

Miami-Dade Back Bay Coastal Storm Risk Management Draft Integrated Feasibility Report and Programmatic Environmental Impact Statement



Draft Feasibility Study

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**US Army Corps
of Engineers®**
Norfolk District



COVER SHEET

Miami-Dade Back Bay Coastal Storm Risk Management Draft Integrated Feasibility Report and Programmatic Environmental Impact Statement

Miami-Dade County, Florida

LEAD AGENCY:

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

COOPERATING AGENCIES:

Florida Department of Transportation; National Oceanographic and Atmospheric Services, National Marine Fisheries Service; U.S. Environmental Protection Agency

ABSTRACT:

The U.S. Army Corps of Engineers, Norfolk District (USACE) and Miami-Dade County propose to implement structural and nonstructural measures to manage coastal storm risk in Miami-Dade County, Florida. Without a plan to promote resiliency and reduce the risks of coastal storm damage, the County will continue to be vulnerable to coastal storm damage. The USACE has prepared a Draft Integrated Feasibility Report and Programmatic 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 (NEPA), implementing regulations of the NEPA, 40 Code of Federal Regulations 1500-1508, and other applicable state and federal laws and USACE policies. Eight alternatives that examined critical infrastructure, nonstructural measures, structural measures and Natural and Nature-Based Features were evaluated in detail to determine the potential impacts to the natural and human environment resulting from the proposed action. Potential impacts to the following resource areas analyzed in the EIS include: land use; geology, physiography, and topography; bathymetry, hydrology, and tidal processes; water quality; floodplains; vegetation, wetlands, and Submerged Aquatic Vegetation; wildlife and terrestrial habitat; plankton community; Essential Fish Habitat and fishery resources; benthic resources; special status species; cultural resources; recreational resources; aesthetics and visual resources; socioeconomic; hazardous, toxic, and radioactive materials and wastes; safety; transportation; navigation; utilities; air quality; and noise and vibration.

All comments concerning this Draft Integrated Feasibility Report and Programmatic EIS are required to be submitted by July 20, 2020.

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

U.S. Army Corps of Engineers, Norfolk District
803 Front Street
Norfolk, Virginia 23510
Attention: Justine Woodward
(757) 201-7728
Justine.R.Woodward@usace.army.mil

EXECUTIVE SUMMARY

This Draft Integrated Feasibility Report and Programmatic Environmental Impact Statement (EIS) is for the Miami-Dade Back Bay Coastal Storm Risk Management (CSRM) Feasibility Study. The U.S. Army Corps of Engineers (USACE) is the lead federal agency for the project and the Miami-Dade County is the non-federal sponsor. Cooperating agencies for the study are the Florida Department of Transportation, the National Oceanographic and Atmospheric Administration, National Marine Fisheries, and the U.S. Environmental Protection Agency (USEPA).

According to the 2018 census, Miami-Dade County (MDC) comprises a metropolitan area of approximately 2.8 million people and 34 municipalities, including the City of Miami, the region's business and economic center. The MDC is diverse, with two national parks and natural resources supporting a large tourism industry and a densely populated urban core.

The MDC is important to the nation for several reasons. The area is a leader in economic activity and international trade. MDC is considered a gateway for the nation to Latin America and the Caribbean. The Port of Miami and Miami International Airport (MIA) are leaders in respective categories. The Miami Customs District is one of the top ten districts in the country with over \$102 billion in total trade in 2016 (MDBC 2019). The MIA handles the most international freight and the second most international passengers in the U.S. The Port of Miami creates approximately \$41 billion in economic activity and indirectly supports 320,000 jobs throughout Miami-Dade County and the State of Florida through international import and export trade.

The Biscayne Bay Aquatic Preserve and Biscayne Bay National Park flanking Miami's eastern shores provides habitat for many rare, threatened and endangered species and provides substantive recreational public opportunities including fishing, swimming, and boating. Tourism to the Biscayne Bay, the oceanfront beaches, cruise ships, and cultural areas contribute to an industry totaling over \$26 billion from overnight visitors (GMCVB 2017). Much of this industry is dependent upon the health and accessibility of the local natural resources.

The MDC is increasingly at risk from flooding and damage from coastal storms. The area is a densely populated and relatively flat community with an average elevation of approximately five feet NAVD88 and a natural high point at 25 feet NAVD88 (USGS 2016). The low elevations, tropical location, and hydrologic connections to Biscayne Bay through canals place a significant percentage of MDC at risk to flooding from high tides, hurricanes, and other storms. Exacerbating the flooding is the phenomenon of sea level rise (SLR), which is the combination of water level rise and land subsidence. South Florida is documented as having a significant rate of RSLR which will increase future flood risk.

The U.S. Army Corps of Engineers (USACE) study is a response to identified coastal storm flood risks. The study develops and evaluates CSRM alternatives for MDC. These measures are formulated to reduce risk to residents, industries, businesses, and infrastructures which are critical to the nation's economy. The U.S. Army Corps of Engineers 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 long-term strategy for resilience

in MDC is a layered solution that includes elements executed by the non-Federal sponsor, other Federal agencies, the State of Florida, and non-governmental organizations (NGO) in addition to the recommendations for implementation by the USACE study. The study seeks not only to reduce coastal storm risk, but also to build on resilience by implementing strategic approaches that address identified stresses from major storms, and the impact on residents and economic activity. In order to accomplish the goal of providing significant near term CSRSM risk reduction for MDC, while maintaining a set schedule and budget, this study will not provide a holistic or comprehensive risk reduction plan for the County. This study does not directly address nuisance flooding, and residual risks still remain. Further studies resulting in additional recommendations for implementation will be needed to more fully address the full extent of existing CSRSM and flooding problems in the study area.

Due to the large geographic scale of the study and the inability to provide a comprehensive recommendation under this study effort, a process was completed to which identified seven of the most vulnerable areas based on flooding potential and social vulnerability. The process to identify those areas, called refined focus areas, is fully described in Chapter 3.

The following Tentatively Selected Plan (TSP) includes a combination of the following types of measures to reduce flood risk across segments of MDC:

Structural CSRSM measures are man-made, constructed measures that counteract a flood event in order to reduce the hazard or to influence the course or probability of occurrence of the event.

For this study, structural measures considered include storm surge barriers, flood walls, and associated pump stations and riprap that are implemented to protect people and property. For this study structural measures would include Inland storm surge reduction with floodwalls along Brickell and Edgewater with associated pump stations and riprap, a sector gate at Miami River with associated floodwalls and pump stations, miter gates at Biscayne Canal and Little River both with associated floodwalls, and pump stations. These measures would provide flood risk reduction for three of the seven refined focus areas determined in the study which is described in Chapter 3. These structural measures will be coordinated with South Florida Water Management District's control structures during the Preconstruction, Engineering, and Design (PED) phase.

Nonstructural CSRSM 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.

For this study, nonstructural CSRSM measures considered include elevating residential structures and floodproofing non-residential structures in the remaining four refined focus areas: Aventura, Cutler Bay, North Beach, and South Beach. These measures were also applied to areas that were on the opposite side of any structural measures above which include: Arch Creek (downstream side of Biscayne Canal floodwall), Little River (downstream side of the Little River floodwall), and Miami River (downstream side of the Miami River floodwalls).

Natural and Nature-Based Features (NNBF) work with or restore natural processes with the aim of wave attenuation and storm surge reduction.

For this study, NNBFs considered include mangrove and native vegetation plantings at the Cutler Bay Site (east of Old Cutler Road and south of 184th street extending to southwest 188th street and extending to Biscayne Bay), enhancements or additional construction of dredged material spoil islands in Biscayne Bay, restoration of Submerged Aquatic Vegetation (SAV) in Biscayne Bay, and restoration of Bird Key in Biscayne Bay. Living shorelines and coral reefs were considered as well as possible NNBFs, however, no site-specific locations for these types of NNBFs were identified during plan formulation or during the Environmental Interagency Meetings so these NNBFs were not selected as potential NNBFs for this study and therefore, are not further discussed. Native vegetation plantings were determined to be the most feasible and cost-effective NNBF measure for this project.

Critical Infrastructure, as defined by the Patriot Act of 2001, are “*systems and assets, whether physical or virtual, so vital to the United States that the incapacity or destruction of such systems and assets would have a debilitating impact on security, national economic security, national public health or safety, or any combination of those matters.*”

The study follows policies and guidelines for consideration of economic, environmental, cultural, and social impacts. The TSP presented herein is formulated and designed for a coastal storm flood elevation calculated by the USACE derived 2079 1 percent annual exceedance probability stillwater level from the Federal Emergency Management Agency (FEMA) South Florida Storm Surge Study (includes tide, storm surge and USACE high curve sea level rise). The USACE high curve was utilized as this best approximated anticipated future sea level change projections. This formulation will continue to be examined and refined before the final report to determine the final flood elevation calculation. To assist with better understanding of the components of the plan it has been broken down into areas. The following paragraphs give a brief description of the TSP broken down by measures.

For this study, coastal storm risk reduction to vulnerable critical infrastructure was analyzed throughout all of MDC even outside of the seven refined focus areas. Critical Infrastructure asset categories included were fire stations, medical facilities, police stations, evacuation centers, wastewater and potable water facilities, emergency operation center (EOC) facilities, vulnerable airport facilities, and railway electrical substations. Floodproofing was the recommended method of flood risk reduction provided to critical infrastructure.

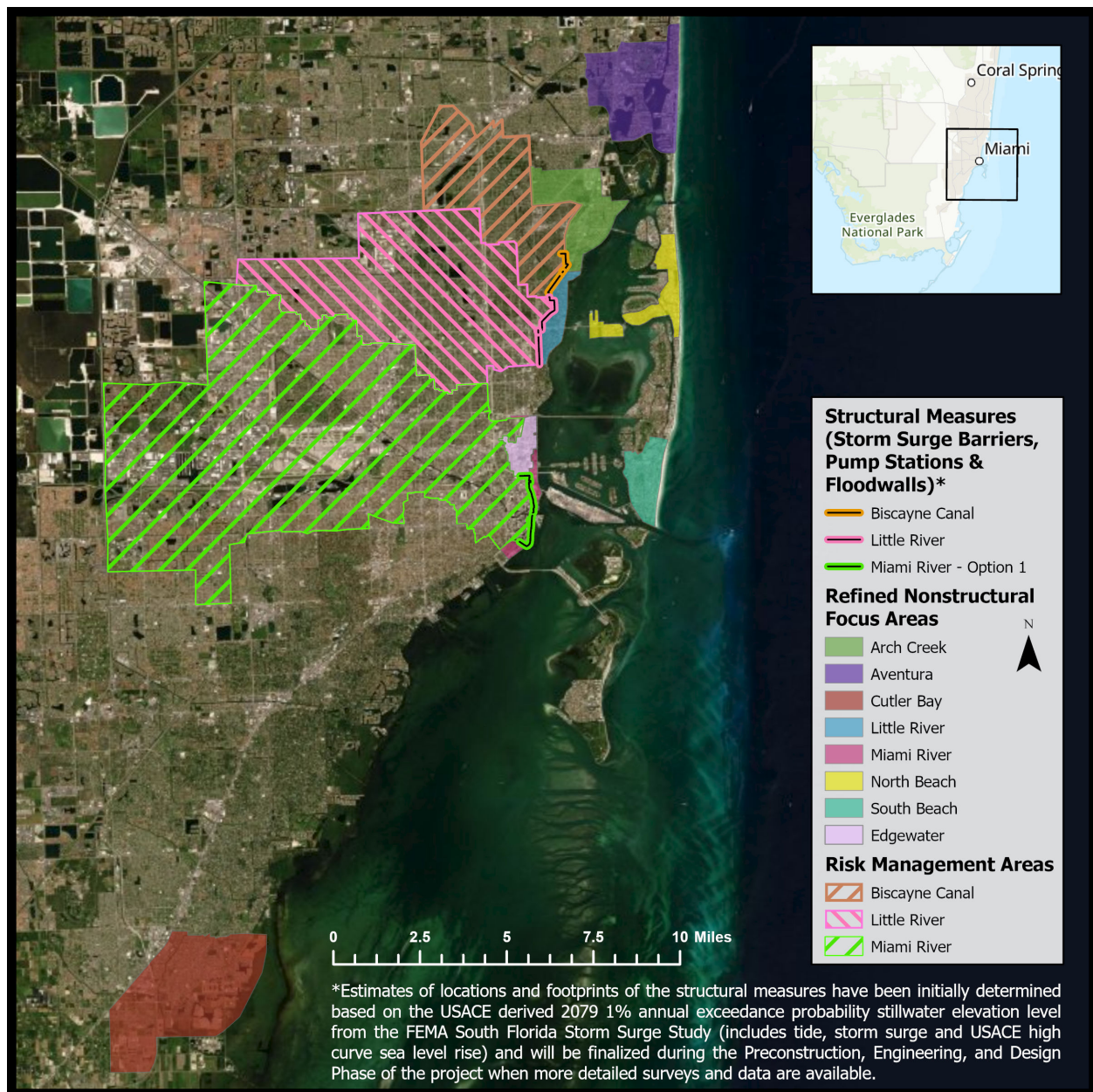


Figure 1. Tentatively Selected Plan

Figure 1 shows the areas of the county impacted by the TSP color coded in order to provide a high level overview of the geographic extent of the measures that make up the TSP. Hashed colored areas are risk management areas defined by the watershed boundaries which are parts of the county that are inland of the proposed structural measures. The seven colored areas represent parts of the county that are recommended to receive nonstructural flood risk management measures. Areas of the city that are not colored or hatched were not recommended for flood risk management in this study since they were not part of the seven socially vulnerable economic damage center focus areas that were identified. It should be noted that the exact locations and footprints of the structural measures (floodwalls and surge barriers)

will continue to be refined throughout the feasibility study and will be finalized during the PED Phase of the project when more detailed surveys and data are available.

Project benefits are anticipated to exceed the project costs. The relationship between benefits and costs is expressed in the BCR shown in Table 1. Project First Cost is estimated to be \$4,586,000,000. Project First Cost is the constant dollar cost of the TSP at current 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 year of the construction schedule. Total Project Cost is the cost estimate used in Project Partnership Agreements for 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 Total Project Cost includes the value of lands, easements, rights-of-way and relocations, and disposal/borrow areas (LERRDs). The non-Federal sponsor is responsible for obtaining and providing all necessary LERRDs for the project, the value of which will be credited against the non-Federal share of project costs. Total LERRDs are estimated to be \$405 million. The first cost apportionment table is shown in Table 2.

Table 1. Project Benefits and Costs

October 2019 Price Levels (Fiscal Year 2020), (2030 - 2079), 2.75 Discount Rate, \$1,000s, rounded

Equivalent Annual Benefits	Project First Costs	Annual Operation & Maintenance Costs	Total Average Annual Costs	Annual Net Benefits	Benefit Cost Ratio
\$1,836,000	\$4,586,000	\$12,600	\$196,000	\$1,640,000	9.4

Table 2. First Cost Apportionment Table

October 2019 Price Levels (Fiscal Year 2020), (2030 - 2079), 2.75 Discount Rate, \$1,000s, rounded

Total Project Cost	Total Federal Share (65%)	Total Non-Federal Share (35% plus relocation)	100% Lands and Damages	Cash Balance
\$4,586,000	\$2,981,000	\$1,605,000	405,000	\$1,200,000

Environmental Impacts and Mitigation for the Tentatively Selected Plan

A public scoping meeting and follow up public meeting was held prior to the release of the Draft Integrated report/EIS and an additional public meeting will be held following the release of the Draft Integrated Report/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 impacts to historic resources. Interagency coordination of the EIS occurred throughout the study process.

The project would have both temporary and permanent impacts that range from negligible to major (significant) impacts on natural resources and the human environment and herein we summarize the more substantive impacts (both adverse and beneficial) of the TSP.

Potential impacts to the following resources were examined: land use; geology, physiography, and topography; water quality, floodplains; vegetation, wetlands, and SAV; wildlife and terrestrial habitat; plankton community; Essential Fish Habitat (EFH), fish, and fishery resources; benthic communities; special status species; cultural resources; recreational resources; aesthetic and visual resources; socioeconomics; hazardous, toxic, and radioactive wastes (HTRW); safety, transportation; navigation; utilities; air quality, and noise and vibration. The anticipated impacts based on available existing data ranged from adverse to beneficial, temporary to permanent, and included classifications as to whether the impacts would have a negligible, minor, moderate, or major (significant impact).

The construction, operation, and maintenance of the surge barriers, floodwalls and associated pump stations, and riprap would result in a range of temporary to permanent impacts to aquatic resources and habitats that range from potentially minor to major (significant) impacts. The construction, operation, and maintenance of the surge barriers and associated floodwalls and pump stations have the potential to cause direct and indirect impacts to SAV (including Johnson's seagrass and associated critical habitat), as well as corals/hardbottom habitat (potentially including federally listed corals), Essential Fish Habitat (EFH), other benthic habitats and species, and mangroves. The surge barriers would result in the temporary trapping of aquatic species including fish, marine mammals, and reptiles. The Brickell Floodwall in the Biscayne Bay would be approximately up to one mile in length with a width of approximately out to up to 50 feet from existing bulkheads resulting in a significant, adverse impacts to benthic resources and habitat. There would be an anticipated permanent loss of SAV, corals/hardbottom habitat, mangrove, and open water benthic habitats.

Potential impacts to federally listed species under the jurisdiction of the National Marine Fisheries Service (NMFS) (Nassau grouper, smalltooth sawfish, boulder star coral, elkhorn coral, lobed star coral, mountainous star coral, pillar coral, rough cactus coral, staghorn coral, green sea turtle, Kemp's ridley sea turtle, hawksbill sea turtle, leatherback sea turtle, loggerhead sea turtle, and Johnson's seagrass) would be may affect, likely to adversely affect. The Biscayne Bay and surrounding waterways are listed as critical habitat for Johnson's seagrass and Johnson's Seagrass Critical Habitat and impacts would be anticipated to result in adverse impacts to Johnson's seagrass and adverse modification of Johnson's seagrass critical habitat.

Impacts to the piping plover, red knot, and the Florida bonneted bat, under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS) would be may affect, not likely to adversely affect. Impacts to the West Indian manatee and American crocodile would be may affect, likely to adversely affect. The Biscayne Bay and surrounding waterways are listed as critical habitat for the West Indian manatee and impacts would be anticipated to result in adverse modification of West Indian Manatee Critical Habitat.

Minor to major, temporary to permanent, adverse effects to EFH, fishery resources, and associated prey species would occur as a result of construction, maintenance, and operation of the proposed storm surge barriers, floodwalls, and associated features. During construction, noise and temporary minimal sedimentation due to disturbance of the bottom is expected, which could disrupt foraging, reproduction, and passage. Once constructed, the storm surge barrier gates would remain open except during testing operations and major storm events requiring closure. The gates would allow passage of aquatic organisms in the open position; however, passage and availability of prey species may be more restricted than currently. Closures would temporarily cut off passage of all aquatic organisms. Water quality plumes resulting from surge barrier and pump stations operations have the potential to adversely affect a range of fish species and benthic habitats.

Construction and maintenance of the surge barriers and floodwalls would result in temporary increases in turbidity and altered sediment deposition processes resulting in adverse, temporary, and minor to moderate water quality impacts. Surge barrier operations could potentially result in altered salinity, Dissolved Oxygen (DO), nutrients, and temperature in the Biscayne Bay, Biscayne Canal, Little River, and Miami River. The operation and testing of the surge barriers and pump stations would directly alter local water quality. Following storm events, plumes have the potential to alter water quality as it ultimately flows into offshore Biscayne Bay. Impacts would be temporary and range from minor to moderate. Ground water flow impacts would be temporary to permanent and moderate.

Adverse impacts from the construction, operation and maintenance of the structural features on bathymetry, hydrology, and tidal processes would range from temporary to permanent impacts that are minor to moderate.

There would be both temporary and permanent adverse impacts to aesthetics and visual resources that would range from minor to major impacts. Construction equipment would be visible at almost all locations, during construction. The floodwalls, storm surge barriers and associated features would be permanent and visible on land and/or water at their locations. The substantive height of the floodwalls (up to approximately 20 feet from ground surface elevation) at the Brickell Floodwall would obstruct views from Miami to the Biscayne Bay resulting in permanent, significant adverse effects to the visual landscape.

Impacts to recreation would be temporary to permanent, and range from minor to major impacts. Mooring and recreational boating at the Brickell Floodwall would be permanently prohibited resulting in adverse, significant impacts.

There would be a range of moderate to major, temporary and permanent adverse impacts to navigation at the Biscayne Canal, Little River, and Miami River Surge Barriers and at the Brickell Floodwall in the Biscayne Bay. The federal navigation channel near the center of the Miami River would remain in operation; a sector gate is being explored as an option to be constructed in this area. The surge barriers would permanently narrow the navigational area in the Biscayne Canal, Little River, and Miami River. There are no Federal navigation channels in the Little River, Biscayne Canal, or within the immediate area of the proposed location for the Brickell Floodwall within Biscayne Bay; however, those areas are heavily used by local residents and recreational boat traffic. Recreational mooring and boating would be permanently

prohibited along the approximately up to one mile of proposed floodwall in the Biscayne Bay at Brickell.

Impacts to mangroves, upland areas, natural drainage features, utilities, existing structures, etc. would generally be within the footprint of the project alignment and immediate surrounding areas. The associated impacts would range from beneficial to adverse, minor to moderate, and temporary to permanent impacts. There would be only minor, potential adverse impacts to the natural floodplain.

Cultural resource impacts would include potential adverse effects to historic buildings from the implementation of the nonstructural measures and/or unidentified archeological sites that could be impacted by the structural measures. Further study will be needed, and these potential impacts are addressed through a Programmatic Agreement with the Florida Division of Historic Resources (FDHR) and consulting parties, pursuant to Section 106 of the National Historic Preservation Act.

Noise impacts would occur from the use of construction and maintenance equipment and to maintain project features. Direct increases in noise and vibration levels on land would occur from the use of vehicles and construction equipment such as excavators, dump trucks, and other motor vehicles during transportation of materials to the project site and other construction activities resulting in minor and temporary impacts. For the in-water construction of the surge barriers and floodwalls noise would be generated from vessels as well as equipment such as pile-driving equipment to install the structural features. There would also be increases in noise from vehicles, vessels/barges, and construction equipment traveling to the construction sites. The noise generated from the construction and maintenance of the surge barriers, floodwalls and associated pump stations and riprap would be typical of construction sites. Other noise would result from the operation of the pump stations which would operate during closure of the pump stations (as needed) and during test operations. There would be underwater adverse impacts to noise and vibration levels that would occur for any in water geotechnical testing and construction and maintenance activities; these impacts would be temporary and moderate. Construction, maintenance, and operation noise impacts would be adverse, temporary and moderate.

Construction, operation, and maintenance of the project features would result in adverse, temporary disturbances to wildlife that are minor. Construction activities would increase ambient noise to levels greater than baseline. These adverse direct and indirect impacts to wildlife and terrestrial habitat have the potential to be minor and temporary to permanent in duration. There would be adverse, permanent, and moderate impacts to terrestrial habitat from the permanent construction footprints of the floodwalls.

Land use impacts from construction and maintenance activities would be adverse, temporary, and minor. Storm surge protection provided to a large expanse of urbanized coastal, low lying areas in Dade County serving to preserve land use functions. Overall, this would result in both adverse and beneficial effects that would be temporary to permanent and range from minor to major impacts.

There would be adverse, temporary to permanent, and moderate impacts to soils and geology resulting in the construction, operation, and maintenance of the project features. Fill and grading

done to construct project features would have an adverse, permanent, minor impact to topography. Impacts to soils and geology would be adverse to beneficial and range from minor to moderate.

Impacts to air quality would be anticipated to be adverse, temporary, and minor. Air emissions would occur from the use of construction equipment such as cranes, excavators, dump trucks, and other motor vehicles and barges/vessels during transportation of materials to the project site and other construction and maintenance activities resulting in minor, temporary impacts to air quality. Temporary and minor impacts to air quality would be anticipated with the operations of pump stations and back-up generators during testing events and/or when in operation during a storm event. However, the surge barriers would be operated only during major storm events that would likely be no more than five times per year for an average duration of approximately five days (and potentially up to 10 days). Therefore, emissions would be very limited and discontinuous.

With respect to socioeconomic and community safety, the structural flood risk management measures, the storm surge barriers and floodwalls and associated features, are typically large scale projects that reduce flood risk for a large number of structures, which is a beneficial and major, significant impact. Alternative 8 provides superior coastal storm risk protection as compared to all other alternatives with its maximum application of structural measures, nonstructural measures, and the inclusion of the Cutler Bay Site NNBF. Of particular mention, only the alternatives with structural measures provided life-loss reduction benefits and the ability to prevent infrastructure as well as structural damage across large, widespread areas in the MDC; the additional benefits to the safety of the community and to the prevention of substantive damage to property and infrastructure would be major benefit. Alternative 8 has some significant adverse impacts to the natural environment but also serves as the alternative with the most substantive coastal storm risk reduction value and best meets the overall project objectives.

The Cutler Bay NNBF Site would serve to provide storm surge dissipation benefits as well as a multitude of beneficial impacts to natural resources and water quality. Plantings of native vegetation including mangroves at the Cutler Bay NNBF Site would serve to reduce erosion, trap sediments and filter stormwater runoff serving to provide minor, permanent benefits to water quality to the Biscayne Bay. Planting of mangroves at the Cutler Bay NNBF would have beneficial, permanent and minor impacts to EFH and fish resources by enhancing fish foraging and nursery habitat. The NNBF site would serve to enhance wildlife habitat and improve migratory bird habitat. Construction of the mangroves at the NNBF Cutler Bay Site would cause minor, permanent alternations in bathymetry and hydrology due to their alteration of bottom conditions. This return to a more natural condition would result in a beneficial, minor impact to bathymetry and hydrology. Implementation of the Cutler Bay NNBF would serve to provide beneficial, minor and permanent impacts to soils. The Cutler Bay NNBF would result in, beneficial impacts to terrestrial habitat and wildlife that would be permanent and minor.

Programmatic NEPA and Future Tiered NEPA and Surveys/Data Collection

This document has been prepared as an integrated feasibility study/Programmatic EIS. The term “programmatic” indicates this is a broad or high-level NEPA document not a site-specific NEPA document. Therefore, during successive phases of the project, additional site-specific

NEPA documents (each one would be considered a tiered NEPA document) would be prepared and coordinated with local, state, and federal regulatory agencies, tribal governments, and the public. Tiering expedites the resolution of more substantive impacts to the human environment in the programmatic NEPA document so that subsequent tiered NEPA documents can focus on site-specific impacts and issues.

The final designs and siting of project features would not occur until the PED Phase of the project when more detailed surveys and data are available. Because of the limited design information available during this feasibility phase (during the feasibility study only approximately a 10 percent level of design will be provided), the Endangered Species Act, Section 7 and the Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat consultations would be conducted during the PED Phase of the project. During this feasibility phase of the project, a Programmatic Agreement is being prepared to ensure compliance under Section 106 of the National Historic Preservation Act.

A wetland jurisdictional determination and detailed environmental surveys of benthic habitat (to include corals, hardbottom habitat, and SAV) would also be conducted during the PED Phase to define site-specific impact acreages, provide input data needed for the final Uniform Mitigation Assessment Method (UMAM) analysis, and to determine required mitigation. During the PED Phase, detailed environmental surveys, and cultural and historic building surveys and data gathering would be conducted to support the site-specific future tiered NEPA document as each phase progresses. Topographic surveys and subsurface geotechnical surveys would be conducted during the PED Phase as well. A detailed operational plan for the project structural features would be developed as well during the PED Phase.

The level of detail in this programmatic NEPA document is sufficient to allow an informed decision among planning-level alternatives and to develop broad mitigation strategies. Additional, more detailed site-specific mitigation assessments would be conducted in future phases of the project. This is especially relevant and an appropriate mitigation strategy for this project as some of required mitigation would be for ephemeral species and habitats such as corals/hardbottom habitat and SAV whose extent and densities can vary considerably over time.

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ACRONYMS

ACE - Annual Chance Exceedance

ADCIRC – Advanced Circulation Model

ADM – Agency Decision Milestone

AEQAS - Aquatic Ecology and Quality Assurance Section

ARI - Annual Recurrence Interval

ATR - Agency Technical Review

BBA - Bipartisan Budget Act of 2018, Public Law 115-123

BBAP – Biscayne Bay Aquatic Preserves

BBSM - Biscayne Bay Simulation Model

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

BCR – Benefit-to-cost Ratio

BFE – Base Flood Elevation

C&SF - Central and Southern Florida Project

CAA – Clean Air Act

CDC - Centers for Disease Control and Prevention's

CDMP - Comprehensive Development Master Plan

CE – Common Era (replaces A.D.)

CERCLA – Comprehensive Environmental Response, Compensation and Liability Information System

CRS - Community Rating System

CSRM – Coastal Storm Risk Management

CWA – Clean Water Act

CZMA – Coastal Zone Management Act

DDF - Depth Damage Functions

DEM - Digital Elevation Model

DEO - Florida Department of Economic Opportunity

DERM – Division of Environmental Resource Management

DO – Dissolved Oxygen

EA – Environmental Assessment

EC - Engineering Circulars

EEL - Environmentally Endangered Lands

EFH – Essential Fish Habitat

EGM - Economic Guidance Memorandum

ENP - Everglades National Park

EO – Executive Order

ER - Engineering Regulation

ERDC - Engineer Research and Development Center

ESA – Endangered Species Act

ETL - Engineering Technical Letters

FAC - Florida Administrative Code

FBC - Florida Building Code

FCSA – Feasibility Cost Sharing Agreement

FDEP – Florida Department of Environmental Protection

FDOT – Federal Department of Transportation

FEMA – Federal Emergency Management Agency

FFE - First Floor Elevations

FIRM – Flood Insurance Rate Map

FIS - Flood Insurance Study

FLDEQ - Florida Department of Environmental Quality

FWC - Fish and Wildlife Commission

FWOP – Future without Project Condition

FWP – Future with Project Condition

GIS – Geographic Information System

H & H – Hydrology and Hydraulics

Hazus - Hazards of the U.S.

HUC - Hydrologic Unit Code

IEPR - Independent Expert Peer Review

IFLOWS - Integrated Flood Observing and Warning System

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

MDC – Miami-Dade County

MSFCMA – Magnuson-Stevens Fishery Conservation and Management Act

MSL – Mean Sea Level

NAAQS – National Ambient Air Quality Standards

NAD – North Atlantic Division

NADA - National Automobile Dealers Association

NAD83 - North American Vertical Datum of 1983	SVI - Social Vulnerability Index
NAVD88 – North American Vertical Datum of 1988	TC - Tropical Cyclone
NED – National Economic Development	TMDL – Total Maximum Daily Load
NEPA – National Environmental Policy Act	TPCS - Total Project Cost Summary
NFIP - National Flood Insurance Program	TSP – Tentatively Selected Plan
NFS – non-Federal Sponsor	TSS – Total Suspended Solids
NHC - National Hurricane Center	UDB - Urban Development Boundary
NHPA – National Historic Preservation Act	USACE – United States Army Corps of Engineers
NMFS – National Marine Fisheries Service	USEPA – United States Environmental Protection Agency
NNBF – Natural and Nature-Based Features	USFWS – United States Fish and Wildlife service
NOAA – National Oceanographic and Atmospheric Administration	USGS – United States Geological Survey
NPS - National Park Service	WASD – Water and Sewer Department
NRHP – National Register of Historic Places	WIIN - Water Infrastructure Improvements for the Nation
NTDE - National Tidal Datum Epoch	WQSP - Water Quality Standards Program
NWI – National Wetlands Inventory Project	WRDA – Water Resources Development Act
OMRR&R - Operation, Maintenance, Repair, Rehabilitation, and Replacement	WSEL - Water Surface Elevations
OSE – Other Social Effects	
PDT – Project Delivery Team	
PED – Preconstruction Engineering and Design	
PGL - Policy Guidance Letter	
PPA - Project Partnership Agreement	
RAP - Rapid Action Plan	
RED - Regional Economic Development	
RER - Regulatory and Economic Resources	
ROI – Region of Influence	
RP - Recommended Plan	
RSLR – Relative Sea Level Rise	
SACS – South Atlantic Coastal Study	
SAD – South Atlantic Division	
SAV – Submerged Aquatic Vegetation	
SFLSSS - South Florida Storm Surge Study	
SFWMD – South Florida Water Management District	
SLC – Sea Level Change	
SLR – Sea Level Rise	
SUCO - Standard Urban Centers District Regulations	

CHAPTER 1 INTRODUCTION

1.1 BACKGROUND

The Miami-Dade Back Bay Coastal Storm Risk Management (CSRM) Feasibility Study has investigated potential structural, nonstructural, and natural and nature-based feature solution sets in terms of CSRM. Coastal storm risk management seeks to address coastal storm surge and flood risk to vulnerable populations, property, ecosystems, and infrastructure along the coast. Miami-Dade County (MDC) has high levels of risk and vulnerability to coastal storms which will be exacerbated by sea level rise (SLR) over the study period.

1.1.1 NON-FEDERAL SPONSOR

Miami-Dade County, Florida is the non-Federal sponsor (NFS) for this study. There are 34 municipalities within the county, the largest of which is the City of Miami. The municipalities of the county will be key stakeholders and partners in the study. The federal cost share agreement (FCSA) for the study was signed on October 9, 2018. The study is 100 percent federally funded.

1.1.2 COOPERATING AGENCIES

The role of cooperating agencies to provide for early coordination in the National Environmental Policy Act (NEPA) process is described in the 40 Code of Federal Regulations (CFR) § 1501.6. Cooperating agencies for the study are the Florida Department of Transportation, National Oceanographic and Atmospheric Services, National Marine Fisheries Service (NMFS) and the U.S. Environmental Protection Agency (USEPA).

1.1.3 ADDITIONAL STUDY GUIDELINES

This study is one of four ongoing USACE CSRM studies that cover MDC. As such, it is important for the various studies to coordinate activities and understand potential cumulative impacts that recommendations will have on the region. It is also important for MDC officials and the local community to understand the diverse challenges being studied that is ongoing in their area.

The following are in addition to this Back Bay Study and commenced in 2018-2019:

Miami-Dade CSRM Study

This study focuses on CSRM solutions for coastline in MDC. Further information on this study can be found on the site below:

<https://www.saj.usace.army.mil/MiamiDadeCountyCSRMFfeasibilityStudy/>

Miami Harbor Improvements Feasibility Study

This study focuses on navigation improvements for improving port and seafaring trade activities. Further information on this study can be found on the site below:

<https://www.saj.usace.army.mil/MiamiHarborNavigationImprovementStudy/>

South Atlantic Coastal Study (SACS)

The SACS is investigating coastal storm risk and its increase as a result of SLR throughout the Corps' South Atlantic Division including, North Carolina, South Carolina, Georgia, Florida,

Alabama, Mississippi, Puerto Rico, and the U.S. Virgin Islands. The purpose is to better understand and describe risk and vulnerabilities from a regional perspective. The MDC area is included in this study. Further information on this study can be found on the site below:

<https://www.sad.usace.army.mil/SACS/>.

1.1.4 FEDERAL INTEREST

The MDC area is extremely vulnerable to coastal storm flooding. Coastal Storm Risk Management is an identified primary mission area of USACE. This feasibility study identifies a variety of solutions that have the potential to be economically justified, environmentally acceptable, addressable through engineering solutions, and consistent with USACE policies. Miami-Dade County is home to a nationally significant economy led by tourism as well as trade via air and sea. This interest is also echoed across the region in the SACS and the various other CSRM studies that are currently being conducted within the State of Florida. The U.S. Army Corps of Engineers authorization, as described in Section 1.4 STUDY AUTHORITY, identifies the need for CSRM in MDC.

1.2 STUDY AREA

Per Engineering Pamphlet 1100-2-1: Procedures to Evaluate Sea Level Change: Impacts, Responses, and Adaptation, the project area should be defined by using the high sea level change curve elevation at 100 years out which will help identify the potential future affected area. Using LiDAR data, MDC ground elevation has a mean of approximately 5 feet North American Vertical of 1988 (NAVD88). Federal Emergency Management Agency's effective 0.1 percent annual chance flood ranges from 0.5 feet to 16.5 feet NAVD88 throughout the county. Using the Vaca Key gage in the USACE Sea-Level Change Curve Calculator 100 years out would add an additional 8.1' of sea level rise resulting in a water surface elevation range of 8.6 feet to 24.6 feet NAVD88. Information as to why Vaca Key, FL gage was used can be found in Appendix B. This type of water level, especially in the mid to upper range, would inundate over 99 percent of the county.

Due to the large geographic scale of the study and the inability to provide a comprehensive recommendation under this study effort, the team first focused on the urban areas of the county. The county has established an Urban Development Boundary (UDB) that discourages development outside its bounds. Much of the county area consists of federally owned land (e.g. Everglades National Park) which is outside of the UDB and not addressed in this study. A process was later completed to further refine the study area by identifying the most vulnerable areas based on flooding potential and social vulnerability which is fully described in Chapter 3. The county is bordered by the Atlantic Ocean to the east, Monroe County to the south and west, Collier County to the northwest, and Broward County to the north as shown in Figure 1-1.

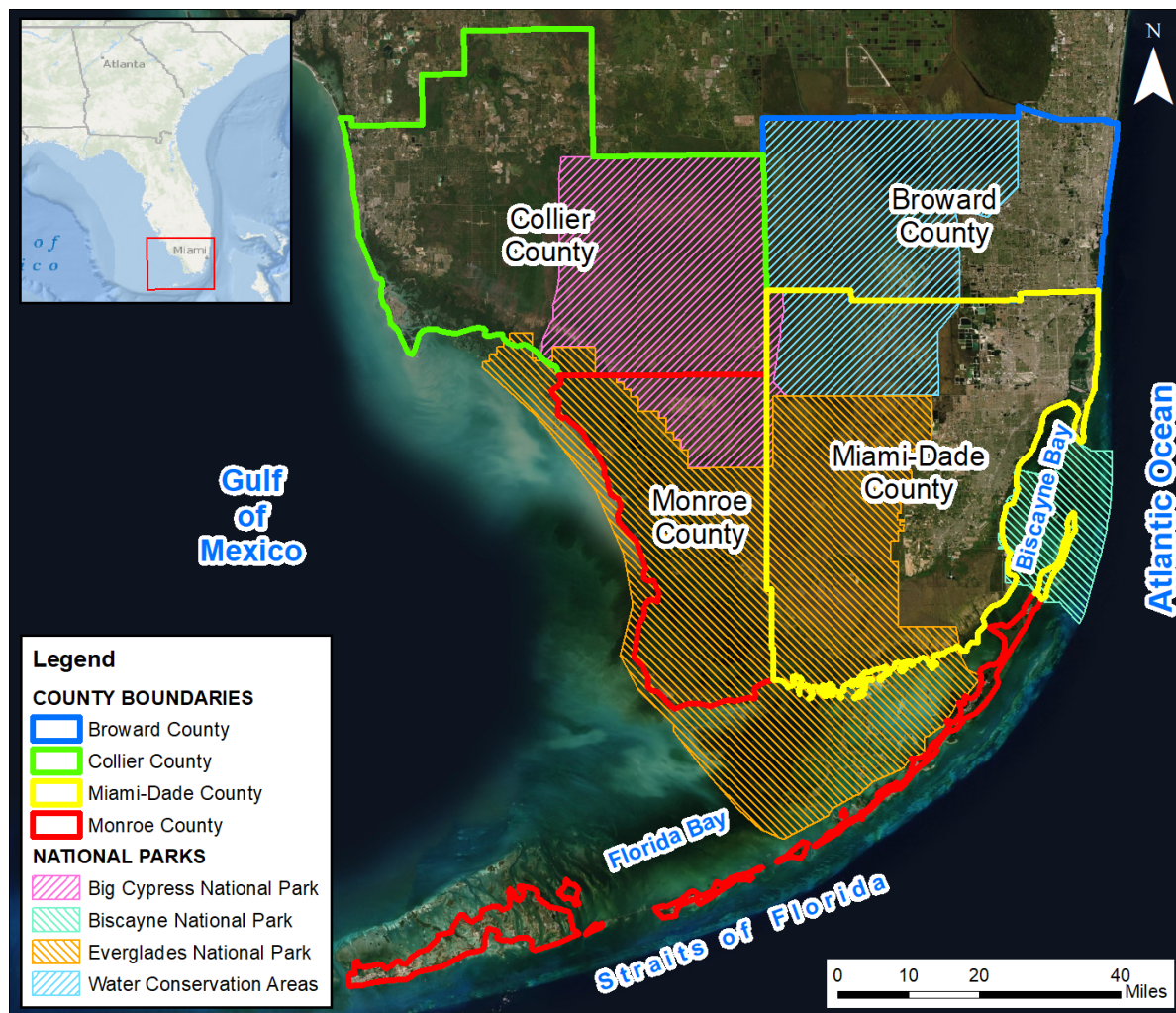


Figure 1-1. Miami-Dade County Vicinity Map

Miami-Dade County has 34 incorporated municipalities and an Unincorporated Municipal Service Area – areas of the County that do not fall within municipal boundaries. Table 1-1 lists the 34 municipalities, their designation, the year of incorporation, and 2010 census population. Figure 1-2 shows the breakdown of Miami-Dade County.

Table 1-1. Miami-Dade County Municipalities Data

Name	Designation	Year Incorporated	2010 Population
Aventura	City	1995	35,762
Bal Harbour	Village	1947	2,513
Bay Harbor Islands	Town	1947	5,628
Biscayne Park	Village	1933	3,055
Coral Gables	City	1925	46,780
Cutler Bay	Town	2005	40,286
Doral	City	2003	45,704
El Portal	Village	1937	2,325
Florida City	City	1914	11,245
Golden Beach	Town	1929	919
Hialeah	City	1925	224,669
Hialeah Gardens	City	1948	21,744
Homestead	City	1913	60,512
Indian Creek Village	Village	1939	86
Key Biscayne	Village	1991	12,344
Medley	Town	1949	838
Miami	City	1896	399,457
Miami Beach	City	2015	87,779
Miami Gardens	City	2003	107,167
Miami Lakes	Town	2000	29,361
Miami Shores	Village	1932	10,493
Miami Springs	City	1926	13,809
North Bay Village	City	1945	7,137
North Miami	City	1953	58,786
North Miami Beach	City	1927	41,523
Opa-locka	City	1926	15,219
Palmetto Bay	Village	2002	23,410
Pinecrest	Village	1996	18,223
South Miami	City	1927	11,657
Sunny Isles Beach	City	1997	20,832
Surfside	Town	1935	5,744
Sweetwater	City	1941	13,499
Virginia Gardens	Village	1947	2,375
West Miami	City	1947	5,965

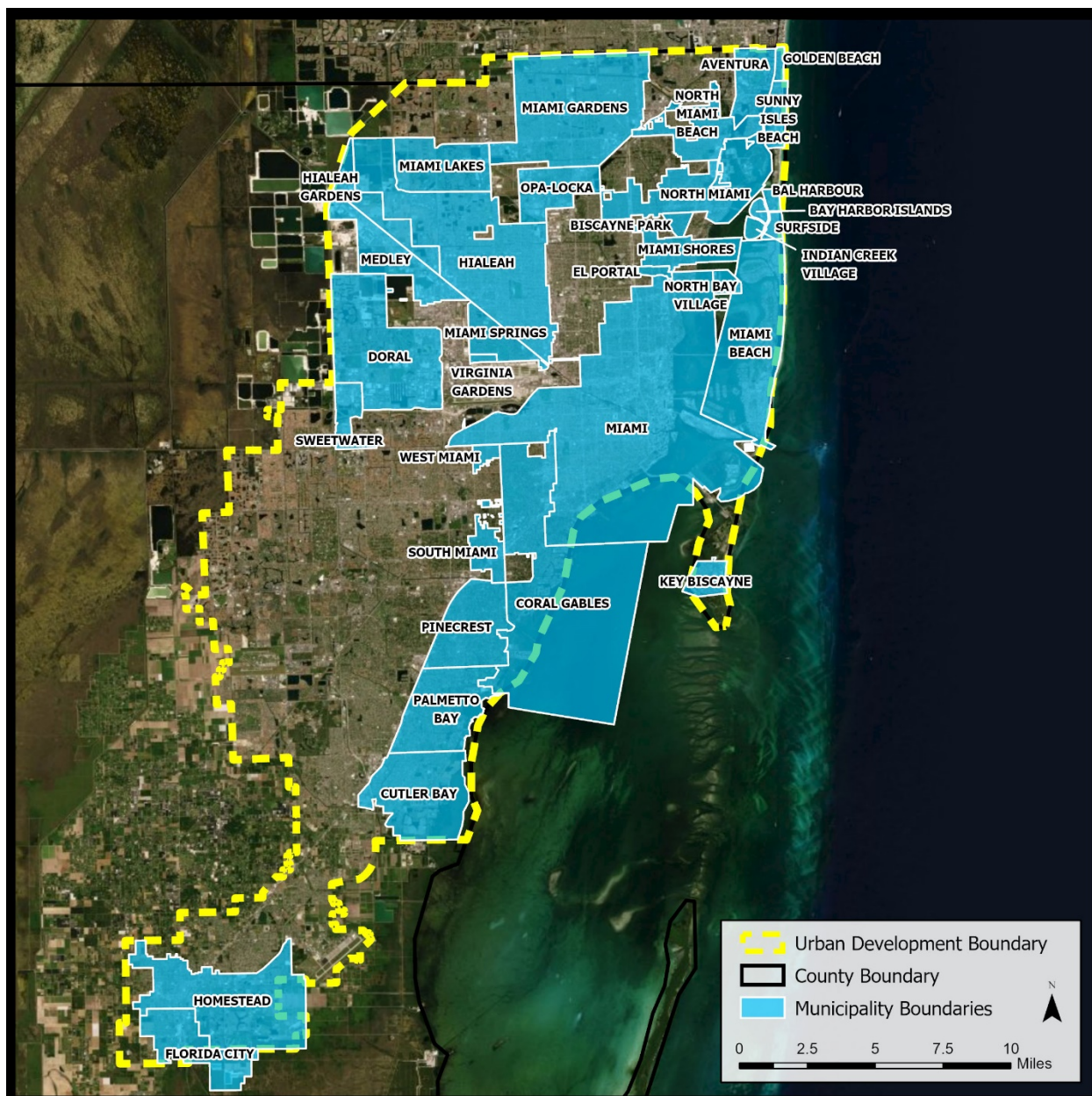


Figure 1-2. Miami-Dade County Municipalities Map

The study will concentrate on recommendations for the urbanized portions of the county. This is defined by the urban development boundary shown in Figure 1-2. Figure 1-3 shows how majority of MDC watershed 5th level, defined by the hydrologic unit code (HUC) 10, is taken up by the Everglades National Park and water conservation areas.

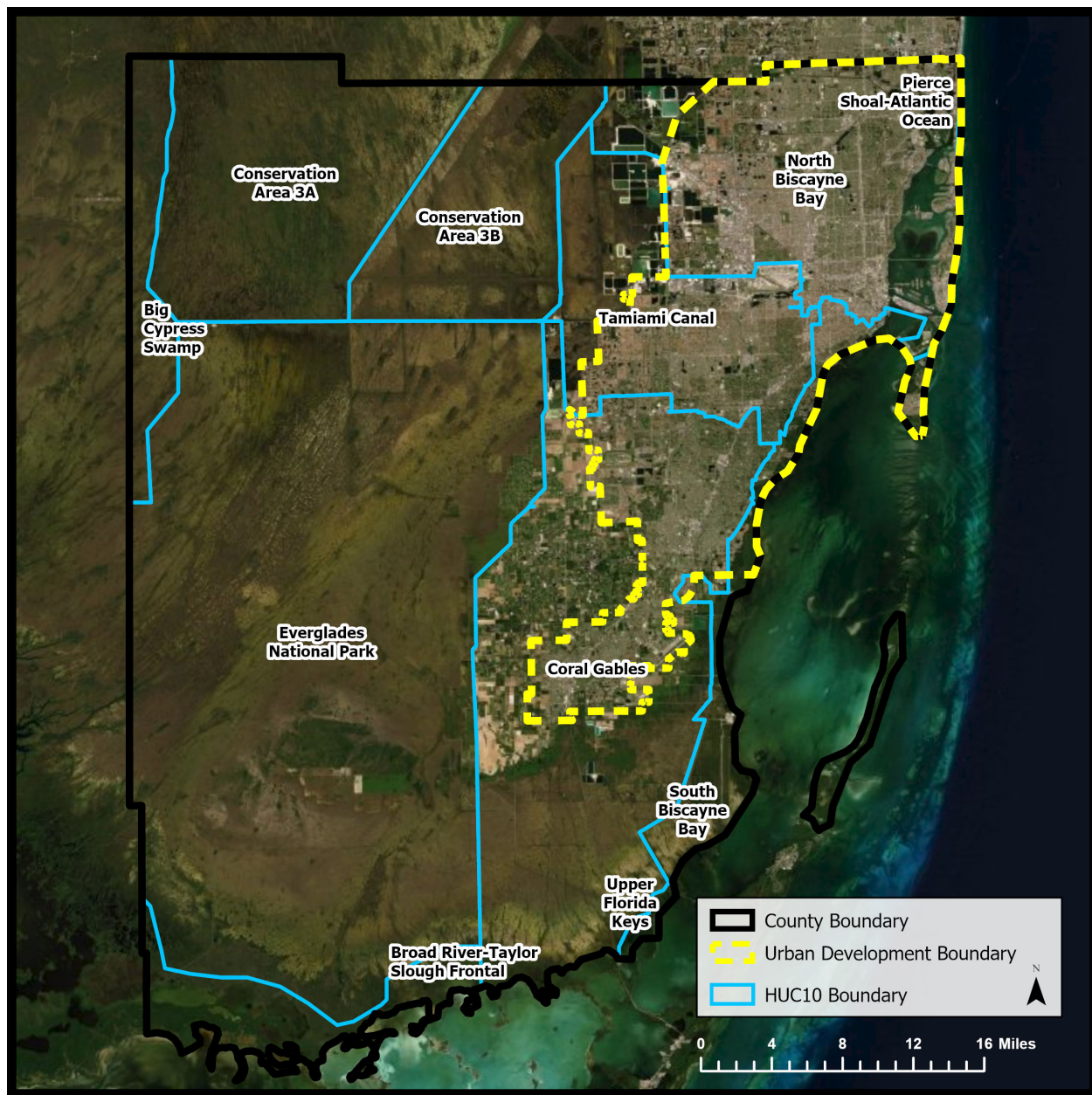


Figure 1-3. Miami-Dade County HUC10 and Urban Development Boundaries

The assessment area lies within the jurisdiction of the following Congressional Delegations: U.S. Senators Marco Rubio and Rick Scott, and U.S. Representatives Mario Diaz-Balart, Alcee Hastings, Debbie Mucarsel-Powell, Debbie Wasserman Schultz, Donna Shalala, and Frederica Wilson.

1.3 PURPOSE AND NEED FOR THE PROPOSED ACTION

This study is a response to the study authority and will develop and evaluate CSRM measures for MDC. The Miami-Dade County and its 34 municipalities, with a total of approximately 2.8 million people, lie in a relatively low-lying and flat coastal area. The region is well known for its risks of coastal flooding from hurricanes and tropical storms. Sea level rise has increased these

risks and will continue to do so in the future. Without plans to reduce coastal flood risk and increase resiliency, threats to life, property, and the economy will continue to increase. This study will develop and evaluate CSRM measures for MDC residents, industries, and businesses, some of which are critical to the regional and national economy.

1.4 STUDY AUTHORITY

The study authority is Public Law 84-71, 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 damage have occurred from hurricane winds and tides. It also authorizes the inclusion of data on the behavior and frequency of hurricanes, and of possible means of preventing loss of human lives and damage to property, with due consideration of the economics of proposed breakwaters, seawalls, dikes, dams, and other structures.

Notwithstanding Section 105(a) of the Water Resources Development Act of 1986 (33 U.S.C. 2215(a)), which specifies the cost-sharing requirements generally applicable to feasibility studies, Title IV, Division B of the Bipartisan Budget Act of 2018, Public Law 115-123, enacted February 9, 2018 (hereinafter “BBA 2018”), authorizes the Government to conduct the Study at full Federal expense to the extent that appropriations provided under the Investigations heading of the BBA 2018 are available and used for such purpose.

1.5 RISK INFORMED DECISION FRAMEWORK

1.5.1 STAKEHOLDER INVOLVEMENT

Stakeholder involvement has been a critical component of the Miami-Dade Back Bay CSRM Study and the development of a countywide vision for managing coastal storm risk throughout MDC. Stakeholders include any member of the public that might be able to affect, are affected by, or are interested in, the results of the Corps planning process. They are people or groups who see themselves as having rights and interests at stake, either directly or indirectly. Environmental interagency meetings have been held approximately monthly throughout the feasibility planning phase.

Federally recognized tribes (as defined in section 102 of the Federally Recognized Indian Tribe List Act of 1994 (25 U.S.C. 5130)) including Alaska Natives are not considered stakeholders due to their sovereign status. Table 1-2 documents some of the more vital meetings, workshops, and charrettes that have taken place in order to add value to the planning effort. Stakeholders identified for this study include but are not limited to the MDC elected officials, staff, and citizens, federal agencies, military interests, state agencies, non-profit environmental organizations, local and regional planning commissions, commercial interests such as shipping and navigation, and recreational interests. The U.S. Army Corps of Engineers has received comments from stakeholders and the public throughout the study which are provided in Appendix D.

Table 1-2. Stakeholder Involvement History

Session	Date	Description
Scoping Meeting	October 29-30, 2018	USACE planning and scoping overview, knowledge exchange
Kickoff Charrette	November 8-9, 2018	Review problems & opportunities, Workshop to Identify measures
NEPA Scoping Meeting	December 5, 2018	Open house public meeting to collect scoping comments
Planning Charrette	March 21-22, 2019	Narrow down focus areas, critical infrastructure asset categories, and measures
NEPA Public Meeting	September 10, 2019	Open house public meeting

1.5.2 ALTERNATIVES DEVELOPMENT

The Miami-Dade County Back Bay CSRM consists of measures that include structural, nonstructural, and natural and nature-based features (NNBF). An alternative plan is comprised of one or more measures functioning together to address one or more planning objectives. The Project Delivery Team (PDT) developed a list of CSRM measures that could reasonably address the identified problems and opportunities.

The U.S. Army Corps of Engineers, with the help of the NFS and other stakeholders, first identified measures applicable to the MDC area during meetings, charrettes, and public involvement. Measures were then screened on their ability to meet the study objectives while avoiding planning constraints.

