there were instances of this inundation affecting evacuation immediately before the storm event.
- Critical infrastructure, U.S. Route 1, and structures throughout the Florida Keys are vulnerable to damage caused by coastal storm events which contributes to both direct and indirect life loss and overall human health and safety risk to the population of the Florida Keys.
- There are rich environmental resources that are unique to the study area that are vulnerable to the effects of coastal storms. Some of these resources, mangroves for example, provide a reduction in the impacts of coastal storms on the study area and their loss increases the risk of storm damage to the built environment in the study area.

3.1.2 Opportunities

Opportunities that could be addressed by a CSRM project in the Florida Keys include:

- Reduce economic damage caused by coastal storms to the built environment in the Florida Keys.
- Reduce damage caused by coastal storms to the natural environment in the Florida Keys.
- Reduce the risks to human life, health, and safety caused by coastal storm events.
- Reduce the vulnerability of Route 1, the primary and only evacuation route from the Keys, to the effects of coastal storms including limited vehicle travel and damage to the roadway structure.

- Increase the resilience of the Florida Keys to the impacts of coastal storms and flooding (Note: the USACE principles of resilience are Prepare, Absorb, Recover, and Adapt).
- Protect and/or restore the natural coastal system of defenses that are existing or were historically present in the study area.
- Improve residential canals to include measures that address sediment management, debris removal, erosion control, and water quality.
- Provide incidental risk reduction to the Department of Defense facilities located in the vicinity (ex. the Naval Air Station in Key West) of the measures recommended by this study.
- Reduce impacts of general sea level rise (sunny day flooding) in the Florida Keys.

3.2 OBJECTIVES

The Federal objective of water and related land resources project planning is to contribute to the national economic development consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, treaties, and other federal planning requirements. The specific planning objectives for this study include:

1. Reduce the risk of damage to U.S. Route 1 caused by wave action and erosion associated with coastal storms in the Florida Keys over the 50 year period of analysis.
2. Reduce the risk of damage to critical infrastructure caused by storm surge inundation associated with coastal storms in the Florida Keys over the 50 year period of analysis.
3. Reduce the risk of damage to development (residential and non-residential structures) caused by storm surge inundation associated with coastal storms in the Florida Keys over the 50 year period of analysis.
4. Reduce the risk to human life, health, and safety to the population in the Florida Keys that is caused by damage of U.S. Route 1, residential and commercial development, and critical infrastructure that is associated with coastal storm events over the 50 year period of analysis.

3.3 CONSTRAINTS

Constraints are identified to avoid undesirable changes between the future without and future with plan conditions. While plans are formulated to achieve planning objectives, they are also formulated to avoid violating the constraints. The following planning constraints have been identified for this study:

- Risk to human health and life safety should not be increased by the recommended plan.
- The recommended plan should not create new inundation/flooding problems and/or exacerbate existing coastal storm risk.

In addition to constraints, planning considerations are identified to highlight the conditions, policies, resources, etc. that would not limit plan formulation like a constraint but may have a significant effect on plan formulation. Considerations can identify factors such as public support for the recommended plan, risk and uncertainty, implementation issues, etc. that are unique to the study area and/or are important to the NFS and other stakeholders. In addition to constraints, the following planning considerations were identified:

- The study area includes a significant amount of protected lands, including the Florida Keys National Marine Sanctuary, multiple State and National Parks, and some conservation easements held by NGOs
- The Florida Keys National Marine Sanctuary (FLKNMS) surrounds almost the entire study area and close coordination will be required to ensure that plan formulation incorporates the Sanctuary's regulatory requirements should measures be proposed within their boundaries.
- There are a variety of unique and/or endangered species located within the study area including by not limited to:
    - Extensive coral reef
    - Key deer
    - Mangroves
- Site conditions such as low elevation, porous geology, etc. may limit the applicability of structural measures in the Keys.
- There are multiple different water and wastewater management organizations within the study area
- There are cultural/historic assets in the study area (ex. Indian Key)
- There are strict state and local codes that govern building and development within the study area, for example there is a cap on the number of new building permits in the study area designated by a Rate of Growth Ordinance.
- Close coordination with FDOT will be critical in the formulation of plans that include risk reduction measures for U.S. Route 1.
- Some of the canals in the study area are privately owned
- Current FKLNMS policy prevents construction of artificial coral reefs in the vicinity of the study area
- Upstream water management operations in the Everglades National Park, which is outside of the study area, may affect the hydrology in Key Largo.
- Work to reduce coastal storm risk to lands under the jurisdiction of another Federal agency must be accomplished on a reimbursable basis, upon request from the agency. Civil works funds cannot be used for the protection of military installations/lands. For this reason, plans considered in this study will not be formulated to specifically reduce coastal storm risk within military installations and other federally owned property within the study area, but there may be incidental benefits provided by the recommended plan to these areas/facilities.

3.4 PERIOD OF ANALYSIS

The period of analysis is 50 years. The economic base year has been established as 2035 which is the year that it is expected the recommended project would begin accruing benefits. With the base year of 2035 as the start year, the period of analysis ends in 2084.

3.5 FUTURE WITHOUT PROJECT SCENARIO

The future without condition reflects the conditions expected during the period of analysis. The future without project condition provides the basis from which alternative plans are formulated and impacts are assessed. Since impact assessment is the basis for plan evaluation, comparison, and selection, clear definition, and full documentation of the without project condition are essential. Chapter 2 of this report provides detailed information about the existing conditions in the Florida Keys and it is generally the case that in the future, that any existing issues caused by coastal storms will continue, and in many cases be exacerbated, in the future without project condition. The Keys are a low-lying chain of islands that have already experienced significant damage and impacts from previous coastal storms such as Hurricane Irma and future conditions, especially sea level change, are expected to exacerbate storm impacts and increase overall coastal storm risk in the future. Chapter 8 of this report also includes detailed assessments of the future without project conditions expected for the different aspects of the study area. The following sections discuss the future without project conditions that are expected for aspects of the study that are likely to have a significant impact on plan formulation.

3.5.1 Population Growth

Based on the US Census Bureau's American Community Survey, Monroe County had a total population of 76,212 in 2019 and contained 30,982 households in 2018. Monroe County experienced population decline of 8.17% between 2000 and 2010 but has grown slowly by 4.27% since. Monroe County is projected to experience low levels (less than 1%) of population growth through 2040. Because population is not expected to grow substantially in the future, population growth is not expected to be a factor that would increase future storm risk in the Florida Keys.

3.5.2 Future Development

Monroe County is required to regulate new residential development based upon the finite carrying capacity of the natural and man-made systems and the growth capacity while maintaining a maximum hurricane evacuation clearance time of 24 hours for residents as mandated by the State of Florida, pursuant to Section 380.0552, F.S. and Rule 28-20.140, FAC, and to maintain the public health, safety, and welfare. The county currently maintains a Permit Allocation System for new residential development known as the Residential Rate of Growth Ordinance (ROGO) System. The Permit Allocation System limits the number of permits issued for new residential dwelling units. New residential dwelling units included in the ROGO allocation system include the following: affordable housing units; market rate dwelling units; mobile homes; and institutional residential units (except hospital rooms). The number of permits issued for residential dwelling units under the ROGO shall not exceed a total of 1,970 new allocations for the time period of July 13, 2013 through July 12, 2023, plus any available unused ROGO allocations from a previous ROGO year. In 2012, pursuant to Rule 28-20.140, FAC, the Department of Economic Opportunity completed hurricane evacuation clearance time modeling and found that with 10 years worth of building permits, the Florida Keys would be at a 24 hour evacuation clearance time. This creates challenges for the State of Florida and Monroe County as there are 8,168 privately owned vacant parcels and with 1,970 new allocations this may result in a balance of 6,198 privately held vacant parcels at risk of not obtaining permits in the future. Monroe County and the State of Florida are currently developing a mutually agreeable position defending inverse condemnation cases and Bert J. Harris, Jr. Private Property Rights Protection Act cases, with the State having an active role both directly and financially in the defense of such cases.

In recognition of the possibility that the inventory of vacant parcels exceeds the total number of allocations which the State will allow the County to award, the County was allowed to consider adopting an extended timeframe for distribution of the ROGO allocations through 2033 with committed financial support from its state and federal partners. Additional time was approved and the current end year for residential permits is now 2026. This additional time provides Monroe County additional time to implement land acquisition and other strategies to reduce the demand for ROGO allocations and help transition land into public ownership.

In addition to the County, the five municipalities in the Florida Keys also have growth management systems in place to meet the 24 hour evacuation requirement. Because significant development is not expected in the future, new development is not expected to be a factor that would substantially increase future storm risk in the Florida Keys. The risk in the future is expected to be driven by non-human factors related to sea level change, storm frequency, and storm intensity.

3.5.3 FDOT Responsibility for Overseas Highway/U.S. ROUTE 1

As the agency responsible for the continued maintenance and repair of U.S. Route 1, FDOT receives funding for and completes maintenance work that is required to keep the roadway operational. Following storm events, FDOT also makes any repairs required to return the roadway to pre-storm conditions. However, they do not expect to receive significant funding in the near future to improve U.S. Route 1 beyond its current design/condition other than the planned projects discussed in section 1.8 and Appendix A of this report. FDOT can be expected to maintain the roadway to the extent that their funding allows and has processes in place to respond to damage caused by coastal storms in a timely fashion. However, this is a mostly reactive approach. The focus of this study in reducing risk to U.S. Route 1 is to prevent damage to the roadway in segments that have been identified as particularly vulnerable to coastal storms. There is benefit to NED in reducing the likelihood and/or extent of damage to U.S. Route 1.

Improvements are programmed separately as reconstruction projects and are funded and justified differently than emergency repairs.

a. Reconstruction projects require an economic analysis.
b. Reconstruction projects rarely are completed in the Keys due to the limit on growth/development—most reconstruction projects are done to increase roadway capacity to meet increased traffic demand.
c. Last time reconstruction projects were completed in the Keys was when new bridges were constructed in the 1970’s.

In the future, it is expected that FDOT will maintain U.S. Route 1 so that vehicle travel may continue during times when there are not storm events, but that the roadway will remain at risk to coastal storms in the future. FDOT has plans in plan to employ rapid repair of U.S. Route 1 if needed following a storm event to restore vehicle traffic, but this approach will become more costly as storm risk increases in the future due to changing sea level and storm patterns.

3.6 CRITICAL ASSUMPTIONS

The study authority limits the study analysis to the effects of coastal storms that impact the Florida Keys. This includes storm surge, wave attack, and erosion with consideration of the effects of sea level change in the estimates of inundation and how it is expected to damage infrastructure. This study did not formulate plans to address the impacts of sea level rise alone, which currently causes nuisance flooding at times outside of coastal storm events. Direct effects of wind and precipitation associated with coastal storms were also not considered in the development of alternatives. Considering these limitations and the schedule and budget guidelines of the USACE SMART Planning process, the recommended plan is not an all-encompassing solution that would address all aspects of coastal storm risk in the Keys and there is some coastal storm risk that will remain even with the recommended plan. This remaining risk is referred to as residual risk, which is inherent to any coastal storm risk management study as there is not one project that can address all facets of coastal storm risk that exist in any study area. Chapter 7 of this report includes a detailed discussion of risk, including residual risk, for the recommended plan.

Scenario planning is a purposeful examination of a range of potential futures that address the uncertainty inherent in long-term planning. Unlike forecasts, scenarios do not indicate what the future will look like so much as what the future could look like. Scenario construction helps planners, decision makers, and stakeholders better adapt to a rapidly changing and complex future. Scenario planning acknowledges the critical influence of a few uncertainty drivers on the future without project (FWOP) condition that provides the base condition for evaluation. Critical assumptions from various disciplines were deliberated within the USACE and communicated with decision makers in the form of a risk register. A few of the most significant assumptions for each discipline are listed below:

- The best available information was used to estimate the future without project conditions in the Florida Keys, especially considerations pertaining to development and land use, sea level change, and work completed by the sponsor and others in the Keys.
- It was assumed that FDOT will continue to maintain and repair U.S. Route 1 over the 50 year period of analysis so that it remains a viable travel route between each of the Keys and to mainland Florida. However, other than the projects FDOT has planned that are accounted for in the FWOP, the agency does not currently anticipate receiving funding for any projects that would significantly reduce the risk of U.S. Route 1 to damage from coastal storms such as elevating and/or armoring large segments of the roadway.
- It was assumed that the built environment will remain consistent with the current conditions throughout the 50 year period of analysis due to the development restrictions set by the ROGO.

- Assumptions were made in development of the structure inventory and running the economic model used in the study based on best available data. The economic model includes various assumptions that reflect expected future conditions, for example, that severely damaged structures will be rebuilt to meet the current first finished floor elevation (FFE) requirement set by FEMA for NFIP participation which is the base flood elevation (BFE)+1 foot and the maximum number of times a structure will be rebuilt was set at five. More information pertaining to the economic model and analysis of the results can be found in Appendix C, Economics.
- Environmental and cultural resources impact analyses were completed using existing surveys and data to inform the plan selection. During the Preconstruction Engineering and Design (PED) phase, environmental and cultural resource impact analysis will be refined as needed to adhere to the Programmatic Agreement and Biological Opinion in order to avoid and minimize any adverse effects to cultural resources and listed species. Plans were not formulated to manage the direct impacts coastal storms inflict on the natural environment, rather coastal storm risk management measures were focused on risk and impacts to the built environment due to limitations set by the study authority.
- It was assumed that SLC in the Florida Keys would be consistent with the USACE high projected rate. This assumption is based on sea level data from a gauge within the study area.

3.6.1 Storm Intensity and Water Surface Elevations

There are multiple storm variables that affect the intensity of storm surge. The wind magnitude, storm size, and exposure time are some of these variables. The FEMA South Florida Storm Surge Study (SFLSSS) developed coastal water surface elevations (WSELs) based on a suite of storms in order to estimate the probability of various storm surge WSELs (FEMA, 2014). Lower probability events represent more extreme storms that produce higher WSELs.
Since the South Atlantic Coastal Study (SACS) was not completed at the time of this study, the information from the FEMA SFLSSS was used. The team concluded that the FEMA SFLSSS provided the best available information to complete this study. More information about the SFLSSS is proved in Appendix B, Engineering.

3.6.2 Relative Sea Level Rise Projections

This study is formulated to consider the impacts that relative sea level rise (RSLR) will have on future conditions both with and without project alternatives in place and is consistent with ER 1100-2-8162, "Incorporating Sea Level Change in Civil Works Programs" and EP 1100-2-1, “Procedures to Evaluate Sea Level Change: Impacts, Responses, and Adaptation.” Research by climate science experts predict continued or accelerated climate change for the 21st century and possibly beyond, which would cause a continued or accelerated rise in the sea level in the Florida Keys. The resulting RSLR will impact future USACE coastal projects and system performance. As a result, coastal studies must consider how sensitive and adaptable both environmental and engineered systems are to the effects of RSLR and climate change.
The forecast for the Florida Keys includes a relative sea level change for the 50 year period of

analysis of 2035 – 2084. According to the USACE Sea Level Rise Calculator, sea level will rise 0.80, 1.49, and 3.68 feet NAVD88 for the USACE low, intermediate, and high curve estimates. The study also evaluated RSLR at 100 years (2134) into the future after the proposed construction year of 2035. Sea level will increase 1.19, 2.82 and 7.98 ft NAVD88 for the USACE low, intermediate, and high curves estimates. Figure 3-1 shows the three USACE sea level change curves for the study area through 2134.

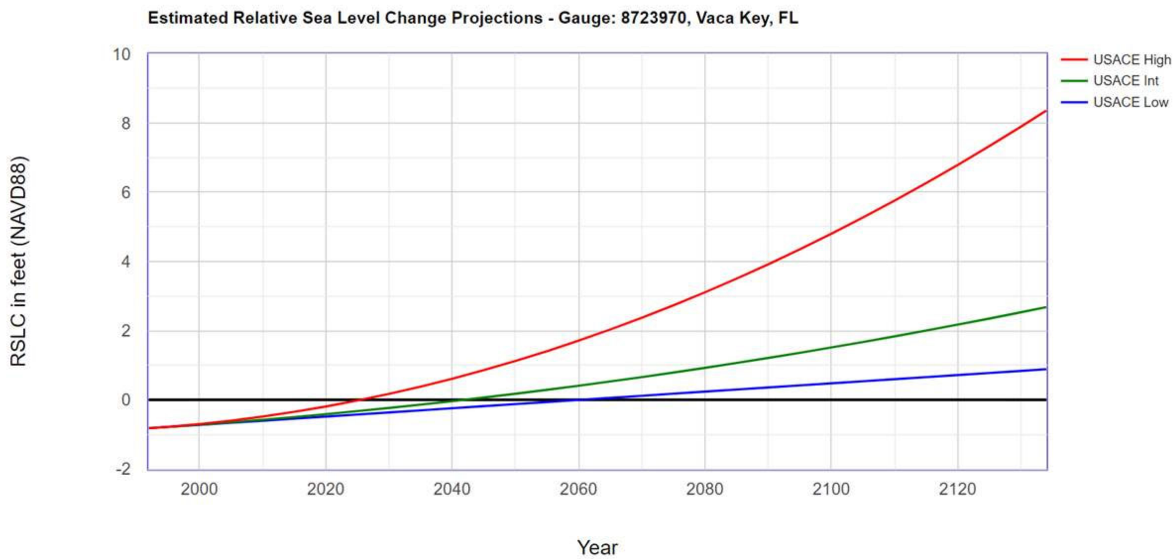


Figure 3-1. USACE Sea Level Change Projections

Other entities have made RSLR predictions for the area. The National Oceanic and Atmospheric Administration (NOAA) predicts 3.97 feet NAVD88 of RSLR (from 2035-2084) for their 2012 high curve, which is slightly higher than the USACE high rate. Appendix B, Engineering includes more information on sea level rise and comparing the USACE sea level rise projections to the Southeast Florida Climate Compact projections which include some of the NOAA curves.

The USACE high curve was selected for use in estimating future design water surface elevations and plan formulation. The high curve is believed to represent a reasonable estimate of RSLR with the currently available information and is recommended for use in this study in coordination with the Jacksonville District of the US Army Corps of Engineers and USACE Climate and Resilience Community of Practice. The project features that are being considered are less adaptable and must be designed considering a long term planning horizon which includes greater uncertainty in sea level change. The Sea Level Tracker tool was used to visualize the observed changes in sea level and to compare trends to the projected sea level changes per USACE Engineer Regulation 1100-2-8162 and Engineer Pamphlet (EP) 1100-2-1.

Figure 3-2 displays the results of this tool, comparing actual SLC for the 19-year (metonic cycle) midpoint moving average (dark blue line) and 5-year midpoint moving average (orange line) against the USACE SLC curve projections. The observed 19-year moving average is tracking along the intermediate SLC scenario while the 5-year moving average has been tracking nearer to the high scenario.

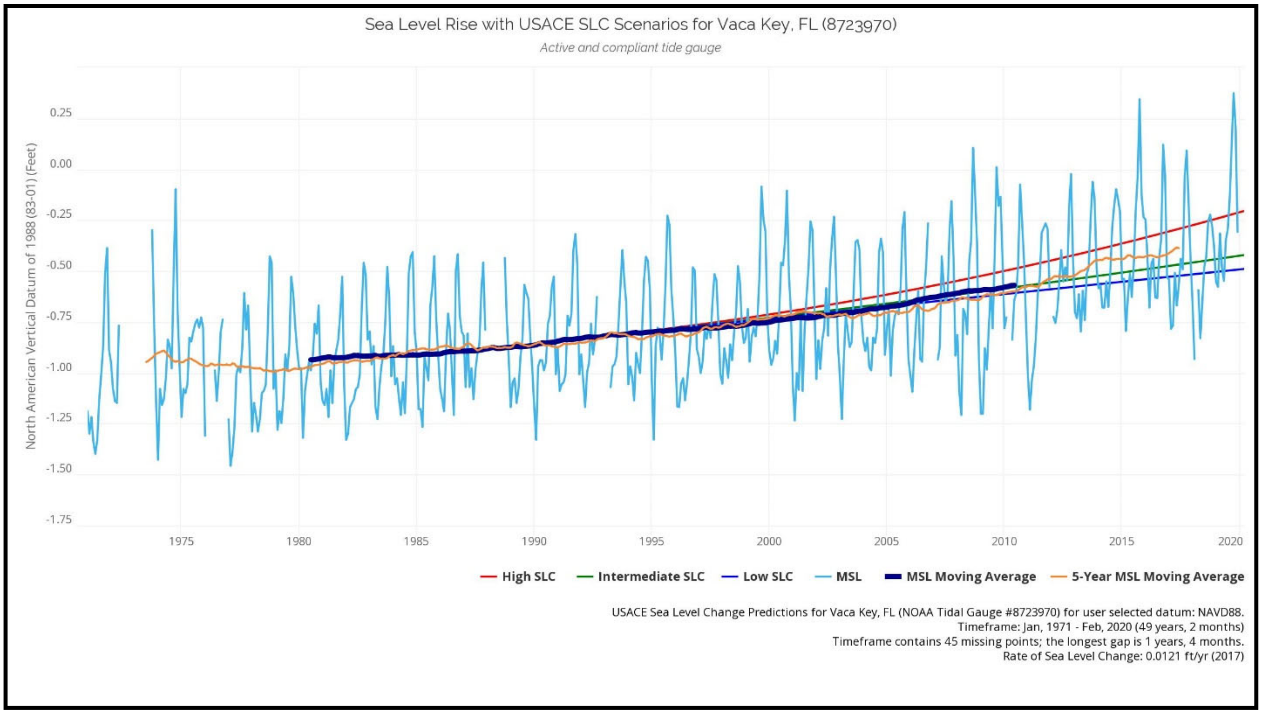


Figure 3-2 Sea Level Tracker for Vaca Key

Attachment HH&C-3 in Appendix B, Engineering includes more detailed information pertaining to sea level change. Table 3-1 shows water levels that are expected to occur for each of the USACE sea level change rates by 2084, which is the end of the 50 year period of analysis that was used for plan formulation and evaluation. There were multiple save points, each with unique water surface elevation data, that were used in the economic model. The values shown in Table 3-1 are for save point 17 which is near Islamorada.

Table 3-1. Water Levels Using Each of the Three USACE SLC Curves (Save Point 17)

AEP (%)	Return Period (yr)	1992 Water Level (ft NAVD88)	Change in Water Levels from 1992 to 2018 using the **USACE Low curve** (ft)	Water Levels at 2018 (ft NAVD88)	Water Levels at 2084 with the **USACE Low Curve** (ft NAVD88)	Water Levels at 2084 with the **USACE Int. Curve** (ft NAVD88)	Water Levels at 2084 with the **USACE High Curve** (ft NAVD88)
5	20	3.89	0.31	4.20	5.00	5.69	7.88
2	50	5.40	0.31	5.71	6.51	7.20	9.39
1	100	6.39	0.31	6.70	7.50	8.19	10.38
0.5	200	7.44	0.31	7.75	8.55	9.24	11.43
0.2	500	8.83	0.31	9.14	9.94	10.63	12.82
0.1	1000	9.77	0.31	10.08	10.88	11.57	13.76

Alternative plans were formulated and evaluated using the USACE high rate of SLC and a sensitivity analysis was completed to evaluate how the USACE low and intermediate rates of SLC could be expected to affect the project performance and economics of the recommended plan. Results of the SLC analysis are in section 7.6.1 of this report and Appendix C, Economics. Tables showing the water levels for additional save points are included in section 3.4.4 of the HH&C Sub-Appendix within Appendix B, Engineering.

CHAPTER 4 HYDROMODELING ANALYSIS

For the Florida Keys CSRM study, the Norfolk District used the FEMA Region IV South Florida Storm Surge Study (SFLSSS Study) stillwater elevations and wave heights for the project analysis and design (FEMA, 2014). The FEMA SFL Study includes the coastal counties of Miami-Dade, Broward, Palm Beach, and Monroe. The purpose of the study is to determine the flood risk from 50 percent (two year), 20 percent (five year), ten percent (ten year), four percent (25 year), two percent (50 year), one percent (100 year), and 0.2 percent (500 year) annual chance floods for these coastal areas for production of revised FIRMs.

4.1 HYDROMODELING ANALYSIS

The SFLSSS study incorporated existing and future probabilistic forcing to perform statistical analyses and numerical hydrodynamic modeling for the region. The statistical analyses resulted in stillwater level elevations as average recurrence intervals (ARI) for a 100 percent flood (one year flood), 50 percent flood (two year flood), 20 percent flood (five year flood), ten percent flood (ten year flood), five percent flood (20 year flood), two percent flood (50 year flood), one percent flood (100 year flood), 0.50 percent flood (200 year flood), 0.20 percent flood (500 year flood), and 0.10 percent flood (1,000 year flood) for different confidence limits (10%, 16%, 50%, 84% and 90%). The numerical modeling study was performed using the two-dimensional hydrodynamic model ADCIRC and the two-dimensional spectral wave model SWAN. The ADCIRC model is a coastal circulation and storm surge model that uses the finite element method to solve the reformulated, depth-averaged shallow water equations. The model is run on a triangulated mesh with elevations derived from a seamless bathymetric/topographic digital elevation model (DEM) that includes both offshore and overland areas. The triangulated format of the mesh allows variation in the element size, so the study area can have a high concentration of nodes while fewer nodes (with higher element areas) can be placed farther away to make the mesh size more efficient without compromising accuracy (FEMA, 2015). The SWAN model runs on the same triangulated mesh that is used with the ADCIRC model. During the model simulations, the water levels from ADCIRC are fed into the SWAN model at 15 minute intervals (of model time). The SWAN model computes the wind driven development of the storm waves, the propagation of the waves over the model domain, and the wave radiation stress gradients where the waves break close to the shore. In turn, the ADCIRC component is informed of the computed radiation stress gradients at the completion of each SWAN component time step. This information is used by the ADCIRC component to adjust the nearshore water levels for the wave driven setdown and setup in the zone of breaking waves near the shoreline. This process continues for the duration of the wind and pressure forcing from the meteorological input files. The model was validated with historic tide gage, high water mark, and wave buoy data. More information about the SFL study can be found in Appendix B, Engineering.

4.2 VERTICAL CONTROLS AND DATUMS

The horizontal datum for this study is tied to the State Plane Coordinate System using the North American Datum of 1983 (NAD83, Florida East, 0901). Distances are in feet by horizontal measurement. Coordinates are Florida East Zone. The vertical datum for this study is tied to the North American Vertical Datum of 1988 (NAVD88), a requirement of ER 1110-2-8160 and elevations are in feet.

CHAPTER 5 ECONOMIC APPLICATION

5.1 BACKGROUND

In this analysis, the existing condition represents current conditions, without sea level change. The future without-project condition is the condition that would likely exist in the future without the implementation of a Federal project and incorporates sea level change. This condition is evaluated for a 50-year period for coastal storm risk management projects, and the results are expressed in terms of average annual damage. For this study, the future without project condition is for the years 2035-2084. The future with-project condition is the condition that would likely exist in the future with the implementation of a Federal project, using the same 50-year period as in the future without-project condition.

5.2 ECONOMIC MODELING

The Generation II Coastal Risk Model (G2CRM) was used to evaluate the expected annual structure damage in the with and without project conditions. G2CRM is a desktop computer model that implements an object-oriented probabilistic life cycle analysis (PLCA) model using event-driven Monte Carlo simulation (MCS). This allows for incorporation of time-dependent and stochastic event-dependent behaviors such as sea level change, tide, and structure raising and removal. The model is based upon driving forces (storms) that affect a coastal region (study area). The study area was subdivided into 34 individual model areas, each with its own hydraulic save point. Model areas were established only to facilitate the model runs and were not established for plan formulation purposes.

The model deals with the engineering and economic interactions as storms occur during the life cycle, areas are inundated, protective systems fail, assets are damaged, and lives are lost. The economic and engineering variables that compose these components are discussed in detail in Appendix B, Engineering, and Appendix C, Economics.

5.3 STRUCTURE INVENTORY

Parcel boundaries and tax assessor data from the year 2018 were provided by Monroe County to assist with characterizing residential and non-residential structures for the economic analysis. Data included addresses, property class description, property use, dwelling year built, dwelling condition/grade, crawl code, number units, number of floors, etc. With the building footprints provided by the County, property class descriptions and Google Maps were used to classify buildings into damage categories and occupancy types. First finished floor elevation assumptions were based on foundation type and verified with available elevation certificates or Google street views. Florida statewide building footprints were used to validate building footprints and to fill in data gaps in the structure inventory dataset. Critical infrastructure status is also noted in the inventory to assist in analyzing and comparing the alternatives.

5.4 REGIONAL ECONOMIC DEVELOPMENT

The Regional Economic Development (RED) analysis measures the effect the recommended plan is expected to have on the regional economy given the interdependence among industries and workers in that economy. The specific input-output model used to complete the RED analysis was RECONS (Regional Economic System). This model was developed by the Institute for Water Resources (IWR), Michigan State University, and the Louis Berger Group. RECONS uses industry multipliers derived from the commercial input-output model IMPLAN to estimate the effects that spending on USACE projects has on a regional economy. The model is linear and static, showing relationships and impacts at a certain fixed point in time. Spending impacts are composed of three different effects: direct, indirect, and induced.

CHAPTER 6 MANAGEMENT MEASURES AND FORMULATION OF ALTERNATIVES

6.1 PLAN FORMULATION STRATEGY

Due to the large geographic extent of the study area and the fact that coastal storm risk is relatively high across the majority of the Florida Keys, three plan formulation strategies were developed by the PDT to assist in the identification of vulnerable areas and the development of alternative plans that would meet the study's planning objectives. The objectives for this study were created to address the coastal storm risk problems identified during the scoping phase of the study, considering the limitations of the study authority, and were used to evaluate and compare the risk reduction each alternative would be expected to generate. The planning objectives include:

1. Reduce the risk of damage to U.S. Route 1 caused by wave action and erosion associated with coastal storms in the Florida Keys over the 50 year period of analysis.
2. Reduce the risk of damage to critical infrastructure caused by storm surge inundation associated with coastal storms in the Florida Keys over the 50 year period of analysis.
3. Reduce the risk of damage to development (residential and non-residential structures) caused by storm surge inundation associated with coastal storms in the Florida Keys over the 50 year period of analysis.
4. Reduce the risk to human life, health, and safety to the population in the Florida Keys that is caused by damage of U.S. Route 1, residential and commercial development, and critical infrastructure that is associated with coastal storm events over the 50 year period of analysis.

These objectives were created to address the problems (Section 3.1 of this report) that the PDT and NFS identified as significant factors contributing to coastal storm risk in the Florida Keys. Because there are many measures that could potentially address each of these objectives at a multitude of different locations across the large study area, the PDT decided to address the different types of coastal storm risk captured in objectives one, two, and three by developing the following plan formulation strategies:

- Reduce coastal storm risk along the U.S. Route 1 corridor. This includes reducing damage to the roadway that is caused by wave action and erosion and potentially also reducing damage to any other infrastructure that is located immediately along U.S. Route 1 should it be located in an area where a measure is recommended to prevent damage to the roadway. The goal of this strategy is to reduce risk of damage to the singular evacuation route from the Keys to the mainland and maintain connectivity between the islands. Alternatives formulated under this strategy meet both the first and fourth planning objectives.
- Reduce coastal storm risk to critical infrastructure. This includes reducing damage caused by inundation associated with coastal storm events to critical infrastructure including emergency services (fire, police, emergency medical services), key utilities (communications, power, water, wastewater/sewer), emergency shelters, etc. The goal of this strategy is to reduce risk to human life and safety by reducing coastal storm damage to vulnerable critical infrastructure that is necessary to maintain public safety and human health. Alternatives formulated under this strategy meet both the second and fourth planning objectives.

- Reduce coastal storm risk to development. The goal of this strategy is to reduce damage caused by inundation associated with coastal storm events to vulnerable residential and non-residential structures to reduce the impact of coastal storms on the national, regional, and local economies. Alternatives formulated under this strategy meet both the third and fourth planning objectives.

In formulating alternative plans using these three plan formulation strategies, measures were combined to develop a plan for each strategy, so that the resulting array of alternatives included a variety of unique plans that provided varying types and amounts of coastal storm risk management to vulnerable infrastructure and development Florida Keys. When the array of alternatives includes a range of plans that address each of the coastal storm risk drivers individually and in different combinations, the NFS is also provided with risk management options for each of the primary concerns.

6.2 MEASURES FOR COASTAL STORM RISK MANAGEMENT

A suite of structural, nonstructural, and NNBF measures were identified to determine which would be effective in reducing coastal storm risk in the Florida Keys. The suite of measures also included feedback gathered during a charette that was held in the Keys on 14 November 2018 with the NFS, relevant state and Federal agencies, and other key stakeholders.

6.2.1 STRUCTURAL MEASURES

Structural measures focus on reducing the probability of coastal storm damage by limiting the amount of storm surge, erosion, wave action, etc. that affects an area or structure that is at risk. A variety of structural measures were considered in this study. These measures are defined and described below.

Breakwaters
In general, breakwaters are structures designed to reduce risk to shorelines, beaches, or harbor areas from the impacts of wave action thereby reducing shoreline erosion and storm damage. Breakwaters, are also constructed in combination with beach restoration as a stabilization measure. Breakwaters are usually rubble-mound structures built roughly parallel to the shoreline at some distance in relatively shallow water in order to maximize amount of risk reduction they provide and to optimize their efficiency at reducing erosion. The dissipation of wave energy usually allows sand to accumulate behind the breakwater, which may further reduce risk the shoreline. In some cases, the beach “salient” formed by the accretion effect connects to the breakwater thus forming a “tombolo.”

Shoreline Stabilization
Revetments are onshore structures with the principal function of reducing the impacts to the shoreline from erosion and typically utilizes stone, concrete, or asphalt to armor sloping natural shoreline profiles. They consist of an armor layer, filter layer(s), and toe protection. The armor layer may be a mass of stone or concrete rubble. The filter assures drainage and retention of

the underlying soil. Filter-type structures such as stone revetments are preferable where groundwater is part of the erosion process.

Sea Walls/Floodwalls

Floodwalls are structures used to reduce risk in relatively small areas or areas with limited space for coastal storm risk management against lower levels of flooding and are usually constructed from concrete. Unlike wider, more stable levees, walls require significant reinforcement and anchoring construction to prevent collapse from hydrostatic pressure. The significant amounts of steel sheeting and/or reinforced concrete used in constructing a typical wall make the feature extremely heavy. Because construction may occur on soft organic soil, pile reinforcement may be required under the base of the wall. The combination of steel sheeting, reinforcement, concrete, and pile support make a floodwall a much more costly structural risk management measure than a similar length and height levee.

Levees

Levees are embankments constructed along a waterfront to prevent flooding in relatively large areas. They are typically constructed by compacting soil into a large berm that is wide at the base and tapers toward the top. Grass or some other type of non-woody vegetation is usually planted on the levee to add stability to the structure. If a levee is located in an erosive shoreline environment, revetments may be needed on the waterfront side to reduce impacts from erosion, or in cases of extreme conditions, the levee face may be constructed entirely of rock. Levees may be constructed in urban areas; however, large tracts of real estate are usually required due to the levee width and required setbacks. The height and width usually limit access to the water for recreation and commercial activities, and like floodwalls, impact the viewshed of coastal properties. Structural measures, such as floodwalls and levees tend to trap rainfall runoff associated with storms on the landward side, so gravity outlets or culverts with flap gates are installed along the length of the structure to drain precipitation. In cases where significant runoff may be trapped behind the structure, ponding areas and pump stations are required.

Storm Surge Barriers

Storm surge barriers reduce risk from storm surge flooding and waves. In most cases, the barrier consists of a series of movable gates that stay open under normal conditions but are closed when storm surge is expected to exceed a certain predetermined level. Storm surge barriers are often chosen as a preferred alternative to closing off waterways completely and may also reduce the required length of flood risk management measures adjacent to and/or behind the barriers. Storm surge barriers range in scale from small/local gates reducing risk to a small coastal inlet to very large barrier systems that are designed to reduce risk to a large estuary or bay and consist of a series of coastal dikes, gates, and in some cases navigation locks. Both are usually combined with other coastal storm risk management measures such as levees or floodwalls.

Small Scale Ring Walls

Ring walls are small floodwalls that are constructed around a particular structure or group of structures to reduce damage from storm surge. The maximum height considered for ring walls is six feet due to engineering and building access constraints.

Canal Improvements
This measure would include improvements to the hundreds of residential canals throughout the study area, to include hardening/protection of the shorelines, dredging and debris removal, or filling as appropriate. The non-Federal sponsor requested that this measure be considered, particularly to determine if debris removal and/or deepening the canals would reduce storm surge impacts on structures adjacent to the canals.

Beachfill and Dunes
Beach restoration, also commonly referred to as beach nourishment or beachfill, typically includes the placement of sand fill to either replace eroded sand or increase the size (width and/or height) of an existing beach, including both the beach berm and dunes. Material similar to the natural sand is artificially placed on the eroded part of the beach. Beachfill designs must also consider the quantity of sand and frequency of renourishments that are required to maintain the design berm and dune over the life of the project. There are many other site specific design criteria that must be considered during detailed beach restoration design: identification of onshore or offshore sources of compatible sediment, beachfill tapers, dune crest alignment, etc. Beachfill alone does not alter preexisting shoreline erosion rates. Generally, it is assumed that shoreline erosion will continue at the same rate with a beachfill project as before the project was constructed. Typically, background erosion is caused by a deficit in sediment budget. Beachfill projects typically experience additional erosion from “spreading out” or diffusion of sand resulting from the shoreline anomaly or “bump” created by the beachfill. Diffusion losses are function of the longshore length of the beachfill, cross-shore width of the beachfill, and wave climate (diffusivity). The rate of diffusion is particularly sensitive to the longshore length of the beachfill project. Shorter projects will generally experience a much higher rate of diffusion than longer projects.

6.2.2 NONSTRUCTURAL MEASURES

Nonstructural measures are permanent or contingent measures applied to a structure and/or its contents that prevent or provide resistance to damage from flooding. Nonstructural measures differ from structural measures in that they focus on reducing the consequences of flooding instead of focusing on reducing the probability of flooding. A variety of nonstructural measures were considered in this study. These measures are defined and described below.

Acquisition (buyouts)
Buildings may be removed from vulnerable areas by acquisition (buyout), subsequent demolition, and relocation of the residents. Property acquisition and structure removal are usually associated with frequently damaged structures. Implementation of other measures such as elevation or floodproofing may be effective, but if a structure is subject to repeated storm damage, acquisition may represent the best alternative to eliminating risk to the property and residents. The property that remains once the structure has been acquired and demolished must remain undeveloped in perpetuity. Acquisition is limited to residential structures and

residents of structures are relocated to equivalent homes in areas that are less vulnerable to storm surge flooding.

Elevation

Elevation of structures is limited to residential structures. Whether a structure may be elevated depends on a number of factors including the foundation type, size of the structure, condition, etc. Elevating a home so that the finished floor is at a height where it is less likely that the structure and/or contents will be damaged by storm surge flooding. Due to structural constraints and wind loading concerns, a maximum height for residential structure elevation was established at 12 feet above ground level.

Dry/Wet Floodproofing

Dry floodproofing involves sealing flood prone structures from water with door and window barriers, small scale rapid deployable floodwalls, or sealants. Dry floodproofing is generally feasible and effective up to a maximum height of three feet above the existing first floor elevation. Wet floodproofing does not prevent water from entering the structure but moves or protects damageable items from the water so that once the surge recedes, the damage to the structure and contents is greatly reduced. Floodproofing is only recommended for non-residential structures, such as commercial buildings and critical infrastructure that cannot be elevated due to their large size.

Warning Systems

Despite improved tracking and forecasting techniques, the uncertainty associated with the size of a storm, the path, or its duration necessitate that warnings be issued as early as possible. There are early warning systems in place currently and these would be continued by the NFS and localities, state, and federal agencies.

Emergency Planning

Emergency and evacuation planning are imperative for areas with limited access, such as barrier islands, high density housing areas, elderly population centers, cultural resources, and areas with limited transportation options. The NFS currently has an emergency and evacuation plan and will continue to engage in emergency planning in the future.

Land Use Planning

Land use planning reduces development in flood prone areas through the use of zoning laws and other policies. The NFS has taken steps to contain growth consistent with the ROGO policy and other zoning and planning actions that will continue in the future.

6.2.3 NATURAL AND NATURE-BASED FEATURES

Natural and Nature Based Features (NNBFs) consist of various habitat types that have been shown to reduce the impacts of coastal storms by reducing storm surge, wave energy, and/or erosion. A variety of NNBFs were considered in this study. These measures are defined and described below.

Beachfill and Dunes
Beachfill is also considered by USACE to be a structural measure. Please refer to section 6.2.1 of this report for a description of this measure.

Mangrove Restoration/Creation
Mangrove restoration would restore mangroves where they were historically present and/or the site conditions are conducive to their survival (water depth, bottom conditions, etc.). Research has shown that areas located behind mangroves generally sustain less coastal storm damage than those areas without mangroves because of the wave attenuation and slight storm surge reduction they provide.

Reef Habitat Restoration/Creation
Reefs enhance resilience of coastal areas by reducing wave energy that degrades the shoreline. In the Florida Keys, coral reef is the predominant reef type and the world's third largest coral reef is located approximately three miles off the Atlantic coast of the study area.

SAV Restoration/Creation
This measure includes the restoration of submerged aquatic vegetation (SAV) in areas where it was historically present and the site conditions are conducive to their survival (water depth, bottom conditions, etc.). SAV may provide some wave attenuation and sediment stabilization.

Living Shorelines
Living shorelines represent a shoreline management option that combines various erosion control methods and/or structures while restoring or preserving natural shoreline vegetation communities and enhancing resiliency. They are natural landscape features that function primarily under normal tidal range conditions and provide a varied mix of habitat such as: shallow water, intertidal, beach, marsh, or dune. They provide some wave reduction benefit under high water and storm conditions. A typical living shoreline is relatively narrow, and they have been promoted in embayments and other lower energy areas to replace or enhance revetments, bulkheads, and other hard shoreline stabilization structures. An essential component of a living shoreline is the rock structure (breakwater/sill) that is constructed offshore and parallel to the shoreline to reduce wave energy that would impact the wetland area and cause erosion of the substrate and damage the tidal plants.

Drainage Improvements/Water Storage Features
Drainage improvements and water storage features include measures that would increase the efficiency and/or storage of water. Usually, this measure is used to address flooding from precipitation in areas behind a large structure such as a floodwall and can reduce the number of pump stations required for interior drainage. USACE policy prohibits feasibility studies from recommending improvements to general stormwater systems, unless it is to mitigate for the effects of a structure such as a floodwall or surge barrier that is included in the recommended plan.

6.3 SCREENING OF MEASURES

The suite of CSRM measures was initially screened qualitatively using the following criteria:

- Does the measure provide a relative measure of coastal storm risk management that would meet one or more of the study objectives?
- Is the measure technically feasible considering the study area characteristics?
- Is the measure sustainable and an economically efficient method of coastal storm risk management for the Florida Keys?

In the first iteration of the planning process, parametric cost estimates and preliminary structure damage benefits were used to determine whether some measures were economically efficient methods of coastal storm risk management. Initial measures screening also considered whether there were environmental or cultural resources in the area that may be affected and parametric costs used for screening purposes included estimates for any environmental mitigation that would be required for a measure. In subsequent iterations of the planning process, new analysis was completed, and measures were screened further using the same criteria, but with more detailed and/or quantitative assessments such as G2CRM results and refined cost estimates.

6.3.1 Structural Measures Screening

It became clear very early on in the study that the study area conditions would limit the applicability of most structural measures, especially the large-scale ones such as sea walls and surge barriers. The Florida Keys are a unique study area and the very characteristics that increase the area's vulnerability to coastal storms are also what limit the application of many risk reduction measures that are used in other coastal communities. Most coastal communities in the U.S., even those in southern Florida, have a defined coastline where coastal storms make landfall and then coastal risk gradually decreases moving inland away from the coast. As an archipelago situated between the Atlantic Ocean and Gulf of Mexico, the Keys have omnidirectional risk. Coastal storms can and do make landfall from any direction and the Islands are so small that there is effectively not a shoreline where efforts can be concentrated to create a single line of structural measures with an inland area to retreat to behind that structural feature. Most structural measures are designed to reduce storm surge and wave energy from one direction, so that there is an area behind that measure with significantly reduced risk. However, in the Keys, there is effectively no way to reduce risk to an area behind a wall or surge barrier without encircling an entire island. Considering this and the porous limestone geology in the Keys, all structural measures were screened from consideration except for shoreline stabilization. Detailed rationale for the screening of structural measures is provided below.

Breakwaters
Breakwaters are usually rock structures that are constructed just offshore from sandy beaches to reduce wave energy on the coastline and prevent erosion of the beach. When the PDT evaluated the applicability of breakwaters in the study area, the engineering team did not

identify any areas where constructing new breakwaters would be feasible from an engineering standpoint and there was also significant structure damage identified that could be used as economic benefit needed to generate a positive BCR needed to justify their construction. This is because there are not many sandy beaches in the Keys where the measure could be considered, and in the areas where there is sandy beach, revetment or nonstructural measures would be much more cost effective methods in reducing coastal storm risk. Breakwaters require a larger quantity of rock to construct vs. revetment which is located on the shoreline and in the Keys, there are very high mitigation costs associated with constructing anything in the water. More information on sites where breakwaters were considered is included in Appendix A, Plan Formulation. For these reasons, breakwaters were screened from further consideration.