Measures were also screened based on varying factors some of which include cost, environmental, social, historical or cultural impacts, and avoiding inducing any flooding in areas. These measures were then combined into different viable alternative plans which combined structural, nonstructural, and critical infrastructure, and NNBF measures. Stakeholder input was incorporated into the plan comparison through public meetings, meetings with cooperating agencies, and meetings with the NFS.

This analysis resulted in the following eight alternatives: 1) No Action; 2) Critical Infrastructure; 3) Miami River Basin; 4) Nonstructural; 5) Structural; 6) Combination of alternatives 3 + 4; 7) Combination of alternatives 4 + 5, and 8) Alternative 7 with structural removed from the Edgewater area and replaced with nonstructural measures.

Further information regarding alternatives and the planning process that led to these alternatives are in Chapter 6.

1.5.3 CLIMATE CHANGE AND SEA LEVEL RISE

The U.S. Army Corps of Engineers has considered SLR in its planning activities since 1986 due to the importance of coastal areas to its missions and operations. The following Engineering Circulars (EC), Engineering Regulations (ER), and Engineering Technical Letters (ETL), some of which supersede the previous ECs, provide guidance on how to address SLR and sea level change (SLC):

- EC 1105-2-186: Planning Guidance on the Incorporation of Sea Level Rise Possibilities in Feasibility Studies (1989)
- Planning Guidance Notebook (2000)
- EC 1165-2-211: Incorporating Sea-Level Change Considerations in Civil Works Programs (2009)
- EC 1165-2-212: Sea Level Change Considerations for Civil Works Programs (2013)
- ER 1100-2-8162: Incorporating Sea Level Change in Civil Works Programs (2019)
- Engineer Technical Letter 1100-2-1: Procedures to Evaluate Sea Level Change: Impacts, Responses and Adaptation (2014)

Engineering Regulation 1100-2-8162 requires the consideration of alternatives to be formulated and evaluated represented by three SLR scenarios – typically the ‘low’, ‘intermediate’, and ‘high’ rates of USACE SLR. For this study, the National Oceanographic and Atmospheric Administration (NOAA) high curve will also be considered in order to have a higher bound than the USACE high which is more in line with the current local projections.

Locally, the rate of relative sea level rise (RSLR), which is a combination of SLR and local land subsidence, has been significantly higher than the global mean. The National Oceanographic and Atmospheric Administration Station ID 8723970, Vaca Key, Florida, (https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=8723970) has a published relative sea level trend of 3.66 +/- 0.44 mm/yr. Information as to why Vaca Key, Florida gage was used can be found in Appendix B. Information describing the study assumptions related to RSLR can be found in section 3.7.2 Relative Sea Level Rise Projections. Note that MDC does not have any land subsidence issues therefore this study addresses SLR and not SLC.

1.5.4 FUTURE STORM FREQUENCY AND INTENSITY

This study is currently using existing historical data and information for estimating storm frequency and intensity. This study does not incorporate estimates for changes in future storm frequency and intensity per ER 1100-2-8162, Incorporating Sea Level Change in Civil Works Programs, which states “At this time, no certain effects of climate change on tropical cyclone (TC) activity in terms of frequency, intensity, and rainfall across global basins have been identified as changes to the variability of TC activity expected from natural causes (Knutson et al., 2010). As a result, the current science related to climate effects on TC activity relevant to the United States has not reached the point of standard consensus necessary to inform a change in storm analysis baselines.” Future sea level rise estimates are incorporated into the study based on scientific estimates and ER 1100-2-8162. Please reference Appendix B for further information regarding future climate change.

1.5.5 RISK BASED STORM FREQUENCY STIMULATION

One of the most significant advancements in the last few years is the development and application of numerical models to replicate coastal storm surges and to statistically determine the potential frequency of events at individual locations. This has been possible due to higher computing powers and better resolutions of data which allows for finer mesh grid sizes of areas in models. There are a few sources of storm surge water surface elevations (WSEL) available for analysis and comparison. The Federal Emergency Management Agency (FEMA) has published WSELs for MDC in 1994, and has revised some parts of the county in 2009. The Federal Emergency Management Agency is currently updating the Flood Insurance Rate Map (FIRM) for MDC. It is estimated to be preliminarily released in spring 2020. There will then be a public review and appeal process, which usually takes six months, after which it will become the new effective FIRM. The U.S. Army Corps of Engineers obtained data from the model and had team members at their Engineer Research and Development Center (ERDC) run statistics on the data. These results could be different from the final FEMA data since it is possible FEMA will use different statistical methodology and the processing of different ADCIRC node data. The South Atlantic Coastal Study will also be developing their own WSELs, but it will not be available until an estimated 2021.

1.5.6 SOCIO-ECONOMIC EVALUATION

Due to MDC having a population of over 2.8 million people and over 500,000 residential and non-residential structures, it was important to first utilize geographic information system (GIS) tools such as ArcGIS to allow for the easier processing of data. The Federal Emergency Management Agency's Hazards of the U.S. (Hazus) software was used to preliminarily assess damage to structures and contents, and Centers for Disease Control and Prevention's (CDC) Social Vulnerability Index (SVI) (<https://svi.cdc.gov/>) ShapeFile was overlaid on top of the Hazus damage in ArcGIS to determine which damage centers were also areas of highest risk to vulnerable populations. Hazus utilizes census block data which includes possible capital stock losses due to structures, contents, vehicles, schools, as well as income losses such as relocation, capital related, wages, and rental income.

According to *A Social Vulnerability Index for Disaster Management*, CDC's SVI uses U.S. Census data to determine social vulnerability of every census tract based on four main themes:

1. Socioeconomic status
2. Household Composition / Disability
3. Minority Status / Language
4. Housing / Transportation.

More information on this analysis is in Chapter 6 and Appendix A. Cultural and historical impacts were also studied in ArcGIS using building and district data from the National Register of Historic Places (NRHP).

1.5.7 SCENARIO PLANNING

It is not possible to predict with absolute certainty the various societal and environmental conditions of the future. In order to reduce the risk and uncertainty in the planning phase, various scenarios are evaluated for plan performance. Scenario planning is an approach for

dealing with key uncertainties. Scenarios represent futures that can plausibly occur given a set of plausible combinations of future conditions. These conditions represent uncertain values of key drivers that will result in different futures. The key drivers that are anticipated to influence future coastal flood risk in MDC are 1) the rates of SLC, 2) storm intensities, and 3) changes in development and population within the County.

1.5.8 EVALUATION CRITERIA FOR RANKING AND COMPARING PLANS

Plan formulation has been conducted with a focus on achieving the federal objective of water and related land resources project planning, which is to contribute to National Economic Development (NED) consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other federal planning requirements. Plan formulation also considers all effects, beneficial or adverse, to each of the four evaluation accounts identified in the 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies (Principles and Guidelines) which are National Economic Development, Environmental Quality, Regional Economic Development, and Other Social Effects.

1.6 STORM DAMAGE HISTORY

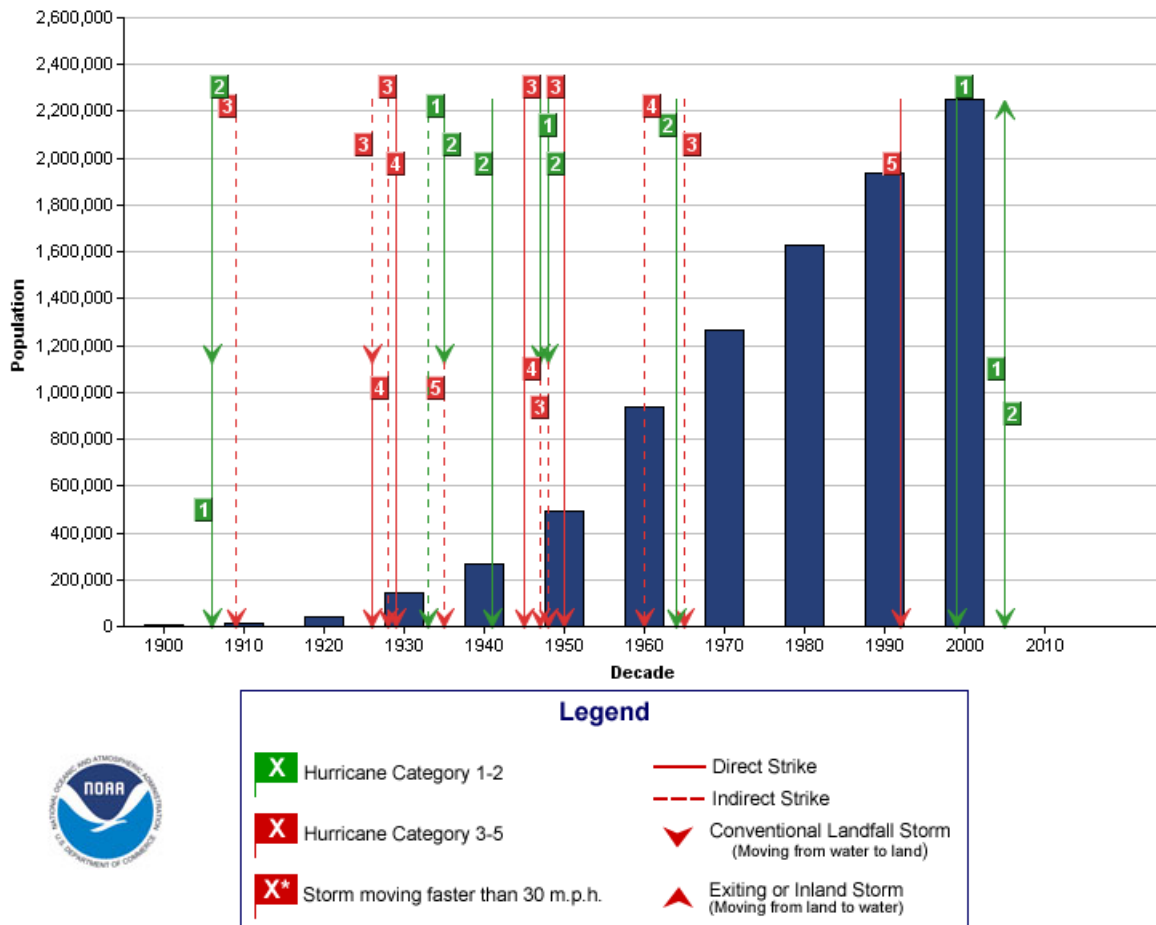
According to the Miami-Dade Emergency Operations Center Comprehensive Emergency Management Plan Volume I (revised November 2017), Southeast Florida has experienced 35 hurricanes between 1994 and 2016 of which nine were major hurricanes (Category 3 or above). Over 1.9 million residents are required to evacuate in the event of a Category 5 hurricane which can become difficult due to surrounding counties evacuating simultaneously thus increasing clearance times. Residents also tend to delay evacuation until the last minute which results in further traffic jams and clearance times.

According to the MDC Local Mitigation Strategy (LMS): Whole Community Hazard Mitigation Part 1: The Strategy (January 2018), MDC has been impacted by many hurricanes and tropical storms including the Great Miami Hurricane (1926), Lake Okeechobee Hurricane (1928), Hurricane King (1950), Hurricane Donna (1960), Hurricane Andrew (1992), Hurricane Katrina (2005), Hurricane Wilma (2005), Hurricane Sandy (2012), Tropical Storm Isaac (2012), Tropical Storm Matthew (2016), and Hurricane Irma (2017). Table 1-3 shows hurricane data within the MDC area taken from National Weather Service – Miami Forecast Office, NOAA National Hurricane Center/Tropical Prediction Center, Florida State University Meteorology Department, and Florida Hurricanes and Tropical Storms (Williams & Duedall). The date listed in Table 1-3 is the date of landfall in South Florida and the category of storm shown is the highest category that existed when the storm passed over or near MDC.

Table 1-3. South Florida Hurricanes & Storms 1906-2014

Date	Name	Category	Wind (MPH)	Surge	Deaths	~ Damage (\$)
6/17/1906	Hurricane	1	80	Unknown	0	Unknown
10/18/1906	Hurricane #8	3	120	Unknown	164	0.16 million
10/11/1909	Hurricane #9	2	100	Unknown	0	Unknown
10/21/1924	Hurricane #7	Tropical Storm	70	Unknown	0	Unknown
9/18/1926	Hurricane #6	4	138	13.2'	243	1.4 billion
10/21/1926	Hurricane #10	2	110	Unknown	0	Unknown
9/17/1928	Hurricane #4	4	132	10-15'	2,500+	26 million
9/28/1929	Hurricane #2	2	100	Unknown	0	Unknown
9/3/1935	Hurricane #2	5	160	20+	408	6 million
11/4/1935	Hurricane #6	1	75	6'	19	5.5 million
10/6/1941	Hurricane #5	3	120	8'	5	0.7 million
9/16/1945	Hurricane #9	4	138	13.7'	4	540 million
9/22/1948	Hurricane #7	2	98	8'	0	Unknown
10/6/1948	Hurricane #8	2	105	6.2'	0	5.5 million
8/27/1949	Hurricane #2	4	130	Unknown	2	52 million
10/18/1950	King	2	105	14'	3	28 million
9/10/1960	Donna	4	136	13'	50	1.8 billion
8/27/1964	Cleo	2	105	6'	3	28 million
9/8/1965	Betsy	3	125	9'	75	6.4 billion
10/4/1966	Inez	1	85	15.5'	48	5 million
9/3/1979	David	2	98	3-5'	5	10 million
8/24/1992	Andrew	5*	155	16.9'	48	30 billion
11/16/1994	Gordon	Tropical Storm	52	3-5'	0	90 million
9/25/1998	Georges	2	98	5-6'	0	12.5 million
11/5/1998	Mitch	Tropical Storm	65	3-4'	0	0.1 million
10/15/1999	Irene	1	75	3-5'	4	800 million
10/3/2000	Leslie	Tropical Storm	35	2-4'	0	500 million
9/3/2004	Frances	1	75	2-4'	0	33 million
9/25/2004	Jeanne	Tropical Storm	50	2-4'	0	10.4 million
8/25/2005	Katrina	1	80	2-4'	0	800 million
9/18/2005	Rita	Tropical Storm	50	2-3'	0	12 million
10/24/2005	Wilma	2	110	5-6'	0	1.5 billion
8/27/2012	Isaac	Tropical Storm	29	1-2'	0	Unknown
10/26/2012	Sandy	1	60	1-2'	0	Unknown

*Hurricane Andrew was reclassified from a CAT 4 storm to CAT 5 in 2002 by the National Hurricane Center



Hurricane Strike Data: National Hurricane Center

Population Data: U.S. Census Bureau

NOTE: Population values may be missing in some counties, particularly for earlier periods. This is most often attributable to the fact that the county had not yet been established.

NOTE: There may be discrepancies between the strike data shown in this chart and the HURDAT strike data used in the Historical Hurricanes Tracks Tool. The National Hurricane Center is currently updating the strike data used for these charts.

For more information visit http://www.aoml.noaa.gov/hrd/data_sub/re_anal.html

NOTE: Population data is current as of 2000 U.S. Census. X-axis on graphs depict years through 2010 to illustrate storms that have occurred from 2000-2006.

Figure 1-4. Hurricane Strikes versus Population for Miami-Dade County, Florida

As shown in Figure 1-4, the population of MDC has been increasing every decade since 1900. Although MDC has not had many direct hurricane strikes in the last 50 years, the figure brings attention to the fact that many did occur between the 1930s to 1960s when the population was on average a quarter of what it is today. A hurricane strike with today's growing population and infrastructure could be potentially disastrous.

1.6.1 HISTORICAL STORMS

There are many storms that have gone through or passed by MDC going as far back as 1857. Figure 1-5 shows the hurricane tracks for the 13 storms mentioned more in depth in this section.

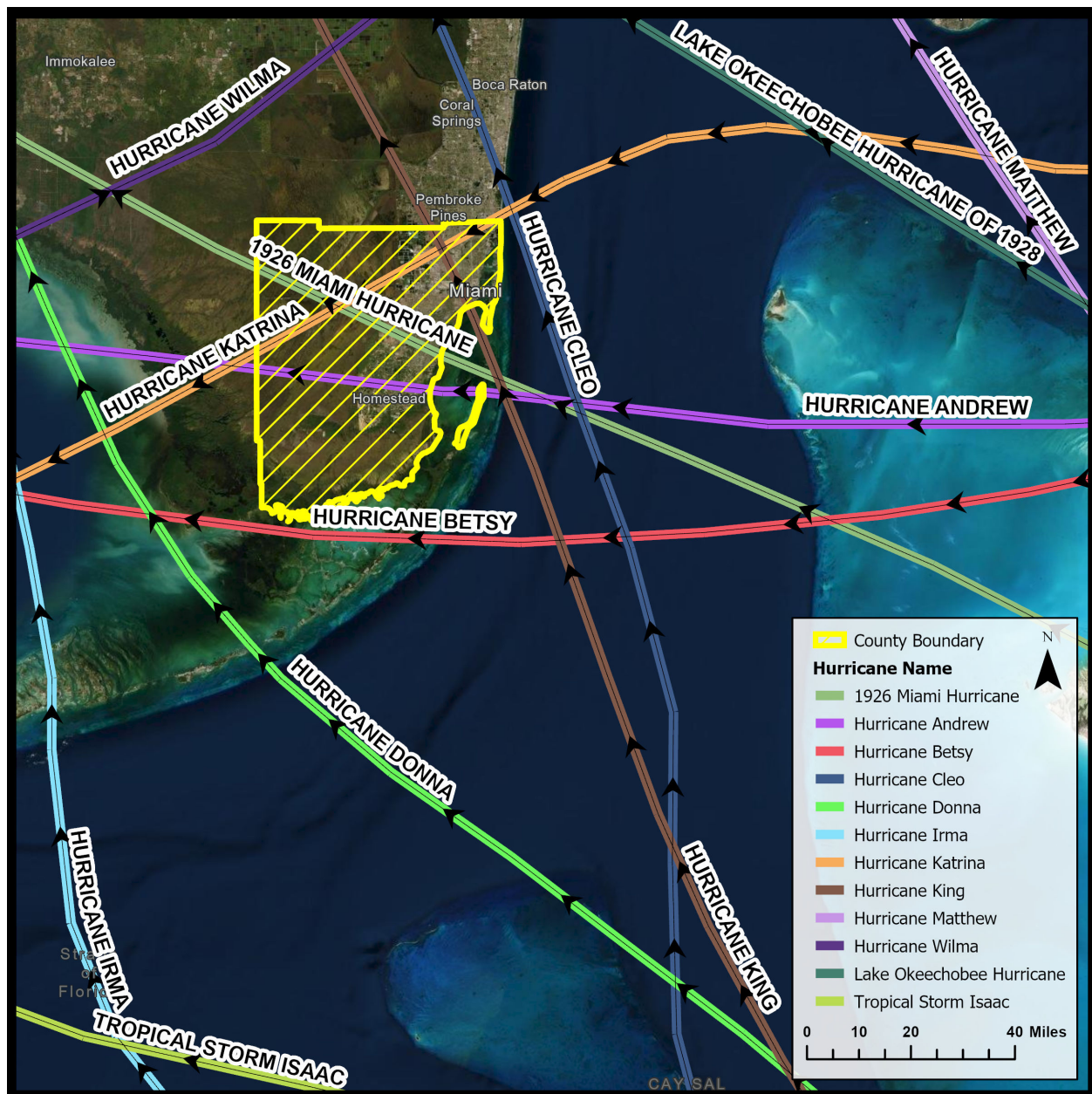


Figure 1-5. Historical Storm Tracks for the Miami-Dade County Area

The 1926 Miami Hurricane

Winds were reported to be nearly 150 mph as the Category 4 “Great Miami” hurricane passed over Turks Islands and the Bahamas on the 16th and 17th of September respectively. The hurricane’s eye moved directly over Miami Beach and then downtown Miami during the morning of the 18th. Storm surge of nearly 15 feet were reported in Coconut Grove just a few miles south of the City of Miami, and approximately 11.7 feet along Biscayne Boulevard in Downtown Miami (Barnes 1998). Figure 1-6 shows storm surge impacts (credit: State Archives of Florida).



Figure 1-6. Submerged Palm Trees in Storm Surge

The MacArthur Causeway connecting Miami and Miami Beach was submerged under six feet of water. Many deaths occurred near Lake Okeechobee due to a large storm surge breaching muck dikes which drowned hundreds of people. Figure 1-7 shows a boat washed ashore due to the Great Miami Hurricane (Credit: NOAA).



Figure 1-7. Boat Washed Ashore onto Bay Shore Drive

The death toll is uncertain since many people were still missing although a Red Cross report lists 373 deaths and 6,381 injuries as a result of the hurricane. Damage was approximately \$105 million, which if normalized to today's conditions, would be approximately \$236 billion making it the costliest Atlantic hurricane to date (Weinkle et al. 2018).

Lake Okeechobee Hurricane of 1928

The Okeechobee hurricane of 1928, also known as the San Felipe Segundo hurricane, made landfall near Palm Beach, Florida on September 16, 1928 as a Category 4 hurricane. Winds reached approximately 78 mph in Miami. According to the National Hurricane Center (<https://www.nhc.noaa.gov/outreach/history/>), majority of the 1,836 deaths, taken as the official count by the National Weather Service, were due to a six to nine feet of surge at Lake Okeechobee causing the surrounding area to inundate.

Hurricane King (1950)

Tropical Storm King intensified to a hurricane while passing to the west of Jamaica. It remained a major hurricane while emerging into the Straits of Florida, and on October 18, 1950 it struck Miami, Florida as a Category 3 hurricane. Two recording stations in Miami reported winds of 122 mph, gusts of about 150 mph, and an eye radius of only five miles wide. King caused a 19.3' storm surge to the City of Miami which caused property damage totaling \$15 million (1950 USD) in the Miami metropolitan area. Overall, King caused four deaths and \$28 million (1950 USD) in damage (Norton 1951).

Hurricane Donna (1960)

Prior to its landfall on September 10, 1960 on the Florida Keys as a Category 4, Hurricane Donna was generally a slow-moving system that roamed the Atlantic for a total of 17 days. It caused up to 11' of storm surge along the southwest coast of Florida. Reported rainfall in the Miami and south Dade County were seven to 10 inches. According to Rusty Pfof, former Weather Forecast Office Miami Meteorologist-in-Charge, Donna subjected the Everglades area to damaging winds for 36 hours resulting in 50-90 percent of foliage torn off. It caused \$6.6 billion (2010 USD) of overall damage which resulted in the name "Donna" being retired from the list used by the National Hurricane Center (NHC) to name storms. It is the only hurricane on record to produce hurricane-force winds in Florida, the Mid-Atlantic States, and New England. It holds the record for retaining major hurricane status in the Atlantic Basin for the longest period of time (nine days).

Hurricane Cleo (1964)

Hurricane Cleo was the first hurricane to directly strike Miami since Hurricane King. Cleo intensified rapidly to a Category 2 just prior to landfall on Miami, Florida on August 27, 1964. According to the South Florida Sun-Sentinel, Cleo cut power to 620,000 homes and businesses in southeast Florida, and electricity was out for five days in Miami Shores. At least two dozen fires blazed across Miami. The storm surge reached between four and six feet between Miami and Pompano Beach.

Hurricane Betsy (1965)

Hurricane Betsy was an intense tropical cyclone that brought widespread damage to South Florida. It was the first tropical cyclone of its time to accrue at least \$1 billion in damage in the Atlantic Basin. Evacuation and traffic coordination plans were set in place for Miami and other surrounding cities. According to local newspapers, an estimated 25,000 telephones were knocked out of service, blackouts cut electric service to 80 percent of customers in the Miami

and Fort Lauderdale areas, two twin-engine cargo craft were blown off the airport's perimeter at the Miami International Airport, and 25 to 50 percent of Florida's citrus crop was damaged due to strong winds (Youngstown Vindicator). Unusual strong storm surge caused majority of the damage in Florida due its low-lying areas (Sugg 1966). Storm tide measured approximately 6.1' along the Miami Beach waterfront causing extensive damage to shoreline property along Biscayne Bay (Connor 1965). Three barges were torn out of their moorings which drifted into the Rickenbacker Causeway causing damage which resulted in isolating Key Biscayne residents from the mainland (Milwaukee Journal 1965). Water was forced into the Miami River causing it to overflow and spread inland for several blocks in Miami.

Hurricane Andrew (1992)

Hurricane Andrew was a powerful and destructive hurricane that made landfall in MDC on August 24th, 1992. According to the MDC LMS, damage was estimated at \$25 billion, with 25,524 homes destroyed and 101,241 homes damaged. An estimated 90 percent of all mobile homes in the southern portion of the county were totally destroyed. The Miami Herald reported \$500 million in losses for boats. According to the NHC, Preliminary Report Hurricane Andrew (Rappaport 1993), the maximum sustained surface wind speed during landfall over Florida is estimated at 145 mph with gusts at about 175 mph.



Figure 1-8. Sewell Park on the Mouth of Miami River on a Normal Day.

The peak storm surge arrived near the time of high astronomical tide causing a storm tide of approximately four to six feet in northern Biscayne Bay and 16.9 feet at the Burger King Headquarters located on the western shoreline in the center of the bay. Figures 1-8 and 1-9 from NOAA respectively show Sewell Park on a normal day and the day Hurricane Andrew made landfall. Rainfall totals in excess of seven inches were recorded in southeast Florida.



Figure 1-9. Sewell Park just after Daybreak on August 24, 1992

Hurricane Andrew was reclassified as a Category 5 hurricane in 2002 after a reanalysis of the hurricane's intensity (Landsea et al. 2004). USACE used almost \$400 million in federal funds to help south Florida recover from the devastation either through debris removal, emergency generators and pumps, temporary housing, water supply and distribution, school repairs, and portable toilets and showers.

Hurricane Katrina (2005)

While Hurricane Katrina is widely remembered for the damage it caused to New Orleans, it also had a large impact on Florida. Katrina made landfall between Miami and Fort Lauderdale, Florida as a Category 1 on August 25, 2005. According to the MDC LMS, Katrina heavy rains caused flooding to 50 single-family dwellings from a measured 12.25 inches of rainfall, and caused significant tree damage at Cape Florida State Park. Eleven Florida counties were declared federal disaster areas. Majority of the 1,833 deaths were in Louisiana. Three died in Miami-Dade County due to drowning. Katrina caused an estimated \$41.1 billion (2005 USD) in insured damage on 1.7 million different claims to vehicles, homes, and businesses across six states. In addition, \$16.1 billion in losses from flooding occurred insured by the National Flood Insurance Program (NFIP) (Knabb 2011).

Hurricane Wilma (2005)

Hurricane Wilma made landfall in southwestern Florida on October 24, 2005 as a Category 3 hurricane. According to the MDC LMS, downtown Miami's high-rise office buildings were severely impacted by hurricane force winds. Power outages occurred county-wide for three weeks due to damaged power lines and utility poles. The Port of Miami sustained damage to approximately 2,000 feet of bulkheads. 300 vessels were damaged when the Sunny Isles

Marina dry storage facility collapsed. Many docks and pilings throughout the county were severely damaged due to moored vessels battering against them.

Tropical Storm Isaac (2012)

According to the MDC LMS, Tropical Storm Isaac produced 1.3 feet of storm surge and sustained winds measuring 29 MPH at the Miami International Airport. Approximately 26,000 customers lost power in MDC. Evacuation orders were only issued for mobile home residents in MDC.

Hurricane Matthew (2016)

According to the LMS, MDC was within the 5-day and 3-day forecast cone of Hurricane Matthew while it was a Category 5; however, it was only affected by the outside bounds of Matthew due to taking a turn thus producing a tropical storm warning.

Hurricane Irma (2017)

According to the LMS, Hurricane Irma was the first hurricane to make landfall in South Florida since Hurricane Wilma in 2005. It produced between five and 10 inches of rainfall. Storm surge was between four and six feet on Biscayne Bay and two and four feet on the east coast. An estimated \$255 million in agriculture damage was reported.

Table 1-4 shows the historic FEMA flood claims in MDC since 1978. Note that the total amount paid has not been brought up to 2020 price levels.

Table 1-4. Historic Federal Emergency Management Agency Flood Claims in Miami-Dade County

Total Claims Since 1978	Total Paid Since 1978	Average Amount Paid Per Claim
57,785	\$704,617,912	\$12,193

Source: Federal Emergency Management Agency (FEMA) as of 10/29/2019

1.7 PRIOR STUDIES, REPORTS, AND EXISTING PROJECTS

Numerous studies and reports have been conducted for MDC. Important reports by USACE as well as useful reports by others, including commissioned or authored by MDC, that may be useful for this study are shown in Table 1 of Appendix A. As previously noted in section 1.5.5., FEMA is currently updating Miami-Dade County's Flood Insurance Study Report which was last updated September 11, 2009.

1.8 PUBLIC, AGENCY, AND TRIBAL COORDINATION

Interagency coordination is ongoing with representatives from local, state, and federal resource agencies. Cooperating and participating agencies were invited to participate in the development of this EIS.

Environmental interagency meetings have been held approximately monthly with cooperating and participating agencies. A list of the participating agencies is provided below with asterisks next to agencies that have formally accepted to be cooperating agencies:

- USEPA*
- Federal Emergency Management Agency
- Florida Department of Environmental Protection (FDEP)*
- Florida Department of Transportation (FDOT)*
- Florida Fish and Wildlife Conservation Commission (FWC)
- NMFS*
- National Park Service
- South Florida Water Management District (SFWMD)
- U.S. Coast Guard (USCG)
- U.S. Fish and Wildlife Service (USFWS)

A stakeholder workshop and planning charrettes was held November 8-9, 2018 with over 70 attendees. Attendees included: USEPA, City of Miami, South Florida Water Management District, South Florida Regional Planning Council, University of Miami, Florida International University, Miami-Dade County Department of Environmental Resources Management, MDC Office of Emergency Management, and Florida Department of Environmental Protection.

A public NEPA scoping meeting was held on December 5, 2018 and an additional public coordination meeting was held on September 10, 2019. Comments and comments responses provided for this project are provided in Appendix D. Following the release of the Draft integrated report/EIS, an additional public coordination meeting is planned.

A multi-day site visit took place on January 13-14, 2020 with representatives from the NFS, FDOT, FDEP, USACE, Town of Cutler Bay, FWC, and the NMFS. Notes from the site visit are provided in Appendix D.

During the feasibility phase substantive coordination regarding the Endangered Species Act, Section 7 consultation is ongoing with the USFWS and the NMFS; however, due to the limited design details that are available during this phase of the study, consultation would not be concluded until the Preconstruction, Engineering, and Design (PED) Phase of the project.

Coordination with the NMFS under the Magnuson-Stevens Fishery Conservation and Management Act and the Marine Mammal Protection Act is ongoing and a programmatic-level Essential Fish Habitat (EFH) Assessment has been prepared and is provided in Appendix D; however, due to the limited design details that are available during this phase of the study, consultation would not be concluded until the PED Phase of the project.

Coordination as required per Section 106 the National Historic Preservation Act is ongoing and a draft Programmatic Agreement has been prepared and is also provided in Environmental Appendix D. Further coordination would occur between the release of this draft and final report.

Consulting parties were invited to participate in the development of a Programmatic Agreement to address potential impacts to historic resources. Consulting parties are the Florida State Historic Preservation Office Miccosukee Tribe of Indians Miami-Dade County Historic

Preservation Commission Seminole Tribe of Florida Seminole Tribe of Oklahoma Thlopthlocco Tribe.

An in person meeting with the Tribal Historic Preservation Officer of the Seminole Tribe of Florida was held in which the project scope and objectives were discussed at the Seminole Civic Center October 18, 2018. Coordination letters were sent to the Seminole Tribe of Florida, the Miccosukee Tribe, and the Seminole Tribe of Oklahoma describing the project and inviting them to NEPA scoping meetings on November 20, 2018.

1.9 PROGRAMMATIC AND TIERED NATIONAL ENVIRONMENTAL POLICY ACT DOCUMENTS

This document has been prepared as an integrated feasibility study/Programmatic EIS. The term “programmatic” indicates this is a broad or high-level NEPA document not a site-specific NEPA document. Therefore, during successive phases of the project, additional site-specific NEPA documents (each one would be considered a tiered NEPA document) would be prepared and coordinated with local, state, and federal regulatory agencies, tribal governments, and the public. Tiering expedites the resolution of more substantive impacts to the human environment in the programmatic NEPA document so that subsequent tiered NEPA documents can focus on site-specific impacts and issues.

Because of the limited design information available at this time (during the feasibility study only approximately a 10 percent level of design will be provided), the Endangered Species Act, Section 7 and the Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat consultations would be conducted during the PED Phase of the project. During this feasibility phase of the project, a Programmatic Agreement is being prepared to ensure compliance under Section 106 of the National Historic Preservation Act.

During the PED Phase, a wetland jurisdictional determination, detailed environmental surveys, and cultural and historic building surveys and data gathering would be conducted to support the site-specific future tiered NEPA document as each phase progresses. The level of detail in this programmatic NEPA document is sufficient to allow an informed decision among planning-level alternatives and to develop broad mitigation strategies. Additional, more detailed site-specific mitigation assessments would be conducted in future phases of the project. This is especially relevant and an appropriate mitigation strategy for this project as some of required mitigation would be for ephemeral species and habitats such as corals/hardbottom habitat and Submerged Aquatic Vegetation (SAV) whose extent and densities can vary considerably over time.

CHAPTER 2 **AFFECTED ENVIRONMENT**

2.1 LAND USE

Definition of Resource

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. 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 designed 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.

Methodology

In describing land use, all existing and proposed future land uses within the Study Area are considered. This includes consideration of the zoning as well as comprehensive plans for the entire Miami-Dade County.

The Region of Influence (ROI) for land use is all land throughout the Study Area, or the entirety of MDC.

Framework

The Comprehensive Development Master Plan (CDMP)

The CDMP expresses Miami-Dade County's general objectives and policies addressing where and how it intends to develop lands or conserve lands and natural resources from 2020-2030.

The CDMP establishes a growth policy that encourages development:

- At a rate proportionate to projected population and economic growth,
- In a contiguous pattern centered around a network of well-connected urban centers, and
- In locations that provide for efficient delivery of public services, while also conserving valuable natural resources (LU - Miami Dade County n.d.).

Miami-Dade County encompasses nearly 2,000 square miles of land, of which almost 500 square miles have been developed for urban uses (LU – Miami-Dade County n.d.).

Local Zoning Code

Miami-Dade County's zoning code is considered a hybrid code containing both a traditional, Euclidian zoning section, a system of zoning where the county is divided into areas of specific land uses, and a form-based section (LU1 – Miami-Dade County n.d.). The form-based section of the Zoning Code is also known as the Standard Urban Centers District Regulations (SUCO) and it regulates land development in the infill and redevelopment areas of unincorporated Miami-Dade County. These areas are also known as Urban Centers and Mixed-Use Corridors,

and are designated in the County's CDMP as areas eligible for higher densities and intensities due to their proximity to premium transit service. Figure 2-1 shows the urban centers and some associated means of public transit within the UDB of Miami-Dade County (LU1 – Miami-Dade County n.d.).

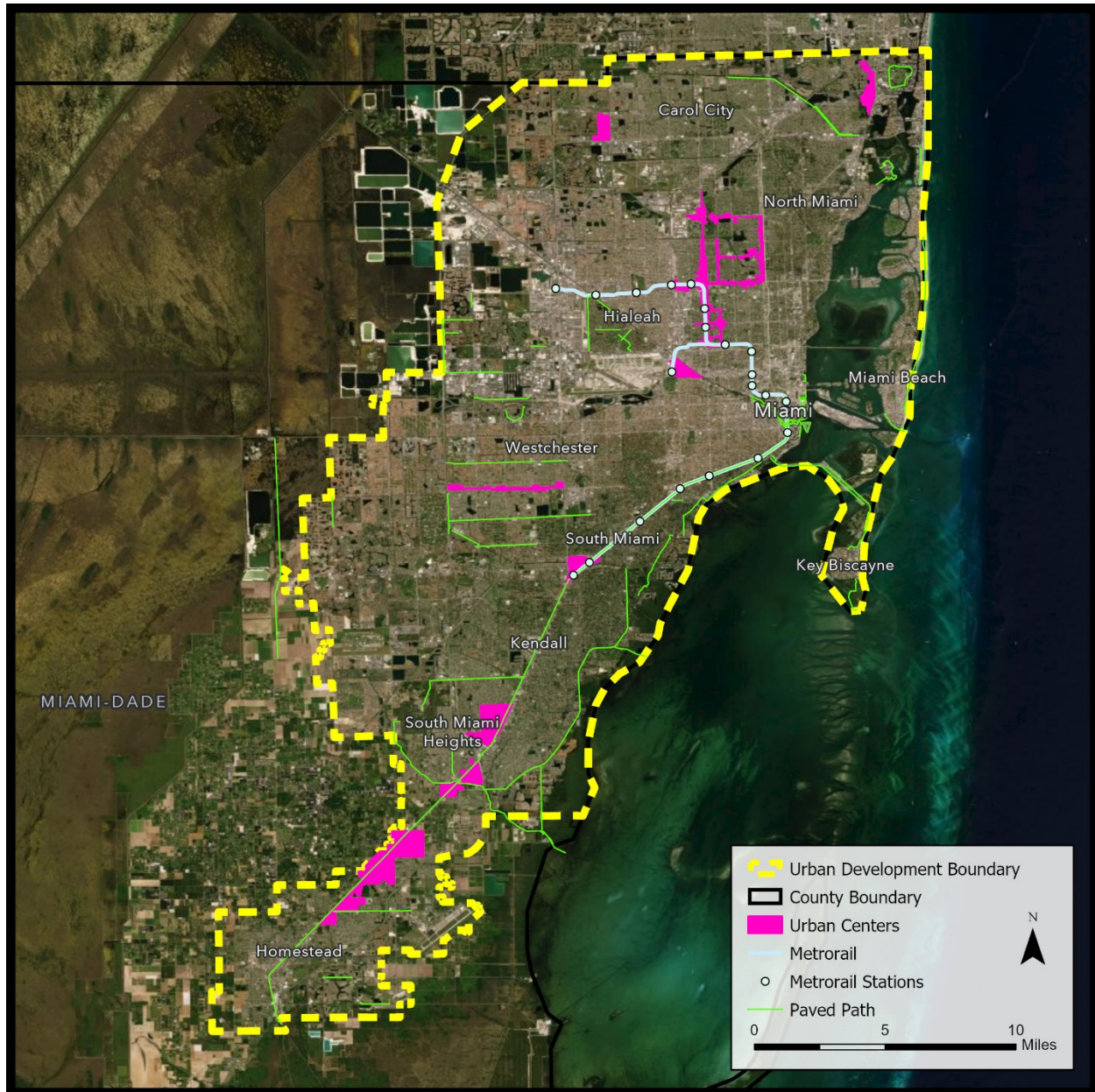


Figure 2-1. Urban Centers and Means of Public Transit

Existing Conditions

Miami-Dade County is Florida's third largest county in terms of land area, encompassing 1,897.72 square miles (US Census Bureau n.d.). The county is home to 34 incorporated municipalities as well as a number of unincorporated areas. The portion of the county within the urban development boundary (UDB) is heavily developed, with many commercial high-rise

buildings along the coast of Biscayne Bay and high density residential developments throughout the UDB.

A central component to the land use and development in MDC is the UDB, which was first established in 1975 to promote efficient and compact development (EPA 2012). There are several purposes to the UDB, these include:

- Directing efficient and cost effective delivery of public services;
- Promoting compact development and encouraging transit ridership; and
- Preserving agricultural lands and wetlands (EPA 2012).

Although the UDB limits certain types of development outside the boundary, it does not limit development. For instance, 1,250 permits have been issued for development of low density residential areas (5-acre minimum lot sizes) between 1994 and 2006, indicating that development is permitted, but not at the pace at which development has previously occurred within the UDB (EPA 2012). While development outside the UDB is measured, it is important to note that much of the area outside the UDB is federally owned and protected, thus limiting the potential area for future UDB expansion. Further limiting available land to expand into are the approximately 67,000 acres of actively used agricultural lands, which are both economically and environmentally important (EPA 2012).

In stark contrast to the bustling, densely populated areas along the coast, Miami-Dade's agricultural epicenter is rural and sparsely populated. This rural, agricultural community in Miami-Dade County is largely made up of family farms, approximately 95% (USDA 2017). A large portion of the agrarian area of Miami-Dade County is found adjacent to the southwestern edge of the UDB; areas like the Redlands make up a large portion of the agricultural economy of the county, contributing approximately \$2.7 billion (LU2 – Miami-Dade County n.d). In 2017, the agricultural area of Miami-Dade County produced \$86,834,000 worth of vegetable, melon, potato, and sweet potato crops, making Miami-Dade County the fourth-most productive county in the state for those crop items (USDA 2017).

The county is bordered by two national parks; to the west, Everglades National Park, and to the east, Biscayne Bay National Park. The State of Florida Biscayne Bay Aquatic Preserve also flanks the Miami-Dade County. Table 2-1 and Figure 2-2 display the Florida Statewide Land Use Land Cover acreage and percent area of land use types within the UDB (SFWMD 2004-2005 & 2008-2009) (Florida Department of Environmental Protection 2016).

Table 2-1. Florida Statewide Land Use and Land Cover Acreage and Percent

Land Use Classification	Acres	Percent Land Use within Urban Development Boundary
Open Water	32,235.79	11.15%
Wetlands	7,615.03	2.63%
Uplands	4,712.94	1.63%
Recreational	12,214.53	4.22%
Agricultural	6,801.41	2.35%
Residential	146,814.50	50.76%
Vacant/Disturbed Lands	8,257.88	2.86%
Transportation	18,387.94	6.36%
Utilities	2,939.89	1.02%
Commercial and Communication	28,884.83	9.99%
Industrial	8,357.44	2.89%
Institutional	11,968.54	4.14%

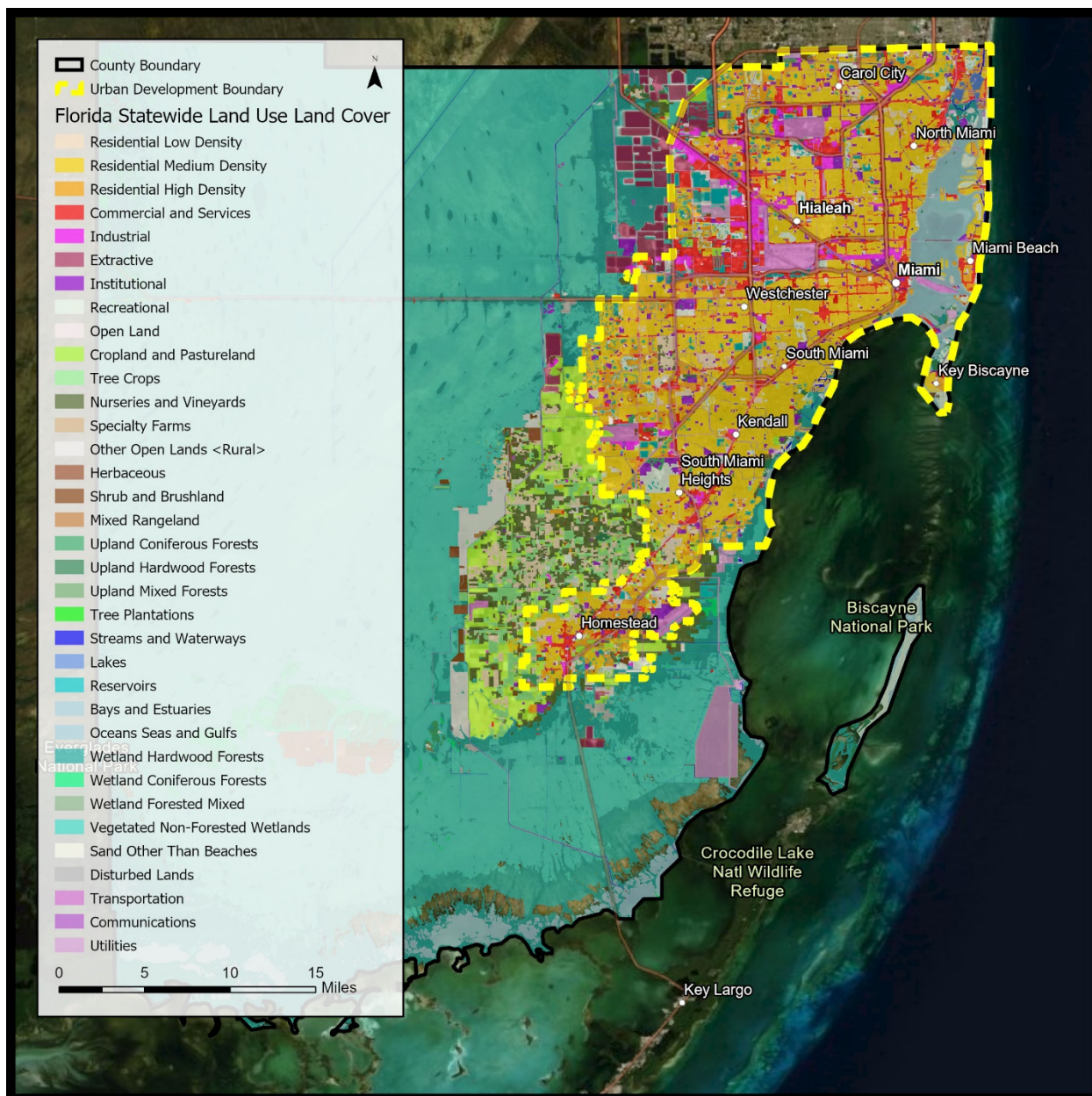


Figure 2-2. Florida Statewide Land Use Land Cover

2.2 GEOLOGY, PHYSIOGRAPHY, AND TOPOGRAPHY

Definition of Resource

Geological resources are defined as the topography, geology, mining, and soils of a given area. Topography describes the physical characteristics of the land such as slope, elevation, and general surface features. The geology of an area includes bedrock materials and mineral deposits. Mining refers to the extraction of resources (e.g., gravel). The principal geologic factors influencing the stability of structures are soil stability, depth to bedrock, and seismic properties. Soil refers to unconsolidated earthen materials overlaying bedrock or other parent material.

This resource section includes a discussion of geotechnical conditions. Geotechnical engineering is defined as the behavior of earthen materials, both natural and man-made.

Methodology

The methodology for identifying, evaluating, and mitigating impacts to geology and soils was established through review of geological and soil studies and reports, and federal and state laws and regulations.

Miami-Dade County is only about 6 feet (1.8 m) above sea level. It is rather new geologically and is at the eastern edge of the Florida Platform, a carbonate plateau created millions of years ago. Eastern Miami-Dade County is composed of Oolite limestone while western Miami-Dade County is composed mostly of Bryozoa. Miami-Dade is among the last areas of Florida to be created and populated with fauna and flora, mostly in the Pleistocene.

Framework

The regulatory framework for geology and soils mainly consists of its potential to affect other resources including air quality and water.

With the adoption of the statewide stormwater rule in 1982, Florida was the first state in the country to require the treatment of stormwater from all new development. The stormwater rule is a technology-based rule relying upon a performance standard (environmental goal) and Best Management Practices (BMPs) design criteria that are presumed to meet the goal. The performance standards are set forth in the Water Resource Implementation Rule (Chapter 62-40, F.A.C.).

Performance standards for erosion and sediment control during grading is to retain sediment onsite, with a backstop that no discharge shall violate the State of Florida's water quality standard for turbidity. Thus, goals of Florida's stormwater regulatory program and the Florida Department of Environmental Protection (FDEP) are to protect water quality and to minimize erosion and sedimentation by requiring the use of effective BMPs during and after grading. Additionally, as mandated by the Clean Water Act (CWA), permits must be obtained for stormwater discharges from construction sites that meet or exceed the Environmental Protection Agency (EPA)'s criteria (see <http://www.epa.gov/region5/water/cwa.htm>). The EPA has the responsibility of administering CWA requirements by requiring National Pollutant Discharge Elimination System (NPDES) discharge permits. FDEP implements the NPDES program in Florida and issues Florida NPDES discharge permits. By reviewing <http://www.dep.state.fl.us/water/stormwater/npdes/index.htm>, readers of this manual can obtain more detailed information on Florida statutory requirements and FDEP programs and requirements.

Existing Conditions

The geology of the ROI and the geology of most of Miami-Dade County is mostly characterized by Qm – Miami Limestone (Figure 2-3) which is white to gray limestone, variably fossiliferous, oolitic and pelletal (Florida Geologic Survey 1993). The surface bedrock under the Miami area is called Miami oolite or Miami limestone. This bedrock is covered by a thin layer of soil, and is no more than 50 feet (15 meters) thick. Miami limestone formed as the result of the drastic changes

in sea level associated with recent glaciations or ice ages. Florida has hundreds to thousands of feet of limestone under it because the geology of Florida formed under the ocean and Florida's geologic strata are divided into formations. (FDEP 2020).

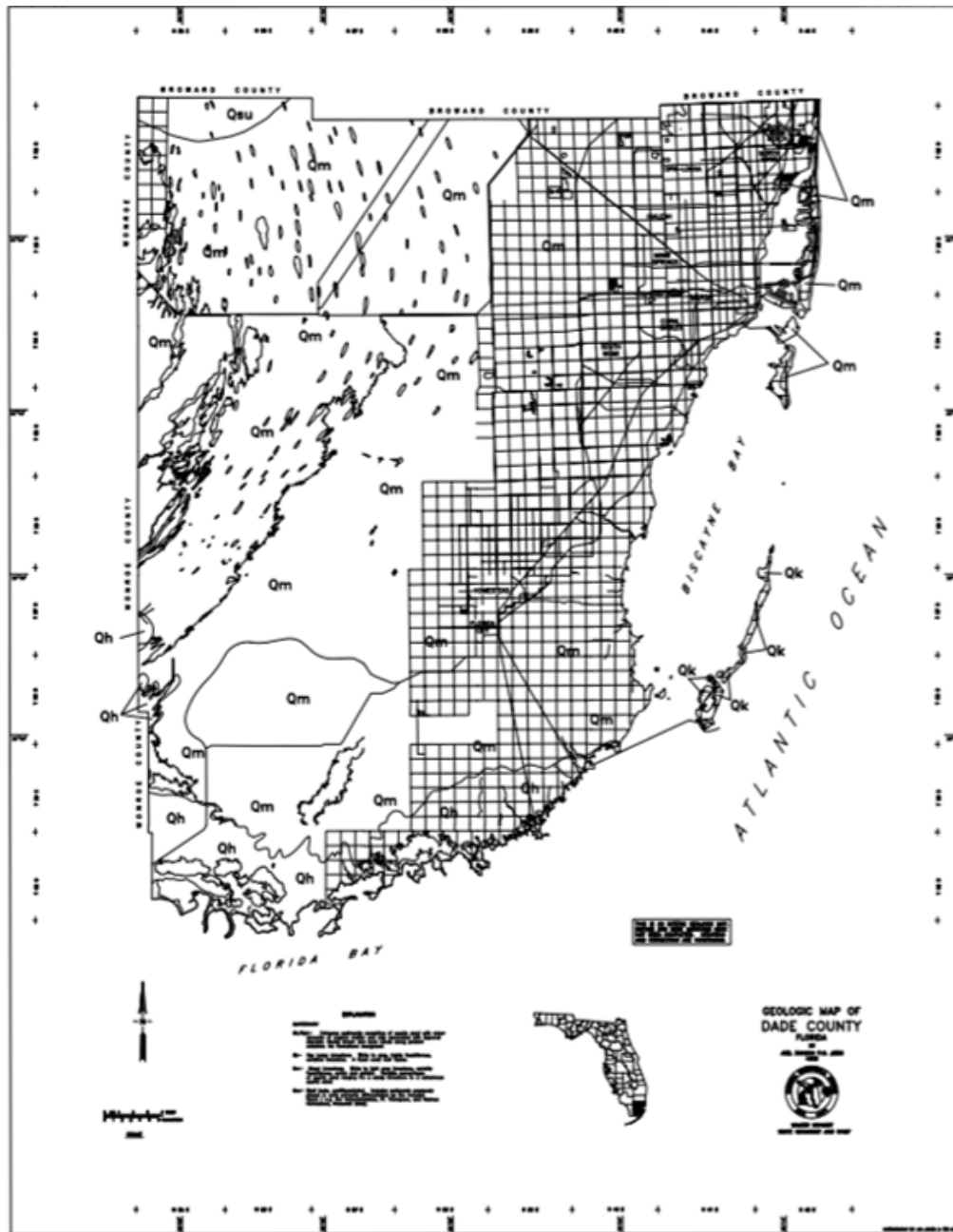


Figure 2-3. Miami-Dade County Geology Characterization

Figure 2-4 shows the different formations in South Florida. There are three main formations in South Florida and these include the Fort Thompson formation, the Anastasia Formation and the Miami Formation. The Miami Formation is known as Miami Oolite and crops out in many areas of Dade County (Florida International University 2000).

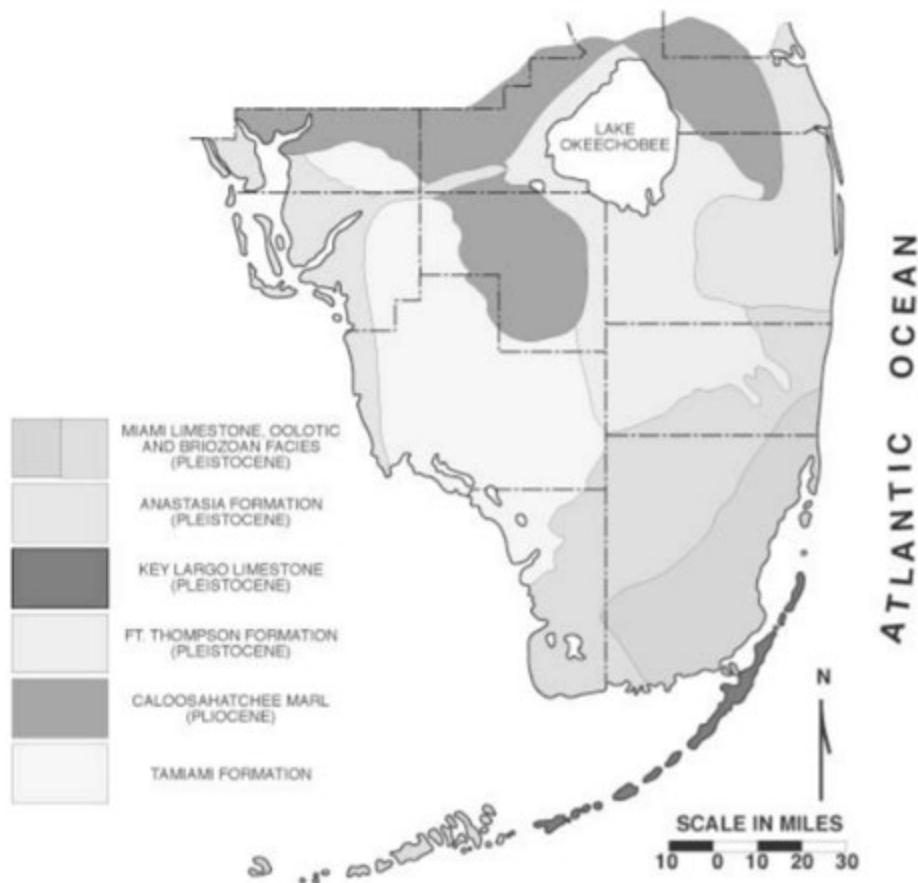


Figure 2-4. Geologic Formations in South Florida

The soils in MDC are calcareous from the limestone and there are two kinds of calcareous soils in MDC: rocky or gravelly soils and marl soils (University of Florida (UF) 2001). The rocky soils have rapid drainage and exist in areas with rocky pinelands which are typically at a higher elevation (UF 2001). The texture of calcareous soils are characterized by being sandy, loamy or gravelly and soil depths range from inches to feet (UF 2001). Calcareous soils are important for agriculture so management of nutrients is important to crop production on calcareous soils (UF 2001). The marl soils are typically at a lower elevation in south Florida than calcareous soils. The drainage of marl soils is poor or very poor and are affected by the modern drainage system in the county (UF 2001). Figure 2-5 shows the MDC detailed soils (USGS 2018).

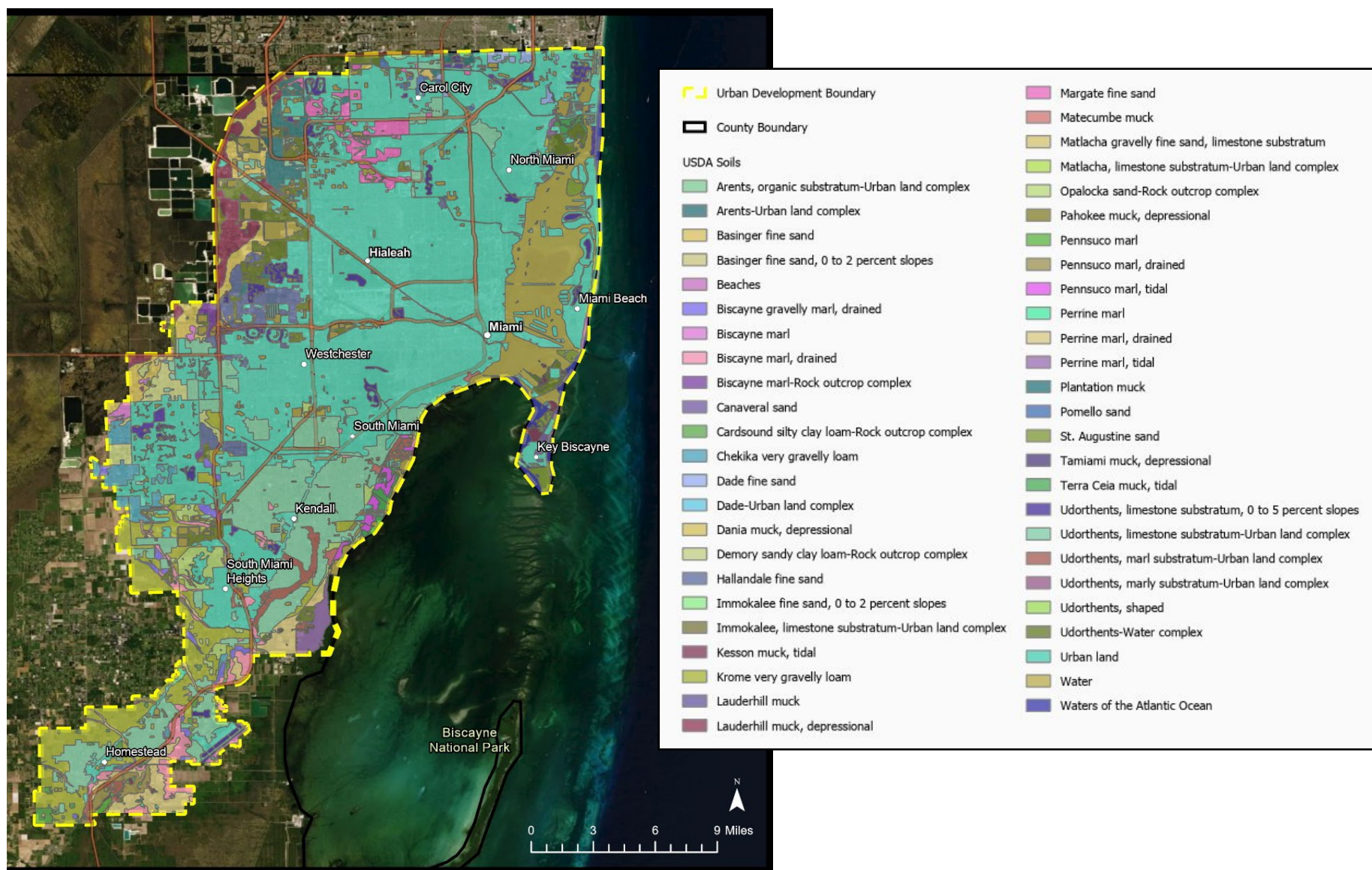


Figure 2-5. Miami-Dade County Detailed Soils

Part of the Biscayne Aquifer lies below MDC and is the main source of water for all of Miami-Dade and Broward counties. Due to the geology of MDC (mostly Miami Limestone), the Biscayne aquifer is highly permeable and also lies at shallow depths throughout the county within the underlying bedrock and overlying surficial soils. (USGS 1990). The shallow depth of the aquifer means that the water could be easily contaminated. The Biscayne aquifer may face salt water intrusion during dry periods because of relatively low elevations throughout the county and close proximity to the ocean. The salt water intrusion may then cause soil contamination as the salt water flows upward and evaporates at the land surface (USDA 1996). Ground water can occur at approximately 20 feet or less which impedes underground construction, though some underground parking garages exist. For this reason, the mass transit systems in and around Miami-Dade County are elevated or at-grade.

The Biscayne Aquifer is separated from the Floridan Aquifer System by a clay confining unit that is approximately 1,000 feet in the Boulder Zone (USGS n.d.). The Floridan Aquifer is found throughout southern Alabama, southeastern Georgia, southern South Carolina, and all of Florida and is considered one of the most productive aquifers in the world for water supply and irrigation. A thick series of Tertiary carbonate rocks (limestone and dolomite) compose the Floridan Aquifer (USGS n.d.). The most substantive and productive systems are the Avon Park Formation and the Ocala Limestone. The aquifer base throughout the majority of Florida contains nearly impermeable beds in the Cedar Keys Formation. Parts of the Lower Floridan Aquifer containing saltwater are used as injection wells for industrial and municipal wastes.

2.3 BATHYMETRY, HYDROLOGY, AND TIDAL PROCESSES

Definition of Resource

Hydrology is the science that deals with the properties, circulation and distribution of water on and under the surface of the earth 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.” Fluvial geomorphology is the study of river forms and the processes that shape them, and involves consideration of the geological setting, channel morphology, hydrology, hydraulics, sediment transport, and riparian and floodplain vegetation. Bathymetry, which is the configuration of the waterway bottom, influences H&H and where applicable, it will be discussed.

Methodology

The following H&H analysis describes existing conditions within the Study Area, outlines the approach to analysis, and evaluates potential impacts and mitigation measures related to implementation of the Proposed Action. The ROI for H&H includes MDC, waters including Miami River and Biscayne Bay. The extent of the regional H&H models extend beyond the Study Area sufficiently both upstream and downstream to characterize any potential impacts due to actions within the Study Area.

Framework

There are not specific regulations regarding H&H, though these will impact water quality, which does have significant regulations on the state and federal level. These are described in the Regulatory Framework in the following section on water quality.

Existing Conditions

Tides in Biscayne Bay and the Miami River as well as nearshore waters outside of the Bay, experience semi-diurnal tides, with two high and two low tides each day. The timing and height of the tides varies over the month with the position of the moon relative to the earth. The typical tidal range between low and high tides in local waters is approximately 1.6 feet, though this can range much higher during storm events and king tides. In southeast Florida, tidal flooding commonly occurs during extreme high tides. These tides are often associated with a full or new moon, when the combined gravitational pull of the sun and moon drives tides slightly higher and lower than normal. Several times a year, when the moon is closest to the earth, this phenomenon is amplified, and a king tides occurs. The more than 15 inches of sea level rise projected for Miami-Dade County by mid-century, on top of these normal tidal variations, will mean that tides can reach further inland and cause flooding with greater frequency (Spanger-Siegfried et al. 2014)

Parts of the county were developed on drained marshland. After a rainfall event, a series of canals and water management structures are used to discharge water ultimately into the Biscayne Bay. Typical annual rainfall levels can be seen in Figure 2-6.

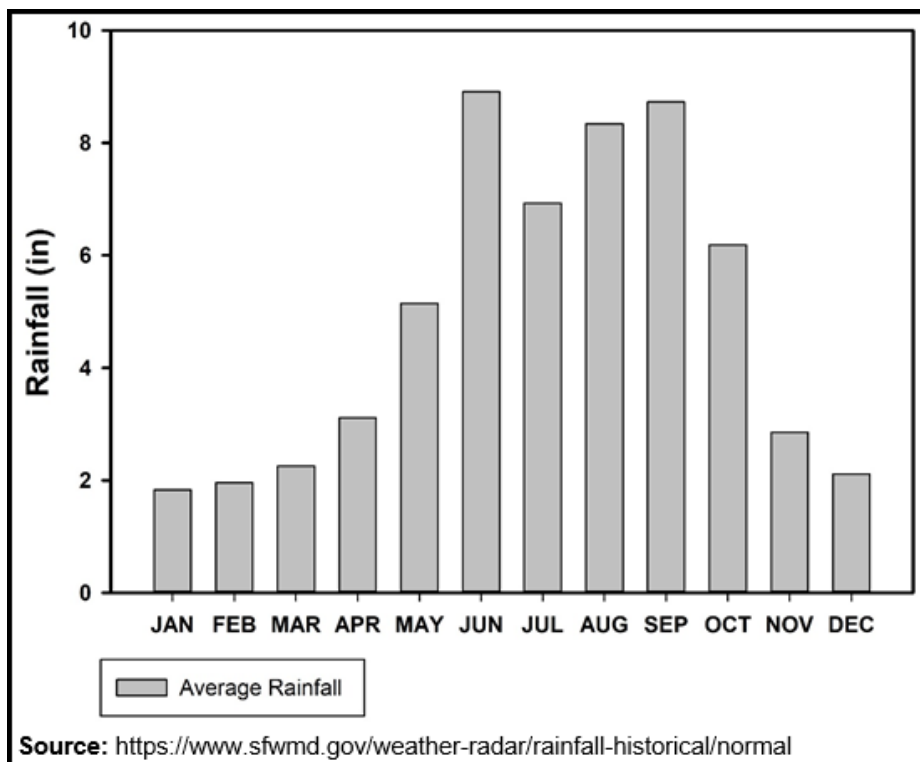


Figure 2-6. 30-year Average Monthly Rainfall

There is a seasonality to rainfall evident, with much higher average rainfall during the warmer months of the year; this coincides with the hurricane season. Salinity varies in Biscayne Bay in tandem with the rainfall pattern, varying from approximately 36.5–33.9 parts per thousand in offshore areas, with the higher salinity corresponding to months of lower rainfall.

During some high tides the sea level can rise higher than water levels in the canals; the canals are increasingly unable to alleviate flooding.

A network of drainage canals completed during the second half of the 20th century has greatly altered the distribution of freshwater within the watershed, and therefore also the quantity, quality, and timing of freshwater discharges to Biscayne Bay (Larsen et al., 1995). The canal system was originally put in place to provide drainage, but was subsequently enhanced to serve the additional functions of flood and salinity-intrusion control. Because of the naturally flat topography of adjacent wetlands and the shallow phreatic (free surface) aquifer, the management of the hydrologic system was constrained to a very narrow water table range and a small soil water storage capacity. These modifications and associated constraints necessitated alterations in the quantity, quality, and temporal distribution of freshwater runoff to the Bay, which became more pulsed with larger peak discharges in the wet season (Wang et al. 2003), which negatively altered the Bay ecosystem. Additionally, the canal system has allowed ground water from as far away as the Everglades National Park, to flow from Biscayne to Florida Bay, which has increased the ground water flow into Biscayne Bay.

Much of the urban and agricultural development that has occurred since the 1900s in southeast Florida can be attributed to the surface-water system of canals. “In urban areas of the county, the surface-water system is used to (1) control urban flooding, (2) supply recharge to production well fields, and (3) control seawater intrusion. Previous studies MDC have determined that on a local scale, leakage from canals adjacent to well fields can supply a large percentage (46 to 78 percent) of the total ground water pumpage from production well fields. Canals in the urban areas also receive seepage from the Biscayne aquifer that is derived from a combination of local rainfall and ground water flow from Water Conservation Area 3 and Everglades National Park, which are west of urban areas of Miami-Dade County.” (Hughes and White 2015)

Biscayne Bay is a shallow embayment, with the majority of the Bay less than six feet in depth, with a maximum depth of only about 16 feet. The Miami River, which flows through the southern portion of the City of Miami, flows into the North end of Biscayne Bay, inshore of Virginia Key. Figure 2-7 shows the detailed depth information for Biscayne Bay in meters (Wang et al. 2003).

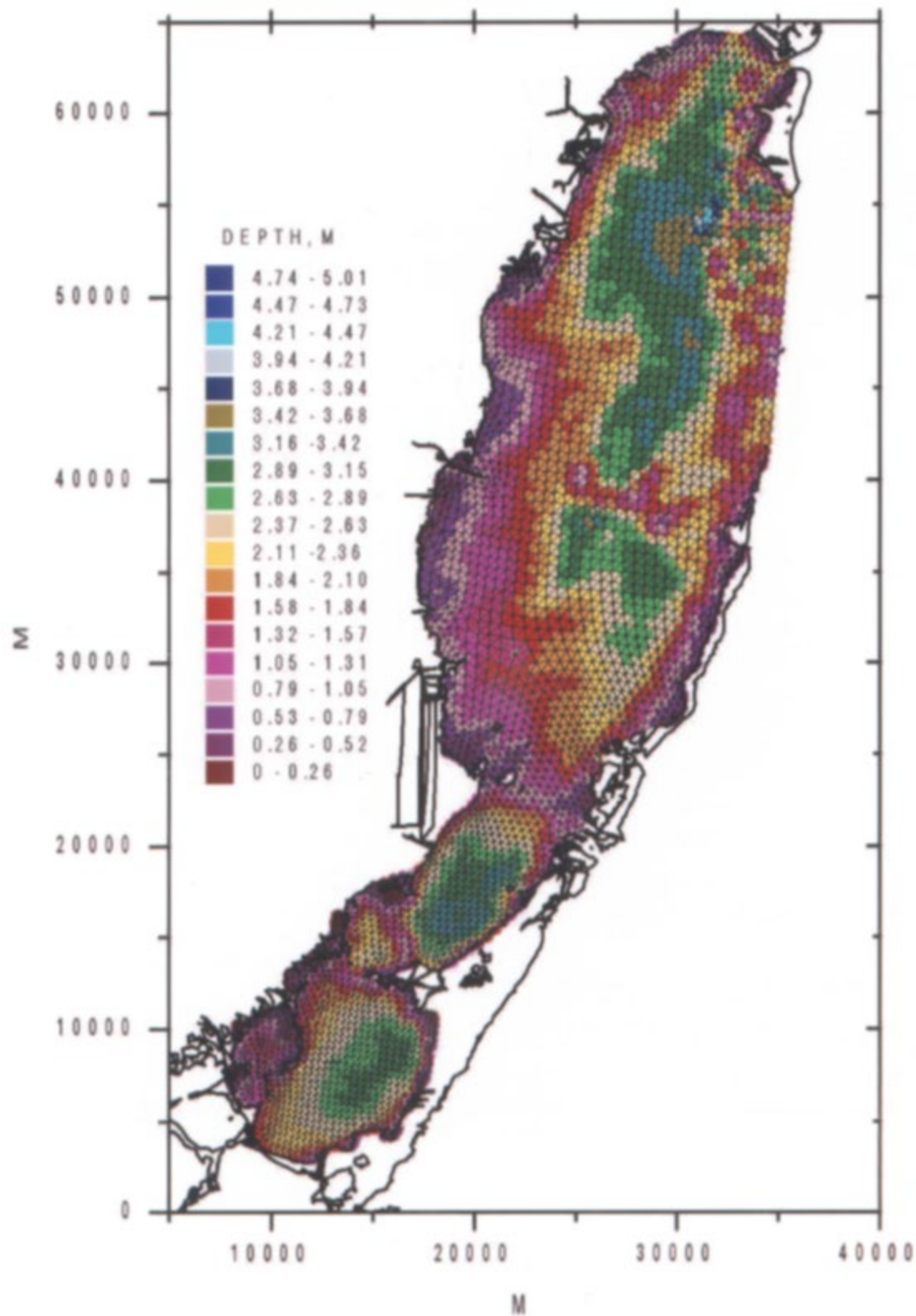


Figure 2-7. Detailed Depth Information for Biscayne Bay

The Bay is quite restricted at its northern and southern ends, with a series of barrier islands lying offshore. Where there are not islands, a shallow ridge extends along most of the outer rim of Biscayne Bay, sheltering the Bay partly from the open Atlantic Ocean waters offshore of the Bay. Within the Bay, local tidal forcing is an important force driving flows throughout Biscayne Bay. Wind is a secondary factor, moving deeper waters in the Bay and having an impact on water residence time, depending on speed and direction of the wind. The general circulation pattern during a flood tide in Biscayne Bay can be seen in Figure 2-8. (Wang et al. 2003).

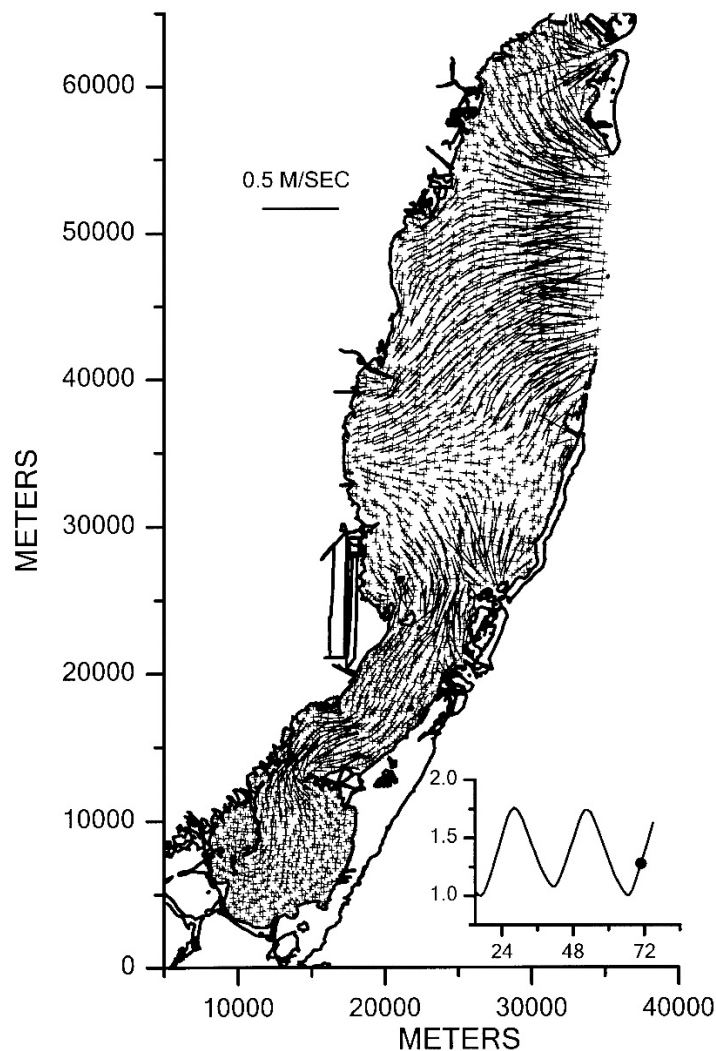


Figure 2-8. Major Direction of Water Flow during Incoming Tide, Biscayne Bay, Florida

A more recent model, the Biscayne Bay Simulation Model (BBSM) is used to evaluate the effects of proposed changes to freshwater flow on salinity in the bay. It has found that, along the coast, there is a significant freshwater input that influences nearshore salinity. It has been noted that areas with water management structures and canals have lower nearshore salinity than areas without such structures. This can be seen in Figure 2-9 (Stabenau and Renshaw 2010).

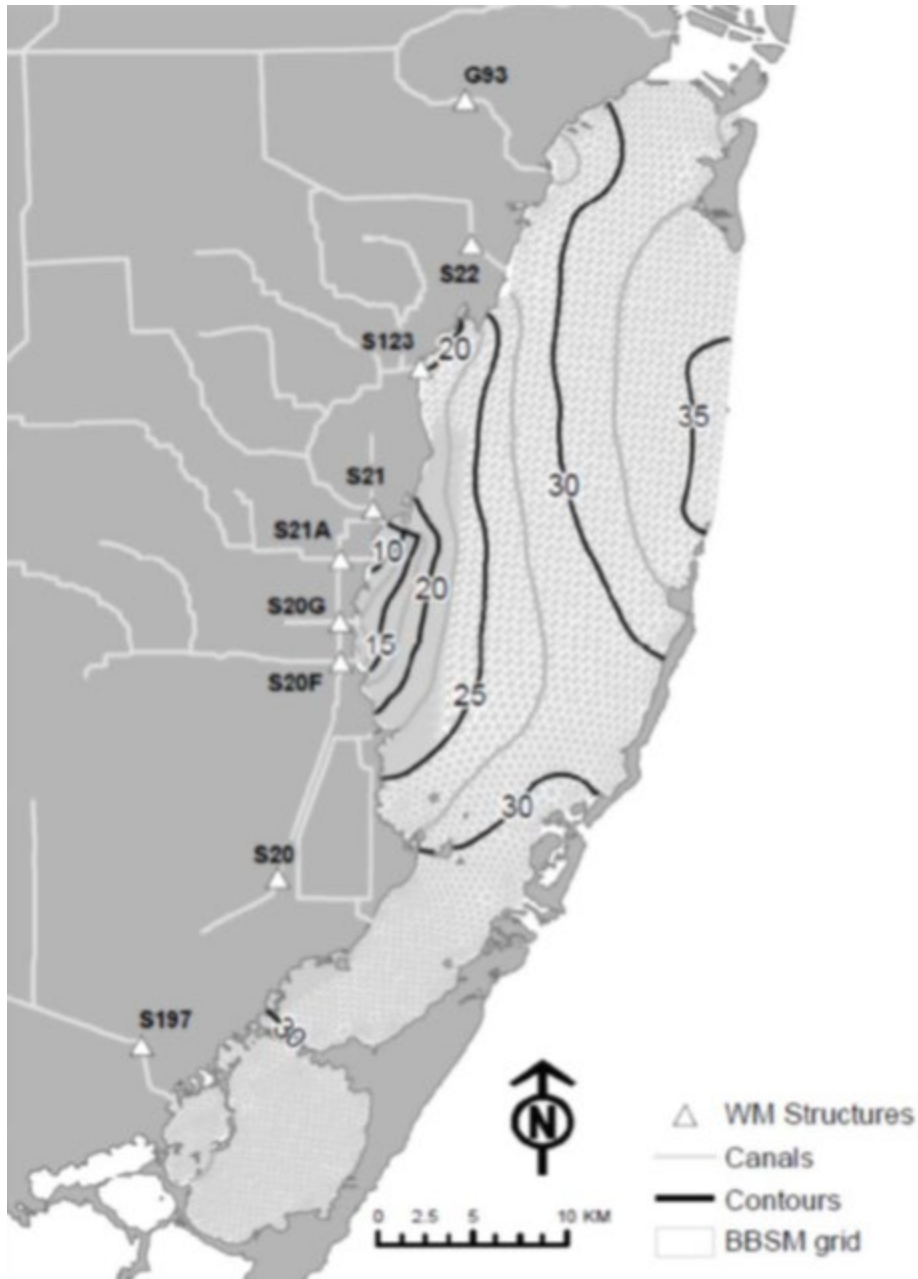


Figure 2-9. BBSM V.4 Modeling Results Showing Influence of Freshwater Input

As can be clearly seen, significant suppression of salinity occurs near water management structures.

2.4 WATER QUALITY

Definition of Resource

Water quality can be defined as the ability of the water to support life, as well as 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.

Methodology

The following analysis of water resources identifies associated regulatory requirements, describes existing conditions within the ROI and vicinity, outlines the approach to analysis, and evaluates potential impacts and mitigation measures related to implementation of the Proposed Action. During this feasibility phase hydrologic and water quality modeling will be done to understand the extent and magnitude of potential water quality impacts in the ROI.

Framework

This water quality analysis has been prepared considering the following federal and state regulations:

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. States must develop a total maximum daily load (TMDL) for each pollutant that contributes to the impairment of a listed water body. The Florida Department of Environmental Quality (FLDEQ) is responsible for ensuring that TMDLs are developed for impaired surface waters in Florida. 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 FLDEQ, verifying that project activities will comply with water quality standards.

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.

State

Florida's surface water quality standards system is published in 62-302 (and 62-302.530) of the Florida Administrative Code (F.A.C.). The components of this system include classifications, criteria, including site specific criteria, an anti-degradation policy, and special protection of certain waters (Outstanding Florida Waters).

The Water Quality Standards Program (WQSP) is made up of the Standards Development Section and Aquatic Ecology and Quality Assurance Section (AEQAS). The WQSP is responsible for the development of water quality standards, the Triennial Review of water quality standards, coordination of bioassessment training and implementation, and providing technical support in the Quality Assurance and ecological aspects of water quality science to other department programs.

Existing Conditions

Compared to other Florida waters, Biscayne Bay is characterized by very low concentrations of nutrients (much like the Everglades) and pollutants, and has water clarity that supports seagrass meadows, commercially important fisheries populations, ecologically critical habitats such as coral and mangrove communities, and provides recreational opportunities for residents and visitors.

The water quality and supported habitats in some portions of the Biscayne Bay and adjunct tidal tributaries exhibit signs of human impact. Portions of a number of canals in urbanized areas do not meet one or more water quality criteria, and are designated by the State of Florida as "impaired." A number of homes in the watershed remain on septic systems instead of being connected to sewage treatment facilities. Due to rising waters in the past, as well as extensive modifications to natural sheet-flow patterns of water transport in the watershed, septic systems have become a significant problem, leaking into local waters, polluting them, and this water then enters Biscayne Bay, lowering water quality in the Bay. In MDC, there are about 105,000 parcels, mostly individual homes that rely on septic tanks (Miami-Dade County 2018) and are not connected to centralized water treatment facilities in the County. Septic tanks must be above the ground water table to function effectively. Rising waters have already impacted a significant number of these septic systems (approximately 1,000) as they are no longer above the water table under normal conditions or during typical high tides. Figure 2-10 illustrates how rising sea levels cause a contaminant rise in the ground water table (Miami-Dade County 2018).

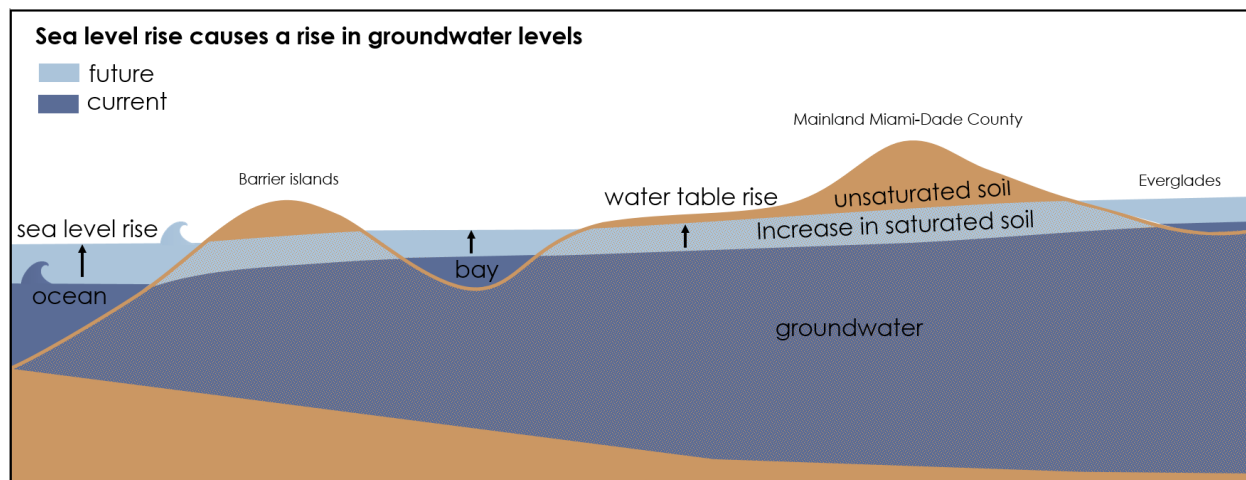


Figure 2-10. Illustration Showing Effects of Sea Level Rise on Contaminant Rise

During storms many more (58,349) parcels are impacted. This results in widespread contamination of surface and ground water – both of which flow into Biscayne Bay. The

underlying limestone karst rock, which is very porous, also negatively affects septic systems by allowing for increased drainage into the underlying ground water beyond typical underlying urban sediments, which in most areas of the US are considerably less porous. This increases the chances for ground water contamination beyond the typical septic field. Figure 2-11 illustrates how rising ground water levels compromise septic systems (Miami-Dade County 2018).

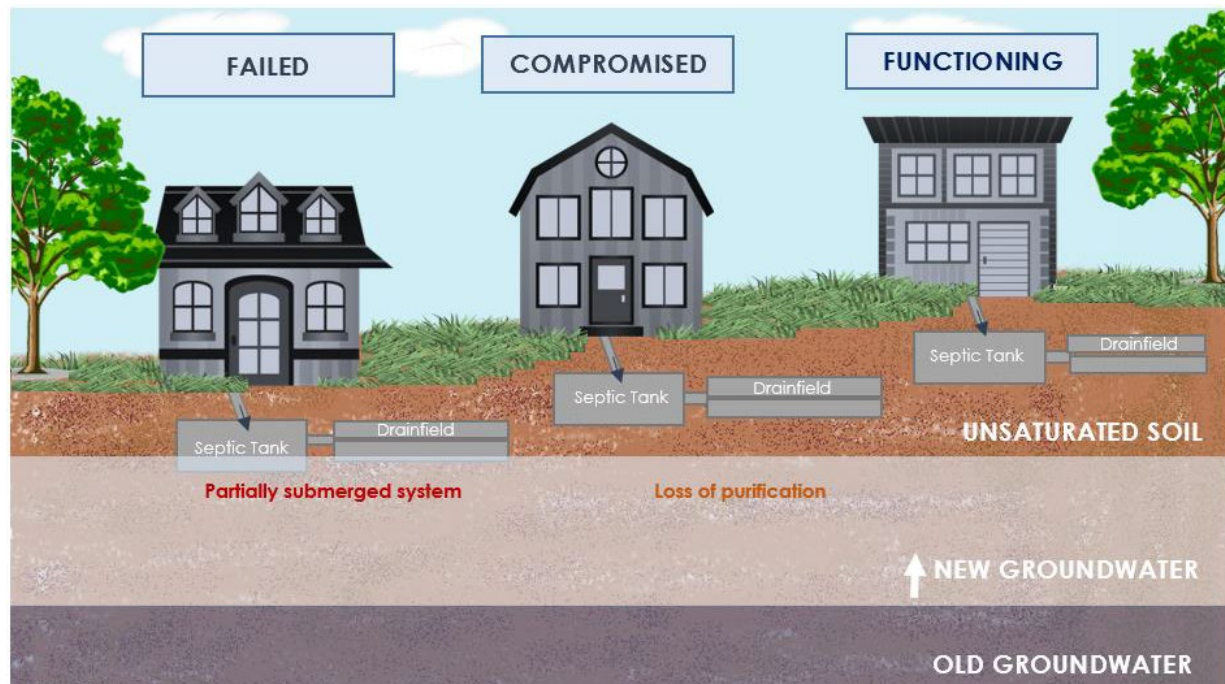


Figure 2-11. Illustration Showing Rising Groundwater Level Compromise Septic Systems

When septic systems are compromised, bacteria, viruses, as well as organic waste material is not properly treated and filtered by surrounding soils and enters the ground water, or during storms and high tides, surface water. In either case, the pathogens and organics are then transported subsequently into waters of Biscayne Bay. The most common resulting problem for the Bay are excess amounts of certain types of bacteria that are indicators of sewage contamination. This is becoming an increasing problem for Biscayne Bay and the Miami River. Recent monitoring has found that waters of Miami River exceed allowable limits for *enterococcus*, a bacteria associated with human waste, as did nearshore waters of Biscayne Bay, including Morningside Park and Coconut Grove.

Additionally, some portions of Biscayne Bay are affected by excess nutrients, which may lead to algal blooms that reduce water clarity, damage seagrass and reduce the ecological health of the Bay. A recent study (Millette et al. 2019) examined eutrophication trends over time (1995-2014) in Biscayne Bay. They found that “chlorophyll a concentrations throughout the northern area, where circulation is restricted, and in nearshore areas of central Biscayne Bay are increasing at a higher rate compared to the rest of the Bay. This suggests increases in chlorophyll a are due to local nutrient sources from the watershed. These areas are also where recent seagrass die-offs have occurred, suggesting an urgent need for management intervention.” Such conditions are also caused by untreated stormwater runoff, a common occurrence in the current canal

system that is worsened by rising waters. Such runoff can be contaminated with bacteria, as well as nutrients from agricultural operations and sources such as lawn fertilizer.

Conditions such as these have played a role in the occurrence of three unprecedented algal blooms in the last decade in Biscayne Bay, and two of these blooms have caused significant harm to the seagrass community. At the time of this report, approximately 21 square miles of SAV have been lost.

The National Park Service (NPS) began water quality monitoring at a limited number of stations, since 1990 the NPS has gathered water quality data with remote sensing systems. The data is collected at six locations that measure specific conductivity, dissolved oxygen, pH, temperature, turbidity and tide height. In 1997, twelve locations were added to support the USACE and their computerized circulation model for Biscayne Bay. Miami-Dade County's Division of Environmental Resources Management (DERM) monitors surface water quality throughout the County monthly. Water quality samples are collected at 87 locations along Biscayne Bay, as well as major drainage canals and tributaries leading to the Bay. The canals were constructed to assist in developing the land, and act to alter the historic sheet flow discharge over the land to a directed, pulse discharge that allowed the land to drain sufficient for development. Sheet flow is when fresh water from precipitation flowed from the Kissimmee River through Lake Okeechobee then into the Everglades, where it slowly filtered continuously through smaller tributaries and aquifers eventually into Biscayne and Florida Bay. Discharge points from canals are areas particularly prone to alterations in water quality, from salinity to pathogens and nutrients that can cause eutrophication and lower salinity, especially near canal outfalls. The restricted northern Bay region and the south-central region, where there are a number of canal outfalls along a relatively short segment of Bay shoreline, are the regions where water quality declines have been the most severe, and also areas where SAV die-off has been the most extensive (Millette et al 2019). Figures 2-12 and 2-13 illustrate sampling areas and the extent of bacterial contamination (Miami-Dade County 2020; Miami-Dade County 2019; Miami-Dade Open Data 2018).

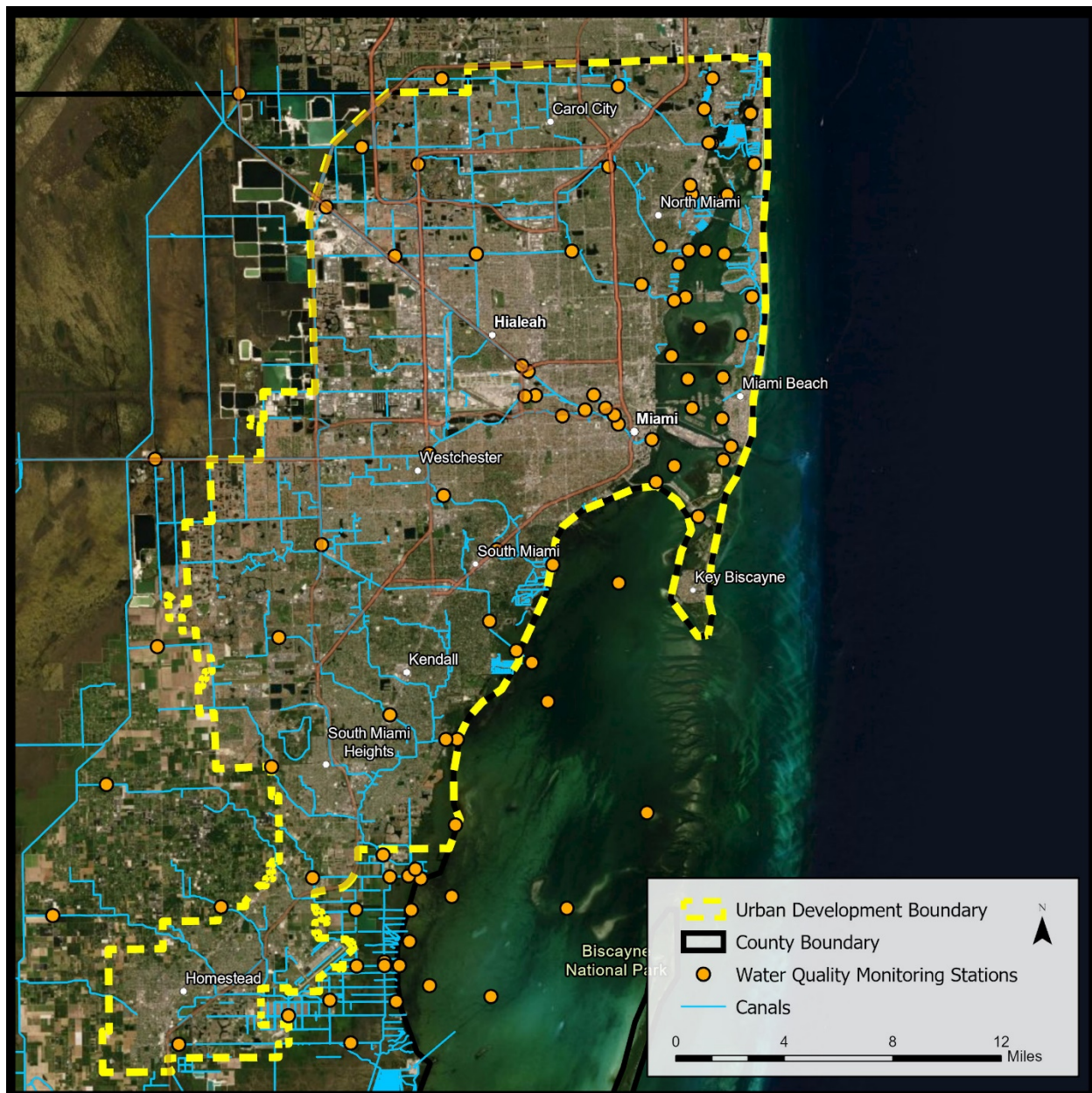


Figure 2-12. Water Quality Monitoring Stations in Miami-Dade County

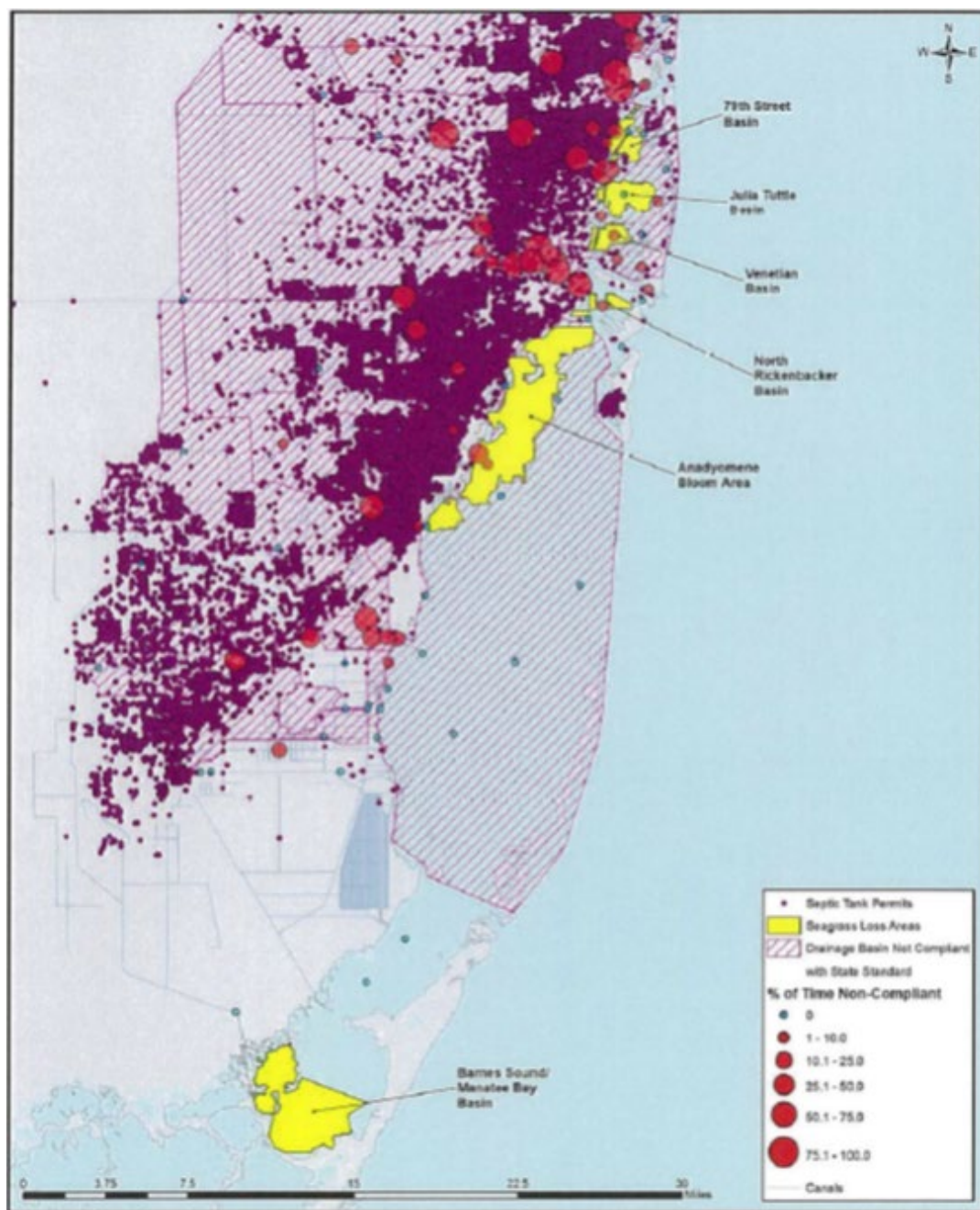


Figure 2-13. Extent of Bacterial Contamination in Biscayne Bay and its Watershed

The importance of surface water quality and its present overall condition was recognized by the State of Florida, when it designated the surface waters of Biscayne Bay an Outstanding Florida Water. This designation provides for the highest levels of protection to assist in maintaining the quality of its waters. Despite this, water quality impacts continue to occur in Biscayne Bay. Further, MDC is undertaking a large-scale effort to reduce the number of septic systems in problem areas.

2.5 FLOODPLAINS

Definition of Resource

For the purpose of the following discussion, flood plains is defined as any land area susceptible to being inundated by floodwaters from any source.

Methodology

The Region of Influence is all flood plain areas within MDC where flooding has occurred in the past or there is a potential for flooding, including tidal and/or rainfall events.

Framework

Executive Order 11988 – Flood Plain Management. Through Executive Order (EO) 11988, federal agencies are required to evaluate all proposed actions within the 1-percent-annual-chance flood plain or Base Flood Plain as defined by the 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.

The U.S. Army Corps of Engineers ER 1165-2-26 - Implementation of EO 11988 on Flood Plain Management. This regulation 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) 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 Cooperation Agreement 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 protection 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. Miami-Dade County has a Hazard Mitigation/Flood Plain Management Plan approved by FEMA in 2015, with continued revisions made through January 2018. FEMA approvals are conducted on a five-year cycle, with the next review and approval in 2020 (MDCWG 2015-2018).

Existing Conditions

As with many coastal communities, MDC can be prone to flooding. By having exposed waterfront areas, flat topography, land areas with low elevations, a network of inland canals, and populated and urbanized areas, the impacts to people, property, and the environment have been experienced from past flood events and continue to be a problem and concern.

Land elevations within the community are generally less than 10 feet above sea level. The western and southern areas are mostly marsh with a mean elevation of approximately five feet above sea level (FEMA 2009). Along some land areas that are low in elevation, MDC 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. Water levels can be higher when the tide is highest during a Spring tide cycle, sometimes referred to a King 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, agricultural fields, etc.

Before official records were initiated, historical evidence shows Florida was impacted by storms prior to the 1900s (FEMA 2009). The National Oceanic Atmospheric Administration (NOAA) began official continuous weather records for the Miami area in 1895 (NOAA 2020a). The National Oceanic and Atmospheric Administration also has the Virginia Key tide gage, established in 1994, at Biscayne Bay. The highest recorded storm tide elevation for the period of record at Virginia Key is 3.8 feet, referenced to NAVD88 on September 10, 2017 (Hurricane Irma) (NOAA 2020b). See Table 2-2 for a list of available data for notable storm tide elevations and/or rainfall amounts for MDC (FEMA and USACE 1993; FEMA 2009; MDCWG 2015-2018;

NOAA 2018, 2020a, b). Where Not Applicable (N/A) is shown, the storm was mainly a rainfall event versus storm tide. The table shows a higher storm tide elevation for Hurricane Irma at 5.75 feet, NAVD88 obtained at Dinner Key, near the Virginia Key gage, which shows how water levels can vary by location. Similarly, Hurricane Andrew in 1992 had a maximum storm tide elevation of 15.3 feet, NAVD88 near Homestead/Charles Deering Estate and the measured storm tide elevation at Dinner Key, approximately seven miles north, was 8.2 feet, NAVD88. The storm surge also extended three miles inland.

Table 2-2. Notable Storm Events for Miami-Dade County

Storm Event	Location	Storm Tide Elevation, Feet, NAVD88	Rainfall, Inches
September 6-22, 1926	Coconut Grove/Mouth of Miami River	11.6/9.3	10 (Miami area)
October 30 to November 8, 1935	Dinner Key	6.4	4 (Miami area)
Hurricane Andrew, August 24, 1992	Homestead, near Charles Deering Estate	15.3	7
Hurricane Irene, October 14-20, 1999	Miami-Dade County	2.7 (Virginia Key)	9-18
October 3-4, 2000	Miami	N/A	15-18
Hurricane Katrina, August 25, 2005	Homestead	1.2 (Virginia Key)	14
October 9, 2011	West Kendall/Tamiami Airport	N/A	10
October 28-31, 2011	Miami-Dade County	N/A	3-12
Tropical Storm Andrea, June 2013	North Miami Beach to Broward County	N/A	8-14
October 3, 2013	Kendall, The Falls, Pinecrest	N/A	10
December 5-6, 2015	Miami Executive Airport, West Kendall, Homestead/Redland	N/A	6-10
August 1, 2017	Miami Beach, Key Biscayne, Downtown Miami, Redland, Kendall, Palmetto Bay, Pinecrest	N/A	4-8
Hurricane Irma, September 10, 2017	Dinner Key	5.75	5-10 (Miami)

EO 11988 references the FEMA 1- and 0.2-percent-annual-chance flood plains. Miami-Dade County participates in FEMA's NFIP. The effective Flood Insurance Study (FIS) and FIRM for MDC and incorporated areas are dated September 11, 2009. The following figure is a map prepared by MDC showing the inland extent of FEMA's effective 1- (Zones VE, AE, AH, and A) and 0.2-percent-annual-chance (Zone X Shaded) flood plains (MDCWG 2015-2018).

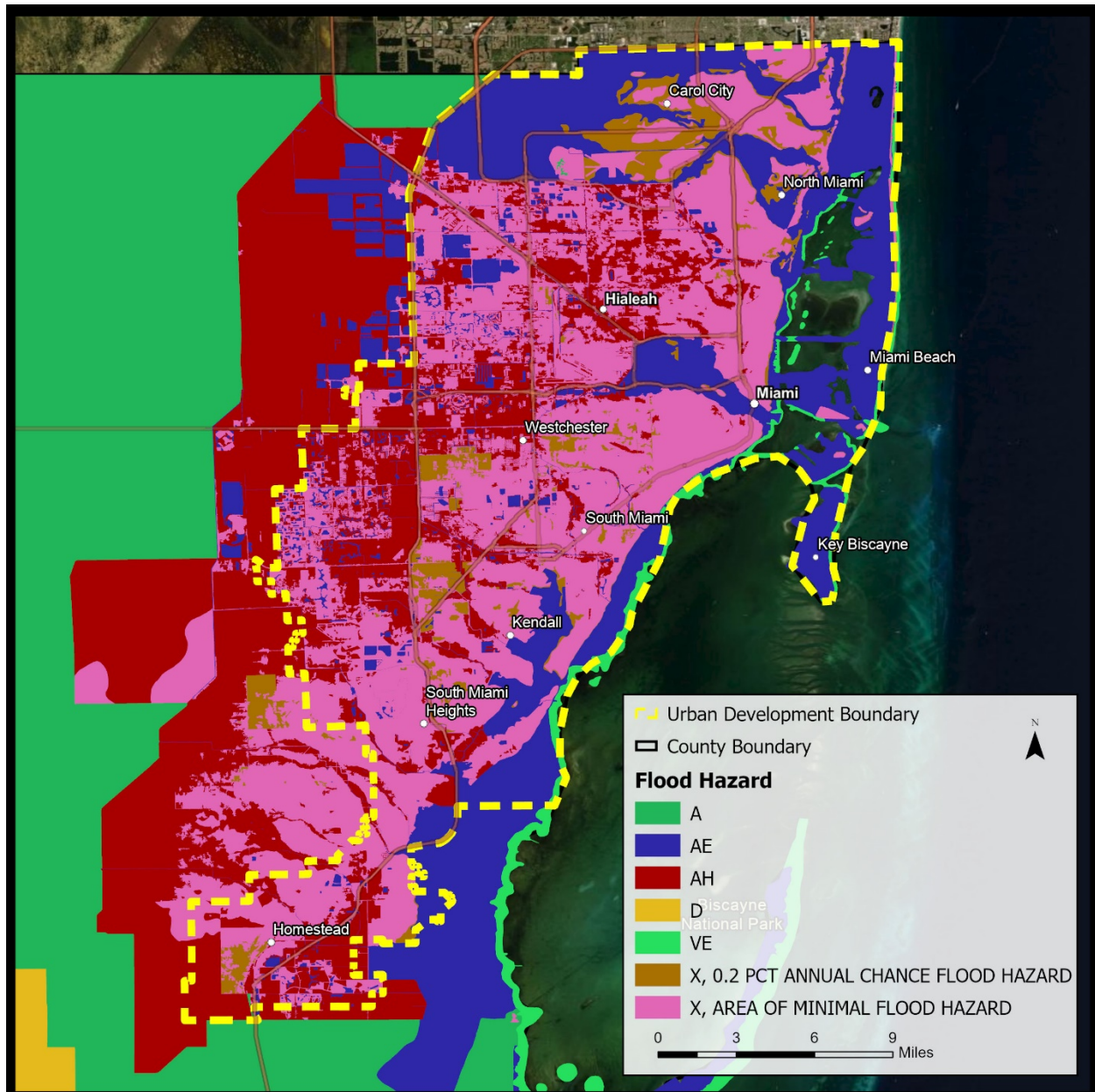


Figure 2-14. Effective 2009 FEMA Flood Plains

For comparison to historical data, the effective maximum FEMA 1-percent-annual-chance stillwater storm tide elevation is 10.0 feet, NAVD88 and the maximum 1-percent-annual-chance wave crest elevation is 16.3 feet, NAVD88. The effective FIS shows the hydrologic analysis used a storm duration of three days for to evaluate flooding from rainfall.

The effective FIS and FIRMs are currently going through a revision and are scheduled to be final in 2020-2021. The revision includes new coastal engineering (storm surge and wave height analyses) and more accurate topographic mapping. The coastal areas shown on effective FIRMs are based on an engineering analysis completed in 1985 and U.S. Geological Survey 7.5 Minute Quadrangle Topographic Mapping, where the topographic contour interval is five feet (FEMA 2009). With new engineering and more detailed and accurate topographic mapping, there could be significant changes with the revised coastal 1- and 0.2-percent-annual-chance flood elevations and flood plain mapping boundaries.

Miami-Dade County completed an assessment of structures (as of 2014) within the 1- and 0.2-percent-annual-chance flood plains. For an estimated population of 2.7 million people, there are approximately 650,000 structures within MDC. Approximately 400,000 structures are located within the FEMA 1-percent-annual-chance flood plain (estimated VE=4,000, AE=247,500, AH=152,500, A=500) and 42,000 within the 0.2-percent-annual-chance flood plain. Jurisdictions with more than 10,000 structures (rounded) within the effective 1-percent-annual-chance flood plain include Aventura (24,000), Cutler Bay (10,000), Hialeah (20,000), Miami Beach (51,000), Miami Gardens (12,000), Miami (53,000), Sunny Isles Beach (11,000), and the unincorporated areas (151,000) (MDCWG 2015-2018). As noted above, the topographic mapping used to delineate the coastal FEMA Flood Plain boundaries was based on a contour interval of five feet. With the flat topography, more accurate topographic mapping could have increased or decreased the number of structures.