Shoreline Stabilization

Shoreline stabilization, in this case, rock revetment, was initially recommended for 15 locations along U.S. Route 1 to reduce erosion and/or washout of the roadway due to the wave energy from coastal storm events. Engineering PDT members initially identified the 15 locations for shoreline stabilization based on a review of aerial imagery to identify areas where the shoreline looked to be encroaching on the road, there was less than 100 linear feet of land from the edge of the roadway to the water, and there was evidence of a high wave energy and/or erosion. These 15 areas were then evaluated based on a cost and benefit analysis, environmental impact analysis, and also coordinated with FDOT. This evaluation and coordination resulted in screening eight of these initial 15 areas out. The designs of 7 remaining areas were also revised following this coordination and two of these were combined into one new larger area. More information on the revetment areas is included in Appendix A, Plan Formulation. Ultimately, six revetment areas were carried forward and are included in the recommended plan.

Roadway Elevation

This measure would increase the road elevation to allow vehicles access to and from impacted areas during a storm event. In the study area, elevation was considered along Route 1 to maintain the ability to travel on the route even with some storm surge from a coastal storm. However, such a significant portion of the roadway would be inundated a significant amount during a storm event, that maintaining travel along the entire length of U.S. ROUTE 1 during a major coastal storm event is not feasible due to the extensive road elevation that would be needed to gain even a low level of benefit. The PDT identified the following reasons why extensive roadway elevation is not a feasible or cost effective measure:

- Roadway sections would require increased transitions from side streets to tie into the elevated road. An increase of five inches equates to an approximate length increase of 21 feet to transition to the existing grade of the side street. Retaining walls may be required to tie into the right-of-way or other fixed object such as a building, fence, or wall.
- Roadway sections will either require increasing the slope from the edge of pavement to the existing right-of-way or maintaining the typical section on either side of the roadway which more than likely will encroach beyond the right-of-way line. The net result would be that property owners would be impacted by the loss of land area and property value. The cost of compensating these landowners to acquire the real estate needed would

increase the already high cost of the road elevation itself.

Road elevation was screened from further consideration. However, the PDT concluded that while it was not feasible or cost effective to prevent inundation of U.S. Route 1, risk can be reduced in sections of the roadway that are at risk to washout or erosion/land loss with shoreline stabilization, which has been included in the array of alternatives.

Canal Improvements

This measure would include improvements to the residential canals throughout the study area, to include hardening of the shorelines, dredging and debris removal, or filling as appropriate. This measure was requested by the NFS because the County is currently evaluating some improvements to these residential canals themselves to remove debris resulting from Hurricane Irma. Canal improvements were considered but were screened from further consideration by the PDT for the following reasons:

- Coastal engineers have established that there would not be a measurable reduction in storm surge or wave action during a significant coastal storm event gained by improving these small canals.
- If there is not a measurable reduction in the effects of coastal storms that would meet the study objective of reducing damage in the study area, there would be no way to quantify an economic benefit to justify the cost of improvements to the canals

Sea Walls and Flood Walls

This measure would include traditional, large scale sea or flood walls that would serve as a barrier to storm surge and wave action to reduce damage to the structures behind them. Sea walls were screened from further consideration for the following reasons:

- For a sea wall to be constructed in a coastal setting, there must be higher ground to tie the end of the wall so that storm surge does not enter the area behind the structure. In the Keys, the terrain is flat and there are not locations where there is high ground to end a wall structure. This would require a ring wall to be constructed on every single Island of the Keys. This is not acceptable from a cost or lifestyle standpoint for residents and tourists in the Keys.
- Existing walls were considered for elevation and/or improvement, such as the one south of the airport. However, due to the flat and low elevation of the islands, a partial wall would not further reduce impacts from coastal storms since storm surge would intrude into the area behind the wall from the unprotected areas.

Levees

This measure is similar to sea walls and flood walls in the method and level of risk reduction. However, levees require a large footprint because unlike walls, they are constructed from earthen fill and require a trapezoidal design. Levees were screened from further consideration for the following reasons:

- The area needed to construct a levee is not available in a fully developed coastal urban environment like the Keys.
- Similar to a sea wall, for a levee to be constructed in a coastal setting, there must be higher ground to tie the end of the structure in. In the Keys, the terrain is flat and there are not locations where there is high ground to end a levee structure. This would require a ring levee to be constructed on every single Island of the Keys. This is not acceptable from a cost or lifestyle standpoint for residents and tourists in the Keys.

Storm Surge Barriers
Storm surge barriers are some sort of gate or closure across an inlet or other body of water that prevent storm surge and waves from affecting areas in the vicinity of that water body. This measure is typically coupled with some type of seawall, floodwall, or levee or must be able to tie into higher ground to provide risk management for geographic gaps and inlets. Surge barriers were considered across the study area, specifically on the canal that runs through the middle of Key West. However, there is no high ground in the vicinity where a surge barrier can be tied in and seawalls/floodwalls and levees were screened from consideration. Without anything to tie a surge barrier into, constructing one would be ineffective because storm surge would rise over the shoreline next to the inlet and flood the structures there even if the canal itself was blocked off with a surge barrier. Surge barriers were screened from further consideration.

Small Scale Floodwalls (Ring Walls)
Although not realistic for all of the structures in the Florida Keys, ring walls were considered for critical infrastructure. However, engineering analysis showed that due to the limestone geology in the Keys, T-walls would be required instead of I-walls. T-walls are much more expensive to construct than I-walls and would not be economically justified. Ring walls were screened from further consideration.

Beachfill and Dunes
Beachfill was initially considered across the entire study area. The PDT looked specifically at areas that have existing sandy shoreline, which would suggest that beachfill is a sustainable measure there. Preliminary structure damage was also incorporated in the consideration of beachfill areas and only areas where structures were experiencing damage were considered. Private property also had to be considered. In some of the areas considered for beachfill, the beaches are privately owned and do not have public access amenities that are required for USACE to recommend a beachfill project, such as established beach access locations and adequate public parking facilities. After reviewing potential sites across the study area, the only area identified as a location where beachfill would be feasible considering these engineering, economic, and public access criteria is the southern shoreline of Key West, from the edge of Naval Air Station Truman Annex eastward to the groin at the end of Smathers Beach. This segment of shoreline does not include the shoreline in front of the Key West Airport. This is because there appears to be a large longshore sediment transport in the area that would supply sand naturally in front of the Key West Airport. To sustain the artificial beach, approximately nine coastal structures (groins, breakwaters, etc.) would be needed. The existing bulkhead

should function as a shoreline stabilization project in this location. The width of the road and bulkhead will dissipate the wave energy before it gets to the airport. Beaches in front of seawalls tend to erode at a faster rate than natural shorelines without seawalls, especially in areas where there is significant longshore sediment transport, due to the wave reflection at walls reflecting back on the beaches. In some areas like this, the anticipated time of renourishment is cut in half (in other words effectively doubling the sand renourishment required). In summary, constructing a beach in front of the seawall near the airport in Key West would be extremely costly and not reduce damage to the airport beyond the existing seawall's function.

Additionally, while the stretch of shoreline from the edge of Naval Air Station Truman Annex eastward to the groin at the end of Smathers Beach did meet the initial three screening criteria, additional analysis was completed on this area to assess the economic feasibility due to the high cost of beachfill in the Florida Keys. When the PDT searched for data needed to develop an initial cost estimate for beachfill in the study area, they were informed that there was just a beachfill project completed in Key West in 2018 (non-USACE/Federal). The material for this project had to be truck hauled from an upland sand source near Lake Okeechobee and the cost per cubic yard of beach quality sand was $76 per cubic yard (CY). This is significantly higher than the cost of beach quality sand in other coastal areas such as the northeast, so alternative sources of sand were researched to ensure that there are not less costly options. After additional research, no additional sources of sand were found that had the quantity and/or quality of sand needed for less than $76/CY. Other sources studied included using dredge material from Key West Harbor and other navigation channels in the study area vicinity, barging sand from the Bahamas, and barging sand from an offshore BOEM borrow site in the Gulf of Mexico off the coast of Naples, FL.

The PDT also completed an initial benefits analysis which was compared to the cost of beachfill in the Truman Annex to Smathers Beach area and found that there would not be enough structure damage or recreation benefit to support beachfill at the cost of $76/CY. This analysis is explained in Appendix A, Plan Formulation. The benefit cost analysis supported the rationale to screen out beachfill from further consideration in this study not just in this area of Key West, but throughout the study area.

Table 6-1 shows the summary of structural measures screening. Red shaded rows indicate measures that were screened from further consideration.

Table 6-1: Summary of Structural Measures Screening

Measure	Measure Type	Notes	Carried Forward?
Breakwaters	Structural	Meets objective #1, but screened out due to the high cost when shoreline revetment can accomplish same risk reduction to U.S. Route 1 for a significantly lower cost and less environmental mitigation, does not reduce damage to structures due to surge inundation per objectives #2 and #3	N
Shoreline Stabilization	Structural	Meets objective #1, includes armoring of shoreline with revetment structures, most relevant to U.S. ROUTE 1 damage reduction	Y
Canal Improvements	Structural	Does not meet objectives, includes shoreline stabilization, debris removal, and dredging or filling as appropriate but these would not reduce inundation of structures or erosion/wave damage to U.S. Route 1	N
Sea Walls	Structural	Would meet objectives #1-4, but screened out due to engineering limitations including low elevation with no high ground to tie wall into, porous limestone geology, and extensive shoreline length which would be cost prohibitive and cause shoreline access issues.	N
Floodwalls	Structural	Meets objectives #1-4, but screened out due to engineering limitations including low elevation with no high ground to tie wall into, porous limestone geology, and extensive shoreline length which would be cost prohibitive and cause shoreline access issues.	N
Levees	Structural	Meets objectives #1-4, but screened out due to engineering limitations including low elevation with no high ground to tie levee into, porous limestone geology, and extensive shoreline length which would be cost prohibitive and cause shoreline access issues.	N

Measure	Measure Type	Notes	Carried Forward?
Small Scale Ring Walls	Structural	Meets objectives #2-4, but screened out due to geological constraints that require T walls which have a much higher cost and would not be efficient on a structure by structure basis	N
Storm Surge Barriers	Structural	Meets objectives #2-4, but screened out due to flat topography and low elevation that does not provide high ground for surge barrier tie into	N
Beachfill/Dunes	Structural/NNBF	Meets objectives #1-4, but screened out due to extremely high cost of procuring beach quality sand ($76/CY) which makes the measure not cost effective in reducing damage to structures	N

6.3.2 Nonstructural Measures Screening

Unlike structural measures, nonstructural measures are applicable across the entire study area and initially they were all carried forward and included in the array of alternatives. Some nonstructural measures, including warning systems, emergency planning, and land use planning, will continue to be implemented and improved upon by the NFS in support of the plan recommended by this study. Additional analysis completed after the draft report release resulted in the screening of acquisition from consideration in the alternatives. Detailed rationale for the screening of nonstructural measures is provided below.

Acquisition (buyouts)
This measure was evaluated to determine if acquisition of property facing a serious threat from coastal storms would be a cost effective in managing coastal storm risk for residential structures. In the Draft Integrated Feasibility Report and EIS that was released for public review in June 2020, approximately 300 structures were identified for acquisition. However, additional analysis completed after the release of the draft report demonstrated that acquisition was not a cost effective measure when compared to elevation. This analysis showed that elevating residential structures would provide a substantial reduction in damage reduction for the water levels evaluated (50, 100, and 200 year storm events) for a significantly lower cost than acquisition. For this reason, acquisition was screened from the final array of alternatives and all at risk residential structures within the study area were only evaluated for elevation.

Structure Elevation
Elevation of residential structures would involve raising homes to a level above design flood elevation at which they would no longer face a threat from storm surge. The 50, 100, and 200 year storm events were evaluated to determine a design height that would reasonably maximize

the reduction in structure damage considering the cost to elevate to that height. Due to structural and wind restrictions, mobile homes were not evaluated for elevation. Due to structural constraints and wind loading concerns, a maximum height for residential structure elevation was established at 12 feet above ground level. Elevation height for each structure is unique and is determined by the adjacent ground elevation and design height. Elevation of residential structures was carried forward to be included in the array of alternatives.

Dry/Wet Floodproofing

Dry floodproofing includes sealing all openings below a certain elevation to prevent floodwaters from entering a structure. Structure owners would have to place the barriers prior to a storm, but once placed, damage could be reduced significantly. Wet floodproofing is a strategy where uninhabited spaces of a structure are intentionally allowed to flood. This strategy helps reduce structural damage that can result from the pressure of the floodwaters. To be implemented, structures need to have space below the flood elevation to be sacrificed, such as a basement or crawl space. Florida State building code does not allow wet floodproofing in most coastal areas, so only dry floodproofing was carried forward to be included in the array of alternatives. It is important to note that due to engineering constraints, the maximum height of dry floodproofing is three feet above the existing first floor elevation.

Warning Systems

Warning systems reduce coastal storm impacts due to increased preparedness. Monroe County already has a warning system in place and modifications to improve the functionality of the current system and/or work were not identified that could be addressed in the recommended plan resulting from this study. Warning Systems were not carried forward as a measure to be included in the alternatives evaluated in this study but will continue to be implemented by the NFS and localities and state and federal agencies in support of the recommended plan.

Emergency Planning

Planning for an emergency decreases the impact it has on a community. Monroe County already has an emergency plan in place and modifications to improve the current plan were not identified that could be addressed in the recommended plan resulting from this study. Emergency planning was not carried forward to be included in the alternatives evaluated in this study but current emergency planning efforts will continue to be implemented by the NFS and localities and state and federal agencies in support of the recommended plan.

Land Use Planning

Land use planning strategies ensure communities are not continuing to place structures in danger and are utilizing the risk management measures that are in place. Land use planning is vital to the success of the entire plan moving forward and was carried forward. Land use and new development is currently heavily regulated by the ROGO and land use planning policies in Monroe County and the Municipalities in the Keys and modifications to improve the current plan were not identified that could be addressed in the recommended plan resulting from this study. would be implemented by the NFS in cooperation with the localities, state, and federal agencies in support of the recommended plan. Land use planning was not carried forward to be included in the alternatives evaluated in this study but current land use management efforts will continue to be implemented by the NFS and localities and state and federal agencies in support of the recommended plan.

Table 6-2 shows the summary of nonstructural measures screening. Red shaded rows indicate measures that were screened from further consideration. Warning systems, emergency planning, and land use planning were not carried forward to be included in a federal plan that would result from this study because they will continue to be implemented by the NFS in cooperation with the localities, state, and federal agencies in support of the recommended plan.

Table 6-2: Summary of Nonstructural Measures Screening

Measure	**Measure Type**	**Notes**	**Carried Forward?**
Buyout/ Acquisition	Nonstructural	Meets objectives #2-4, not a cost efficient measure to reduce residential structure damage when compared to elevation	N
Elevation	Nonstructural	Meets objectives #3 and #4, only residential structures can be elevated	Y
Dry/Wet Floodproofing	Nonstructural	Meets objectives #2-4, only dry floodproofing is carried forward for critical infrastructure and non-residential structures	Y
Warning Systems	Nonstructural	Meets objective #4, would be implemented by the NFS and other federal, state, and local entities as appropriate	N
Emergency Planning	Nonstructural	Meets objective #4, would be implemented by the NFS and other federal, state, and local entities as appropriate	N
Land Use Planning	Nonstructural	Meets objectives #2-4, would be implemented by the NFS and other federal, state, and local entities as appropriate	N

6.3.3 Natural and Nature Based Measures Screening

The study area is extremely rich in unique environmental resources and the team recognized early in the study that it would be important to consider NNBF measures to full extent possible in this study. However, recognizing that the study authority does not include ecosystem restoration, NNBF measures must be considered and screened based on the same criteria that structural and nonstructural measures were with the understanding that they must provide coastal storm risk management that can be quantified in terms of net NED benefit. There is inherent value provided by all of the different NNBF measures in any coastal system, but evaluation of NNBF measures did not identify any that would provide a significant measurable contribution to NED in the Keys in order to meet economic justification requirements. It is also important to note that NNBF measures must not displace other important and/or protected aquatic resources, such as existing seagrass beds, hardbottom habitat, or wetlands, which would themselves have to be mitigated if impacted. In many locations where NNBF were evaluated during the screening process, protected habitat was already present and mitigation would have been required if NNBF measures were proposed there. The PDT determined that it would not be appropriate to impact one environmental resource to implement a different nature based feature. Detailed rationale for the screening of NNBF measures is provided below.

Beachfill and Dunes

Beachfill is considered to be both a structural measure and NNBF. The rationale provided for beachfill and dunes in the structural measures section also applies to this measure as a NNBF because NNBF measures must be economically justified according to the same policy requirements as structural and nonstructural measures. Per the rationale in section 6.3.1, this measure was screened from further consideration.

Mangrove Restoration/Creation

Horstman et al (2014) have found that mangroves are capable of reducing storm surge and wave action during coastal storm events, which is the reason why damage is less in areas where they are present. Several mangrove restoration locations were initially identified and evaluated; however, none were deemed suitable because they would have displaced other existing aquatic resources and/or other waterway uses, or otherwise were not located in areas where habitat conditions were appropriate. Mangrove restoration was screened from further consideration.

Reef Habitat Restoration/Creation

Coral reef restoration was considered in the study area. The third largest coral reef in the world is located about three miles off the Atlantic coast of the Keys, so there is no doubt that the study area vicinity would support coral reef habitat. However, "Altering the seabed, or placing or abandoning any structure on the seabed" is prohibited in the Florida Keys National Marine Sanctuary (FLKNMS). A new artificial coral reef would be classified as a structure that would need to be a permitted by the FKNMS and there is considerable risk that a permit would not be granted. The predominance of deep water large reef tracts (and the best likely potential sites for success) are outside the Designated FKNMS Management Areas. These deep water coral reefs are more than three miles from the Florida Keys and PDT engineers have established that at such a distance, there would not be a significant, measurable reduction in coastal storm effects such as storm surge and wave action that would inflict damage on developed areas. Additionally, while it is true that a small amount of wave attenuation and reduced damages could be attributed to the installation of new coral reefs in these areas, the propagation of coral reefs is an expensive and lengthy process. This means that it would take a significant portion of the period of analysis to begin accruing economic benefits from this measure, making it likely that it would not be economically justified. Armoring the shoreline with revetment would be more cost effective and likely more effective in reducing wave damage on the study area. Reef restoration was screened from further consideration.

SAV Restoration/Creation
Upon research into the reduction in storm surge and/or wave energy on coastal infrastructure, there is little evidence that SAV would provide significant storm surge or wave reductions. Also, no reliable way to quantify any potential reductions could be identified. Therefore, SAV restoration was screened from further consideration.

Living Shorelines
Living shorelines are a type of shoreline stabilization that include more natural features in addition to rock and other hard materials. In this study, living shorelines were considered in areas that are identified for shoreline stabilization along Route 1. However, none of the six proposed revetments would be compatible with living shorelines, except for the one at Long Key; but this area is needed for the required replacement and replanting of upland beach vegetation for mitigation purposes. Living shoreline was screened from further consideration.

Drainage Improvements/Water Storage Features
USACE policy prohibits feasibility studies from recommending improvements to general storm water systems, unless it is to mitigate for the effects of a structure such as a floodwall or surge barrier that is included in the recommended plan. Because floodwalls, seawalls, levees, and surge barriers have been screened from further consideration in this study, this measure must be screened as well. The PDT did consider the possibility of storing storm surge water, but due to the high levels of surge expected with a storm event in the Keys, it would not be possible to have a measurable reduction in the effect of surge on the Keys by storage features. This measure was screened from further consideration.

Table 6-3 shows the summary of NNBF screening. Red shaded rows indicate measures that were screened from further consideration.

Table 6-3: Summary of NNBF Screening

Measure	Measure Type	Notes	Carried Forward?
Beachfill/Dunes	Structural/NNBF	Meets objectives #1-4, but screened out due to extremely high cost of procuring beach quality sand ($76/CY) which makes the measure not cost effective in reducing damage to structures	N
Mangrove Restoration/Creation	NNBF	Contributes to, but does not completely meet objectives #1-4, no locations were identified where habitat is suitable and where NNBFs would be a compatible with surroundings	N
Reef Habitat Restoration/Creation	NNBF	Contributes to, but does not completely meet objectives #1 and #4, but artificial reefs are not approved by the FKNMS and natural reef is too far offshore to provide measurable CSRM benefit to infrastructure at risk to wave/erosion damage	N
SAV Restoration/Creation	NNBF	Does not meet objectives, not effective in providing a measurable reduction in surge and/or waves	N
Living Shorelines	NNBF	Contributes to, but does not entirely meet objectives #1 and #4, were considered however, no locations where the habitat is suitable adjacent to proposed revetments were identified	N
Drainage Improvements/Water Storage Features	NNBF	Contributes to, but does not entirely meet objectives #2-4, not technically feasible for CSRM benefit, sunny day flooding and storm water management are NFS responsibility	N

6.4 FORMULATION OF ALTERNATIVES

Measures carried forward after screening were combined using the three plan formulation strategies described in Section 6.1 to develop Alternatives 1, 2, and 3. A full array of alternatives was then completed with the addition of Alternatives 4, 5, 6, and 7 which are combinations of the measures included in Alternatives 1, 2, and 3. The no action alternative was also evaluated as Alternative 8 and served as the basis by which all other alternatives were compared. These alternatives were formulated according to the four criteria from the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. The criteria include completeness, effectiveness, efficiency, and acceptability. 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. Effectiveness is the extent to which the alternative plans contribute to achieve the planning objectives. Efficiency is the extent to which an alternative plan is the most cost effective means of achieving the objectives. Acceptability is the extent to which the alternative plans are acceptable in terms of applicable laws, regulations, and public policies. All seven alternative plans are complete, effective, efficient, and acceptable as required by the Principles and Guidelines. However, while all of the alternatives were formulated to meet all four criteria, they do vary in the extent that they are effective. All of the alternatives meet at least two objectives and therefore are effective, but there are some alternatives that manage coastal storm risk management more extensively and meet three or four study objectives. The final array of alternatives is shown in Table 6-4 and each alternative is described in detail below.

Table 6-4: Array of Alternatives

Alternative	**Description**	**Measures**	**Objectives Met**
1	U.S. Route 1 Corridor	Shoreline stabilization (revetment)	1 and 4
2	Critical Infrastructure	Floodproofing	2 and 4
3	Development	Floodproofing and elevation	3 and 4
4	Combo Alts 1 + 2	Shoreline stabilization (revetment) and floodproofing	1, 2, and 4
5	Combo Alts 1 + 3	Shoreline stabilization (revetment), floodproofing, and elevation	1, 3, and 4
6	Combo Alts 2 + 3	Floodproofing and elevation	2, 3, and 4
7	Combo Alts 1 + 2 + 3	Shoreline stabilization (revetment), floodproofing and elevation	1, 2, 3, and 4 (all objectives met)
8	No Action	N/A	N/A

6.4.1 Alternative 1, U.S. Route 1 Corridor

This alternative was designed to address the first and fourth planning objectives and therefore is a complete and effective plan to manage coastal storm risk to U.S. Route 1, which is the only roadway that connects all of the islands in the Florida Keys to each other and then to the Florida mainland. Considering the extent of expected storm surge during a hurricane or other significant storm event and that structural measures such as road elevation and sea walls were screened and not carried forward to be included in alternatives, there is no practical way to prevent the entire length of U.S. Route 1 from being inundated by surge from a coastal storm event. Therefore, plan formulation for U.S. Route 1 focused on measures that would maintain the road structure as much as possible even if inundated by storm surge so that once a storm has passed, the roadway would likely remain intact.

The PDT identified shoreline stabilization as the most appropriate and efficient measure to reduce the impact of erosion and wave energy on vulnerable segments of U.S. Route 1. Rock revetment structures were designed for six at risk areas along U.S. Route 1 to stabilize a total of approximately 5,500 linear feet of the shoreline directly adjacent to the roadway and reduce the risk of washout due to wave action and erosion. The revetment will be constructed of limestone rock designed to project the shoreline between the roadway and the shoreline and due to differences of the roadway elevation and shoreline conditions, the revetment heights range from four to ten feet NAVD88. The top of structure elevation is shown for each of the revetments in Table 6-5.

Table 6-5. Top of Revetment Elevations

Revetment Location	Top of Revetment Elevation (feet, NAVD88)
West Summerland Key	6
Bahia Honda Key	8
Long Key	4
Fiesta Key East	10
Fiesta Key West	7
Indian Key Fill	10

A two foot horizontal to one foot vertical slope was used in the design. The revetment in this alternative was coordinated with FDOT and costs include environmental mitigation required where there will be impacts to natural resources, so it is acceptable considering applicable laws and policies. Appendix A, Plan Formulation, provides more detail on how the six shoreline stabilization areas were identified. Appendix B, Engineering, provides more detail on the engineering analysis and designs for the revetment. Locations and project extents of the six revetment sites included in this alternative are shown in Figures 6-1 through 6-3.

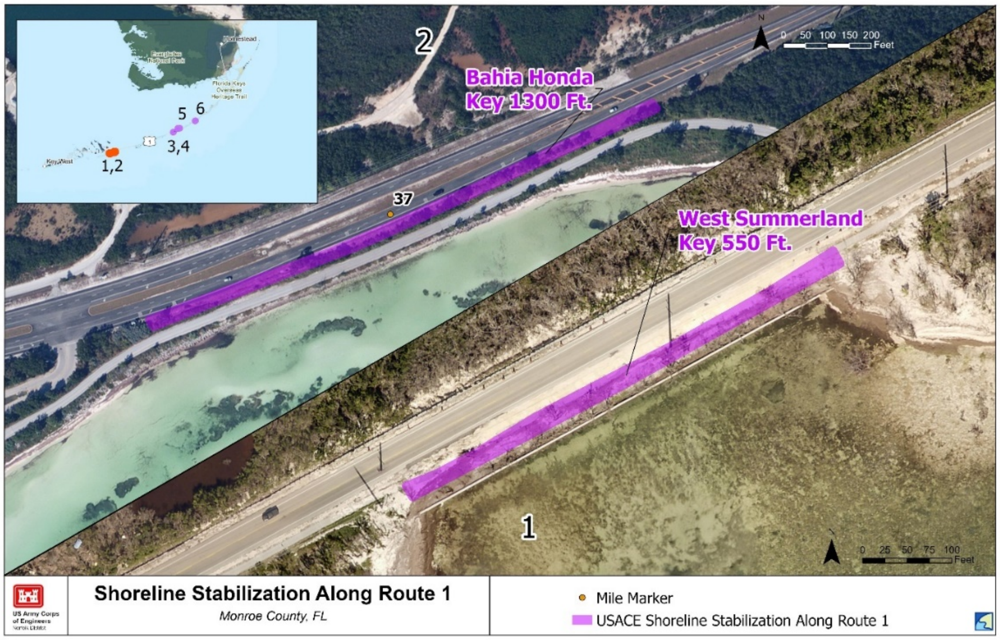


Figure 6-1: Shoreline Stabilization Areas 1 (bottom) and 2 (top)

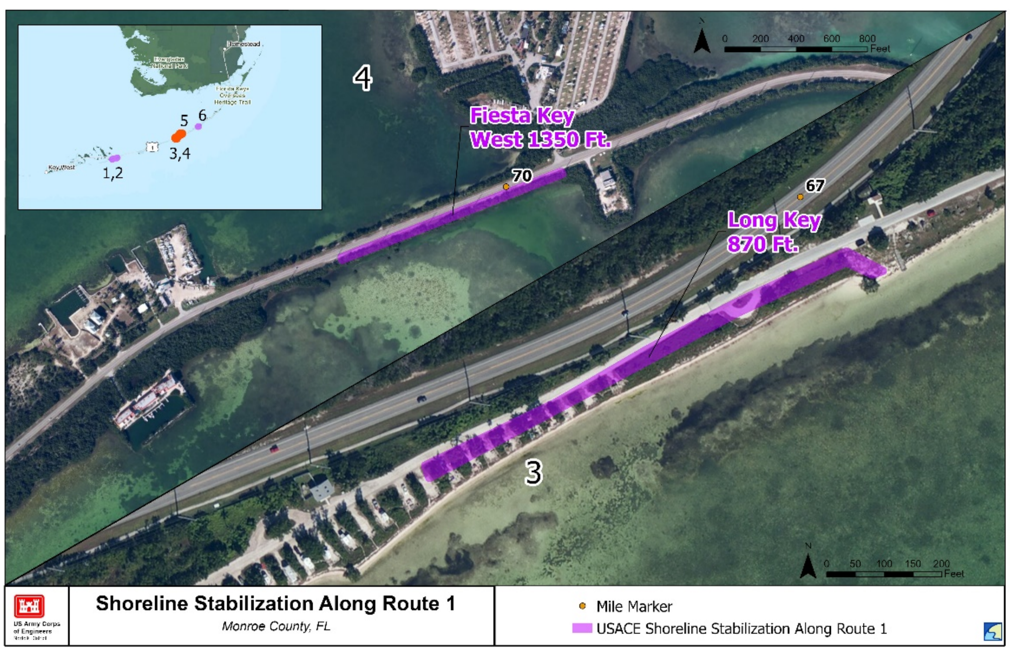


Figure 6-2: Shoreline Stabilization Areas 3 (bottom) and 4 (top)

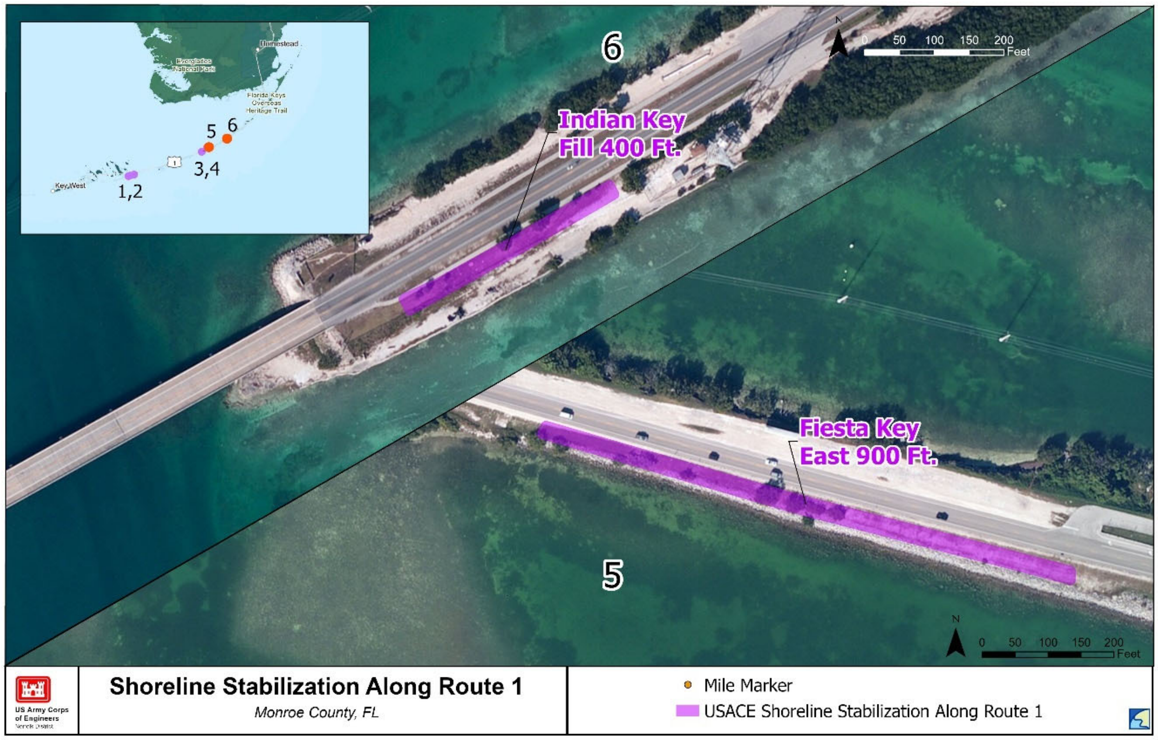


Figure 6-3: Shoreline Stabilization Areas 5 (bottom) and 6 (top)

6.4.2 Alternative 2, Critical Infrastructure

This alternative was designed to address the second and fourth planning objectives and therefore is a complete and effective plan to manage coastal storm risk to critical infrastructure. The only measures carried forward that would reduce damage to any structure vulnerable to storm surge flooding, critical or not, are nonstructural. Considering the size of critical infrastructure buildings does not allow them to be elevated and they would not be acquired because they are necessary and must remain in place, the only nonstructural measure that would be appropriate and efficient for critical infrastructure would be dry floodproofing. There are engineering and safety restrictions that limit dry floodproofing to a maximum of three feet above the existing first floor elevation, which may leave some structures vulnerable to residual risk if damage occurs from storm surge that exceeds three foot maximum height. However, floodproofing is still expected to reduce a significant amount of damage to vulnerable critical infrastructure in the study area. A list of critical infrastructure buildings was provided by the non-Federal sponsor and the following critical infrastructure types were evaluated for floodproofing using the economic model:

- Potable Water Pumping Stations
- Wastewater Facility
- Emergency Operations Center (EOC) Facilities
- Health care

- Schools
- Fire Stations
- Police Stations
- Airports

As required by USACE Planning Bulletin 2019-03, structures evaluated for nonstructural measures were aggregated to include those that would be inundated by the 100 year storm event (0.01 AEP) still water levels (at the 50% confidence level and including SLC expected by the year 2084). The analysis identified 53 vulnerable critical infrastructure buildings within the study area that could be floodproofed. These structures will be dry floodproofed up to the maximum of three feet above the existing first floor elevation as required to reduce damage to the structure and contents due to storm surge. This alternative was formulated considering applicable laws and policies, including floodplain management regulations and building codes, and is therefore acceptable. Table 6-6 shows the distribution of critical infrastructure buildings throughout the Florida Keys. The Real Estate Plan (Appendix F) includes maps that display the location of structures recommended for nonstructural measures, including critical infrastructure.

Table 6-6: Critical Infrastructure Included in the Recommended Plan

Location	Airport	Emergency Centers	Fire Station	Health Care Facility	Police Station	School	Wastewater Facility	Grand Total
City of Key Colony Beach	0	0	0	0	1	0	1	2
City of Key West	0	0	2	0	1	3	6	12
City of Layton	0	0	1	0	0	0	0	1
City of Marathon	1	2	3	1	2	2	3	14
Monroe County	1	0	6	1	0	2	5	15
Village of Islamorada	0	0	1	0	0	0	8	9
Grand Total	2	2	13	2	4	7	23	53

6.4.3 Alternative 3, Development

This alternative was formulated to address the third and fourth planning objectives and therefore is a complete and effective plan to manage coastal storm risk to residential and commercial structures in the Florida Keys. The only measures carried forward that would reduce storm damage to structures in the study area that are vulnerable to storm surge flooding are nonstructural. The PDT determined that two nonstructural measures, elevation and dry floodproofing, could be implemented to reduce storm surge damage to residential and nonresidential structures in a cost effective manner consistent with USACE policy. Three different storm event frequencies were evaluated to determine the water surface elevation that reasonably maximized the reduction in structure damage as compared to the cost to elevate or floodproof structures. The Generation 2 Coastal Risk Model (G2CRM) was used to estimate structure damage in the Florida Keys for three different with project scenarios, including elevating and floodproofing structures up to water surface elevations associated with 50, 100, and 200 year storm event frequencies. This analysis resulted in the selection of the 100-year storm event as the water surface elevation that optimized the net economic benefit associated with elevation and floodproofing and was therefore most efficient. As required by USACE Planning Bulletin 2019-03, structures evaluated for nonstructural measures were aggregated to include those that would be inundated by the 100-year storm event still water levels (at the 50% confidence level and including SLC expected by the year 2084). Additional height was added to design elevations to account for waves. If a structure is in a VE or V zone, the full estimated wave height was added to the design elevation height (if wave data was available, a standard 3 feet was added). If a structure is in an AE, AH, or AO zone, 25% of the estimated wave height was added (If no wave data was available, a standard .75 feet was added.

Given the varying ground elevation throughout the study area and differences in each structure's existing FFE, the height required to elevate residential structures so that the FFE is just above the water surface elevation expected in the 100 year storm event varies up to the 12 foot maximum above ground level. 12 feet is the maximum height for structure elevation due to structural integrity and wind load constraints.

The economic analysis identified 4,698 residential structures for elevation and 1,052 nonresidential structures for floodproofing. This alternative was formulated considering applicable laws and policies, including floodplain management regulations and building codes, and is therefore acceptable. The Real Estate Plan (Appendix F) includes maps that display the location of structures recommended for nonstructural measures and the Nonstructural Implementation Plan (Appendix G) includes additional information pertaining to the implementation of the recommended nonstructural measures.

6.4.4 Alternative 4, U.S. Route 1 and Critical Infrastructure

This alternative is a combination of the six revetments that are recommended in the U.S. Route 1 shoreline stabilization plan (alternative 1) and the critical infrastructure identified for floodproofing (alternative 2). This alternative meets the first, second, and fourth planning objectives and therefore is more effective than Alternatives 1-3 in that it meets three planning objectives vs. two.

6.4.5 Alternative 5, U.S. Route 1 and Development

This alternative is a combination of the six revetments that are recommended in the U.S. Route 1 shoreline stabilization plan (alternative 1) and the structures identified for either floodproofing or elevation (alternative 3). This alternative meets the first, third, and fourth planning objectives and therefore is more effective than Alternatives 1-3 in that it meets three planning objectives vs. two.

6.4.6 Alternative 6, Critical Infrastructure and Development

This alternative is a combination of the critical infrastructure identified for floodproofing (alternative 2) and the structures identified for either floodproofing or elevation (alternative 3). This alternative meets the second, third, and fourth planning objectives and therefore is more effective than Alternatives 1-3 in that it meets three planning objectives vs. two.

6.4.7 Alternative 7, U.S. Route 1, Critical Infrastructure, and Development

This alternative is a combination of all measures included in alternatives 1, 2, and 3. It would reduce coastal storm risk to U.S. Route 1, critical infrastructure, and residential and nonresidential structures that are damaged by surge due to coastal storms. This alternative meets all of the planning objectives and therefore is the most effective plan in the array of alternatives. Alternative 7 is the most comprehensive plan and would provide more risk reduction in the Florida Keys than any of the other six alternatives because it addresses all three of the critical risk areas identified to be addressed by this study: U.S. Route 1, critical infrastructure, and development.

6.4.8 Alternative 8, No Action

The no action alternative assumes that no action would be taken by USACE as a result of this study and is effectively the future without project condition. This is the alternative/condition by which all other alternatives are compared.

6.5 EVALUATION AND COMPARISON OF ALTERNATIVES

There are four accounts established by the Economic and Environmental Principles for Water and Related Land Resources Implementation Studies that are used to facilitate evaluation and display of effects of alternative plans. The NED account is the basis for justification of federal interest, but the EQ, RED, and OSE accounts also have a material bearing on the decision making process and should inform plan selection.

- The national economic development (NED) account displays changes in the economic value of the national output of goods and services.
- The environmental quality (EQ) account displays non-monetary effects on significant natural and cultural resources.
- The regional economic development (RED) account registers changes in the distribution of regional economic activity that result from each alternative plan. Evaluations of regional effects are to be carried out using nationally consistent projections of income, employment, output, and population.
- The other social effects (OSE) account registers plan effects from perspectives that are relevant to the planning process but are not reflected in the other three accounts.

The alternatives in the final array were evaluated and compared on the basis of the four accounts in order to identify the recommended plan.

6.5.1 National Economic Development

Each of the alternatives were evaluated to determine the NED benefit generated. The national economic development account displays changes in the economic value of the national output of goods and services. The NED account is typically the basis for justification of federal interest. The primary NED benefit for this study is defined by the reduction in inundation damage expected to occur with an alternative plan. This benefit is estimated by using model results from G2CRM to compare the expected future without project scenario to the future with project scenario. G2CRM is a desktop computer model that implements an object-oriented probabilistic life cycle analysis (PLCA) model using event-driven Monte Carlo simulation (MCS) to estimate structure damage caused by storm surge inundation throughout the 50 year period of analysis. G2CRM accounts for hydraulic and other factors that affect structure damage estimation such as sea level change, tide, waves, and structure raising and removal. A variety of economic and engineering variables are considered in the economic modeling. Detailed information pertaining to modeling details, inputs, and settings can be found in Appendix C, Economics.

It is important to note that the NED benefit generated by alternatives one, two, and three is not dependent on the implementation of any other alternatives or project features. Because the U.S. Route 1, critical infrastructure, and development alternatives are independent from an economic standpoint, they become separable elements when combined to form alternatives four, five, six, and seven. In ER 1105-2-100, a separable element is defined as any part of a project which has separately assigned benefits and costs, and which can be implemented as a separate action. However, it is important to note that although the combination alternatives (alternatives 4-7) contain elements that are considered separable in terms of economic benefits and costs, there is significantly more risk reduction provided by plans that address more than one facet of coastal storm risk, especially in terms of life risk, resiliency, and other social effects.

U.S. Route 1

There is likely NED benefit likely associated with the six revetments proposed for U.S. Route 1; however, the economic benefit of the revetment could not be quantified with G2CRM or Beach-fx, which are the two coastal economic models currently approved for use in USACE planning studies. Traffic analysis was also considered as a method of quantifying NED benefit associated with vehicle traffic delays, but the current USACE approved methodology relies on delay times that result from detours and rerouting of traffic to determine NED benefit resulting from the opportunity cost of road closures and detours. The six revetments proposed for U.S. Route 1 are in locations where there are no detour routes and it is not possible to accurately estimate where, how often, and how long the roadway would be damaged by coastal storms during the 50 year period of analysis. Therefore, the PDT could not reasonably estimate the extent that U.S. 1 would be closed to vehicle traffic in the future without the use of models such as G2CRM and Beach-fx that use the Monte Carlo method to estimate storm effects over the 50 year period of analysis. Appendix C, Economics, provides a more detailed explanation of the attempt to evaluate NED benefit for the U.S. Route 1 shoreline stabilization.

The study team discussed the possible methods of quantifying NED benefit for the revetments with various subject matter experts across USACE and ultimately determined that it would be more appropriate to include the U.S. Route 1 element on the basis of overall project effectiveness in reducing coastal storm risk by meeting all of the study objectives, by reducing life risk, and benefits to resiliency rather than NED benefit. Table 6-7 shows the economic evaluation for Alternative 1, U.S. Route 1 shoreline stabilization. Because NED benefit could not be quantified for U.S. Route 1 using existing USACE approved models and methods, there is a negative net NED benefit associated with Alternative 1. If the Recommended Plan includes the U.S. Route 1 shoreline stabilization, the PDT must seek approval from the Assistant Secretary of the Army for Civil Works ASA(CW) to include the separable element on the basis of life risk and resilience benefits vs. NED benefit, even if the overall plan has a positive net NED benefit and is economically justified.

Table 6-7: Economic Evaluation for Alternative 1, U.S. Route 1

Economic Evaluation	**Total**
Revetment First Cost	$19,746,000
Interest During Construction	$102,000
Annualized IDC Cost	$4,000
Capital Recovery Factor at 2.75%	3.5%
Average Annual O&M	$161,000
Total Average Annual Cost	$964,000
Total PV Benefits for the Revetment	N/A
Average Annual Benefits	N/A
Benefit to Cost Ratio	N/A
Total Annual Net Benefits	-$964,000

(1) Discount Rate: 2.5%, October 2020 Price Levels
(2) Estimates rounded
(3) Assumed O&M annual costs are $5,000. Reconstruction costs are estimated to be 10% of the initial first cost and will occur every five years in the period of analysis.
(4) The present value benefit estimate is with respect to the base year 2035 and the 50-year period of analysis
(5) Reduction in damage estimates were generated utilizing the USACE high sea level change curve

Critical Infrastructure

Economic modeling was completed using G2CRM to determine which of the approximately 180 critical infrastructure buildings in the structure inventory were expected to be significantly damaged by storm surge due to coastal storm events. The average reduction in damage, quantified by comparing the structure damage estimated to occur in the future without project scenario and future with project scenario over the 50 year period of analysis, is the primary NED benefit for the 53 structures recommended for floodproofing in Alternative 2. Table 6-8 shows the economic evaluation for Alternative 2, critical infrastructure.

Table 6-8: Economic Evaluation for Alternative 2, Critical Infrastructure

Economic Evaluation	**Total**
Number of CI Eligible for Floodproofing	53
Floodproofing First Cost	$20,672,000
Interest During Construction	$64,000
Annualized IDC Cost	$2,000
Capital Recovery Factor at 2.75%	3.5%
Total Average Annual Cost	$839,000
Total PV Benefits for CI Floodproofing	$165,012,000
Average Annual Benefits	$5,818,000
Benefit to Cost Ratio	6.9
Total Annual Net Benefits	$4,979,000

(1) Discount Rate: 2.5%, October 2020 Price Levels
(2) Estimates rounded
(3) The present value benefit estimate is with respect to the base year 2035 and the 50-year period of analysis
(4) Reduction in damage estimates were generated utilizing the USACE high sea level change curve

Development

Economic modeling was completed using G2CRM to determine which of the approximately 39,000 structures in the structure inventory were expected to be significantly damaged by storm surge due to coastal storm events. Nonstructural measures were evaluated at the water levels for the 50, 100, and 200 year storm events to identify which reasonably maximized the net NED benefit. This analysis indicated that net NED benefit was reasonably maximized at the 100 year event water level. The average reduction in damage, quantified by comparing the structure damage estimated to occur in the future without project scenario and future with project scenario over the 50 year period of analysis, is the primary NED benefit for the 4,698 residential structures recommended for elevation and 1,052 nonresidential structures recommended for floodproofing in Alternative 3. Table 6-9 shows the economic evaluation for the nonstructural measures included in Alternative 3, development.

Table 6-9: Economic Evaluation for Alternative 3, Development

Economic Evaluation	**Total**
Number of Structures Eligible for Elevation	4,698
Number of Structures Eligible for Floodproofing	1,052
Total First Cost	$2,063,044,000
Interest During Construction	$6,378,000
Annualized IDC Cost	$225,000
Capital Recovery Factor at 2.75%	3.5%
Total Average Annual Cost	$83,754,000
Total PV Benefits for Development	$3,567,553,000
Average Annual Benefits	$125,785,000
Benefit to Cost Ratio	1.5
Total Annual Net Benefits	$42,031,000

(1) Discount Rate: 2.5%, October 2020 Price Levels
(2) Estimates rounded
(3) The present value benefit estimate is with respect to the base year 2035 and the 50-year period of analysis
(4) Reduction in damage estimates were generated utilizing the USACE high sea level change curve

NED Comparison of Alternatives

Table 6-10 shows the economic evaluation and comparison of the alternatives. Alternative 6 maximizes net NED benefit as required by ER 1105-2-100 and is therefore the NED plan. However, Alternative 7 provides the same amount of net NED benefit and is a more comprehensive plan than Alternative 6 because it reduces risk to U.S. Route 1 which provides more resilience and life safety benefit at a cost that is higher by only a negligible amount. All four accounts should be considered when selecting a plan and because Alternative 7 is a more complete plan that reduces more coastal storm risk and meets all of the study objectives, it is recommended for authorization and construction. Engineering and Construction Bulletin (ECB) No. 2020-6 discusses that the “consideration of resilience may result in recommendations by the project team for measures to improve resilience. There recommendations can be incorporated into the design when they are permitted by project authorities and do not significantly increase total project life cycle cost, including recovery costs.” With a cost that is less than one percent of the total first cost for the alternative, the U.S. Route 1 shoreline stabilization provides resilience benefit without significantly increasing the cost of the total project life cycle cost. However, the Norfolk District must seek approval from the Assistant Secretary of the Army for Civil Works ASA(CW) to include the separable element on the basis of life risk and resilience benefits vs. NED benefit, even if the overall plan has a positive net NED benefit and is economically justified. A NED exception request was submitted to the ASA(CW) so Alternative 7 could be recommended and the ASA(CW) granted an exception.

Table 6-10: Economic Comparison of Alternative Plans

Cost Item	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
Total First Cost	$19,746	$20,672	$2,063,044	$40,418	$2,082,790	$2,083,716	$2,103,462
IDC	$102	$64	$6,378	$166	$6,479	$6,441	$6,543
Annualized I IDC Cost	$4	$2	$225	$6	$228	$227	$231
Annualized O&M Cost	$161	$0	$0	$161	$161	$0	$161
Total Average Annual Cost	$964	$839	$83,754	$1,803	$84,718	$84,593	$85,557
PV Damages FWOP	$25,398,605	$25,398,605	$25,398,605	$25,398,605	$25,398,605	$25,398,605	$25,398,605
PV Damages FWP	$25,398,605	$25,233,593	$21,831,052	$25,233,593	$21,831,052	$21,666,040	$21,666,040
Present Value Benefit	N/A	$165,012	$3,567,553	$165,012	$3,567,553	$3,732,565	$3,732,565
Total Average Annual Benefit	N/A	$5,818	$125,785	$5,818	$125,785	$131,603	$131,603
Benefit-Cost Ratio	N/A	6.9	1.5	3.2	1.5	1.6	1.5
Net Benefit	-$964	$4,979	$42,031	$4,015	$41,067	$47,010	$46,046

(1) Discount Rate: 2.5%, October 2020 Price Levels
(2) Estimates rounded
(3) All numbers in thousands of dollars, except for the benefit-cost ratio
(4) The present value benefit estimate is with respect to the base year 2035 and the 50-year period of analysis
(5) Damage estimates are with respect to the time period 2020-2084 and are generated utilizing the USACE high sea level change curve

6.5.2 Other Social Effects

The OSE account is a means of displaying and integrating information on plan effects from perspectives that are not reflected in the other three accounts. The PDT evaluated the seven alternatives based on OSE metrics using the rating scheme outlined in the Institute for Water Resources' handbook for Applying Other Social Effects in Alternatives Analysis (2013). This method uses a -3 to 3 scale with -3 representing significant negative effects and 3 representing significant beneficial effects. Zero is negligible effects or no impact. The one and two rankings indicate minor and moderate effects in either the negative or positive direction. Per this IWR handbook methodology, the score is an assessment of the relative impact an alternative would have on a particular metric in relation to the without project condition which the same as the no action alternative (alternative 8). The assessment is made from an overall planning perspective and does not necessarily reflect impacts to individuals or small groups. For more detailed information pertaining to the evaluation of OSE, please refer to Appendix A, Plan Formulation. Results of the OSE analysis are shown in Table 6-11.

Table 6-11: Results of OSE Analysis

Factor	Metric	Alt 1 U.S. 1	Alt 2 Critical Infrastructure	Alt 3 Development Centers	Alt 4 Combo Alts 1+2	Alt 5 Combo Alts 1+3	Alt 6 Combo Alts 2+3	Alt 7 Combo Alts 1+2+3
Health and Safety	Human Health	3	3	3	3	3	3	3
	Life Safety	3	3	3	3	3	3	3
Economic Vitality	Business Climate	1	1	1	1	2	2	2
	Tourism Revenue	1	1	1	1	1	1	1
	Real Estate Values	0	0	1	0	1	1	1
Social Connectedness	Community Cohesion	2	0	1	2	2	1	2
	Local/Cultural Identity	1	1	1	1	1	1	1
Resiliency (4 USACE Resilience Principles)	Prepare	2	2	3	2	3	3	3
	Absorb	2	2	3	2	3	3	3
	Recover	2	2	3	2	3	3	3
	Adapt	1	1	2	2	2	2	3
Recreation	Recreational Opportunities	-1	0	0	-1	-1	0	-1
	Total Score	17	16	22	18	23	23	24

The results of the OSE analysis show that overall, all seven alternatives have a positive effect on OSE metrics. Only the plans that include U.S. Route 1 shoreline stabilization have a negative effect on OSE, and that is only a minor negative effect on the recreational opportunities metric. This minor effect is due to the fact that two of the six U.S. Route 1 revetments are located near state parks and the parks have indicated some concern on how these structures would impact recreation at the park. However, the PDT does not expect these two revetments to pose more than a minor impact on recreation at the parks, which is why the score of -1 was assigned for that metric for all alternatives that include the U.S. Route 1 shoreline stabilization. It is also important to note that while it may have a small impact on recreation, the U.S. Route 1 shoreline stabilization greatly improves the health and safety and resiliency factors.

Another trend observed in the results of the OSE analysis is that alternative 3, development centers, and the combination plans that include the nonstructural measures of alternative 3 had the highest scores of all the alternatives. This level of OSE benefit is consistent with the level of risk reduction that can be expected from a plan that includes nonstructural measures for 5,803 structures. Alternative 7 provides the most OSE benefit because it addresses all three of the risk drivers that were identified for the study and therefore is the most effective plan in the array of alternatives.

6.5.3 Regional Economic Development

In addition to NED, RED is considered in the evaluation and comparison of alternatives. The specific input-output model used in this analysis is RECONS (Regional Economic System). RECONS uses industry multipliers derived from the commercial input-output model IMPLAN to estimate the effects that spending on USACE projects has on a regional economy. “Output” is the sum total of transactions that take place as a result of the project, including both value added and intermediate goods purchased in the economy. “Labor Income” includes all forms of employment income, including employee compensation (wages and benefits) and proprietor income. “Gross Regional Product” is the value-added output of the study regions. This metric captures all final goods and services produced in the study area as a result of the project’s implementation. RED is not expected to vary significantly enough between the alternatives to have an effect on plan selection. A RED evaluation of the Recommended Plan is provided in Chapter 7. Appendix C, Economics, includes more detailed information on the RED and RECONS evaluation.

6.5.4 Environmental Quality

The EQ account has been addressed in Chapter 8 of this report, which discusses environmental consequences associated with each of the alternatives. The nonstructural measures are not expected to significantly impact environmental quality in the Florida Keys. The alternatives that include structural measures (Alternatives 1, 5, and 7) require mitigation for revetment impacts to less than a quarter of an acre of herbaceous wetlands. This wetland impact is further described in Section 8.10; and the Environmental Mitigation Plan is included in Appendix D, Environmental, Subappendix D. Overall, the environmental impacts associated with the shoreline stabilization are minor and thus did not affect plan selection.

CHAPTER 7 RECOMMENDED PLAN

This study considered a range of nonstructural and structural measures to manage coastal storm risk in the study area. Planning objectives were identified based on the problems, needs, and opportunities, as well as existing physical and environmental conditions present in the study area. Through an iterative planning process, potential coastal storm risk management measures were identified, evaluated, and screened. The measures that were carried forward were combined into different coastal storm risk management alternatives that composed a final array of eight alternatives. Alternatives must contribute to NED by reducing the risk of damage caused by storm surge within the study area, consistent with the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Based on an evaluation and comparison of the costs and benefits of the array of alternatives on the basis of each of the four accounts, Alternative 7, U.S. Route 1, Critical Infrastructure, and Development Centers, was selected as the Recommended Plan.

7.1 DESCRIPTION OF THE RECOMMENDED PLAN

The Recommended Plan is Alternative 7, which includes measures to manage coastal storm risk to U.S. Route 1, critical infrastructure, and development throughout the Florida Keys. This alternative is the most comprehensive plan in the focused array of alternatives and addresses all four of the planning objectives and is economically justified with a BCR of 1.5. The recommended plan includes the following measures:

- Shoreline stabilization in six different locations along U.S. Route 1 (Overseas Highway) that were identified at risk of damage due to erosion and/or wave energy during a storm event. These six rock revetment structures range in height from four to ten feet NAVD88 and were designed to reduce damage to a total of approximately 5,500 linear feet of roadway by stabilizing the shoreline and reducing the risk of washout so that vehicle traffic can resume more quickly after a storm event and to maintain connectivity between the islands of the Keys and to the mainland.
- Dry floodproofing 53 critical infrastructure buildings that were identified at risk to damage from coastal storms. Structures included in the plan will be floodproofed up to the maximum of three feet above the existing first floor elevation as required to reduce damage to the structure and contents caused by storm surge.
- Dry floodproofing 1,052 nonresidential structures that were identified at risk to damage from coastal storms. Structures included in the plan will be floodproofed up to the maximum of three feet above the existing first floor elevation as required to reduce damage to the structure and contents caused by storm surge. Participation in floodproofing is completely voluntary and the owners of structures included in the plan can decide if they would like to participate in the project.
- Elevating 4,698 residential structures that were identified at risk to damage from coastal storms. Structures included in the plan will be elevated up to the maximum of 12 feet above ground level as required to reduce damage to the structure and contents caused by storm surge associated with the 100 year return period (0.01 AEP), including sea

level rise estimated to occur by 2084 based on the USACE high projected sea level change rate. Participation in home elevation is completely voluntary and the owners of structures included in the plan will decide if they would like to participate in the project.

7.1.1 Environmental Quality Considerations

The U.S. Route 1 element of the Recommended Plan will impact an estimated 10,250 square feet (0.23 acres) of herbaceous wetlands. Based on the Unified Mitigation Assessment Methodology (UMAM) initial estimate, approximately 11,760 square feet (0.27) acres of in-kind herbaceous permittee-responsible wetland mitigation is included in the project cost to offset this functional loss of wetlands. This wetland impact is further described in Section 8.10; and the Environmental Mitigation Plan is found in Appendix D, Environmental, Subappendix D, of this report. The estimated wetland impacts and mitigation are based on the current conceptual design footprints for the shoreline stabilization features, which were designed upslope of the water, so there are no in-water impacts. Wetland impacts were estimated based on conservative field measurements and a wetland jurisdictional determination will be conducted during the Preconstruction Engineering and Design (PED) phase of the project. If during the PED phase the shoreline stabilization design changes and increased wetland impacts and/or encroachment into the water become necessary, then supplemental National Environmental Policy Act (NEPA) documentation, additional Endangered Species Act Section 7 coordination, and additional mitigation may be required. In addition, a permit would likely be required from the Florida Keys National Marine Sanctuary (FKNMS) for all in-water impacts, and additional permit coverage would be required from the Florida Department of Environmental Protection (FDEP) for the Water Quality Certification.

7.2 RECOMMENDED PLAN ECONOMICS

NED benefits were evaluated using G2CRM as documented in Chapter 6 of this report and Appendix C, Economics. Nonstructural costs were developed using information from FEMA and nonstructural projects recently completed in southern Florida and Monroe County. Structural costs were developed based on a concept level design to estimate the construction, associated real estate, and environmental mitigation costs. A cost schedule risk analysis was completed in December 2020 and the results were used to determine the risk based contingency that was applied to the estimated total project cost. Table 7-1 below shows the results of the cost and benefits analysis for the Recommended Plan. Table 7-2 shows the first cost for each element of the recommended plan from the total project cost summary.

Table 7-1: Recommended Plan Cost and Benefit Analysis

Recommended Plan Economic Summary	**Total**
Recommended Plan First Cost	$2,103,462,000
Interest During Construction	$6,543,000
Annualized Interest During Construction	$231,000
Capital Recovery Factor at 2.5%	3.5%
Average Annual O&M	$161,000
Total Average Annual Cost	$85,557,000
Total PV Benefits	$3,732,565,000
Average Annual Benefits	$131,603,000
Benefit to Cost Ratio	1.5
Total Annual Net Benefits	$46,046,000

(1) Discount Rate: 2.5%, October 2020 Price Levels
(2) Estimates rounded
(3) The present value benefit estimate is with respect to the base year 2035 and the 50-year period of analysis
(4) Reduction in damage estimates were generated utilizing the USACE high sea level change curve

Table 7-2. Recommended Plan First Cost

Civil Works WBS Number	Feature Description	Project First Cost[1] ($1,000s, Constant Dollar Basis)
6[2]	Fish & Wildlife Facilities	$362
16	Bank Stabilization	$14,437
18	Cultural Resource Preservation	$15,758
19	Buildings, Grounds, & Utilities	$1,561,036
	Construction Estimate Totals	$1,591,594
1	Lands and Damages	$50,305
30	Planning, Engineering, & Design	$230,781
31	Construction Management	$230,781
	Project Cost Total	$2,103,462

1. October 2020 price levels, Includes 28% contingency
2. This is the cost for environmental mitigation required for the U.S. Route 1 shoreline stabilization

The recommended plan has an overall positive net NED benefit and a BCR of 1.5. It provides more NED benefit than the cost to implement the plan. However, the U.S. Route 1 shoreline stabilization included in the plan is a separable element that is not economically justified on the basis of NED benefit. There is considerable non-monetary benefit associated with the U.S.

Route 1 shoreline stabilization element and the cost for that element is only one percent of the overall project cost as demonstrated by the first cost breakdown shown in Table 7-2. As discussed in Section 6.5 of this report, the Assistant Secretary of the Army for Civil Works ASA(CW) approved an exception to NED policy to allow the recommended plan to include the separable element on the basis of life risk and resilience benefits vs. NED benefit.

7.2.1 Regional Economic Development

This section provides the RED results of the Recommended Plan. The expenditures associated with all work activities of the Recommended Plan are estimated to be approximately $2.0 billion. Of this total expenditure, $1.3 billion will be captured within the local impact area of Monroe County. The remainder of the expenditures will be captured within the state and the nation. These direct expenditures generate additional economic activity, often called secondary or multiplier effects. The direct and secondary impacts are measured in output, jobs, labor income, and gross regional product (value added) as summarized in the following tables. The regional economic effects are shown for the local, state, and national impact areas. In summary, the project expenditures support an estimated total of 18,607 full-time equivalent jobs, $1.1 billion in labor income, $1.2 Billion in value added output, and $2 billion in economic output in the local impact area. More broadly, these expenditures support 36,044 full-time equivalent jobs, $2.4 billion in labor income, $3.2 billion in the gross regional product, and $5.4 billion in economic output in the nation.

Table 7-3. Regional Economic Development

Area	Local Capture ($1,000s)	Output ($1,000s)		Jobs	Labor Income ($1,000s)	Value Added ($1,000s)
Local						
Direct Impact		1,305,873		14,036	864,872	834,875
Secondary Impact		730,443		4,571	229,793	414,493
Total Impact	1,305,873	2,036,316		18,607	1,094,665	1,249,368
State						
Direct Impact		1,404,648		11,107	785,293	817,386
Secondary Impact		1,607,803		9,348	512,371	885,595
Total Impact	1,659,168	3,012,452		20,455	1,297,664	1,702,981
US						
Direct Impact		1,904,892		18,843	1,292,057	1,243,069
Secondary Impact		3,522,066		17,200	1,120,831	1,918,473
Total Impact	1,904,892	5,426,958		36,044	2,412,887	3,161,542
(1)	(2) Jobs are presented in full-time equivalence (FTE) (3) Estimates are with respect to 2021					

Table 7-4 provides total impact estimates. However, the impact will be spread out over the 10-year period. The table below provides estimates for average annual impact to output, with respect to the 10-year period of construction.

Table 7-4: Impact to Output, by Area

Area	Total Impact to Output ($1,000)	Average Annual Impact to Output ($1,000)
Local	2,036,316	208,722
State	3,012,452	308,776
National	5,426,958	556,263
(1) Total impact with respect to 2021 (2) Annual estimates are with respect to a 10-year construction period and a 2.5% discount rate		

7.3 IMPLEMENTATION OF THE RECOMMENDED PLAN

The recommended plan is estimated to be at approximately a ten percent design level and is based upon current information and the best available estimates and projections of future conditions in the study area. Therefore, modifications to the project design and operations are likely during later stages of project design and construction to ensure that the project considers any unforeseen changes in the existing or future conditions that have occurred since the completion of this feasibility study. Modifications may require new investigation into environmental and social impacts. There are also some analyses that have been deferred to or must occur during the PED phase when more detailed plans and specifications are developed, including:

- Detailed cultural resources surveys
- Review of conditions that may have changed since the completion of the feasibility study that would affect the design of structural or nonstructural measures included in the recommended plan
- Detailed assessment of structures identified for nonstructural measures, including but not limited to surveys, structural assessments, etc.
- Any additional environmental coordination that may be required if there are environmental, cultural, and/or historic resource impacts that were not identified during the feasibility study.
- Modifications may require new investigation into environmental and social impacts.

This feasibility study was delegated to the Norfolk District in order to more efficiently use USACE coastal planning expertise and resources when a large number of CSRM studies were authorized at once in the South Atlantic Division's area of responsibility. Once this feasibility study is complete, the Norfolk District will transfer the study documentation to the Jacksonville District which will immediately assume responsibility for the design and construction of the project. The recommended plan is extensive and includes structural and nonstructural measures throughout the Florida Keys. With an estimated total project cost greater than $2 billion, it is estimated that it will take at least ten years to fully implement the authorized project. In that ten year implementation period, different increments of the project will be completed as funding allows. The phased implementation will consider the priorities of the NFS, completing certain elements of the plan in a way that captures efficiencies in the construction and/or contracting process, and the capability of the NFS and Jacksonville District to complete work in any given year. The non-federal sponsor must obtain the lands, easements, rights of way, and disposal areas (LERRDs) required to implement any civil works project. This includes the real estate needed to construct structural measures and implement nonstructural measures. Participation in elevation and floodproofing is voluntary. More detailed information on the implementation of nonstructural measures is included in Appendix G, Nonstructural Implementation Plan.

It is expected that the non-federal sponsor will continue to pursue the various resilience initiatives discussed in section 1.8 of this report as well as new opportunities that may become available to them in the future that would reduce coastal storm risk in the Florida Keys. Monroe County is currently working to identify county-maintained roadway segments that should be elevated and/or improved to reduce the impacts of sea level rise. The county is also currently executing a grant to elevate homes that were damaged by Hurricane Irma and also is working to use the Hazard Mitigation Grant Program (HMGP) to elevate and acquire homes that are at risk to inundation caused by coastal storm events. Because this ongoing work will continue by the NFS and other organizations in the Keys after this study has been completed, it will be important to reassess the existing condition in terms of road infrastructure and the structure inventory during PED to ensure that the recommended plan accounts for any changes to the development in the Keys that may have occurred after this feasibility study is completed. A structure cannot be elevated or floodproofed if it has already been improved with funds from another federal source such as the HMGP, so it is possible that the number of structures included in the nonstructural recommendation may be slightly reduced to account for improvements that were not completed at the time of this study. Roadway improvements that are currently being evaluated by the County will be considered in the prioritization of nonstructural measures included in the recommended plan.

7.4 PARTICIPATION IN NONSTRUCTURAL MEASURES

The recommended plan includes elevation of residential homes and floodproofing of non-residential structures throughout Monroe County. The primary economic analysis assumes 100% participation of the structures included in the Recommended Plan. The total project cost that is ultimately authorized into law will be the estimated cost to implement 100% of the structures recommended for nonstructural measures. However, while project economics have confirmed that 100% of these structures comprise a plan that reasonably maximizes NED benefits, these measures will be implemented on a voluntary basis and structure owners may choose to participate in the project. For this reason, study teams should consider participation rates that are appropriate for the study and utilize sensitivity analyses of different participation rates to clearly communicate to decision makers the uncertainty in benefits and costs for voluntary nonstructural measures.

The study team considered other USACE nonstructural projects and coordinated with Monroe County to complete an evaluation of the expected participation rate for nonstructural measures in the recommended plan. The study team used the five factors in the USACE Nonstructural Committee's Best Practice Guide 02 (BPG 2020-02) to evaluate the likely participation in voluntary nonstructural measures in the Florida Keys.

1) Temporal proximity of severe flood damage
2) Decent, safe, and sanitary
3) Hazardous, toxic, and radioactive waste (HTRW)
4) Temporary relocation
5) Physical requirements

Based on information specific to the Florida Keys, a qualitative score of slight, moderate, or significant was assigned depending on how much of an effect that factor is expected to have on the participation in nonstructural measures. In addition to the five factors from the BPG, the study team identified some additional factors that are expected to affect the participation rate for nonstructural measures. These additional considerations are expected to moderately increase the participation rate for nonstructural measures. These local factors include: concern over sea level rise and "sunny day flooding" which is already impacting part of the Keys currently; A higher level of education than the state and national averages; home elevation design height will likely bring residents up to the minimum FFE required for participation in the NFIP.

Given the results of this evaluation and a minimum expected participation rate of 50 percent, the estimated most likely participation rate for nonstructural measures in the recommended plan is 70 percent. An optimistic upper bound or "best case scenario" participation rate was also established in addition to the worst case and most likely rates. In assuming that in the best case scenario temporary relocation and physical requirements factors did not have a slightly negative effect on the overall scoring, 80 percent was determined to be the upper bound for participation in nonstructural measures. Appendix C, Economics, contains the full participation rate analysis.

7.5 EXECUTIVE ORDER 11988 AND PUBLIC LAW 113-2 CONSIDERATIONS

This study has considered the requirements of EO 11988, Flood Plain Management and PL 113-2, the Disaster Relief Appropriations Act of 2013. Specifically, this section of the report addresses:

- The Water Resources Council Floodplain Management implementing guidelines for EO 11988;
- The specific requirements necessary to demonstrate that the project is economically justified, technically feasible, and environmentally acceptable, per PL 113-2.

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 floodplains 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 floodplains 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 infrastructure.

2. If the action is in the base floodplain, identify and evaluate practicable alternatives to the action or to location of the action in the base flood plain. Chapter 6 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 EIS was developed and NEPA procedures were followed concurrently with the study. During this process, 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 floodplain values. Where actions proposed to be located outside the base floodplain will affect the base floodplain, impacts resulting from these actions should also be identified. The anticipated impacts and environmental compliance associated with the Recommended Plan are summarized in Chapters 8 and 9. The project is not expected to alter or impact the natural or beneficial floodplain values.

5. If the action is likely to induce development in the base floodplain, determine if a practicable non-floodplain alternative for the development exists. The project provides benefits for existing and development and is not expected to induce significant 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 floodplain values. This should include reevaluation of the “no action” alternative. The project is not expected to induce development in the floodplain. In areas where the project may impact the natural or beneficial floodplain values, environmental mitigation is

planned. Chapter 6 of this report summarizes the alternative identification, screening, and selection process. The no action alternative was included in the plan formulation process.

7. If the final determination is made that no practicable alternative exists to locating the action in the floodplain, advise the general public in the affected area of the findings. The Draft Integrated Feasibility Report and Environmental Impact Statement was provided for public review in 2020. Public meetings were also held during the public review period. Each comment received has been addressed and, if appropriate, incorporated into the Final Report. A record of all comments received is included in Appendix D.

8. Recommend the plan most responsive to the planning objectives established by the study and consistent with the requirements of the Executive Order. The Recommended Plan is the most responsive to all of the study objectives and the most consistent with the executive order.

7.6 RISK AND UNCERTAINTY

All CSRM projects are comprised of different risk management alternatives represented by the tradeoffs among engineering performance, project cost, economic and environmental resilience, and life loss consequences. These increments contain differences in damage reduced, residual risk, local and federal project cost, impacts to the environment, and life loss. The PDT selected the recommended plan considering all of these tradeoffs in order to identify a plan that reduces risk and also considers other conditions appropriately. Throughout the study and project implementation, the PDT will communicate with the non-Federal sponsor, local residents, and stakeholders so they understand these tradeoffs and can fully participate in the study and implementation of the project.

7.6.1 Project Performance

There is inherent uncertainty in the characterization of the future without project and future with project conditions. The goal of the feasibility study is to reduce the level of uncertainty surrounding the selection and performance of the recommended plan to a level where there is reasonable certainty that of all the plans considered, the best plan has been selected and there is a tolerable level of risk associated with that plan. By accounting for changes in conditions using the best available projections and data, the team has identified the plan that is expected to both reasonably maximize NED benefit and generate other benefits to life safety and resilience. The recommended plan is expected to manage coastal storm risk as designed through the 50 year period of analysis.

Floodproofing
The dry floodproofing maximum height is three feet above the existing condition first floor elevation. Because the majority of the study area is currently in the FEMA 100 year return period (0.01 AEP) floodplain and storm surge inundation is expected to exceed the maximum floodproofing design height during many coastal storm events, it was assumed that all

structures recommended for dry floodproofing would be elevated to the maximum height of three feet. To determine project performance, three feet was added to the average existing condition first floor elevation for structures recommended for floodproofing in each of the 34 model areas to estimate the design height for floodproofing so that expected exceedance probability could be determined for the measure. The average existing first floor elevation ranges from 2.32 feet NAVD88 to 8.21 feet NAVD88 across all model areas so therefore, the floodproofing height ranges from 5.32 feet NAVD88 to 11.21 feet NAVD88 within the study area. Based on these design heights, the risk reduction associated with floodproofing relative to AEP ranges from the 5 to 1,000 year storm event at the 50 percent confidence level and from the 5 to 500 year storm event at the 90 percent confidence level for the period of economic analysis which is 2035 through 2084. In model areas where the ground elevation and existing condition first floor elevations are higher, the risk reduction relative to AEP is also higher. Appendix A, Plan Formulation, includes nonstructural measure performance estimates, including the annual and long term exceedance probabilities, for all model areas included in the recommended plan at the 50 percent and 90 percent confidence levels. Figures 7-1 and 7-2 below show the average performance of the floodproofing for all structures included in the recommended plan in the three USACE SLC scenarios at the 50 and 90 percent confidence limits. The confidence limit is used to communicate uncertainty in the project performance. At the 50 percent confidence limit, the project can be expected to perform at a certain return period 50 percent of the time. At the 90 percent confidence limit, the project can be expected to perform at a certain return period 90 percent of the time.

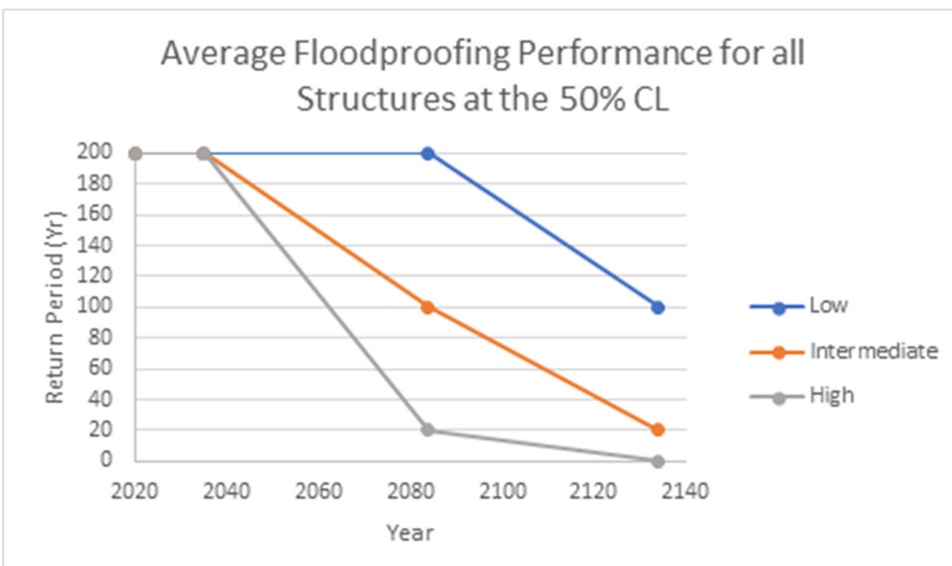


Figure 7-1. Floodproofing Performance for USACE SLC Scenarios Through 2134, 50% Confidence Limit

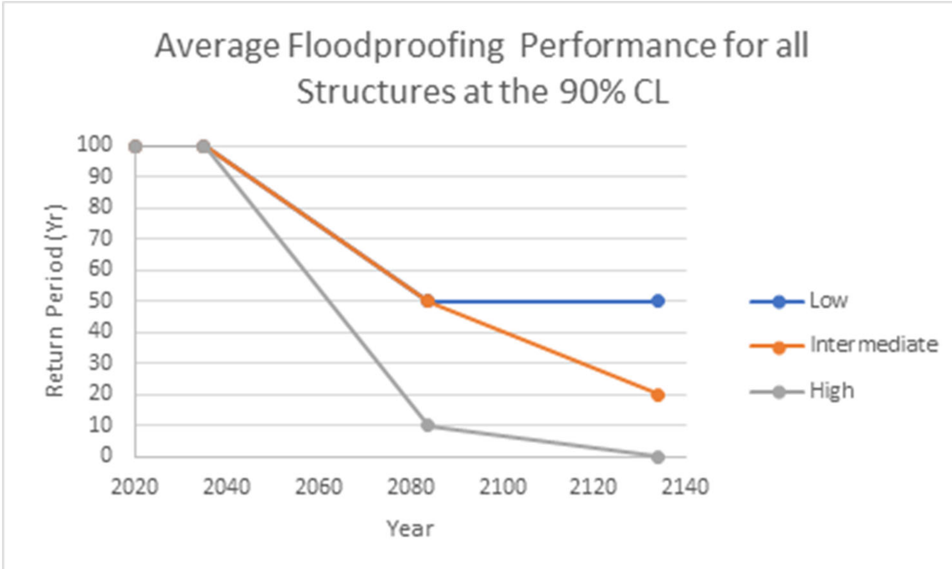


Figure 7-2. Floodproofing Performance for USACE SLC Scenarios Through 2134, 90% Confidence Limit

Local tide gage trends were consistent with the USACE high rate of SLC, that was the scenario that was used for plan formulation and evaluation. Because it was expected that any CSRM measure would be very sensitive to SLC, using the USACE high rate of SLC to inform the recommended plan will reduce the risk that the project will not perform as expected in the future. However, as shown in Figures 7-1 and 7-2, the floodproofing portion of the recommended plan performs much better in the USACE low and intermediate SLC scenarios than the high. In 2035, which is the beginning of the 50 year economic period of analysis, there is 90 percent confidence that the recommended floodproofing can be expected to perform at the 100 year return period and in the USACE high SLC scenario it will still perform at the 10 year return period by 2084, which marks the end of the economic period of analysis. In the intermediate and low SLC scenarios, the floodproofing can be expected to perform at the 50 year return period in 2084. Performance is also shown to 2134 to show the long term impact of sea level rise over a 100 year period. Consistent with the trends of decreasing project performance as SLC increases over time, the floodproofing performance is greatly diminished in the USACE high SLC scenario after the 50 year period of analysis ends in 2084. However, the project would still perform well in the intermediate and low SLC scenarios.

Elevation

The residential structure elevation maximum height is 12 feet above ground level. The design height for elevation of structures included in the recommended plan was based on the water surface elevation for the 100 year return period (0.01 AEP at the 50% CL) with the SLC expected with the USACE high projected rate by 2084. If the design height based on the 0.01 AEP water surface elevation would require a structure to be elevated higher than 12 feet above ground level, the structure elevation will be limited to the 12 feet above ground level. This design height was selected because it reasonably maximized NED benefit for structures in the study area. The WSE expected for the 0.01 AEP plus high SLC varies slightly between the 34 model areas due to location specific conditions that affect the amount of storm surge. Each model area has its own hydraulic information and WSE estimates used in the damage estimation modeling. The WSE for the 0.01 AEP plus high SLC at the 50 percent CL ranges from 7.12 feet NAVD88 to 11.32 feet NAVD88 across all model areas. Considering the model area where storm surge flooding is expected to be the highest of all model areas within the study area has an average ground elevation of 3.33 feet NAVD88, the maximum design height of 11.32 feet NAVD88 is within the 12 foot above ground level maximum elevation height. This indicates that the max elevation constraint should not affect the elevation of structures to the recommended plan design height. The elevation is designed for the 100 year return period (0.01 AEP) with the USACE high projected rate of SLC at the 50 percent confidence level which equates to project performance ranging from the 20 to 50 year AEP at the 90 percent confidence level depending on the model area. Appendix A, Plan Formulation, includes nonstructural measure performance estimates, including the annual and long term exceedance probabilities, for all 34 model areas at the 50 percent and 90 percent confidence levels. Figures 7-3 and 7-4 below show the average performance of the elevation for all model areas included in the recommended plan in the three USACE SLC scenarios at the 50 and 90 percent confidence limits.

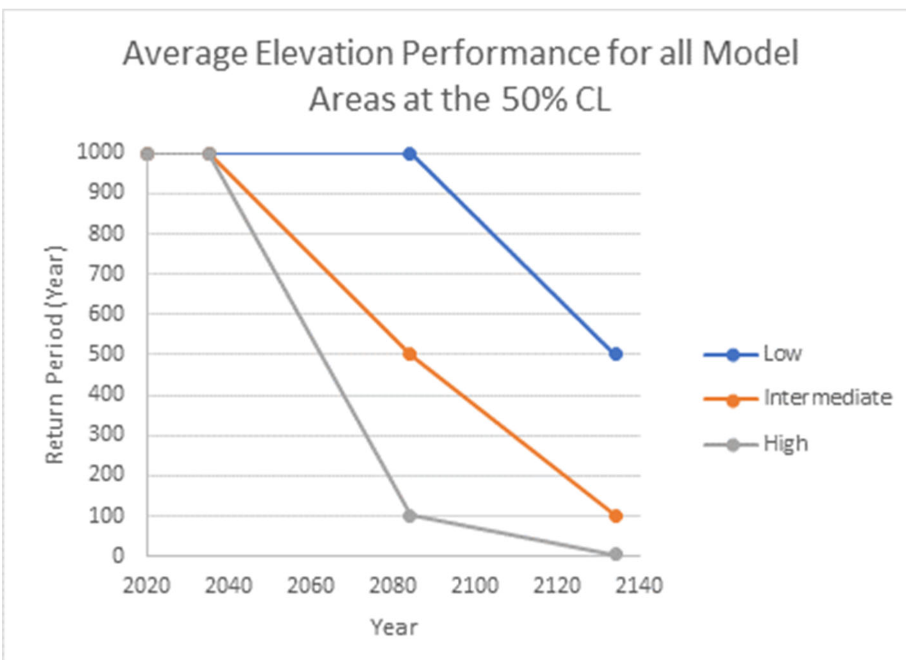


Figure 7-3. Elevation Performance for USACE SLC Scenarios Through 2134, 50% Confidence Limit

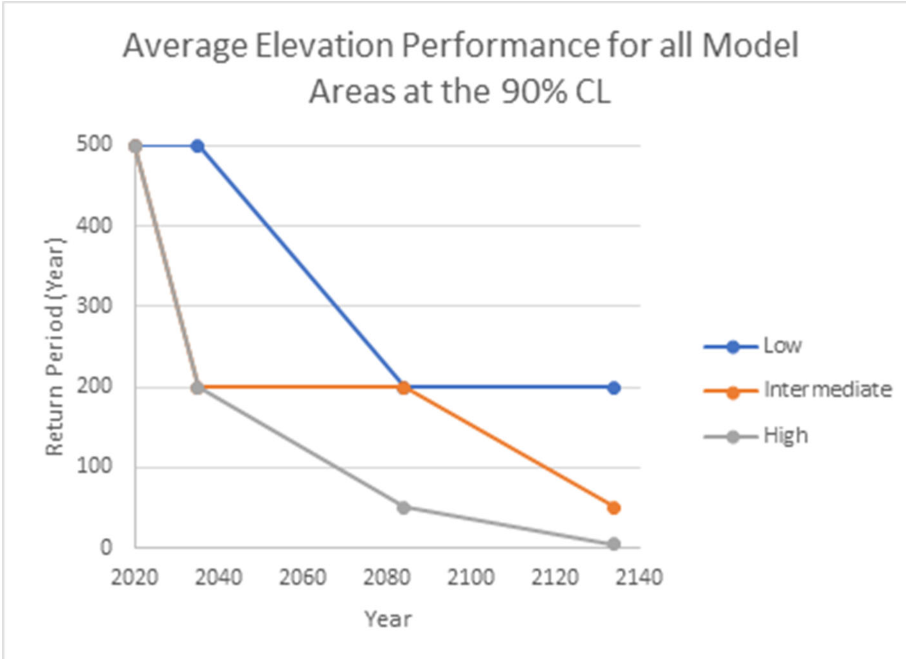


Figure 7-4. Elevation Performance for USACE SLC Scenarios Through 2134, 90% Confidence Limit

Local tide gage trends were consistent with the USACE high rate of SLC, that was the scenario that was used for plan formulation and evaluation. Because it was expected that any CSRM measure would be very sensitive to SLC, using the USACE high rate of SLC to inform the recommended plan will reduce the risk that the project will not perform as expected in the future. However, as shown in Figures 7-3 and 7-4, the elevation portion of the recommended plan performs much better in the USACE low and intermediate SLC scenarios than the high. In 2035, which is the beginning of the 50 year economic period of analysis, there is 90 percent confidence that the recommended elevation can be expected to perform at the 200 year return period and in the USACE high SLC scenario it will still perform at approximately the 50 year return period by 2084, which marks the end of the economic period of analysis. In the intermediate and low SLC scenarios, the floodproofing can be expected to perform at the 200 year return period in 2084. Performance is also shown to 2134 to show the long term impact of sea level rise over a 100 year period. Consistent with the trends of decreasing project performance as SLC increases over time, the elevation performance is greatly diminished in the USACE high SLC scenario after the 50 year period of analysis ends in 2084.

Economics

It is important to determine how uncertainty may affect the recommended plan's economic performance. The expected NED benefits and BCR figures are displayed as an expected (mean) value the minimum, median, and maximum estimated values in Table 7-5. Appendix C, Economics, includes additional economic risk analysis for the full array of alternatives.

Table 7-5. NED Benefit Risk Analysis

Alt.	Average Annual Damage ($1,000)		AAD Reduced ($1,000)	Uncertainty in AAD Reduced ($1,000)		
	Without Alternative	With Alternative	Mean	Minimum	Median	Maximum
7	895,505	763,902	131,603	79,245	137,846	143,197

(1) Discount rate: 2.5%
(2) Estimates rounded
(3) The present value benefit estimate is with respect to the base year 2035 and the 50-year period of analysis
(4) Reduction in damage estimates were generated utilizing the USACE high sea level change curve

The mean, median, and maximum expected average annual damage reduction (benefit) estimates exceed the average annual cost of the project, $85,557,000. The minimum expected average annual damage reduction (benefit) estimate, $79,254,000, is slightly lower than then the average annual cost of the project; however, it is unlikely that realized benefits will reach this extreme. Realized project benefits are most likely to follow mean and median estimates. These results suggest, with a high level of confidence, the project is likely economically justified with a BCR greater than 1.0 regardless of uncertainties captured in the model. A sensitivity analysis was also completed to determine how uncertainty related to SLC could affect the project economics. These results suggest that the Recommended Plan will should still be economically justified regardless of sea level rise uncertainty. The BCR for the USACE low sea level curve rate is just below 1.0; however, the likelihood of realizing this scenario is highly unlikely as the PDT was advised to use the USACE high sea level curve rate. Table 7-6 displays how the three different SLC scenarios would affect the recommended plan economics.

Table 7-6. Sea Level Change Economic Uncertainty

Sea Level Rise Rate	Total Average Annualized Benefit ($1,000)	Total Average Annual Cost ($1,000)	Benefit-Cost Ratio	Net Remaining Benefits ($1,000)
High	131,603	85,557	1.54	46,046
Intermediate	94,834	85,557	1.11	9,277
Low	82,480	85,557	0.96	-3,078

(1) Discount rate: 2.5%, October 2020 Price Levels
(2) Estimates rounded
(3) The present value benefit estimate is with respect to the base year 2035 and the 50-year period of analysis
(4) Reduction in damage estimates were generated utilizing the USACE high sea level change curve

The cost estimate includes risk based contingencies developed by completing a Cost and Schedule Risk Analysis. For structural measures, risks include the cost of environmental mitigation and the cost to transport construction materials down to the Keys. Risks that affect the estimated cost of nonstructural measures are primarily related to the implementation, including uncertainty around contracting and construction. It is also important to note that while the project cost was estimated for 100 percent of the structures recommended for either elevation or floodproofing in the recommended plan, the team has estimated that participation rate will likely be 70 percent. The minimum participation is estimated to be at least 50 percent and the maximum 80 percent. Table 7-7 displays the effect that these different participation rates would have on the economics for the recommended plan.

Table 7-7. Participation Rate Effect on Recommended Plan Economics

Recommended Plan	Participation Rate			
	100%	80%	70%	50%
AAC ($1,000)	85,557	43,222	37,819	27,014
AAB ($1,000)	131,603	68,952	60,333	43,095
BCR	1.5	1.6	1.6	1.6
Net Benefits ($1,000)	46,046	25,730	22,513	16,081

(1) Discount rate: 2.5%, October 2020 Price Levels
(2) Estimates rounded
(3) The present value benefit estimate is with respect to the base year 2035 and the 50-year period of analysis
(4) Reduction in damage estimates were generated utilizing the USACE high sea level change curve

Because with nonstructural measures a reduction in the quantity results in a reduction of both the benefits and costs, the BCR remains approximately the same for each of the participation rates. Therefore, the project would still be economically justified even if the participation rate differs from what has been projected. Detailed information for the participation rate analysis is in Appendix C, Economics.

7.6.2 Residual Risk

The recommended plan is expected to significantly reduce coastal storm risk throughout the Florida Keys. However, this study did not formulate plans to address the impacts of general sea level rise that causes nuisance flooding which is often referred to as “sunny day flooding,” precipitation, or the direct effects of wind associated with coastal storms. Considering this and other study limitations, no one project or action that is proposed, evaluated, adopted, and implemented as a result of a feasibility study would completely eliminate coastal storm risk.

Thus, with any CSRM project there will be some amount of residual risk that remains once the project has been implemented. The recommended plan for the Florida Keys is comprised of mostly nonstructural measures, which means that while economic damage will be substantially reduced to both residential and nonresidential structures, the project will not reduce the likelihood or extent of storm surge flooding in the study area. This means that during a coastal storm event, the roadways and utility systems that support those structures that are included in the recommended plan will still be impacted by storm surge flooding and it will be critical that current evacuation plans continue into the future even once the recommended plan has been implemented. The recommended plan does include shoreline stabilization to reduce damage to U.S. Route 1 caused by waves and erosion. However, the proposed shoreline stabilization measures will not prevent storm surge from flooding the roadway during a coastal storm event. The shoreline stabilization areas were designed to retain the shoreline and roadway to the extent possible even if they are inundated during a coastal storm event so that once the surge recedes, the roadway should have sustained far less damage than if the measure was not implemented there.