For most communities within MDC, the initial FEMA FIRMs were produced on September 29, 1972. Almost half of the structures within MDC were built before 1973, where regulatory flood elevations were not yet established and are thus more likely to experience more of a hazard than structures built with FIRM elevations in place. Many structures in MDC are built with slab-on-grade construction, where the lowest finished floor is six inches to one foot above the ground. Jurisdictions with more than 10,000 structures (rounded) built before 1973 include Coral Gables (12,000), Hialeah (28,000), Miami Beach (30,000), Miami Gardens (22,000), North Miami Beach (11,000), North Miami (13,000), and the unincorporated areas (117,000) (MDCWG 2015-2018).

Miami-Dade County also evaluated FEMA Repetitive Loss data (1979-2014) from past storms. 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. Jurisdictions with more than 50 Repetitive Loss properties (rounded) include Doral (70), Hialeah (200), Miami (240), Miami Beach (80), Miami Springs (70), Sweetwater (80), and the unincorporated areas (2,300) (MDCWG 2015-2018). Note, 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.

In addition to buildings being impacted by flooding, MDC has an extensive system of inland canals that drain into the Atlantic Ocean and the Everglades and help with storm drainage. Tidal flooding within the canals can cause saltwater intrusion into the ground water of the Biscayne

aquifer, which is MDC's main source of drinking water. Tidal flooding within the canals is partially controlled by salinity control structures. The operation of the salinity control structures during tidal and rainfall events is most important (MDCWG 2015-2018). Flooding impacts to sanitary and septic systems, oil/fuel/chemical facilities, gas/electrical/oil/chemical fires, stormwater systems, water quality, roadways/evacuation routes, other critical infrastructure, beach/dune erosion, agricultural areas, natural habitat areas and animals, historic and cultural resources, life-safety (death from drowning or electrocution), etc. are also concerns of MDC. 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 (1931-2018) at the Virginia Key tide gage is approximately 0.11 inches per year or about one foot per 100 years (NOAAAb). A 2016 study titled, Increasing flooding hazard in coastal communities due to rising sea level: Case study of Miami Beach, Florida, evaluated tide and rain gauge records, media reports, insurance claims, and photo records from Miami Beach acquired during 1998-2013. The study indicated that significant changes in flooding frequency occurred after 2006, in which rain-induced events increased by 33 percent and tide-induced events increased by more than 400 percent. The study also analyzed tide gage records from Southeast Florida and detected decadal-scale accelerating rates of sea level rise. The average pre-2006 rate is 0.12 ± 0.08 inches per year, similar to the global long-term rate of sea level rise, whereas after 2006 the average rate of sea level rise in Southeast Florida rose to 0.35 ± 0.16 inches per year (Wdowski et al. 2016).

As discussed above, 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, short term or long term depending on the situation. This could include loss of wages for homeowners, loss of revenue for businesses, loss of 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, for a structure within the 1-percent-annual-chance flood plain, regardless of whether the structure has flood insurance, is not in compliance with the requirements for lowest floor being elevated to or above the 1-percent-annual-chance flood plain (or flood proofed if non-residential) in accordance with local flood plain regulations, 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 that does not have proper insurance, the situation could be very costly to restore the structure and meet local flood plain regulations.

The ROI for this project does not include any Coastal Barrier Resources Act (CBRA) Otherwise Protected Areas or Designated Units. Therefore, a CBRA consultation with the U.S. Fish and

Wildlife Service is not required and this topic is dismissed from further consideration in this Integrated Report/EIS.

Flood mitigation activities are used to help reduce or eliminate the impacts from flooding. Miami-Dade County has completed many activities in trying to address the many flooding problems and help its citizens. FEMA also 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 5-percent discount for each class obtained, ranging from ratings of Class 1, a 45-percent discount, to Class 9, a 5-percent discount. As of October 2019, the following communities achieved a CRS Class 4, 5, and 6 rating: Class 4 – Cutler Bay, Class 5 – Miami Beach, Miami-Dade County, and Class 6 – Miami Gardens, Miami Lakes, and North Miami (FEMA 2019). A listing of completed flood mitigation activities can be found in Miami-Dade County's Hazard Mitigation Plan (MDCWG 2015-2018); some communities may have the information posted on their websites.

2.6 VEGETATION, WETLANDS, AND SUMBERGED AQUATIC VEGETATION

Definition of Resource

Wetlands

Wetlands are defined by the Clean Water Act 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 2019) 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.

Wetlands play a critical role in a vast number of functions for any ecosystem where they naturally occur, which include water purification, ground water/aquifer recharge, retention of flood waters, fish and wildlife habitat, shoreline stabilization, protection from coastal erosion, and many more.

Seagrasses/SAV

Submerged aquatic vegetation (SAV) are non-flowering or flowering plants that grow completely underwater. In the South Florida region, SAVs generally grow in shallow areas ranging from high salinity regions to freshwater tidal environments and also in deeper areas as well. (Marine Sanctuary, 2019) Seagrass occurs throughout the soft-bottom, shallow-water areas within the Biscayne Bay and its surrounding tributaries 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. Seagrasses also play a major role in the health of benthics and serve as a shelter, feeding grounds, and nursery habitat for marine life. More information is available in Section

2.10 BENTHIC RESOURCES. There are both sparse and continuous sea grass beds mapped throughout the Biscayne Bay. The entire Biscayne Bay is considered critical habitat for Johnson's sea grass, *Halophila johnsonii*, which is listed as threatened on the U.S. Fish and Wildlife Endangered Species List. Johnson's sea grass is the only marine plant species to be listed under the Endangered Species Act. Additional information can be found in Section 2.11 SPECIAL STATUS SPECIES.

Natural Forest Communities

Natural Forest Communities are rare upland plant communities. In MDC, "these plant communities typically consist of Pine Rocklands and Tropical Hardwood Hammock habitats that contain a large diversity of native plants, many of which are found only within Miami-Dade County." (Miami-Dade, 2014) These forested habitats once covered approximately 180,000 acres in South Florida and now are estimated around 3,000 acres remaining due to land clearing for agriculture and development.

Methodology

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.

The ROI for SAV is all aquatic areas where structure or fill is being placed or dredging is being conducted, for storm surge barriers, floodwalls, pump stations, natural and nature-based features, or other activities associated with the project. The ROI also includes any areas that may be indirectly affected due to alterations in currents, velocities, salinity, tidal flushing, sedimentation, total suspended solids, or other alterations in hydrodynamics.

The ROI for vegetation, specifically NFC communities, includes all NFC areas within the Study Area to be directly filled, excavated, or otherwise temporarily or permanently converted to another use as a result of the construction of the measures, as well as any NFC vegetation that would be indirectly adversely affected by the project.

Framework

The Clean Water Act (CWA) of 1972, as amended (33 USC Section 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 CWA, Section 404 requires a permit for the dredging and/or filling of jurisdictional waters of the U.S, including wetlands. Under the CWA implementing regulations, SAVs (or vegetated shallows) are defined as a special aquatic site. The CWA Section 401 requires a State Water Quality Certification for impacts to waters of the U.S., including wetlands and other special aquatic sites.

Section 10 of the Rivers and Harbors Act of 1899, as amended (33 USC Section 403) regulates structures and work that would affect navigable waters of the U.S. Structures include piers, wharves, jetties, bulkheads, groins, breakwaters, etc. Work includes dredging, filling,

excavation, or other modifications to navigable waters of the U.S. All waters subject to the ebb and flow of the tide are by definition navigable waters (33 CFR 328).

In addition to federal regulations and the State Water Quality Certification, there are numerous other state laws, regulations, and/or policies that also help to regulate any potential impacts to wetlands or SAVs.

The state of Florida acquired title to sovereignty submerged lands on March 3, 1845, by virtue of statehood. "Sovereignty submerged lands include, but are not limited to, tidal lands, islands, sandbars, shallow banks and lands waterward of the ordinary or mean high water line, beneath navigable fresh water or beneath tidally influenced waters." (FDEP 2019) FDEP requires submerged lands approval to build any structure on or over a submerged bottom land. Most submerged lands in Biscayne and Dumfounding Bays and their natural tributaries including the Miami River, Little River, Oleta River and Arch Creek are owned by the State of Florida, and proprietary approval from FDEP is generally necessary prior to the issuance of a Class I permit.

The Florida Administrative Code also has a statute, Chapter 18-18, The Biscayne Bay Aquatic Preserves Act, that manages and enforces any potential impact to the Biscayne Bay through a permitting process and restricts (aside from a few exceptions) any potential impacts past 18" of the existing sea wall along the shoreline of Biscayne Bay. Chapters 18-18, 18-20 and 18-21, F.A.C., are the three administrative rules directly applicable to the uses allowed in aquatic preserves specifically and sovereignty lands generally. These rules are intended to be cumulative, meaning that Chapter 18-21, F.A.C., should be read together with Chapter 18-18, F.A.C., or Chapter 18-20, F.A.C., to determine what activities are permissible within an aquatic preserve. (Biscayne Bay Aquatic Preserves and the Florida Department of Environmental Protection Coastal and Aquatic Managed Areas, 2013)

The South Florida Water Management District regulates residential and commercial developments, roadway construction and agriculture projects to protect wetlands and other surface waters and works jointly with the FDEP which oversees power plants, ports, wastewater treatment plants and single-family home projects. An Environmental Resource Permit is required for projects that will involve the dredging and filling in wetlands or surface waters, construction of flood protection facilities, site grading, or other activities that have the potential to affect state waters.

Existing Conditions

Biscayne Bay is a shallow subtropical estuary on the southeastern coast of Florida and it is located primarily in MDC. The bay can be divided into four major areas: North Bay, Central Bay, South Bay, and Card and Barnes sounds. Each of the four areas has distinct physical and ecological characteristics. Eleven major conveyance canals discharge fresh water into the bay from the mainland. The bay is hydrologically connected to the Greater Everglades ecosystem, historically, through tributaries, sloughs, and ground water flow and beginning in the twentieth century, through conveyance canals. Although the area along Biscayne Bay from the Broward County line through the City of Miami is heavily impacted by adjacent urban development, benthic communities exist and are dominated by seagrasses intermixed with calcareous green algae. Development along Biscayne Bay south of the City of Miami grades from suburban to

agricultural to park land where much of the natural mangrove wetlands are still intact along the western shore and eastern barrier islands because they lie within Biscayne National Park.

Biscayne Bay Aquatic Preserves Management Plan released in February 2013 noted an acreage breakdown from FDEP's Office of Coastal and Aquatic Managed Areas (CAMA) for the Biscayne Bay Aquatic Preserves (BBAP) which stretches from MDC to Monroe County. The plan documented 48,255.21 acres of seagrass bed, 31.17 acres of tidal marsh, and 903.77 acres of tidal swamp as of 2013. (Biscayne Bay Aquatic Preserves and the Florida Department of Environmental Protection Coastal and Aquatic Managed Areas, 2013)

The Environmentally Endangered Lands (EEL) Program in MDC is funded through property taxes. The program uses funds collected to acquire, protect, and maintain environmentally endangered lands. As of 2019, the EEL program has bought more than 20,700 acres of EEL lands and manages 2,800 acres of natural lands. The specific types of purchased lands include 1,550 acres of rockridge pineland, 1,790 acres of tropical hardwood hammock, 18,832 acres of freshwater wetlands, 625 acres of coastal wetlands, and 19 acres of scrub habitat. (Miami-Dade, 2019). Figure 2-15 provides wetlands found throughout the ROI based on the USFWS National Wetland Inventory (USFWS 2020).

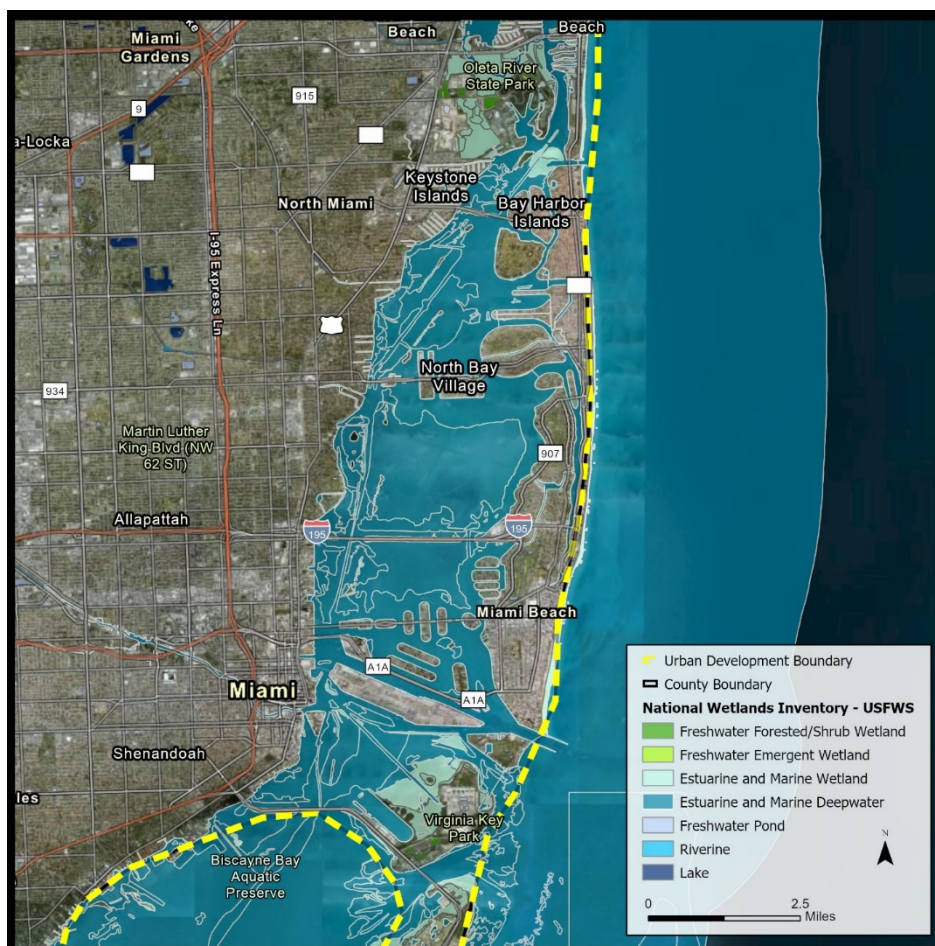


Figure 2-15. Miami-Dade Back Bay CSRM Study Area National Wetlands Inventory Map
Freshwater Wetlands

Freshwater wetlands occur throughout Miami-Dade, particularly in the western and southern parts of the county. There are two types of freshwater wetlands: marshes and swamps. Marshes are ecosystems dominated by herbaceous plants rooted in shallow water that remains at or above ground level for most of the year and comprise of about one-third of the wetlands in southern Florida. Swamps are wetland forests. These freshwater wetlands are a major element of the South Florida landscape, even though they have been reduced to half of their original extent. (Miami-Dade, 2013) The largest freshwater wetlands in Florida is the Everglades.

During the Preconstruction, Engineering, and Design (PED) Phase of the study, a field survey would take place to determine the extent and presence of any potential wetlands within the ROI. If wetlands were present within the ROI, a jurisdictional determination (JD) would be conducted.

Coastal Wetlands and Mangroves

Coastal wetlands consist of salt marshes and mangrove swamps and historically occurred continuously throughout the County adjacent to shorelines. Salt marshes are extensive intertidal areas that can be found in temperate areas along the coast in Florida. This ecosystem is dominated by grasses and herbaceous plants, which provide the coastline with protection from direct wave action and have dominant species such as smooth cordgrass (*Spartina alterniflora*) and blackrush (*Juncus roemerianus*). (Miami-Dade, 2014)

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. (Marine Sanctuary, 2019) Mangrove forests help to stabilize coastlines, and help reduce erosion from storm surge, currents, waves, tides, and hurricane damage. (Marine Sanctuary, 2019) They also slow down and filter runoff which aids in improved water quality.

Mangroves in south Florida consist of the red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), and white mangrove *Laguncularia racemosa*). 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 to many commercially and recreationally important fin 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 frigate birds, white crowned-pigeon, osprey, bald eagles and resident and migratory songbirds, hawks and falcons. The black and white mangrove species are found further up-slope in coastal wetlands. (Marine Sanctuary, 2019) Green 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. (Miami-Dade, 2014)

Mangrove communities along the coastal areas of Biscayne Bay stabilize bottom sediments and protect shorelines from erosion and storm surge. (Miami-Dade 2014) These communities can also help to potentially reduce the damage to upland areas from hurricanes. Mangrove wetlands have drastically reduced in size due to increased development in and around Miami over the years but in 1996, the State of Florida passed the Florida State Mangrove Trimming and Preservation Act. The Act limits the removal and trimming of mangroves on both public and

private property. In MDC, a Class 1 permit is required before trimming or removing a mangrove tree.

Within the ROI, there were a few noted isolated mangroves along the existing bulkheads and seawalls. At other areas along proposed surge barrier locations, there were observations of mowed and maintained vegetation along the rip-rapped shorelines at the Miami River. At the Little River and Biscayne Canal there were observed isolated vegetative species that had been planted and/or also grew opportunistically in an urban, maintained environment.



Figure 2-16. Mangrove Wetlands within the ROI Growing Along the Seawall in Biscayne Bay

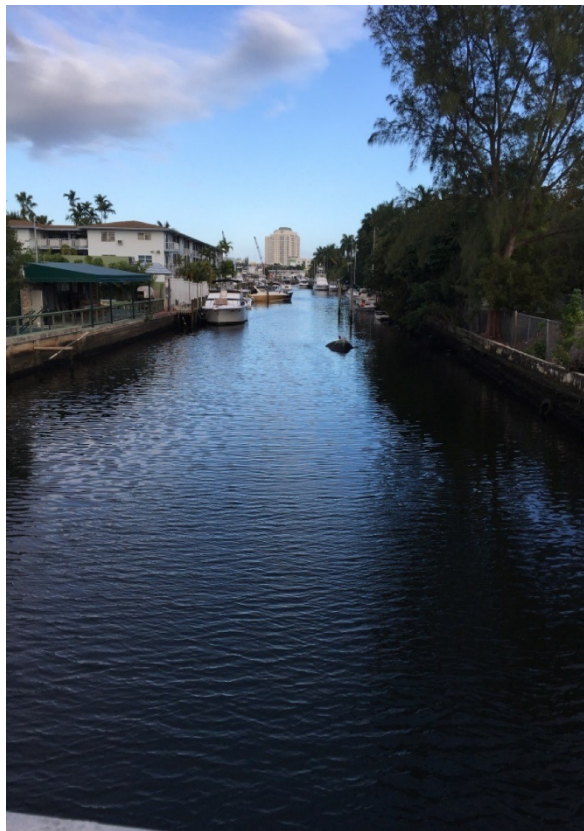


Figure 2-17. Proposed Surge Barriers at Little River (left) and Biscayne Canal (right)

Seagrasses and SAVs

The ROI for SAV is all aquatic areas where structure or fill is being placed or dredging is being conducted, for storm surge barriers, floodwalls, pump stations, natural and nature-based features, or other activities associated with the project. The ROI also includes any areas that may be indirectly affected due to alterations in currents, velocities, salinity, tidal flushing, sedimentation, total suspended solids, or other alterations in hydrodynamics.

Seagrasses are also referred to as submerged aquatic vegetation (SAV) and macrophytes, discussed below, and in terms that may include both attached and drift macro algae. There is an estimated 48, 255 acres of sea grass bed within the Biscayne Bay Aquatic Preserves. This includes, “an expansive subtidal or intertidal area, occupied primarily by rooted vascular macrophytes, (e.g., shoal grass, halophila, widgeon grass, manatee grass and turtle grass); may include various epiphytes and epifauna; octocorals, sponges, stony corals, and attached macrophytic algae sparse, if present.” (Biscayne Bay Aquatic Preserves and the Florida Department of Environmental Protection Coastal and Aquatic Managed Areas, 2013, page 27)

“Marine and estuarine seagrass beds are floral based natural communities typically characterized as expansive stands of vascular plant.” (Biscayne Bay Aquatic Preserves and the Florida Department of Environmental Protection Coastal and Aquatic Managed Areas, 2013, page 27) Seagrass beds occur most commonly in subtidal zones and are an indicator as to the health of the water they are in. Seagrass loss can be attributed to changes in temperature,

salinity, water quality, nutrient levels, or scarring damage from boats. The loss of seagrass can have devastating impacts to the marine ecosystem as they serve as essential foraging habitat, nursery, and provide shelter to countless species of marine life. Seagrass beds also naturally help to reduce the wave-energy on the bottom and promote settling of suspended particulates.

“Three seagrass species commonly occur in varying degrees of abundance throughout South Florida’s coastal ecosystem: turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*), and shoal grass (*Halodule wrightii*) (Zieman 1982). Three other species of seagrass are sparsely distributed within this range: star grass (*Halophila engelmannii*), paddle grass (*Halophila decipiens*), and Johnson’s seagrass (*Halophila johnsonii*). In areas of reduced salinity, widgeon grass (*Ruppia maritima*) is often found intermixed with shoal grass.” (USFWS, undated, page 3-598) Biscayne Bay is host to a variety of seagrasses but specifically it is also designated critical habitat for Johnson’s Seagrass, *Halophila johnsonii*. Johnson’s seagrass is the only marine plant to be listed under the Endangered Species Act. Like other native seagrasses, it serves as a vital resource as a shelter, foraging habitat, and nursery for marine life.



Figure 2-18. Map of Seagrass Habitat and 2018 Seagrass Coverage in Northern Biscayne Bay

Within the ROI, there were seagrass beds continuous and sparse throughout Biscayne Bay that were observed during the January 14, 2020, site visit boat tour. At other areas along the proposed surge barrier location, there were observations at the Miami River which also appeared to be seagrass beds. Photographs were taken but the images did not accurately capture the underwater species. It was noted during the site visit tour that DERM has recent 2019 survey data of the seagrass populations that is in the process of being compiled. Additional detailed surveys regarding the extent and presence of seagrass vegetation will take place later in the study in coordination with the study's interagency partners. Cumulative survey data over the course of a span of many years will also be researched and studied to ensure an accurate depiction of the presence of seagrass within Biscayne Bay, the Miami River, Little River, and Biscayne Canal.

Algae

Algae are a diverse group of organisms that are in the plant kingdom although technically are not plants. Algae do not have roots, stems, or leaves. There are types of microscopic algae similar to phytoplankton, discussed in Section 2.8 PLANKTON COMMUNITY, and like phytoplankton, algae plays an integral and important role in the ecosystem. Algae is also a primary component in the food web. (UF/IFAS, 2018)

However, algae can also grow out of control when nutrient levels are out of balance resulting in algal blooms. Increased nutrient availability will result in increased frequency, severity, duration, and spatial extent of algal blooms. In Florida, chlorophyll (an indicator of algae presence) concentrations of more than 40 micrograms per liter are called an "algae bloom" or "algal bloom." (UF/IFAS 2018) Algal blooms can adversely affect other water quality parameters, such as light penetration and depleting dissolved oxygen levels which results in the death of other native aquatic vegetation to include seagrasses.

Florida's surface water quality standards identify estuarine-specific nutrient criterion, or limits, in 62-302.532 for Total Phosphorous (TN), Total Nitrogen (TN), and chlorophyll-a which serves as an overall indicator for water quality conditions. Nine separate regions have been designated within Biscayne Bay with site specific criteria, expresses as annual geometric means (AGM), not to be exceeded more than once in a three year period. For example, 62-302.532 lists the criterion for TP, TN, and chlorophyll-a as 0.007 milligrams/liter (mg/L) as AGM, 0.31 mg/L as AGM, and 0.5 micrograms/liter as AGM, respectively for the North Central Inshore Region of Biscayne Bay.

Upland Vegetation

Prior to the establishment of the City of Miami and its surrounding areas, pine rocklands encompassed an estimated 185,000 acres in MDC and today have been reduced to about 3,000 acres due to development and agriculture. Pine rocklands and hammocks are found on some of the highest elevations in the County, and prior to the construction of extensive drainage systems, were the first areas utilized for development.

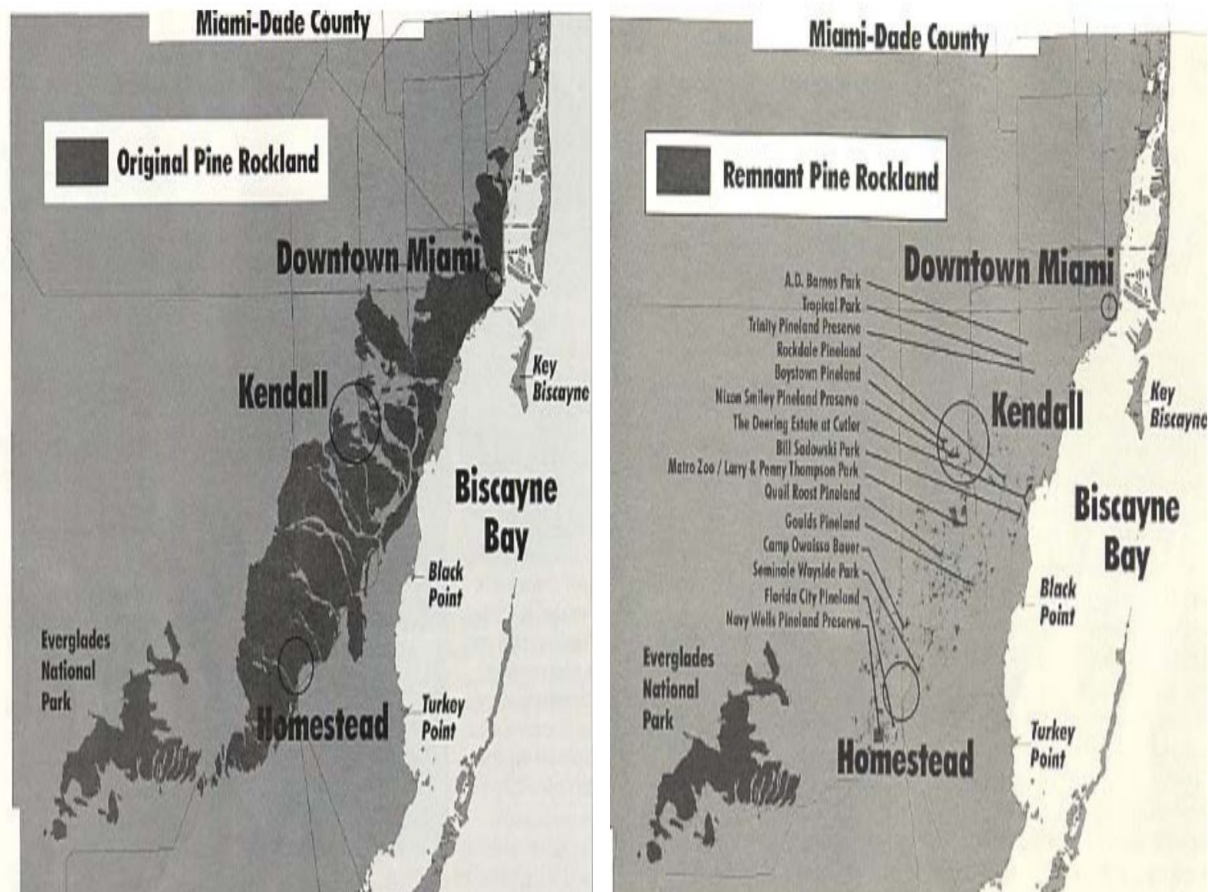


Figure 2-19. Miami-Dade County Original and Remnant Pine Rockland Areas

2.7 WILDLIFE AND TERRESTRIAL HABITAT

Definition of Resource

For the purpose of the following discussion, wildlife is limited to terrestrial species of invertebrates, amphibians, reptiles, birds, and mammals. Protected species and more information on migratory bird species are discussed in Section 2.11 SPECIAL STATUS SPECIES; freshwater and coastal wetlands are described Section 2.6 VEGETATION, WETLANDS, and SUBMERGED AQUATIC VEGETATION; and aquatic species are discussed in the fisheries and benthic sections, 2.9 EFH AND FISHERY RESOURCES and 2.10 BENTHIC RESOURCES, respectively.

Methodology

The ROI is all areas within the County that could potentially be affected by the proposed storm surge barriers, floodwalls, pump stations, Natural and Nature-Based Features (NNBFs), or other activities associated with the project, including all noise and disturbance effects to species in and adjacent to areas that are filled, graded, cleared, excavated, or otherwise converted to another use as a result of the construction of the measures. It also includes areas indirectly adversely affected by the project, by means such as erosion, alteration of wildlife passage corridors, or changes in community type.

Framework

Fish and Wildlife Coordination Act requires the USACE to coordinate with the USFWS and FLFWS on water resources related projects to obtain their views toward preservation of fish and wildlife resources and migration of unavoidable impacts.

Environmentally Endangered Lands Program “identifies and secures lands for preservation per the requirements and conditions set forth by Chapter 25B-11 of the Miami-Dade County Code, Section 193.501, Florida Statutes and Section 4(b), Article VII of the Constitution of the State of Florida” (W – Miami-Dade County n.d.).

Existing Conditions

Miami-Dade County is largely comprised of state and national parks, approximately 60% of the land area (W2 – Miami-Dade County n.d.). Most of the urbanization occurs within the urban development boundary (UDB), which encompasses a portion of the Atlantic and Biscayne Bay coastlines. The highly urban city center and sprawl within the UDB is highly built out and encroaching on adjacent wildlife habitat, which includes a system of freshwater and coastal wetlands, beach, scrub, and forest habitats. Due to the unique character of southern Florida, the biodiversity is immense, with species filling very distinct niches found only in South Florida.

The unique environment and ecosystems characteristic of southern Florida are home to a growing number of threatened and endangered species. Due to continued urbanization and development, ecosystems and habitats have been disrupted and/or lost. To protect these habitats unique to southern Florida, and more specifically, MDC, the Miami-Dade County Department of Regulatory and Economic Resources (RER) began administering the Environmentally Endangered Lands Program (EEL) in 1990 (W – Miami-Dade County n.d.). The Program aims to acquire, protect, and maintain lands that have been identified as environmentally endangered; these habitats include rockridge pineland, tropical hammock, and scrub habitats. For information regarding threatened and endangered species, refer to Section 2.11 SPECIAL STATUS SPECIES.

Since the EEL Program’s inception, thousands of acres of land have been purchased for protection and conservation, including -

- 1,550 acres of rockridge pineland
- 19 acres of scrub habitat
- 1,790 acres of tropical hardwood hammock
- 18,832 acres of freshwater wetlands
- 625 acres of coastal wetlands

Currently, the EEL program, in conjunction with MDC parks, protects more than 23,500 acres of land (W – Miami-Dade County n.d.). Only about 5,500 acres of EEL occur within the urban development boundary (W2 – Miami-Dade County n.d.).

In general, the area within the UDB is home to species tolerant to human activity and well-adapted to conditions ranging from highly urbanized to residential. Common amphibians include various species of toads, frogs, salamanders. Reptiles include alligator (*alligator mississippiensis*), alligator snapping turtle (*Macrochelys temminckii*), American crocodile

(*Macrochelys temminckii*), water snakes (*Nerodia* spp.) and other reptiles, to include various species of snakes, lizards, and terrapins.

Bird species include wading birds, raptors, and songbirds, including whooping crane (*Gus americana*), brown pelican (*Pelecanus occidentalis*), and eastern bluebird (*Sialia sialis*). Mammals known to occur include rodents (voles, mice, rats, squirrels, groundhogs, etc.), raccoons (*Procyon lotor*), opossum (*Didelphis virginiana*), and whitetail deer (*Odocoileus virginianus*).

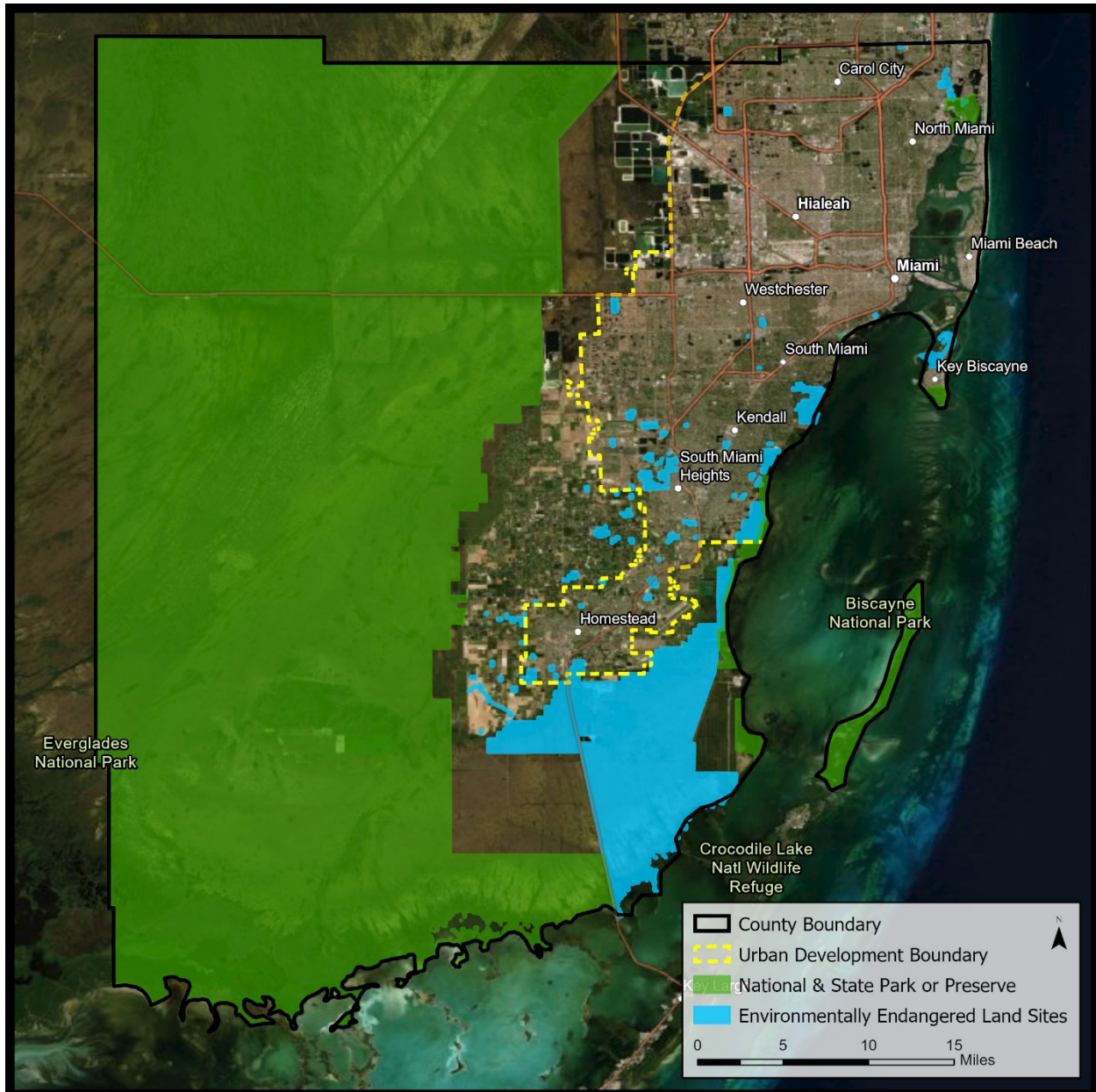


Figure 2-20. Miami-Dade County Parks/Preserves & Environmentally Endangered Land Sites

Rockridge pineland

“Pine rockland is a globally critically imperiled plant community that is “extremely limited in distribution,” having a designation of “G1/S1” – the rarest rank possible, shy of extinction” (FNAI 2010, as cited in Possley et al. 2018).

Prior to rapid development and urbanization in the mid-20th century, MDC boasted nearly 161,660 acres of rockridge pinelands; by 1995, this area was reduced to an estimated 4,400 acres of fragmented pineland habitat, and in 1996 it was estimated that only 2% of the pine forest remained in the urbanized areas of the County (USFWS n.d.; W3 – Miami-Dade County n.d.).

Pine rocklands are an imperiled plant community unique to southern Florida, Cuba, and the Bahamas (USFWS n.d.). This ecological community once flourished on the Miami Rock Ridge, a limestone ridge stretching from the Mahogany Hammock region of Everglades National Park northeast through MDC’s UDB (USFWS n.d.). This community is made up of an association of a single canopy tree, South Florida slash pine (*Pinus elliotii* var. *densa*), a diverse hardwood and palm subcanopy, and a rich herbaceous layer (USFWS, n.d.). There are 40 plant taxa that are found only in south Florida rockridge pinelands, as well as numerous federally and state listed wildlife species (Possley et al. 2018). Other species documented to persist in this habitat include, but are not limited to the Eastern coachwhip snake (*Masticophis flagellum*), Eastern diamondback rattlesnake (*Crotalus adamanteus*), atala hairstreak butterfly (*Eumaeus atala*), coyote (*Canis latrans*), and bobcat (*Felidae rufus floridanus*). This habitat, characterized by its limestone ridge, reduced amount of soil substrate needed for growth, and unique flora and fauna, is adapted and even depends periodic fires to survive and thrive (W3 - Miami-Dade County n.d.). To maintain the health of this ecosystem, fires are prescribed cyclically every 3-5 years.

Scrub

In MDC, scrub communities are at their southernmost extent, with scrub habitat only in the northernmost part of the County; these areas, “County Line Scrub” and “Dolphin Center Addition,” have been acquired by the EEL Program for protection and conservation, as scrub habitat and many of its inhabitants are endangered (Miami-Dade County n.d.).

Florida scrub habitat is characterized by woody shrubs, little-to-no overhead canopy, and frequent patches of bare sand. There are several dominant plant species that make up the recognizable scrub habitat, these include myrtle oak or scrub oak (*Quercus myrtifolia* or *Q. inopina*), sand live oak (*Quercus geminate*), crookedwood (*Lyonia ferruginea*), saw palmetto (*Serenoa repens*), and Florida rosemary (*Ceratiola ericoides*), among others (USFWSb n.d.). Species inhabiting the ecosystem range from the Florida mouse (*Peromyscus floridanus*) to the gopher tortoise (*Gopherus Polyphemus*) (USFWSb n.d.).

Similar to the rockridge pineland habitat, Florida scrub is a fire dependent community, and requires recurrent burning for the ecosystem to persist (USFWSb n.d.).

Tropical Hardwood Hammock

Tropical hardwood hammocks are found throughout south Florida, but have large concentrations along the Miami Rock Ridge in MDC; this ecosystem is characterized by a dense

canopy and fringe consisting of broad-leafed trees, shrubs, and vines (W4 - Miami-Dade County n.d.). Unlike pine rocklands or scrubs, tropical hardwood hammocks are not a fire-dependent community, and could be severely damaged if a wildfire were to occur in the community.

Hardwood hammocks can be found in the dry, upland areas of marshes, mangrove swamps, wetland tree islands, and in pinelands. Trees and shrubs commonly found in the tropical hardwood hammock ecosystem include, but are not limited to the Florida royal palm (*Roystonea elata*), live oak (*Quercus virginiana*), pigeon plum (*Coccoloba diversifolia*), wild tamarind (*Lysiloma latisiliqua*), gumbo limbo (*Bursera simaruba*), strangler fig (*Ficus aurea*), paradise tree (*Simarouba glauca*), and poisonwood (*Metopium toxiferum*) (W4 – Miami-Dade County n.d.). This ecosystem houses around 24 species of reptiles and amphibians, including the brown anole (*Anolis sagrei*) and eastern narrow mouthed toad (*Gastrophryne carolinensis*); birds inhabiting hardwood hammocks include species such as the mangrove cuckoo (*Coccyzus minor*), black-whiskered vireo (*Vireo atilquus*), and white-crowned pigeon (*Columba leucocephala*) (Dalrymple 1988 and Snyder et al. 1990, as cited in USFWSa n.d.).

Freshwater and Coastal Wetlands

For information regarding the freshwater and coastal wetlands found in MDC, refer to Section 2.6 VEGETATION, WETLANDS, AND SUBMERGED AQUATIC VEGETATION.

2.8 PLANKTON COMMUNITY

Definition of resource

Plankton are free-floating organisms found in freshwater and marine ecosystems that are transported by wind and currents, though some zooplankton have limited swimming abilities.

Zooplankton form a crucial link in the food chain between the primary producers and higher levels of the food chain. Zooplankton consists of primary consumers (those that eat phytoplankton) and secondary consumers (larger zooplankton that consume the secondary consumers). Zooplankton are then consumed by fishes and some filter feeding benthos, which are subsequently prey for larger fishes and wildlife. (Reshetiloff 1997) Meroplankton, another abundant element in estuarine water, consists of the eggs and larvae of many fish and benthic invertebrate species.

Copepods are tiny crustaceans that are about one millimeter long. Larval fish and shellfish, which include commercial and recreational fisheries species and species of restoration and management concern, constitute an important component of the zooplankton community. For example, oyster, crab, and finfish larvae such as red drum compose the zooplankton community seasonally.

Protozoa are single-celled zooplankton that consume bacteria and decaying plant and animal matter. Bacteria also play a crucial role in the bay and surrounding tributaries because they break down decaying plant and animal matter and provide nutrients in the food chain for higher level organisms. Comb-jellies and jellyfish are larger zooplankton that are visible to the naked eye and have some swimming ability, however, their location is largely driven by tides and currents and therefore, they are still considered zooplankton.

All fish in the Biscayne Bay and its surrounding tributaries depend, whether directly or indirectly, on zooplankton because of its' critical role in the food chain. Some fish such as anchovies, herring, and shad solely feed on the zooplankton throughout their entire life cycle. Other fish species depend on plankton for a portion of their lifecycle either directly their own larval phase or indirectly through the food chain, such as sturgeon.

Phytoplankton (microalgae) are tiny, single-celled organisms. Phytoplankton are primary producers because they generate food and oxygen in the Biscayne Bay and its surrounding tributaries by a process called photosynthesis. Phytoplankton need the energy of sunlight to perform photosynthesis and they are typically found in the upper reaches of the water column. Phytoplankton are able to use the sunlight's energy to produce food via a green pigment called Chlorophyll *a*. The amount of Chlorophyll *a* in the water column is a function of phytoplankton biomass in the water column. There are hundreds of species of phytoplankton in the Biscayne Bay, the project ROI for this resource, but the most abundant phytoplankton in the project ROI and its nearby waters are diatoms, with pico-nanoplankton and dinoflagellates found in lower amounts but typically present.

Phytoplankton require Nitrogen and Phosphorus to grow. However, in ecosystems out of balance, elevated phytoplankton biomass can lead to poor water quality and reduced dissolved oxygen levels as excess biomass is not consumed, sinks to the bottom, dies and decomposes, entering the detrital food chain. Dinoflagellates periodically bloom in great numbers as toxic red or brown tides. Such tides are often caused by eutrophication, the addition of excess nutrients, often from human origin, to local waters in the form of dissolved nitrogen (N) and phosphorus (P), which stimulates plant growth.

Methodology

The ROI for plankton are waters above and around the proposed flood wall and the proposed surge barriers and pump stations, and waters that could be impacted by the traverse of vessels carrying construction equipment, and waters that could be temporarily impacted by temporary construction measures.

Framework

There are not specific regulations regarding the phytoplankton community itself but instead these are indirectly included in regulations that cover water quality and EFH habitat, among others. These are described in the Regulatory Framework in Section 2.4 WATER QUALITY and Section 2.9 EFH AND FISHERY RESOURCES.

Existing Conditions

Over the past twenty years, Florida International University, Miami-Dade County Department of Environmental Resources Management, and South Florida Water Management District scientists have recorded increased concentrations of chlorophyll *a*, an index of phytoplankton abundance (NOAA 2015). In Biscayne Bay, chlorophyll *a* and nutrients are increasing, which could cause a potential decrease in P-limitation and lead to more eutrophication of Biscayne Bay (NOAA 2017). SAV has recently been in decline, with total losses now close to 21 square miles throughout the Bay. A recent NOAA study found the following: "Water quality data collected at 48 stations throughout Biscayne Bay over a 20-year period (1995–2014) were

examined to identify any water quality trends associated with eutrophication. Chlorophyll a and phosphate concentrations have increased throughout Biscayne Bay, which is a primary indicator of eutrophication. Moreover, chlorophyll a concentrations throughout the northern area, where circulation is restricted, and in nearshore areas of central Biscayne Bay are increasing at a higher rate compared to the rest of the Bay. This suggests increases in chlorophyll a are due to local nutrient sources from the watershed. These areas are also where recent seagrass die-offs have occurred, suggesting an urgent need for management intervention. State of Florida has listed Biscayne Bay as a medium priority impaired body of water.” (Millette et al. 2019). Figure 2-21 shows the ChlA concentrations in Biscayne Bay relative to various nutrient inputs and tidal restriction (Millette et al. 2019).

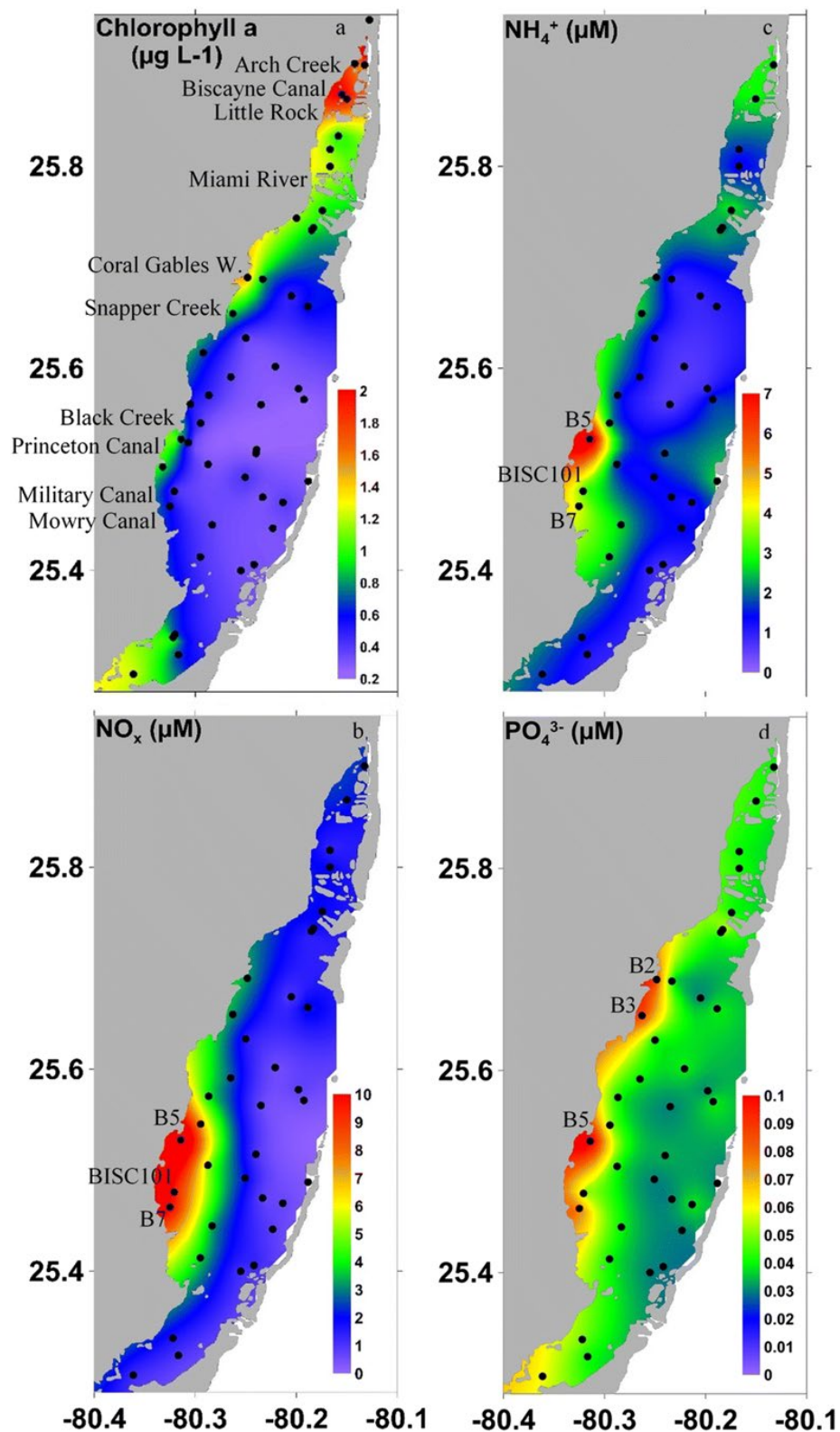


Figure 2-21. Data on Chl a Concentrations in Biscayne Bay, Relative to Various Nutrient Inputs and Tidal Restriction

In the Southern Bay, in 2013, there was an expansive diatom bloom and macro algae overgrew on seagrass beds in the central bay as phytoplankton species increased. Biscayne Bay water quality could decrease if phytoplankton species continue to increase. As the water quality decreases, these events could potentially cause seagrass loss as the increases in phytoplankton result in a reduction of sunlight and other nutrients available to seagrass (NOAA, 2015). There is a negative correlation between algal blooms induced by eutrophic conditions and SAV, with recent losses of SAV related to increases in ChlA due to increased phytoplankton in Biscayne Bay.

2.9 EFH AND FISHERY RESOURCES

Definition of Resource

Essential Fish Habitat (EFH) is defined as “those waters and substrate necessary for fish to spawn, breed, feed, or grow to maturity.” “Waters” is further defined by the South Atlantic Fisheries Management Council (SAFMC) as those “aquatic areas and their associated physical, chemical, and biological properties that are utilized by fished,” and “necessary” is further defined as the “habitat required to support a sustainable fishery and healthy ecosystem” (1998).

A further classification of EFH is a Habitat Area of Particular Concern (HAPC), which are essential fish habitats that meet certain criteria. The criteria are:

1. The importance of the ecological function provided by the habitat
2. The extent to which the habitat is sensitive to human-induced environmental degradation
3. Whether, and to what extent, development activities are, or will be stressing the habitat type, and the rarity of the habitat (SAFMC 1998).

Methodology

As stated in the February 2004 “Preparing Essential Fish Habitat Assessments: A Guide for Federal Action Agencies” document, and 50 CFR 600.920(e)(3), an EFH Assessment must include specific items. These items include, a description of the proposed action (Section 2.9), analysis of the potential adverse effects (individual and cumulative) of the action on EFH and managed species, proposed compensatory mitigation, and avoidance and minimization measures. This section of the integrated report will satisfy the requirements set forth in the above guidance and regulations.

Framework

Pursuant to the Magnuson-Stevens Fishery Conservation and Management Act of 1996, waters and substrate within the project area have been identified as EFH by the SAFMC (1998). Important habitats of the South Atlantic region are broadly divided into estuarine/inshore and marine/offshore with many subcategories under each. Estuarine / inshore habitats include salt and brackish marshes, mangroves (including buttonwood), seagrass, oyster reefs, shellbanks, intertidal flats, and freshwater wetlands; while marine/offshore habitats include coastal, open shelf, live/hardbottom, shelf edge, and lower shelf (SAFMC 1998). Each of these habitats have their own unique assemblage of fishes, invertebrates, and plants.

The Miami-Dade Back Bay Coastal Storm Risk Management Study area encompasses mangrove (including buttonwood), seagrass, coral reef, coral colony, and live/hardbottom habitats. Seagrass and mangroves (including buttonwoods) are discussed in section 2.6.

The SAFMC is responsible for managing fisheries and habitat within the waters of the project area and has produced several Fisheries Management Plans (FMs) for single and mixed groups of species. These FMPs, including penaeid shrimp, spiny lobster, snapper-grouper complex and coastal migratory pelagics, were amended in a single document (SAFMC1998) to address EFH within the South Atlantic region. In addition to the FMPs managed by the SAFMC, highly migratory species are managed under the Highly Migratory Species Management Unit, Office of Sustainable Fisheries, and National Marine Fisheries Service (NMFS).

Existing Conditions

Biscayne Bay is an oligotrophic (clear, highly oxygenated) body of water spanning a length of about 35 miles north-to-south, with the northernmost part of the bay positioned between the central business district of Dade County and Miami Beach.

Biscayne Bay and Biscayne Bay National Park (both will be referred to as Biscayne Bay) are Aquatic Preserves that are designated as Outstanding Florida Waters, which are “waters designated by the environmental Regulation Commission as worth of special protection because of their natural attributes” (62-302.700 (26) F.A.C., as cited in SAFMC 2017). These state-designated areas meet the criteria for EFH-Habitat Areas of Particular Concern (EFH-HAPC) and are geographically-define HAPC, which is independent of habitats that by themselves are HAPC.

Habitat Descriptions

Coastal

In the project area, the coastal habitat predominately consists of Biscayne Bay, a shallow, warm water estuarine environment where freshwater from the mainland mixes with saline oceanic water. Mangroves, wetlands, and seagrasses are characteristic of the environment of Biscayne Bay; these habitats are described in Section 2.6. The bay provides important nursery habitat for the growth and development of various fishes, ranging from reef-fish to oceanic predators. In the project area, the sediment composition is largely made up of a mixture of sand, silt, and clay, with proportions of sand varying from >90% to as low as 50% (McNulty, Work, and Moore 1962). The benthic community, discussed in Section 2.10, provides habitat for a variety of benthic flora and fauna, including invertebrates, which are relied upon as a food source for a variety of fish assemblages. Figure 2-22 displays seagrass, mangrove, and wetland habitats in and adjacent to the project area (Florida Fish and Wildlife Conservation Commission 2017, 2019; Miami Dade Open Data 2018).