There is also residual risk associated with the nonstructural measures that are included in the recommended plan. Nonstructural measures were formulated to address a significant amount of the structure damage that is expected to occur in the future, not eliminate all structure damage that could occur due to coastal storm events. There are 38,670 structures in the Keys that are not included in the recommended plan. The average annual residual damage for these structures is estimated at $764,000,000 which is 85% of the total structure damage in the Florida Keys. Appendix C contains more detailed residual risk information.

There are also engineering constraints that contribute to residual risk that exists with nonstructural measures. The maximum height a nonresidential structure can be floodproofed is three feet above the existing first floor elevation. The WSEs associated with the 100 year return period (0.01 AEP) range from 7.12 feet NAVD88 to 11.32 feet NAVD88, with an average WSE of 9.51 feet NAVD88 for all model areas. Considering the average height of floodproofing for all model areas is 6.38 feet NAVD88, there will be storm events that will exceed the risk reduction capability of the floodproofing. Because water levels would likely exceed the floodproofing design height, there is residual risk to structures that have been floodproofed during coastal storm events of higher magnitudes. Considering the maximum height a nonresidential structure can be floodproofed is three feet above the existing first floor elevation and with the USACE high rate of sea level change is expected to be 3.68 feet NAVD88 by 2084, SLC alone may begin to approach the design height of floodproofing in areas where the ground elevation is very low. For example, model area 12 has an average ground elevation of 0.32 feet NAVD88 which is the lowest in the study area. Structures in this model area can only be floodproofed to a maximum of 3.34 feet NAVD88, which is slightly below the level of SLC expected by 2084. However, this would only be an issue in that one model area, as the rest of the model areas all have an average ground elevation of 1.18 or higher.

Even though the design height for home elevation is within the maximum elevation height of 12 feet above the adjacent ground level, the design height corresponds to the 100 year return period (0.01 AEP) event plus high SLC and is expected to elevate homes so the FFEs are equivalent to or above the base flood elevation plus one foot. However, elevated homes would still be vulnerable to damage during storm events of magnitudes higher than the design height.

It is important to acknowledge that although the recommended plan will reduce damage to 5,803 structures by either floodproofing or elevating them, these structures account for less than a quarter of all structures in the Keys. The nonstructural evaluation identified the structures that are estimated to experience significant damage in the future, however this does not mean that structures not included in the plan will not experience storm damage. There is also residual risk expected to occur within the structures that were included in the recommended plan. With 100 percent participation not expected for the voluntary nonstructural measures, residual risk associated with the recommended plan will increase with decreased participation.

7.6.3 Life Risk

One study objective was the reduction of risk to life safety and life risk was evaluated for the structural and nonstructural alternatives. The evaluation was completed as required by Planning Bulletin 2019-04 “Incorporating Life Safety into Planning Studies.” It is extremely important to evaluate life risk because it is a critical facet of the overall coastal storm risk characterization for the study area. However, when it was determined that NED benefits could not be quantified for the U.S. Route 1 element, the life risk analysis also became an important factor in plan selection. The focus of the Life risk Evaluation is to estimate how residual life risk would change, or otherwise transform, if coastal storm risk management measures were introduced to the study area. The life risk analysis considered both direct and indirect life loss.

Direct Life Loss

A direct flood fatality is attributed to a person’s physical interaction with flooding. The forces of the flood cause life loss whether someone is in a structure, vehicle, or outdoors. Common causes of fatalities from direct flood impacts include drowning (in structures, vehicles, in the open); suffocation; physical trauma (debris flow) and structure collapse. Less frequent causes are road collapse; hydroplaning into flood ditches, and electrocution (caused by interaction with water). Direct flood fatalities do not include those caused by other environmental conditions during the flood event such as high winds or falling trees.

The nonstructural measures were expected to reduce direct life loss caused by storm surge flooding. Life loss is evaluated by estimating the likelihood of an event occurring and the corresponding life loss consequences of that event. These estimates can be made at the event level, but for the purposes of this analysis, and the focus on considering over the life cycle of the project, it was necessary to consider a range of possible events that could cause damaging flooding in the Florida Keys. HEC-LifeSim 2.0 was used to estimate direct life loss from coastal storm events and RMC-TotalRisk 1.0 was used with the LifeSim results to estimate Expected Annual Life Loss (EALL) for the existing, future without, and future with project conditions. EALL represents the annualized estimate of life loss for the range of storm events considered (0.5 AEP through 0.001 AEP). Table 7-8 shows the EALL estimates for each of the three project scenarios.

Table 7-8. Expected Annual Life Loss Estimates

Project Scenario	EALL
Existing Condition	1.92
Future With Project Condition	3.94
Future Without Project Condition	10.31

The Existing Condition shows the lowest EALL estimate. This is a product of the change in the hydrologic record due to climate change during the period of analysis from 2018 to 2084. The nonstructural measures included in the recommended plan are expected to provide a significant reduction in future EALL as compared to the future without project condition.

Indirect Life Loss

An indirect flood fatality can occur before, during or after a major flood event. The flood disaster changes the characteristics (e.g. transportation infrastructure) of a geographic area and creates unsafe conditions that lead to death. Common mortalities include stress-induced medical conditions (e.g. heart attack); power related fatalities (e.g. carbon monoxide poisoning; asphyxiation); exposure to extreme temperatures (hyperthermia or hypothermia); infections from contact with water; and lack of medical treatment for chronic conditions or minor but treatable conditions.

Because HEC-LifeSim evaluates direct life loss due to flooding, in this case from storm surge during coastal storm events, it was an effective tool to quantify the life risk reduction expected with the implementation of nonstructural measures. However, the shoreline stabilization proposed for six locations along U.S. Route 1 in the recommended plan will not prevent inundation of the road caused by storm surge. The shoreline stabilization is designed to reduce the likelihood that the roadway will be damaged due to erosion and waves associated with coastal storms. Considering the roadway will likely be inundated by storm surge during coastal storm events of significant magnitude and that the majority of the population will be evacuated prior to the arrival of a significant coastal storm event such as a hurricane, the U.S. Route 1 element is not expected to reduce direct life loss like the nonstructural measures are expected to. However, the U.S. Route 1 revetment is expected to reduce the indirect life loss that would occur due to coastal storms in the Florida Keys.

A USACE Risk Management Center (RMC) Technical Note was drafted in July 2020 that identifies a method for estimating Indirect Life Loss from flood events. Because that method is still being reviewed by the USACE Economics Community of Practice (CoP) indirect life loss cannot be evaluated on a quantitative basis for this study. However, the PDT met with senior members of the USACE Economics and Plan Formulation CoPs to discuss including the U.S. Route 1 element on the basis of the life risk benefits that it contributes to the recommended plan by reducing indirect life loss and it was agreed that a qualitative assessment of the life risk benefit would be acceptable.

The RMC Technical Note identifies factors that can be evaluated for non-evacuees and evacuees based on how they impact the known contributors of indirect life loss for those groups of the population. For non-evacuees, these include health and age factors, extreme temperature, power problem, exposure duration, response capability, and isolationism. For evacuees, the factors include health and age factors, critical health facility evacuation, intensity factor, extreme temperature, and evacuation duration. The qualitative evaluation of indirect life loss expected to result from the U.S. Route 1 element was completed by addressing these factors identified in the RMC Technical Note to explain how they can be expected to affect the likelihood of indirect life loss occurring in the Florida Keys with and without the recommended plan.

The different factors contributing to indirect life loss would impact the Florida Keys with various levels of severity, but the key is whether U.S. Route 1 becoming impassable would increase the potential for indirect life loss post-disaster. If during a storm event U.S. Route 1 becomes damaged, the inability to travel by automobile within the islands and/or to the Florida Mainland would likely increase mortality in the Florida Keys. Indirect Life Loss in the Florida Keys is likely to be driven by a power problem that persists for a long period of time (more than one week). A prolonged power outage would increase the possibility of people losing their lives due to extreme temperatures, electrocution, CO poisoning, falling or blunt force trauma and vehicle accidents due to inoperable traffic lights. If U.S. Route 1 is available for vehicle traffic, people remaining on the Florida Keys after a hurricane (those who did not evacuate) could reduce their exposure to the power problem by traveling to the Florida Mainland.

Consider Hurricane Irma. The National Hurricane Center's report on Hurricane Irma states that only 75% of the population on the Florida Keys evacuated ahead of the hurricane making landfall at Cudjoe Key. The Florida Keys population in 2017 was approximately 25,000 people. If only 75% of the population took protective action and evacuated the Keys ahead of Irma making landfall, that leaves approximately 6,250 people on the Keys when the storm arrives. If a similar event took place, the evacuation rate was the same as it was with Irma and that event knocked out the power infrastructure on and to the Keys, then more than 6,000 people would be exposed to a power problem created by the storm. If even half of that remaining group could leave the Florida Keys and avoid prolonged exposure to a power problem, that would remove as many as 3,000 people from that group that did not evacuate.

If U.S. Route 1 were impassable following a storm, the approximately 6,000 people remaining in the Florida Keys after an evacuation is ordered could be exposed to a prolonged power problem. Airborne and marine rescue would reduce that number but rescuing people by aerial or aquatic means is time consuming and only small groups can be moved at any one time. Even with rescue, people being able to take protective action on their own and evacuating to the mainland to avoid prolonged exposure to post-disaster conditions in the Florida Keys would be the most significant way to reduce the risk of indirect mortality on the Florida Keys from a hurricane event. The purpose of the proposed revetments along U.S. Route 1 is to increase the likelihood that the roadway will remain open to vehicle traffic following a coastal storm event which would reduce the risk to life safety that can be expected to occur without terrestrial travel. If vehicle travel impacts following a storm are less severe, emergency services can resume more quickly, storm cleanup and repair efforts can begin more rapidly, and residents that did not evacuate will be able to move more freely within and/or out of the Keys after a storm event. This will reduce the indirect life loss associated with coastal storm events.

7.7 RESILIENCY, SUSTAINABILITY, AND ADAPTABILITY

This section has been prepared to address how the recommended plan contributes to resiliency, how it affects sustainability, and how it may be adapted to continue to perform under changed future conditions in the Florida Keys.

7.7.1 Resiliency

Resiliency is defined in the February 2013 USACE-NOAA Infrastructure Systems Rebuilding Principles white paper as the ability to adapt to changing conditions and withstand, and rapidly recover from disruption due to emergencies. The USACE Climate Change Adaptation Goal is to minimize impacts from climate change and maximize resiliency in the coastal landscape. The 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.” The USACE Resilience Initiative Roadmap (EP 1100-1-2, 2016) and Engineering and Construction Bulletin 2020-6, Implementation of Resilience Principles in the Engineering and Construction Community of Practice, also provide guidance pertaining to resilience.

Anticipate
The recommended plan was formulated and evaluated with the USACE high rate of sea level change. The decision to use the high rate of sea level change for this analysis was based on local sea level change data and as a result, the project is designed consistent with the observed rate of sea level change in the Florida Keys. Other future conditions and land use and development trends have been anticipated through the review of existing information and studies completed by Monroe County and other stakeholders.

Prepare
Monroe County currently implements various floodplain management, zoning, and planning strategies that consider relative sea level rise and in addition to maintaining these risk reduction efforts, is also preparing for changing future conditions. The implementation of the recommended plan will enhance those efforts by the County to increase preparedness by managing coastal storm risk to U.S. Route 1, critical infrastructure, and development in the Keys. The structural and nonstructural measures included in the recommended plan are designed to reduce damage from future storm events to vulnerable infrastructure and structures which increases the preparedness of the structure owners and the Florida Keys as a whole due

to the collective benefit of the reduced damage to residential and commercial structures throughout the community.

Respond

The recommended plan includes floodproofing of critical infrastructure which will improve the ability for the Florida Keys to respond to the effects of coastal storms by reducing risk to structures that support emergency services, hospitals, schools (storm shelters), potable water infrastructure, etc. The shoreline stabilization proposed for 6 areas along U.S. Route 1 will also improve the response and recovery following coastal storm events by reducing the risk that segments of U.S. Route 1 will be damaged to the extent that vehicle traffic is limited or prevented. Connectivity between the islands of the Florida Keys is critical to the recovery after a storm event so that residents can return to their homes and more quickly begin to assess and repair damage to their homes and businesses. Connectivity of U.S. 1 also directly affects the life risk aspect of coastal storm risk in the Florida Keys. As discussed in Section 7.6.3 of this report, indirect life loss would be reduced if vehicle travel disruptions are prevented or reduced following a coastal storm event.

Adapt

The recommended plan will improve the resiliency of the Florida Keys, particularly with future sea level rise considered in the formulation and design. The project will reduce the average annual damage to infrastructure and homes from coastal storms. Nonstructural measures for critical infrastructure will enable the Keys to maintain and more quickly recover services critical to the functioning of the Keys. The project is complemented by projects and efforts completed by Monroe County and other stakeholders. Every project has its limitations and the recommended plan is no different. However, the residents of the Florida Keys will experience improvements to resiliency through the reduction in structure damage and vehicle travel disruptions from coastal storms.

7.7.2 Sustainability

Sustainability is defined in the February 2013 USACE-NOAA Infrastructure Systems Rebuilding Principles white paper as the ability to continue (in existence or a certain state, or in force or intensity), without interruption or diminution. The recommended plan is expected to sustain performance over the 50 year period of analysis that was evaluated. This is mostly due to the consideration of sea level change over that period, as sea level change is the biggest known source of uncertainty that would affect project performance in the future. By incorporating the USACE high rate of sea level change in the formulation and design of measures included in the recommended plan, that uncertainty is greatly reduced and the project is expected to generate NED benefits as estimated by the economic analysis for the entire period of analysis. The long term coastal storm risk management by the recommended plan will have a positive effect on the sustainability of the Florida Keys.

7.7.3 Adaptability

Adaptability is defined as the quality of being able to adjust to new conditions or the capacity to be modified for a new use or purpose. The USACE Climate Change Adaptation Goal is to minimize impacts from climate change and maximize resiliency in the coastal landscape. The recommended plan was formulated and considering the effects of sea level rise at the projected USACE high rate and is expected to perform as designed through the 50 year period of analysis. However, as shown in Figures 7-1 and 7-3, after the 50 year period of analysis ends the project is not expected to provide coastal storm risk management as designed and project performance would diminish from 2085 to 2134 in the high rate of sea level change. Depending on SLC and other future conditions, there may be a desire to adapt the project to sustain the risk management if project performance is affected.

Adaptation of Nonstructural Measures in the Recommended Plan
In the recommended plan, dry floodproofing will be implemented at the three foot maximum. This maximum height is based on engineering limitations, so it is not expected that the height of dry floodproofing could be increased beyond what was implemented as part of the project. However, some residential structures that have been elevated could be elevated again after the project is implemented, as the design height is below the maximum elevation height of 12 feet above ground level and it would be feasible from an engineering standpoint to elevate some structures if future conditions such as SLC have affected the risk management provided by the elevation implemented as part of the federal project. Federal assistance could not be used to elevate structures included in the recommended plan a second time though and this may present an obstacle if homeowners must pay for additional elevation on their own and/or with only local or state assistance. This study determined that acquisition of structures was not a cost effective measure when compared to elevation, however, the non-federal sponsor may want to consider acquiring properties as an adaptation strategy in the future.

Adaptation of Structural Measures in the Recommended Plan
The ten percent design for the shoreline stabilization proposed for six segments of U.S. Route 1 accounts for the effects of SLC and climate change. The shoreline stabilization design was based on the existing road height, so if the roadway is raised after the construction of the shoreline stabilization features the revetment would need to be adapted based on the new road height in order to effectively stabilize the shoreline and prevent erosion and wave damage to the roadway. As of this report's publication, no plans have been presented to USACE to raise U.S. Route 1 near the six shoreline stabilization measures proposed in the recommended plan. If the road is raised in the next 50 years where shoreline stabilization is proposed, more rock material can be added to the structures as needed to match the top of road elevation. The existing site conditions at the time of adaption need to be evaluated and design refinements may be required to adapt the shoreline stabilization features. During the PED phase, the monitoring procedures for the project and adaptation will be included in the OMRR&R Manual. The OMRR&R manual will discuss in detail the specific thresholds for adaption, with lead times required for each action. Once constructed, the project will be placed in USACE's Comprehensive Evaluation of Projects with Respect to Sea Level Change (CESL) 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 RSLR and provide added benefits to other USACE activities. Section 5.9 of Appendix B, Engineering, includes more information about the adaptation of the proposed shoreline stabilization.

CHAPTER 8 ENVIRONMENTAL CONSEQUENCES*

SUMMARY OF IMPACTS

A summary and comparison of resource impacts for the final array of project alternatives is provided in **Error! Reference source not found.**. This chapter provides a baseline for the impact analysis by presenting an overview of the existing conditions for each resource.

All of the alternatives involve either structural improvements to U.S. Route 1, nonstructural improvements to critical infrastructure, nonstructural improvements to development centers, or varying combinations of two or all three of these. To avoid duplication of text, the results of the impacts analysis of four alternatives are presented in this Chapter: Alternative 1 (Structural Measures Only for the U.S. Route 1 Corridor); Alternative 6 (Nonstructural Measures Only for both Critical Infrastructure and Development Centers); Alternative 7, a combination of Alternatives 1 and 6, which encompasses all structural and nonstructural measures; and Alternative 8, the No Action/Future Without Project Alternative.

A detailed analysis of potential impacts for each of the final array of project alternatives for each resource area is provided in this chapter following the summary of impacts description as well.

Table 8-1: Summary of Impacts for the Final Array of Project Alternatives

Environmental Factor	Alternative 1 (Structural Only)	Alternative 6 (Nonstructural Only)	Alternative 7, Recommended Plan (Combination of Alternatives 1 and 6)	Alternative 8 (No Action/ Future Without Project
Land Use	Direct and indirect, temporary and permanent adverse effects on land use that are minor to moderate. Permanent moderate adverse effects related to impacts along Long Key State Park shoreline near campground facility. Temporary, direct and indirect minor adverse effects during construction, due to possible limitation of use of Overseas Trail and a public fishing pier.	Significant, permanent effects on land use. These effects include both adverse and beneficial effects. Significant beneficial effects for those receiving elevations or floodproofing. Temporary, direct and indirect significant adverse effects, due to the need to temporarily relocate residents during home elevations.	Significant, adverse and beneficial permanent effects on land use. Significant beneficial effects for those buildings to be elevated or floodproofed. Direct and indirect, temporary and permanent adverse effects on land use along Long Key State Park shoreline near campground facility. Significant temporary adverse effects due to temporary relocation of residents.	No direct effects. Land use would continue. However, indirectly, by not doing the project, there is the potential for moderate adverse effects due to greater coastal storm damage to U.S. Route 1 and buildings within existing development centers.

Environmental Factor	Alternative 1 (Structural Only)	Alternative 6 (Nonstructural Only)	Alternative 7, Recommended Plan (Combination of Alternatives 1 and 6)	Alternative 8 (No Action/ Future Without Project
Socioeconomics	Moderate permanent benefit in the form of a more resilient U.S. Route 1. Minor temporary beneficial effect resulting from temporary construction jobs.	Significant, permanent effects on socioeconomics. These would be, both for elevations and floodproofing, in the form of greater coastal resiliency. Significant temporary adverse effects during construction of elevations, due to need to temporarily relocate residents. Will temporarily disrupt communities and affect Environmental Justice communities, during construction. Temporary, direct and indirect minor adverse effect, due to noise.	Significant, permanent effects on socioeconomics. These effects include both adverse and beneficial effects, Significant beneficial effects for those receiving elevations or floodproofing, in the form of greater coastal resiliency. Significant temporary adverse effects during construction of elevations, due to need to temporarily relocate residents, including some disadvantaged populations. Moderate permanent benefit in the form of a more resilient U.S. Route 1. Minor temporary beneficial effect resulting from temporary construction jobs.	No direct effect. However, over time, there is potential for moderate permanent and temporary adverse effect. Risk to people, property, and the economy of the Florida Keys would continue to increase as climate change is expected to result in more frequent and powerful Atlantic hurricanes, and sea level rise make their floods more damaging.

Environmental Factor	**Alternative 1 (Structural Only)**	**Alternative 6 (Nonstructural Only)**	**Alternative 7, Recommended Plan (Combination of Alternatives 1 and 6)**	**Alternative 8 (No Action/ Future Without Project**
Transportation	Permanent direct and indirect minor to moderate beneficial effects, through the risk management applied to vulnerable sections of U.S. Route 1 from erosional damage due to coastal storms. Minor temporary impacts during construction.	Permanent, minor to moderate beneficial effects, because flood warning systems and emergency planning would help residents evacuate more effectively, orderly, and safely, reducing direct impacts on the traveling public. Land use planning would reduce the future number of evacuees on the transportation network prior to and during storm events.	Permanent, minor to moderate beneficial direct and indirect effects, through the risk management applied to vulnerable sections of U.S. Route 1, and through flood warning systems, emergency planning, and land use planning.	Minor to moderate indirect temporary adverse effect, due to increased vulnerability of U.S. Route 1, the evacuation route, to more frequent storm damage.
Navigation	Temporary adverse effects on navigation near Indian Key would be negligible to minor.	No effect.	Temporary adverse effects on navigation near Indian Key would be negligible to minor.	No effect.

Environmental Factor	**Alternative 1 (Structural Only)**	**Alternative 6 (Nonstructural Only)**	**Alternative 7, Recommended Plan (Combination of Alternatives 1 and 6)**	**Alternative 8 (No Action/ Future Without Project**
Geology, Topography, and Soils	Minor adverse effects to soils during construction; a strict erosion and sediment control plan would reduce those impacts. There would be permanent alteration of soils and topography at the revetment sites, but there would be minor beneficial effects on soils, as the revetment locations would be more stable and would greatly limit erosion.	Minor adverse effects to soils during construction. There may be permanent minor soil and topography alterations around the buildings. A strict erosion and sediment control plan would reduce those impacts.	Minor adverse effects to soils during construction. There may be permanent minor soil and topography alterations around the buildings. A strict erosion and sediment control plan would reduce those impacts. There would be permanent minor beneficial effects on soils, as the revetment locations would be more stable and would no longer erode.	Minor adverse indirect effect due to increased erosion of soils.
Hydrology, Hydraulics, and Bathymetry	Minor permanent adverse indirect effect for revetment at Long Key State Park due to potential for deflection of wave energy. Minor temporary adverse effect during construction.	No effect	Minor permanent adverse indirect effect for revetment at Long Key State Park due to potential for deflection of wave energy. Minor temporary adverse effect during construction.	Minor adverse indirect effect due to increased erosion of soils and sea level rise

Environmental Factor	**Alternative 1 (Structural Only)**	**Alternative 6 (Nonstructural Only)**	**Alternative 7, Recommended Plan (Combination of Alternatives 1 and 6)**	**Alternative 8 (No Action/ Future Without Project**
Water Quality	Negligible to minor indirect permanent adverse effects due to minor wetland impact, and negligible temporary adverse effects. Strict erosion and sediment control measures would be adhered to.	No direct or indirect, temporary or permanent adverse effects. Strict erosion and sediment control measures would be adhered to.	Negligible to minor indirect permanent adverse effects due to minor wetland impact, and negligible temporary adverse effects. Strict erosion and sediment control measures would be adhered to. The FDEP has indicated that it has no objections; the Water Quality certification will be obtained in PED.	No effect, other than those expected for all alternatives, due to sea level rise, such as erosion.
Floodplains	Negligible to minor, adverse temporary impacts and accounted for during design and construction.	Minor and beneficial short-term and long-term on the flood plain itself. One nonstructural measure for critical infrastructure is proposed; however, it would meet an exemption for CBRA.	Minor beneficial short-term and long-term on the flood plain itself. One nonstructural measure for critical infrastructure is proposed; however, it would meet an exemption for CBRA.	No direct effect, however, there would be permanent moderate adverse effects over time, because structures in flood plains would continue to suffer storm damage and more frequent flooding due to sea level rise and climate change.

Environmental Factor	Alternative 1 (Structural Only)	Alternative 6 (Nonstructural Only)	Alternative 7, Recommended Plan (Combination of Alternatives 1 and 6)	Alternative 8 (No Action/ Future Without Project
Beaches and Terrestrial Habitat	An estimated 15,000 square feet of beach and vegetated dune land will be permanently modified for the installation of the revetment at Long Key State Park. This impact would be minor to moderate because the vegetative impacts would be mitigated with a planting plan. Otherwise, minor permanent and temporary direct impacts on low-quality terrestrial habitat. Long-term predicted loss and/or retreat of beaches and terrestrial habitat landward, due to sea level rise would continue to occur, but would be reduced in the revetment areas.	Negligible permanent and negligible to minor direct temporary adverse impacts because land disturbance for this alternative would be limited to modification of and land disturbance around existing buildings. Long-term predicted loss and/or retreat of beaches and terrestrial habitat landward, due to sea level rise.	An estimated 15,000 square feet of beach and vegetated dune land will be permanently modified for the installation of the revetment at Long Key State Park. This impact would be minor to moderate because the vegetative impacts would be mitigated with a planting plan. Otherwise, minor permanent and temporary direct impacts on low-quality terrestrial habitat. Long-term predicted loss and/or retreat of beaches and terrestrial habitat landward, due to sea level rise would continue to occur, but would be reduced in the revetment areas.	No direct or indirect effect, other than the long-term predicted loss and/or retreat of beaches and terrestrial habitat landward, due to sea level rise.

Environmental Factor	Alternative 1 (Structural Only)	Alternative 6 (Nonstructural Only)	Alternative 7, Recommended Plan (Combination of Alternatives 1 and 6)	Alternative 8 (No Action/ Future Without Project
Wetlands	Direct, permanent adverse impacts on approximately 10,250 square feet of sea purslane and sea oxeye-dominated herbaceous wetlands. Permanent wetland impacts would be mitigated, and thus would be negligible. Negligible to minor temporary wetland impacts are expected to occur, as it is the intention to utilize non-wetland areas for construction access and staging. If any wetland areas are disturbed during construction, these areas would be restored after construction. Long-term predicted loss and/or retreat of wetlands landward, due to sea level rise.	Negligible direct or indirect effect, other than the long-term predicted loss and/or retreat of wetlands landward, due to sea level rise.	Direct, permanent adverse impacts on approximately 10,250 square feet of sea purslane and sea oxeye-dominated herbaceous wetlands. Permanent wetland impacts would be mitigated, and thus would be negligible. Negligible to minor temporary wetland impacts are expected to occur, as it is the intention to utilize non-wetland areas for construction access and staging. If any wetland areas are disturbed during construction, they areas would be restored after construction. Long-term predicted loss and/or retreat of wetlands landward, due to sea level rise.	No direct or indirect effect, other than the long-term predicted loss and/or retreat of wetlands landward, due to sea level rise.
Benthics and Submerged Aquatic Vegetation	No direct or indirect effect other than adverse effects due to climate change.	No direct or indirect effect other than adverse effects due to climate change.	No direct or indirect effect other than adverse effects due to climate change.	No direct or indirect effect other than adverse effects due to climate change.

Environmental Factor	Alternative 1 (Structural Only)	Alternative 6 (Nonstructural Only)	Alternative 7, Recommended Plan (Combination of Alternatives 1 and 6)	Alternative 8 (No Action/ Future Without Project
Fish and Fishery Resources	No direct or indirect effect other than adverse effects due to climate change.	No direct or indirect effect other than adverse effects due to climate change.	No direct or indirect effect other than adverse effects due to climate change.	No direct or indirect effect other than adverse effects due to climate change.

Special Status Species and Critical Habitat	Moderate permanent adverse effects on loggerhead sea turtles, American crocodile, roseate terns, red knot, piping plover, and Cape Sable thoroughwort. Permanent modifications of up to 1.75 acre of American crocodile critical habitat; 0.5 acre of piping plover critical habitat; 0.5 acre of Cape Sable thoroughwort critical habitat; and 0.25 acre of loggerhead sea turtle critical habitat, in known turtle nesting areas. There would be no effect on marine mammals or other strictly aquatic animals. Otherwise, expected adverse effects due to climate change. Formal Section 7 consultation with USFWS was completed. No effects to species under the purview of the NOAA PRD as no structures or construction would be in the water.	Negligible to minor temporary adverse effects due to noise or visual disturbance is possible; however, no undeveloped or undisturbed areas would be impacted; all disturbance would be immediately surrounding the buildings to be treated. No direct effect other than adverse effects due to climate change.	Moderate permanent adverse effects on loggerhead sea turtles, American crocodile, roseate terns, red knot, piping plover, and Cape Sable thoroughwort. Permanent modifications of up to 1.75 acre of American crocodile critical habitat, 0.5 acre of piping plover critical habitat, 0.5 acre of Cape Sable thoroughwort critical habitat, and 0.25 acre of loggerhead sea turtle critical habitat, in known turtle nesting areas. There would be no effect on marine mammals or other strictly aquatic animals. Otherwise, expected adverse effects due to climate change. Formal Section 7 consultation with USFWS is completed. No effects to species under the purview of the NOAA PRD as no structures or construction would be in the water.	No direct or indirect effect other than adverse effects due to climate change.

Environmental Factor	Alternative 1 (Structural Only)	Alternative 6 (Nonstructural Only)	Alternative 7, Recommended Plan (Combination of Alternatives 1 and 6)	Alternative 8 (No Action/ Future Without Project
Wildlife	Direct and indirect, temporary and permanent, minor adverse impacts on wildlife, from the permanent alteration of habitat and shorebird and migratory bird foraging and loafing area by the Long Key revetment footprint. Temporary indirect and direct adverse effects; disturbance during construction would cause wildlife to avoid the areas. Other expected adverse effects due to climate change.	Negligible temporary or permanent adverse impacts to wildlife species; land disturbance for this alternative would be limited to modification of the construction area in the immediate vicinity of existing buildings. Wildlife would likely avoid the area during construction. Other expected adverse effects due to climate change.	Direct and indirect, temporary and permanent, minor adverse impacts on wildlife, from the permanent alteration of habitat and shorebird and migratory bird foraging and loafing area by the Long Key revetment footprint. Temporary indirect and direct adverse effects; disturbance during construction would cause wildlife to avoid the areas. Other expected adverse effects due to climate change. Coordination under the Fish and Wildlife Coordination Act was completed.	No direct or indirect effect other than adverse effects due to climate change.

Environmental Factor	**Alternative 1 (Structural Only)**	**Alternative 6 (Nonstructural Only)**	**Alternative 7, Recommended Plan (Combination of Alternatives 1 and 6)**	**Alternative 8 (No Action/ Future Without Project**
Cultural Resources	No indirect and direct, temporary and permanent adverse effects to any National Register of Historic Places (NRHP)-eligible sites. No effect anticipated on archeological sites.	Moderate permanent adverse effects to any NRHP eligible buildings anticipated; these impacts would be primarily in the NRHP-listed Key West Historic District. Elevating any NRHP-eligible structure would be an adverse effect. These should be avoided if practicable. A Regional Programmatic Agreement has signed by all signatories and consulting parties, to address impacts and mitigation.	Moderate permanent adverse effects to any NRHP eligible buildings anticipated; these impacts would be primarily in the NRHP-listed Key West Historic District. Elevating any NRHP-eligible structure would be an adverse effect. No effect anticipated on archeological sites. A Regional Programmatic Agreement has been signed by all signatories and consulting parties, to address impacts and mitigation.	No direct or indirect effect, other than adverse effects due to climate change. Historic buildings would continue to be exposed to flood risk.

Environmental Factor	Alternative 1 (Structural Only)	Alternative 6 (Nonstructural Only)	Alternative 7, Recommended Plan (Combination of Alternatives 1 and 6)	Alternative 8 (No Action/ Future Without Project
Recreational Resources	Direct and indirect temporary and permanent impacts on recreation that are minor to moderate. Temporary, direct and indirect, adverse effects on use of sections of the Overseas Trail, the public pier at Fiesta Key, Long Key State Park campground roadway, and Indian Key Fill beach access area, during an approximately 4-5 month construction window. However, permanent, beneficial effect due to erosion management. Permanent adverse effect on approximately 1,500 linear feet of Long Key beach.	No direct or indirect permanent impacts on any known recreational facilities. Potentially negligible to minor, temporary adverse effect during construction.	Direct and indirect temporary and permanent impacts on recreation that are minor to moderate. Temporary, direct and indirect, adverse effects on use of sections of the Overseas Trail, the public pier at Fiesta Key, Long Key State Park campground roadway, and Indian Key Fill beach access area, during an approximately 4-5 month construction window. However, permanent, beneficial effect due to erosion management. Permanent adverse effect on approximately 1,500 linear feet of Long Key beach.	No direct or indirect effect, other than adverse effects due to climate change.

Environmental Factor	Alternative 1 (Structural Only)	Alternative 6 (Nonstructural Only)	Alternative 7, Recommended Plan (Combination of Alternatives 1 and 6)	Alternative 8 (No Action/ Future Without Project
Visual Resources	Direct temporary and permanent minor adverse effects.	Direct minor temporary and direct permanent adverse effects that are minor to moderate Building elevations will change appearances and viewshed, and the buildings would be more visible in the landscape.	Direct minor temporary and permanent adverse effects. Building elevations will change appearances and viewshed, and the buildings would be more visible in the landscape.	No direct or indirect effect.
Hazardous, Toxic, Radioactive Waste (HTRW)	No direct or indirect effect.	Negligible adverse permanent and minor adverse temporary impacts. Phase 1 Environmental Site Assessment needed for elevation of any affected structure constructed prior to 1978. If any such contaminants are found, lawful demolition, removal, and disposal of such wastes would be followed.	Negligible adverse permanent and minor adverse temporary impacts. Phase 1 Environmental Site Assessment needed for elevation of any affected structure constructed prior to 1978. If any such contaminants are found, lawful demolition, removal, and disposal of such wastes would be followed.	No direct or indirect effect.

Environmental Factor	Alternative 1 (Structural Only)	Alternative 6 (Nonstructural Only)	Alternative 7, Recommended Plan (Combination of Alternatives 1 and 6)	Alternative 8 (No Action/ Future Without Project
Safety	Permanent direct and indirect minor beneficial effects for safety, through the management measures designed to reduce erosional damage of U.S. Route 1, the only land evacuation route from the Keys. However, all other effects from climate change would still be expected.	Permanent direct and indirect minor beneficial effects. Relocation of residents from repetitive loss areas. Land use planning, flood warning systems, and emergency planning would also help residents prevent damage, and evacuate more effectively. However, all other effects from climate change would still be expected.	Permanent direct and indirect minor beneficial effects for safety, through the combined measures to reduce erosional damage of U.S. Route 1, relocation of residents from repetitive loss areas, better land use planning, flood warning systems, and emergency planning. However, all other effects from climate change would still be expected.	No direct or indirect effects. However, increased vulnerability coastal storm damage caused by climate change can lead to damaged evacuation route, stranded residents, and damaged buildings.
Utilities	Potential for minor temporary direct adverse effects. Potential for minor beneficial effects if the revetments protect utility corridors. Utility impacts would be thoroughly vetted and coordination would occur as the design process continues. Temporary, minor disruptions of service would be avoided.	Potential for minor temporary direct effects. Negligible permanent effects. Utility impacts would be thoroughly vetted and coordination would occur as the design process continues. Temporary, minor disruptions of service would be avoided.	Potential for minor permanent beneficial effects and temporary direct minor effects. Potential for minor beneficial effects if the revetments protect utility corridors. Utility impacts would be thoroughly vetted and coordination would occur as the design process continues. Temporary, minor disruptions of service would be avoided.	No direct or indirect effects. However, climate change would continue to pose a threat to utility infrastructure.

Environmental Factor	Alternative 1 (Structural Only)	Alternative 6 (Nonstructural Only)	Alternative 7, Recommended Plan (Combination of Alternatives 1 and 6)	Alternative 8 (No Action/ Future Without Project
Air Quality	Minor, temporary impacts during construction. No permanent effects.	Minor, temporary impacts during construction. No permanent effects.	Minor, temporary impacts during construction. No permanent effects.	No direct or indirect effect.
Noise	Minor, temporary impacts during construction. No permanent effects.	Minor, temporary impacts during construction. No permanent effects.	Minor, temporary impacts during construction. No permanent effects.	No direct or indirect effect.
Climate Change	Negligible adverse effect on climate change due to temporary greenhouse gas emissions. However, there would be permanent, minor beneficial effects for resiliency and adaptation to climate change.	Negligible adverse effect on climate change due to temporary greenhouse gas emissions. However, there would be permanent significant beneficial effects for resiliency and adaptation to climate change, Vulnerable residences, and governmental and critical infrastructure would be more resilient to coastal storm damage. Land use planning, flood warning systems, and emergency planning would also help residents prevent damage, and evacuate more effectively.	Negligible effect on climate change due to temporary greenhouse gas emissions. However, there would be permanent significant beneficial effects for resiliency and adaptation to climate change. Vulnerable residences, and governmental and critical infrastructure would be more resilient to coastal storm damage. Land use planning, flood warning systems, and emergency planning would also help residents prevent damage, and evacuate more effectively.	No direct or indirect impacts would occur. However, the cumulative effects of climate change would still occur. Significant, permanent adverse effects due to damages to buildings, roadways, and environments due to sea level rise and coastal storms would be expected to continue and increase.

8.1 LAND USE

8.1.1 Alternative 1: Structural Only Alternative (Revetments Only)

Land Use for this alternative consists of uses compatible with areas within 100 feet of the U.S. Route 1 highway corridor. These uses are transportation and recreation. Effects on those resources are mentioned below and discussed in greater detail in those sections of this chapter. This alternative affects four recreational facilities: the U.S. Route 1 Overseas Trail, Bahia Honda State Park, Long Key State Park, and a public pier at Fiesta Key. These land uses are mentioned below and covered in greater detail in the Recreation section of this chapter. There are no residential, commercial, or institutional land uses within the ROI for this alternative, so these land uses would not be affected.

Overseas Trail along West Summerland Key, Bahia Honda Key, Fiesta Key East, Fiesta Key West, and Indian Key Fill
The Overseas Trail is in close proximity to all of the proposed revetment locations, except for the one in Long Key State Park. The proposed revetments cannot permanently displace any sections of the trail, and therefore would have no direct, permanent adverse impact or conversion of land use of the Overseas Trail itself. However, sections of the trail may have to be closed or restricted during the construction window at these three locations, which is expected to take approximately four to five months at each location. Once construction is complete, the revetments would provide added permanent erosion management for the trails and the roadway itself.

West Summerland Key
The proposed revetment at this location would be placed largely in an area that is currently vegetated herbaceous wetlands. This effect is discussed in the Wetlands section of this chapter. This area, which is between an existing concrete floodwall and the Overseas Trail, does not appear to have an active land use.

Bahia Key State Park
The revetment along this segment is directly along the roadway shoulder and does not appear to be actively used.

Long Key State Park
The proposed revetment, to be approximately 1,500 linear feet, is planned on a very narrow vegetated beach, upslope of MHW and parallel to the Park's campground access road. Installing a permanent revetment at this location would have a temporary and permanent direct and indirect adverse effect on this park. Areas that are currently open for wading, swimming, walking, bird watching, and other passive uses would have more limited access with a permanent revetment structure in place. In addition, construction staging area stretches across the park access roadway to the campground, which would require its temporary closure for four to five months. This would be a direct, temporary moderate impact, and a direct, permanent moderate land use impact on Long Key State Park. A permit from the FDEP Division of Parks

and Recreation (DPR) would be required for the temporary and permanent revetment encroachment.

Public Pier at Fiesta Key East

Between mile markers 70 and 71, across U.S. Route 1 from the Fiesta Key East revetment, there is a long public pier. Once a bridge trestle for U.S. Route 1, it now parallels U.S. Route 1 to the north. The pier is used mostly for fishing, but also sightseeing, photography, bird watching, walking, and other passive uses. There is a large public parking area adjacent to it, and this area would be used for construction staging. There would be no indirect or direct permanent impact on recreation here because the area where the revetment itself will be placed is not used for recreation. However, construction would require the temporary closure of the pier for approximately four to five months. There is no other such pier nearby for use as an alternative; therefore, this would have a direct, temporary minor to moderate effect on recreational land use.

Indian Key Fill

This location, while not a "facility," is owned by both DPR and FDOT and currently used by the public for recreation. This alternative would have a direct and indirect, minor temporary impact on recreational land use during construction. However, the embankment on which the revetment will be constructed is not conducive to recreational use, so the revetment would have no direct or indirect permanent adverse effect on land use.

In order to construct the revetments on DPR or FDOT land, Monroe County must go through authorization processes. For DPR, including both parkland and Overseas Trail easement, there is an application process in which the applicant must submit a completed questionnaire that includes an accurate aerial map of the proposed easement area(s) and a sketch and legal description of the easement area(s), to the park managers' and district offices for review and DPR comment; and upon receipt of all comments, DRP's managing agency review letter will be provided. After that, the applicants submit a completed easement application, including the DPR letter, to the Division of State Lands/DSL, which has the responsibility of reviewing and issuing easements. For acquisition of an easement from FDOT, the County must first receive a formal written request from a department head or director. Any request to surplus property or convey property rights has to be routed to the different units within FDOT for comment. Once comments are given, the request is presented to the Right of Way Department Manager and the Transportation Director, who would make the final determination whether to grant the request or not. FDOT would also need an adopted resolution stating the public purpose need of the request prior to executing the easement.

Overall, Alternative 1 would have direct and indirect, temporary and permanent adverse effects on land use that are minor to moderate.

8.1.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Alternative 6 involves construction on existing upland structures and construction access and staging. Construction staging areas would be directly co-located with the affected structures.

Elevation and Floodproofing
Approximately,4,698 residences would be eligible for elevation or raising of their homes. It is currently unknown how many of the homes are structurally sound enough for an elevation. Elevation of structures would apply only to residences, and floodproofing would be done for critical infrastructure and some government facilities. The nonstructural measures are voluntary; therefore, any owner may opt out, but tenants would be subject and affected by to the landlord's decision. Floodproofing treatments would be done for approximately -1,093 commercial, governmental, and for an additional 53 critical infrastructure facilities. In these locations, the land use would not change. However, there would be a direct, permanent significant, beneficial effect on land use, because those residences and facilities would be more coastal resilient. The Proposed Action should result in fewer coastal storm damages to structures.

The nonstructural measures would require the temporary relocation of residents during elevation construction, which would be a significant, temporary adverse effect, due to the relative scarcity of housing. Construction would have to be phased such that there is adequate temporary housing available for each phase, in order to reduce the impact on residents and land use. Temporary, indirect and direct adverse effects would result from construction noise and presence and use of heavy equipment in residential and commercial land use areas. It is anticipated that, if possible, the nonstructural measures for whole blocks or streets of residences could be closed off and conducted simultaneously, so that construction windows in within neighborhoods can be minimized.

8.1.3 Alternative 7: Nonstructural and Structural Alternative, Combined (Recommended Plan)

The effects of this alternative would be a combination of those described above under Alternatives 1 and 6. The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. Overall, this alternative would have direct, significant, permanent beneficial effects on land use. These effects include both adverse and beneficial effects. There would be temporary, significant, indirect and direct adverse effects due to requirement for temporary relocation of residents, and effects from construction noise and presence and use of heavy equipment in residential and commercial land use areas.

8.1.4 Alternative 8: No Action and Future Without Project

The No Action Alternative and Future Without Project would involve no additional action from current or planned future actions to mitigate against coastal storm risk. No direct effects on land use would occur from the Proposed Action; however, there is the potential for greater coastal storm damage to U.S. Route 1 and buildings within existing development centers without Proposed Action.

8.1.5 Best Management Practices to Avoid and Minimize Impacts on Land Use for Alternative 7

1) Coordination with all affected residents and businesses will be conducted by the County and USACE.
2) All laws and regulations pertaining to relocation and compensation would be adhered to.
3) Construction would have to be phased such that there is adequate temporary housing available for each phase, in order to reduce the impact on residents and land use.
4) If possible, construction would be phased to include simultaneous construction within blocks or neighborhoods, so that the construction window might be minimized.
5) For public safety, the shoreline areas that are under construction and their staging areas will be closed to the public.
6) Staging areas will be the minimum necessary to construct the project, and construction will be completed as soon as practicable.
7) Further coordination will be conducted with DPR in the PED phase, to avoid and minimize conflicts with the park and Overseas Trail operations. All required permits would be obtained.
8) The timing of the work will be coordinated with the County and FDOT to avoid and minimize conflicts with planned or ongoing County projects.

8.2 SOCIOECONOMICS

8.2.1 Alternative 1: Structural Only Alternative (Revetments Only)

Alternative 1 would improve socioeconomic resilience, the ability of the population to resume commerce after a coastal storm, by helping to keep U.S. Route 1 passable after a storm. This would be a permanent, moderate benefit, as U.S. Route 1 is the backbone of land transport in the Florida Keys. Construction of the revetments would temporarily support jobs locally, or bring workers into the Florida Keys, resulting in a negligible to minor economic benefit. Construction access and operations may be somewhat disruptive to residences and businesses, but should have a negligible to minor temporary adverse effect on the overall socioeconomics within the Florida Keys.

8.2.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Alternative 6 involves construction on existing upland structures, and construction access and staging. Construction staging areas would be directly co-located with the affected structures.

Elevation and Floodproofing
Approximately 4,698 residences located throughout the Keys would be eligible for elevation or raising of homes. Elevation of structures would apply only to residences, would be voluntary for property owners, and would have a beneficial effect on socioeconomics in the form of less

damage from coastal flood risk damage. However, structural elevations may cause daily inconvenience to all, and special hardships to the elderly and handicapped. Floodproofing treatments would be done for approximately 1,052 for applicable governmental, commercial, and multi-unit housing facilities. An additional 53 critical infrastructure facilities would also be floodproofed.

For elevation, temporary relocation and/or restriction of use by residents and businesses would be necessary during construction. Because elevations and floodproofing are voluntary, property owners would not receive temporary relocation aid; however tenants occupying affected residences would be eligible for the aid under the Uniform Relocation Assistance Act (URA), as described in the Real Estate Plan Appendix, Appendix F. Temporary relocations are anticipated to be difficult and expensive, due to the number of temporary relocations and the scarcity of housing noted by Monroe County, within the Florida Keys, including its incorporated cities. Time spent moving also would cause some, including some low-income households, to miss days of work and income. Temporary relocation during construction also could present special hardships to the elderly, handicapped, minority, or low-income people, for whom moving may be more burdensome, and relocation options may be more limited. Also restricted use of individual residences and businesses during construction would be an adverse social impact. Therefore, temporary displacement during construction could be a temporary significant adverse effect. The assistance provided pursuant to the URA would help offset these impacts. In addition, construction would need to be phased and timed to ensure that adequate lodging is available, and neighborhoods done simultaneously, if possible.

Compliance with Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations is discussed further in Section 9.21. Otherwise, there would be significant beneficial permanent effects for elevated and floodproofed structures, in the form of improved coastal storm resilience. The Proposed Action would result in fewer coastal storm damages to structures and an overall improvement of socioeconomic resilience, through the ability of the population to resume normal life after a coastal storm, by keeping infrastructure functional for longer. This would be a significant benefit as critical infrastructure includes utilities, emergency services, and other essential elements of daily life.

Temporary, indirect and direct adverse effects would result from construction noise and presence and use of heavy equipment in residential and commercial structures. A beneficial temporary socioeconomic effect would be that additional construction work would support jobs locally, or bring workers into the Florida Keys, resulting in a negligible to minor economic benefit.

8.2.3 Alternative 7: Nonstructural and Structural Alternative, Combined (Recommended Plan)

The effects of this alternative would be a combination of those described above under Alternatives 1 and 6. The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. Overall, this alternative would have direct, significant, permanent beneficial and significant temporary adverse effects on socioeconomics.

For elevation, temporary relocation of residents and businesses would be necessary during construction. Temporary relocation could cause individuals to have to miss days of work during the process, which could adversely affect their families' income. Temporary relocation during construction also could present special hardships to the elderly, handicapped, minority, or low-income people, for whom moving may be more burdensome, and relocation options may be more limited. Because elevation and floodproofing are voluntary, property owners would not receive relocation aid; however tenants occupying affected residents would be eligible for the aid under the URA, as described in the Real Estate Plan Appendix, Appendix F. Temporary, indirect and direct adverse effects would result from construction noise and presence and use of heavy equipment in residential and commercial structures and at the revetment locations.

8.2.4 Alternative 8: No Action and Future Without Project

The No Action Alternative would involve no additional action from current or planned future actions to mitigate against coastal storm risk. No structures would be modified. There would be no direct effect, but indirectly, there would be a moderate adverse effect. Risk to people, property, and the economy of the Florida Keys would continue to increase as climate change is expected to result in more frequent and powerful Atlantic hurricanes, and sea level rise will likely increase the frequency of damaging floods.

8.2.5 Best Management Practices to Avoid and Minimize Impacts on Socioeconomics for Alternative 7

1) Strict adherence to the URA.
2) Minimize adverse effects on socioeconomics through regular communication and coordination with affected residents.
3) Attempt to accommodate the citizens of the Florida Keys, particularly the elderly, disabled, minority, and low-income residents, to the extent reasonable and practicable and in accordance with law and regulation.
4) Phase construction of the nonstructural measures to ensure that adequate temporary housing is available.
5) Phase construction by neighborhood to minimize the construction window and inconvenience for each neighborhood.

8.3 TRANSPORTATION

8.3.1 Alternative 1: Structural Only Alternative (Revetments Only)

For this alternative, the identified locations along U.S. Route 1 that have less than 100 feet of land between the road footprint and the shoreline and are not already being stabilized by others and need long-term stabilization, will be stabilized with revetments. Revetments would be placed landward of mean high water but would armor roadway embankments and help break up wave energy during storm events to protect roadways against erosion. If revetments can help prevent roadway damage or a washout at even one location, that would be a minor to moderate transportation benefit, as U.S. Route 1 is the only land ingress and egress to and from the Florida Keys.

Due to the proximity of the revetments to U.S. Route 1, it is possible that temporary lane closures or restrictions on U.S. Route 1 may necessary during the four to five-month construction window at each revetment location. Also, heavy equipment will need to enter and exit U.S. Route 1 to travel to and from staging and equipment storage areas. These effects could cause direct and indirect minor, temporary adverse effects due to travel delays. However, the project schedule would need to take into consideration seasonal traffic patterns and actions to avoid conflicts with hurricane evacuations. If these and all safety regulations are followed during construction, there would be negligible adverse effects on transportation safety for construction workers and the public.

There would be permanent direct and indirect beneficial effects for transportation, that are minor to moderate, through the risk management measures applied to vulnerable sections of U.S. Route 1 from erosional damage due to coastal storms and SLR. This is crucial, as U.S. Route 1 is both the only transportation network connecting all of the inhabited Florida Keys and the only land evacuation route from the Keys.

8.3.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Alternative 6 involves temporary construction on existing structures and construction access. Staging areas would not directly affect roadways, however, heavy equipment entering and exiting the transportation network could cause temporary, indirect negligible to minor travel delays. During construction, if all safety regulations are followed, there would be negligible temporary adverse effects on transportation safety.

Flood warning systems and emergency planning would also help residents make preparations to prevent damage, and/or evacuate more effectively, orderly, and safely, reducing direct impacts on the traveling public. There would be permanent, minor to moderate beneficial effects, because flood warning systems and emergency planning would help residents evacuate more effectively, orderly, and safely, reducing direct impacts on the traveling public. Land use planning also would reduce temporary and permanent adverse transportation impacts by reducing the future number of residents needing to evacuate on the transportation network prior to and during storm events.

8.3.3 Alternative 7: Nonstructural and Structural Alternative, Combined (Recommended Plan)

The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. Overall, there would be indirect and direct temporary adverse effects that are minor to moderate. There would be indirect and direct, minor to moderate permanent beneficial effects on U.S. Route 1 and the travelling public.

8.3.4 Alternative 8: No Action and Future Without Project

The No Action Alternative and Future Without Project would mean not implementing an alternative. No temporary or permanent impacts to safety would occur, due to any alternative. However, the Keys are located in a low-lying region, which makes them vulnerable to increased frequency of unsafe flooding conditions and damage. The six proposed revetment locations likely would not receive protection and would therefore be more vulnerable to washouts, which are likely to occur on a more frequent basis due to climate change and sea level rise. This can lead to various potentially dangerous conditions such as flooded or damaged evacuation route, and stranded motorists. Therefore, this alternative would result in indirect and direct, temporary and permanent, adverse effects that are minor to moderate.

8.3.5 Best Management Practices to Avoid and Minimize Impacts on Transportation for Alternative 7

1) Prior to construction, a transportation plan would be developed by USACE and approved by FDOT and the County for any temporary impacts on traffic.
2) Prior to construction, schedules would be coordinated with FDOT and the County to prevent conflicts with other construction schedules affecting the transportation network.
3) Construction workers would be required to follow the Occupational Safety and Health Act (OSHA) regulations.
4) Public access would be prohibited in construction zones.

8.4 NAVIGATION

8.4.1 Alternative 1: Structural Only Alternative (Revetments Only)

For this alternative, there would be no temporary or permanent in-water impacts. Therefore, there would be no permanent adverse impacts on navigation.

Construction access and staging would occur from the land side rather than from the water. Construction will require staging of heavy equipment in areas near the water, for approximately four to five months near each revetment location. During construction, these areas would be closed to the public for safety reasons. There are no public boating launches, aids to navigation, or buoys located in the near vicinity of any of the proposed revetments or staging areas; however, there are nearshore areas where navigation access for small craft such as canoes or kayaks could occur, and it is possible that some people may access the water directly off the shorelines. For this reason, temporary adverse effects on navigation would be negligible to minor. Recreational effects are discussed more in the Recreation Resources section of this chapter.

8.4.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Alternative 6 involves only construction on existing upland structures, demolition of structures to be acquired, and construction access and staging for both. Construction staging areas would be directly co-located with the affected structures. There would be no in-water effects, and no temporary or permanent adverse effects on navigation would occur.

8.4.3 Alternative 7: Nonstructural and Structural Alternative, Combined (Recommended Plan)

The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. There would be no permanent adverse effects, and negligible to minor temporary adverse effects on navigation.

8.4.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would involve no additional action from current or planned future actions to mitigate against coastal storm risk. No effects on navigation would occur.

8.4.5 Best Management Practices to Avoid and Minimize Impacts on Navigation for Alternative 7

For navigational safety, the shoreline areas that are under construction and their staging areas will be closed to the public.

8.5 GEOLOGY, TOPOGRAPHY, AND SOILS

8.5.1 Alternative 1: Structural Only Alternative (Revetments Only)

For this alternative, embankments would be graded and filled with core stone and covered with rock, to produce to a more stable slope. Soils would be permanently altered and covered by the new revetments. There also would be temporary minor adverse effects to soils during construction; in and surrounding the project footprint, and in the temporary staging areas. A strict erosion and sediment control plan would reduce those impacts.

Although the soil and topography would permanently be altered for the revetments, there would be permanent beneficial effects on soils and topography, because all disturbed areas would be reshaped if necessary for stabilization, and the revetment areas would be more stable and erosion would be greatly reduced. There would be minor effects on the geology within the ROI.

8.5.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Alternative 6 involves construction on existing structures and temporary construction access for both. This would require the temporary use of heavy equipment, trucks, building materials such as lumber, and jacks. There would be minor adverse effects to soils during construction; a strict erosion and sediment control plan would reduce those impacts. There could be permanent beneficial effects on soils; following construction, these areas would be reshaped if necessary for drainage and stabilization and seeded. There would be negligible effects on the geology within the ROI.

8.5.3 Alternative 7: Nonstructural and Structural Alternative, Combined (Recommended Plan)

The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. Overall, temporary minor adverse impacts and beneficial permanent effects would be expected for topography and soils, and negligible impacts on geology.

8.5.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would involve no additional action from current or planned future actions to mitigate against coastal storm risk. No temporary or permanent impacts to topography, soils, or geology would occur. However, bank erosion would continue to occur and may increase in the future.

8.5.5 Best Management Practices to Avoid and Minimize Impacts on Geology, Topography, and Soils for Alternative 7

1) Strict erosion and sediment control measures should be employed during construction, in accordance with the State of Florida's Erosion and Sediment Control Designer and Reviewer Manual, July 2013 (or most current version).

2) Following construction, disturbed areas would be seeded, vegetated, and stabilized in accordance with state requirements.

8.6 HYDROLOGY, HYDRAULICS (H&H) AND BATHYMETRY

8.6.1 Alternative 1: Structural Only Alternative (Revetments Only)

As described in the Affected Environment, the watershed within the ROI contains benthic habitats that include beaches, sandflats and mudlflats, hardbottom, corals, seagrass beds; and red mangrove habitat. Like most shorelines, these areas regularly experience erosive forces. Originally, the proposed revetments would have directly and adversely impacted sandflats, mudflats, hardbottom, and red mangroves. However, upon further consideration of the existing site conditions and proposed stabilization to be constructed by others, it was determined that it is practicable to construct the revetment footprints upslope of mean high water (MHW) for all revetments, including upslope of the existing mangrove wetlands at Fiesta Key East and West, and Indian Fill Key. Embankments would be graded as needed, filled with core stone, and covered with rock, to produce to a more stable slope. Soils would be permanently covered by the new revetments. Strict erosion and sediment control measures will be adhered to during construction. None of the six revetments would have temporary or permanent direct adverse effects on bathymetry. Although revetments are effective means of stabilizing shorelines, sometimes revetments placed nearshore and/or seaward of MHW can indirectly contribute to minor erosion in adjacent areas by deflecting wave energy.

The proposed revetment footprint at Bahia Honda Key would be placed in a grassed roadside that includes a treeline. However, a revetment along a roadway embankment would be expected to have a negligible to minor permanent adverse effect on erosive, hydrodynamics along the beach.

The revetment at Long Key State Park will be placed adjacent to the MHW line, on a sand-based beach substrate that also contains upland herbaceous beach vegetation. While revetments along shorelines protect them from erosion, they can also deflect wave energy to other shorelines in the vicinity. For this reason, the revetment at Long Key State Park could have indirect temporary and permanent minor adverse effects on H & H. However, if it is determined during the Operations and Maintenance (O & M) phase that any of the revetments have indirectly and unexpectedly induced flanking along the banks, appropriate actions would be determined and taken to address these areas.

8.6.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Because there are no in-water or nearshore impacts associated with this alternative, this alternative will have no effect on H & H, or bathymetry.

8.6.3 Alternative 7: Nonstructural and Structural Alternative, Combined (Recommended Plan)

The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. This alternative would have no direct or indirect adverse effect on bathymetry, but could have indirect temporary and permanent minor adverse effects on H & H, due to wave energy deflection of the revetment near the beach. It would have a negligible effect on groundwater.

8.6.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would not implement a build alternative to mitigate against coastal storm risk. For this alternative, the areas not protected would continue to experience SLR, coastal storms, and higher tides, which could result in minor adverse effects on H&H due to continuing erosion of the banks, shorelines, and beaches.

8.6.5 Best Management Practices to Avoid and Minimize Impacts on H & H and bathymetry for Alternative 7

1) Strict erosion and sediment control measures will be adhered to during construction, in accordance with the State of Florida's Erosion and Sediment Control Designer and Reviewer Manual, July 2013 (or most current version).
2) All required state and local permits pertaining to the CCCL program would be obtained, and the conditions would be adhered to.
3) Following construction, disturbed areas would be seeded, vegetated, and stabilized in accordance with state requirements.

8.7 SURFACE WATERS, GROUNDWATER, AND WATER QUALITY

8.7.1 Alternative 1: Structural Only Alternative (Revetments Only)

All revetments have been relocated upslope of the mean high water (MHW) line. Only the revetment at West Summerland Key will entail wetland impacts behind a sea wall, landward of the MHW line. A Section 401 Clean Water Act permit and mitigation will be required for those impacts. However, it should be noted that wetlands are covered in Section 8.10.

Other than these wetlands, no surface waters will be directly or permanently impacted by this alternative. Because these impacts would be landward of MHW, no permit from the FKNMS would be required.

Implementation of Alternative 1 also would require temporary construction access. Access would be expected to be from existing roads and staging areas; no access from the water is expected to occur. Some grading would be required to install the riprap. During construction, as well as for any subsequent periodic maintenance and repairs, strict erosion and sediment control measures would be employed to prevent sedimentation and turbidity in adjacent waterways.

Negligible to minor indirect permanent adverse effects due to minor wetland impact, and negligible temporary adverse effects to surface waters, groundwater, or water quality would occur as a result of this alternative.

8.7.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

No direct surface water, groundwater, or water quality impacts would occur as a result of implementation of Alternative 6, because land disturbance for this alternative would be limited to modification of existing buildings.
Implementation of Alternative 6 would require construction access to all structures to be treated; this would be expected to be from existing roads. Similarly, localized maintenance, as repairs will be needed over time.

No direct or indirect permanent adverse effects to surface waters, groundwater, or water quality would occur as a result of this alternative. Appropriate erosion and sediment control measures would be utilized during construction.

8.7.3 Alternative 7: Nonstructural and Structural Alternative, Combined (Recommended Plan)

The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. As the recommended plan, it was coordinated with the FDEP, and FDEP responded on August 25, 2020, that it had no objections to the project at this stage.

Negligible to minor indirect permanent adverse effects due to minor wetland impact, and negligible temporary adverse effects to surface waters, groundwater, or water quality would occur as a result of this alternative. Appropriate erosion and sediment control measures would be utilized during construction.

8.7.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would involve no additional action from current or planned future actions to mitigate against coastal storm risk. No temporary or permanent water quality impacts would occur. However, climate change would continue to cause sea level rise, increased erosion and associated sedimentation, warmer waters, ocean acidification, etc.

8.7.5 Best Management Practices to Avoid and Minimize Impacts on Water Quality for Alternative 7

1) Strict erosion and sediment control measures should be employed during construction. Following construction, disturbed areas would be seeded, vegetated, and stabilized in accordance with the State of Florida’s Erosion and Sediment Control Designer and Reviewer Manual, July 2013 (or most current version).
2) USACE will apply for the appropriate permits under CWA 401 and 402 during the PED phase when more details on the project design are available. All permit conditions will be followed.
3) Proactive stormwater management via increased engineering (silt fences, etc.) and administrative controls (site stormwater inspections, permitting, BMPs) would provide additional assurance that potential impacts (runoff, contaminant transport, sedimentation, etc.) to the marine environment from land-disturbing activities would be minimized.

8.8 FLOOD PLAINS

8.8.1 Alternative 1: Structural Only Alternative (Revetments Only)

As a major transportation route for the community, the revetments along U.S. Route 1 are expected to provide minor beneficial and permanent effects with regards to daily travel and hurricane evacuation, unless the measures fail or the design flood level is exceeded. As the main road out of the Florida Keys, it is important to have a reliable evacuation route to get people out of area in advance of a storm event. Road closures during construction could disrupt travel plans for citizens or emergency personnel, which could be negligible to moderate, adverse temporary impacts.

Impacts to the environment and flood plain areas, including wetlands, upland areas, natural drainage features, utilities, existing structures, etc. will generally be within the footprint of the project. Recognizing the value of existing wetlands, the revetment footprints were shifted upslope. Avoidance and minimization efforts are expected to result in wetland impacts only at West Summerland Key, which would be result in minor, adverse permanent impacts to wetlands that would be mitigated. Impacts to natural drainage and utilities will be negligible to minor, adverse temporary impacts and accounted for during design and construction.
None of the structural measures would be within the Coastal Resource Barrier Act (CRBA) designated unit maps.

8.8.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Because no new structures or impoundments will be constructed in flood plains, there would be minimal adverse effect on them. Use of non-structural flood risk management measures for critical infrastructure, dry and wet flood proofing, could provide minor beneficial, permanent, and beneficial effects on flood plains, unless the measures fail or the design flood level is exceeded. Protecting critical infrastructure will help communities be more resilient and sustainable after a flood event occurs. However, if the mitigation measures fail or the flood level exceeds the design, although temporary, the impacts could be adverse and major for a community to recover after a flood event, especially if there are back-to-back flood events. The flooding of critical infrastructure could cause damage to structures in the flood plain, and its contents and depending the type of facility, could cause harm to the environment. Although temporary, the level of flooding could cause the impacts to range from negligible to major to any structures in the flood plain. Regarding life-safety issues, if non-structural measures are used, people should not be in a critical facility during a flood event, just in case it does become flooded. Before a flood event, items should be elevated or relocated to avoid possible flood damage. The following non-structural measures are being used for residential or commercial structures:

Elevation – elevation is only applied to residential structures. FEMA recognizes elevation as a way to reduce flood insurance premiums. If a structure is located within the FEMA one percent annual chance flood plain, in general, the higher the lowest rated floor is above the one percent annual chance flood elevation, the less expensive the flood insurance will be.

Dry Floodproofing – dry floodproofing applies only to commercial, governmental, or critical infrastructure facilities. FEMA only recognizes floodproofing of commercial structures to reduce flood insurance premiums, but not for residential structures. A floodproofed building has been designed and constructed to be watertight, substantially impermeable to floodwaters, up to a recommended depth of three feet for conventional built structures. Closure panels are used at openings and a sump pump and drain system installed. To receive an insurance rating based on the one percent annual chance flood, the building must be flood proofed to an elevation at least one foot above the one percent annual chance flood. Insurance premiums will be lower if floodproofing exceeds this requirement.

Nonstructural measures will help keep neighborhoods and communities sustainable and resilient after a flood, where a structure could possibly stay flood-free during its design life Elevating or wet-proofing existing structures in the flood plain could allow a minimal increase in hydrologic access to the flood plains. However, if the mitigation measure fails or the flood level exceeds the design, although temporary, the impacts could be adverse and major for a community, family, or business to get back to normal after a flood event, especially if there are back-to-back flood events. The flooding could cause damage to the structure and its contents and depending on the type of facility, could cause harm to the environment. Although temporary, the level of flooding could cause the impacts to range from negligible to major to any structures in the flood plain. With nonstructural measures, Monroe County should inform citizens on the need to evacuate in the event of a flood, to protect themselves and not to put first responders in danger as well, which should be addressed in the USACE required Flood Plain Management Plan.

If an existing structure does not meet FEMA's regulations, in general with respect to the building's finished floor elevation and the effective one percent annual chance flood elevation, and has been substantially improved, as may apply with a nonstructural measure such as elevation, then the structure will need to be brought into compliance with FEMA and Monroe County's flood plain regulations. A Substantially Improved Building is a building that has undergone reconstruction, rehabilitation, addition, or other improvement, the cost of which equals or exceeds 50 percent of the market value of the building before the "start of construction" of the improvement. This term does not include a building that has undergone reconstruction, rehabilitation, addition, or other improvement related to:

1. Any project or improvement of a building to correct existing violations of a State or local health, sanitary, or safety code specifications that have been identified by the local code enforcement official and which are the minimum necessary to assure safe living conditions; or

2. Any alteration of a "historic building," provided that the alteration will not preclude the structure's continued designation as a "historic building."

Designated historical structures can use any type of non-structural measure to reduce flood damage, as long as it maintains its historical status, including being exempt from FEMA's

Substantial Improvement regulations. However, the structure is still rated for flood insurance according to its lowest rated floor elevation. If the structure loses its historical status, then it will have to comply with FEMA and Monroe County's flood plain regulations.

One nonstructural measure is proposed for a water treatment facility within the CRBA unit map; however, it would meet an exemption from the act, for existing infrastructure that is a critical part of a network or system.

While there would be significant and beneficial short-term and long-term effects due to protection of structures in the floodplain, there would be minor beneficial effects on flood plains themselves. Nonstructural projects are small in scale such that any adverse impacts due to construction would be localized to each structure and will be temporary and negligible to minor. Erosion and sediment control measures should be implemented during construction activities, in accordance with the State of Florida's Erosion and Sediment Control Designer and Reviewer Manual, July 2013, (or most recent version).

8.8.3 Alternative 7: Nonstructural and Structural Alternative, Combined (Recommended Plan)

The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. There could be minor short-term and long-term beneficial effects on the floodplain itself. However, as discussed earlier under land use and socioeconomics, effects on dwellings, businesses, governmental buildings and critical infrastructure located in existing the flood plains would be significant and beneficial. Overall, any adverse impacts due to construction would be localized to each structure and will be temporary and negligible to minor. Adverse impacts to natural drainage and utilities also will be negligible to minor, and temporary.

8.8.4 Alternative 8: No Action and Future Without Project

Alternative 8, the No Action and Future Without Project Alternative, would involve no action from USACE to mitigate against coastal storm risk. Monroe County would continue addressing current flooding issues and those in the future. Flooding is a temporary condition, where the impacts on structures in the flood plain are generally adverse, from negligible to major, depending on the level flooding. From previous storm events, the community has experience in dealing with nuisance type flooding to more severe flooding. With ongoing and continued relative sea level rise and possible climate change, where there may be an increase in storm frequency, storm surge flooding, and rainfall, the communities will need to continue flood mitigation activities in order to protect people, property, and the environment. Although many of the communities participate in FEMA's Community Rating System, with the number of structures located in the flood plain and mitigation projects currently identified in their Local Mitigation Strategy, and competition for available limited funding, it will continue to be a struggle to fund and complete many of the projects. There would be no direct effect, however there would be permanent moderate adverse effects over time on existing and any future structures in the flood plain, because structures in floodplains would continue to suffer storm damage and more frequent flooding due to sea level rise and climate change.

8.8.5 Best Management Practices to Avoid and Minimize Impacts on Flood Plains for Alternative 7

Specific examples of best management practices to avoid and minimize impacts on flood plains include:

1) Community officials should have a continuous outreach and education plan in place for citizens to understand the types of flooding, flood mitigation activities, design limitations, impacts, and their role if given instructions from local officials. Citizens come and go and people forget about past flood events or are not aware of the possible flooding.
2) Considering how vulnerable Monroe County is to flooding, community officials should encourage flood insurance, even if it is not required. Federal flood insurance is based on the one percent annual chance flood, but floods greater have and will occur in the future.

8.9 BEACHES AND TERRESTRIAL HABITAT

8.9.1 Alternative 1: Structural Only Alternative (Revetments Only)

With the exception of Long Key, the six proposed locations for the revetments currently provide limited beach or terrestrial habitat.

West Summerland Key
This revetment site includes approximately 10,250 square feet of wetland impacts; this is discussed in the Wetland section of this chapter. Some of the vegetation to be cleared is dead but standing mangroves. Approximately 0.82 acres of sparsely vegetated upland would be temporarily used as a staging area, and approximately 0.35 acres of that would be permanently converted to a wetland compensation site.

Bahia Honda
In order to avoid beach impacts, the Bahia Honda Key revetment was originally planned along the beach, but was shifted upslope to a grassed and treeline area between the Park fence line and U.S. Route 1 and the Overseas Trail. Its staging area will be located on uplands elsewhere, away from the beach. A thin treeline along the road will be the only permanently affected vegetation community.

Long Key
The Long Key revetment location is along the beach. An estimated 15,000 square feet of land will be permanently modified for the installation of the revetment, and much of this area is vegetated with herbaceous and scrubby shoreline species. The wrackline debris would also be permanently displaced; it would fall along the revetment rather than along a beach, making it less useable for foraging or loafing habitat. There will be approximately 1.25 acre of temporary impacts for staging and construction access that would be restored following construction.

Pursuant to Section 161.053 Florida Statutes (F.S.), CCCL is defined as the demarcation on the beach and dune system subject to severe fluctuations based on a 100-year storm event. It establishes the landward limit of jurisdiction of the FDEP along sandy beaches of the State along the Gulf of Mexico, the Atlantic Ocean, and the Straits of Florida. On sandy beach areas where no CCCL, has been established, such as the Florida Keys, coastal construction is prohibited within 50 feet of the line of MHW unless authorized by waiver or variance of the setback requirements pursuant to Section 161.052, F.S. The statute states that unless expressly authorized by the permit, native coastal vegetation destroyed during construction should be replaced.

DPR expressed concerns about the beach impacts in their comments to USACE. This is more fully discussed in the Recreation section of this chapter, but specifically, DPR indicated that it prefers no hard structures in the Long Key State Park, and that a planting plan is being developed for this area. However, if agreeable to the Park, its planting plan could be supplemented with a USACE upland dune vegetation mitigation plan to replace the impacted dune vegetation. This also is discussed more in the Environmental Mitigation Plan, in the Environmental Appendix.

This alternative would result in indirect and direct, temporary and permanent, adverse impacts on the beach and its vegetation that are minor to moderate. Similarly, localized maintenance and repairs will be needed over time, and would also involve temporary construction impacts. Also, suitable beach foraging areas will remain outside of the revetment footprint and area to be affected by construction noise and disturbance. USACE would follow best management practices. In addition, continued beach erosion and sea level rise throughout the Keys would be expected to occur.

Fiesta Key East and Indian Key Fill
The proposed revetment is located on an eroded or grassed roadside and trail side slopes, and therefore, lack a vegetative community.

Fiesta Key West
The proposed revetment also immediately adjacent to the road and trail, and is in very close proximity to mangrove and buttonwood mixed wetlands immediately downslope. However, the revetment will be built upslope of those wetlands and therefore, they will not be permanently impacted.

8.9.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Negligible permanent and negligible to minor temporary adverse impacts to beaches and/or terrestrial vegetation are expected to result from implementation of Alternative 6, because land disturbance for this alternative would be limited to modification of existing buildings and land disturbance int their immediate vicinity.

Implementation of Alternative 6 would require construction access to all structures to be treated; this would be expected to be from existing roads. Similarly, localized maintenance, as repairs will be needed over time. In addition, continued beach erosion and sea level rise throughout the Keys would be expected to occur.

8.9.3 Alternative 7: Nonstructural and Structural Alternative, Combined (Recommended Plan)

The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. Overall, this alternative would result in indirect and direct, temporary and permanent, adverse impacts on the beach and its vegetation that are minor to moderate. The effects would be minimized through a replanting plan and the other Best Management Practices described in Section 8.10.5.

8.9.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would involve no additional action to mitigate against coastal storm risk. No temporary or permanent impacts to beaches and terrestrial vegetation would occur. However, continued beach erosion and sea level rise would be expected to occur.

8.9.5 Best Management Practices to Avoid and Minimize Impacts on Beaches and Upland Vegetation for Alternative 7

1) Buffers of at least 10 meters (approximately 30 feet) should be maintained around sensitive plants, per Jacksonville District standard BMPs.
2) Strict erosion and sediment control measures should be employed during construction, in accordance with the State of Florida's Erosion and Sediment Control Designer and Reviewer Manual, July 2013 (or most current version).
3) Planting native vegetative seed mixes on disturbed land after construction is complete.
4) Vegetated dune impacts would be replanted at a 1:1 ratio, in the vicinity of the impacts, and would be coordinated with Long Key State Park to complement its proposed planting plan.
5) The following standard BMPs to prevent the spread of invasive species will be followed:
    a. Prior to the commencement of work, an invasive species prevention plan will be developed. It shall identify specific transfer prevention procedures and equipment cleaning sites.
    b. Sightings of any invasive species shall be included in a preconstruction report. Any subsequent sighting of invasive species shall be reported within 24 hours of siting. The reporting shall include date, time, location (latitude and longitude), photographs, environmental conditions, circumstances surrounding sighting disposition/behavior of the species, and any other notable observations. Reports shall be provided to the Jacksonville District Planning Division, Environmental Branch.

c. All equipment would be thoroughly cleaned prior to and following work on the project site to ensure that materials including soil, vegetative matter, eggs, seeds, and other debris are not transported to other sites.
d. Prevention protocols will also apply to clothing and personal protective equipment.

8.10 WETLANDS

8.10.1 Alternative 1: Structural Only Alternative (Revetments Only)

As described in the Affected Environment, the ROI contains many areas of mangrove and mixed mangrove and buttonwood wetland communities, as well as patches of herbaceous wetlands dominated by sea purslane and sea oxeye further upslope.

Originally, the proposed revetments combined would have impacted over an acre of wetland communities. Mangrove and/or buttonwood wetlands are present in the vicinity of the revetments at the West Summerland Key, Fiesta Key West, Fiesta Key East, and Indian Key Fill. However, recognizing the value of these wetlands, the revetment footprints were shifted upslope. Avoidance and minimization efforts are expected to result in wetland impacts at only one of the revetment locations.

It should be noted that at this early stage, a jurisdictional determination (JD) to identify waters of the U.S., including wetlands, has not been conducted. Instead, wetlands were spot-checked in the field. Aerial maps and National Wetland Inventory (NWI) maps were also checked to determine an estimate. Once project plans and impact areas are finalized, a JD will be undertaken pursuant to the 1987 Wetland Delineation Manual and the Atlantic and Gulf Coast Regional Supplement, to ascertain the actual footprint of jurisdictional wetlands impacted by the project. This will be done in the PED phase.

West Summerland Key
Minor, adverse permanent impacts to wetlands will occur as a result of implementation of Alternative 1. An estimated 10,250 square feet of sea purslane and sea oxeye-dominated herbaceous wetland community behind an existing concrete seawall will be displaced for the installation of the revetment. There are also several dead mangrove and/or buttonwood individuals, and an estimated 100-200 square feet of live mangroves in this wetland area. However, these likely can be avoided by designing the revetments to during future design (PED phases (Figure 8-1).

Figure 8-1: Wetlands to be impacted at West Summerland Key.

The USACE is required to avoid, minimize, and mitigate impacts to wetlands, pursuant to Section 401 and 404 of the Clean Water Act and 33 C.F.R. 336(c)(4) and 33 C.F.R. 320.4(b) and Executive Order 11990, Protection of Wetlands. The mitigation would be in-kind replacement, near the impact site. The Uniform Mitigation Assessment Methodology (UMAM), is being utilized to determine what wetland mitigation would be required. The tentative Environmental Mitigation Plan for both wetland and vegetated dune impacts is found in the Environmental Appendix. Refinement and implementation of the Environmental Mitigation Plan would be completed in the PED phase. With the Environmental Mitigation Plan, this wetland impact would be mitigated to a negligible level.

Implementation of Alternative 1 also would require temporary construction access. This would be expected to be from existing roads and staging areas. Similarly, localized maintenance, as repairs will be needed over time. However, negligible to minor temporary wetland impacts are expected to occur, as it is the intention to utilize non-wetland areas for construction access and staging. If wetland areas are disturbed for access, the areas would be restored after construction.

It can also be expected that due to natural causes such as sea level rise, erosion would continue to occur, and shoreline wetlands could therefore be eroded and/or migrate further inland.

8.10.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Negligible temporary or permanent adverse impacts to wetland resources are expected to result from implementation of Alternative 6, because land disturbance for this alternative would be limited to modification of existing buildings.

Implementation of Alternative 6 would require construction access to all structures to be treated; this would be expected to be from existing roads. Similarly, localized maintenance, as repairs will be needed over time.

It can also be expected that due to natural causes such as sea level rise, erosion would continue to occur and shoreline wetlands could therefore be eroded and/or migrate further inland.

8.10.3 Alternative 7: Nonstructural and Structural Alternative, Combined (Recommended Plan)

The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. Overall, because the wetlands impacts will be minimized and mitigated in accordance with the Best Management Practices described in Section 8.11.5, minor, adverse permanent impacts to wetlands that would be mitigated to a negligible level of impact would occur as a result of implementation of this alternative. Negligible to minor temporary wetland impacts are expected to occur.

8.10.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would involve no additional action beyond any current or planned future actions to mitigate against coastal storm risk. However, it can be expected that due to natural causes such as sea level rise, erosion would continue to occur, and shoreline wetlands could therefore be eroded and/or migrate further inland.

8.10.5 Best Management Practices to Avoid and Minimize Impacts on Wetlands for Alternative 7

1) Revetments are designed to provide for a one-foot buffer off of any mangrove and/or buttonwood wetlands.
2) It is possible that the footprints of the revetments might need to be slightly modified during PED, to avoid and minimize impacts on mangroves, and/or to incorporate them into the design as appropriate, as shown in the typical cross section in the Engineering Appendix.
3) USACE will apply for the appropriate permits under CWA 401 during the PED phase when more details on the project design are available. All permit conditions will be followed.

4) Unavoidable wetland impacts will be mitigated according to the UMAM. The Environmental Mitigation Plan is found in the Environmental Appendix.
5) Strict erosion and sediment control measures should be employed during construction, in accordance with the State of Florida's Erosion and Sediment Control Designer and Reviewer Manual, July 2013 (or most current version), as well as the conditions of any permits issued for the project
6) The Standard BMPs for invasive species as described under Section 8.10 will be followed.

8.11 BENTHICS AND SUBMERGED AQUATIC VEGETATION

8.11.1 Alternative 1: Structural Only Alternative (Revetments Only)

As described in the Affected Environment section of this report, the watershed within the ROI contains benthic habitats that include beaches, sandflats and mudlflats, hardbottom, corals, submerged aquatic habitat (SAV), and red mangrove habitat.

It was determined that it is practicable to construct the revetment footprints upslope of mean high water (MHW) and all benthic and SAV habitat. In addition, strict erosion and sediment control measures will be adhered to during construction. Therefore, there will be no effect on these resources.

However, it can be expected that due to natural causes such as sea level rise, deeper, warmer waters and increased acidification of tidal waters due to increased absorption of CO_2, benthic communities and SAV could become stressed over the next 50 years, as is discussed in the Cumulative Effects section.

8.11.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Because there are no in-water impacts associated with this alternative, it will have no effect on benthic or SAV resources.

However, it can be expected that due to natural causes such as sea level rise, deeper, warmer waters and increased acidification of tidal waters due to increased absorption of CO_2, benthic communities and SAV could become stressed over the next 50 years, as is discussed in the Cumulative Effects section.

8.11.3 Alternative 7: Nonstructural and Structural Alternative, Combined (Recommended Plan)

The nature and type of impacts associated with this alternative are the same as described under Alternatives 1 and 6 above: no effect due to this Alternative, but expected adverse effects due to sea level rise and climate change.

8.11.4 Alternative 8: No Action and Future Without Project

This alternative would have no effect on benthic or SAV resources. However, it can be expected that due to natural causes such as sea level rise, deeper, warmer waters and increased acidification of tidal waters due to increased absorption of CO_2, benthic communities and SAV could become stressed over the next 50 years, as is discussed later in the Cumulative Effects section.

8.12 FISH AND FISHERY RESOURCES

8.12.1 Alternative 1: Structural Only Alternative (Revetments Only)

Because no subaqueous habitat channelward of MHW will be impacted, and strict erosion and sediment control measures will be adhered to during construction, there will be no effect on fish or fishery resources. However, it can be expected that due to natural causes such as sea level rise, deeper, warmer waters and increased acidification of tidal waters due to increased absorption of CO_2, fish and fishery resources could become stressed over the next 50 years, as is discussed in the Cumulative Effects section.

8.12.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Because no subaqueous habitat channelward of MHW will be impacted, there will be no effect on fish or fishery resources. However, it can be expected that due to natural causes such as sea level rise, deeper, warmer waters and increased acidification of tidal waters due to increased absorption of CO_2, fish and fishery resources could become stressed over the next 50 years, as is discussed in the Cumulative Effects section.

8.12.3 Alternative 7: Nonstructural and Structural Alternative, Combined (Recommended Plan)

The nature and type of impacts associated with this alternative are the same as described under Alternatives 1 and 6 above: no effect due to this Alternative, but expected adverse effects due to sea level rise and climate change.

8.12.4 Alternative 8: No Action and Future Without Project

This alternative would have no effect on fish or fishery resources. However, it can be expected that due to natural causes such as sea level rise, deeper, warmer waters and increased acidification of tidal waters due to increased absorption of CO_2, fish and fishery resources could become stressed over the next 50 years.

8.13 THREATENED AND ENDANGERED SPECIES

8.13.1 Alternative 1: Structural Only Alternative (Revetments Only)

The ROI contains nesting, migratory, breeding, foraging, and overwintering habitat for numerous threatened and endangered species. In addition, there are designated critical habitats for the loggerhead sea turtle, the piping plover, the American crocodile, the Cape Sable thoroughwort, the West Indian manatee, staghorn coral and elkhorn coral.

Originally, the proposed revetments combined would have impacted approximately 19 acres (11 temporary and 9 perpetual) of critical habitat for threatened and endangered species and had in water impacts to additional threatened and endangered species within the ROI. These resources and habitats are present in the vicinity of the revetments at all locations. However, recognizing the value of these resources, the revetment footprints were shifted upslope to eliminate in water impacts. Impacts to in-water species and critical habitat for West Indian manatee, elkhorn coral, and staghorn coral are no longer expected. With the modifications, the revetments are expected to impact approximately 7.5 acres (5.5 temporary and 2 permanent) total of critical habitat for piping plover, loggerhead sea turtle, American crocodile, and Cape Sable thoroughwort.

West Summerland Key
Minor, adverse temporary and permanent impacts will occur as a result of implementation of Alternative 1.

There are no anticipated impacts to critical habitat on West Summerland Key. The Cape Sable thoroughwort was historically found throughout the Keys, however the current range within the ROI is only expected to occur on Long Key (USFWS 2019). Historically, loggerhead sea turtles nested on West Summerland Key in 1991 and 1995. However, there have been no documented nests at the site since 1995. Green, hawksbill, Kemp’s ridley, and leatherback sea turtles are not known to nest on West Summerland Key. American crocodiles and alligators may find the habitat suitable for nesting. However, the revetment is proposed behind an existing seawall which would prevent access from potential nesting reptiles. The main impacts expected to occur on West Summerland Key are impacts to migratory birds. Construction activities may temporarily disturb or displace foraging and roosting piping plovers, red knots, roseate terns, and other migratory birds. Roseate terns have the potential to breed and nest in the area as well, although it would be considered rare as 95 percent of the known nesting population of roseate terns occurs on Boca Chica Key (Florida Natural Areas Inventory 2001). Some impacts to breeding and nesting roseate terns could be mitigated by avoiding construction during nesting season. Revetments have the potential to modify the intertidal feeding areas for various seabirds (Dugan and Hubbard 2006), however, the revetment is proposed behind an existing seawall and no intertidal impacts are expected to occur. The permanent footprint of the revetment would permanently alter the site.

Implementation of Alternative 1 also would require temporary construction access (Figure 8-2). This would be expected to be from existing roads and staging areas; however, the impacts are expected to be minor and temporary. There would also be localized maintenance, as repairs will be needed over time.

Approximately 10,250 square feet of herbaceous wetlands made up mostly of sea purslane and sea oxeye would be permanently impacted. In addition, approximately 0.82 acres of sparsely vegetated upland would be temporarily used as a staging area, and approximately 0.35 acres of that would be permanently converted to a wetland compensation site. There is no Critical Habitat on land at West Summerland Key; therefore, none would be affected. However, plant surveys would be conducted during PED for any potential habitat areas, in order to avoid and minimize any adverse effects to any of the three plant species identified as potentially occurring within the ROI: Cape Sable Thoroughwort, tree cactus, and Garber's spurge. If the plants are present, the Sponsor would contact the Service for additional preconstruction guidance which could include relocation to a suitable habitat, and/or a minor alteration in the revetment template.

Figure 8-2: West Summerland Key revetment location.

Bahia Honda Key

Adverse temporary and permanent impacts will occur as a result of implementation of Alternative 1 (Figure 8-3). An estimated 18,200 square feet (0.41 acres) of land will be permanently and directly modified for the installation of the revetment footprint. Approximately 1.0 acres of upland southeast of Route 1 would be temporarily disturbed for staging and construction.

There will be permanent adverse modifications of up to 0.5 acre and temporary adverse modifications of up to 1.0 acre of piping plover critical habitat on Bahia Honda Key. Bahia Honda Key has the largest concentration of loggerhead nests within the ROI. In addition, green, hawksbill, and leatherback sea turtles have historically nested there. Kemp's ridley sea turtles are not known to nest on Bahia Honda Key. American crocodiles and alligators may find the habitat suitable for nesting. However, the revetment is proposed along the U.S. Route 1 roadside, north of an existing fence and campground road maintained by the park service, which would prevent access from potential nesting reptiles. Therefore, there are no anticipated effects to reptilian nesting habitat on Bahia Honda Key.

The main impacts expected to occur on Bahia Honda Key are impacts to migratory birds, sea turtles, American crocodiles, and alligators. Construction activities may temporarily disturb or displace foraging and roosting piping plovers, red knots, roseate terns, and other migratory birds. Roseate terns have the potential to breed and nest in the area as well, although it would be considered rare as 95 percent of the known nesting population of roseate terns occurs on Boca Chica Key (Florida Natural Areas Inventory 2001). Construction activities have the potential to disturb nesting sea turtles or crocodilians via visual and auditory disturbances and increased activity within the site. These disturbances could cause a species to temporarily relocate to a different area expending valuable energy. The permanent footprint of the revetment would permanently alter the site and 0.5 acre of piping plover critical habitat.

Implementation of Alternative 1 also would require temporary construction access. This would be expected to be from existing roads and staging areas; however, the impacts are expected to be minor and temporary. Similarly, localized maintenance such as repairs will be needed over time.

Figure 8-3: Bahia Honda Key site conditions. The revetment is proposed along U.S. Route 1, north of this campground road, and these locations. An existing fence separates these nesting areas from the proposed location of the revetment.

Long Key

Adverse temporary and permanent impacts will occur as a result of implementation of Alternative 1. An estimated 15,000 square feet (0.34 acre) of land will be permanently modified for the installation of the revetment footprint at Long Key. Approximately 1.25 acres of land adjacent to the shoreline, including a campground road, would be impacted temporarily for staging and construction.

Of this area, there would be permanent adverse modifications of up to 0.5 acre of American crocodile critical habitat, 0.5 acre of Cape Sable thoroughwort critical habitat, and 0.25 acre of loggerhead sea turtle critical habitat. There will be temporary adverse modifications of up to 1.25 acres of American crocodile critical habitat, 0.75 acre of Cape Sable thoroughwort critical habitat, and 0.25 acre of loggerhead sea turtle critical habitat. Long Key has the second largest concentration of loggerhead sea turtles nests within the ROI. Green, hawksbill, Kemp’s ridley, and leatherback sea turtles are not known to nest on Long Key. American crocodiles and alligators may find the habitat suitable for nesting. Long Key is the only known location of the Cape Sable thoroughwort within the ROI.