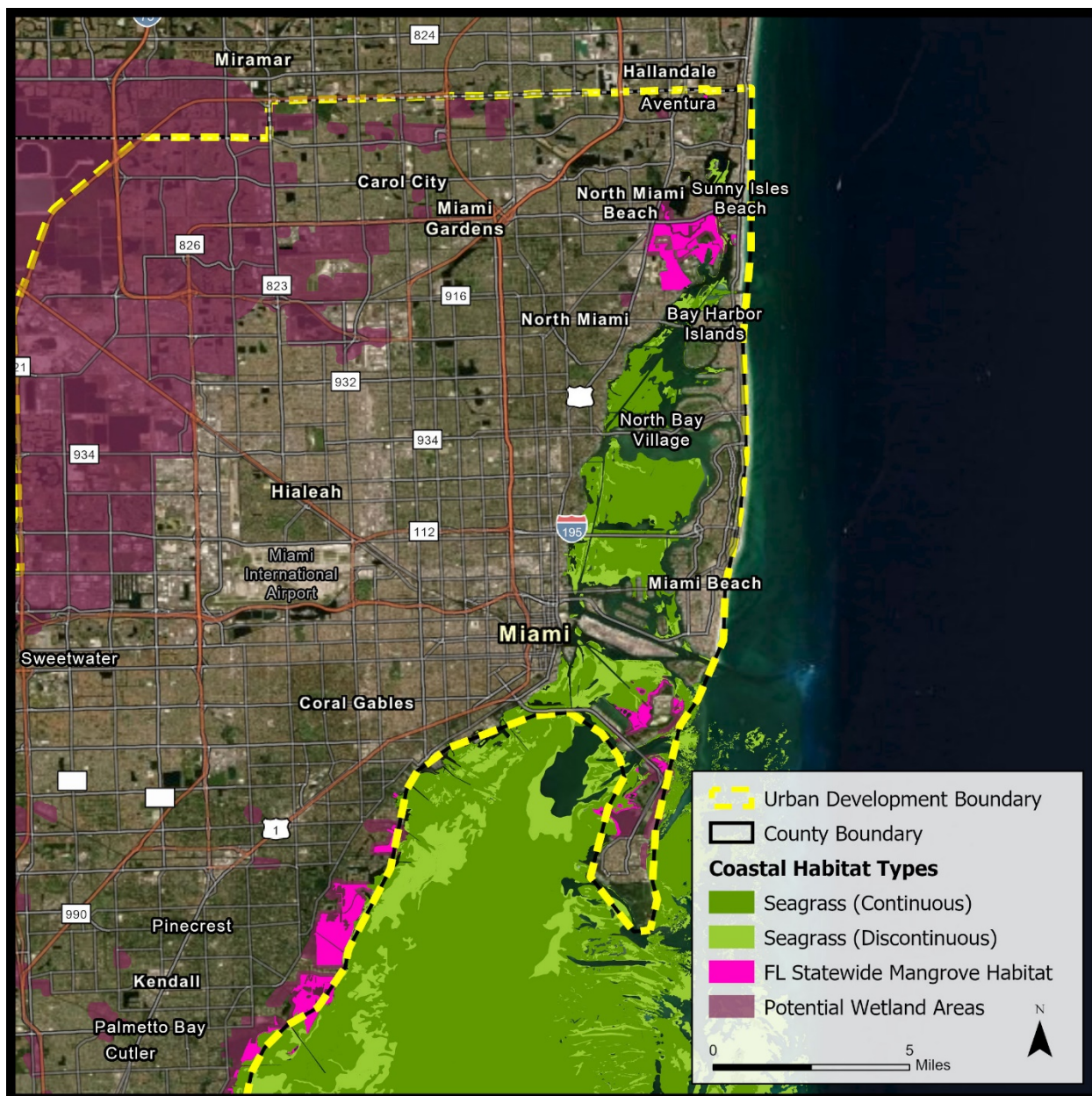


Figure 2-22. Seagrass, Wetland, and Mangrove Habitats Present in the Project Area

Coral Reef, Coral Colony, and Live/Hardbottom

Live/Hardbottom

Nearshore environments on the Atlantic Ocean side of the Region of Influence (ROI) 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. Hardbottom 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.

Coral reef and Coral Colony

Coral 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 continuous reef elevated off the seafloor. Coral reefs are irregularly shaped structures, having nooks, ledges, crannies, etc., and have interstitial space where fish, invertebrates, and other organisms can take up residence, forage, or hunt. Coral reefs represent an aquatic oasis, unlike vast open expanses, a healthy coral reef is diverse and abundant.

The Florida Reef Tract, which extends from the Dry Tortugas in the west to St. Lucie inlet (about 130 miles north of Miami) off of the southeast coast of the Florida peninsula, is the most extensive living coral reef ecosystem in North American waters. The reef tract extends through Biscayne National Park. 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.

In MDC, there are 233 recorded artificial reefs both within Biscayne Bay and off the east coast of Miami Beach (Miami-Dade Open Data 2016). Of the 233, there are 48 within the northern portion of Biscayne Bay as shown in Figure 2-23 (Florida Fish and Wildlife Conservation Commission 2017; Miami-Dade Open Data 2016). The man-made reefs are made out of materials including reef balls, limestone boulders, and sunken barges and vessels. In addition to corals colonizing to artificial reef structures, they are known to grow on bulkheads and seawalls along Dade County's urban coastline. These structures provide a recruitment surface for larval coral, which then settle and mature to coral polyps, then further mature to coral colonies and reefs, though the corals growing on the seawalls do not form coral reefs.

Corals and coral reefs are sensitive to nutrient inputs (runoff), algal blooms, temperature variation, overfishing and poor fishing practices. As global ocean temperatures have risen, corals have become stressed, increasing the likelihood of the spread of disease, bleaching, and die-off.

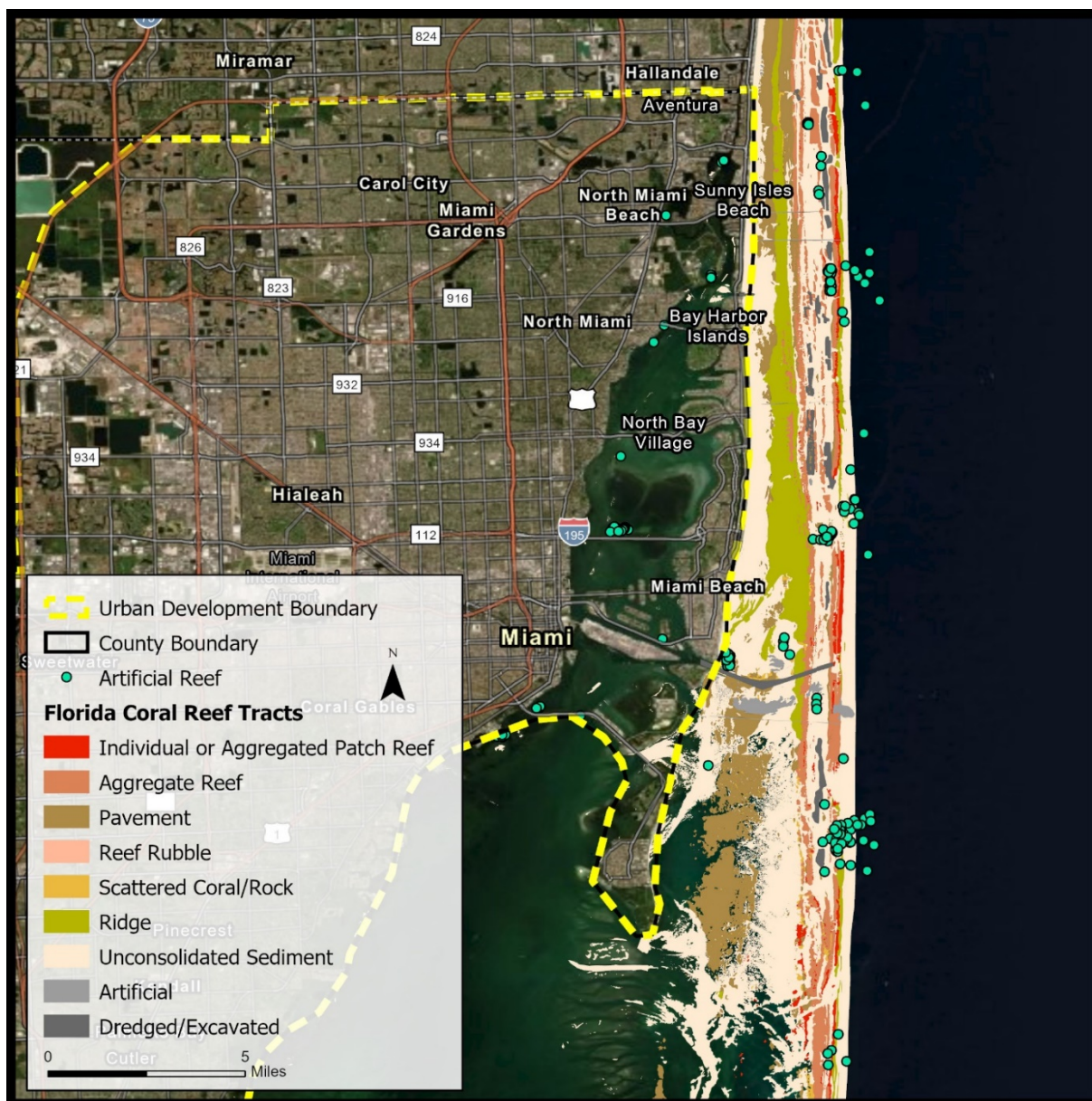


Figure 2-23. Coral Reef Tracts and Location of Artificial Reefs in and Adjacent to Miami-Dade County

Managed Species and Species Groups

Of the species or species groups managed by the SAFMC and NMFS, the following may occur within the project area for at least a portion of their life history:

- Coral Reef, Coral Colony, and Live/Hardbottom Habitats
- Penaeid Shrimp
- Spiny Lobster
- Coastal Migratory Pelagics
- Snapper/Grouper Complex
- Highly Migratory Species

Figure 2-24 displays the coral, spiny lobster, coastal migratory pelagic, and snapper-grouper complex management groups (NOAA Fisheries 2015). Table 2-3 summarizes this data which is provided at the end of the section. The SAFMC's EFH designations apply to all waters from the exclusive economic zone (EEZ) to the landward most influence of the tide (1998).

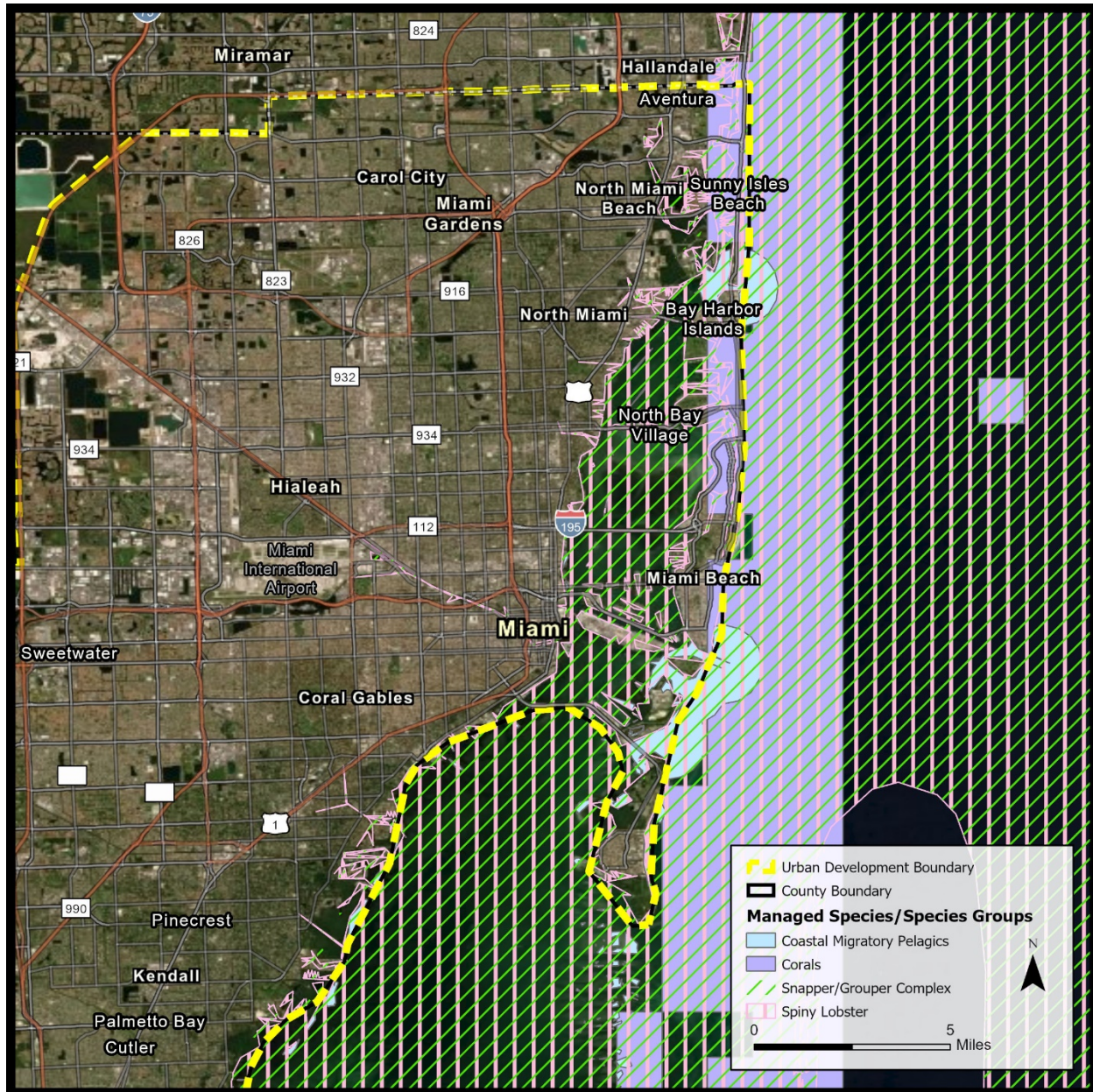


Figure 2-24. Species/Species Groups with Portion of Life History within Project Area

Coral Reef, Coral Colony, and Live/Hardbottom (Groups A & C)

In Biscayne Bay, coral colonies, or clusters of coral polyps, are commonly found on man-made structures such as bulkheads, armor stone/riprap, and other materials modifying the natural aquatic environment. It is important to note that while materials placed by humans are not EFH

under the SAFMC designation, the coral colonies themselves are an HAPC under the snapper/grouper fishery management plan.

Hermatypic Stony Corals. The EFH for hermatypic stony corals includes rough, hard exposed stable substrate in waters ranging between subtidal and depths of 30m, subtropical temperatures ranging from 15-35 C, oligotrophic waters with high salinity (30-35 ppt.), and turbidity levels low enough to provide algal symbionts enough sunlight for photosynthesis (SAFMC 2017).

Octocorals. The EFH for octocorals, excluding the order Pennatulacea (sea pens and sea pansies), consists of rough, hard, expose, stable substrate in subtidal to outer shelf depths within a wide range of salinity and light penetration throughout its management area (SAFMC 2017).

Phragatopoma (worm reefs). The polychaete, *P. lapidosa* contribute to the nearshore hardbottom features in the project area. This species, defined as a foundational or structural species, forms large colonies commonly referred to as worm rock (Kirtley and Tanner 1968).

Penaeid Shrimp

Penaeid shrimp managed by the SAFMC and potentially found in the project area include brown shrimp (*Farfantepenaeus aztecus*), white shrimp (*Litopenaeus setiferus*), and in particular, pink shrimp (*Farfantepenaeus duorarum*). For penaeid shrimp, EFH encompasses a series of habitats used throughout their life history with two basic phases: adult and juvenile benthic phase, and planktonic larval and post-larval phase (SAFMC 1998). Benthic adults aggregate to spawn in shelf waters over coarse, calcareous sediments. Eggs attached to the females' abdomen hatch into planktonic larvae. These larvae and subsequent post-larval shrimp feed on zooplankton in the water column and make their way to inshore, estuarine waters where they settle to the bottom where they begin their lives in the benthos. Young penaeid shrimp prefer shallow-water habitats with nearby sources of organic detritus such as estuarine emergent wetlands, often dominated by the marsh grass *Spartina alterniflora*, or mangrove fringes (SAFMC 1998).

Pink shrimp are the most prevalent penaeid shrimp in Florida's coastal waters, are commonly found in Biscayne Bay as juveniles; they are ecologically important, acting as a food source for wading birds, crocodiles, and game fish.

Biscayne Bay, being a State-designated nursery habitat, meets the criteria for penaeid shrimp EFH-HAPC, as it is an important nursery that allows juvenile shrimp to grow to maturity. It is likely that post larval and juvenile penaeid shrimp may be found in or in the vicinity of the project area.

Spiny Lobster

Essential Fish Habitat for spiny lobster management unit, which includes the Spiny lobster (*Panulirus argus*) and Slipper lobster (*Scyllarides nodifer*) consists of a variety of habitats. These habitats include: nearshore/shelf waters including hardbottom with sponges, coral reefs, crevices, cracks or other structured bottom; seagrass meadows; unconsolidated bottom (soft sediments); algal communities (*Laurencia*); and mangrove prop roots (SAFMC 1998). Spiny

lobster has a complex series of planktonic larvae transported by small scale currents as well as the Gulf Stream, which is EFH-HAPC due to its importance in larvae transport (SAFMC 1998). Adult spiny lobster are frequently found in holes, crevices, and under ledges that provide protection from predators. On occasion, adults migrate, walking in groups or single file along the open seafloor.

Biscayne Bay, being a State-designated nursery habitat, is EFH-HAPC for the spiny lobster. There is potential for all life stages of the spiny lobster management unit to occur in or in the vicinity of the project area.

Coastal Migratory Pelagics

Coastal migratory pelagic species managed by the SAFMC include cobia (*Rachycentron canadum*), Spanish mackerel (*Scombrus maculatus*), and king mackerel (*Scomberomorus cavalla*). The EFH for coastal migratory pelagic fishes includes *Phragmatopoma* reefs (worm reefs), sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters, from the Gulfstream shoreward (including *Sargassum*) (SAFMC 1998).

There is limited potential for all life stages to occur within or adjacent to the project area, as the project occurs largely in the back-bay area of MDC.

Snapper Grouper Complex

The snapper-grouper complex managed by the SAFMC is comprised of 59 species from 10 families, and is predominately composed of tropical, reef fishes (SAFMC 2014). Though the climate in Dade County is subtropical, temperatures, in general, are sufficiently warm enough to support many of the species and life stages that make up the snapper-grouper complex. Habitats vary for the life stages of individuals in the snapper-grouper complex. These habitats include coral and artificial reefs, live/hardbottom, seagrass, and medium to high profile outcroppings on and around the shelf break zone from shore to at least 600 feet (SAFMC 1998). Coral and artificial reef colonies are designated EFH-HAPC for the snapper-grouper complex. The adult habitat for this managed species group is largely offshore of the project area; early life stages rely on habitats such as attached macroalgae, seagrasses, salt marshes, tidal creeks, mangrove fringe, oyster reefs and shell banks, soft sediments, artificial reefs, coral reefs and hard/live bottom (SAFMC 1998).

There is potential for all life stages of varying species in the snapper-grouper complex to be present in or adjacent to the project area.

Biscayne Bay, being a State-designated nursery habitat, meets the criteria for snapper-grouper complex EFH-HAPC, as it is an important nursery that allows young life stages to grow to maturity.

Highly Migratory Species

The east coast of Florida is a diversity hotspot for highly migratory, oceanic predators, which include a variety of sharks, billfishes (Istiophoridae), and tunas (*Thunnus* spp. and *Katsuwonus pelamis*) (Worm et al. 2003). These highly migratory species are managed under the Highly Migratory Species Management Unit, Office of Sustainable Fisheries, NMFS.

Species including the sailfish (*Istiophorus albicans*) and the skipjack tuna may have adult and juvenile life stages occur in the project area. Though predominately pelagic, open-ocean waters, both skipjack tuna and sailfish are known to move inshore to spawn off the east coast of Florida (NOAA Fisheries 2017). Other tuna and billfishes commonly occur further off the coast from the project area.

Coastal sharks, including requiem sharks (*Carcharhinus* spp., *Negaprion brevirostris*, *Galeocerdo cuvier*), hammerheads (*Sphyrna* spp.), nurse shark (*Ginglymostoma cirratum*), and whale sharks (*Rhincodon typus*) occur in various life stages in bays, estuaries, and nearshore shelf waters of east Florida. Some of these species are wide-ranging and loosely associated with a variety of habitats, including soft bottom, hardbottom, and the water column. Others, and in particular, the nurse shark, are closely associated with hardbottom habitats.

Table 2-3. Summary Table of Management Groups with Essential Fish Habitat in the Project Area.

Species / Management Unit	Common Name	Scientific Name	Lifestages Present	Habitats Utilized within Project Area
Highly Migratory Species	Bull shark	<i>Carcharhinus leucas</i>	Juvenile / Adult	Coastal (ocean inlets); Seagrass
	Spinner shark	<i>Carcharhinus brevipinna</i>	Neonate	Coastal
	Caribbean reef shark	<i>Carcharhinus perezi</i>	All	Coastal
	Lemon shark	<i>Negaprion brevirostris</i>	Juvenile / Adult	Coastal; Seagrass
	Sandbar shark	<i>Carcharhinus plumbeus</i>	Adult	Coastal
	Tiger shark	<i>Galeocerdo cuvier</i>	Neonate / Juvenile / Adult	Coastal
	Blacktip shark	<i>Carcharhinus limbatus</i>	Juvenile / Adult	Coastal; Hardbottom (Reef)
	Great hammerhead shark	<i>Sphyrna mokarran</i>	All	Coastal
	Scalloped hammerhead shark	<i>Sphyrna lewini</i>	Juvenile / Adult	Coastal; Mud; Seagrass
	Nurse shark	<i>Ginglymostoma cirratum</i>	Juvenile / Adult	Coastal; Hardbottom; Seagrass
	Whale shark	<i>Rhincodon typus</i>	All	Coastal
	Sailfish	<i>Istiophorus platypterus</i>	Juvenile / Adult	Coastal

Species / Management Unit	Common Name	Scientific Name	Lifestages Present	Habitats Utilized within Project Area
	Skipjack tuna	<i>Katsuwonus pelamis</i>	Adult	Coastal
Coral Reef, Coral Colony, and Live / Hardbottom	Hermatypic Stony Corals (var. spp.)	-	-	Hardbottom
	Octocorals (var. spp.)	-	-	Hardbottom
	Worm Reefs	<i>Phragatopoma lapidosa</i>	-	Hardbottom; Sand (Unconsolidated)
Penaeid Shrimp	Brown Shrimp	<i>Farfantepenaeus aztecus</i>	All	Coastal; Mangrove; Wetland; Seagrass; Unconsolidated; Hardbottom (Reef)
	White Shrimp	<i>Litopenaeus setiferus</i>	All	Coastal; Mangrove; Wetland; Seagrass; Unconsolidated; Hardbottom (Reef)
	Pink Shrimp	<i>Farfantepenaeus duorarum</i>	All	Coastal; Mangrove; Wetland; Seagrass; Unconsolidated; Hardbottom (Reef)
Spiny Lobster	Spiny Lobster	<i>Panulirus argus</i>	All	Hardbottom (Reef); Seagrass; Mangrove; Unconsolidated
	Slipper Lobster	<i>Scyllarides nodifer</i>	All	Hardbottom (Reef); Seagrass; Mangrove; Unconsolidated
Coastal Migratory Pelagics	Cobia	<i>Rachycentron canadum</i>	All	Coastal; Unconsolidated; Hardbottom
	Spanish Mackerel	<i>Scombrus maculatus</i>	All	Coastal; Unconsolidated; Hardbottom
	King Mackerel	<i>Scomberomorus cavalla</i>	All	Coastal; Unconsolidated; Hardbottom
Snapper-grouper Complex	Reef Fishes (var. spp.)	-	-	Coastal; Mangrove; Wetland; Seagrass; Unconsolidated; Hardbottom (Reef)

Fish Resources

The diverse assemblage of fishes found in and adjacent to the ROI is vital to the health of the marine ecosystem, which supports commercial and recreational fishing as well as various ecotourism activities. Recreational fishing, which occurs in multiple habitats in both bay and ocean waters, targets species such as bonefish (*Albula vulpes*), snook (*Centropomus undecimalis*), tarpon (*Megalops atlanticus*), permit (*Trachinotus falcatus*), blue crabs (*Callinectes sapidus*), stone crabs (*Menippe mercenaria*), snappers (Lutjanidae), groupers (Serranidae), grunts (Haemulidae), barracuda (*Sphyraena barracuda*), spadefish (*Chaetodipterus faber*), spiny lobster, and triggerfish (Ballistidae) (National Park Service 2014).

Commercial fishing also occurs in both bay and ocean waters, and targets numerous species including invertebrates (lobster, blue crabs, stone crabs, and bait shrimp), food fish (typically members of the snapper/grouper complex, concentrated on yellowtail snapper (*Ocyurus chrysurus*)), and baitfish (e.g., ballyhoo (*Hemiramphus brasiliensis*), Spanish sardines (*Sardinella aurita*), thread herring (*Opisthonemoa oglinum*), and pilchard (*Harengula jaguana*)) (NPS 2014).

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. Additionally, an introduced species, lionfish (*Pterois volitans*, *Pterois miles*), a predatory fish originally from the Indo-Pacific, has numerous large, venomous spines along many of its fins, leaving it virtually predator-free as an adult in local waters. It grows up to 18 inches in length, and is a generalist predator. It also has a fast reproductive rate, and has become an increasing problem since first spotted in local waters in the early 2000s, as it competes directly with local fish for food and eats local fish also, inhibiting recovery of larger species by eating their juveniles. They are multiplying rapidly in local waters, and there is no take limit for lionfish. They are edible, and human consumption is encouraged.

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.

Commercial Fisheries

Miami-Dade commercial fisheries are of significant value to the economy – not only do fisheries include charter fishing boats, it also includes fishermen that build their livelihood on their catch. The largest and most valuable commercial fisheries are for spiny lobsters, followed by bait shrimp, pink shrimp, and stone crab – depending on the year (Florida Fish and Wildlife Conservation Commission 2017, 2018, 2019). The estimated value of all commercial fisheries from 2017 – 2019 are \$3,775,526 (2017), \$4,543,901 (2018), and \$3,185,224 (2019), indicating a relatively stable industry in terms of estimated annual value (Florida Fish and Wildlife Conservation Commission). Table 2-4 displays the top ten commercial fisheries landings for MDC in 2017, 2018, and 2019 (Florida Fish and Wildlife Conservation Commission 2017, 2018, 2019).

Table 2-4. Top Ten Commercial Fisheries Landings for Miami-Dade County in 2017 - 2019

YEAR	SPECIES	POUNDS	TRIPS	AVERAGE PRICE	ESTIMATED VALUE
2017	LOBSTER, SPINY	169,761	996	\$7.49	\$1,271,190
	SHRIMP, BAIT	273,320	2,074	\$2.84	\$777,433
	SHRIMP, PINK	351,601	280	\$0.98	\$345,307
	BALLYHOO	343,903	138	\$0.76	\$262,061
	SPINY, LOBSTER	24,446	141	\$8.62	\$210,758
	CRAB, STONE, JUMBO CLAWS	9,108	279	\$19.29	\$175,678
	CRAB, STONE, LARGE CLAWS	6,878	298	\$13.36	\$91,881
	CRAB, BLUE (HARD)	30,442	301	\$2.97	\$90,391
	MISC. FOOD FISH	27,266	124	\$3.23	\$87,966
	BAIT FISH	31,119	418	\$2.65	\$82,351
2018	LOBSTER, SPINY	382,007	1,272	\$6.51	\$2,488,350
	SHRIMP, BAIT	138,395	1,492	\$3.00	\$414,933
	SHRIMP, PINK	216,745	243	\$1.07	\$232,400
	CRAB, STONE, JUMBO CLAWS	8,103	346	\$23.90	\$193,688
	CRAB, BLUE (HARD)	83,515	558	\$2.18	\$181,812
	CRAB, STONE, LARGE CLAWS	8,299	370	\$19.75	\$163,913
	BALLYHOO	200,811	102	\$0.81	\$163,475
	BAIT FISH	54,275	525	\$2.08	\$113,030
	CRAB, STONE, MEDIUM CLAWS	6,181	291	\$14.12	\$87,256
	SCAD, BIGEYE (GOGGLE EYE)	4,450	178	\$19.24	\$85,607
2019	LOBSTER, SPINY	197,140	864	\$7.39	\$1,457,073
	CRAB, STONE, JUMBO CLAWS	10,799	284	\$25.44	\$274,683
	SHRIMP, BAIT	79,278	821	\$2.84	\$225,444
	CRAB, STONE, LARGE CLAWS	9,577	302	\$19.36	\$185,435
	BALLYHOO	401,224	91	\$0.42	\$168,220
	BAIT FISH	49,558	476	\$2.70	\$134,008
	SCAD, BIGEYE (GOGGLE EYE)	6,956	181	\$12.75	\$88,687
	CRAB, STONE, UNGRD CLAWS	5,329	75	\$15.53	\$82,768
	CRAB, STONE, MEDIUM CLAWS	5,741	246	\$13.48	\$77,382
	CRAB, BLUE (HARD)	24,170	307	\$2.77	\$67,008

Recreational Fisheries

Many finfish species of significant interest in the recreational fishery, are now considered overfished. Targeted species in the recreational fishery include snappers and groupers, hogfish, tarpon, bonefish, permit, and stone crab.

Snapper and Grouper

Snappers and groupers, managed by the SAFMC, comprise an ecologically important complex of reef fishes with commercial and recreational value in the region. Groupers are a suite of mostly large, predatory fish that typically ambush their prey and swallow it whole, rather than bite it to pieces as a shark does. Some species, i.e. Warsaw groupers (*Epinephelus nigritus*) and Goliath groupers (*E. itajara*), can weigh well over 300 pounds; however, it is rare to find fishes of this size now-a-days due to overfishing. 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.

Snapper include a number of species locally, all from the family Lutjanidae. They are predatory fishes with elongated bodies, sharp canine teeth, and blunt or forked tails. Most species are schooling, unlike groupers which tend to live alone outside the breeding season. There are a number of snapper species in local waters, the red snapper (*Lutjanus campechanus*) is the most popular to fish, and is also the largest, reaching up to 50 pounds.

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. Of the recreationally fished species, 4 out of 5 grouper and 5 out of 6 snapper species are currently overfished. In 2007, one gag grouper was landed for every ~1,566 person-hours of fishing effort in suitable grouper habitat and one black grouper was landed for every ~1044 person-hours of fishing effort in suitable grouper habitat (National Park Service 2014). In 2009, the average size of harvested gag grouper, red grouper, lane snapper, and mutton snapper was each below the species' minimum legal size limit (National Park Service 2014). Both snappers and groupers are typically fished as a food fish, as their meat is edible and highly prized.

Hogfish

An economically important reef fish, hogfish are found in tropical and subtropical waters of the Atlantic Ocean, Gulf of Mexico, and Caribbean. Hogfish rely on reef habitat for protection from predators and for feeding on benthic invertebrates. They are a large species of wrasse, growing up to 3 feet in length and up to 24 lbs. in weight. They have a large, laterally compressed body shape, with an elongated mouth which it uses to dig for prey, typically crustaceans, molluscs, and sea urchins buried in or on the surface of the sand. 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). 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. In 2008, 28.4% of landed hogfish were under the legal

size limit, indicating the population of larger fish is low (National Park Service 2014). Hogfish today are considered overfished and are being managed to recover the population. Hogfish meat is edible and they are typically fished as a food fish.

Tarpon

Biscayne Bay is a popular fishing area for tarpon, a large predatory fish growing up to 8 feet long and a maximum weight of 280 lbs. Tarpon are considered a primitive fish, with a direct lineage that extends over 100 million years in the fossil record. They have large, shiny, silvery scales that cover most of their elongated bodies, and large mouths with a lower jaw that juts out farther than the upper jaw, and forked tails. They are able to survive in a wide range of salinities and are able to tolerate low dissolved oxygen due to their ability to breathe air, which they must do periodically or they will die. These fish are typically fished for sport, as their meat has many small bones, and they are most often released after capture on hook and line.

Bonefish

Bonefish are a relative of the tarpon, and its scales and body shape are somewhat similar, though it is much smaller, growing up to 41 inches in length and 19 lbs. in weight. It has a small jaw, with the upper jaw jutting out past the lower jaw. It feeds on benthic invertebrates, moving into shallow mud and sand flats to feed with incoming tides. There is a popular recreational fly-fishery for the bonefish, and similar to its larger relative the tarpon, their flesh has many small bones in it, and they are most often (now required in Florida waters) released after being caught on hook and line.

Permit

Permit fish are a larger fish, growing up to 4 feet in length and weighing up to 79 lbs., with elongated dorsal and anal fins, and a very laterally compressed body, making the fish seem tall and thin when viewed from the front, very similar in appearance to their smaller relative, the pompano. They are a popular sport fish and actively sought after in Biscayne Bay. They feed on crustaceans and molluscs. Although their flesh is edible, they are more often a catch-and-release fish rather than kept for food.

Stone Crab (Menippe mercenaria)

Stone crabs are a popular recreational and commercial fishery in South Florida waters in the winter, their harvest season runs from October 15 to May 15. Crabbers are encouraged to remove the claws, which contain most of the meat on the crab, and release the live crab back into the water, where it can regenerate lost claws over time.

There are a number of species that are present in Biscayne Bay, but that have not been discussed. See Appendix D for a table showing fishes that occur in the bay.

2.10 BENTHIC RESOURCES

Definition of Resource

Benthos include organisms living near, in, or on the bottom sediments of the various waterbodies included in the present study. This study mostly focuses on the benthos living in Biscayne Bay. Although the area along Biscayne Bay from the Broward County line through the

City of Miami is heavily impacted by adjacent urban development, benthic communities exist and are dominated by seagrasses intermixed with calcareous green algae. Development along Biscayne Bay south of the City of Miami grades from suburban to agricultural to park land where much of the natural mangrove wetlands are still intact along the western shore and eastern barrier islands because they lie within Biscayne National Park. Benthos in Biscayne Bay include highly motile forms such as flounder, spiny lobster, semi-motile forms capable of relocating short distances in response to changes in their environment, such as hard clams and polychaetes, to sessile invertebrates that remain in place all their adult lives, such as oysters. For purposes of this study, most of these communities are estuarine.

The freshwater entering the Bay can result in somewhat lower salinities in Bay waters compared to ocean water outside the Bay. The incoming fresh water is also typically nutrient rich, improving productivity in the Bay, although in modern times excess nutrients present in such waters contribute to negative impacts to the benthic ecosystem as described in the water quality section of this EIS. Due to the shallowness of Biscayne Bay, light can generally penetrate to the bottom, which allows photosynthesis to occur anywhere in the Bay. This encourages a wide variety of benthic habitat types and organisms to be able to live and grow in the Bay.

Methodology

The ROI is the aquatic benthic habitats flanking the County of Miami-Dade. The regulatory framework for these fauna are described under the Fish and Fishery Resources.

Existing Conditions

During the last century, the environs of Biscayne Bay have been greatly affected by anthropogenic alteration through urbanization of the Miami/Dade County area. The sources, timing, delivery, and quality of freshwater flow into the Bay have been changed by construction of a complex canal system that controls movement of water throughout south Florida. Changes in shoreline and sub-aquatic vegetation and marine organisms have been observed and changes in water delivery are believed to be the cause. Current restoration goals are attempting to restore natural flow of fresh water into Biscayne and Florida Bays and to restore the natural fauna and flora. Biscayne Bay and is associated with diatomaceous muds that are rich in organic matter, suggesting high productivity. Most of Biscayne Bay now lies within the protected Biscayne National Park (BISC), running the length of Biscayne Bay from the headwaters of the Oleta River south to Card Sound. Primary benthic habitat types are SAV (seagrasses), corals/hardbottom habitats, and sandy bottom/open-water habitats.

Biscayne Bay can be divided up into three regions, Northern, Central and Southern Biscayne Bay (South Florida Water Management District, 1994). Northern Biscayne Bay is fairly restricted and extends from Dumbfoundling Bay south to, and including the Port of Miami. The major sediment types within the Northern Bay are quartz and clastic sands (Wanless 1976) that support hardbottom and bare-bottom benthic communities (SFWMD, 1994). Salinities at sites sampled ranged from 31.1 to 35.2 parts per thousand (ppt) in the Northern Bay. This region of Biscayne Bay has been impacted profoundly by urbanization and development of both the coastal region and waterways. Major coastal development has increased surface and storm runoff and destroyed the natural coastal vegetation patterns. Freshwater and saltwater budgets to Northern Biscayne Bay have been altered with the construction of canals and inlets,

respectively. Other developed regions in Biscayne Bay's watershed have been similarly modified, which has altered the original sheet flow of fresh water into the Bay to a much more direct, pulsed discharge from canals at specific outfall points where canal waters enter the Bay. These canals were created to drain the region so it could be developed. A typical canal was created by digging into the underlying limestone up to 20 feet deep (Biscayne Bay Aquatic Preserves 2012). In addition to alterations caused by constructing the canal system, considerable dredging has destroyed benthic communities, increased turbidity and changed the morphology of the Bay basin. The natural circulation has been disrupted within Northern Biscayne Bay by the construction of the major causeways, which have restricted flow in and out of this region.

Central Biscayne Bay represents the transition zone between the heavily impacted Northern Biscayne Bay and Southern Biscayne Bay, and includes the northern portion of Biscayne National Park. Four primary benthic communities, bare bottom, hardbottom, seagrass with a hardbottom matrix and seagrass communities (SFWMD, 1994), occur in the Central Bay. These are supported on substrates including calcareous and quartz sands, calcareous mud, and organic-rich muds. Salinities at sites sampled within Central Bay ranged from 32.0 to 37.4 ppt. in the open bay and 29.5 ppt at the discharge of Snapper Creek Canal. The northern part of Central Biscayne Bay is strongly influenced by the Miami River, which accounts for the high turbidity, high nutrient, and high pollutant levels in this region of the Central Bay. Further south, Snapper Creek, Coral Gables Waterway and Cutler Drain have been identified as pollutant point sources. However, flushing of these regions occurs on a regular basis due to Government and Norris Cuts. The southern part of Central Bay is increasingly pristine and includes Biscayne National Park. Significant impacts to the ecosystem in this region are localized, many related to watercraft use such as sewage and solid waste, fuel leakage and spillage, and propeller scouring of seagrass beds.

Southern Biscayne Bay includes the southern portion of Biscayne National Park and the northern part of the Florida Keys National Marine Sanctuary (Barnes and Card Sounds). Sediments in Southern Bay include non-tidal mud banks, calcareous mud, and sands (Wanless, 1976), and support seagrass and seagrass with hardbottom matrix communities (SFWMD, 1994). Salinities at sites sampled ranged from between 38.5 and 37.3 ppt. north of Card Sound, to as low as 22.2 ppt. in Barnes Sound. Although not as severely affected by urbanization as the Northern and Central Bay, Southern Biscayne Bay is impacted by channelized fresh water input and nutrient enrichment from the canal systems. In addition, Card and Barnes Sounds are very restricted, thus reducing their flushing cycles. Other factors that influence the ecosystem of Southern Biscayne Bay are pollutants from adjacent landfills and propeller scour in shallow regions.

An additional consideration with respect to the Biscayne Bay ecosystem is the impact of ground water. Ground water seepage at the coastal margins and from subsurface springs has been noted historically (Kohout and Kolipinski, 1967). This acts as an additional source of fresh water, but also may provide an additional source of contaminants by pollutant enriched ground water.

Increased nutrient availability will result in increased frequency, severity, duration, and spatial extent of algal blooms. Algal blooms can adversely affect other water quality parameters, such

as light penetration and dissolved oxygen regimes, which subsequently affect the bay biota with cascading effects through the ecological web.

Open areas of Biscayne Bay generally exhibit nutrient concentrations from 0.001–0.015 milligrams per liter (mg/L) of total phosphorus (TP) and 0.04–1.07 mg/L of total nitrogen (TN). In December 2012, the State of Florida established numeric nutrient criteria for TP, TN, and chlorophyll-a (Chla; used as an indicator for overall water quality conditions). Nine indicator regions were defined throughout the bay. Criteria were established for each region based on the specific conditions and natural variation within each region.

This benthic fauna section will focus on describing the main habitats of importance, which are seagrass beds, (native spp.) macroalgal beds, sponge beds, and hardbottom, which includes reef (octocoral, mollusk, and coral). Unconsolidated sediments (sand) is also present, but although it is productive, it is not nearly as productive as the three other habitat types.

Submerged aquatic vegetation (SAV), or seagrass, is one of the main benthic habitat types in Biscayne Bay. Miami-Dade County is unique in being one of a handful of counties that are home to all seven species of seagrasses found in the state of Florida. These seven species are: *Thalassia testudinum* (Turtle grass), *Syringodium filiforme* (Manatee grass), *Halodule wrightii* (Shoal grass), *Halophila decipiens* (Paddle grass), *Halophila johnsonii* (Johnson's seagrass), *Halophila enge/mannii* (Star grass), and *Ruppia maritima* (Widgeon grass). Johnson's seagrass was the first marine plant to be listed under the Endangered Species act in 1998 as Threatened. It is only found in embayments along approximately 200 km along the southeastern Florida coast. During the past five years, the three most abundant species of seagrass have been remarkably stable in Southern Biscayne Bay, except for two areas that were impacted by phytoplankton blooms (Card Sound to Manatee Bay) or macroalgal (*Anadyomene* spp.) blooms (central Biscayne Bay). Such blooms are becoming more frequent over time in Biscayne Bay, especially since 2005. Where blooms occur they compete for light with SAV, shading it, and lowering water quality (Santos et al. 2020) and can cause significant mortality of SAV.

Halodule wrightii and *Syringodium filiforme* abundance in southern Biscayne Bay is normally less than 25% where found; however, due to their limited distribution, their overall coverage is < 5%. *Thalassia testudinum* is the obvious dominant seagrass in this region. The variation in *T. testudinum* abundance noted in the last five years, outside of areas impacted by algal blooms, has been slight and is consistent with levels of variability noted in the past. However, two disturbance events—a phytoplankton bloom in 2005–2008 and a macroalgal bloom from 2006 to present—had significant negative impacts on seagrass and the associated benthic communities, including hardbottom communities. This bloom was primarily of a macroalgae, *Anadyomene* spp., where the macroalgae bloomed, *Thalassia* declined precipitously (Santos et al. 2020). There is concern (Millette et al. 2019) that Biscayne Bay could be headed towards a regime shift from a benthic (SAV) to pelagic (phytoplankton) dominated system. The County has recently (2019) conducted a study on the current status of SAV in Biscayne Bay, and found significant declines in many areas of the Bay. “The Julia Tuttle basin had reduced seagrass habitat by 77 percent and 79th Street Basin by 89.6 percent. Barnes Sound and Manatee Bay basins have had a decrease of 93 percent. Areas near Coral Gables experienced a decrease of about 85 percent. Areas north of the Rickenbacker Causeway decreased about 66-89 percent (Miami-Dade County 2019).” Figure 2-25. (Miami-Dade County 2019) illustrates the recent

losses of SAV benthic habitat in Biscayne Bay, of interest is the fact that these areas are concentrated near canal and areas where bacteria are known to exceed health standards.

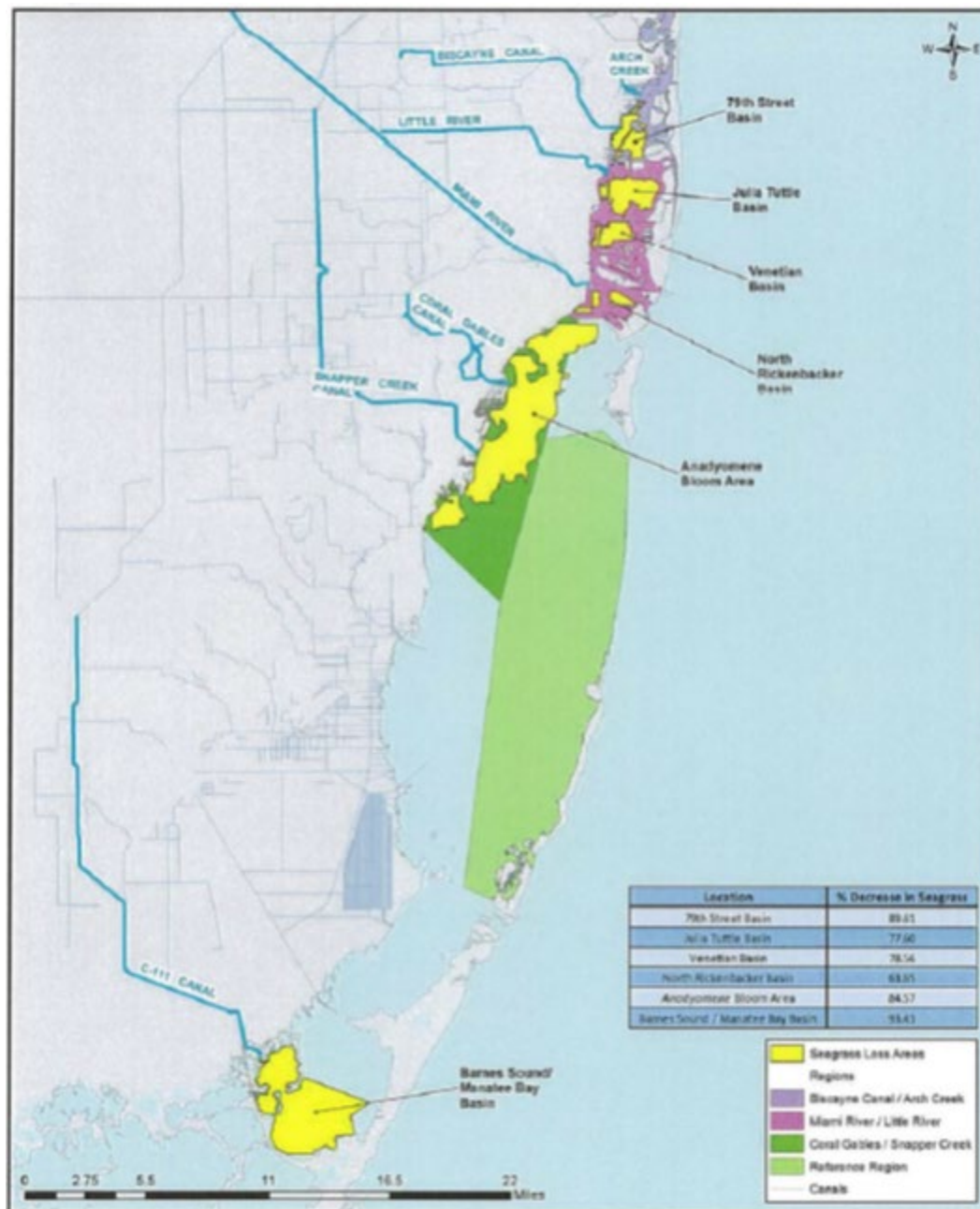


Figure 2-25. Submerged Aquatic Vegetation Loss Areas in Biscayne Bay

Seagrass beds are very extensive and found throughout Biscayne Bay, covering more acres than other benthic habitat type. Native species of macroalgae often colonize areas where seagrass is not found. They can also be found growing on hard bottom habitat, though typically not to the extent where it smothers the hardbottom, as there are numerous herbivores that prey on it, such as sea urchins. They typically do not grow at densities that negatively impact other

habitat types, as species responsible for macroalgal blooms and phytoplankton blooms do under eutrophic conditions.

Table 2-5. Common Macroalgal Species Found in Biscayne Bay

Common Native Macroalgal Species in Biscayne Bay			
<i>Acanthophora spicifera</i>	<i>Caulerpa prolifera</i>	<i>Laurencia gemmifera</i>	<i>Sargassum fluitans</i>
<i>Acetabularia calyculus</i>	<i>Caulerpa racemosa</i>	<i>Laurencia intricata</i>	<i>Sargassum natans</i>
<i>Acetabularia crenulata</i>	<i>Caulerpa sertularioides</i>	<i>Laurencia poitei</i>	<i>Sargassum pteropleuron</i>
<i>Acetabularia schenckii</i>	<i>Chondria baileyana</i>	<i>Lobophora variegata</i>	<i>Spyridia filamentosa</i>
<i>Amphiroa compressa</i>	<i>Cladosiphon occidentalis</i>	<i>Neogoniolithon spectabile</i>	<i>Stypopodium zonale</i>
<i>Anadyomene stellata</i>	<i>Digenea simplex</i>	<i>Neomeris annulata</i>	<i>Udotea conglutinata</i>
<i>Batophora occidentalis</i>	<i>Halimeda copiosa</i>	<i>Penicillus capitatus</i>	<i>Udotea dixonii</i>
<i>Batophora oerstedii</i>	<i>Halimeda goreau</i>	<i>Penicillus dumetosus</i>	<i>Udotea flabellum</i>
<i>Caulerpa lanuginosa</i>	<i>Halimeda incrassata</i>	<i>Penicillus pyriformis</i>	<i>Ventricaria ventricosa</i>
<i>Caulerpa mexicana</i>	<i>Halimeda monile</i>	<i>Porolithon pachydermum</i>	<i>Wrangelia penicillata</i>
<i>Caulerpa paspaloides</i>	<i>Halimeda tuna</i>	<i>Rhipocephalus phoenix</i>	

Hardbottom communities consist of a variety of marine organisms, mostly sessile, that can deposit calcium carbonate as a protective feature. There are several marine macroalgal species capable of this, as well as coralline algae, corals themselves, and shell-producing sessile invertebrates from barnacles to oysters and other mollusks. While hardbottom often has corals present, such habitat is not necessarily a coral reef. Two species of coral are most common in Biscayne Bay, *Siderastrea radians* and *Porites furcata*, along with less common to listed species such as Boulder star coral, *Montastraea annularis*. Federally listed species of coral, as well as all other such species found in local waters, will be addressed in the Species of Special Concern section of this EIS. In addition to these species, hardbottom habitat provides refuge for a wide suite of species, from fish such as grouper, spiny lobsters, octopus, crabs, and many more. A table providing the list of marine species found in local waters, many of which require or prefer hardbottom habitat is available in Appendix D. Sponges are often found associated with hard bottom habitat. A large-scale commercial fishery once existed in the project area, and

other areas of Florida. Until the 1940s it was the most valuable commercial fishery in Florida. Diseases, overfishing, and more recently algal blooms have been sources of sponge mortality in Biscayne Bay and throughout their range in Florida. Biscayne Bay was closed to commercial sponge fishing in 1991. The densest sponge communities today can be found in a north-south cluster in Central Bay (NOAA 2000).

Surveys of the area typically have not had high enough resolution to differentiate between different types of hardbottom habitat. Based on the site visit conducted in January 2020, hard bottom habitat occurs in the Biscayne Bay in the ROI. Figure 2-28 provides results of a previous survey evidencing the presence of hardbottom habitat in the Biscayne Bay

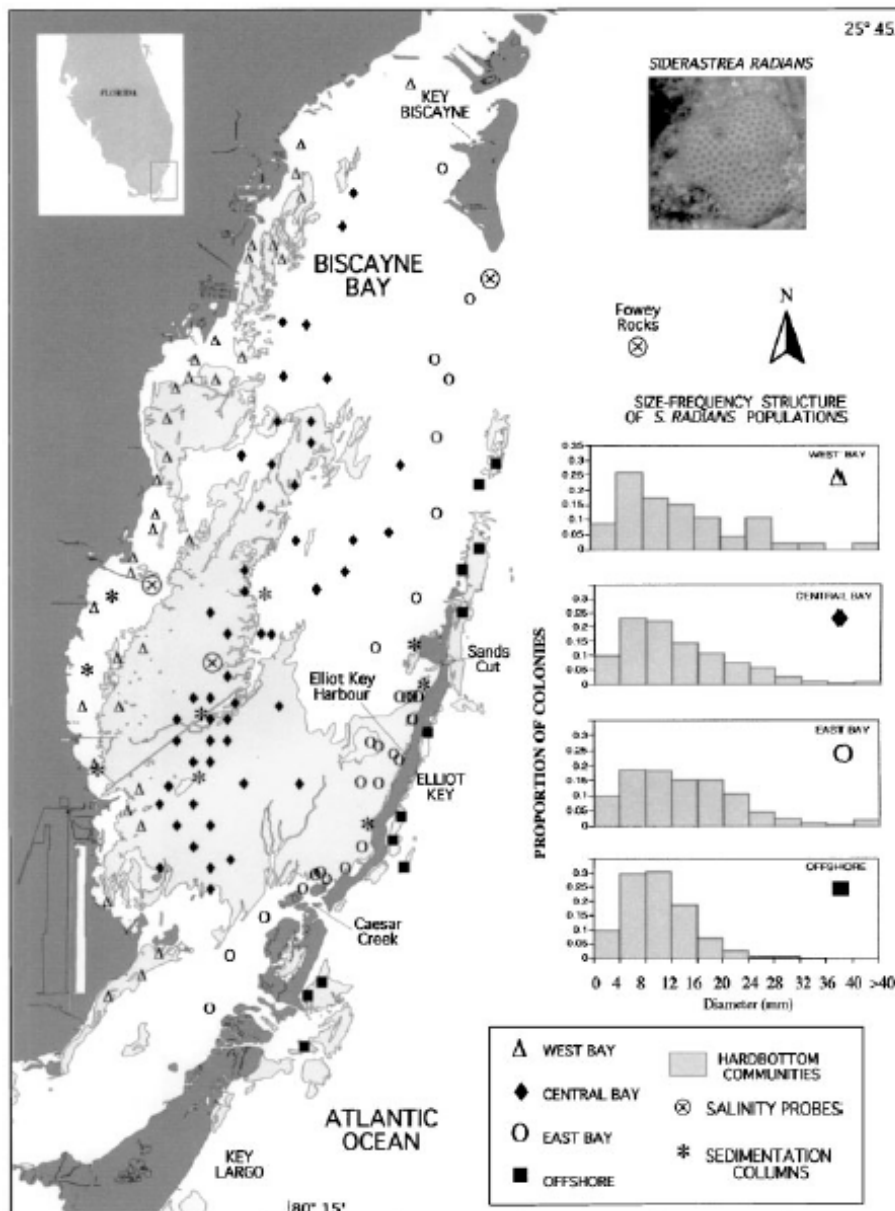


Figure 2-26. Survey of Biscayne Bay Showing All Hardbottom Habitat

2.11 SPECIAL STATUS SPECIES

Definition of Resource

Federally Listed Species and Critical Habitat

In reference to the Endangered Species Act of 1973 (ESA), as amended, “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 U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) have sufficient information on their biological status and threats to propose them as endangered or threatened. “Critical habitat” is designated per 50 Code of Federal Regulation (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.

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 Nonessential 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.

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). In the Region of Influence (ROI) for this project, only cetaceans and sirenians would be anticipated to occur in the Action Area.

Migratory Birds

Migratory birds are defined as those described by the USFWS in the 50 CFR 10.13 and consist of species that belong to a family or group of species in the U.S. as well as Canada, Japan, Mexico, or Russia. Most birds native (naturally occurring in the U.S.) to the U.S. belong to a protect family and are protected by the Migratory Bird Treaty Act.

A species qualifies for protection under the Migratory Bird Treaty Act if it meets one or more of the following four criteria as designated in the Act (directly quoted from USFWS n.d):

- (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 U.S. 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.

Methodology

The ROI (or Action Area per 50 Code of Federal Regulation (CFR) 402.02 with respect to special status 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 are 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 state and federally and state 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 provided by the USFWS on February 18, 2020 (provided in Appendix D);
- Official Species List correspondence provided by the NMFS on February 18, 2020 (provided in Appendix D);
- Information, Planning, and Conservation (IPaC) Database and associated Resource List (U.S. Fish and Wildlife Service (USFWS) 2020);
- 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).