The main impacts expected to occur on Long Key are impacts to nesting loggerhead sea turtles, American crocodiles, alligators, migratory birds, and Cape Sable thoroughwort. Construction activities may temporarily disturb or displace foraging and roosting piping plovers, red knots, roseate terns, and other migratory birds. Roseate terns have the potential to breed and nest in the area as well, although it would be considered rare as 95 percent of the known nesting population of roseate terns occurs on Boca Chica Key (Florida Natural Areas Inventory 2001). Some impacts to breeding and nesting roseate terns could be mitigated by avoiding construction during nesting season. Revetments have the potential to modify the intertidal feeding areas for various seabirds (Dugan and Hubbard 2006). Construction activities have the potential to disturb nesting loggerhead sea turtles and/or crocodilians via visual and auditory disturbances and increased activity within the site. These disturbances could cause a species to temporarily relocate to a different area expending valuable energy.

The Cape Sable thoroughwort could be trampled, disturbed, or killed by construction and increased human activities. This could be avoided by surveying the project site prior to construction and creating a buffer around Cape Sable thoroughwort. Plant surveys would be conducted during PED for any potential habitat areas, in order to avoid and minimize adverse effects to any of the three plant species identified as potentially occurring within the ROI: Cape Sable Thoroughwort, tree cactus, and Garber's spurge. If the plants are present, the Sponsor would contact the Service for additional preconstruction guidance which could include relocation to a suitable habitat, and/or a minor alteration in the revetment template. The permanent footprint of the revetment would permanently alter the site, 0.5 acre of American crocodile critical habitat, 0.5 acre of Cape Sable thoroughwort critical habitat, and 0.25 acre of loggerhead sea turtle critical habitat.

Implementation of Alternative 1 also would require temporary construction access. This would be expected to be from existing roads and staging areas; however, the impacts are expected to be minor and temporary. Similarly, localized maintenance such as repairs will be needed over time.

Fiesta Key East

Minor, adverse temporary and permanent impacts will occur as a result of implementation of Alternative 1. An estimated 11,700 square feet (0.27 acres) of land will be permanently modified for the installation of the revetment footprint (Figure 8-4). Up to 1.25 acres of temporary impacts may occur for staging; this would be along the roadside and in the front lawn of a water treatment plant. However, all of this area is mapped as critical habitat for the American crocodile.

There would be permanent adverse modifications of up to 0.5 acre and temporary adverse modifications of up to 1.25 acre of American crocodile critical habitat on Fiesta Key East. Historically, loggerhead, green, hawksbill, Kemp's ridley, and leatherback sea turtles are not documented to nest on Fiesta Key East. American crocodiles and alligators may find the habitat suitable for nesting. However, the revetment is proposed behind an existing rip rap revetment which would prevent access from potential nesting reptiles. The main impacts expected to occur on Fiesta Key East are impacts to migratory birds and the permanent alteration of up to 0.5 acre of critical habitat for American crocodile. Construction activities may temporarily disturb or displace foraging and roosting piping plovers, red knots, roseate terns, and other migratory birds. Roseate terns have the potential to breed and nest in the area as well, although it would be considered rare as 95 percent of the known nesting population of roseate terns occurs on Boca Chica Key (Florida Natural Areas Inventory 2001). Some impacts to breeding and nesting roseate terns could be mitigated by avoiding construction during nesting season. Revetments have the potential to modify the intertidal feeding areas for various seabirds (Dugan and Hubbard 2006),

Implementation of Alternative 1 also would require temporary construction access. This would be expected to be from existing roads and staging areas; however, the impacts are expected to be minor and temporary. Similarly, localized maintenance such as repairs will be needed over time.

Figure 8-4: Existing rip rap revetment along Fiesta Key East.

Fiesta Key West

Minor, adverse temporary and permanent impacts will occur as a result of implementation of Alternative 1. An estimated 17,550 square feet (0.40 acres) of land will be modified for the installation of the revetment footprint.

There will be permanent adverse modifications of up to 0.5 acre and temporary adverse modifications of up to 1.0 acre of American crocodile critical habitat on Fiesta Key West. Historically, loggerhead, green, hawksbill, Kemp's ridley, and leatherback sea turtles are not documented to nest on Fiesta Key West. American crocodiles and alligators may find the habitat suitable for nesting. However, the revetment is proposed adjacent to the road and separated from the shoreline by a dense area of vegetation (Figure 8-5). The revetment site is not immediately adjacent or contiguous to waters accessible by American crocodiles or alligators. The main impacts expected to occur on Fiesta Key West are impacts to migratory birds and the permanent alteration of up to 0.5 acre of critical habitat for American crocodile.

The temporary staging area would be the same as for the Fiesta Key East revetment. Construction activities may temporarily disturb or displace foraging and roosting piping plovers, red knots, roseate terns, and other migratory birds. Roseate terns have the potential to breed and nest in the area as well, although it would be considered rare as 95 percent of the known nesting population of roseate terns occurs on Boca Chica Key (Florida Natural Areas Inventory 2001). Some impacts to breeding and nesting roseate terns could be mitigated by avoiding construction during nesting season. Revetments have the potential to modify the intertidal feeding areas for various seabirds (Dugan and Hubbard 2006). However, the revetment location proposed is not immediately adjacent or contiguous to the shoreline, and no intertidal impacts are expected to occur. The permanent footprint of the revetment would permanently alter the site and up to 0.5 acre of American crocodile critical habitat.

Implementation of Alternative 1 also would require temporary construction access. This would be expected to be from existing roads and staging areas; however, the impacts are expected to be minor and temporary. Similarly, localized maintenance such as repairs will be needed over time.

Figure 8-5: Area for the revetment adjacent to the road on Fiesta Key West.

Indian Key Fill

Minor, adverse temporary and permanent impacts will occur as a result of implementation of Alternative 1. An estimated 8,400 square feet (0.19 acres) of land will be modified for the installation of the revetment footprint at Indian Key Fill.

There will be permanent adverse modifications of up to 0.25 acre and temporary adverse modifications of up to 1.0 acre of American crocodile critical habitat on Indian Key Fill. Historically, loggerhead, green, hawksbill, Kemp's ridley, and leatherback sea turtles are not documented to nest on Indian Key Fill. American crocodiles and alligators may find the habitat suitable for nesting. However, the revetment is proposed behind an existing seawall which would prevent coastal access to the site by reptiles. The revetment site is not immediately adjacent or contiguous to waters accessible by American crocodiles or alligators. The main impacts expected to occur on Indian Key Fill are impacts to migratory birds and the permanent alteration of up to 0.25 acre of critical habitat for American crocodile. Construction activities may temporarily disturb or displace foraging and roosting piping plovers, red knots, roseate terns, and other migratory birds. Roseate terns have the potential to breed and nest in the area as well, although it would be considered rare as 95 percent of the known nesting population of roseate terns occurs on Boca Chica Key (Florida Natural Areas Inventory 2001). Some impacts to breeding and nesting roseate terns could be mitigated by avoiding construction during nesting season. Revetments have the potential to modify the intertidal feeding areas for various seabirds (Dugan and Hubbard 2006) (Figure 8-6). However, the revetment location proposed behind an existing seawall, and no intertidal impacts are expected to occur. The permanent footprint of the revetment would permanently alter the site and up to 0.25 acre of American crocodile critical habitat.

Implementation of Alternative 1 also would require temporary construction access. This would be expected to be from existing roads and staging areas; however, the impacts are expected to be minor and temporary. Similarly, localized maintenance such as repairs will be needed over time.

Figure 8-6: Existing sea wall along Indian Key Fill.

8.13.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Negligible to minor temporary or permanent adverse impacts to threatened and endangered species are expected to result from implementation of Alternative 6, because land disturbance for this alternative would be limited to modification of existing buildings. There would be temporary land disturbance in yards and impervious surfaces surrounding the existing buildings; however. no new undeveloped habitats would be impacted. Implementation of Alternative 6 would require construction access to all structures to be treated; this would be expected to be from existing roads. Similarly, localized maintenance, as repairs will be needed over time.

There could be temporary visual and auditory effects during construction. However, if there are any listed species nearby, they would be expected to avoid the construction areas.

8.13.3 Alternative 7: Nonstructural and Structural Alternative, Combined (Recommended Plan)

The effects of this alternative would be a combination of those listed above under Alternatives 1 and 6. The following Table 8-2, Species Conclusion Summary Table, summarizes these effects.

Table 8-2: Species Summary Conclusion Table

SPECIES / RESOURCE NAME	ESA SECTION 7 / EAGLE ACT DETERMINATION	NOTES / DOCUMENTATION
Piping Plover, Red Knot, Roseate Tern	May Affect, Likely to Adversely Affect	Construction may impact prey species and foraging areas, will alter habitat and may cause species to leave the action area from the visual disturbances, auditory disturbances, and increased human activity.
Piping Plover Designated Critical Habitat	Adverse Modification	Construction of a revetment would permanently alter up to 0.5 acres and temporarily alter up to 1.0 acre of designated Critical Habitat on Bahia Honda Key, and could impact prey species and foraging habitat. The revetments would adversely modify designated critical habitat. However, this is a very small percentage considering that almost the entire Bahia Honda Key is designated Critical Habitat.
Nassau Grouper, Smalltooth Sawfish, Oceanic Whitetip Shark, Giant Manta Ray	No Effect	There are no in water impacts associated with this project.
Pillar Coral, Rough Cactus Coral, Lobed Star Coral, Boulder Star Coral, Mountainous Star Coral. Elkhorn Coral, Staghorn Coral	No Effect	There are no in water impacts associated with this project.
Elkhorn Coral, Staghorn Coral Designated Critical Habitat	No Effect	There are no in water impacts associated with this project.
West Indian Manatee	No Effect	There are no in water impacts associated with this project.

SPECIES / RESOURCE NAME	ESA SECTION 7 / EAGLE ACT DETERMINATION	NOTES / DOCUMENTATION
American Alligator and American Crocodile	May Affect, Not Likely to Adversely Affect	Construction may disturb species due to temporary increases in human disturbance including auditory and visual disturbances during construction. The revetments would temporarily and permanently alter designated critical habitat. However, existing sea walls, revetments, and vegetation block access to Fiesta Key East and West and Indian Key Fill, creating limited access to these areas. In addition, the 2014 USFWS notes that crocodiles are uncommon south of Key Largo. Using the guidance from this letter, it is anticipated the impacts will be insignificant.
American Crocodile Designated Critical Habitat	Adverse Modification	Construction of a revetment would permanently alter up to 1.75 acres of designated critical habitat, however, 1.25 of those acres are not accessible to crocodiles due to existing sea walls and rip rap revetments. The remaining 0.5 acre is at the southernmost extent of the range in the Florida Keys and occurrence is uncommon. In addition, approximately 4.5 acres of temporary impact to critical habitat is possible during construction.
Kemp's ridley sea turtle	No Effect	Kemp's ridley sea turtles do not nest within the action area. Kemp's ridley sea turtles do not have critical habitat within the action area. There are no in water impacts associated with this project.
Green Sea Turtle, Hawksbill Sea Turtle, Leatherback Sea Turtle	May Affect, Not Likely to Adversely Affect	Green, Hawksbill, and Leatherback sea turtles rarely nest on Bahia Honda Key within the action area. The revetment on Bahia Honda Key will be north of an existing fence and campground road. The nesting area is south of the existing fence and campground road on Bahia Honda Key. Impacts to green, hawksbill, and leatherback sea turtles will be temporary and insignificant. There are no in water impacts associated with this project.
Loggerhead Sea Turtle	May Affect, Likely to Adversely Affect	Within the action area, Loggerhead sea turtles nest on Bahia Honda and Long Key. Historically, nests were also documented on West Summerland Key in the 90's. The revetment on Long Key will block access to nesting habitat. The revetment on Bahia Honda Key will be north of an existing fence and campground road, away from the beach. The nesting area is south of the existing fence and campground road, so impacts to nesting turtles are not anticipated on Bahia Honda Key.
Loggerhead Sea Turtle Designated Critical Habitat	Adverse Modification	Construction of a revetment would permanently alter up to 0.25 acres and temporarily alter another 0.25 acres of designated critical habitat and could impact nesting habitat on Long Key. The revetments would adversely modify designated critical habitat.

SPECIES / RESOURCE NAME	ESA SECTION 7 / EAGLE ACT DETERMINATION	NOTES / DOCUMENTATION
Cape Sable Thoroughwort	May Affect, Likely to Adversely Affect	Construction and human activities could disturb or trample plant. Construction of a revetment would permanently alter up to 0.5 acre and temporarily alter up to 0.75 acres of designated critical habitat. Plant surveys would be conducted during PED, and if this species is found, it would be avoided or transplanted by a qualified biologist to a suitable habitat.
Cape Sable Thoroughwort Designated Critical Habitat	Adverse Modification	Construction of a revetment would permanently alter up to 0.5 acre and temporarily alter up to 0.75 acres of designated critical habitat. The revetments would adversely modify designated critical habitat.
Tree cactus	May Affect, Likely to Adversely Affect	Construction and human activities could disturb or trample plant. USFWS Region 4 documents potential habitat for the tree cactus on West Summerland Key, Bahia Honda Key, and Long Key. Construction and human activities could disturb or trample the plant, if present. Construction of a revetment would permanently alter up to 0.5 acre and temporarily alter 0.75 acres of potential habitat at Long Key. Based on the species habitat description, it is less likely to be within the 0.41-acre permanent footprint of the Bahia Honda revetment along a roadside, or its laydown area. The West Summerland Key revetment will permanently impact approximately 0.23 acres of herbaceous wetland community dominated by sea purslane, sea oxeye, and a few sparse mangroves; therefore, this area may be too wet for the species. The species could be present within the proposed 0.35-acre mitigation site location or its associated 0.47-acre laydown area. Plant surveys would be conducted during PED, and if this species is found, it would be avoided or transplanted by a qualified biologist to a suitable habitat.

SPECIES / RESOURCE NAME	ESA SECTION 7 / EAGLE ACT DETERMINATION	NOTES / DOCUMENTATION
Garber's spurge	May Affect, Likely to Adversely Affect	Construction and human activities could disturb or trample plant. USFWS Region 4 has informed USACE that according to its records, for this species, there are occurrence data points located approximately 0.6 mile north of the project site on Bahia Honda Key, and approximately 0.3 and 0.4 mile north and south of the project site on Long Key, respectively. Construction of a revetment would permanently alter up to 0.5 acre and temporarily alter 0.75 acres of potential habitat of potential habitat at Long Key. The species is less likely to be within the 0.41-acre permanent footprint of the Bahia Honda revetment along a roadside, or its laydown area. Plant surveys would be conducted during PED, and if this species is found, it would be avoided or transplanted by a qualified biologist to a suitable habitat.

There will be no effects to species under the purview of the NOAA PRD, as no structures or construction would be in the water.

Formal Section 7 consultation was conducted with the USFWS and was concluded with a non-jeopardy Biological Opinion on April 12, 2021. The Biological Opinion is located in the Environmental Appendix, Appendix D, Subappendix A.

8.13.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would involve no additional action from current or planned future actions to mitigate against coastal storm risk. No temporary or permanent impacts to threatened and endangered species or critical habitat would occur, other than those expected due to climate change, sea level rise, and erosion.

8.13.5 Required Reasonable and Prudent Measures for the Recommended Plan

The Reasonable and Prudent Measures (RPM) as a result of formal Section 7 consultation with the USFWS are summarized below, and will be followed:

1) Daily surveys shall be conducted by sea turtle permit holders. Nests laid adjacent to the work area shall be marked by flag and rope for avoid
2) A barrier shall be installed around the perimeter of the revetment and staging area sufficient to prevent adult and hatchling sea turtles from accessing the sit
3) Construction equipment and materials shall be stored in a manner that will minimize impacts to sea turtles to the maximum extent possible
4) No work shall occur at night (between sunset and sunrise.

5) If any safety lighting associated with the Project is required, the Corps must coordinate with the Service.
6) If entrapment of sea turtles occurs in the revetment, the Corps shall meet with the Service to discuss a possible solution prior to the next nesting season.
7) A report describing the actions taken to implement the Reasonable and Prudent Measures and Terms and Conditions of this incidental take statement shall be submitted to the Service.

The more detailed Terms and Conditions for implementation of these RPMs may be found in the Biological Opinion.

Sections 7(b)(4) and 7 (o)(2) of the ESA generally do not apply to listed plant species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of federally listed endangered plants or the malicious damage of such plants on areas under federal jurisdiction, or the destruction of endangered plants on non-federal areas in violation of State law or regulation or in the course of any violation of a state criminal trespass law.

8.13.6 Best Management Practices to Avoid and Minimize Impacts on Threatened and Endangered Species for Alternative 7

1) Surveys for protected species would be conducted for the plant species in PED as appropriate, prior to final design, so that they may inform the final design and construction schedules. Costs for surveys are anticipated to be less than $25,000 and therefore would not be significant enough to affect the selection of Alternative 7.
2) Construction schedules should avoid the most productive biological seasons, typically the nesting season for sea turtles, crocodiles, shorebirds and waterbirds but in some areas also may include migration or overwintering periods where fauna are present in high concentrations.
3) Buffers of 100 meters should be maintained around wading bird colonies, 200 meters around mixed tern/skimmer colonies, and 100 - 200 meters around solitary bird nests and larger for species with chicks. Buffers of at least ten meters should be maintained around sensitive plants.
4) Strict erosion and sediment control measures should be employed during construction, in accordance with the State of Florida’s Erosion and Sediment Control Designer and Reviewer Manual, Latest Update July 2013 (or most current version), as well as the conditions of any permits issued for the project.
5) Biological resources should be monitored and/or surveyed during and throughout construction.

8.14 WILDLIFE

8.14.1 Alternative 1: Structural Only Alternative (Revetments Only)

This section is intended to focus on more common wetland and terrestrial wildlife species. Threatened and endangered species and migratory birds were discussed in the special status species section; and aquatic species were discussed in the fisheries and benthics sections.

With the exception of Long Key, the six proposed locations for the revetments currently provide limited habitat and/or foraging quality for wildlife.

West Summerland Key
This revetment includes approximately 10,250 square feet of wetland impacts. However, these are not high-quality wetlands; they are almost entirely herbaceous wetlands behind a seawall, cut off from the waterway.

Bahia Honda Key
The Bahia Honda Key revetment was originally planned along the beach, however, in order to avoid beach impacts, it was shifted upslope to a grassed and tree line area between the park fence line and U.S. Route 1 and the Overseas Trail. With this close proximity of these revetments to roadway noise as well as the danger of vehicle strike, as well as lack of vegetative community, they likely already have limited use by wildlife. The temporary construction staging area will be located on open uplands elsewhere, away from the beach, in an area that is not likely good habitat for wildlife.

Fiesta Key East, and Indian Key Fill
These proposed revetment locations are on eroded slopes adjacent to roadway and trail shoulders. With this close proximity of these revetments to roadway noise as well as the danger of vehicle strike, as well as lack of vegetative community, they likely already have limited use by wildlife.

Fiesta Key West
This proposed revetment is also immediately adjacent to the road and trail, is in very close proximity to mangrove and buttonwood mixed wetlands immediately downslope. However; these areas will not be permanently impacted. There would be temporary adverse effects on wildlife, as wildlife would likely avoid the mangrove area due to noise and disturbance during construction.

Long Key
The proposed Long Key revetment location is along the beach. Wildlife, and in particular foraging birds, will likely be displaced by the revetment location at Long Key. The special status species section describes the nesting, migratory, breeding, foraging, and overwintering habitat for numerous bird and turtle species. An estimated 15,000 square feet of land will be permanently modified for the installation of the revetment and much of this area is vegetated with herbaceous and scrubby shoreline species. The wrackline debris would also be displaced.

There will be approximately 1.25 acres of temporary impacts for staging and construction access adjacent to the work area in the campground road, which would be restored following construction.

As mentioned earlier, FDEP's DPR expressed concerns about these wildlife impacts in their comments to USACE. USACE is aware that Long Key State Park is preparing a planting plan for this area. If agreeable to the park, its planting plan could be supplemented with a USACE upland dune vegetation mitigation plan to replace the impacted dune vegetation. This will likely take place within the state park, in an area the park deems ideal.

This Alternative would result in both indirect and direct, temporary and permanent, adverse impacts on wildlife. These impacts include disturbance from the permanent alteration of habitat and foraging area by the revetment footprint. Temporary construction access, grading activities, temporary stockpiling of rock would also occur in foraging areas. Similarly, localized maintenance, as repairs will be needed over time. The effects can be considered minor because the noise and construction activity would be temporary. Also, suitable beach foraging areas will remain outside of the revetment footprint and area to be affected by construction noise and disturbance. Best management practices would be followed.

8.14.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Negligible to minor temporary or permanent adverse impacts to wildlife species are expected to result from implementation of Alternative 6, because land disturbance for this alternative would be limited to modification of existing buildings. Animal species would likely avoid the area during construction.

Implementation of Alternative 6 would require construction access to all structures to be treated; this would be expected to be from existing roads. Similarly, localized maintenance, as repairs will be needed over time.

8.14.3 Alternative 7: Nonstructural and Structural Alternative, Combined (Recommended Plan)

The nature and type of impacts associated with this alternative are the same as described under Alternatives 1 and 6 above. This Alternative would result in both indirect and direct, temporary and permanent, adverse impacts on wildlife. These impacts include disturbance from the permanent alteration of habitat and foraging area by the revetment footprint. Temporary construction access, grading activities, temporary stockpiling of rock would also occur in foraging areas. Similarly, localized maintenance, as repairs will be needed over time. The effects can be considered minor, because the noise and construction activity would be temporary. Also, suitable beach foraging areas will remain outside of the revetment footprint and area to be affected by construction noise and disturbance. Best management practices described in Section 8.15.5 of this report would be followed.

The USACE conducted coordination with USFWS pursuant to the Fish and Wildlife Coordination Act (FWCA), and USFWS determined that the project is in compliance with the FWCA.

8.14.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would involve no additional action to mitigate against coastal storm risk. Wildlife could continue to use the area for foraging. No temporary or permanent impacts to wildlife would occur, other than those expected due to climate change, sea level rise, and erosion.

8.14.5 Best Management Practices to Avoid and Minimize Impacts on Wildlife for Alternative 7

1) If practicable, construction schedules should avoid the most productive biological seasons for shorebirds and waterbirds but in some areas also may include migration or overwintering periods where fauna are present in high concentrations.
2) The Proposed Action shall adhere to the following standard Jacksonville District BMPs for migratory and shorebirds.
    a. All construction personnel shall be advised that migratory birds are protected by the Florida Endangered and Threatened Species Act of 1977, Title XXVIII, the Migratory Bird Treaty Act of 1918, and the Endangered Species Act of 1973, as amended. The contractor may be held responsible for harming or harassing the birds, their eggs, or their nests.
    b. Construction activities will be under surveillance, management, and control to prevent impacts to migratory birds and their nests.
    c. A qualified bird monitor shall be present and shall monitor the construction area from April 1 through August 31, unless there is an exception granted by a USACE biologist.
    d. The bird monitor must be approved by a USACE biologist, and must possess qualifications that include, but are not limited to: identifying bird species, nesting behavior, eggs and nests, and habitat requirements. He or she must also be familiar with state requirements and reporting procedures.
    e. The bird monitor shall record any nesting activity in accordance with reporting requirements. Should nesting begin within the construction area, a temporary 200 to 300 foot buffer, as specified by the monitor and the USACE biologist, shall be created and marked with signs to avoid entry.
3) Strict erosion and sediment control measures should be employed during construction, in accordance with the State of Florida’s Erosion and Sediment Control Designer and Reviewer Manual, Latest Update July 2013 (or most current version), as well as the conditions of any permits issued for the project.
4) Planting native vegetative seed mixes on disturbed land after construction is complete.
5) Vegetated dune impacts would be mitigated with a planting plan that complements the Park’s, at a location agreeable to the Park. A draft planting plan and estimated mitigation costs are included in the Environmental Mitigation Plan found in the Environmental Appendix, Appendix D.

8.15 CULTURAL RESOURCES

Cultural resource correspondence and other documents associated with this section can be found in Appendix E. Potential adverse effects resulting from implementation of any of the action alternatives would be mitigated in accordance with the Regional Programmatic Agreement procedures. Should adverse effects to listed and eligible historic properties occur, mitigation would be agreed upon and conducted as required per the Regional Programmatic Agreement provided in the Cultural Appendix. Specific mitigation measures (if required) would be determined during the Preconstruction, Engineering, and Design Phase in accordance with the Regional Programmatic Agreement.

8.15.1 Alternative 1: Structural Only Alternative (Revetments Only)

Most of the proposed revetments are on artificial landforms and have had prior survey. Two recorded sites are within project areas, both dating to the first half of the 20th century. Site MO01473, Long Key Siding, is a railroad bed and was evaluated as not NRHP eligible but the revetment Area of Potential Effect NRHP (APE) on Long Key would impact the site. The other site is MO02117, a 20th century trash dump in the APE of a proposed construction yard area on Bahia Honda Key. Neither is eligible for the NRHP.

8.15.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

No infrastructure facilities in the Florida Keys have been identified as NRHP-eligible, so their modifications would not cause adverse effects to historic properties. However, where measures may cause ground disturbance, archaeological survey would be needed.

As described in detail in the Nonstructural Plan in Appendix G, elevation of historic structures would consist of elevating the foundation of the structure on a new foundation so that the lowest finished floor is approximately above 12 feet NAVD88. All utilities and mechanical equipment, such as air conditioners and hot water heaters would also be raised to this elevation. Floodproofing of historic structures would consist of sealing all areas of a structure up to a maximum of approximately three feet above the existing first floor elevation to reduce damage caused by coastal storm surge inundation by making walls, doors, windows and other openings resistant to penetration by water. Walls would potentially be coated with sealants, waterproofing compounds, or plastic sheeting. Back-flow from water and sewer lines would be prevented by installing mechanisms such as drain plugs, standpipes, grinder pumps, and back-up valves. Openings, such as doors, windows, sewer lines, and vents, may also potentially be closed temporarily with sandbags or removable closures, or permanently sealed.

In residential areas, nonstructural measures would cause moderate impacts to any NRHP eligible buildings, these impacts would be primarily in the NRHP listed Key West Historic District. Elevating any NRHP eligible structure would be an adverse effect, but some designs are less so than others. Elevations may cause adverse visual effects to a historic district.

Floodproofing may be adverse, or non-adverse. Dry floodproofing designs which require windows and doors to be sealed would cause adverse effects. There would also be beneficial effects to historic structures as the elevation and floodproofing measures would prevent flood damages to the structure. This alternative would be expected to have permanent, moderate adverse to beneficial effects.

8.15.3 Alternative 7: Nonstructural and Structural Alternative, Combined (Recommended Plan)

The effects of this alternative would be a combination of those listed above under Alternatives 1 and 6. This alternative would be expected to have permanent, moderate adverse effects.

8.15.4 Alternative 8: No Action and Future Without Project

The No Action/Future Without Project Alternative would involve no additional action from current or planned future actions to mitigate against coastal storm risk and associated storm damage. Historic buildings would continue to be exposed to flood risk, which can be expected to increase with climate change.

8.15.5 Best Management Practices to Avoid and Minimize Impacts on Cultural Resources for Alternative 7

1) Employ distinct but compatible designs when elevating historic buildings.
2) Adhere to the requirements of the Regional Programmatic Agreement (PA) including all required mitigation. The executed PA is located in the Cultural Resource Appendix, Appendix E.

8.16 RECREATION

8.16.1 Alternative 1: Structural Only Alternative (Revetments Only)

This alternative potentially affects four recreational facilities: the U.S. Route 1 Overseas Trail, Bahia Honda State Park, Long Key State Park, and a public pier at Fiesta Key.

Overseas Trail

The Overseas Trail, which parallels U.S. Route 1, has been damaged and some sections have been unusable since Hurricane Irma in September 2017. The trail is in close proximity to all of the revetments except for the one in Long Key State Park. As mentioned earlier, FDOT’s plans to repair the trail sections at West Summerland Key, Fiesta Key East and Fiesta Key West are expected to occur prior to the implementation of this project. The proposed revetments cannot permanently displace any sections of the trail, and therefore would have no direct, permanent adverse impact on the Overseas Trail itself. However, sections of the trail may have to be closed during the construction window at these three locations, which is expected to take approximately four to five months at each location. However, trail users could divert around the construction and use open sections of the trail. Once construction is complete, the revetments would provide added permanent erosion management for the trails and the roadway itself. For the locations where the revetments are within the Florida DPR trail property, a permit would be required from the DPR for the permanent riprap encroachment.

Bahia Honda State Park
Florida DPR submitted a comment memo to the USACE indicating that DPR prefers no hardened structures in the Park, and instead suggested raising the campground roadway. As an alternative, USACE determined that there was enough space to move the revetment upslope of the campground road, and directly adjacent to the Overseas Trail, outside of the Park fence. With this shift, and with the temporary construction staging area also outside of the Park boundaries, the revetment will no longer have direct or indirect adverse effects on this Park.

Long Key State Park
The proposed revetment, estimated to be approximately 1,500 linear feet, is planned on a very narrow vegetated beach, upslope of MHW and parallel to the Park's campground access road. The beach itself is too narrow to provide areas for sunbathing use; however, there a few scattered picnic tables upslope of the beach. The beach and shallow water are usable for wading, swimming, walking, bird watching, and other passive uses, though there are other sections of beach that are more conducive for public use.

The DPR, in its comment memo, stated the following:
"DPR does have concerns with the preliminary plans at this Park. DPR has contractors in the permitting phase of installation of a visitor restroom in the area between US1 and the park drive, which is directly adjacent to the area proposed for shoreline stabilization. Construction/installation is slated to begin in spring 2020 and the project should take approximately six months after permit approval. Additionally, the Park's campground rebuilding design is nearing completion and this area is not compatible with shoreline armoring. DPR has plans to stabilize the area with a natural shoreline."

Because the proposed revetment would not go to construction in the near future, it would not conflict with the DPR's construction schedule for the restroom. In addition, the revetment conceptual plan could be further refined during the PED phase to be compatible and complementary to the campground rebuilding design, and/or to avoid impacting any plantings that the DPR installs. Further coordination with and authorization from DPR would occur in the PED phase.

However, installing a permanent revetment at this location would have a temporary and permanent direct and indirect adverse effect on this Park. Areas that are currently open for wading, swimming, walking, bird watching, and other passive uses would have more limited access with a permanent revetment structure in place. In addition, construction staging area stretches across the Park access roadway, which would require its temporary closure for four to five months. This would be a direct, temporary moderate impact, and a direct, permanent moderate impact on Long Key State Park. A DPR permit would be required for the temporary and permanent revetment encroachment.

Public Pier at Fiesta Key East
Between mile markers 70 and 71, across U.S. Route 1 from the Fiesta Key East revetment, there is a long public pier. Once a bridge trestle for U.S. Route 1, it now parallels U.S. Route 1 to the north. The pier is used mostly for fishing, but also sightseeing, photography, bird watching, walking, and other passive uses. There is a large public parking area adjacent to it, and this area would be used for construction staging. There would be no indirect or direct permanent impact on recreation here, because the area where the revetment itself will be placed is not used for recreation. However, construction staging would require the temporary closure of the pier for approximately four to five months. There is no other such pier nearby for use as an alternative; therefore, this would have a direct, temporary minor to moderate effect on recreation.

Indian Key Fill
This location, while not a "facility," is owned by both DPR and FDOT and used by the public for recreation. As one of the few locations on the Keys where visitors can park and obtain free access to the water, the Indian Key Fill islands serve as gathering places for visitors wanting to spend leisure time near the water, wade, swim, fish, or put canoes or kayaks in the water. At least a portion of this upland area would have to be closed to the public temporarily during construction for safety. There are two other sections of Indian Key Fill to the southwest of this location that are similarly used for public recreation, and the public could still use those during construction. This alternative would have a direct and indirect, minor temporary impact on recreation. However, the embankment itself is not conducive to recreational use, so the revetment would have no direct or indirect permanent adverse effect on recreation.

For this alternative, there would be no temporary or permanent in-water impacts. Therefore, there would be no permanent adverse impacts on recreational navigation. Construction access and staging would occur from the land side rather than from the water. There are no public boating launches, aids to navigation, or buoys located in the near vicinity of any of the proposed revetments or staging areas; however, there are nearshore areas where navigation access for small craft such as canoes or kayaks could occur, and it is possible that some people may access the water directly off the shorelines.

Overall, Alternative 1 would have direct and indirect temporary and permanent impacts on recreation that are minor to moderate. In addition, recreational activities could be impacted by natural causes such as sea level rise and increased future storms. These could cause future damage to recreational areas such as beaches, the Overseas Trail, State Parks, etc., as is discussed in the Cumulative Effects section of this report.

8.16.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Alternative 6 involves construction on existing upland structures, and construction access. Construction staging areas would be directly collocated with the affected structures.

Elevation of structures would apply only to residences and would therefore have no temporary or permanent effect on recreation.

No known recreational facilities would be affected directly or indirectly by this alternative. However, if they are, they will be compensated and/or relocated; and would be at least temporarily closed during construction or relocation.

For these reasons, this alternative could have a direct, negligible to minor, temporary adverse effect on recreation and a negligible to minor permanent adverse effect on recreation. In addition, recreational activities could be impacted by natural causes such as sea level rise and increased future storms. These could cause future damage to recreational areas such as beaches, the Overseas Trail, State Parks, etc., as is discussed in the Cumulative Effects section of this report.

8.16.3 Alternative 7: Nonstructural and Structural Alternative, Combined (Recommended Plan)

The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. Overall, this alternative would have direct and indirect temporary and permanent impacts on recreation that are minor to moderate. In addition, recreational activities could be impacted by natural causes such as sea level rise and increased future storms. These could cause future damage to recreational areas such as beaches, the Overseas Trail, State Parks, etc., as is discussed in the Cumulative Effects section of this report.

8.16.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would involve no additional action from current or planned future actions to mitigate against coastal storm risk. In addition, recreational activities could be impacted by natural causes such as sea level rise, increased future storms, and associated impacts such as erosion. These could cause future damage to recreational areas such as beaches, the Overseas Trail, State Parks, etc., limiting recreational activities.

8.16.5 Best Management Practices to Avoid and Minimize Impacts on Recreation for Alternative 7

1) For recreational safety, the shoreline areas that are under construction and their staging areas will be closed to the public.
2) Staging areas will be the minimum necessary to construct the project, and construction will be completed as soon as practicable.
3) Further coordination will be conducted with DPR in the PED phase, to avoid and minimize conflicts with the park and Overseas Trail operations. All required permits would be obtained.
4) The timing of the work will be coordinated with the County, FDOT, and FDEP DRP, to avoid and minimize conflicts with planned or ongoing County and park projects.

8.17 AESTHETICS

8.17.1 Alternative 1: Structural Only Alternative (Revetments Only)

As described in the Affected Environment, the ROI is characterized by beautiful vistas of the water and wetlands, as well as views of the U.S. Route 1 Overseas Highway and Trail. As the only highway in Florida to be recognized as an "All-American Road" by the National Scenic Byways Program of the Department of Transportation's Federal Highway Administration, overall viewsheds from both the Overseas Highway and the Trail are a unique part of the Florida Keys. During the scoping process, commenters stated verbally and in writing that they did not want unattractive structures installed.

The viewshed in the vicinity of each of the six revetment locations varies, but all revetment locations are within 100 feet of the Overseas Highway and Trail. Mangrove and/or buttonwood wetlands are present in the vicinity of the revetments at the West Summerland Key, Fiesta Key West, Fiesta Key East, and Indian Key Fill (Figure 8-7). However, recognizing impact on wetlands and aesthetics, the revetment footprints were shifted upslope to avoid these areas.

Figure 8-7: West Summerland Key impact area (l). Long Key impact area (r).

All six of the proposed revetments would likely be visible from the Overseas Highway and Trail. At West Summerland Key, an herbaceous wetland would be replaced with approximately 750 linear feet of revetment adjacent to the Overseas Trail, which will itself need to be repaired and stabilized by FDOT. This Key is one of the less developed and more naturalized areas, so the revetment would be somewhat visually intrusive. Along Bahia Honda State Park, the revetment was relocated further upslope adjacent to the roadway and trail and away from the beach, thereby reducing the aesthetic impacts within the park itself. This would require removal of a portion of a tree line; however, this would be outside of the park limits. At Long Key, the revetment would be along a beach where currently remnants of an old riprap structure remain. The new revetment will be approximately 1,000 feet long and approximately 15 feet wide. It would replace the old revetment; however, approximately half of the revetment would extend into areas that are not currently riprapped. The area is mostly naturalized and enjoyed by visitors, however; and new riprap would be an intrusive view. This is also an area where the Park has conceptual plans for shoreline planting; therefore, the new revetment structure would need to avoid plantings as practicable. At Fiesta Key West, approximately 1,350 linear feet of revetment would be placed immediately adjacent to the Overseas Trail. Minor tree removal may be needed there, but the revetment will be placed upslope of the existing mature mangroves. FDOT will also repair the damaged Overseas Trail and stabilize the slope at this location. At Fiesta Key East, there is already an extensive riprap revetment in place; the new revetment would be added to that and would be in keeping with this view. At Indian Key, approximately 400 linear feet of revetment would be placed on a sloped embankment immediately adjacent to the roadway and trail, which already contains some rock. This is an open area, and it is also in the vicinity of areas used by visitors, so it would be visible from the roadway, trail, and the open space area itself (Figure 8-8).

Figure 8-8: Fiesta Key East impact area (l) and Indian Key Fill impact area (r).

Implementation of Alternative 1 also would require temporary construction access. This would be expected to be from existing roads and staging areas. During these times, heavy equipment would be visible for approximately four to five months at each location, in order to construct the riprap revetment. Similarly, localized maintenance, as repairs will be needed from time to time, for a lesser period of time.

Revetments are not commonly visible in the Keys; however, they do exist. Revetments in the six proposed locations would not degrade the overall viewshed of the ROI. Overall, this alternative would have temporary and permanent minor adverse effects on aesthetics within the ROI.

8.17.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

The nonstructural measures, particularly elevation, would definitely change the appearance of the homes. This could be a beneficial or adverse effect, depending on perspective. Depending on current FFE, the final elevation would be between 3 and 12 feet off the ground. The homes would be placed on timber supports. Lifting the homes this far off the ground would make them more visible for longer distances. In some neighborhoods, only a few homes would be treated, and those might stand out in the neighborhood, due to height.

Land disturbance for this alternative would be limited to modification of existing buildings. Structures that will be elevated would remain similar in appearance, except that they could be seen from further distances.

Implementation of Alternative 6 would require construction access to all structures to be treated; this would be expected to be from existing roads. Similarly, localized maintenance, such as repairs, will be needed over time. During those timeframes only, construction vehicles would be visible.

Minor to moderate temporary and permanent adverse impacts to aesthetics are expected to result from implementation of Alternative 6.

8.17.3 Alternative 7: Nonstructural and Structural Alternative, Combined (Recommended Plan)

The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. Overall, this alternative would have direct, minor, temporary and permanent adverse effects on aesthetics.

8.17.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would involve no additional action from current or planned future actions to mitigate against coastal storm risk. No temporary or permanent impacts to aesthetics would occur, other than those expected due to climate change, sea level rise, and associated increased erosion.

8.17.5 Best Management Practices to Avoid and Minimize Impacts on Aesthetics for Alternative 7

1) Revetment footprints have been reduced to avoid impacting existing woody vegetation to the extent practicable.
2) The minimum necessary vegetation will be removed for construction access.
3) After construction is complete, temporarily disturbed areas will be seeded, vegetated, and stabilized.

8.18 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE (HTRW)

8.18.1 Alternative 1: Structural Only Alternative (Revetments Only)

The ROI currently consists of roadside embankments along or near the Overseas Highway and Trail. Implementation of this alternative would include temporary and permanent land disturbance. However, no known industrial activities produce hazardous, toxic, and/or radioactive wastes adjacent to the project site; no known industrial activities discharge effluents near the shoreline; and no known records of such past activities exist. There also was no evidence noted of any of these contaminants during a site visit in December 2019. Therefore, no temporary or permanent adverse effects caused by HRTW would be expected to occur as a result of implementing this alternative.

8.18.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Alternative 6 involves disturbance to existing structures of varying ages; therefore, the potential exists for some structures to contain lead-based pain (LBP), asbestos containing materials (ACM), or polychlorinated biphenols (PCBs). As a result, a Phase 1 Environmental Site Assessment should be conducted for any affected structure constructed prior to 1978. If any such contaminants are found, the construction contract must include procedures for the lawful demolition, removal, and disposal of such wastes. With this stipulation, there would be negligible adverse permanent and minor adverse temporary impacts on HRTW.

8.18.3 Alternative 7: Nonstructural and Structural Alternative, Combined (Recommended Plan)

The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. Overall, with adherence to the Best Management Practices in Section 8.19.5, this alternative could have direct, but temporary and minor effects on HRTW. For either alternative, or for this combined alternative, a potential for hydrocarbon spills exists with dredging and construction equipment in the area, but accident and spill prevention plans specified in the contract specifications should prevent most spills. The construction contract would include requirements to properly manage, store, and dispose of all fuels and materials generated by or used for the project.

8.18.4 Alternative 8: No Action/Future Without Project

The No Action Alternative would involve no additional action from current or planned future actions to mitigate against coastal storm risk. No temporary or permanent impacts to HRTW would occur.

8.18.5 Best Management Practices to Avoid and Minimize Impacts on HRTW for Alternative 7

1) A Phase 1 Environmental Site Assessment is recommended for any structure to be disturbed that is older than 1978, to check for ACM, LBP, and PCBs.
2) If HRTW materials are found, the project specifications will include procedures that require that they be handled and disposed of in a lawful manner.
3) If HRTW materials are found, coordination will occur with the FDEP's Waste Division will occur.
4) The project specifications should include a fuel spill contingency plan.

8.19 SAFETY

8.19.1 Alternative 1: Structural Only Alternative (Revetments Only)

For this alternative, the identified locations along U.S. Route 1 that have less than 100 feet of land between the road footprint and the shoreline, and are not already being stabilized by others, will be stabilized with revetments. During construction, if all safety regulations are followed, there would be negligible temporary adverse effects on safety for construction workers and the public. There would be permanent minor direct and indirect beneficial effects for safety, through the management of erosional damage due to coastal storms and SLR of vulnerable sections of U.S. Route 1, which is the only land evacuation route from the Keys.

8.19.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Alternative 6 involves temporary construction on existing structures, demolition of structures to be acquired, and construction access for both. During construction, if all safety regulations are followed, there would be negligible temporary adverse effects on safety.

There would be permanent minor direct and indirect beneficial effects for safety as a result of this alternative. Elevation and dry floodproofing both aid in adaptation of structures to SLR due to climate change. In addition, the resulting open space could also help absorb coastal storm floodwaters and SLR and potentially help reduce flooding and unsafe conditions elsewhere. Flood warning systems and emergency planning would also help residents make preparations to prevent damage, and/or evacuate more effectively, orderly, and safely, reducing direct impacts on residents and businesses. Land use planning would also reduce impacts by reducing the future number of citizens located in areas most vulnerable to damage.

8.19.3 Alternative 7: Nonstructural and Structural Alternative, Combined (Recommended Plan)

The nature and type of impacts associated with this alternative are a combination of those described above under Alternatives 1 and 6. With best management practices, there would be negligible temporary adverse effects on safety, and there would be permanent minor direct and indirect beneficial effects for safety.

8.19.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would mean not implementing a build alternative. No temporary or permanent impacts to safety would occur, due to any build alternative. However, the Keys are located in a low-lying region, which makes them vulnerable to increased frequency of unsafe flooding conditions and damage. This can lead to various potentially dangerous conditions such as flooded or damaged evacuation route, stranded residents, power outages, and damaged buildings.

8.19.5 Best Management Practices to Avoid and Minimize Impacts on Safety for Alternative 7

1) Construction workers would be required to follow the Occupational Safety and Health Act (OSHA) regulations
2) Public access would be prohibited in construction zones
3) Construction schedules would be coordinated with the County and the Parks to prevent conflicts with other construction schedules.

8.20 UTILITIES

8.20.1 Alternative 1: Structural Only Alternative (Revetments Only)

As described in the Affected Environment, the ROI includes all utilities within the Study Area in Monroe County that have the potential to be impacted. The major utilities within the Study Area include: buried potable, wastewater, and stormwater infrastructure, and buried and aboveground power transmission lines. Other underground telecommunication lines are also present within the Study Area.

There are existing underground utilities, including private telecommunication lines and a water transmission main located within portions of the FDOT right-of-way adjacent to U.S. Route 1 throughout Monroe County; however, there are no above ground utilities occurring in the proposed footprint of the six revetments. Construction of the six revetments would not directly impact any existing above-ground public or private utilities. Local investigations would be required to determine the exact location of buried utilities and their proximity to the revetment footprints. Utility impacts would be thoroughly vetted as the design process continues. Coordination would occur with the local utility companies including telecommunication providers (such as AT&T and Verizon) and the Florida Keys Aqueduct Authority to determine what action, if any, would be needed. At this time, utility relocation is not anticipated; however, if relocation was determined necessary in the future, it would represent a permanent, negligible to minor temporary adverse impact. There would be minor permanent beneficial impacts if any utilities are protected by the revetments.