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.

Framework

Federally Listed Species and Critical Habitat

Animals and plants listed as endangered or threatened are protected under the Endangered Species Act of 1973, as amended (ESA). 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.

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 Nonessential Experimental population species as stipulated in the Florida Administrative Rule 68A-27.003. Species listed by the FWC are included on the Florida Endangered and Threatened Species List as State designated Threatened species and are those species listed as designated in the Florida Administrative Rule 68A-27.003.

Marine Mammals

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. (NMFS 2016). All marine mammals in the U.S. are afforded protection under the MMPA.

The term "take" per the Marine Mammal Protection Act 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:

- Can 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.

Migratory Birds

The Migratory Bird Treaty Act (MBTA) and Executive Order (EO) 13186 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. (USFWS IPaC, August 2017). The American Bald and Golden Eagle Act of 1972 is a federal law that serves to protect gold (*Aquila chrysaetos*) and bald eagles. 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.

Existing Conditions

Federally Listed Species and Critical Habitat

Table 2-6 provides the federally listed species that have the potential to occur in the ROI and also designated critical habitats. In the ROI, West Indian manatee and Johnson's seagrass critical habitats are found in aquatic portions of the ROI as shown in Figures 2-30 and 2-31.

Table 2-6. Federally Listed Species with the Potential to Occur in the Region of Influence and Designated Critical Habitat

Taxonomic Category / Common Name	Scientific Name	Status	Critical Habitat
Birds			
Piping plover [^]	<i>Charadrius melodus</i>	T	Y*
Red knot [^]	<i>Calidris canatus rufa</i>	T	N
Fish			
Nassau grouper	<i>Epinephelus striatus</i>	T	N
Smalltooth sawfish	<i>Pristis pectinata</i>	E	Y*
Invertebrates			
Boulder star coral	<i>Montastraea annularis</i>	T	N
Elkhorn coral	<i>Acropora palmata</i>	T	Y*
Lobed star coral	<i>Orbicella annularis</i>	T	N
Mountainous star coral	<i>Orbicella faveolata</i>	T	N
Pillar coral	<i>Dendrogyra cylindricus</i>	T	N
Rough cactus coral	<i>Mycetophyllia ferox</i>	T	N
Staghorn coral	<i>Acropora cervicornis</i>	T	Y*
Mammals			
Florida bonneted bat	<i>Eumops floridanus</i>	E	N
West Indian manatee [^]	<i>Trichechus manatus</i>	T	Y
Reptiles			

Taxonomic Category / Common Name	Scientific Name	Status	Critical Habitat
American crocodile [^]	<i>Crocodylus acutus</i>	E	Y*
Green sea turtle (North and South Atlantic DPS)	<i>Chelonia mydas</i>	T	Y*
Hawksbill sea turtle	<i>Eretmochelys imbricata</i>	E	Y*
Kemp's ridley sea turtle	<i>Lepidochelys kempii</i>	E	N
Leatherback sea turtle	<i>Dermochelys coriacea</i>	E	Y*
Loggerhead sea turtle (Northwest Atlantic Ocean DPS)	<i>Caretta</i>	T	Y*
Vegetation and Seagrass			
Johnson's seagrass	<i>Halophila johnsonii</i>	T	Y
DPS = Distinct Population Segment; E = Endangered; T = Threatened; Y = Yes; N = No; Species classification is reported as it pertains to the DPS/Action Area; *Critical Habitat designated but is not located in the Region of Influence/Action Area; [^] Species under the jurisdiction of the U.S. Fish and Wildlife Service; remaining species are under the jurisdiction of the National Marine Fisheries Service			

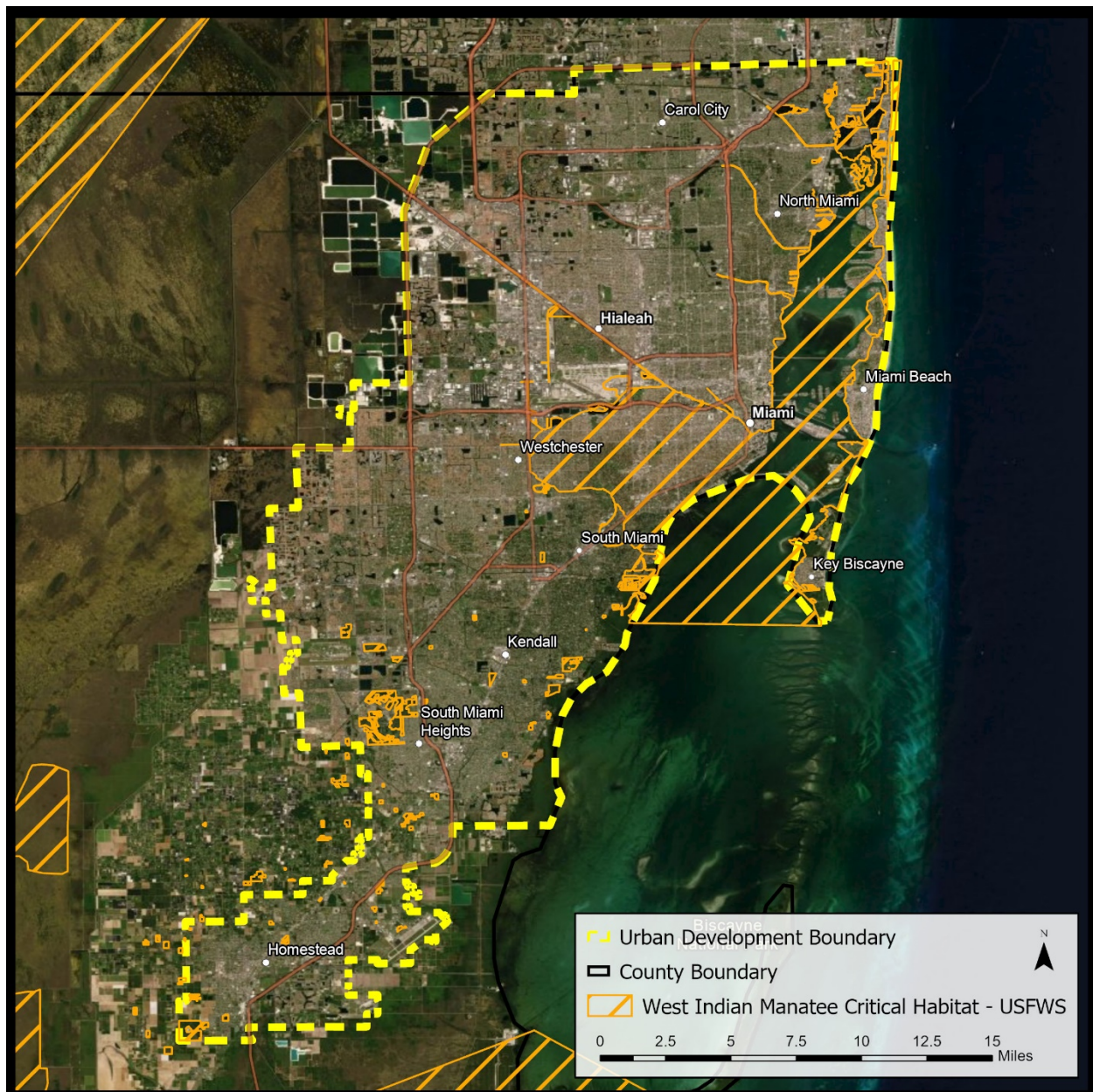


Figure 2-27. West Indian Manatee Critical Habitat in the Region of Influence

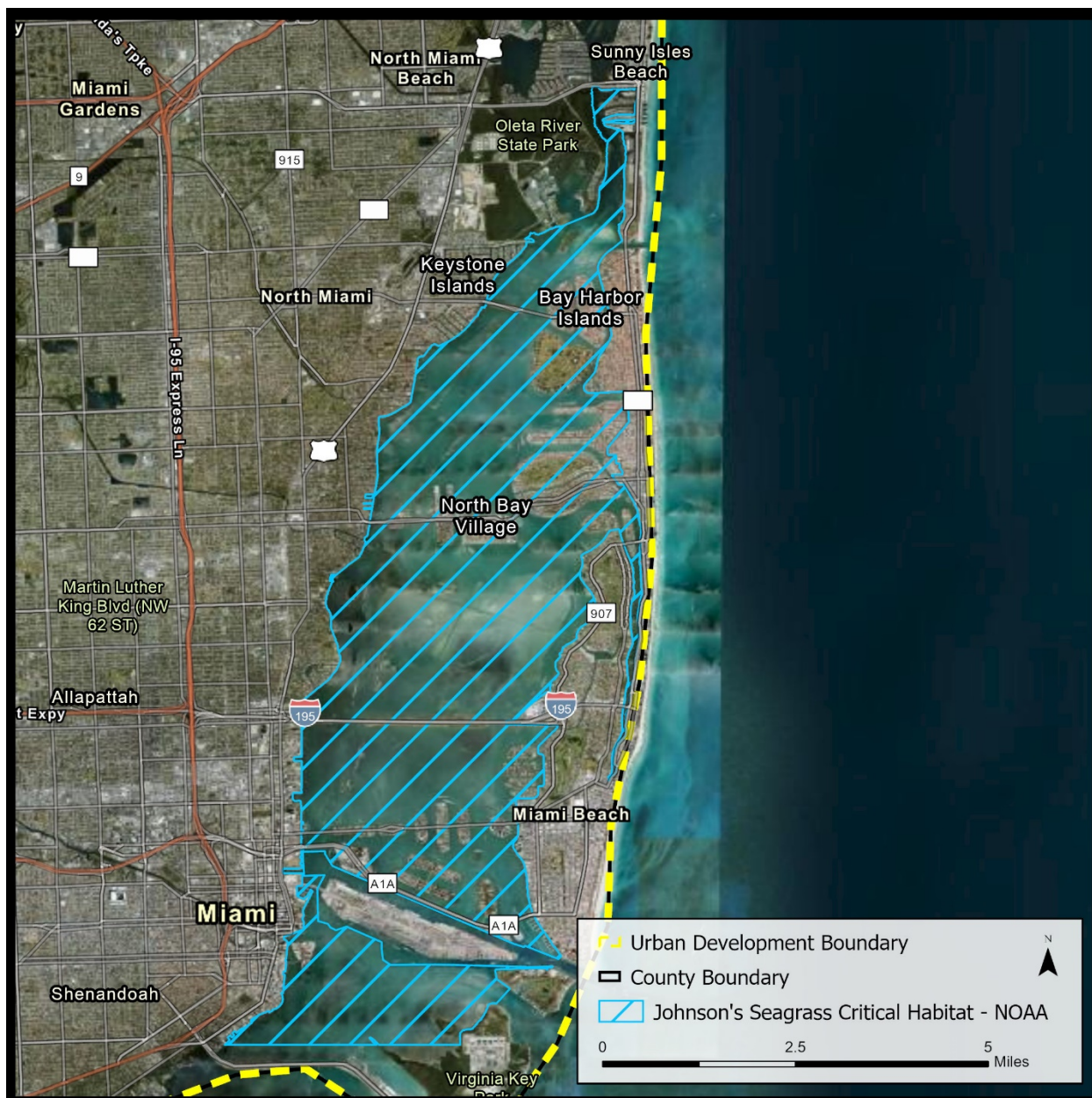


Figure 2-28. Johnson's Seagrass Critical Habitat in the Region of Influence

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 2-6 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 besides those already described in Table 2-6. State listed species with the potential to occur in the ROI are provided in Table 2-7.

Table 2-7. Additional State Listed Species with the Potential to Occur in the Region of Influence

Taxonomic Category/Common Name	Scientific Name	Status
Birds		
American oystercatcher	<i>Haematopus palliatus</i>	Threatened
Black skimmer	<i>Rynchops niger</i>	Threatened
Least tern	<i>Sterna antillarum</i>	Threatened
Limpkin	<i>Aramus guarauna</i>	Threatened
Reddish egret	<i>Egretta rufescens</i>	Threatened
White-crowned pigeon	<i>Patagioenas leucocephala</i>	Threatened
Mammal		
Everglades mink	<i>Mustela vison evergladensis</i>	Threatened

Marine Mammals

In addition to the federally listed marine mammals described in Table 2-6, 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 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 2-8 (USFWS 2020).

Table 2-8. Migratory Birds with the Potential to Occur in the Region of Influence

Common Name	Scientific Name	Common Name	Scientific Name
American kestrel	<i>Falco sparverius paulus</i>	Pomarine jaeger	<i>Stercorarius pomarinus</i>
American oystercatcher	<i>Haematopus palliatus</i>	Prairie warbler	<i>Dendroica discolor</i>
Bald eagle	<i>Haliaeetus leucocephalus</i>	Prothonotary warbler	<i>Protonotaria citrea</i>
Black scoter	<i>Melanitta nigra</i>	Razorbill	<i>Alca torda</i>
Black skimmer	<i>Rynchops niger</i>	Red-breasted merganser	<i>Mergus serrator</i>
Black-whiskered vireo	<i>Vireo altiloquus</i>	Red-headed woodpecker	<i>Melanerpes erythrocephalus</i>
Bonaparte's gull	<i>Chroicocephalus philadelphia</i>	Red-necked phalarope	<i>Phalaropus lobatus</i>
Brown pelican	<i>Pelecanus occidentalis</i>	Reddish egret	<i>Egretta rufescens</i>
Common eider	<i>Somateria mollissima</i>	Ring-billed gull	<i>Larus delawarensis</i>
Common ground-dove	<i>Columbina passerina exigua</i>	Roseate tern	<i>Sterna dougallii</i>
Common loon	<i>Gavia immer</i>	Royal tern	<i>Thalasseus maximus</i>
Common tern	<i>Sterna hirundo</i>	Ruddy turnstone	<i>Arenaria interpres morinella</i>
Double-crested cormorant	<i>Phalacrocorax auritus</i>	Semipalmated sandpiper	<i>Calidris pusilla</i>
Dunlin	<i>Calidris alpina arctica</i>	Short-billed sowitcher	<i>Limnodromus griseus</i>
Great black-backed gull	<i>Larus marinus</i>	Short-tailed hawk	<i>Buteo brachyurus</i>
Great shearwater	<i>Puffinus gravis</i>	Smooth-billed ani	<i>Crotophaga ani</i>
Herring gull	<i>Larus argentatus</i>	Sooty tern	<i>Onychoprion fuscatus</i>
Kirtland's warbler	<i>Setophaga kirtlandii</i>	Swallow-tailed kite	<i>Elanoides forficatus</i>
Least Tern	<i>Sterna antillarum</i>	Whimbrel	<i>Numenius phaeopus</i>

Common Name	Scientific Name	Common Name	Scientific Name
Lesser yellowlegs	<i>Tringa flavipes</i>	White-crowned pigeon	<i>Patagioenas leucocephala</i>
Limpkin	<i>Aramus guarauna</i>	White-winged scoter	<i>Melanitta fusca</i>
Magnificent frigatebird	<i>Fregata magnicens</i>	Willet	<i>Tringa semipalmata</i>
Mangrove cuckoo	<i>Coccyzus minor</i>	Wilson's plover	<i>Charadrius wilsonia</i>
Northern gannet	<i>Morus bassanus</i>	Wilson's storm-petrel	<i>Oceanites oceanicus</i>
Parasitic jaeger	<i>Stercorarius parasiticus</i>	Yellow warbler	<i>Dendroica petechia gundlachi</i>

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 Migratory Bird Treaty Act. 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 2017-2016), there are no known bald eagle nesting territories in the ROI. The closest reported bald eagle nesting territories are located more than a mile away from the ROI shown in Figure 2-30 (FWC 2016-2017).

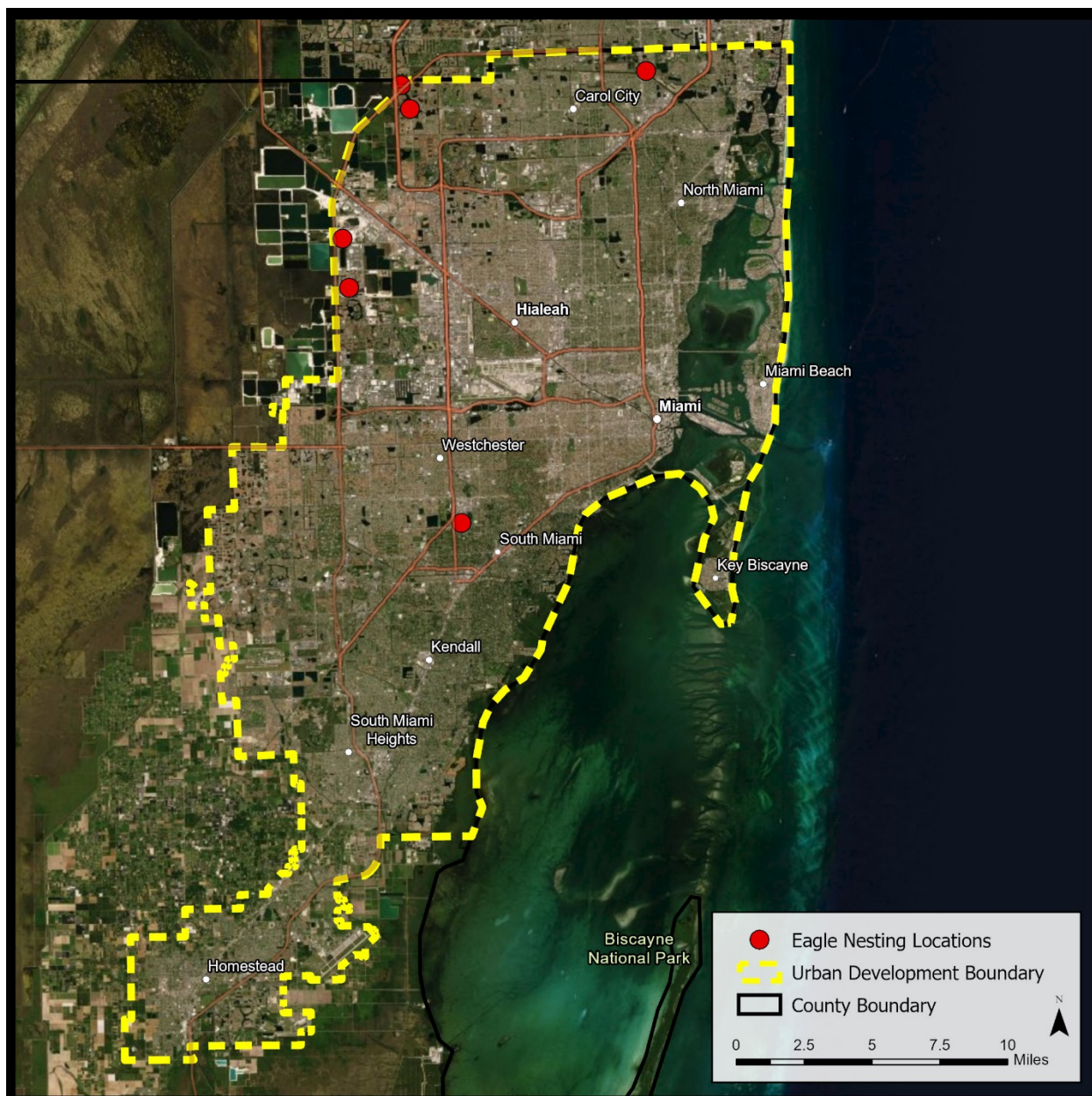


Figure 2-29. Bald Eagle Nesting Locations

2.12 CULTURAL RESOURCES

Definition of Resource

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: A) that are associated with events that have made a significant contribution to the broad patterns of history; or B) that are associated with the lives or persons significant in our past; or C) 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 D) that have yielded, or may be likely to yield, information important in prehistory or history” (36 CFR § 60.4).

NEPA regulations at 40 CFR § 1508.8, definition of effects, are basically the same as those for NHPA at 36 CFR PART 800, but do not refer to 36 CFR § 60.4.

Methodology

Information for this section was taken from the State Historic Preservation Office data base (Florida Department of Historic Resources 2018) and publications cited.

Framework

Laws, regulations, Executive Orders (EOs), and policies that protect and preserve historic resources under the jurisdiction of federal agencies are provided below:

- 16 USC 461-467 Historic Sites Act of 1935, and Implementing Regulations
- 36 CFR § 65 National Historic Landmarks Program
- Public Law 89-665 National Historic Preservation Act of 1966
- 36 CFR § 60 National Register of Historic Places
- 36 CFR § 67 The Secretary of the Interior’s Standards for Rehabilitation
- 36 CFR § 68 The Secretary of the Interior’s Standards for Preservation Projects

- 36 CFR § 79 Curation of Federally Owned Archaeological Resources
- 36 CFR § 800 Protection of Historic and Cultural Properties
- Public Law 91-190 National Environmental Policy Act of 1969
- Public Law 96-95 Archaeological Resources Protection Act of 1979
- 32 CFR § 229 Protection of Archaeological Resources
- 43 CFR §7 Protection of Archaeological Resources, Uniform Regulations
- Subparts A and B and Department of the Interior Supplemental Regulations

- Public Law 101-601 Native American Graves Protection and Repatriation Act of 1990

- 43 CFR §10 Native American Graves Protection and Repatriation Regulations
- 16 USC 469c-2 Archaeological and Historic Preservation Act of 1974
- 42 USC 1996-1996a American Indian Religious Freedom Act of 1978
- EO 11593 (1971) Protection and Enhancement of the Cultural Environment
- EO 13007 (1996) Indian Sacred Sites – May 24, 1996
- EO 13175 (1998) Consultation and Coordination with Indian Tribal Governments

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 Wendover 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.

There are two federally recognized tribes (Miccosukee Tribe of Indians of Florida (Miccosukee Tribe) and the Seminole Tribe of Florida (STOF)) that are located within and adjacent to the project area (Figure 3 6). Both tribes maintain a strong connection to the project area through continued use and regard the indigenous populations of Florida as their ancestors. The project area includes a large segment of the Miccosukee Tribe's Alligator Alley Reservation which spans portions of WCA 3A, the Tamiami Trail Reservation Area which consists of three parcels of land used for commercial services, and the Miccosukee Reserved Area which is the center of the Miccosukee Indian population. In addition, both tribes have leases and easements within WCA 3A and have historically recognized rights within ENP that stems from the Native Americans who lived within the ENP boundary prior to the Park's creation.

The Miccosukee Tribe and the STOF have a long history of living within the project area. Both tribes moved into the region during the eighteenth and nineteenth centuries from Georgia and Alabama. Fleeing the U.S. Army and the forced relocation policies of the Indian Removal Act (1830), the Miccosukee and Seminoles were part of Native American groups commonly referred to as Seminoles; however, there are references to some of the groups involved in the conflict as Mikasuki, which supports the subsequent separation of the two groups (Weisman 1999). Many of these groups fled into the swamp areas of south Florida and made their homes within the Everglades and other remote areas of region. The coming of the Civil War led to the abandonment of the removal efforts and the various Native American groups were largely left alone until the late nineteenth century. In 1928 the Tamiami Trail opened, cutting through the Everglades and bringing along with it tourists and explorers into the region, and, for the first time, bringing complete access for the various tribes to participate in the larger economy that was growing in south Florida.

As early as 1894, the Federal governmental and later the State of Florida started to acquire lands within the Big Cypress area. However, initial attempts to relocate tribal members to these areas failed as there were simply no incentives to abandon traditionally occupied areas in favor of the new lands (Weisman 1999). “The Indian New Deal changed that, and for the first time, services, programs, and land were brought together...at Big Cypress” (Weisman 1999:125). In the 1930s, the Federal Government started to bring services to the various Seminole groups. Some of the groups relocated and started to receive Federal aid, while some groups resisted government intrusion into their lives and remained in various traditional areas that now included sites along Tamiami Trail (Weisman 1999). Throughout the next two decades the Federal Government instituted various aid programs to assist the Native American groups living within the reservations until the early 1950s. In the early 1950s, the Federal Government’s policies radically changed, as it was felt that native groups should now join “mainstream society” and that Federal aid should come to an end (Weisman 1999:131). Being faced with a reduction in support and possible termination of recognition as a group by the government, various Native American groups on these reservations began to organize and form their own tribal governments to assist in the protection of their interests. In 1957, the STOF received Federal recognition. However, wishing to remain separate and to maintain their own identity, many of the groups along the Tamiami Trail refused to join and instead held out to form their own government that would be federally recognized in 1962 as the Miccosukee Tribe of Indians of Florida.

Today most of the Miccosukee Tribe lives within the confines of the reservation located along the forty mile bend of Tamiami Trail, while many of the STOF live on various reservations properties with the largest being those of Big Cypress, Hollywood, and Brighton Reservations. In addition to the Federal reservation, the Miccosukee Tribe has also established a perpetual lease to large portions of the WCA 3A area while the STOF has a lease within the northwestern portion of WCA 3A.

Members of both groups maintain a traditional life style that is intricately connected to the Everglades. Traditional practices of hunting, fishing, and general living are still maintained, along with modern entrepreneurship through various enterprises such as cattle ranching and with tourism related businesses along Tamiami Trail. Today, both tribes have vibrant, thriving

cultures based within the Everglades region. These practices continue to tie the Tribes to the Everglades in such a way that careful consideration of effects is warranted.

After European contact, Native American populations in the region continuously declined and remained at low levels until Miccosukee and Seminole tribal groups moved into the area while fleeing the U.S. Army and U.S. Governments' forced relocation program. Many sites associated with both the Miccosukee and Seminole tribes are known to exist throughout the region (see Native American section for more background).

The broad region of ENP and WCA 3 has been subject to numerous cultural resource investigations and has been found to contain a wide variety of cultural resources that vary within their significance. There are archaeological resources associated with some of the earliest habitation sequences within south Florida and relatively recent sites directly associated with modern Native American tribes who were removed from ENP shortly after its creation.

Juan Ponce de León was the first European to visit the area in 1513 by sailing into Biscayne Bay. His journal records he reached Chequescha, a variant of Tequesta, which was Miami's first recorded name.] It is unknown whether he came ashore or made contact with the natives. Pedro Menéndez de Avilés and his men made the first recorded landing when they visited the Tequesta settlement in 1566 while looking for Avilés' missing son, shipwrecked a year earlier. Spanish soldiers led by Father Francisco Villarreal built a Jesuit mission at the mouth of the Miami River a year later but it was short-lived. After the Spaniards left, the Tequesta Indians were left to fend themselves from European-introduced diseases like smallpox. By 1711, the Tequesta sent a couple of local chiefs to Havana, Cuba, to ask if they could migrate there. The Cubans sent two ships to help them, but Spanish illnesses struck and most of the Tequesta died.

The first permanent European settlers arrived in the early 19th century. People came from the Bahamas to South Florida and the Keys to hunt for treasure from the ships that ran aground on the treacherous Great Florida Reef. Some accepted Spanish land offers along the Miami River. At about the same time, the Seminole Indians arrived, along with a group of runaway slaves. The area was affected by the Second Seminole War, during which Major William S. Harney led several raids against the Indians. Most non-Indian residents were soldiers stationed at Fort Dallas. It was the most devastating Indian war in American history, causing almost a total loss of population in Miami.

After the Second Seminole War ended in 1842, William English re-established a plantation started by his uncle on the Miami River. He charted the "Village of Miami" on the south bank of the Miami River and sold several plots of land. In 1844, Miami became the county seat, and six years later a census reported there were ninety-six residents in the area. The Third Seminole War was not as destructive as the second, but it slowed the settlement of southeast Florida. At the end of the war, a few of the soldiers stayed.

Dade County was created on January 18, 1836, under the Territorial Act of the United States. The county was named after Major Francis L. Dade, a soldier killed in 1835 in the Second Seminole War, at what has since been named the Dade Battlefield. At the time of its creation, Dade County included the land that now contains Palm Beach and Broward counties, together with the Florida Keys from Bahia Honda Key north and the land of present-day MDC. The

county seat was originally at Indian Key in the Florida Keys; then in 1844, the County seat was moved to Miami. The Florida Keys from Key Largo to Bahia Honda were returned to Monroe County in 1866. In 1888 the county seat was moved to Juno, near present-day Juno Beach, Florida, returning to Miami in 1899. In 1909, Palm Beach County was formed from the northern portion of what was Dade County, and then in 1915, Palm Beach County and Dade County contributed nearly equal portions of land to create what is now Broward County. There have been no significant boundary changes to the county since 1915.

Recorded Historic Resources in Miami-Dade County

The Florida Division of Historic Resources was consulted in the development of this document, and provided copies of the GIS data for MDC historic resources. There are 181 NRHP listed properties in MDC. This number includes archaeological sites, buildings, structures, objects and historic districts. It does not include properties contributing to historic districts. There are 640 archaeological sites in the County. The majority of these are prehistoric Native American sites, with many shell middens, but also 10 burial mounds, along with other burials, platform mounds, earthworks, and habitation sites. Of the archaeological sites recorded, but not already NRHP listed, 62 are considered eligible, 16 are considered potentially eligible or having insufficient information to evaluate, and 562 have been evaluated as ineligible. Seventy-three of the sites include human remains.

There has been extensive architectural history survey in MDC with 11,817 buildings surveyed. Out of this number 1366 are considered eligible (including as contributing to districts), 364 were considered likely eligible, 4027 had either insufficient information or no evaluation, and 6052 were evaluated as ineligible. One hundred thirty-six bridges have been surveyed with 34 considered NRHP eligible, 39 not evaluated, and 53 not eligible. One cemetery, the City of Miami Cemetery, is considered NRHP eligible.

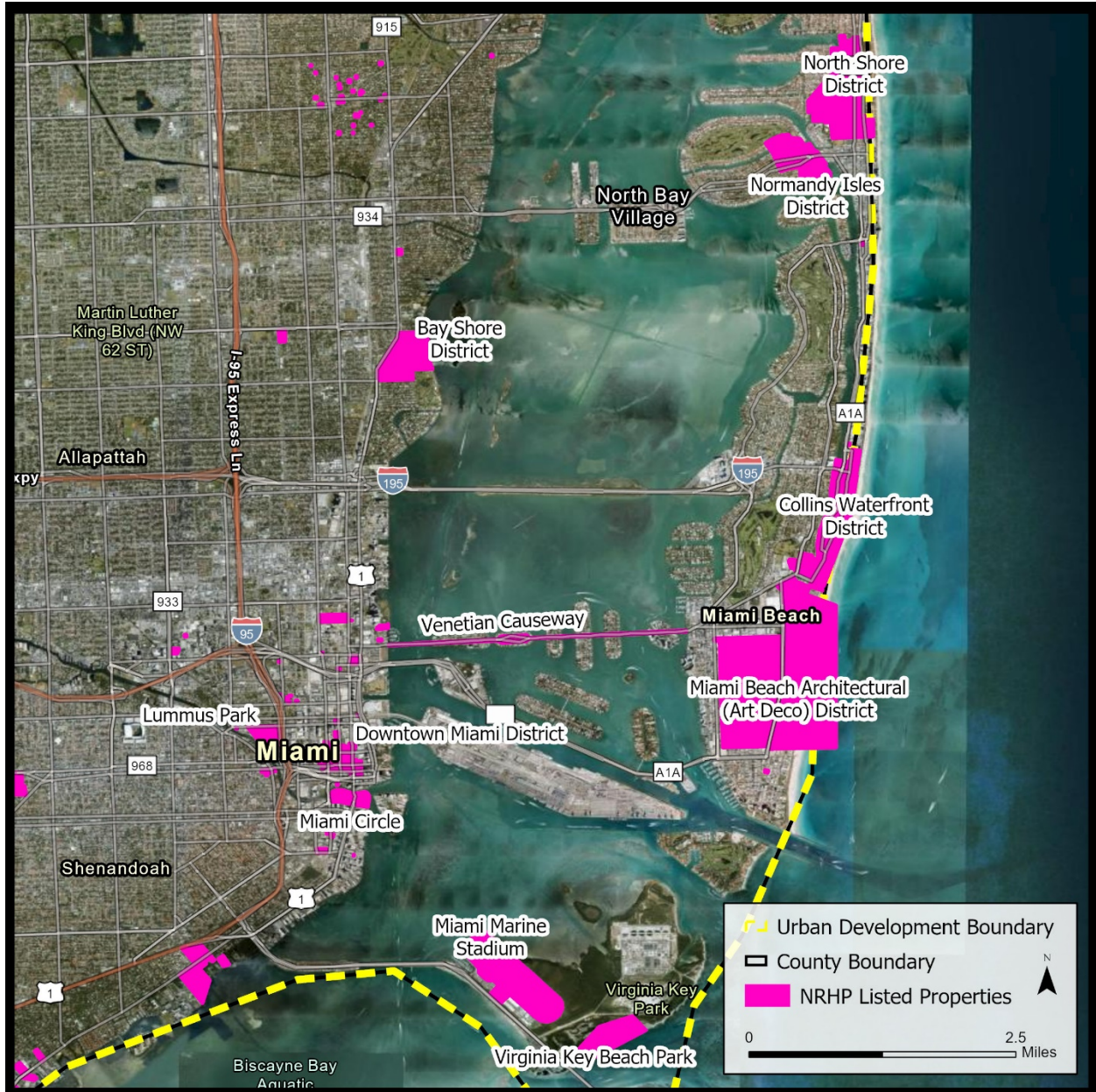


Figure 2-30. National Register of Historic Places Listed Properties in the Miami Area



Figure 2-31. Archaeological Surveys in Miami-Dade

2.13 RECREATIONAL RESOURCES

Definition of Resource

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, trails, boat ramps, piers, marinas, athletic fields, playgrounds, and community centers. 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, playground use, or participation in sports.

Methodology

The ROI is defined as all recreational lands and facilities within the County that would be affected either directly or indirectly by the project. This includes recreational areas where structure or fill is being placed for storm surge barriers, floodwalls, pump stations, natural and nature-based features, or other measures or activities associated with the project, including all areas that are filled, 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.

Framework

Parks and Open Space Master Plan. On February 19, 2008, the Miami-Dade County Board of County Commissioners (BCC) accepted the *Miami-Dade County Park and Open Space System Master Plan*, which updates the original 1969 Recreation Open Space Master Plan (Miami-Dade County, 2010). The plan envisions a new long-term framework for growth – one that results in a more livable and sustainable community; this includes incorporating a system of parks, public spaces, natural and cultural places, greenways, trails and streets, and blueways (water-based trails) (Miami-Dade County 2010). The plan is integrated into the overall fabric of the community and helps to create the kind of place where residents want to live, employers want to do business, and tourists want to visit. This Park and Opens Space System Master Plan is the result of collaboration between the county, municipality, state, and federal park agencies.

The Parks Foundation of Miami-Dade. When it was realized that the county's funds would not be sufficient to maintain, expand upon, and sustain the Miami-Dade Parks, Recreation and Open Spaces Department, the Parks Foundation of Miami-Dade was established in 2004 as a non-profit 501(c)3 organization (Parks Foundation of Miami-Dade n.d.). Its mission is to create a healthier, more livable and sustainable Miami community by ensuring the implementation of the Parks Open Space Master Plan and the development of year-round park and recreation programs for local children, adults and people with disabilities (Phillips and Howe 2013).

Existing Conditions

Tourism is a quintessential part of the economy of Florida, and especially MDC. As an international premier destination, MDC boasted a nearly 18 billion dollar revenue from more than 23 million tourists in 2018 alone (Portero 2019). Countless opportunities for recreation, creativity, and relaxation draws crowds from around the world to visit and participate in recreational activities unique to MDC.

The county services approximately 25 million people per year, who use parks, attend events and participate in programs. One of the leading parks systems in the country, Miami-Dade Parks offers families nurturing, and stimulating recreational opportunities. Today, it is the third largest park system in the United States, and along with 270 county parks, more than 13,00 acres of land, six golf courses, six marinas, 16 miles of beaches, over 150 miles of bike paths/trails, and attractions like Zoo Miami (R - Miami-Dade County n.d.; Parks Foundation of Miami-Dade n.d.). Additionally, MDC has a rich arts district as well as night life and premier shopping.

Parks and Open Space

A three-time national Gold medal winner for excellence in Parks administration, the Miami-Dade municipal park system is the only one of its size to be awarded National Accreditation from the Commission on Accreditation of Parks, Recreation and Open Space Agencies (R - Miami-Dade County n.d.).

Parks have played an important role in the community since 1930, when the first park, Matheson Hammock Park was established from a donation of 80 acres of land; since then, the number of county parks has grown to nearly 270. Additionally, there are 519 municipal parks, 3 Federal parks, and 3 state parks that have been established over time (Miami-Dade Open Data 2019). The county has designated Matheson Hammock Park, as well as six other parks 'Heritage Parks,' or parks that have played vital roles in the community's history, environment, and recreational and cultural experiences (R – Miami-Dade County n.d.).

The City of Miami has more than 100 parks, gardens, recreational areas, and playgrounds. Parks and open space help connect people to their environment, strengthen community, and promote health and fitness.



Figure 2-32. Areas in Miami-Dade that Provide Outdoor Recreation Opportunities

Beaches

With average temperatures ranging between a low of 57°F in January to a high of 91°F in the summer months, the beaches in MDC are an attraction to locals and tourists year-round. There are over 20 miles of sandy beach stretching from Key Biscayne north to Golden Beach, which provide ample opportunity visitors to lounge, walk, swim, snorkel, etc. (Florida Department of Environmental Protection n.d.).

Arts/Culture

For those passionate about art and culture, there are numerous areas where art, architecture, and culture can be appreciated. These areas include, but are not limited to, Little Havana, Wynwood (Art District) Little Haiti, and the Art Deco Historic District. For more information regarding the socioeconomic and cultural resources in MDC, refer to sections 2.15 and 2.12, respectively.

Recreational Boating and Cruises and Fishing

Beautiful cerulean blue waters hug Dade County's coastline, drawing anglers, kayakers, pleasure boaters, and cruise-line passengers to the water.

There are nearly 250 marinas, including 6 county owned and operated marinas, along the coastal and riverine waterways in MDC. From these marinas, boaters of all types launch their vessels to recreate Dade County's coastal waters. In a study conducted by Gorzelany, the five most commonly occurring vessels are motorboat (51%), cabin motorboat (22%), sailboat (14%), personal watercraft (5%), and kayaks/canoes (3%) (2009). The greatest number of recreational boaters occurs in the summer; during a particular aerial survey, a weekend in June reached nearly 2,000 vessels underway (Gorzelany 2009). It was found that the weekend-weekday ratio of boaters was 4.8:1, indicating a substantially higher number of recreational boaters on the water on the weekends (Gorzelany 2009). Overall boat density is the greatest in areas with nearby access to the Atlantic Ocean; these areas include Bakers Haulover Inlet, Government Cut, portions of Key Biscayne, and Sands Cut/Elliott Key (Gorzelany 2009).

In addition to recreational boating, tourists flock to Dade County to board cruise liners and set sail to destinations like the Bahamas and the Caribbean. Due to the proximity of the Port of Miami to highly sought after cruise destinations, it is the world's leading cruise port with 22 cruise liners berthing 55 ships, and is known as the "Cruise Capital of the World" (Port Miami n.d.).

Within the aquatic portions of the ROI fishing from shorelines and boats is a common and sought after recreational activity. Many valuable recreational fish species are found in the area.

Wildlife Viewing and Photography

Wildlife viewing and photography occur within the aquatic portions of the ROI and at the Cutler Bay area. The Cutler Bay Site is a sought after bird watching and sought after wildlife photography area.

Exercising

Many people use the Riverwalk or other public areas/sidewalks in the ROI to walk their dogs or to exercise (running and walking). Biking is another recreational exercise activity that occurs throughout the ROI.

2.14 AESTHETICS AND VISUAL RESOURCES

Definition of Resource

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.

Methodology

Visual resources can be subjective by nature, and therefore the level of the proposed project’s visual impacts can be challenging to quantify. Generally, projects that create a high level of contrast to the existing visual character of a project setting are more likely to generate adverse visual impacts due to visual incompatibility. Thus, it is important to assess project effects relative to the existing conditions of the area. On this basis, project components effect on the visual environment are quantified and evaluated for impact assessment purposes based on factors affecting setting compatibility such as changes in visual vividness, intactness, and unity from the existing conditions.

Within a discrete viewshed, an individual's visual perception is a function of the area’s spatial properties, visual content, and an individual’s previous experiences. The visual character of an area can be altered by actions that would modify the landscape. In addition, views toward a given location in the viewshed can be affected by a proposed action. To provide a baseline for assessing potential visual impacts of actions on a viewshed, the ROI must be described in terms of its visual characteristics (using visual assessment elements), and a description of the user groups (viewer groups) who would experience any changes in visual character.

Visual Assessment Elements

The following characteristics were used to describe and assess visual resources: viewshed, visual character, visual quality (vividness, intactness, and unity), visual sensitivity, and key observation points.

Viewshed

Viewshed is an area of the landscape that is visible from a particular location (e.g., an overlook) or series of points (e.g., a road or trail). To identify the importance of views of a resource, a viewshed may be broken into distance zones consisting of: (1) foreground, (2) middleground, and (3) background. Generally, the closer a resource is to the viewer, the more visually dominant it is and the greater its significance to the viewer.

Visual Character

Visual character is based on defined attributes of an area. A change in visual character cannot be described as having good or bad attributes until it is compared with the viewer response to

that change. If there is public preference for the established visual character of a regional landscape and a resistance to a project that would contrast that character, then changes in the visual character can be evaluated.

Visual Quality

Visual quality is determined by analyzing three elements of the visual environment: vividness, intactness, and unity. None of these is itself indicative of visual quality, and all three must be high to indicate high visual quality. Vividness is the visual power or memorability of landscape components as they combine in striking or distinctive visual patterns. Examples of significant vividness include views of areas such as the Grand Canyon or the Statue of Liberty. Intactness is the visual integrity of the natural and artificial landscape and its freedom from encroaching elements. Intactness can be present in well-kept urban and rural landscapes, as well as in natural settings. Intactness relates to the physical setting. For example, in a natural setting, it is the freedom from development or infrastructure; in a rural setting, it is the freedom from urban influences; and in an urban/suburban setting, it is the freedom from uses such as industrial smokestacks in an area with office buildings or intensive commercial development in a residential area. Unity is the visual coherence and compositional harmony of the landscape considered as a whole; it frequently attests to the careful design of individual components in the artificial landscape. Examples of high unity would include a well-maintained master-planned community or a mixed-use downtown development.

Visual Sensitivity

Visual sensitivity is based on the visibility of resources in the landscape, the proximity of viewers to the visual resource, the relative elevation of viewers to the visual resource, and the types and expectations of individuals and viewer groups. The criteria for identifying the importance of views are related in part to the position of the viewer relative to the resource. Visual sensitivity also depends on the number and type of viewers and the frequency and duration of views. Generally, visual sensitivity increases with an increase in total number of viewers, the frequency of viewing (e.g., daily or seasonally), and the duration of views (i.e., how long a scene is viewed). In addition, visual sensitivity is higher for views seen by people who are driving for pleasure; people engaging in recreational activities, such as hiking, biking, or camping; and homeowners. Views from recreation trails and areas, scenic highways, and scenic overlooks are generally assessed as having high visual sensitivity.

Key Observation Points

Key observation points are official (e.g., a vista point) or unofficial (e.g., mountain peak) viewing locations that individuals identify as providing a place from which to take in remarkable views.

Viewer Groups

Viewers are placed into one of two groups based on activities and functions within a viewshed: (1) those with a view of the Proposed Action, and (2) those with a view from the Proposed Action. For example, while viewers with a view from an existing roadway will generally experience a similar visual landscape, viewers of a new road could observe a new visual landscape. All viewers can have different types of perception and thus impressions of the

viewshed depending on their viewing perspective (e.g., motorist, resident, recreational user, business employees/patrons).

The Region of Influence (ROI) for visual resources is defined by those parts of the areas in which temporary or permanent visual changes could occur. For the Study Area, this includes MDC.

Framework

Visual resources are mentioned in NEPA and CEQ regulations to implement NEPA under the heading of aesthetics. These regulations identify aesthetics as one of the elements or factors in the human environment that must be considered in determining the effects of a project. As prescribed by NEPA and CEQ, it is the “continuous responsibility” of federal and state governments to “assure all Americans” an environment that is composed of “aesthetically pleasing surroundings. There are no State of Federal regulations for aesthetics.

Existing Conditions

The general visual landscape of the study area can be described as mostly urban, with a network of parks and associated waterways including various rivers and canals. Among the dominant features in the visual landscape is the extensive transportation network within MDC. This network includes, but is not limited to, railroads, highways, shipping and cruise line Terminal and related loading docks, bridges, bus stations, and airports (both civilian and military). Within the city there are parks and green spaces even though a large amount of the city has been hard structured through development. The county is highly developed with the largest amount of open space to the west (Everglades National Park) and south (Homestead Air Force Base) of the City of Miami. As shown in Figure 2-36, the ROI is highly developed. Development extends up to the shoreline.



Figure 2-33. Region of Influence Next to the Miami River and Brickell Key

On site visits with the county, it was noted that the viewshed from the shoreline to the water is very important to the public. The city even promotes public access to the water. There is a city charter and a zoning code (Miami 21 Zoning Code) that requires public access to the waterfront and visual access to the water. A public access Riverwalk/Baywalk in Miami from Edgewater to Brickell has been in city plans for decades. The city's plan is to have a continuous public access zone along the shoreline. The Riverwalk/Baywalk is not complete, but some sections have been constructed. The location for the final continuous Riverwalk/Baywalk is shown in Figure 2-37. (Miami DDA 2019).



Figure 2-34. Riverwalk/Baywalk Location

The Riverwalk/Baywalk is designed so that the walkway is directly adjacent to the shoreline water. While there are occasional palm tree or vegetation, most of the view is unobstructed. The Miami 21 Zoning Code includes guidelines for the waterfront design shown in Figure 2-36. (Miami-Dade County 2019). The current constructed portions are along the Brickell area shoreline. The public uses the path for recreation and transport.

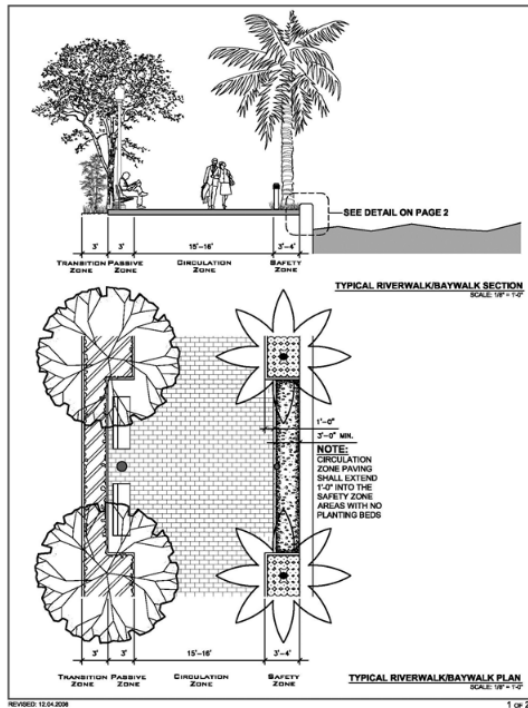


Figure 2-35. Baywalk Section



Figure 2-36. Miami-Dade Development Authority Conceptual Idea for the Riverwalk/Baywalk

Source: The Big Bubble Miami, 2018

Miami-Dade County developed an Aesthetics Master Plan in November of 2009. The plan was developed to address landscaping and landscape maintenance of all public roadways and County facilities. The rationale for the plan was that people want to live in and visit beautiful places and that the physical appearance of a city has long been considered as sign of its socioeconomic health and prosperity. Aesthetics is important to MDC given its reliance on tourism.

During this study measures suggested and locations should be in accordance with the MDC Aesthetics Master Plan.

2.15 SOCIOECONOMICS

Definition of Resource

Socioeconomics is defined as the basic attributes and resources associated with the human environment, particularly population, demographics, and economic development. Demographics entail population characteristics and include data pertaining to race, gender, income, housing, poverty status, and educational attainment. Economic development or activity typically includes employment, wages, business patterns, an area's industrial base, and its economic growth.

Methodology

Existing demographic and economic information was drawn from the U.S. Census Bureau, Bureau of Labor Statistics, and other agencies. 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. Environmental Protection Agency guidance (USEPA 2010) on environmental justice was considered in describing the potentially affected environment. The ROI for socioeconomic and environmental justice are defined by the census tracts that are within the MDC.

Framework

The CEQ regulations implementing NEPA state that when economic or social effects and natural or physical environmental effects are interrelated, the EIS will discuss these effects on the human environment (40 CFR 1508.14). The CEQ regulations further state that the "human environment shall be interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment." Following from these CEQ regulations, the socioeconomic analysis evaluates how elements of the human environment such as population, employment, education, and housing might be affected by the Proposed Action.

In 1994, EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low- Income Populations*, was issued to focus the attention of federal agencies on human health and environmental conditions in minority and low-income communities. In addition, EO 12898 aims to ensure that the environmental effects of federal actions do not fall disproportionately on low-income and minority populations. To support an evaluation of environmental justice issues, this section includes data related to the existence of minority and low-income populations in the vicinity of the Proposed Action that could potentially be

disproportionately affected. For an analysis of impacts to minority, low-income, and child populations, refer to Chapter 6, *Other Considerations Required by NEPA*.

EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, tasks “each federal agency [to] make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high adverse human health and environmental effects of its programs, policies, and activities on minority populations and low-income populations.” EO 12898, dated February 11, 1994, aims to: (1) focus the attention of federal agencies on the environmental and human health conditions in minority communities and low-income communities with the goal of achieving environmental justice; (2) foster non-discrimination in federal programs that substantially affect human health or the environment; and (3) give minority communities and low-income communities greater opportunities for public participation in, and access to public information on, matters relating to human health and the environment.

The USEPA describes environmental justice as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies (USEPA 2010). Fair treatment means that no group of people, including racial, ethnic, or socioeconomic, should bear a disproportionate share of the negative environmental consequences resulting from the execution of federal, state, local, and tribal programs and policies. The goal of fair treatment is not to shift risks among populations but to identify potential disproportionately high and adverse effects and identify alternatives that may mitigate these effects. Federal agencies must provide minority and low-income communities with access to information on matters relating to human health or the environment and opportunities for input in the NEPA process, including input on potential effects and mitigation measures.

Because children may suffer disproportionately from environmental health risks and safety risks, EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks*, was issued on April 21, 1997 to help ensure that federal agencies’ policies, programs, activities, and standards address environmental health and safety risks to children. EO 13045 requires all federal agencies to make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children and ensure that its policies, programs, activities, and standards address disproportionate risks to children that may result from environmental health risks or safety risks.

The demographic information, including age, race and income of the populace, is vital to framing both a socioeconomic analysis and an analysis of environmental justice conditions. Thus, the existing conditions presented apply to both areas. However, the analysis of impacts between the concepts is different in scale. While a socioeconomic analysis can be completed separate from other resources, impacts that may affect environmental justice may be tied to several other resources, such as water quality and air quality.

Existing Conditions

Demographics

Existing demographic and economic information was drawn from the U.S. Census Bureau, Bureau of Labor Statistics, and local planning agencies. 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. Environmental Protection Agency guidance (USEPA 2010) on environmental justice was considered in describing the potentially affected environment.

Of the 19.1 million people living in Florida, 2,549,075 – 13.28% - live in MDC. It is a densely populated area, with this number crowded into about half of the county's 2400 square miles. It is a place of immigrants with 51.3% of its people were born outside of the United States. Due to this statistic, approximately one third of Miami residents speak English as a first language and a third do not speak any English.

With only 14.4% of the population over 65 years old, Miami-Dade is comparatively youthful compared with other localities, statewide the proportion is 17.8%. This is reflected in the relatively large portion of the population in the labor force, 62.6%, with Florida as a whole at 60.1%. Education level is almost an exact match with 26.3% of MDC residents holding a bachelor's degree or higher, and 26.4% for Florida. Ethnically diverse MDC population is 85.53% minority. Comprising this proportion is 18.35% black, 66.43% Hispanic, and 1.58% Asian. In spite of being home to the federally recognized Miccosukee Tribe, American Indians make up only 0.13% of the population in Miami-Dade.

Economics

Tourism of course plays an important role in the economy of MDC with Miami Beach drawing tourists from all over the world, but its location on the shipping lanes and air routes makes it an important nexus between the United States, the Caribbean, and Latin America. Owing to this, a number of large corporations are headquartered in MDC including Intradeco Holdings, Brightstar Corporation, Latin Flavors, Norwegian Cruise Line, Burger King, and Ryder truck rental.

Wages, along with the cost of living being higher in Miami-Dade, average yearly employee wages are \$44,389 in comparison with the state as a whole a \$41,022. It is a community of stark economic contrasts, where census tracts with some of the highest Median Household Income (MHI) in the country exist within blocks of those with an MHI below the poverty level. 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.

Table 2-9. Real Gross Domestic Product

	Real Gross Domestic Product				Percent Change From Preceding Period		
	Thousands of Chained (2012) dollars (\$1000s)				Percent Change		
	2015	2016	2017	2018	2016	2017	2018
United States	17,403,843	17,688,890	18,108,082	18,638,164	1.6	2.4	2.9
Florida	839,124	866,730,997	896,117	924,873	3.3	3.4	3.2
Miami-Dade	131,625	136,397	141,350	145,883	3.6	3.6	3.2

Environmental Justice and Social Vulnerability

Environmental justice is the concept that constructed or permitted undertakings may impact the livability of the environment in areas where people are less able to contest these decisions. Figures 2-38 and 2-39 (US Environmental Protection Agency (USEPA) 2019) show percent of households below the poverty level and the number of black population below the poverty level, respectively, both by census tract based on the American Community Survey 2012-2016.

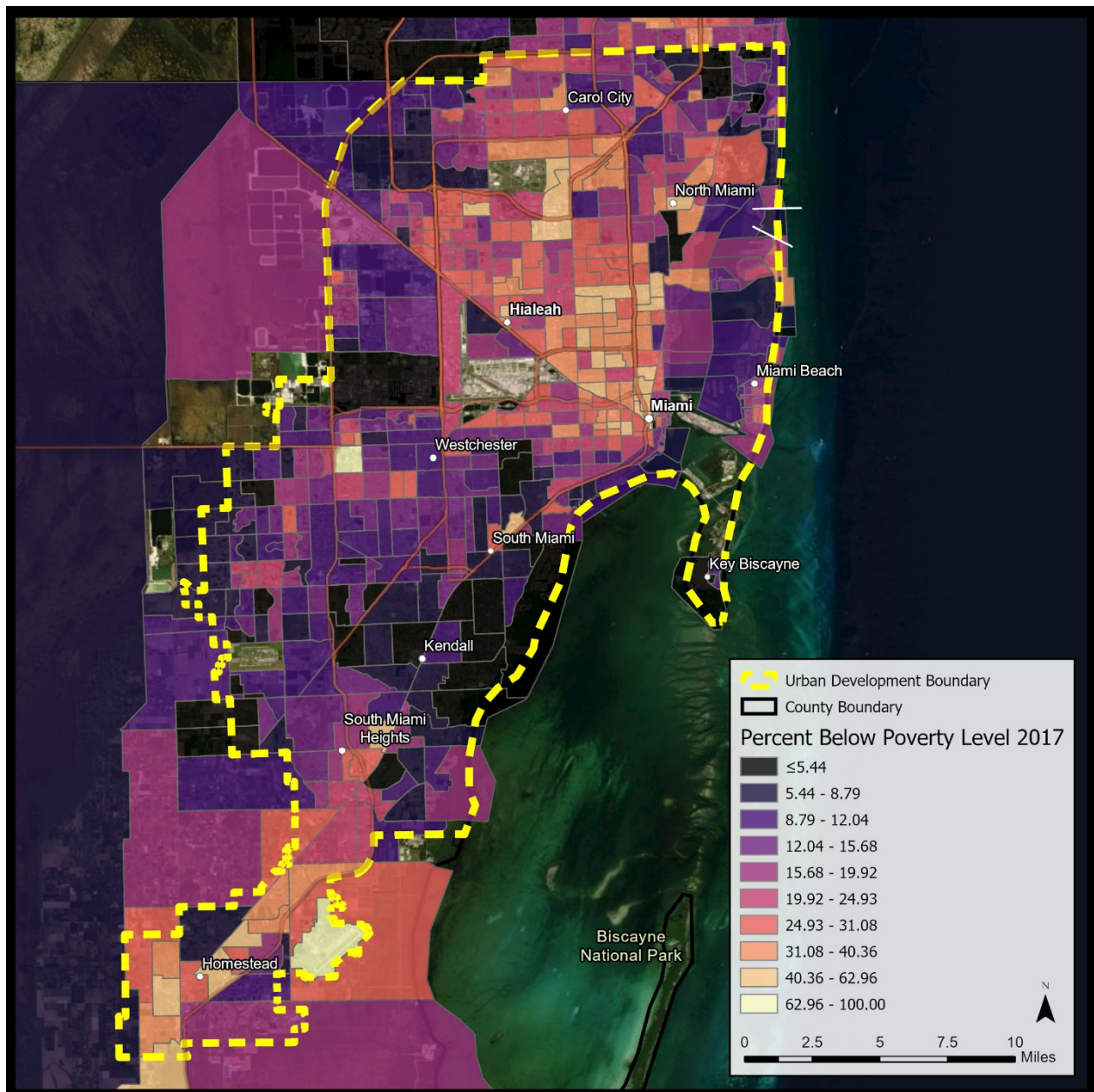


Figure 2-37. Percent of the Population below the Poverty Level

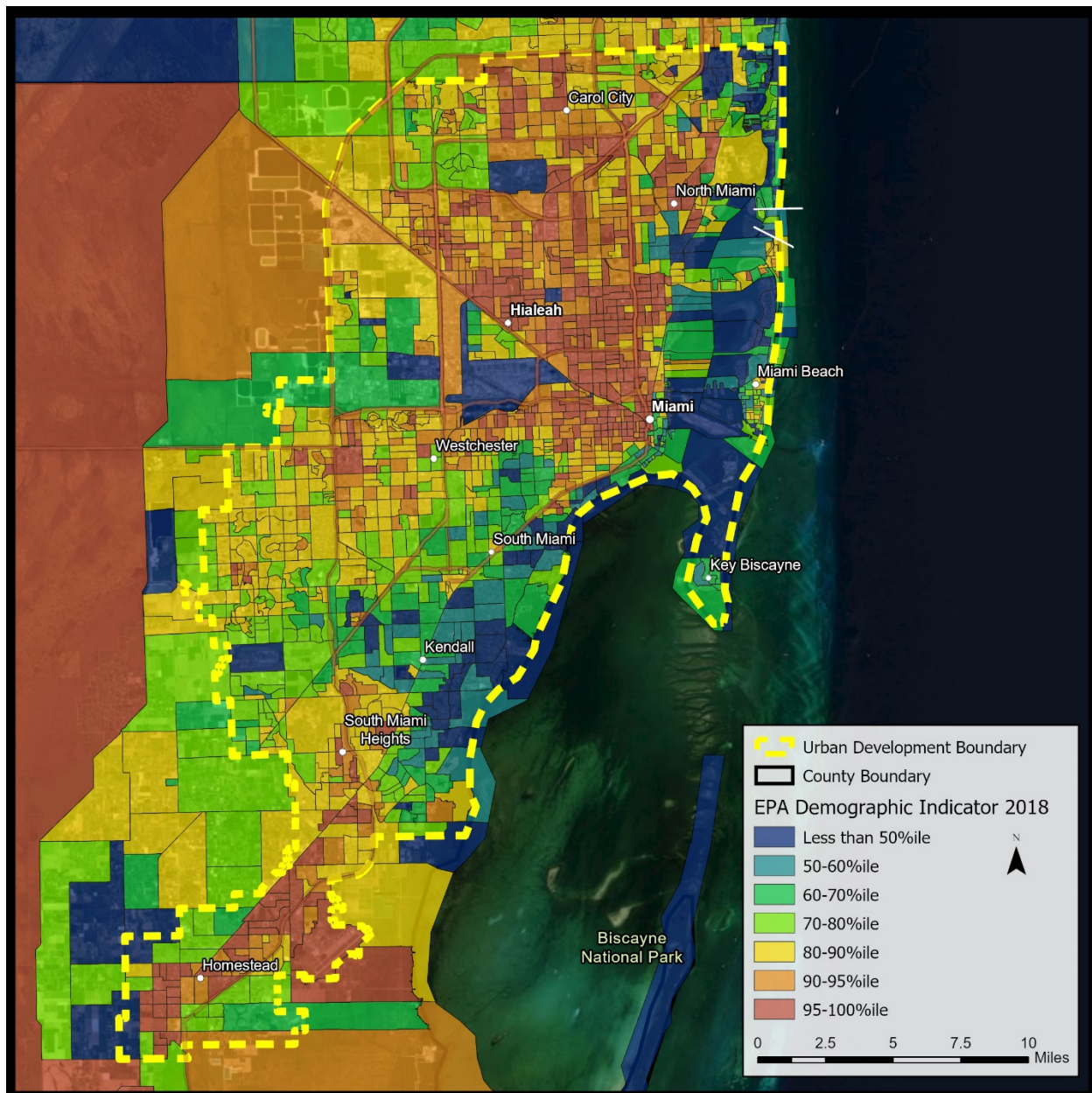


Figure 2-38. Environmental Justice Index by Census Tract

The term “gentrification” was coined over 40 years ago to describe the effects of affluent households moving into old urban neighborhoods, causing a rise in real estate prices and taxes, and making housing unaffordable for the preexisting lower income residents there. While the appeal to the affluent to move into urban core areas has been shorter commutes and proximity to urban amenities, there is a new dynamic at work in south Florida. In the past properties on or near the ocean and bay shores demanded the highest prices. With mounting concerns over storm flooding and sea level rise causing “blue sky flooding” lots in high ground areas away from open water have become increasingly sought after. These areas had been those of lower income neighborhoods, but are now being affected by “climate gentrification.”

The Center for Disease Control (CDC) has developed a Social Vulnerability Index (SVI) using U.S. Census data to determine the vulnerability of people to disasters by census tract. Census tracts are subdivisions of counties for which the Census collects statistical data. The SVI ranks each tract on 15 social factors, including poverty, lack of vehicle access, and crowded housing, and groups them into four related themes: Socioeconomic Status, Household Composition, Ethnicity and Language, and Housing/Transportation. Each theme is given a score on a scale of 0 for least vulnerable to 1 for most vulnerable, and combined score for the census tract is computed in the same way. The SVI for MDC varies greatly between census tracts, and shows patterns similar to the Environmental Justice mapping.

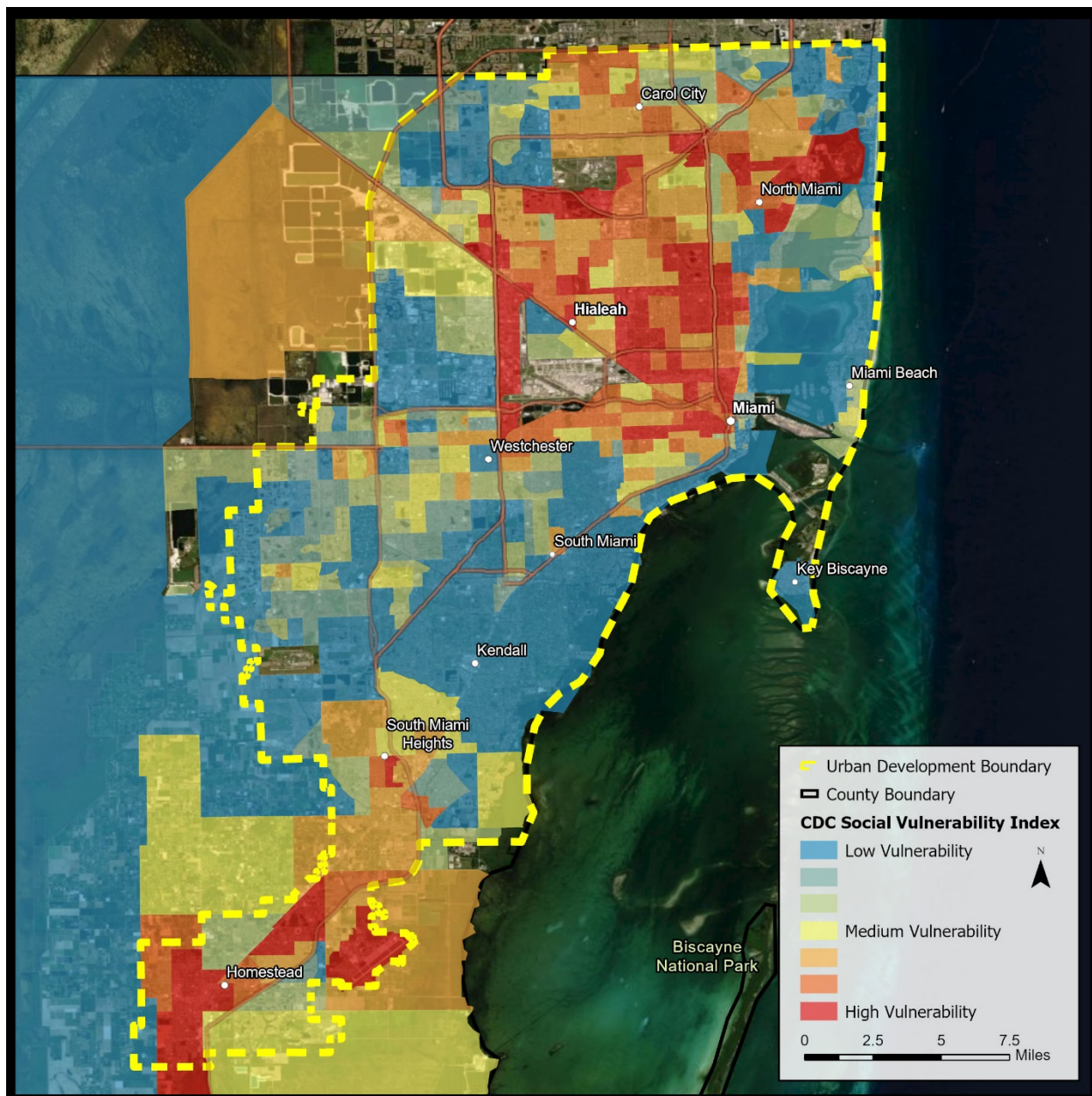


Figure 2-39. The Centers for Disease Control Social Vulnerability by Census Tract

2.16 HAZARDOUS, TOXIC, AND RADIOACTIVE MATERIALS AND WASTES

Definition of Resource

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. Radioactive waste is produced at all stages of the nuclear fuel cycle associated with nuclear power plants and from when it is used in medicine, research, manufacturing, and minerals exploration. Radioactive waste is typically classified as either low-level (LLW), intermediate-level (ILW), or high-level (HLW), dependent, primarily, on its level of radioactivity.

Methodology

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 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.

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.

FDEP's Division of Waste Management is charged with implementation of state and federal laws to protect the environment from the improper handling and disposal of solid and hazardous wastes. The division also works closely with regulatory programs for waste facilities and pollutant storage systems, and non-regulatory activities such as financial and technical assistance for recycling and waste reduction. (FDEP 2020) The division also oversees and contracts out remediation efforts sites contaminated with petroleum products, dry cleaning solvents, or other hazardous wastes. The State of Florida has numerous rules regulating the control, handling, and disposal of hazardous wastes to include Chapter 62-730, Hazardous Waste of the Florida Administrative Code amended as recent as November 13, 2019; rules on used oil management, management of lamps and devices containing mercury, underground storage tank systems, detailed criteria for contaminated site clean-up, among others.

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.

A few of the common database and inventories that are used that report on hazardous waste sites and/or the potential for hazardous materials include:

- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Information System. This database lists potential hazardous release sites under the Superfund Program, a federal program to clean up the most hazardous sites.
- Resource Conservation and Recovery Information System (RCRIS). This is an inventory of hazardous waste handlers.
- Toxics Release Inventory (TRI). This is an information system about toxic chemicals that are being used, manufactured, treated, transported, or released into the environment.
- Solid Waste Facilities Inventory. This is an information system about large facilities for the storage and handling of solid waste, whether transported or left in place.

Existing Conditions

The Florida Department of Environmental Protection (FDEP) Division of Waste Management indicates the following inventories of generators and sites of Hazardous, Toxic, and Radioactive Wastes (HTRW) within the study area as shown in Figure 2-41 (FDEP 2020).

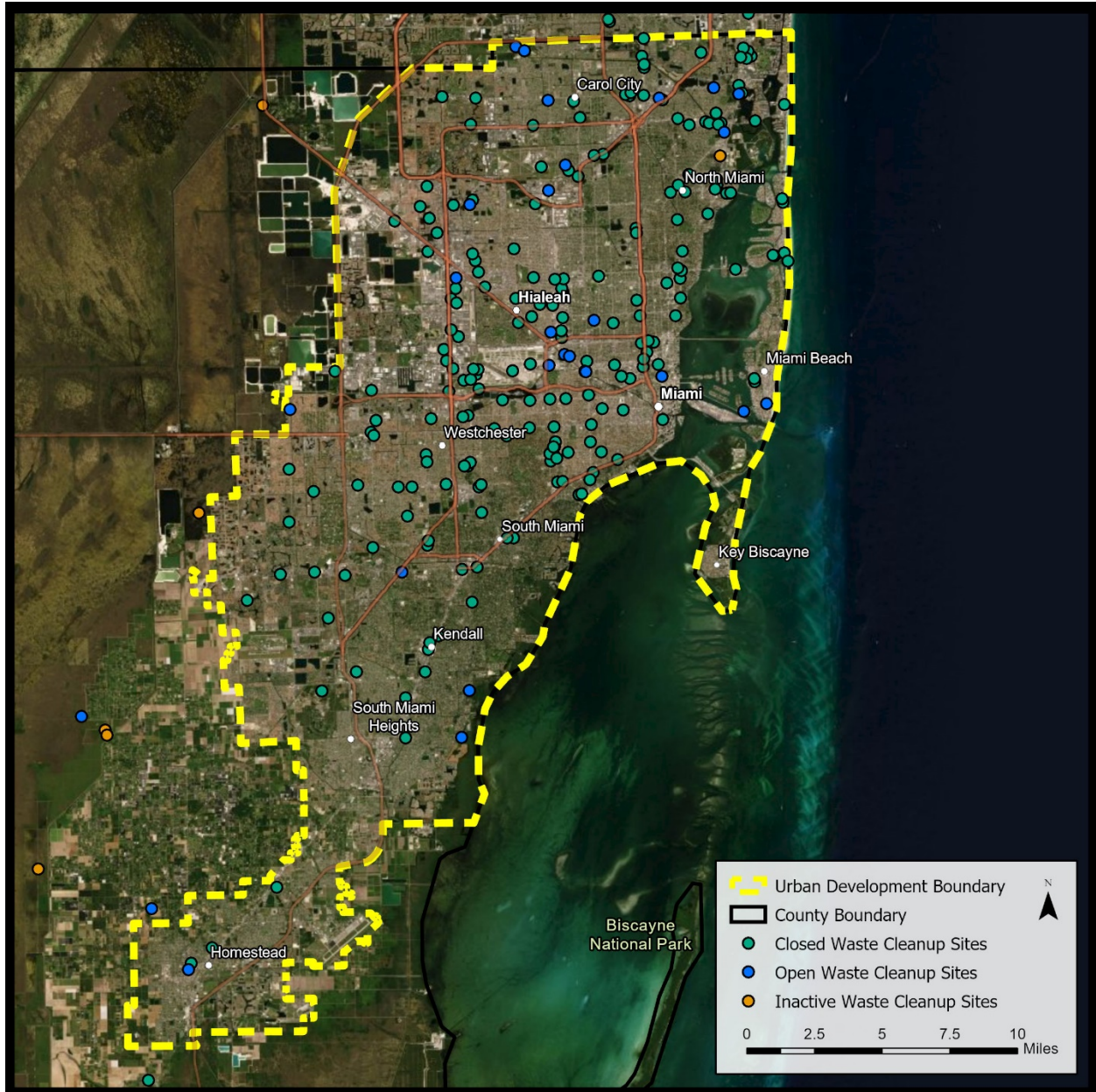


Figure 2-40. The Florida Department of Environmental Protection List of Contaminated Sites

The EPA Regulated facilities and clean-up sites are displayed in Figures 2-42 and 2-43 (USACE Corp Maps. Accessed on: January 31, 2020) which does include listed sites in the study area.

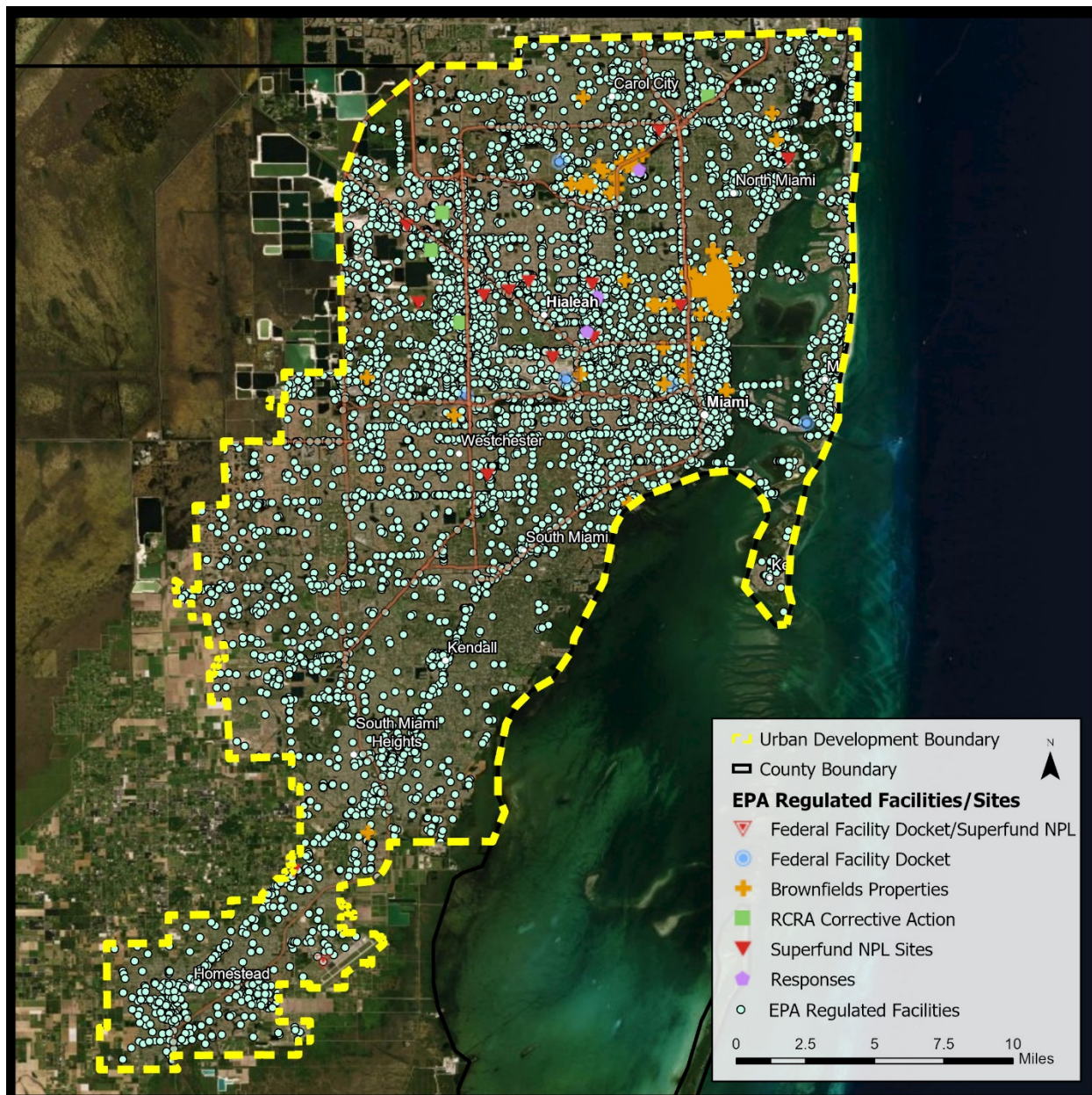


Figure 2-41. Environmental Protection Agency Regulated Facilities and Clean-up Sites

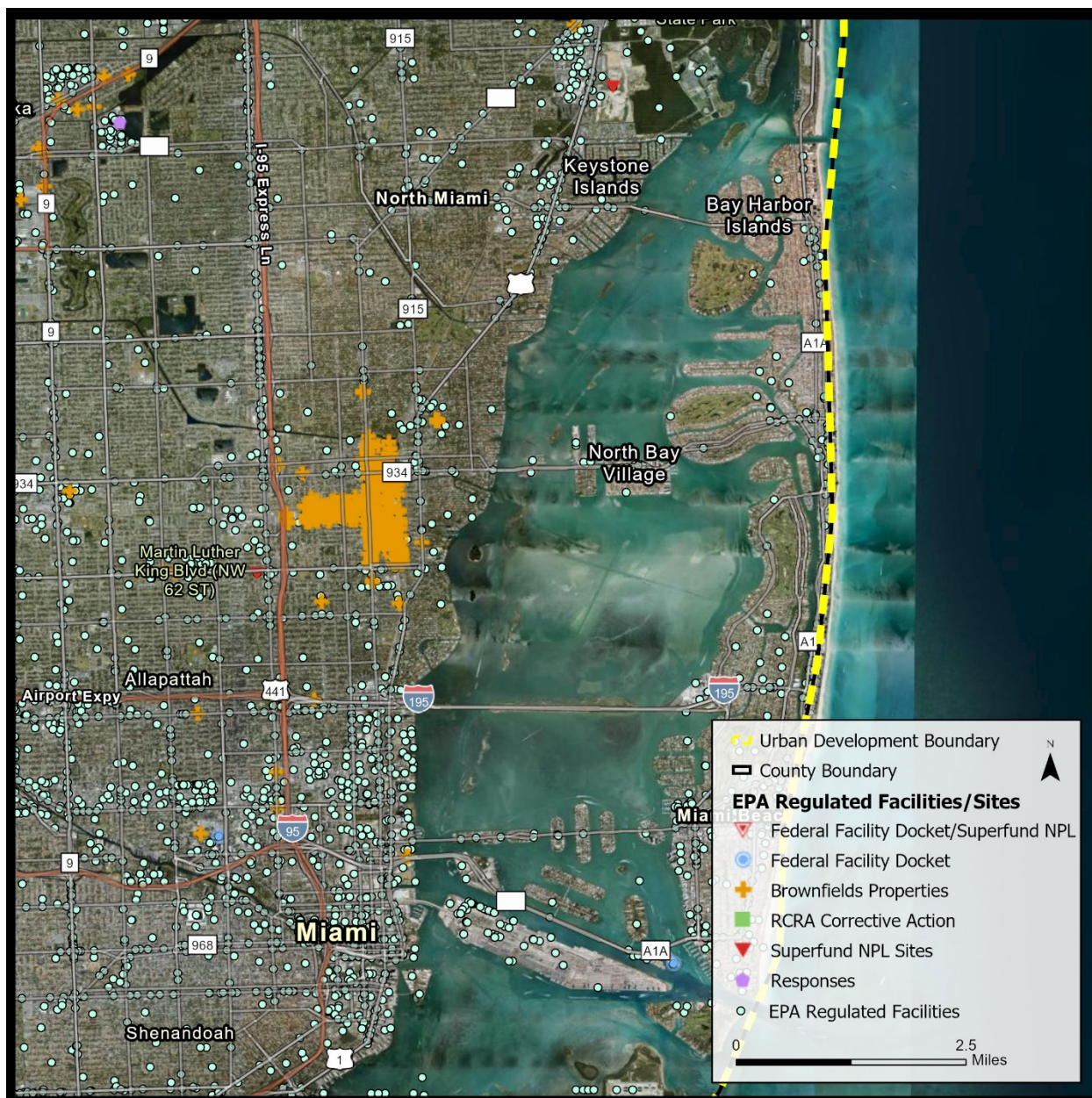


Figure 2-42. Environmental Protection Agency Regulated Facilities and Clean-up Sites (zoomed extent)

Table 2-10. Comprehensive Engineering Research Center Laboratory Sites (U.S. Environment Protection Agency 2008)

SITE NAME	LATITUDE/LONGITUDE	National Priority List (NPL) STATUS FOR MIAMI-DADE
Anodyne, Inc. 1270 NW 165 Street North Miami Beach, FL 33169	Latitude: 25.923189 Longitude: -80.221531	On final NPL
Munisport Landfill 152nd St. NE and Biscayne Blvd. North Miami, FL 33161	Latitude: 25.908331 Longitude: -80.154169	Deleted from NPL
Pepper Steel and Alloys, Inc. 11100 NW S. River Dr. Medley, FL	Latitude: 25.873611 Longitude: -80.353331	On final NPL
Standard Auto Bumper Corp. 2500 West 3rd Court Hialeah, FL 33010	Latitude: 25.844444 Longitude: -80.289721	On final NPL
Anaconda Aluminum Co./Milgo Electronics Corp. 3630 NW 76th St. Miami, FL	Latitude: 25.843061 Longitude: -80.256531	Deleted from NPL
B and B Chemical Co., Inc. 875 W 20th St. Hialeah, FL 33010	Latitude: 25.839581 Longitude: -80.300139	On final NPL
Miami Drum Services 7049 NW 70th St. Miami, FL 33166	Latitude: 25.837219 Longitude: -80.313061	On final NPL
Northwest 58th Street Landfill NW 58th St. Hialeah, FL 33012	Latitude: 25.833331 Longitude: -80.347219	Deleted from NPL

SITE NAME	LATITUDE/LONGITUDE	National Priority List (NPL) STATUS FOR MIAMI-DADE
Airco Plating Co. 3636 NW 46th Street Miami, FL 33142	Latitude: 25.8152 Longitude: -80.2559	On final NPL
Varsol Spill Miami Int'l Airport Miami, FL 33159	Latitude: 25.8047 Longitude: -80.2772	Deleted from NPL
Gold Coast Oil Corp. 2835 SW 71st Ave. Miami, FL	Latitude: 25.7434 Longitude: -80.3112	Deleted from NPL
Woodbury Chemical Co. (Princeton Plant) 13920 SW 248th St. Princeton, FL 33032	Latitude: 25.5367 Longitude: -80.4124	Deleted from NPL
Homestead Air Force Base Florida Turnpike East Homestead Air Force Base, FL	Latitude: 25.489444 Longitude: -80.396944	On final NPL

Table 2-10 shows the locations of MDC thirteen Superfund Sites listed on the United States Environmental Protection Agency's National Priorities List (NPL) (USEPA 2008).

There are no Formally Used Defense Sites (FUDS) within the study's focus areas, defined later in Chapter 3, but there are sites within MDC as shown in Figure 2-44 (USACE Corp Maps. Accessed on: January 31, 2020).

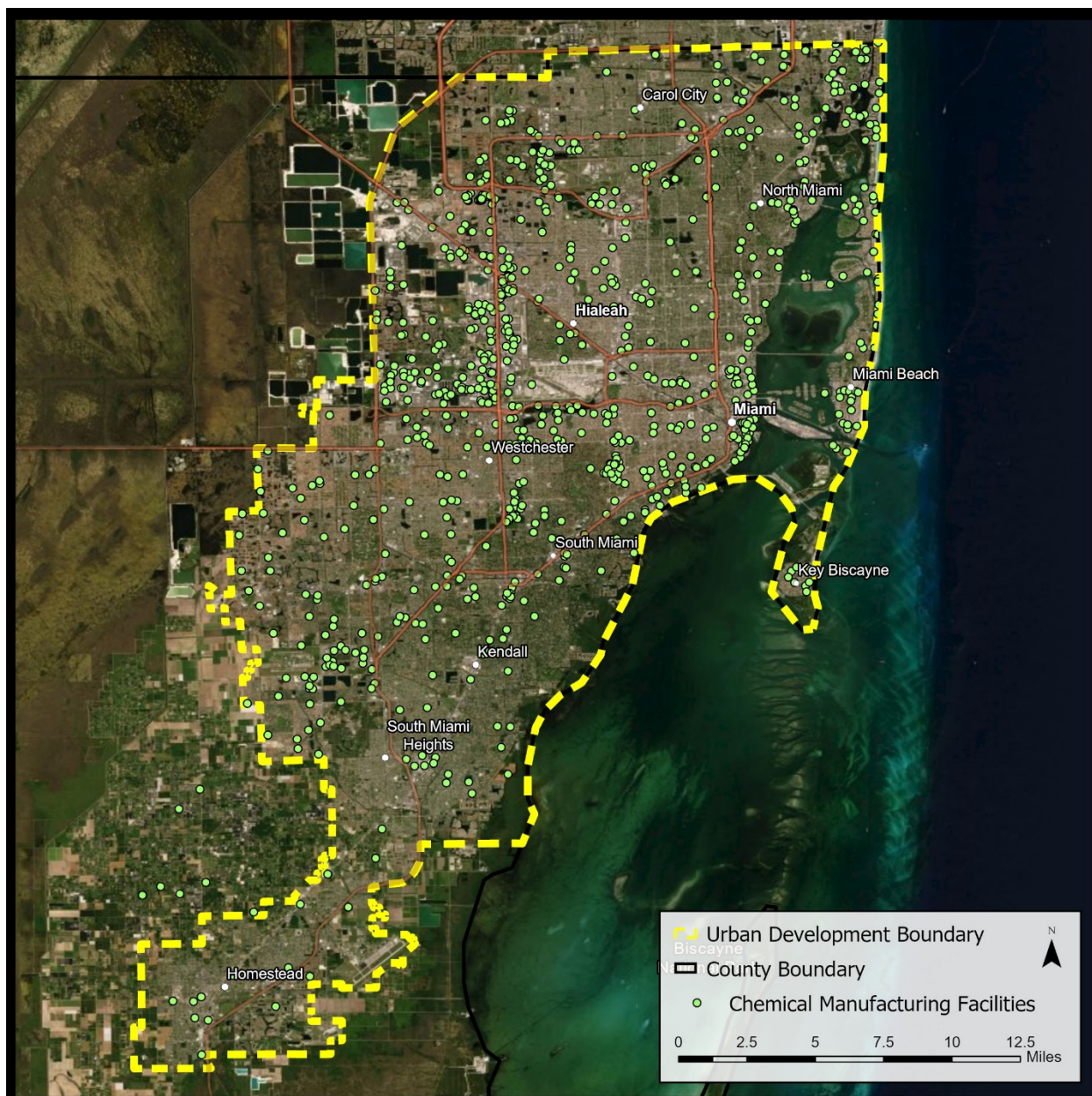


Figure 2-43. Chemical Manufacturing Facilities within Miami-Dade County

Storage Tanks

The Florida Department of Environmental Protection requires the registration of above-ground Storage Tanks (AST) and underground Storage Tanks (UST). Tanks commonly range in size from 110 to 10,000 gallons or more.

Miami-Dade County has a Storage Tanks Program responsible for inspecting facilities that store petroleum substances such as gasoline and diesel. This includes a wide range of establishments such as gas stations, hotels, hospitals and other non-retail facilities. (Miami-Dade 2013) The program conducts annual inspections. In addition to compliance inspections,

the Storage Tanks program oversees removal and installation of new UST/AST systems to verify that these are conducted in accordance with applicable state and local regulations.

Brownfields Sites

Brownfields is a term used to describe tracts of land formerly used for industrial or commercial purposes. They may contain construction debris and contaminants, but not to the degree of a Superfund site. EPA has a grant program for the rehabilitation of brownfields sites. A brownfield area is a contiguous area of one or more brownfield sites, some of which may not be contaminated, and which has been designated by a local government by resolution (Miami-Dade 2018).

A brownfield site is defined as any real property where the expansion, redevelopment or reuse is complicated by actual or perceived environmental contamination. Miami-Dade County has been delegated authority by FDEP to administer the Florida Brownfields Redevelopment Program on behalf of FDEP. The program provides eligibility for benefits and incentives for site cleanup, including a Voluntary Cleanup Tax Credit, other incentives, and the application of Risk-Based Corrective Action principles to site rehabilitation using Chapters 62-777 and 62-780, Florida Administrative Code (Miami-Dade 2018).

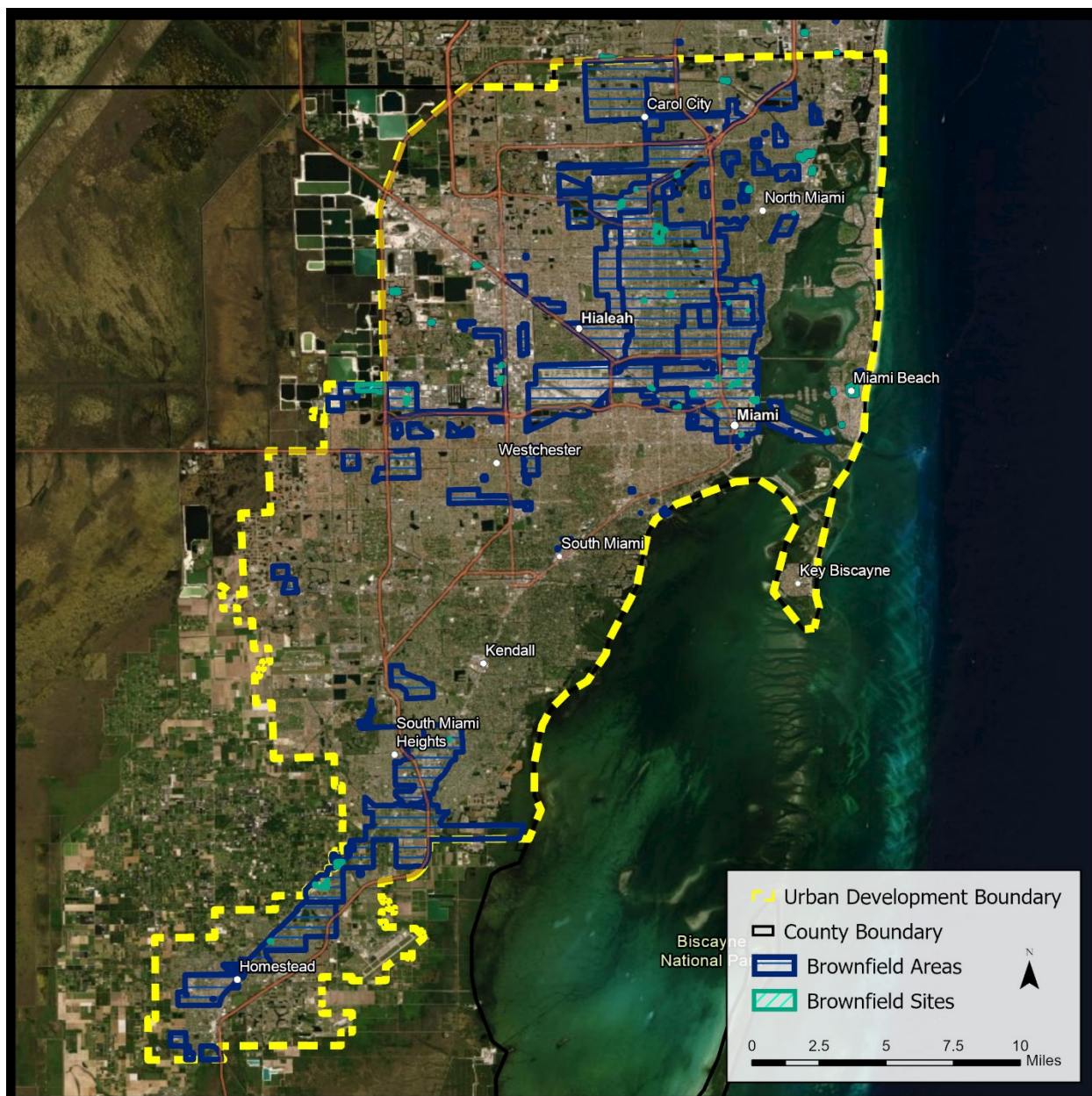


Figure 2-44. Brownfields Map within Miami-Dade County

Source: Florida Department of Environmental Protection (FDEP), 2019. Environmental Considerations GIS Tool, Brownfield Areas and Contaminated Sites. Retrieved from: <https://ca.dep.state.fl.us/mapdirect/?focus=brnfllds>. Accessed on: April 1, 2019.

Port

The Port of Miami is designated a "clean port," meaning that it does not transport bulk cargos such as petroleum, scrap metal, grain, phosphates, coal, or other potentially environmental threatening commodities. The USACE's 2004 Miami-Harbor Navigation Study noted that, "...the Port has a low potential for on-site contamination: the Port handles primarily containerized cargo and has

no facilities for large-scale storage or handling of hazardous or toxic materials. The Port's channels have been regularly deepened into environmentally un-impacted rock. Previous deepening projects removed all surface sediments (where contaminants might accumulate) and any potential historic contamination that might have accumulated in channel bottoms.” (Dial Cordy 2004)

2.17 SAFETY

Definition of Resource

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.

Methodology

In reviewing public safety, the safety of the public may be evaluated in terms of flood risk to life and property. This analysis considers flood extents and identifies structures potentially affected by a major flood event. For tidal flooding improvements, the major flood event would be tropical storms, hurricanes, tropical depressions, or king tides. For the interior drainage, the major flood event considered is the 100-year storm event. Safety is evaluated in terms of initial risk, emergency response, and communication of emergency procedures to the potentially affected populations. The potentially affected population consists of the public at risk of harm from flooding, including those residing in and/or working on project construction, maintenance, and operation in the county of Miami-Dade.

Framework

The Federal Emergency Management Agency (FEMA) coordinates the administration of disaster relief resources and assistance to states. FEMA is part of the Department of Homeland Security (DHS). There are numerous federal laws and policies that mandate and provide guidance on how national emergency response and assistance is conducted and define the role that FEMA has in conjunction with states and localities. Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act), PL 100-707, amended in 2016, constitutes FEMA and FEMA programs for Federal disaster response activities. Under the Stafford Act, a state governor in an emergency situation that exceeds the state’s ability to respond can request assistance and the President can declares all or a portion of the state a “major disaster” or “emergency” area. (ASTHO 2019)

The Disaster Recovery Reform Act of 2018 was passed to better outline the shared responsibility for disaster response and recovery, prepare for catastrophic events, and to reduce the complexity of current regulation.

Presidential Policy Directive 8 (PPD-8) is aimed at strengthening the security and resilience of the United States through systematic preparation for the threats that pose the greatest risk to the security of the nation, including acts of terrorism, cyber-attacks, pandemics, and catastrophic natural disasters. It requires an annual National Preparedness Report to evaluate and measure the strengths and weaknesses for all levels of government in preparedness.

The National Incident Management System (NIMS) provides guidance to all levels of government and the private sector to work together to prevent, protect against, mitigate, respond to, and recover from all types of incidents. The National Response Framework (NRF) also provides guidance on how the federal government responds to disasters.

The State of Florida Comprehensive Emergency Management Plan (CEMP), provides the framework for how the state will support impacted local governments, individuals and businesses. Florida law establishes the Comprehensive Emergency Management Plan as the master operations document for the State of Florida and it is the framework through which the state handles emergencies and disasters. It defines the responsibilities of the government, private, volunteer and non-governmental organizations that comprise the State Emergency Response Team (SERT). The document consists of a Basic Plan, which describes the process for preparedness, response, recovery, and mitigation activities of the SERT. It also contains an annex for the eighteen Emergency Support Functions (ESFs), the primary mechanisms for providing assistance at the state level, and annexes for responding to specific hazards such as wildfires and pandemic disease outbreaks. The CEMP ensures that all levels of government are able to mobilize as a unified emergency organization to safeguard the well-being of the state's residents and visitors. All other disaster response plans in Florida must be aligned with the CEMP.

As part of Miami-Dade County's CEMP plan, it analyzes mitigation strategies to minimize potential risks and provides a vulnerability assessment. Noted in its Local Mitigation Strategy (LTS) are the following vulnerabilities for the County: drought, erosion, flooding, hurricanes and tropical storms, saltwater intrusion, sea level rise, severe storms, tornados, wildfires, and winter storms. (Miami-Dade, 2019) The LTS also describes the coordination efforts for all aspects of emergency management that are ongoing between the County, municipalities, state, and federal entities to help access and mitigate these vulnerabilities.

In accordance with 27P-6.0023, Florida Administrative Code, County Comprehensive Emergency Management Plans and County Emergency Management Programs, requires each jurisdiction to prepare and keep current a local emergency operations plan. Every four years the jurisdiction shall conduct a comprehensive review and revision of its emergency operations plan to ensure it remains current. The revised plan shall be formally adopted by the jurisdiction's governing body.

The CEMP complies with NIMS and incorporates the guidelines outlined in the Incident Command System (ICS). Florida's CEMP mirrors the activities and functions outlined in the NRF and the National Disaster Recovery Framework (NDRF). (FDEM 2020)

Existing Conditions

Due to MDC unique location and climate it is susceptible to drought, erosion, flooding, hurricanes and tropical storms, saltwater intrusion, sea level rise, severe storms, tornados, wildfires, and winter storms. For the purpose of this report, the discussion will include an overview of natural based disasters and significant weather events and the existing services within the study area to respond to these events. This discussion does not include man-made or other types of disaster related events.

Hurricanes/Tropical Storms/Severe Storms/Tornados

Based on the LTS data, MDC has a 16% chance of experiencing impacts from a hurricane, tropical depression, or tropical storm in any given year. These storms can cause extensive damage to both life and property through high winds, storm surge, torrential winds, and flooding. In addition, in the category of severe storms, there were 473 severe storm events, 136 occurrences of tornados, and 27 occurrences of winter storms from 1950 to 2017 reported in MDC. (Miami-Dade 2018)

Coastal Flooding

The County of Miami-Dade is a coastal locality. The County is surrounded by major bodies of water with Biscayne Bay and Atlantic Ocean to its east and the Everglades National Park with numerous rivers, lakes, and canals to its west. The County is located in a low-lying physiographic region with an average elevation of six feet above sea level, which presents additional challenges in flood mitigation because drainage gradients are limited. The proximity to water paired with low drainage gradients results in a significant percentage of the County that is susceptible to flooding from high tides, hurricanes, and other storm events. The intensity of this flooding ranges from nuisance flooding, typically associated with high tides, to severe, albeit less frequent flooding from hurricanes and major storms. The flooding causes damages to residential and commercial properties, roads, and other infrastructure.

Miami-Dade County, its municipalities, and the entire state of Florida have been working for years in cooperation to try to address coastal flooding problems. Many studies, flood mitigation projects, and capital improvement projects are underway to help to address coastal flooding and sea level rise.

Sea Levels are rising in and around the MDC because of Miami's unique location and ocean currents. It is estimated that the total number of acres within Urban Miami-Dade to be impacted by sea level rise for a 1-foot scenario is 121,378 acres (12%), for 2-foot 150,142 acres (16%) and for the 3 foot scenario it could be 168,896 acres (18%) of the county. (Southeast Florida Regional Climate Change Work Group 2012) Sea level rise is leading to serious flooding even when not associated with rain events. Much of the ground that the city was built on is comprised of limestone made from ancient reefs enabling the saltwater to penetrate from the ground up. (Loria 2018)

High tides and the highest tides of the year, king tides, are also associated with unprecedented flooding. King Tides are technically referred to as "perigean spring tides" but occur in both spring and fall seasons with the highest tides in Florida occurring in the fall. As sea levels rise, the frequency and intensity of these events are increasing.

It is also affecting the public health as flooding comes up through storm drains flooding streets and residential property during high tide events. Miami-Dade County lies close to sea level and its underground water supply is just below the ground surface. Therefore, major rain events sometimes leave rainwater nowhere to drain, causing occasional flooding in some areas of the County. The flooded water has the potential to be mixed with wastewater and stormwater and

can potentially contaminate drinking water. The saltwater intrusion from these flooding events also has the potential to affect freshwater plant life and contaminate drinking water.

When a hurricane, tropical storm, or tropical depression produces a deadly storm surge that may overwhelm coastal areas as it makes landfall. Storm surge is water pushed onshore by the force of the winds swirling around the storm. This advancing surge combines with the normal tides to create the hurricane storm tide, which can increase the average water level 15 feet or more.

Coastal Erosion

Coastal erosion is a serious problem for the County's coastline. The beaches along the coastline serve as a natural barrier to protect from storm surges and sea level rise. The most severe erosion typically occurs due to extreme storms and hurricane events. In 2017, Hurricane Irma caused beach erosion throughout the County with an estimated loss of about 170,000 cubic yards of sand. (Miami-Dade 2018)

Emergency Services

Miami-Dade County's thirty-four municipalities, each has its own government and provides city services such as police and fire rescue. Miami-Dade County provides metropolitan services such as emergency management, airport, and port operations to all residents within the County.

Police Department

The Miami-Dade Police Department (MDPD) is full-service County Police Department serving MDC unincorporated area for police services. The MDPD has approximately 4,700 employees, making it the largest police department in the southeastern United States. The MDPD operates out of eight district stations throughout MDC with specialized patrol teams and assists with emergency management. MDPD works with police departments from the local municipalities as well as DHS to respond to emergency incidents, including natural disasters. Each incorporated municipality has its police department although a few contract with the County for police and fire services.

The Miami Police Department (MPD) has over 1,100 police officers that have jurisdiction within the city limits and work jointly with MDPD and other adjacent municipality police departments.

Fire-Rescue Services

The Miami-Dade Fire and Rescue Service District (MDRF) provides services to the entire County except for the cities of Hialeah, Miami, Miami Beach, Key Biscayne, and Coral Gables. Each of these aforementioned cities has their own fire rescue departments. The City of Miami Department of Fire-Rescue provides fire protection services and emergency medical care within the city limits.

MDRF is the founding member of one of Florida's two FEMA Urban Search and Rescue Task Force. Florida Task Force 1 (FL-TF1) is available to respond to natural or man-made disasters around the county and world and assist with search and rescue, medical support, damage assessment, and communications. The Task Force works in cooperation with FEMA, the State of Florida, and other agencies to coordinate response efforts.

Miami-Dade County has numerous hospitals within its limits to include one Level I Trauma Center and 2 Provisional Level I Trauma Centers. Each hospital has associated ambulance and emergency response services.

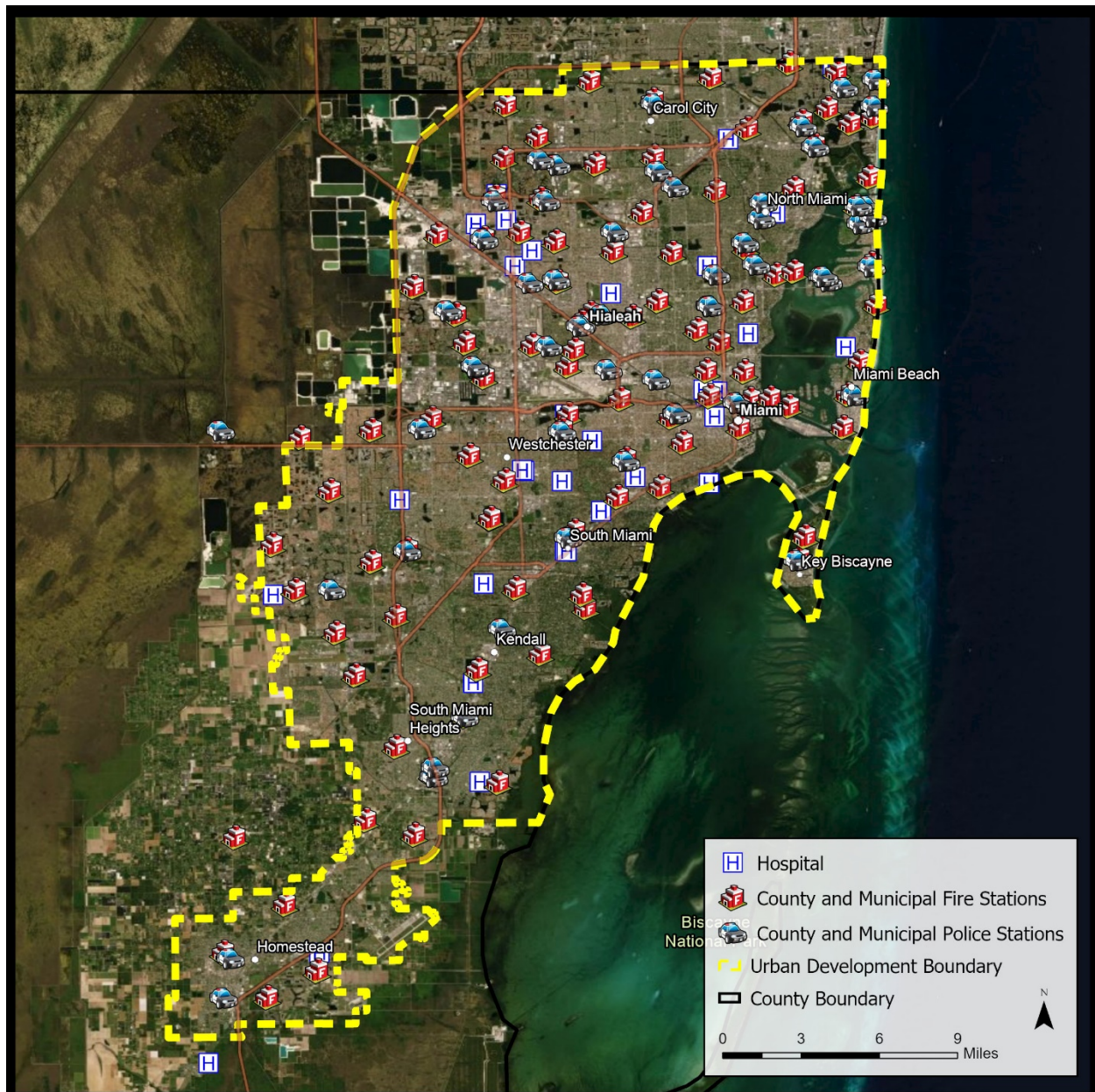


Figure 2-45. Emergency Management Service Stations, Fire Stations, and Hospitals

Emergency Management

The County's Office of Emergency Management operates under Miami-Dade Fire Rescue Department and has its own CEMP. The CEMP provides the foundation to ensure the County and all of its municipalities are prepared for emergencies. The Miami-Dade County's CEMP outlines the roles of the localities, state, federal agencies, and volunteer organizations to respond in emergency situations. Annually the County publishes an Emergency Preparedness

Report to ensure the status of the County's ability to prepare for and respond to disasters and emergencies.

The City of Miami Department of Fire-Rescue is responsible for coordinating disaster preparedness, response, recovery, and mitigation concerns for all of the City's departments and updates the City's CEMP. The City's Emergency Responses Division under the Fire-Rescue Department oversees preparedness for multiple types of emergencies and disasters. (City of Miami 2019)

The County has also received recognition along with certain communities within MDC for being "Storm Ready" under a National Weather Service's StormReady Program to encourage localities to take a proactive approach to strengthen their safety programs and emergency response plans for hazardous weather.

Emergency Evacuations

The County and its municipalities each have established emergency response services in place. One example is the Emergency & Evacuation Assistance Program (EEAP) which provides evacuation support programs for residents who need specialized assistance. The EEAP may be used for emergencies and hazardous events, both manmade and natural. Evacuation routes are discussed in both the transportation and navigation sections.

Miami-Dade County's website notes that there are two types of evacuation instructions – an evacuation recommendation and an evacuation order. The County also has designed a detailed Storm Surge Planning Zone Finder whereby residents can input their address to see if they are at risk for storm surge. For those without vehicles, there are also bus pick-up locations. The County also has an interactive map based on address for when an evacuation order is given. The Evacuation Orders map lists the areas by zone for evacuation shown in Figure 2-48.