8.20.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

There would be minor, temporary to permanent impacts to utility infrastructure with implementation of Alternative 6. Implementation of measures such as elevation and dry floodproofing would likely require local investigations for existing utilities such as service lines to individual buildings for water, sewage, and power. There is the potential that smaller electrical components might require elevation (i.e. generator, air conditioning units, etc.) in conjunction with the floodproofing and elevation activities.

There would be temporary negligible to minor adverse impacts to utilities. There would be negligible permanent effects on utilities.

8.20.3 Alternative 7: Nonstructural and Structural Alternative, Combined (Recommended Plan)

The effects of this alternative would be a combination of those listed above for Alternatives 1 and 6. Utility impacts would be direct, minor and temporary to permanent with the implementation of both nonstructural and structural measures. There would be minor permanent beneficial impacts if any utilities are protected by the revetments.

8.20.4 Alternative 8: No Action and Future Without Project

Coastal storms would continue to pose a potential threat to utility infrastructure in the future; consequently, existing public and private utilities would need to be repaired, upgraded, or relocated as needed.

8.20.5 Best Management Practices to Avoid and Minimize Impacts on Utilities for Alternative 7

Avoidance and minimization measures will be employed to the maximum extent practicable for all potential utility impacts. Practicable is defined as meaning the alternative is available and capable of being done after taking into consideration cost, existing technology, and/or logistics in light of the overall project purpose(s). Specific examples of best management practices to avoid and minimize impacts on utilities include:

1) A thorough vetting of all potential utilities in the construction footprint would be conducted in the PED phase.
2) Once final revetment alignments and laydown areas are confirmed a detailed survey and coordinated effort with local utility companies would take place to accurately document the location of existing utilities.
3) To ensure public safety, construction activities would safeguard against any temporarily exposed or relocated utility features, as necessary.

4) Potential impacts to both the general public in regard to service interruptions and to the utility providers in regard to utility relocations would be minimized to the maximum extent practicable.

8.21 AIR QUALITY

8.21.1 Alternative 1: Structural Only Alternative (Revetments Only)

As described in the Affected Environment, the ROI for air quality is Monroe County, Florida, which comprises all of The Florida Keys – from Key Largo south to Key West. Monroe County is currently in attainment for all NAAQS criteria pollutants; therefore, the EPA's general conformity rule to implement Section 176(c) of the CAA does not apply and a conformity analysis is not required.

Direct air emissions would occur from the use of construction equipment such as excavators, dump trucks, and other motor vehicles during transportation of materials to the project site and construction of the six revetments resulting in negligible, temporary impacts to air quality. However, emissions would be localized and expected to disperse quickly.
Florida DEP regulates HAPs in accordance with the National Emissions Standards for Hazardous Air Pollutants (NESHAP), and permits are required for operations subject to applicable regulations or that emit air pollutants in sufficient quantities to warrant regulation. No air quality permits would be anticipated for the use of mobile construction equipment for construction of the six revetments. There would be temporary minor adverse effects and no permanent adverse effects on air quality.

8.21.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Air quality impacts resulting from implementation of Alternative 6 would be similar to Alternative 1 and would occur from the use of construction equipment necessary to elevate or demolish existing structures, as determined necessary. Impacts to air quality resulting from construction equipment emissions would be minor and temporary. There would be no permanent adverse effects on air quality.

8.21.3 Alternative 7: Nonstructural and Structural Alternative, Combined (Recommended Plan)

The effects of this alternative would be a combination of those listed above under Alternatives 1 and 6. Emissions from construction equipment for revetment construction or structure elevation or demolition would be localized and expected to disperse quickly. Additionally, project implementation would occur over a period of months to years and would not result in impacts that could be meaningfully measured. There would be direct, temporary minor adverse effects and no permanent adverse effects on air quality.

8.21.4 Alternative 8: No Action and Future Without Project

No impacts to air quality would occur with implementation of the No Action and Future Without Project Alternative.

8.21.5 Best Management Practices to Avoid and Minimize Impacts on Air Quality for Alternative 7

1) No unnecessary idling of trucks or other equipment shall occur when not in use during construction.
2) Fugitive dust must be kept to a minimum. Dust minimization measures would be implemented as needed.
3) Spilled or tracked dirt or other materials must be removed promptly from pavement.

8.22 NOISE

8.22.1 Alternative 1: Structural Only Alternative (Revetments Only)

The ROI currently is subject to ambient traffic noise of the Overseas Highway and Trail that is permanent but varies throughout the day and night. All of the constructed revetments would be within 100 feet of this corridor.

Alternative 1 would have no permanent direct or indirect adverse effect on noise. However, there would be minor temporary adverse effects on noise during construction, due to backhoes, excavators, trucks, and other heavy equipment working in the vicinity of the revetment locations, as well as entering and exiting the highway.

The following are typical noise levels of construction equipment:

- Backhoe (maximum noise level: 80.0 dBA10)
- Compactor (maximum noise level: 80.0 dBA)
- Bulldozer (maximum noise level: 85.0 dBA)
- Dump truck (maximum noise level: 84.0 dBA)
- Excavator (maximum noise level: 85.0 dBA)
- Front end loader (maximum noise level: 80.0 dBA)
  (USDOT, 2006)

Passive recreational use of the two state parks, Bahia Honda and Long Key, as well as Indian Key Fill, are the only noise-sensitive land uses within the ROI; no residences, schools, churches, businesses are present. The construction in the vicinity of Bahia Honda State Park would be outside of the park fence and much closer to U.S. Route 1 than construction at Long Key; therefore, the temporary effects on Long Key State Park would be more pronounced than those at Bahia Honda State Park. Because both are passive use parks, construction noise would impact such uses as camping, wading, hiking, canoeing, bird and wildlife watching, etc. Indian Key Fill also is used by visitors for similar passive uses such as wading, gatherings, canoeing, and boating, therefore, effects would be similar. However, for safety reasons, visitor access and use will also be restricted around the construction zones, and possibly certain sections of the parks and Indian Key Fill may need to be closed off entirely. Therefore, the noise would occur when no or fewer people were in the vicinity.

Overall, this Alternative will have temporary, minor to moderate adverse effects, during construction only. Construction is expected to take between four to five months at each location. Noise levels would be subject to local noise ordinance requirements. Construction would be expected to take place only during normal business hours and not occur at night, early mornings, or on Sundays.

Sound can be abated by vegetation and objects (including buildings) that are between the location and a direct line-of-sight of the construction. Therefore, the mangrove and/or buttonwood wetlands that are currently present along the shorelines will remain in the vicinity of the revetments at the West Summerland Key, Fiesta Key West, Fiesta Key East, and Indian Key Fill may help to buffer noise effects from those using the waterways.

8.22.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Alternative 6 would have no permanent, direct or indirect adverse noise effects. However, minor temporary adverse noise effects are expected to result from implementation of Alternative 6, because construction for this alternative would take place in populated areas throughout the Keys and would include modification of existing buildings.

These impacts will be similar to that of Alternative 1, except that less equipment and a shorter time at each location will be needed to raise a structure. Noise due to construction could be ten dBA higher than ambient noise up to 400 feet away from the construction site. Non-physical actions will not affect noise levels.

Overall, this Alternative will have temporary, minor adverse effects, during construction only. The duration of time to complete all of the work this alternative is not known at this time. However, just as for Alternative 1, noise levels would be subject to local noise ordinance requirements. Construction would be expected to take place only during normal business hours and not occur at night, early mornings, or on Sundays.

8.22.3 Alternative 7: Nonstructural and Structural Alternative, Combined (Recommended Plan)

The effects of this alternative would be a combination of those described above under Alternatives 1 and 6. Overall, this Alternative will have temporary, minor to moderate adverse effects during construction only. There would be no permanent effects.

8.22.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would involve no additional action from current or planned future actions to mitigate against coastal storm risk. No temporary or permanent impacts to noise would occur.

8.22.5 Best Management Practices to Avoid and Minimize Impacts on Noise for Alternative 7

1) Time constraints including noise ordinance requirements and use of equipment regulations can be effective in reducing the impacts caused during sensitive time periods.
2) Operating noisy equipment only when necessary and switching off such equipment when not in use can minimize noise impacts.
3) Other temporary abatement techniques could include the use of temporary and/or movable shielding for both specific and nonspecific operations, if needed. Some mobile shielding is capable of being moved intact. An example of such a barrier utilizes noise curtains in conjunction with trailers to create an easily movable, temporary noise barrier system (FHWA).

8.23 CLIMATE CHANGE AND SEA LEVEL RISE

8.23.1 Alternative 1: Structural Only Alternative (Revetments Only)

For this alternative, the identified locations along U.S. Route 1 that have less than 100 feet of land between the road footprint and the shoreline, and are not already being stabilized by others, will be stabilized with revetments. Direct air emissions of greenhouse gases would occur from the temporary use of construction equipment such as excavators, dump trucks, and other motor vehicles during transportation of materials to the project site and construction of the six revetments. Greenhouse gas emissions would have an indirect permanent but negligible effect on climate change. There would be permanent beneficial effects for adaptation to climate change. The revetment areas would help reduce the risk of damage to U.S. Route 1 from erosion due to coastal storms and SLR. However, the cumulative effects of climate change, such as sea level rise, as described in the Affected Environment chapter, and in the Cumulative Effects section below, would still occur. If it is determined during the Operations and Maintenance (O&M) phase that any of the revetments require maintenance, appropriate actions would be determined and taken to address these areas.

8.23.2 Alternative 6: Nonstructural Only Alternative (Critical Infrastructure/Development Centers Only)

Alternative 6 involves temporary construction on existing structures, construction access. Greenhouse gas emissions resulting from implementation of Alternative 6 would occur from the use of construction equipment necessary to elevate or demolish existing structures, as determined necessary. The greenhouse gas emissions would have an indirect permanent but negligible effect on climate change.

There would be permanent direct and indirect significant beneficial effects for adaption to climate change as a result of this alternative. Elevation and dry floodproofing would both aid in adaptation of thousands of structures to SLR due to climate change. Flood warning systems and emergency planning would also help residents make preparations to prevent damage, and/or evacuate more effectively, reducing direct impacts on residents and businesses. Land use planning would also reduce impacts on residents and businesses by reducing the number of structures located in areas most vulnerable to damage. However, the cumulative effects of climate change, such as sea level rise, as described in the Affected Environment chapter, and in the Cumulative Effects section below, would still occur.

8.23.3 Alternative 7: Nonstructural and Structural Alternative, Combined (Recommended Plan)

The effects of this alternative would be a combination of those described above under Alternatives 1 and 6. There would be an indirect permanent but negligible effect on climate change due to greenhouse gas emissions. However, there would be permanent direct and indirect significant beneficial effects for adaptation to climate change. Elevation and dry floodproofing would both aid in adaptation of thousands of structures to SLR due to climate change. Flood warning systems and emergency planning would also help residents make preparations to prevent damage, and/or evacuate more effectively, reducing direct impacts on residents and businesses. Land use planning would also reduce impacts on residents and businesses by reducing the number of structures located in areas most vulnerable to damage. However, the cumulative effects of climate change, such as sea level rise, as described in the Affected Environment chapter, and in the Cumulative Effects section below, would still occur.

8.23.4 Alternative 8: No Action and Future Without Project

The No Action and Future Without Project Alternative would mean not implementing a built alternative. No temporary or permanent impacts to climate change would occur, due to any build alternative. However, the cumulative effects of climate change as described in the Affected Environment chapter, and in the Cumulative Effects section below, would still occur. Significant adverse effects due to damages to buildings and roadways due to SLR and coastal storms would be expected to continue and increase, and structures and roadways protected by the proposed action would be more vulnerable to damage.

8.23.5 Best Management Practices to Avoid and Minimize Impacts on Climate Change and SLR for Alternative 7

1) Energy requirements for the proposed alternative would be limited to the fuel construction equipment associated with beach placement.
2) No unnecessary idling of trucks or other equipment shall occur when not in use during construction.

8.24 CUMULATIVE EFFECTS

There are a multitude of past, present, and reasonably foreseeable future projects within the study area. Regardless of whether Alternatives 1, 6, 7, or 8 is adopted, these efforts planned by others would be expected to occur.

A myriad of local, state, and federal projects and studies with sea level rise and climate change resiliency efforts from governmental and non-profit agencies will continue to be studied and implemented. Existing coastal storm risk management resilience efforts in Monroe County would continue to be implemented and maintained. Monroe County has a very active resiliency program. These efforts include, but are not limited to: conducting site-specific vulnerability studies, conducting studies for numerous roadway elevations, completing a watershed management plan of the storm water infrastructure, updating LIDAR elevation data and SLR projections, identifying repetitive loss and adaption action areas, and adding policies to the comprehensive plan that dis-incentivize development in high-risk areas. This could also include physical efforts such as secondary and tertiary road raisings. Development centers may continue to grow; however, they would be subject to wetland, floodplain, and County regulations and requirements.

As a result of Hurricane Irma, there have been numerous washouts of the U.S. Route 1 Overseas Trail and/or the U.S. Route 1 roadway embankment along various sections of the Florida Keys. FDOT will be placing revetments or articulating block bank repairs at approximately 99 locations, including five that were deleted from our initial array of alternatives. This work includes fill and slope repairs to the Overseas Trail where needed. Specifically, West Summerland Key and Fiesta Key West and East are among the locations that FDOT intends to repair and are near the proposed revetments. FDOT's work also would require temporary upland staging areas. During this study, USACE coordinated closely with FDOT on their proposed revetments; and coordination of construction schedules would also occur in PED, to avoid any conflicts.

It is unknown at this time when FDOT's work will be done and what areas will be used for staging; so there may be cumulative temporary adverse effects on recreational land use on the Overseas Trail with the proposed revetments and FDOT repairs. Many sections of damaged trails unusable now will be restored. Once completed, these actions, should have permanent cumulative beneficial bank stabilization effects on the Overseas Trail, and in conjunction with the Proposed Action in particular, would further protect trail repairs at West Summerland Key and Fiesta Key West and East. FDOT's work, although mostly small-scale operations, will also repair damaged roadway embankments and help prevent future damage. FDOT's bank work and the Proposed Action would be designed to enhance preservation of utility infrastructure and service and have beneficial effects on safety and transportation. It may be visible at certain locations, but if so, would be expected to have minor adverse aesthetic effects.

Other routine bank stabilization projects on public and private property would be expected to continue. It is possible that some of the existing breakwaters that are in disrepair in the Keys could be repaired or maintained by the County or others. Some of this work could potentially affect surface waters and water quality, vegetated wetlands. It could also potentially affect threatened and endangered species by blocking access and degrading existing habitat and foraging capabilities that was previously useful. Other reasonably foreseeable work within the ROI is planned within Bahia Honda and Long Key State Parks. Both parks experienced washouts of their campground sites and access roadways in the vicinity of the proposed revetments; and both plan to repair the roads and campsites and reopen them for public use. Both parks also plan to implement shoreline replantings in washout areas. The Long Key revetment would need to be planned in coordination with the park and to accommodate their planting plan as practicable. Effects on threatened and endangered species or wildlife from those plantings would be expected to be beneficial enhancements through habitat enhancement and protection. Because there will be no in-water impacts, and there would be strict erosion and sediment control measures during construction, there would be no cumulative effect on fish or fishery resources, benthics, hardbottom, or SAV resources.

Cumulative effects on transportation from implementation of Alternative 7 combined with those of other described actions are predicted to be minor to moderate and beneficial. Cumulative adverse effects from implementation of Alternative 7 to navigation, geology, topography, and soils, HTRW, emissions and air quality and attainment status, noise, are predicted to be temporary, localized, and negligible to minor.

Any cumulative adverse effects from implementation of Alternative 7 are predicted to be minor and localized and range from temporary to permanent in duration for aesthetics, and for hydrology, hydraulics, and bathymetry. Cumulative effects on wetlands and vegetated beach will also be to be minor and localized, and range from temporary to permanent in duration, because the unavoidable impacts will be mitigated. However, it can be expected that due to natural causes such as sea level rise, erosion would continue to occur. Sea level rise also may cause reduced growth or die-off of existing mangroves (Krauss et al., 2008), while the presence of the proposed revetments would preclude up-slope migration of new mangroves. The six revetments would have the potential to block that migration particularly at the Fiesta Key West location where there are currently mangroves seaward of the proposed revetments. Natural forces also could cause further beach erosion and further inland retreat of upland vegetation. Expected SLR will be taken into account for the mitigation grading plan.

There also would be no significant cumulative temporary or permanent adverse effects to recreation from implementation of Alternative 7. However, recreational activities could be impacted by natural causes such as sea level rise and increased future storms, which could cause future damage to recreational areas such as beaches, the Overseas Trail, State Parks, etc., limiting recreational activities.

Threatened and endangered species in the ROI have species specific cumulative impacts. Piping plovers, red knots, and roseate terns are prone to effects from run off, invasive plants, habitat loss, and shoreline stabilization efforts. Sea turtles are prone to fishery interactions, boat strikes, habitat loss and artificial lighting along the coast. American crocodiles and alligators are prone to vehicle strikes, habitat loss, and hurricanes. Three species of threatened or endangered plants have the potential to be present within the revetment construction areas. Plant surveys would be conducted during PED, and if individuals are found, either the revetment design would be modified to avoid them, or they would be transplanted by a qualified biologist to a suitable habitat. Cumulative adverse effects to threatened and endangered species, critical habitat, and wildlife species from implementation of Alternative 7 are predicted to be localized and range from temporary to permanent in duration (affecting up to 7.5 total acres- 2 permanent and 5.5 temporary) of critical habitat). It also should be noted that threatened or endangered species could become stressed due to deeper, warmer, more acidic waters from climate change and sea level rise. Cumulative impacts on threatened and endangered species are discussed in greater detail in the Biological Assessment in the Environmental Appendix, Appendix D, and coordination with USFWS is ongoing. Following the Reasonable and Prudent Measures (RPM) determined at the conclusion of coordination would ensure compliance with the Endangered Species Act (ESA), and would prevent long-term cumulative adverse effects to threatened and endangered species.

Minor to moderate effects are anticipated for cultural resources and socioeconomics, from the Proposed Action itself. Cumulative cultural resources effects, when combined with other potential effects by private homeowners, could be moderate if numerous historic homes and/or districts are affected by elevation. A PA has been drafted to address future effects and mitigation. Future land use restrictions and SLR, could result in less land and housing availability. However, the land use restrictions and SLR would occur with or without the Proposed Action, and all affected residents would be eligible for temporary relocation to a comparable residence with less potential for coastal storm damage.

Construction noise and emissions would be associated with some of these past, present, and reasonably foreseeable physical efforts. Any work within surface waters and/or wetlands by others would require Section 401 and 404 Clean Water Act permits, a Rivers and Harbors Act permit County, and FKNMS requirements; all of which would require strict erosion and sediment controls, including minimization of turbidity, during construction. They also would be subject to applicable ESA and EFH regulations. However, the County indicates that generally, very limited wetland impacts are allowed; and as a general rule, mangrove impacts are not allowed. Climatic changes such as sea level rise and increasing global temperatures are predicted to continue over the next 50 years. Predicted climate change impacts such as increased ocean temperatures, ocean acidification, sea level rise, and changes in currents, upwelling and weather patterns, have the potential to cause changes in the nature and character of the estuarine ecosystem, sea levels and surface land temperatures in the ROI. Due to the synergistic effects from a combination of factors, and relative SLR, and an increase in the frequency and strength of storms, the risk from coastal inundation will rise in the coming years for the Florida Keys. Most of these impacts will directly affect local flooding and people, property, and the environment. As a result, beaches, vegetated shorelines, banks, and wetlands could erode further or become regularly inundated. As mentioned, all aquatic organisms, including fisheries, benthics, SAV, and threatened and endangered species, could become stressed due to deeper, warmer, more acidic waters from climate change and SLR.

However, implementation of Alternatives 1, 6, 7, or 8 would not be predicted to substantially cumulatively or synergistically adversely interact with climate change and/or effects. Overall, the Proposed Action and those of other actions would be beneficial for adaptation to climate change.

8.25 IRREVERSIBLE AND IRRETRIEVABLE RESOURCES

Irreversible and irretrievable commitment of resources are ones in which the ability to use and/or enjoy the resource is lost forever. Irreversible effects primarily result from the use or destruction of a specific resource (such as energy or minerals) that cannot be replaced within a reasonable timeframe. Irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored because of the action (such as the disturbance of a cultural resource site).

At the Long Key revetment location, a section of beach and vegetated dune area would be permanently converted to revetment and the habitat and/or foraging value would be lost for shorebirds, and threatened or endangered species such as the piping plover and/or sea turtle nesting. Likewise, potential habitat for three threatened/endangered plant species may also be permanently displaced by the revetments; however, the plants, if found during a survey, could be relocated to suitable habitat.

Cultural resources may be permanently altered and adversely affected by elevation or floodproofing, but not irretrievably lost. The cultural resources PA addresses these effects and mitigation for them.

Use or access to residences and/or buildings to be elevated or floodproofed may be limited for a short time, but would be restored post-construction. Use of recreational areas such as the community fishing pier near Fiesta Key and small sections of the Overseas Trail may be lost or limited for a time, but also would be restored after to construction. Wetland and dune vegetation also would be temporarily lost; however, they would be mitigated in-kind, Use of habitat areas within or near the construction zone may be temporarily lost or restricted for wildlife and threatened/endangered species; however, these areas would also be restored following construction. Therefore, none of these would be irreversibly or irretrievably lost.

CHAPTER 9 ENVIRONMENTAL COMPLIANCE

Compliance with the following environmental laws (and implementing regulations) and Executive Orders is required for the project alternatives under consideration (Tables 9-1 to 9-3) (note: this is not necessarily an exhaustive list of all applicable environmental requirements).

9.1 TABLES OF ENVIRONMENTAL COMPLIANCE, EXECUTIVE ORDERS, AND PERMITTING REQUIREMENTS

Table 9-1: Environmental Compliance

Title of Law	U.S. Code	Compliance Status
Abandoned Shipwreck Act of 1987	43 United States Code (U.S.C.) 2101	N/A
American Bald and Golden Eagle Protection Act of 1962, as amended	16 U.S.C. 668	Full compliance
Anadromous Fish Conservation Act of 1965	16 U.S.C. 757 a et seq	N/A
Clean Air Act of 1972, as amended	42 U.S.C. 7401 et seq	Full compliance
Archaeological and Historic Preservation Act of 1974	Public Law 93-291 and 16 U.S.C.469-469c	Full compliance, with execution of Regional PA with SHPO.

Title of Law	U.S. Code	Compliance Status
Clean Water Act of 1972, as amended	33 U.S.C. 1251 et seq	The FDEP has indicated that based on minimal impacts, it has no objections to the project at this feasibility stage. Clean Water Act Section 401 Water Quality Certification is issued from FDEP, as part of the Environmental Resource Permit (ERP), as required per Florida Administrative Rule 62-330.062. Water Quality Certification and Coastal Zone Consistency Concurrence. DEP will issue 401 Water Quality Certification during the PED Phase of the project with submittal of 401 WQC application. This project falls within USACE Regulatory boundaries based on the state of Florida Clean Water Act Section 404 assumption, as it falls within the 300-foot guideline established from the ordinary high water mark or mean high tide line of the retained water. No Section 404 permit is required; however, the project will adhere to the Section 404(b)(1) guidelines.
Coastal Barrier Resources Act and Coastal Barrier Improvement Act of 1990	Public Law 113-314 and 16 U.S.C. 3501 et seq	Full compliance. USFWS has determined that an exemption applies for the nonstructural measure of floodproofing one critical infrastructure facility.
Coastal Zone Management Act of 1972, as amended	16 U.S.C. 1451 et seq	Full compliance. Federal Consistency Determination concurrence received.

Title of Law	U.S. Code	Compliance Status
Comprehensive Environmental Responses, Compensation and Liability Act of 1980	42 U.S.C. 9601	No coordination currently required. If CERCLA regulated materials are later identified, coordination will then be initiated. In such event, full compliance is anticipated.
Deepwater Port Act of 1974, as amended	33 U.S.C. 1501	N/A
Emergency Wetlands Resources Act	16 U.S.C. 3901-3932	N/A
Endangered Species Act of 1973	16 U.S.C. 1531	Full compliance. The formal Section 7 Consultation with USFWS was completed. No effect to species under NMFS purview.
Estuary Protection Act of 1968	16 U.S.C. 1221 et seq	N/A
Fish and Wildlife Coordination Act of 1958, as amended	16 U.S.C. 661	Full compliance
Flood Control Act of 1970	33 U.S.C. 549	Full compliance
Land and Water Conservation Act	16 U.S.C. 460	Full compliance
Magnuson-Stevens Fishery Conservation and Management Act	16 U.S.C. 1801	N/A, no in-water structures proposed.
Marine Mammal Protection Act of 1972, as amended	16 U.S.C. 1361	N/A, no in-water structures proposed.
Marine Protection, Research, and Sanctuaries Act of 1972	33 U.S.C. 1401	Full compliance. The Florida Keys National Marine Sanctuary (FKNMS) was an active cooperating agency. No in-water impacts are proposed within the FKNMS. With adherence to Best Management Practices, including strict erosion and sediment control, the Proposed Action would have negligible to minor adverse effects on the FKNMS.

Title of Law	U.S. Code	Compliance Status
Migratory Bird Conservation Act of 1928, as amended	16 U.S.C. 715	The Proposed Action would adhere to the standard Jacksonville District Best Management Practices for Migratory Birds, as detailed in Section 9.24, and therefore would be in full compliance.
Migratory Bird Treaty Act of 1918, as amended	16 U.S.C. 703	The Proposed Action would adhere to the standard Jacksonville District Best Management Practices for Migratory Birds, as detailed in Section 9.24, and therefore would be in full compliance.
National Environmental Policy Act of 1969, as amended	42 U.S.C. 4321 et seq	Full compliance upon signature of the final ROD
National Historic Preservation Act of 1966, as amended	54 U.S.C. § 300101, et seq.	Full compliance, with execution of Regional Programmatic Agreement (PA) with SHPO.
National Marine Sanctuaries Act of 1972	16 U.S.C. 1431 et seq.	Full compliance
Noise Control Act of 1972, as amended	42 U.S.C. 4901	Full compliance
Resource Conservation and Recovery Act of 1976	42 U.S.C. 6901 et seq	Full compliance
River and Harbor Act of 1888, Section 11	33 U.S.C. 608	Full compliance
River and Harbor Act of 1899	33 U.S.C. 401 et seq	Full compliance
Safe Drinking Water Act of 1974, as amended	42 U.S.C. 300	Full compliance
Toxic Substances Control Act of 1976	15 U.S.C. 2601	Full compliance
Uniform Relocation and Assistance and Real Property Acquisition Policies Act	42 U.S.C. 4601 et seq	Full compliance

Table 9-2: Executive Orders

Title of Executive Order	Executive Order Number	Compliance Status
Coral Reef Protection	13089	Full compliance
Protection and Enhancement of Environmental Quality	11514/11991	Full compliance
Protection and Enhancement of the Cultural Environment	11593	Full compliance
Floodplain Management	11988	Full compliance, with floodplain management guidelines, as documented in Sections 7.5 and 9.18
Protection of Wetlands	11990	Full compliance
Federal Compliance with Pollution Control Standards	12088	Full compliance
Federal Compliance with Right-to-Know Laws and Pollution Prevention	12856	Full compliance
Federal Actions to Address Environmental Justice and Minority and Low-income Populations	12898	Full compliance.
Protection of Children from Environmental Health Risks and Safety Risks	13045	Full compliance
Invasive Species	13112	Full compliance
Marine Protected Areas	13158	Full compliance
Consultation and Coordination with Indian Tribal Governments	13175	Full compliance
Responsibilities of Federal Agencies to Protect Migratory Birds	13186	Full compliance
Facilitation of Cooperative Conservation	13352	Full compliance
Preparing the United States for Impacts of Climate Change	13659	Full compliance
Efficient Federal Operations	13834	Full compliance
Planning for Federal Sustainability in the Next Decade (2015)	13693	Full compliance

Table 9-3: Permitting Requirements

Law	Agency Responsible	Permit, Agreement, Authorization, or Notification Required
American Bald and Golden Eagle Protection Act of 1962, as amended	USFWS	“Take” permit if any eagles are accidentally harmed or killed; no take permit is anticipated
Comprehensive Environmental Responses, Compensation and Liability Act of 1980, as amended	USEPA	No effect, no superfund sites within the ROI
Clean Water Act, Section 401*	FDEP	Clean Water Act Section 401 Water Quality Certification is required, and is issued from FDEP, as part of the Environmental Resource Permit (ERP), as required per Florida Administrative Rule 62-330.062. Water Quality Certification and Coastal Zone Consistency Concurrence. DEP will issue 401 Water Quality Certification during the PED Phase of the project with submittal of 401 WQC application.

Law	Agency Responsible	Permit, Agreement, Authorization, or Notification Required
Clean Water Act, Section 404	FDEP has partially assumed the Section 404 program; however according to the "Memorandum of Agreement between FDEP and the Department of the Army (DOA)", the wetlands affected by this project would remain under the jurisdiction of USACE.	The Proposed Action falls within USACE Regulatory boundaries, based on the state of Florida 404 assumption agreement, as it falls within the 300 ft guideline established from the ordinary high water mark or mean high tide line of the retained water. However, no CWA 404 permit would be required from USACE, because USACE does not permit its own projects. The Proposed Action must adhere to the 404B1 analysis, which is found in the Environmental Appendix, Appendix D.
Coastal Barrier Resources Act	USFWS	An exemption for one critical infrastructure wastewater facility within the CBRA purview has been issued by USFWS.
Coastal Zone Management Act (CZMA)	FDEP	CZMA Federal Consistency Determination concurrence received.
Endangered Species Act of 1973	NMFS	No effect, and no incidental take permit for species under NMFS' purview, as no structures will be in the water.
Endangered Species Act of 1973	USFWS	Formal Consultation completed. Incidental take statement issued. USFWS Biological Opinion will be adhered to in PED.
Fish and Wildlife Coordination Act (FWCA)	USFWS	FWCA Concurrence Memorandum and letter received

Law	Agency Responsible	Permit, Agreement, Authorization, or Notification Required
Magnuson-Stevens Fishery Conservation and Management Act	NMFS	No effect, and no incidental take permit anticipated as no structures will be in the water.
Marine Mammal Protection Act of 1972, as amended	NMFS	No effect, and no incidental take permit anticipated as no structures will be in the water.
Marine Protection, Research, and Sanctuaries Act of 1972*	USEPA	No permit anticipated as no structures will be in the water.
Migratory Bird Treaty Act of 1918, as amended	USFWS	"Take" permit; no take permit is required.
National Historic Preservation Act of 1966, as amended	Advisory Council on Historic Preservation, Florida DHR	Regional PA was coordinated with SHPO and other consulting parties and will be adhered to in PED
Noise Control Act of 1972	USEPA	Notification of any noncompliance; none anticipated.
Resource Conservation and Recovery Act of 1976	USEPA, FLDEP	Testing, quantification, and notification for any hazardous materials.
Rivers and Harbors Act of 1899	U.S. Coast Guard	No permit required, as no structures will be in the water.

N/A = Not Applicable; FLDEP = Florida Department of Environmental Protection; NMFS = National Marine Fisheries Service; USEPA = U.S. Environmental Protection Agency; USFWS = U.S. Fish and Wildlife Service; PED = planning, engineering, design phase

9.1 National Environmental Policy Act of 1969, as amended, 42 U.S.C. 4321 *et seq.*

The NEPA requires that all federal agencies use a systematic, interdisciplinary approach to protect the human environment. This approach promotes the integrated use of natural and social sciences in planning and decision making that could have an impact on the environment. NEPA requires the preparation of an EIS for any major federal action that could have a significant impact on quality of the human environment and the preparation of an Environmental Assessment (EA) for those federal actions that do not cause a significant impact but do not qualify for a categorical exclusion. The NEPA regulations issued by CEQ provide for a scoping process to identify and the scope and significance of environmental issues associated with a project. The process identifies and eliminates from further detailed study issues that are not significant.

As previously stated, the USACE used this process to comply with NEPA and focus this Integrated Feasibility Study and EIS on the issues most relevant to the environment and the decision-making process. For a description of the agency, tribal, and public coordination completed to date and information on the NEPA scoping that was completed, please refer to the Chapter 1, under Public and Agency Coordination. All public and agency comments have been addressed; and responses to the comments are included in the Environmental Appendix D, Subappendix E, Environmental Correspondence. The Final EIS and Draft Record of Decision (ROD) will undergo a 30-day agency, tribal, and public review period only. The Final Integrated Feasibility Report and EIS, including all appendices and supporting documentation, fulfill requirements of the NEPA for the Florida Keys Coastal Storm Risk Management Study. Upon completion of the Final Integrated Feasibility Report and EIS, which is signified by the signing of the ROD, the project will be in full compliance with the NEPA.

9.2 Clean Water Act

The USACE will obtain a Water Quality Certification (WQC) from the Florida Department of Environmental Protection (FDEP) pursuant to the CWA. All construction activities will comply with federal guidance and regulations to provide information to reach a factual determination concerning Clean Water Act, Section 404 requirements (40 CFR 230.11) and applicable state water quality standards.

Section 401 and 404 of the CWA and 33 C.F.R. 336(c)(4) and 33 C.F.R. 320.4(b) require the USACE to avoid, minimize, and mitigate impacts to wetlands. Impacts to approximately 10,250 square feet of herbaceous wetlands are anticipated with implementation of this project. A wetland delineation has not been completed yet. It will be completed in the PED phase of the project. Final impact amounts will be refined upon more complete design of the project. The plan will be finalized as wetland impacts are determined in greater detail.

Coordination with the FDEP was conducted, and FDEP indicated on August 25, 2020 that it had no objection to the project at this stage. Clean Water Act Section 401 Water Quality Certification would not be obtained until the Environmental Resource Permit (ERP) is issued from DEP as is required per *Florida Administrative Rule 62-330.062. Water Quality Certification and Costal Zone Consistency Concurrence*. Therefore, DEP will not issue conditional nor full 401 Water Quality Certification until the PED Phase of the project.

It is noted that wetland mitigation will also be required to be done in compliance with the requirements under State and Federal laws, regulations, and requirements. A conceptual wetland mitigation plan is provided in the Environmental Appendix, Appendix D, and would be refined and coordinated again with FDEP during the ERP permit process in PED.

9.3 Rivers and Harbors Act, 33 U.S.C. 401 et seq.

This law and its implementing regulations prohibit the construction of any bridge, dam, dike, or causeway crossing over or in navigable waters of the U.S. without Congressional approval. The U.S. Coast Guard administers Section 9 and issues permits for construction of crossings over navigable waters. This law and its implementing regulations also allows the U.S. Coast Guard to require necessary lighting and aids to navigation and to approve any temporary or permanent closures or restrictions of navigation channels.

No in-water structures are being proposed, so no permit is required.

9.4 Federal Coastal Zone Management Act, 16 U.S.C. 1451 et seq.

The Federal Coastal Zone Management Act (CZMA) requires each federal agency activity performed within or outside the coastal zone (including development projects) that affects land or water use, or natural resources of the coastal zone to be carried out in a manner which is consistent to the maximum extent practicable, i.e. fully consistent, with the enforceable policies of approved state management programs unless full consistency is prohibited by existing law applicable to the federal agency.

To implement the CZMA and to establish procedures for compliance with its federal consistency provisions, the U.S. Department of Commerce, NOAA, promulgated regulations which are contained in 15 C.F.R. Part 930. As per 15 CFR 930.37, a federal agency may use its NEPA documents as a vehicle for its consistency determination.

The Florida Coastal Management Program (FCMP) was approved by NOAA in 1981 and is codified at Chapter 380, Part II, F.S. The state of Florida's coastal zone includes the area encompassed by the state's 67 counties and its territorial seas. The FCMP consists of a network of 24 Florida Statutes administered by eight state agencies and five water management districts. This framework allows the state to make integrated, balanced decisions that ensure the wise use and protection of the state's water, property, cultural, historic and biological resources; protect public health; minimize the state's vulnerability to coastal hazards; ensure orderly, managed growth; protect the state's transportation system; and sustain a vital economy.

As the designated lead coastal agency for the state, FDEP communicates the agencies' comments and the state's final consistency decision to federal agencies and applicants for all actions other than permits issued under Clean Water Act Section 404 and Section 10 of the Rivers and Harbors Act. The state's consistency decisions on those permits are made through the approval or denial of the wetland resource or environmental resource permits issued under Chapter 373, Part IV, F.S.

Coordination with FDEP for the Federal Consistency Determination (FCD) was initiated upon the release of the Draft EIS, and concurrence was received on August 25, 2020. (The FCD with the CZMA concurrence is provided in the Environmental Appendix, Appendix D).

9.5 Clean Air Act, as amended, 42U.S.C. 7401 *et seq.*

The Clean Air Act (CAA) is the comprehensive federal law that regulates air emissions from stationary and mobile sources. Among other things, this law authorizes the USEPA to establish National Ambient Air Quality Standards (NAAQS) to protect public health and public welfare and to regulate emissions of hazardous air pollutants.

Monroe County is designated as an attainment area for Federal air quality standards under the CAA. There would be temporary increases in air emissions associated with the construction of these alternatives. No air quality permits are anticipated to be required for this project 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.

9.6 U.S. Fish and Wildlife Coordination Act, 16 U.S.C.661-666(c)

The project was coordinated with the USFWS and the State of Florida. A Fish and Wildlife Coordination Act Memorandum was prepared by the USFWS, which stipulated that USFWS's comments pursuant to the FWCA would be submitted during the NEPA process, and/or the Endangered Species Act Section 7 consultation. The USFWS has provided a letter indicating that this consultation is complete.

9.7 Endangered Species Act

A Biological Assessment evaluating the potential impacts of the proposed action on endangered and threatened species was prepared and is provided in Appendix D, Environmental Appendix. Critical habitat has been designated for some of the species that occur in the action area. Formal consultation with the USFWS was conducted pursuant to Section 7 of the ESA for the species provided in Table 9-4 below.

Formal consultation with the USFWS was conducted because of the potential, adverse effects to loggerhead sea turtle nearshore breeding, foraging and nesting areas; piping plover, red knot, roseate tern foraging and loafing areas. In addition, there is potential habitat for the Cape Sable Thoroughwort, Garber's spurge, and the tree cactus, due to the construction of the revetments in the Action Area. Other effects to federally listed species include no effect or may affect, and not likely to adversely affect determinations. The USFWS Biological Opinion was signed on April 12, 2021, completing formal consultation. The analysis and findings are described in detail in the Special Status Species Section and in the Biological Assessment and the Biological Opinion found in the Environmental Appendix D, Subappendix A.

There will be no effects to species under the purview of the NMFS, as no structures or construction would be in the water.

Table 9-4: Federally Listed Species Known or with the Potential to Occur in the Action Area.

SPECIES / RESOURCE NAME	ESA SECTION 7 / EAGLE ACT DETERMINATION	NOTES / DOCUMENTATION
Piping Plover, Red Knot, Roseate Tern	May Affect, Likely to Adversely Affect	Construction may impact prey species and foraging areas, will alter habitat and may cause species to leave the action area from the visual disturbances, auditory disturbances, and increased human activity.
Piping Plover Designated Critical Habitat	Adverse Modification	Construction of a revetment would permanently alter up to 0.5 acres and temporarily alter up to 1.0 acre of designated Critical Habitat on Bahia Honda Key, and could impact prey species and foraging habitat. The revetments would adversely modify designated Critical Habitat. However, this is a very small percentage considering that almost the entire Bahia Honda Key is designated Critical Habitat.
Nassau Grouper, Smalltooth Sawfish, Oceanic Whitetip Shark, Giant Manta Ray	No Effect	There are no in water impacts associated with this project.
Pillar Coral, Rough Cactus Coral, Lobed Star Coral, Boulder Star Coral, Mountainous Star Coral. Elkhorn Coral, Staghorn Coral	No Effect	There are no in water impacts associated with this project.
Elkhorn Coral, Staghorn Coral Designated Critical Habitat	No Effect	There are no in water impacts associated with this project.
West Indian Manatee	No Effect	There are no in water impacts associated with this project.

SPECIES / RESOURCE NAME	ESA SECTION 7 / EAGLE ACT DETERMINATION	NOTES / DOCUMENTATION
American Alligator and American Crocodile	May Affect, Not Likely to Adversely Affect	Construction may disturb species due to temporary increases in human disturbance including auditory and visual disturbances during construction. The revetments would temporarily and permanently alter designated Critical Habitat. However, existing sea walls, revetments, and vegetation block access to Fiesta Key East and West and Indian Key Fill, creating limited access to these areas. In addition, the 2014 USFWS letter referenced in Section 2.3.5 notes that crocodiles are uncommon south of Key Largo. Using the guidance from this letter, it is anticipated the impacts will be insignificant.
American Crocodile Designated Critical Habitat	Adverse Modification	Construction of a revetment would permanently alter up to 1.75 acres of designated Critical Habitat on Long Key, Fiesta Key, and Indian Key. However, 1.25 of those acres are not accessible to crocodiles due to existing sea walls and rip rap revetments. The remaining 0.5 acre is at the southernmost extent of the range in the Florida Keys and occurrence is uncommon. In addition, approximately 4.5 acres of temporary impact to critical habitat is possible during construction.
Kemp's ridley sea turtle	No Effect	Kemp's ridley sea turtles do not nest within the action area. Kemp's ridley sea turtles do not have Critical Habitat within the action area. There are no in water impacts associated with this project.
Green Sea Turtle, Hawksbill Sea Turtle, Leatherback Sea Turtle	May Affect, Not Likely to Adversely Affect	Green, Hawksbill, and Leatherback sea turtles rarely nest on Bahia Honda Key within the action area. The revetment on Bahia Honda Key will be north of an existing fence and campground road. The nesting area is south of the existing fence and campground road on Bahia Honda Key. Impacts to green, hawksbill, and leatherback sea turtles will be temporary and insignificant. There are no in water impacts associated with this project.

SPECIES / RESOURCE NAME	ESA SECTION 7 / EAGLE ACT DETERMINATION	NOTES / DOCUMENTATION
Loggerhead Sea Turtle	May Affect, Likely to Adversely Affect	Within the action area, there is loggerhead sea turtle nesting on Bahia Honda and Long Key. Historically, nests were also documented on West Summerland Key in the 90's. The revetment on Long Key will block access to nesting habitat. The revetment on Bahia Honda Key will be north of an existing fence and campground road, away from the beach. The nesting area is south of the existing fence and campground road, so impacts to nesting turtles are not anticipated on Bahia Honda Key.
Loggerhead Sea Turtle Designated Critical Habitat	Adverse Modification	Construction of a revetment would permanently alter up to 0.25 acres and temporarily alter another 0.25 acres of designated Critical Habitat and could impact nesting habitat on Long Key. The revetments would adversely modify designated Critical Habitat.
Cape Sable Thoroughwort	May Affect, Not Likely to Adversely Affect	Construction and human activities could disturb or trample the plant, if present. Construction of a revetment would permanently alter up to 0.5 acre and temporarily alter 0.75 acres of designated Critical Habitat at Long Key. Plant surveys would be conducted in the during the Preconstruction, Engineering, and Design (PED) phase, and if the plant is present, the Sponsor would contact the Service for additional preconstruction guidance which could include relocation to a suitable habitat, and/or a minor alteration in the revetment template.
Cape Sable Thoroughwort Designated Critical Habitat	Adverse Modification	Construction of a revetment would permanently alter up to 0.5 acre and temporarily alter 0.75 acres of designated Critical Habitat. The revetments would adversely modify designated Critical Habitat.

SPECIES / RESOURCE NAME	ESA SECTION 7 / EAGLE ACT DETERMINATION	NOTES / DOCUMENTATION
Tree Cactus	May Affect, Not Likely to Adversely Affect	USFWS Region 4 documents potential habitat for the tree cactus on West Summerland Key, Bahia Honda Key, and Long Key. Construction and human activities could disturb or trample plants if present. Construction of a revetment would permanently alter up to 0.5 acre and temporarily alter 0.75 acres of potential habitat at Long Key. Based on the species habitat description, it is less likely to be within the 0.41-acre permanent footprint of the Bahia Honda revetment along a roadside, or its laydown area. The West Summerland Key revetment will permanently impact approximately 0.23 acres of herbaceous wetland community dominated by sea purslane, sea oxeye, and a few sparse mangroves; therefore, this area may be too wet for the species. The species could be present within the proposed 0.35-acre mitigation site location or its associated 0.47-acre laydown area. Plant surveys would be conducted in the during PED, and if the plant present, the Sponsor would contact the Service for additional preconstruction guidance which could include relocation to a suitable habitat, and/or a minor alteration in the revetment template.
Gruber's spurge	May Affect, Not Likely to Adversely Affect	USFWS Region 4 has informed USACE that according to its records, for this species, there are occurrence data points located approximately 0.6 mile north of the project site on Bahia Honda Key, and approximately 0.3 and 0.4 mile north and south of the project site on Long Key, respectively. Construction and human activities could disturb or trample plants if present. Construction of a revetment would permanently alter up to 0.5 acre and temporarily alter 0.75 acres of potential habitat of potential habitat at Long Key. The species is less likely to be within the 0.41-acre permanent footprint of the Bahia Honda revetment along a roadside, or its laydown area. Plant surveys would be conducted in the during PED, and if the plant is present, the Sponsor would contact the Service for additional preconstruction guidance which could include relocation to a suitable habitat, and/or a minor alteration in the revetment template.

The Reasonable and Prudent Measures (RPM) and Conservation Measures (CM) would be adhered to, as required for compliance with ESA. There are requirements for plant surveys, to be conducted during the PED phase. If any listed plants are identified, recoordination with USFWS would be required, at which time it would be determined whether minor modifications to the revetment design or staging areas, or relocation of plant species to suitable habitat, would be most appropriate.

9.8 Magnuson-Stevens Fishery Conservation and Management Act (MSA), 16 U.S.C.1801 *et seq*.

This Act requires federal action agencies to consult with the National Marine Fisheries Service (NMFS) if a proposed action may affect Essential Fish Habitat (EFH). The waters of the Florida Keys, including the Atlantic Ocean, Florida Strait, and Florida Bay, contain EFH for many species. However, because there will be no in water or tidal wetland impacts, there will be no effect on EFH.

9.9 Anadromous Fish Conservation Act, 16 U.S.C. 757, *et seq.*

No in-water structures are being proposed; therefore, there will be no effect on anadromous fish.

9.10 Marine Mammal Protection Act, 16 U.S.C. 1631 et seq.

The Marine Mammal Protection Act (MMPA) prohibits the take of marine mammals including the West Indian manatee, and all cetaceans found in the ROI. No in water structures are being proposed; therefore, there will be no effect on Marine Mammals.

9.11 Section 106 and 110(f) of the National Historic Preservation Act, 16 U.S.C. 470 *et seq.*

The National Historic Preservation Act (NHPA) applies to properties listed in or eligible for listing in the National Register of Historic Places (NRHP); these are referred to as “historic properties.” Historic properties eligible for listing in the NRHP include prehistoric and historic sites, structures, buildings, objects, and collections of these in districts. Section 106 of the NHPA and its implementing regulations at 36 CFR Part 800, require the lead federal agency to assess the potential effects of an undertaking on historic properties that are within the proposed project’s Area of Potential Effect (APE), which is defined as “the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist” (36 C.F.R. § 800.16[d]).

Minor to moderate adverse effects are likely, as floodproofing and elevation would be conducted on some NRHP-eligible structures and/or historic districts, particularly within the Key West Historic District.

A summary of the coordination and consultation done for the Regional PA is provided in a Memorandum for the Record dated February 9, 2021 and is provided in the Cultural Appendix. Coordination was conducted with tribal governments, the ACHP, and SHPO to notify them that the Regional PA would be utilized for the Florida Keys Integrated Report and Environmental Impact Statement. The Regional PA was executed on March 9, 2021; and letters to all signatories and consulting parties were sent on April 21, 2021, signifying that the Regional PA has been signed, concluding the Section 106 process pursuant to the NHPA. All coordination materials are provided in the Cultural Resources Appendix.

9.12 Coastal Barrier Resources Act of 1982, as amended 1990.

The Coastal Barrier Resources Act (CBRA) was passed by Congress in 1982 to encourage conservation of hurricane-prone, biologically rich coastal barriers. The two types of mapping units under this Act are System Units and Other Protected Areas (OPAs).

- The System Units are predominantly privately owned coastal barrier lands along the Florida Keys that were relatively undeveloped at the time of their designation. CBRA prohibits most new federal expenditures that encourage development or modification of coastal barriers. Therefore, most new or substantially improved residences, businesses, or other developments in the CBRS are not eligible for certain federal funding and financial assistance, including coverage under the NFIP. Development can still occur within the CBRS, as long as private developers or other non-federal parties bear the full cost.
- OPAs are predominantly comprised of conservation and/or recreation areas such as national refuges, state and national parks, local conservation areas. The only federal spending prohibition within OPAs is the prohibition on federal flood insurance.

None of the proposed revetments occur within System Units. The revetments proposed at Bahia Honda Key and Long Key are within the OPAs, but that does not prohibit their construction.

Only one nonstructural measure would be installed within the CBRA System Unit mapping (FL-51). This is for floodproofing of a wastewater treatment facility. The USFWS concurred that the exemption for “essential publicly owned structures or facilities that are essential links in a larger network or system” applies. All other nonstructural measures will occur outside of the CBRA System Units.

9.13 Resource Conservation and Recovery Act, as amended, 42 U.S.C. 6901 *et seq*.

The Resource Conservation and Recovery Act (RCRA) controls the management and disposal of hazardous waste. Hazardous and/or toxic wastes classified by RCRA are materials that may pose a potential hazard to human health or the environment due to quantity, concentration, chemical characteristics, or physical characteristics. This applies to discarded or spent materials that are listed in 40 CFR 261.31-.34 and/or that exhibit one of the following characteristics: ignitable, corrosive, reactive, or toxic. Radioactive wastes are materials contaminated with radioactive isotopes from anthropogenic sources (e.g., generated by fission reactions) or naturally occurring radioactive materials (e.g., radon gas, uranium ore).

Elevation or demolition of buildings older than 1978 have the potential to generate chemical contamination, specifically in the form of asbestos-containing materials (ACMs), lead-based paint (LBP), or potentially polychlorinated biphenyls (PCBs). Prior to any disturbance of these structures, a Phase 1 Environmental Site Assessment would be required. If these materials are identified, they will be handled in accordance with RCRA and all other relevant laws. Excavation within the ROI of the proposed project is not anticipated to generate material with chemical contamination but that would be confirmed during the PED phase. Therefore, the project is in full compliance with RCRA.

9.14 Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. 9601 *et seq.*

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund) governs the liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive hazardous substance disposal sites.

There are no CERCLA/Superfund sites within the ROI. However, if any contaminated material was discovered in adjacent areas during construction, it will be handled in accordance with all federal, state, and local regulations, and be disposed of at upland disposal sites able to safely handle and store such material. Detailed specifications and requirements would be determined during the PED phase.

9.15 Submerged Lands Act of 1953

The proposed project will not affect submerged lands of the State of Florida.

9.16 Marine Protection, Research and Sanctuaries Act

The Act has two essential aims: to regulate intentional ocean disposal of materials, and to authorize any related research. While the MPRSA regulates the ocean dumping of waste and provides for a research program on ocean dumping, it also provides for the designation and regulation of marine sanctuaries.

Ocean dredged material placement is regulated under Section 103 of the Marine Protection Resources and Sanctuaries Act of 1972, Public Law 92-532 (MPRSA). The law states that any proposed placement of dredged material into ocean waters must be evaluated through the use of criteria published by the EPA in Title 40 of the Code of Federal Regulations, Parts 220-228 (40 CFR 220-228).

The FKNMS is a cooperating agency, and therefore has been involved during the development of this EIS. Although revetment structures were initially proposed within Marine Sanctuary waters, the revetment footprints were relocated upslope to avoid these areas. Therefore, no Marine Sanctuary waters are anticipated to be impacted, and no permit would be required. However, should the design change and should there be any impacts below mean high water (MHW), then USACE will re-coordinate with FKNMS during the PED phase and obtain any required permits.

9.17 Executive Order 13089, Coral Reef Protection

The proposed action may affect U.S. coral reef ecosystems as defined in the EO. The order established the interagency U.S. Coral Reef Task Force to develop and implement a comprehensive program of research and mapping to inventory, monitor, and "identify the major causes and consequences of degradation of coral reef ecosystems." The Order also directs federal agencies to expand their own research, preservation, and restoration efforts.

There will be no in water structures or impacts, and the project will adhere to strict erosion and sediment controls; therefore, there would be no effect on coral reefs.

9.18 Executive Order 11988, Floodplain Management

This EO states that federal agencies shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out agency responsibilities. Federal agencies should avoid, to the extent possible, the long and short term adverse impacts associated with the occupancy and modification of the Base Flood Plain (one percent annual chance floodplain as defined by FEMA), and the avoidance of direct and indirect support of development in the Base Flood Plain wherever there is a practicable alternative. For critical facilities, the 0.2 percent annual chance flood plain is typically evaluated. Under the EO, USACE is required to provide leadership and take action to:

- Avoid development in the Base Flood Plain unless it is the only practicable alternative;
- Reduce the hazard and risk associated with floods;
- Minimize the impact of floods on human safety, health and welfare;
- and Restore and preserve the natural and beneficial values of the Base Flood Plain.

From USACE ER 1165-2-26, in accordance with EO 11988, USACE uses the eight step process below to address flood plain management, with project-specific responses:

1. **Determine if the proposed action is in the Base Flood Plain.** As noted in Chapter 2, the effective 2005 FEMA FIRMs show that most of the study area is located within the Base Flood Plain, such that all alternatives are generally located in the Base Flood Plain. In addition, preliminary draft FEMA FIRMs for the ongoing FEMA revision show the entire study area within the Base Flood Plain. The preliminary draft FEMA FIRMs are available on the County's website for the public to review.

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 6-7 of this report discuss the process of considering, screening, and comparing alternatives.

3. **If the action must be in the flood plain, advise the general public in the affected area and obtain their views and comments.** As discussed in Chapter 1 of this report, as part of NEPA, on December 3-4, 2018, the USACE held National Environmental Policy Act (NEPA) Open-House-Style Public Scoping meetings in the Cities of Islamorada and Key West. USACE staff were on-hand with storyboards to show the areas of the city to be addressed,

to describe the potential measures, to answer questions, and to obtain public comments. Approximately 31 people attended, and eight public comments were submitted during and after the meeting. On September 11-12, 2019, the USACE held Open House Style Public Meetings in Key Largo and Key West to update the public on the measures and the alternatives. The meeting was an open-house style forum including updated storyboards and a brief introduction to the study and status update by the Norfolk District at the midpoint of the meeting. Approximately 40 people and the media attended these meetings, and a total of 23 public comments were received. The public was again given the opportunity to comment after the NOI was published on November 8, 2019. Prior to the September 2019 public meetings, a web-based GIS tool called Crowd Source Reporter was developed for the study to facilitate the communication of the proposed alternatives to the public and as an additional platform for the public and stakeholders to make comments with an option to reference them to a certain location on the map. All public comments and USACE responses from both of these meetings are included in the environmental appendix.

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.** Coastal storm risk management for structures using structural and nonstructural measures will be beneficial and help the community to be more resilient and sustainable; if failure or the design is exceeded, impacts to people, property, and the environment would be adverse, temporary, and ranging from negligible to major depending on the level of flooding. Minimal losses of natural and beneficial flood plain values are expected mainly within the construction area and considered temporary and negligible.

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 proposed action is not likely to induce development in the Base Flood Plain. The purpose of the proposed action is not to induce development, but to help existing development be more resilient and sustainable to flooding. New development is likely to occur without the proposed action, mostly infill development or redevelopment due to limited vacant land. In addition, the State requires the County to regulate and control population growth with respect to hurricane evacuation clearance times.

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.** Citizens should be encouraged to have flood insurance and to evacuate if ordered to do so. New and existing citizens and local staff should have continuous outreach and education, as people tend to forget past flood events or they simply are not aware of the possible flooding. Local decision makers

need to be fully informed and staff need to be able to properly conduct operations and maintenance.

7. **If the final determination is made that no practicable alternative exists to locating the action in the Base Flood Plain, advise the general public in the affected area of the findings.** As noted in Step 1, most or all of the entire study area is located in the Base Flood Plain. The preliminary draft FEMA FIRMs for the ongoing FEMA revision are available on the County's website for the public to review. The Draft EIS report for this study was released to the general public for review on June 26, 2020, using eNEPA and the project website. In addition, two public meetings and two office hour sessions were held in July 2020. The comment period ran from June 26 to August 10, with a total of 14 public comments received. The Draft ROD/Final EIS was be released to the public with a comment period. Availability of the Final ROD/Final EIS will be announced in the Federal Register by the EPA, at a minimum. It will also be available on eNEPA and the project website.

8. **Recommend the plan most responsive to the planning objectives established by the study and consistent with the requirements of the Executive Order.** The recommended plan is the one most responsive to the planning objectives and consistent with the requirements of the EO.

9.19 Executive Order 11990, Protection of Wetlands

This EO directs all federal agencies to minimize the destruction, loss, or degradation of wetlands; and preserve and enhance the natural beneficial values of wetlands in the conduct of the agency's responsibilities. Although a jurisdictional wetland determination has not yet been conducted for the Proposed Action, it is estimated to cause the unavoidable loss of approximately 10,250 square feet of herbaceous wetlands.

The Environmental Mitigation Plan for wetland impacts and a replanting plan for vegetated dune impacts are found in the Environmental Appendix, Appendix D. The total wetland impacts would need to be confirmed during more detailed analysis. The finalized impacts and the required mitigation amounts would need to be refined in the Environmental Mitigation Plan accordingly, and the plan would be implemented during the PED phase.

9.20 Executive Order 13112, Invasive Species

Under this EO, the introduction of invasive species has been evaluated. The project would not induce the introduction or spread of invasive species to the project area, because the Proposed Action would adhere to the following standard BMPs for the Jacksonville District:

- Prior to the commencement of work, an invasive species prevention plan will be developed. It shall identify specific transfer prevention procedures and equipment cleaning sites.
- Sightings of any invasive species shall be included in a preconstruction report. Any subsequent sighting of invasive species shall be reported within 24 hours of siting. The

reporting shall include date, time, location (latitude and longitude), photographs, environmental conditions, circumstances surrounding sighting disposition/behavior of the species, and any other notable observations. Reports shall be provided to the Jacksonville District Planning Division, Environmental Branch.

- All equipment would be thoroughly cleaned prior to and following work on the project site to ensure that materials including soil, vegetative matter, eggs, seeds, and other debris are not transported to other sites.
- Prevention protocols will also apply to clothing and personal protective equipment.

9.21 Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations

This EO directs federal agencies to identify and address the disproportionately high and adverse human health or environmental effects of their actions on minority and low-income populations, to the greatest extent practicable and permitted by law. The order is intended to promote nondiscrimination in federal programs that affect human health and the environment, as well as provide for minority and low-income communities' access to public information and public participation.

According to the U.S. Census Bureau, American Community Survey (2019), Monroe County has a population of approximately 74,228. However, these are the figures for permanent residency; the total population during peak season more than doubles, to a total population of approximately 158,000 (Monroe County, 2020).

Approximately 66 percent is white, 24 percent is Hispanic, 7 percent is black, 1 percent is Asian, with "other" making up 1 percent or less. Approximately 19 percent of the population of Monroe County is foreign-born, or about 90 percent of the rate of the State of Florida, at 21.1 percent (US Census, 2019).

The Median Household Income (MHI) for Monroe is $68,589, or approximately 20 percent higher than the State of Florida MHI of $59,227. The poverty incidence rate of Monroe County is 8.7 percent, which is about two-thirds the rate of the State of Florida, which is 12.7 percent. There are approximately 32,839 permanent households in Monroe County. There is a total of 53,896 housing units in Monroe County, 61 percent of which are occupied. Of those occupied units, 57 percent are owner-occupied and 43 percent are renter occupied (US Census, 2019). However, as mentioned earlier, during peak season, population and occupancy increases substantially.

Approximately 4,698 residences located throughout the Keys would be eligible for elevation or raising of homes. Elevation would be voluntary for all residence owners; and both homeowners and renters would be forced to move temporarily while the elevation construction is accomplished.

Residential structures were identified for elevation based on an assessment of which measure produced the most economic benefit. The economic modeling and analysis completed in this study compared the reduction in damage, or economic benefit, provided by for each structure at risk to flooding caused by coastal storms, to the cost to implement that measure. However, the Proposed Action must be compliant with the Uniform Relocation Assistance and Real Property Acquisition Act (URA), which provides protections and benefits to residents affected by elevation of their residence.

In accordance with this EO, the USACE has determined that there are potentially significant adverse temporary effects, as well as significant permanent beneficial effects on disadvantaged minority and low-income populations.

Population Statistics

The following discussion should be considered a generalization, for purposes of our consideration of EO 12898.

Thousands of residences within the low or low-to-moderate income dominated census block groups would be eligible for residence elevation. It should be noted that this does not mean that all residences located in a low or low-to-moderate income dominated census block groups are low income and/or minority populations; it means that the majority of the population within that block meets that description. The following further breaks down the preliminary locations, from west to east, of the elevations in relation to these block groups and localities.

Key West, Stock Island, and Big Coppitt Key (Mile Marker 0 through 11)

This area is the most populous section of the Florida Keys, which is made up of Key West, Stock Island, Boca Chica Key, and Big Coppitt Key. In 2019, it had a combined population of approximately 32,084.

Key West, the most populous of these, contains 13 low- and low-to-moderate income census tracts block groups. Key West also has 40 percent non-white minority populations, with 11.3 percent of the population below the poverty line. Fifty-nine percent are renters (US Census 2019). Approximately 2,028 elevations of residences, and 400 floodproofings are proposed here, and at least 60 percent of those would occur within low or low-to-moderate income block groups (US Census 2020). Immediately to the east, Stock Island has a population of 4,416. Approximately 37 percent of its population is white, 51 percent is Hispanic, and 12 percent are other minorities. It has four low-and low-to moderate income census tract block groups; and approximately 15.2 percent of its residents are below the poverty line.

Approximately 81 percent of its housing units were occupied, as of 2019, and 66 percent of its residents are renters. Within the four low- and low-to-moderate census group blocks on Stock Island, approximately 130 elevations and 63 floodproofs are proposed. Big Coppitt Key (MM 10-11) has a population of 2,825, with an ethnic breakdown of 55 percent white, 33 percent Hispanic, and 10 percent other races. The poverty rate there is 9.2 percent; however, there are no low-or low-to-moderate income census block groups there (US Census, 2019). There are approximately 88 elevations and 22 floodproofings are proposed on Big Coppitt Key.

East of Boca Roca Key through Cudjoe Key (Mile Marker 11 through 23)
This locality has a 2019 Census population of approximately 5,936. Of this population, approximately 31 percent are minority; 26 percent are low income, and 31 percent are renters. However, this segment includes no census block groups that have a majority of low- to low-to-moderate income residents, so none fall within those block groups. Approximately 41 percent of its housing units are vacant, and 23 percent of its residents are renters (U.S Census 2019). There are over 200 elevations and 21 floodproofings in this section.

East of Cudjoe Key through West Summerland Key (Mile Marker 23 through 35)
This locality has a 2019 Census population of approximately 9,943. Of this population, approximately 18 to 19 percent are minority; 18 percent are low income, and 27 percent are renters. Approximately 27 percent of the units are vacant. This segment includes three census block groups that have a majority of low to low-to-moderate income residents (US Census 2019). Over one hundred households that fall within a majority low or low-to-moderate income block group are proposed for elevations, and 50 for floodproofing, and thus would be temporarily affected.

East of West Summerland Key, Marathon, Key Colony Beach, through Duck Key, (Mile Marker 35 through 60)
This area has a 2019 Census population of approximately 9,977. Of this number, 8,702 lives in Marathon. Marathon has approximately 44 percent minority population; 10.6 percent are below the poverty line, and 46 percent renters. Within Marathon, there are five census block groups that have a majority of low to low-to-moderate income residents Key Colony Beach has a population of 541, 15 percent of which consists of minority populations, and a 0.8 percent poverty rate, and 29 percent renters. Likewise, Duck Key has a 2019 population of approximately 741, 17 percent of which are minority, 22.8 percent are below the poverty line, and 20 percent are renters. However, neither Key Colony Beach nor Duck Key contains any low or low-to-moderate income census block groups. Within this segment of the Keys, there would be approximately 649 elevations and 239 floodproofs. Roughly one-third of these fall within the low or low-to-moderate income. Vacancy percentage rates for Marathon, Key Colony Beach, and Duck Key are 37 percent, 77 percent, and 64 percent, respectively (US Census 2019). Many of these are likely vacation homes.

Long Key through Sea Oats Beach, and Islamorada (Mile Marker 60 through 91)
This section has a 2019 Census population of 6,433. Of this population, approximately 16 percent are minority; and 6.3 percent below the poverty line. There are 5,915 housing units, 53 percent of which are vacant. Of the occupied residences, 23 percent are renters. There are two low-or low-to-moderate income census block groups in Islamorada (US Census 2019). There are 208 elevations and 83 floodproofings proposed in Islamorada. Approximately 36 of those elevations and 12 floodproofings would be in the low or low-to-moderate census block group.

Tavernier (Mile Marker 91 through 96)
This locality has a 2019 Census population of 2,132. Of this population, approximately 41 percent are minority; and 5.7 percent are below the poverty line. There are approximately 1,877 housing units in Tavernier, 59 percent of which are vacant. Of the occupied units, 40 percent are renters. This segment includes two census block groups that have a majority of low- to low-to-moderate income residents (US Census 2019). Around 138 households that fall within the majority low or low-to-moderate income block group are proposed for elevations, and 33 other buildings are proposed for floodproofing.

Key Largo (Mile Marker 96 through 111)
This locality has a 2019 Census population of 9,952. Of this population, approximately 27 percent are minority; and 16.5 percent are below the poverty line. There are approximately 8,875 housing units in Key Largo, with approximately 51 percent of them being vacant, and of those that are occupied, 23 percent are renters. This segment includes two large census block groups that have a majority of low to low-to-moderate income residents (US Census, 2019). At least 173 housing units and approximately 20 other buildings fall within the majority low or low-to-moderate income block group are proposed for elevations, and thus would be temporarily affected.

North Key Largo
This locality has a 2019 population of 886. Of this population, approximately 4 percent minority; and 12.6 percent are below the poverty line. There are approximately 1,763 housing units, and only 23 percent are permanently occupied. Only 8 percent are renters. There are no low- to low-to-moderate income census block groups in this area. Approximately 88 residences would be elevated and 23 buildings would be floodproofed.

It is important to note that there also may be affected disadvantaged individuals throughout the Keys who do not necessarily reside in a low or low-to-moderate income block group.

Uniform Relocation Act (URA)

As described in the Real Estate Appendix, Appendix F, the following discussion addresses the URA. Affected residents would be compensated through relocation to comparable residences and provided relocation aid, subject to the URA.

- Elevation. Because elevation is voluntary, no relocation reimbursements would be anticipated under the Uniform Relocation Act for homeowners. However, an exception to paying relocation expenses exists when there is an eligible tenant in the property, and the tenant (rather than the property owner) is displaced to accomplish the voluntary measure benefiting the property owned by a lessor. In this case, such tenants may receive relocation benefits. Given that many low-income and minority families are tenants, this would help mitigate the adverse effect on those populations.
- Floodproofing. Dry floodproofing includes sealing all openings below a certain elevation to prevent floodwaters from entering a structure. The maximum height a structure can be dry floodproofed is three feet above ground elevation due to

engineering constraints. Structure owners would have to place the barriers prior to a storm, but once placed, damages could be reduced significantly. Wet floodproofing is a strategy where uninhabited spaced of a structure are intentionally allowed to flood.

Eligible tenants temporarily relocating are reimbursed for the cost of temporary alternate housing, meals and incidentals (such as laundry services), and the fees for disconnection and connection of utilities at the temporary residence. Alternate housing could be hotels or apartments, depending upon availability in the community. All temporary housing costs require advance approval by the NFS after first obtaining the prior written approval of USACE. General Services Administration (GSA) per diem rates are the basis of allowable hotel reimbursement. Apartment costs are on market rents.

All conditions of temporary relocation must be reasonable. Any residential tenant who temporarily relocated for more than one year must be offered permanent relocation assistance, which may not be reduced by the amount of any temporary relocation assistance previously provided. At a minimum, tenants shall be provided the following: reimbursement for all reasonable out-of-pocket expenses incurred in connection with the temporary relocation, including the cost of moving to and from the temporarily occupied housing, and any increase in monthly rent or utility costs at such housing. Tenants are entitled to receive relocation advisory services as well, including reasonable advance written notice of the following:

- Address of the suitable decent, safe, and sanitary dwelling to be made available for the temporary period;
- Terms and conditions under which the tenant may lease and occupy a suitable decent, safe and sanitary dwelling in the building/complex upon completion of the project;
- Provisions of reimbursement for all reasonable out of pocket expenses incurred in connection with the temporary relocation as noted above; and
- In addition to relocation advisory services, displaced tenants may be eligible for other relocation assistance including relocation payments for moving expenses and replacement housing payments for the increased costs of renting or purchasing a comparable replacement dwelling.

The temporary displacement during construction could be potentially significant, due to the number of temporary relocations and the scarcity of housing noted by Monroe County, within the Florida Keys, including its incorporated cities. Work would have to be phased such that there was adequate temporary housing for all affected residents. It is intended that phasing would be grouped such that whole neighborhoods could be done simultaneously, to minimize ingress/egress conflicts during construction.

Once construction is complete, residences would be permanently made more resilient to coastal storm risk. Elevations could present special hardships to the elderly, handicapped, minority, or low-income people, for whom moving may be more burdensome. Elevation heights (new foundation heights) would range from 3-12 feet, with an average of about 9 feet. Some homes may require an elevator or lift, for the disabled. Elevations also could cause individuals to have to miss days of work during the process, which could adversely affect their families' income. Over a thousand low and low-to-moderate income households would be subject to the temporary impact of being relocated during the elevation of their homes. This could cause significant temporary effects. One mitigating factor is that elevation is a voluntary measure; property owners may choose not to take advantage of elevation. However, if the residents are renters, then they would be subject to the decisions of the property owners. Another mitigating factor is that tenants would qualify for temporary relocation costs reimbursement. Also, the disruption would be temporary; they could return to the same residences, so their communities would not be permanently disrupted. Therefore, the elevation measure would not cause significant adverse permanent effects on any disadvantaged populations. There would be beneficial permanent effects for elevation: residents relocated to areas would be less susceptible to damage, in the form of improved coastal storm resilience.

In closing, the Proposed Action would cause significant adverse temporary effects and significant permanent beneficial effects on low income and/or minority populations.
All members of the public were invited to participate in the NEPA public scoping meetings and to submit comments. All public comments were considered in the development of the Final EIS/Draft ROD and are addressed in the Correspondence section of the Environmental Appendix. Therefore, the Proposed Action has met the requirement to identify and address the disproportionately high and adverse human health or environmental effects of their actions on minority and low-income populations, and to provide for minority and low income communities' access to public information and public participation. Further coordination with affected property owners and residents concerning phasing and real estate matters would occur during PED.

9.22 Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks

This EO ensures that all federal actions address the unique vulnerabilities of children. Prior to any disturbance of structures older than 1978, a Phase 1 Environmental Site Assessment would be required. If ACM, LBP, or PCBs are identified, they will be handled in accordance with RCRA and all other relevant laws. Therefore, in accordance with this EO, the USACE has determined that no children would bear a disproportionately high share of adverse environmental consequences resulting from the proposed work and there should be no effect on children.

9.24 Migratory Bird Treaty Act, 16 U.S.C. 703 *et seq.*; Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds

This Act makes it illegal for anyone to take, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, or barter, any migratory bird, or the parts, nests, or eggs of such a bird except under the terms of a valid permit issued pursuant to federal regulations. Migratory birds would be minimally affected by placement of revetments. Temporary displacement would also occur in the staging areas during construction. The Proposed Action will adhere to the following USACE Jacksonville District's standard migratory and shorebird BMPs:

1. All construction personnel shall be advised that migratory birds are protected by the Florida Endangered and Threatened Species Act of 1977, Title XXVIII, the Migratory Bird Treaty Act of 1918, and the Endangered Species Act of 1973, as amended. The contractor may be held responsible for harming or harassing the birds, their eggs, or their nests.
2. Construction activities will be under surveillance, management, and control to prevent impacts to migratory birds and their nests. Construction areas would be monitored at dawn or dusk daily during nesting season to protect nesting migratory birds.
3. A qualified bird monitor shall be present and shall monitor the construction area from April 1 through August 31, unless specifically excepted by a USACE biologist.
4. The bird monitor must be approved by a USACE biologist, and must possess qualifications that include, but are not limited to: identifying bird species, nesting behavior, eggs and nests, and habitat requirements. He or she must also be familiar with state requirements and reporting procedures.
5. The bird monitor shall record any nesting activity in accordance with reporting requirements. Should nesting begin within the construction area, a temporary 200-300 foot buffer, as specified by the monitor and the USACE biologist, shall be created and marked with signs to avoid entry.

With adherence to these BMPs, a minor level of impact is expected on local migratory birds. No significant impacts to migratory birds are expected as a result of project implementation.

CHAPTER 10 CONCLUSIONS AND RECOMMENDATIONS

As a result of the hurricanes and coastal flood disasters in calendar years 2014, 2015, 2016, and 2017 that affected 33 states and three U.S. territories, supplemental investigation funds were appropriated for the initiation and completion of authorized flood and storm damage reduction studies by Public Law 115-123. The Florida Keys Coastal Storm Risk Management Feasibility Study will be completed at 100 percent federal expense to recommend a project for implementation that would reduce the coastal storm risk and increase resiliency to the people and infrastructure throughout the Florida Keys. Once the recommended project is authorized by Congress, the construction will be cost shared on a 65 percent federal and 35 percent non-federal basis.

Given the projections for the frequency of intense coastal storms, their associated water surface elevations, and the added uncertainty of SLC, it is clear that coastal storm risk to the Florida Keys is not static and will increasingly affect the community in the future. The manner of attaining risk reduction, as well as the level of that risk reduction that is attainable, is influenced by a range of considerations presented in this report. Economics are only one part of the analysis. The USACE, along with Monroe County and engaged stakeholders have also considered impacts to regional economic development, other social effects, and cultural and environmental resources along with the NED evaluation.

Based on the analysis completed during the feasibility study, the team has recommended a plan that includes a combination of structural and nonstructural coastal storm risk management measures. The recommended plan is a large project with a total project cost of $2.8 billion. The project will provide extensive coastal storm risk management to critical infrastructure, residents, and businesses throughout the Florida Keys. It will also provide coastal storm risk management for U.S. Route 1, the critical transportation route for evacuation and connectivity between the islands of the Florida Keys.

10.1 CONSTRUCTION SEQUENCING STRATEGY FOR THE RECOMMENDED PLAN

Due to the size and cost of the recommended plan, it is unlikely that funding for construction would be made available all at once. The Norfolk District, Jacksonville District, and Monroe County have discussed the need to develop a strategy for implementation and sequencing of the recommended plan in order to be prepared for construction of certain project elements when construction funds become available and to communicate the implementation priority to stakeholders. The following sections describe a recommended path forward for project implementation. Appendix G, Nonstructural Implementation Plan, includes detailed information on the implementation of nonstructural measures proposed in the recommended plan.

10.2 PLAN IMPLEMENTATION

10.2.1 Consistency with Laws and Policy

This integrated feasibility report and EIS has been prepared in accordance with relevant laws and USACE policy. Specifically, this section of the report addresses:

- The specific requirements necessary to demonstrate that the project is technically feasible, economically justified, and environmentally compliant.
- The project costs and cost-sharing to support a Project Partnership Agreement (PPA).

The recommended plan described in this report is economically justified and technically feasible to implement. An EIS has been prepared to meet the requirements of NEPA and demonstrate that the recommended plan is compliant with environmental laws, regulations, and policies and has effectively addressed any environmental concerns of resource and regulatory agencies.

10.2.2 Cost Sharing and Real Estate Costs

The project First Cost is the constant dollar cost of the recommended plan at current (October 2020) price levels and is the cost used in the authorizing document for a project. Total project cost is the constant dollar fully funded with escalation to the estimated midpoint of construction. The construction duration varies for the different elements of the recommended plan. The midpoint of construction is 2027 (Q2) for the U.S. Route 1 shoreline stabilization, 2026 (Q2) for the critical infrastructure floodproofing, 2030 (Q4) for the elevation of residential structures, and 2027 (Q3) for floodproofing of the nonresidential structures that are not critical infrastructure. The estimated first and total project costs include a 28 percent contingency, environmental mitigation, and preconstruction engineering and design costs. Total Project Cost is the cost estimate used in Project Partnership Agreements (PPAs) for implementation of design and construction of a project. The recommended plan First Cost is $2,103,462,000 and the recommended plan Total Project Cost is $2,772,359,000 (Tables 10-1 and 10-2).

Table 10-1: First Cost

Civil Works WBS Number	Feature Description	Project First Cost[1] ($1,000s, Constant Dollar Basis)
6[2]	Fish & Wildlife Facilities	$362
16	Bank Stabilization	$14,437
18	Cultural Resource Preservation	$15,758
19	Buildings, Grounds, & Utilities	$1,561,036
	Construction Estimate Totals	$1,451,001
1	Lands and Damages	$50,305
30	Planning, Engineering, & Design	$230,781
31	Construction Management	$230,781
	Project Cost Total	$2,103,462

1. Includes 28% contingency, October 2020 price levels
2. This is the cost for environmental mitigation required for the U.S. Route 1 shoreline stabilization

Total Project Cost is the cost estimate provided to non-federal sponsors for their use in financial planning as it provides information regarding the overall non-federal cost sharing obligation. In accordance with the cost share provisions in Section 103 of the Water Resources Development Act (WRDA) of 1986, as amended (33 U.S.C. 2213), project design and implementation are cost shared 65 percent federal and 35 percent non-federal. The non-federal costs include the value of lands, easements, rights of way and relocations, and disposal/borrow areas (LERRDs). Total LERRDs, fully funded per the estimated total project cost, are estimated to be $58,925,000 with the non-federal cash contribution estimated to be $911,401,000 (Table 10-2).

Table 10-2: Total Project Cost Apportionment

	Federal (65%)	Non-Federal (35%)	Total
Total Project Cost	$1,802,033,000	$970,326,000	$2,772,359,000
LERRD Credit	$0	$58,925,000	$58,925,000
Cash Contribution	$1,802,033,000	$911,401,000	$2,713,434,000

1. October 2020 price levels

Operation, maintenance, repair, rehabilitation, and replacement (OMRR&R) requirements are considered in the economic analysis for the project. The non-federal sponsor is responsible for 100 percent of annual OMRR&R requirements, estimated at $161,000 per year. The federal government is responsible for preparing and providing an OMRR&R manual to the sponsor upon completion of the project.

10.2.3 Non-Federal Sponsor Responsibilities under the Project Partnership Agreement

A PPA package will be prepared, coordinated, and executed subsequent to the completion of the feasibility study and the final approval of this decision document. The PPA serves as the agreement between the Government and non-federal sponsor for the next phase of the project. The PPA reflects the recommendations of the feasibility study.

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 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 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. Assume, as between the Government and the non-Federal sponsor, complete performance and financial responsibility for all necessary cleanup and response actions and costs of any HTRW regulated under applicable law that are located in, on, or under real property interests required for construction, operation, maintenance, repair, rehabilitation, or replacement of the project;

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.

10.2.4 Design and Construction Considerations and Schedule

Once a study is completed and the project is authorized, the next phase is called preconstruction engineering and design (PED). It is in this phase that plans and specifications for construction are completed. Further detailed design completed during PED may include additional design features and/or changes necessary to account for changed conditions in the project area and/or mitigate environmental or social effects associated with the project. Section 7.3 of this report discusses implementation of the recommended plan, including the analysis that is expected to occur during PED. For PED to be initiated, USACE must execute a PPA with the non-Federal sponsor to cost share PED and construction. The recommended plan must be authorized by congress for PED and construction to begin. PED and construction are cost shared 65 percent federal and 35 percent non-federal. Implementation would then occur, provided that sufficient funds are appropriated to design and construct the project.

A schedule for plan implementation was developed for planning and cost estimating purposes (Table 10-3). Actual construction timelines are subject to future project authorization and appropriation of implementation funds.

Table 10-3: Estimated Implementation Schedule

Milestone	Date
Submission of Chief's Report	April 2021
Chief Signs Report	September 2021
Congress Authorizes Project	WRDA 2022
Execute Design Agreement*	March 2023
Pre-Construction Engineering and Design (PED)*	March 2023
New Start Approval	May 2024
Project Partnership Agreement (PPA)*	December 2024
First Construction Contract Award*	August 2025
Construction Complete*	August 2035

*Requires additional funding beyond Feasibility Report

10.2.5 Real Estate Requirements

The non-federal sponsor is required to provide LERRDs necessary to implement a USACE Civil Works project. Currently, the recommended plan will require the non-federal sponsor to acquire temporary and permanent easements for construction. Total LERRDs cost is estimated to be $53,905,000.

10.2.6 Views of the Non-Federal Sponsor

The non-federal sponsor, Monroe County, Florida, has indicated their support for releasing this report for public and agency review and comment. The non-federal sponsor, Monroe County, has provided a letter confirming their support for the recommended plan that will be recommended for authorization by Congress and their desire to execute a PPA, which is required to implement the project. This letter is included in Appendix F of the final report.

10.3 PATH FORWARD

A Chief's Report, the report of the U.S. Army Corps of Engineers Chief of Engineers, is developed when a water resources project requires Congressional authorization for construction. After the final feasibility report is submitted to USACE Headquarters, a Chief's Report is developed. Once the Chief of Engineers signs the report, the Chief of Staff signs the notification letters forwarding the Chief's Report to the chairpersons of the Senate Committee on

Environment and Public Works and the House of Representatives Committee on Transportation and Infrastructure. The signed Chief's Report is also supplied to the Office of the Assistant Secretary of the Army for Civil Works for review by the Administration. This report, “Florida Keys Integrated Coastal Storm Risk Management Feasibility Study and Environmental Impact Statement” is scheduled to be submitted to USACE Headquarters in March 2021. A signed Chief’s Report is anticipated in September 2021.

Using the information in this feasibility report, the USACE will continue to coordinate with Monroe County to implement the recommended project in accordance with current policy and in the most expeditious manner available by maximizing the use of available construction and study authorities (i.e. modifications of ongoing projects/studies, post-authorization change reports, or new authorizations).

10.4 RECOMMENDED ACTIONS FOR OTHERS

While the USACE project would provide a significant reduction in coastal storm risk throughout the Keys, the recommended plan does not address all facets of the coastal storm risk experienced in the Florida Keys under current conditions or in the future. The study authority limited the study analysis to the effects of coastal storms including storm surge with consideration for wave attack, erosion, and sea level change in the estimates of inundation and how it is expected to damage infrastructure. This study did not formulate plans to address the impacts of general sea level rise that is often referred to as “sunny day flooding,” precipitation, or direct effects of wind associated with coastal storm events. Due to these study limitations, there will be remaining coastal storm risk in the Keys, even with the implementation of the recommended plan. This remaining risk is referred to as residual risk, which is inherent to any coastal storm risk management project as impossible to eliminate coastal storm risk with one project in any study area.

With the recommended plan there remains residual risk from flooding beyond the design limitations. The recommended plan only addresses the coastal storm risk to very vulnerable infrastructure and with nonstructural measures designed for specific structures, there will still be impacts to roadways, utilities, and the environment due to storm surge flooding. The USACE recognizes that the authority and plan formulation methodology is limited in what it can provide, therefore, the study includes recommended actions for the NFS and other entities to consider in a more holistic approach to flood risk mitigation and overall resiliency.

10.4.1 U.S. Route 1

FDOT is the agency responsible for the maintenance and repair of U.S. Route 1 and the agency has been meeting this responsibility to the best of their ability as funding has allowed. FDOT will be completing various shoreline stabilization projects along U.S. Route 1 in the next few years and it is recommended that they continue to not only maintain, but continually evaluate these projects and other areas along U.S. Route 1 to assess their vulnerability to coastal storm damage and if there are ways that they can be adapted to improve resiliency.

10.4.2 Nonstructural Recommendations

Monroe County has enacted code that disincentivizes development in high risk areas and identifies building special building requirements and restrictions to reduce coastal storm risk to residential and nonresidential structures. Additionally, new residential development in the Keys is limited and will ultimately cease in 2026 with the goal of maintaining an evacuation time of 24 hours as prescribed by the State of Florida. These regulations are encouraged to be maintained and expanded upon as needed throughout the Keys as they are important in reducing the level of coastal storm risk throughout the Keys. It is also important that the county continues their work on current ongoing resilience initiatives and engages in new efforts as resources allow. Monroe County has recognized the need for adaptation measures for sea level rise and “sunny day” or nuisance flooding and is currently working on various studies and projects to reduce the impacts of sea level rise in the Keys.

10.4.3 Natural and Nature Based Features

NNBF are not included in the recommended plan, but the PDT recognizes that there are various opportunities for the implementation of NNBF in the Florida Keys even though they could not be recommended considering the authority for this study and the limitations protected habitat placed on the NNBFs considered in this study. Opportunities for NNBFs in the Florida Keys include both the enhancement/expansion of existing natural resources and the addition of natural features in new areas. The PDT recommends that Monroe County, the five municipalities, state and Federal resource agencies, and other nongovernmental organizations in the Keys continue to prioritize the restoration of NNBFs in the Keys as a method of not only reducing coastal storm risk, but also improving the overall quality of the environment.

10.5 LIST OF AGENCIES CONTACTED

Table 10-4 list the agencies contacted through the process of this study.

Table 10-4: Agencies Contacted

Agency	Name of Contact People
Advisory on Historic Properties	Christopher Daniel
Federal Emergency Management Agency	Gracias Szczech
Federal Highway Administration	Brandye Hendrickson
National Oceanic and Atmospheric Administration, Florida Keys National Marine Sanctuary	Sarah Fangman, Lisa Symons, Joanne Delaney, Ray Crabtree
National Oceanic and Atmospheric Administration, Marine Fisheries Service	Jennifer Schull, Pace Wilber, Sophie Godfrey-McKee
National Oceanic and Atmospheric Administration, Fisheries Division	Sarah Furtak, Mark Lamb
National Park Service	Robert Johnson
U.S. Army Corps of Engineers	Maria Bezanilla, Angela Dunn, Jason Spinning, Kristin Donofrio, Kevin Hodges, Kelly Lagault, Andrew Condon, Hunter Bredsen, Troy Mayhew, Matthew Trammell, Michael Neves, Milton Corson, Tim McQuillen, Stacey Roth, Idris Dobbs, Trisston Brown, David Dudley, William Reilly, Jason Engle, Millan Mora, Jason Harrah, Tony Ledford, Matthew Cunningham, Laureen Borochaner, Kim Brooks-Hall
U.S. Coast Guard	Rear Admiral Peter Brown
U.S. Environmental Protection Agency	Jamie Higgins
U.S. Fish and Wildlife Service	Jeff Howe
U.S. Navy	Captain Bobby Baker
Florida Bureau of Historic Preservation, State Historic Preservation Officer	Jason Aldridge
Florida Bureau of Natural and Cultural Resources	Leah Gerlock
Florida Department of Environmental Protection	Roxanne Dow, Gus Rios, Gregory Garis, Meredith Kruse, Travis Ferguson, Chris Stahl
Florida Department of Environmental Protection, Department of Parks and Recreation	Diane Martin, Mark Duncan, Donald Bergeron, Steve Cutshaw
Florida Department of Environmental Protection, Southern Florida Watershed Management District	Kaitlyn Lizza, Barbara Conmy
Florida Department of Transportation	Steven James, Elizabeth Fulcher, Jacquelyn DeAngelo,James Wolfe

Agency	Name of Contact People
Florida Wildlife Conservation Commission	Sue Schaf, James Keltner
Seminole Tribe of Florida, Tribal Historic Preservation Officer	Bradley M. Mueller, Anne Mullins, Marcellus Osceola, Jr.
The Seminole Nation of Oklahoma	Gregory Chilcoat, David Frank
Miccosukee Tribe of Indians	Fred Dayhoff, Kevin Donaldson, Billy Cypress
Muskogee (Creek) Nation	Corain Lowe-Zepeda
Monroe County Historic Preservation Commission	Diane Silva
Thlopthlocco Tribal Town	Gaylen Cloud

10.6 LIST OF REPORT PREPARERS

Table 10-5 lists the preparers who worked on this study and their specific disciplines.

Table 10-5: Report Preparers

Name	Contribution
Bryan Adkins	Cost Engineering
Trent Elder	Geotechnical Engineering
Rachel Haug	Plan Formulation
John Haynes	Cultural Resources
Ethan Crouson	Economics
Candice Miranda, EIT	Hydrology and Hydraulics
Jesse Morrill-Winter	Life Risk Analysis
Paul Moye, P.E., CFM	Floodplain Management
Alicia Barrette	Real Estate
Kathy Perdue	Environmental Analysis
Tammy Younkins	GIS

10.7 STATEMENT FROM THE DISTRICT ENGINEER

I concur with the findings of the PDT and advise the recommended plan, as fully detailed in this Integrated Feasibility Report and Environmental Impact Statement, be authorized for construction as a Federal project.

I have given consideration to all significant aspects of the public interest. These interests include environmental, social, and economic effects that are anticipated from the implementation of the Recommended Plan. The engineering feasibility and compatibility of the project with the policies, desires, and capabilities of Monroe County, the State of Florida, and other non-federal interests have also been considered.

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

Brian P. Hallberg, PMP
Colonel, U.S. Army
Commanding

CHAPTER 11 REFERENCES

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