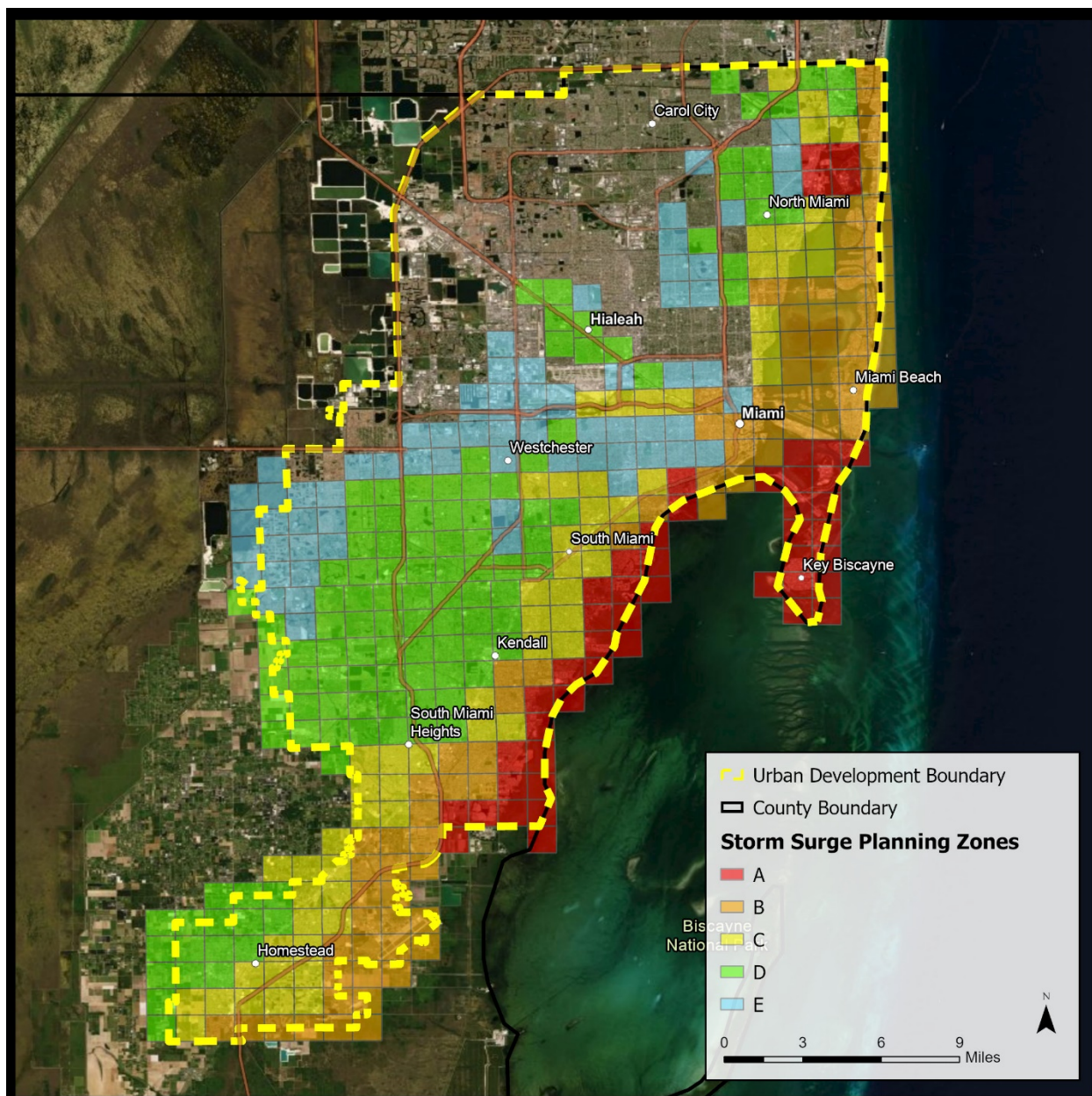


Figure 2-46. Storm Surge Planning Zones

2.18 TRANSPORTATION

Definition of Resource

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, bridges, public transit services, freight rail lines, and non-motorized transportation facilities (including bicycles, sidewalks, and pedestrian trails). It should be noted that recreational trails

are covered under the Recreation section of this document and navigation is covered under the Navigation section of this document.

Methodology

The ROI for transportation includes all roadways to include the right-of-way (ROW) of (freeways, major and minor arterial roads, collector roads, and neighborhood roads) and bridges; train, light rail, bus routes, other mass transit, and pedestrian sidewalks within the Study Area, that will be affected directly or indirectly by the project.

Framework

The Florida Department of Transportation (FDOT) regulates the establishment and maintenance of public transportation projects within the State of Florida. FDOT has authority through a Memorandum of Understanding (MOU) dated December 2016 to assume the Federal Highway Administration (FHWA) responsibilities for compliance with NEPA and all other Federal environmental laws pertaining to the review or approval of FDOT's transportation highway projects. FDOT's District Six is responsible for planning, designing, building and maintaining all State-owned roadways and bridges in Miami-Dade and Monroe counties with roads that are traveled an estimated 30.8 million miles daily. (FDOT 2019)

The Miami-Dade Transportation Planning Organization (TPO), formally called the Metropolitan Planning Organization for the Miami Urbanized Area, guides the transportation planning process in MDC. (Miami-Dade TPO 2019) The TPO oversees the federally-mandated regionally-based long-range transportation planning process for urbanized areas to ensure that federal regulations and projects are in accordance with endorsed plans and programs. FDOT adopts the TPO's Long Range Transportation Plan (LRTP) as the plan for implementing transportation improvement projects in MDC. (Miami-Dade TPO 2019)

There are a multitude of transportation plans that include the study area and overlap in their initiatives but a few include: Miami-Dade County's Comprehensive Development Master Plan (CDMP) lays out its general objectives and policies addressing development and land use over the next 10-20 years (Miami-Dade County 2018), Miami-Dade County Vision Zero Plan aimed at reducing fatalities and injuries from the transportation network, a 2045 Long Range Transportation Plan (LRTP), the Strategic Miami Area Rapid Transit (SMART) Moves Program which is advancing six rapid transit corridors for improvements with greater options for pedestrians and cyclists and self-driving vehicles along with an improved Bus Express Rapid Transit (BERT) initiative to implement mass transit projects within MDC. (Miami-Dade TPO 2019) In addition, the State of Florida has a long range transportation vision and policy plan entitled the Florida Transportation Plan (FTP).

Miami-Dade Expressway Authority, MDX, is a state sanctioned, locally administered, public agency created in 1994 by the State of Florida and the Board of County Commissioners of Miami-Dade County. MDX oversees, operates and maintains five toll expressways: S.R. 836/Dolphin Expressway; S.R. 112/Airport Expressway; S.R. 874/Don Shula Expressway; S.R. 878/Snapper Creek Expressway; and S.R. 924/Gratigny Parkway. (MDX 2020) There is current litigation as of early 2020 that might result in changes to MDX's jurisdiction and management.

In 2010, MDC released *GreenPrint: Our Design for a Sustainable Future* which outlined a fully collaborative “roadmap” to become MDC first Climate Action Plan and outlined 137 separate initiatives. (Miami-Dade County 2010) This was developed by the City of Miami’s Mayor’s Sustainability Advisory Board, Miami-Dade County, the Climate Change Advisory Task Force, the Southeast Florida Regional Climate Change Compact partners, community stakeholders, local partnering agencies, and many more. In December 2015, an update was provided on the County’s progress towards meeting the guidelines established in *GreenPrint*. One aspect of the update included the Responsible Land Use and Smart Transportation and detailed the status of each initiative (i.e. better integrating land use and transportation modeling for the long-range transportation planning process, innovative and additional funding mechanisms, prioritizing infrastructure and service areas to be consistent with the CDMP, increasing cycling and pedestrian corridors, etc.).

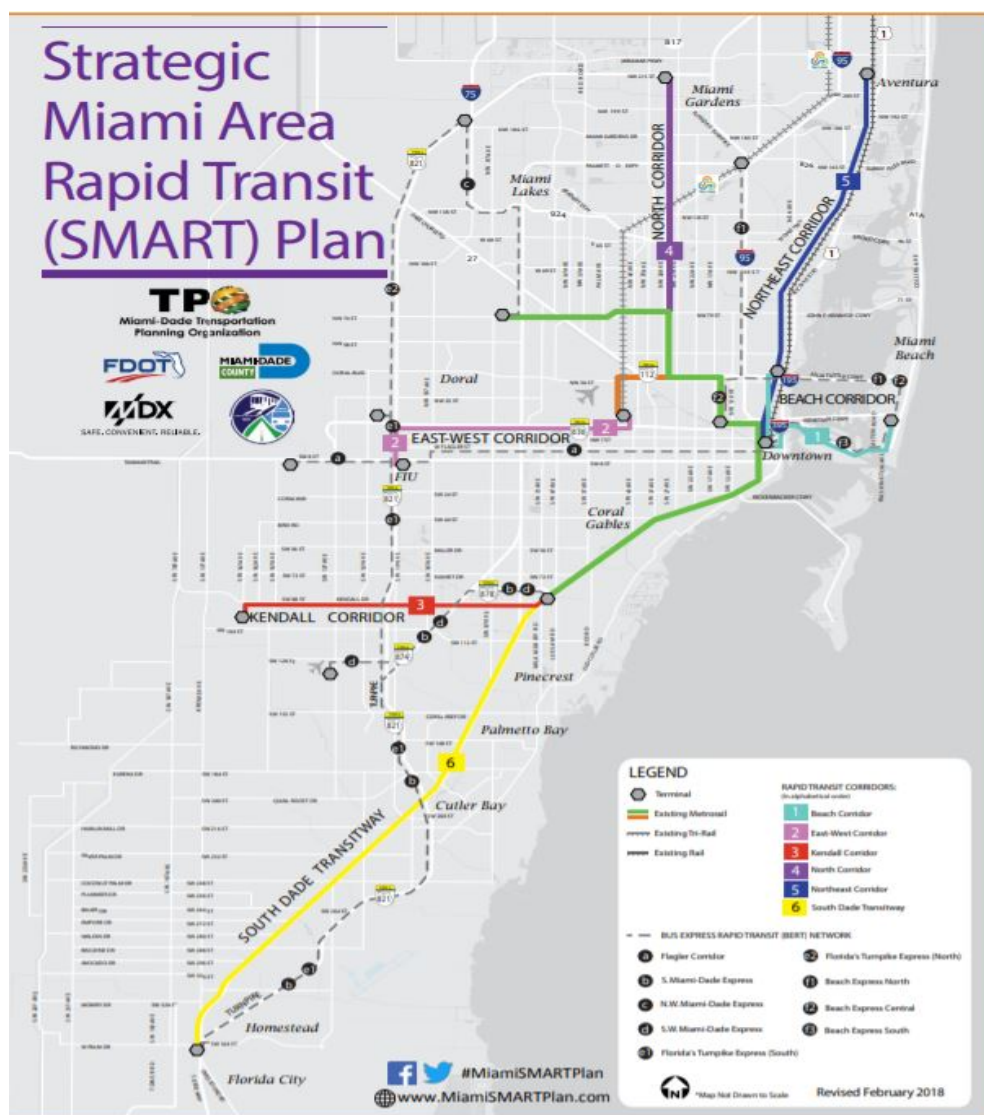


Figure 2-47. Strategic Miami Area Transportation Areas

Miami-Dade County is home to a massive network of a freight transportation system that serves as a forefront in moving freight domestically and internationally. “This system serves as the cornerstone of the region’s economy, providing goods and services to Florida’s largest consumption market as well as connecting the region to the global economy through major sea and air gateways, taking into account emerging and future technologies.” (Miami-Dade TPO 2019) There is also a well-established Freight Plan which was most recently updated in June 2018. The 2018 Freight Plan, prepared by MARLIN Engineering, Inc. for the Miami-Dade TPO, updated the previous plan, developed an application for a MDC designated Freight Logistics Zone (FLZ), and coordinated with freight stakeholders in the preparation of an updated list of transportation needs. (MARLIN 2018) The list of projects developed in the Freight Plan also went forward for consideration as projects to be funded in the development of the TPO’s Year 2045 Long Range Transportation Plan (2045 TPO LRTP). Regional and statewide Freight Plans also exist whereby the Miami-Dade’s Freight Plan is incorporated, the South Florida Regional Freight Plan and the Statewide Freight Mobility and Trade Plan. (Miami-Dade TPO, 2019)

The 2018 Freight Plan included a proposed Miami-Dade County Freight Logistics Zone (FLZ) Designation. In 2015, the Florida Legislature created a new section in Florida Statutes Chapter 311, “Designation of state freight logistics zones (FLZs)”. FLZs provide a framework for potential funding to freight projects within defined boundaries. FLZs are intended to increase the efficiency of freight moving to, from, and through the designated area. The proposed Miami-Dade FLZ includes the entire county and encompasses key subareas that provide for freight and logistics operations. (MARLIN 2018)

The Port of Miami is part of multiple long range transportation plans to include its own 2035 Master Plan. The long range plan is focused on improving processes while anticipating an unprecedented growth in its cargo traffic and cruise travel operations. The PortMiami 2035 Master Plan is a sub-element of the CDMP. The plan also includes emission reduction initiatives and notes its current successes and future goals to reduce air and diesel emissions associated with cargo equipment and daily operations.

The Florida Division of Emergency Management (FDEM) has evacuation modeling that was developed in 2008 and 2009 in coordination with eleven Regional Planning Councils in Florida. This modeling is entitled the Statewide Regional Evacuation Study Program (SRESP) model. This model includes planning assumption, a traffic evacuation zone (TEZ) system, and an evacuation highway network. An evacuation transportation analysis report was published by WilburSmith Associates for FDEM in 2010 and at the time reported that there were 17,238 TEZ zones in Florida. (WilburSmith 2010) The model makes certain assumptions over traffic behavior and results in clearance times for evacuation.

Existing Conditions

Transportation is first discussed herein, in an overarching sense, in terms of the Study Area as a whole and detailed where applicable within the Study Area. It should be noted that intention of this section of the report is not to describe all transportation corridors within the Study Area, which would be an exhaustive document in and of itself. Rather, the intention is to first describe an overview of transportation network and options within the County as a whole, while focusing in greater detail on those areas that will be directly or indirectly affected by the project.

The area is served by one public airport (Miami International Airport (MIA)), four private airports (Miami-Kendall Executive Airport, Miami-Opa Locka Executive (OPF) Airport, Miami Homestead General Aviation Airport, and MIA's General Aviation Center), the Florida East Coast Railway (FEC) and other rail lines, Hialeah Railyard, the deep-water Port of Miami, the Miami River and IntraCoastal Waterway, roadways that consist of interstates, toll roads/expressways, and other key state highways, and freight hub connectors (roadway, waterway, and/or railway connectors).

MIA is located on a 3,300-acre site about five miles northeast of downtown Miami in an unincorporated area of MDC. It is noted as one of the busiest international airports with over eighty airlines and an estimated 416,000 landings and takeoffs in 2018. (MIA 2019) The airport has approximately 35 million passengers each year and is a major hub for American Airlines. It is also the third largest international port of entry in the United States.

The Port of Miami is owned and operated by the Seaport Department of Miami-Dade County. It is located directly in downtown Miami in the Biscayne Bay and has ongoing terminal expansion and associated improvements projects. The port is a vital asset to the U.S. trade industry (in 2018, an estimated 1,000 cargo ships docked here with an estimated value of \$27 billion) and the cruise industry (in 2018 an estimated 1,220 cruise ships docked here). (PortMiami 2019) Many modes of transportation and industry are directly and indirectly associated with the port, for both people and goods, there are services such as intermodal rail, the airport, and tractor tug services, etc. "PortMiami is one of the largest container ports in Florida and is known as the cruise capital of world, Miami International Airport handles almost 80 percent of Florida's air cargo and is one of the busiest cargo airports in world, and the Miami River, an emerging SIS waterway, provides key niche waterborne cargo services to smaller ports in the Caribbean Basin and supports an active industrial core along the river corridor. Two railroads serve the region connecting South Florida to the rest of North America, providing intermodal and carload services, and a well-established network of roadways provide regional mobility as well as gateways to Florida and more distant hinterland markets. These transportation facilities complement a mature warehouse/distribution center and international banking and brokerage infrastructure that combined facilitate international trade activities." (Miami-Dade TPO 2019)

"The existing air, port, rail, truck and roadway transportation facilities complement the largest warehouse/distribution center agglomeration in the State as well as the international banking and brokerage infrastructure that facilitates international trade activities for the region." (Miami-Dade TPO 2019) The freight network and all of its components which are designated as Florida Strategic Intermodal System (SIS) facilities. SIS is listed as the highest priority network of transportation systems to support the State's economy and mobility. (MARLIN 2018)

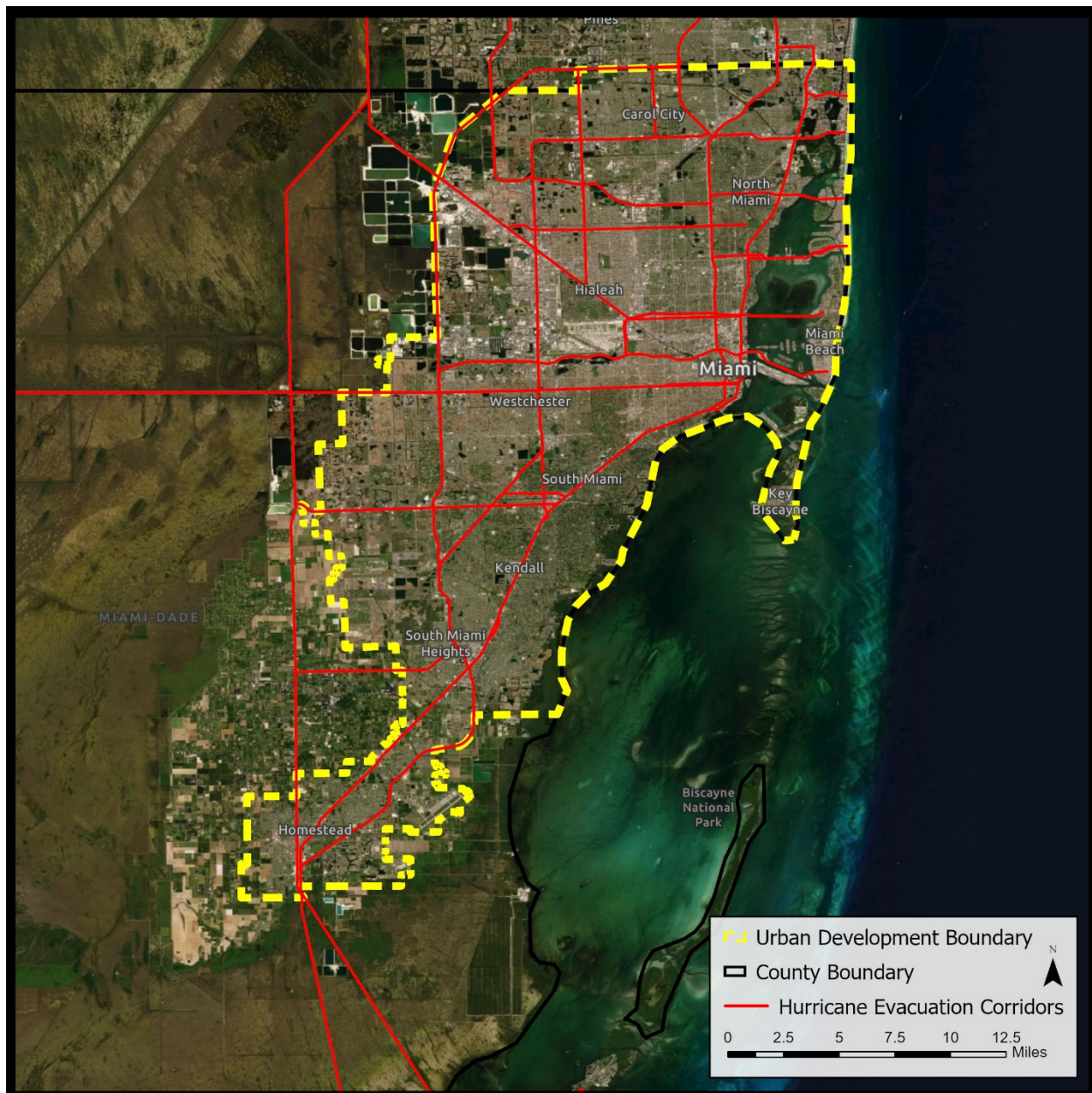


Figure 2-48. Miami-Dade County Evacuation Corridors

The railroad company of CSX Transportation, Inc. serves the Port of Miami. The Miami-Dade County Seaport Department owns 2.1 miles of track at the Port of Miami on Dodge Island, which consists of a main line track extending the length of the island and a four-track, closed-end intermodal rail yard. The main track on Dodge Island connects with the Florida East Coast Railway (FEC) via a rail bridge. A connection with CSX Transportation, Inc. is effected through an interchange in the west part of the City of Miami. (USACE 2004)

The Florida East Coast Railway (FEC) is a Class II regional railroad that has a 351 mile mainline track from Jacksonville to Miami, Florida. It is the only rail provider for the Port of Miami and in Jacksonville, Florida, the FEC connects to rail services nationwide.

The Port is also less than one mile from major highways: Interstate 95 and Federal Route 1 via Interstate 395, and Interstate 75 via Dolphin and Palmetto Expressways.

The road network in MDC consists of an arterial network of interstates, expressways, state highways and state roads, county roads, and city streets. A street grid stretches from downtown Miami throughout the county which was adopted by the City of Miami following World War I. The grid is laid out with Miami Avenue as the meridian going north–south and Flagler Street the baseline going east-west. There are also numerous bridges to include timed draw bridges such as U.S. Route 1 over the Miami River.

Miami-Dade County has multiple major expressways and one minor expressway in downtown Miami. These include: Interstate 75 (I-75), Interstate 95 (I-95), Airport Expressway (SR 112)/Interstate 195 (I-195), Palmetto Expressway (SR 826), Dolphin Expressway (SR 836)/Interstate 395 (I-395), and Florida's Turnpike Homestead Extension (SR 821). MDX is responsible for the maintenance and operation of five of the major expressways (SR 112, SR 836, SR 874, SR 878, and SR 924).

State highway roads such as U.S. Route 1, U.S. Route 27, U.S. Route 41, and U.S. Route 441 have corridors throughout the study area as well as state roads A1A, 874, 878, and 924. Miami-Dade has fewer county roads than any other location in Florida to include: County Road (CR) 854, CR 913, CR 948, CR 959, CR 973, CR 992, and CR 9823.

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.

FDOT also provides funding assistance to Miami-Dade Transit (MDT), which is the 14th largest public transit system in the United States and the largest in Florida. MDT oversees public transit services via the Metrobus, Metrorail, Metromover, and Paratransit. MDT operates 893 buses in the district. (FDOT 2019) The Metrorail is a 22 mile elevated rapid transit system that includes 22 accessible Metrorail stations and includes service to MIA. The Metromover is a fully automated people mover system that services central downtown Miami, and the Omni and Brickell areas. The Paratransit is a type of Special Transportation Services (STS) program that provides approximately 135,000 trips on a monthly basis. (FDOT 2020)

The Statewide Regional Evacuation Study Program (SRESP) model within Florida was last updated in 2015. Current evacuation models can be seen in Figure 2-48 in Section 2.7 SAFETY which account for increases in population since 2015. Evacuation routes within the study area are illustrated on Figure 2-51.

2.19 NAVIGATION

Definition of Resource

Navigation refers to the use of waterways, either primarily for transportation or recreational purposes, by any type of vessel. Vessels would include ships, barges, ferries, boats, sailboats, and small craft.

Methodology

The ROI for navigation includes the navigable waterways 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.

Framework

There are many regulations and regulatory authorities (Captain of the Port of Miami, the United States Coast Guard, the United States Navy, etc.) that implement these regulations for the waters in and around Miami. Title 33 includes the federal regulations over navigation and navigable waters. The regulated navigation areas under 33 CFR 165.726 in the study area include “all waters of the Miami River, Miami, Florida, from the Brickell Avenue Bridge inland to the South Florida Water Management District’s salinity dam.” (ECFR 1997) There are restrictions but one noted exception is that nothing will prohibit USACE from requiring the relocation or movement of vessels in a declared flood emergency.

The Florida Inland Navigation District (FIND) is a multi-county special district that regulates the management and maintenance of the Atlantic Intracoastal Waterway (ICW), which is also known as the M-95 marine highway. (FIND 2016) FIND’s oversight consists of twelve counties along the east coast of Florida from Nassau to Miami-Dade. The District also serves as the local sponsor for the ICW project and works with USACE to maintain the ICW. Acting as the local sponsor, FIND provides upland land parcels, right of ways (ROWs) for the management of dredged material. (FIND 2016)

The Florida Wildlife Commission regulates state recreational boating laws in Florida and notes that any violation of federal regulations is also a violation of state regulations. Florida’s state boating laws are summarized in Chapters 327 and 328 of the Florida Statutes. Florida Statute 943.10 also gives authority to law enforcement officers of FWC, counties, and municipalities to remove or relocate vessels that are deemed to be an interference to navigation or a hazard to public safety. (State of Florida 2019)

FWC’s boating regulations also provide for the protection of natural resources and threatened and endangered species. FWC has navigation charts that identify seagrass beds. Regulations state that boaters should stay within channels to the extent possible and avoid going through seagrass beds. It is against Florida law to damage seagrass in certain areas of the state of Florida’s waters. (FWC 2019) Manatees are protected by state and federal law. Boaters must abide by all applicable regulations and observe manatee protection zone requirements.

There are a multitude of long range plans for transportation and navigation that include the study area and overlap in their initiatives. Miami-Dade County’s Comprehensive Development Master Plan (CDMP) lays out its general objectives and policies addressing development and

land use over the next 10-20 years. (Miami-Dade County 2018) The Port of Miami is also part of multiple long range transportation plans with its own 2035 Master Plan, which is a sub-element of the CDMP. The long range plan is focused on improving processes while anticipating an unprecedented growth in its cargo traffic and cruise travel operations.

Existing Conditions

Overall, the waters surrounding Miami are used regularly by commercial shipping industries, cruise travel, the military, commercial fisheries, commercial tourism, and private use watercraft. The deep-water port of PortMiami, Biscayne Bay, the Miami River and Intracoastal Waterway, as well as an intricate network of other rivers and canals all serve as a vital network of navigable waterways in MDC.

Ports

The Port of Miami is owned and operated by the Seaport Department of Miami-Dade County. It is located directly in downtown Miami in the Biscayne Bay and has ongoing terminal expansion and associated improvement's projects. The port is a vital asset to the U.S. trade industry (in 2018, an estimated 1,000 cargo ships docked here with an estimated value of \$27 billion) and the cruise industry (in 2018, an estimated 1,220 cruise ships docked here). (PortMiami 2019) Many modes of transportation and industry are directly and indirectly linked to the port, for both people and goods, there are services such as intermodal rail, the airport, and tractor tug services, etc. "PortMiami is one of the largest container ports in Florida and is known as the cruise capital of world..." and, "the Miami River, an emerging SIS waterway, provides key niche waterborne cargo services to smaller ports in the Caribbean Basin and supports an active industrial core along the river corridor." (Miami-Dade TPO 2019)

The Port is connected to the Miami mainland by two bridges, "...a 65- foot vertical clearance, fixed span vehicular bridge with a horizontal clearance of 90 feet, and a bascule rail bridge with a vertical clearance of 22 feet at center and a horizontal clearance of 90 feet. It is linked to the Florida East Coast Railroad Company's main line track." (USACE 2004, page 11)

Federal Channels

Federal Navigation Channels, as defined by the U.S. Army Corps of Engineers "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. Within the ROI, the authorized federal navigation channels include the Intracoastal Waterway, portions of Biscayne Bay, and the Miami River as illustrated in Figure 2-52. The Intracoastal Waterway Project is primarily a small boat channel that extends from Trenton, New Jersey to Miami, Florida along the east coast of the United States. That waterway has a bottom width of 125 feet and a depth that varies from 10 to 12 feet. (USACE 2004) The Miami River is a federally authorized channel that was constructed in the 1930s.

The Miami River is a federally authorized channel constructed in the 1930s. The width of the channel varies from 150 feet wide at the mouth of the river, to 125 feet wide above the NW 17th Avenue bridge, to 90 feet wide above the NW 27th Avenue bridge. (Dial Cordy 2004) The Miami River dredging project was completed in 2008, allowing for a depth of -15 feet mean low

tide and included both the Federal Channel and the Non-Federal Channel for the 5.5 mile long narrow shipping corridor.

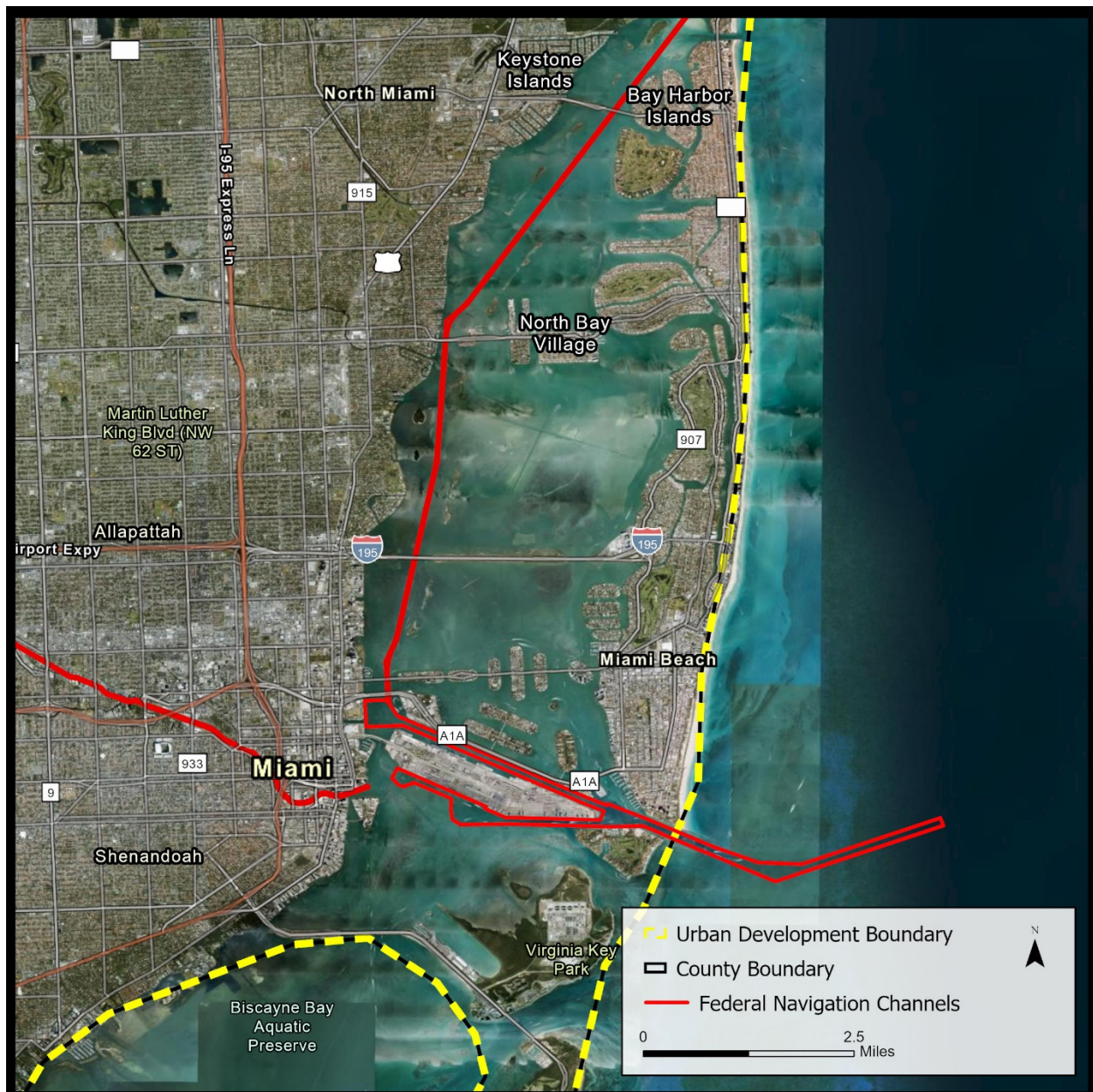


Figure 2-49. Federal Navigation Channels, Miami-Dade County

Nonfederal Channels

Within the ROI, the nonfederal channels include the Little River, Biscayne Canal, portions of the Miami River, and other smaller waterways as shown in Figure 2-52.

Mooring Buoys

Mooring buoys, which are 18 inches in diameter with a blue stripe, are used in MDC as an alternative to anchoring, which can break and damage the coral reef. There are over 42 mooring

buoys available for use within MDC available on a first-come, first-served basis at no cost to the boater.

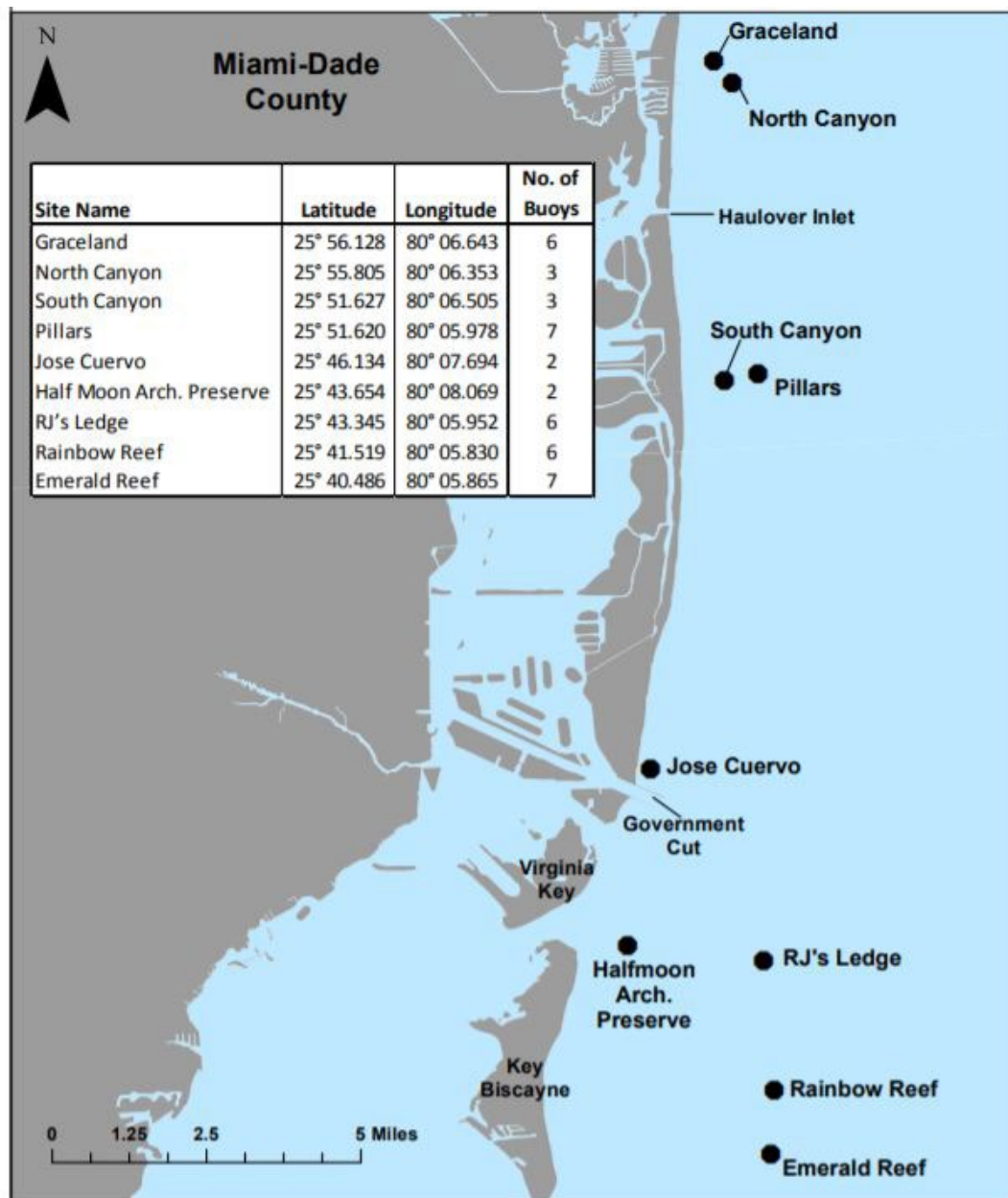


Figure 2-50. Miami-Dade County Mooring Buoy Sites

Evacuation Routes

The Miami River is used as an evacuation route to get boats further inland. The Miami River has commercial marinas and dry docks that stretch further inland offering safety for vessels in a hurricane protected safe zone. For both routine storage and during impending storm events, boats ranging in size from small vessels up to some mega-yachts can be stored in pre-arranged boat lift slips. When a hurricane is approaching, MDC announces certain times to the public that drawbridges will be locked into place.

Protected Areas

All the waters in MDC were designated a critical habitat for the manatee under the Endangered Species Act (ESA) in 1976. The Manatee Protection Areas in Biscayne Bay (Figure 2-56) were designated as an essential manatee habitat under the 1995 Miami-Dade County Manatee Protection Plan (DERM 1995). The protection areas also include designated Manatee Protection Zone (DCMPZ) Limited Marine Construction Areas, No-Entry Manatee Protection Zones, and designated Essential Manatee Habitat areas.

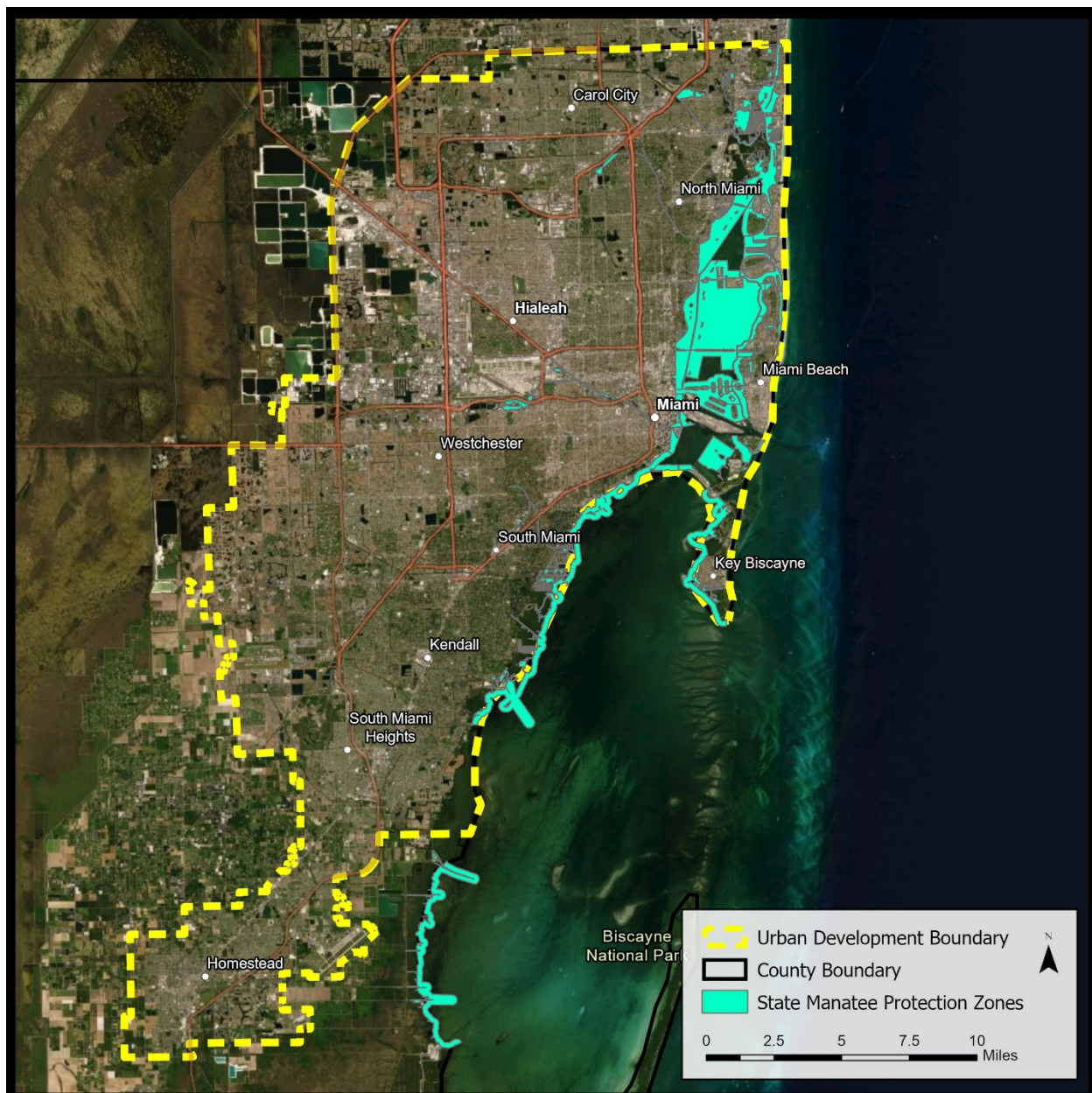


Figure 2-51. Map Showing Manatee Protection Area

The Bill Sadowski Critical Wildlife Area (BSCWA) is located south of the Port of Miami. BSCWA was established in 1990 and includes an area of about 700 acres designated to protect the

shallow submerged seagrass and hardbottom habitats, intertidal mudflats, and coastal mangrove wetlands in the Biscayne Bay area west of Virginia Key. The area serves as a refuge for shorebirds, wading birds, manatee habitat and calving grounds, shark habitat, small tooth sawfish, and countless other marine life with success in wetland restoration efforts on its shores. Buoys mark the BSCWA boundary onsite and the area is closed to boating year-round.

Other Projects/Studies

There are numerous dredging and construction projects and studies in MDC that include aspects of navigation. USACE's Jacksonville District (SAJ) is currently conducting the Miami Harbor Navigation Improvements Study to assess the effects of potential navigation improvements to Miami Harbor. The alternatives under consideration for this study include no action plan include widening and/or deepening specific areas within Miami's federally authorized channels. USACE SAJ has completed construction for the Miami Harbor Deepening Project, which was the first Federal navigation project in the southeast built to a 50-foot depth to accommodate the present day shipping needs. There are also ongoing projects in the Biscayne Bay and surrounding waterways to include beach erosion control projects, shoreline stabilization projects, and environmental restoration projects.

2.20 UTILITIES

Definition of Resource

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 an 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.

Methodology

Regional utilities occurring within the Study Area are discussed below. Potential impacts and mitigation measures related to the implementation of the Proposed Action are assessed based on their effects in relation to the existing utility infrastructure. The ROI for utilities is the Study Area, the County of Miami-Dade and its bordering waterways.

Framework

Surface Water Quality Standards are defined in Chapter 62-302 of the Florida Administrative Code (FAC) and establishes 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, a collection of state laws organized into a code by subject matter, authorizes the Florida DEP to establish a state National Pollutant Discharge Elimination System (NPDES) permitting program in accordance with Section 402 of the Clean Water Act.

Article IV and V of Chapter 24, Environmental Protection, of the Miami-Dade County Code of Ordinances include the regulations for both stormwater management and stormwater utilities. The stormwater utility was established in MDC in 1991 to help solve the problem of polluted stormwater and to improve the drainage capability to flood-prone areas (Miami-Dade County 2019). The stormwater utility is responsible for the operation, maintenance, and governance of a Countywide stormwater utility to plan, construct, operate, and maintain stormwater management systems as set forth in the local program and required under Section 403.0891(d) of the Florida Statutes. It may also authorize one or more districts or sub-districts within its service area. The City of Miami is the permitting authority for all land-disturbing activities and oversees all aspects of stormwater management and inspection of stormwater facilities within the city limits. Other municipalities within MDC have similar authority over stormwater management programs.

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 covering sixteen counties to include MDC.

The Miami-Dade County Enforcement of Protection of Underground Utilities, 21-220, is an ordinance to enforce by civil penalties the provisions of Chapter 556, Florida Statutes, protecting underground facilities and thereby preventing personal injuries and interruption of vital services. Any violation of Sections 556.105, and 556.107 through 556.109 of the Florida Statutes is also a violation of this ordinance.

Existing Conditions

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

Utilities such as, gas, telecommunication and electricity are all operated by privately owned companies that provide service to the County. Information on gas lines is proprietary so a discussion on gas lines is limited.

MDC Utility Coordination Map

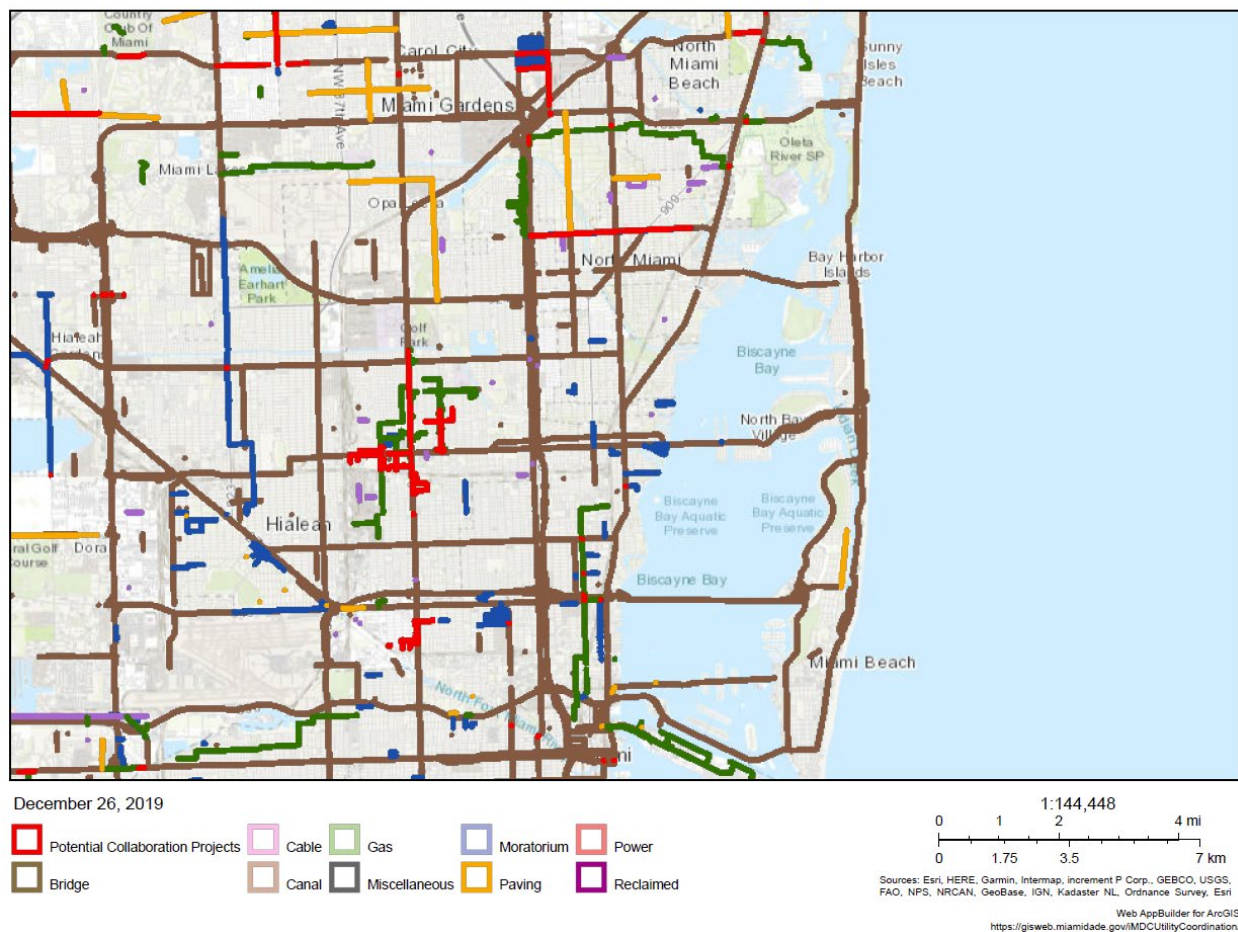


Figure 2-52. Miami-Dade County Utility Coordination Map

Water/Wastewater

Miami-Dade County is the largest water and sewer utility in the southeastern United States. The Miami-Dade Water and Sewer Department (WASD) maintains more than 7,700 miles of underground water lines, as well as about 6,200 miles of sewer lines, with three regional water plants and serving some 2.3 million residents and thousands of visitors. WASD withdraws approximately 300 million gallons of water every day from the Biscayne Aquifer. (Miami-Dade 2019) The department is currently researching alternative water supply sources including reclaimed water projects as well as extracting water from the Florida Aquifer, water efficiency programs, and water loss reduction initiatives.

WASD service area relies on underground pipes and aboveground facilities to transport wastewater to its three major treatment plants as well as septic tank systems. Where needed the service area also has pump stations to lift wastewater from a lower to a higher elevation. Within MDC, there are approximately 730 facilities with private pump stations and approximately 1,420 public pump stations currently in operation. (Miami-Dade 2019) Effluents from wastewater treatment plants in MDC discharge to an ocean outfall, deep well injection, and/or are used for underground irrigation.

WASD owns a force sewer main in a submarine crossing within the Biscayne Bay leading from downtown Miami to its Virginia Key Wastewater Treatment Plant. Additionally, WASD owns a water main in a submarine crossing leading from Fisher Island to Lummus Island.

Stormwater

Throughout the County, 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).

The City of Miami is in process of updating the previous Stormwater Master Plan (SWMP) that was completed in 2012. The SWMP is directly associated with Miami-Dade County's Comprehensive Development Master Plan (CDMP). The City of Miami is currently in the phase of data collection and evaluation to update the SWMP, the City's consultants are digitizing 30,000 plans of stormwater systems and 1,500 archived plans and documents to create digital maps of stormwater access and identify problem areas with flooding. A mobile phone application tool has been designed so that citizens can track and record flooding and backup draining events. The City through a "Miami Forever Bond" that passed in November 2017 includes a \$400-million dollar program to help the City of Miami combat sea-level rise and flooding. Various initiatives of this bond include the updates to the SWMP and the installation of tidal backflow valves throughout the City for stormwater and flood prevention efforts.

The Village of Miami Shores, City of North Miami, and other municipalities all within MDC have similar stormwater plans and ordinances governing stormwater management systems, implementation of BMPs, associated maintenance and improvements, and its funding through stormwater utilities. The stormwater utilities are operated as a normal utility that bills regularly to consumers.

Power

Due to confidentiality concerns, detailed information on mappings of the electrical distribution system is limited and only maps of transmission-level substations and power lines operated by Flower Power and Light, the power supplier for MDC, are available.

Florida Power & Light Company's (FPL) services more than 5 million customer accounts in Florida. According to its website, FPL is working on initiatives to strengthen power lines, upgrade grid technology, hardening of main power lines that serve critical community facilities and services, etc. The term "hardening" means to install structures with stronger materials that can withstand hurricane force winds and shortening the distance between poles and/or underground installation. In 2018, FPL started the "Storm Secure Underground Program," a three-year pilot program to find new affordable options to underground residential areas. In addition, by the end of 2022, FPL expects that all of its transmission structures will be steel or concrete. By the end of 2024, FPL expects to have hardened or undergrounded all main power lines within its distribution system. (FPL 2019)

FPL owns transmission lines in a submarine crossing leading from its Fisher Island plant to Lummus Island and other portions of Biscayne Bay.

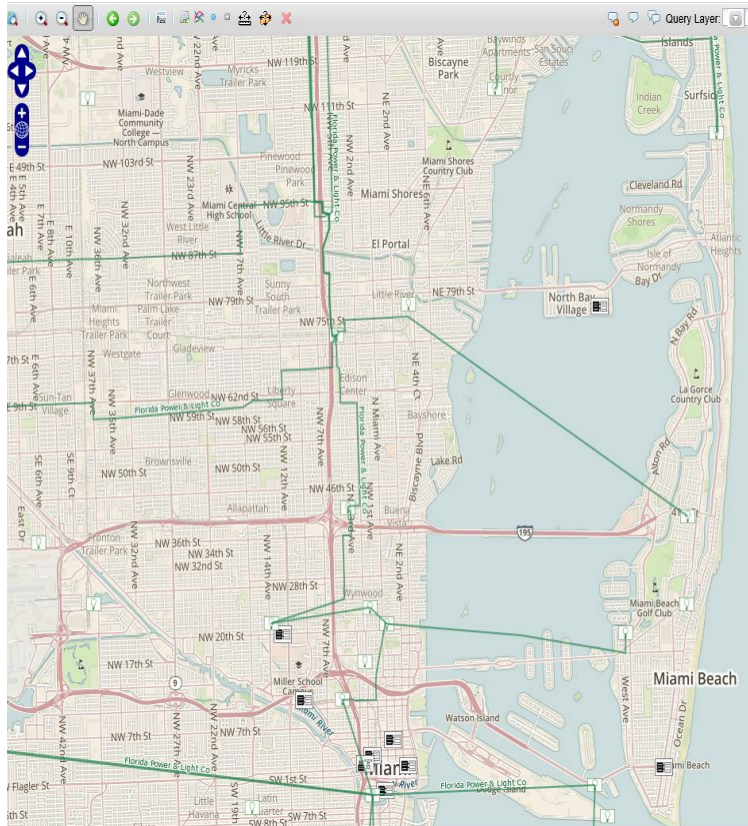


Figure 2-53. Miami-Dade County Electrical and Waste Management Facilities

Miami-Dade County has one nuclear power plant, Turkey Point Nuclear Power Plant, and one coal generation power plant. Some of the power utilized by FPL comes from the Turkey Point Nuclear Generating Station located in the southernmost edge of MDC which is at an elevation below sea level.

Florida City Gas is a natural gas distribution company also servicing residential and commercial customers in Miami-Dade County (west of Interstate 95). Florida City Gas is a subsidiary of NextEra Energy. Teco, Peoples Gas, an Emera Company also services Miami-Dade customers.

Telecommunications

Telecommunication utilities and associated infrastructure, such as fiber optic cabling and cellular communication towers, are present throughout the study area allowing residential and commercial access to services for purchase such as high speed internet and wireless communications. Multiple carriers serve Miami-Dade, including Verizon, Cox, NTelos, Sprint, AT&T, U.S. Cellular and Vonage. All communication is directed through wire centers, which are physical locations that contain telecommunications switches, including mobile services. Wire centers are vulnerable to flooding.

2.21 AIR QUALITY

Definition of Resource

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 U.S. Environmental Protection Agency (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.

Criteria Pollutants

Ozone

Ozone (O₃) builds up near the ground through a series of complex chemical reactions involving VOCs and NO_x (Volatile Organic Compounds, oxides of nitrogen; respectively) in the presence of sunlight. Ozone concentrations vary depending on the weather conditions. Ozone 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. ("Ground-level Ozone Pollution | US EPA", 2019) ("Florida's Air Quality | Florida Department of Environmental Protection", 2019)

Carbon Monoxide

Carbon monoxide (CO) is a colorless, odorless, poisonous gas produced by the incomplete combustion of fossil fuels. Sources of carbon monoxide affecting outdoor air includes: 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.

Long-term monitoring in Florida shows a significant decrease in carbon monoxide concentrations. Urban areas that use to suffer occasional high levels of carbon monoxide are no longer violating the air quality standard. As the result of vehicle emissions controls and local measures to reduce traffic congestion, Florida has not recorded a violation of the carbon monoxide standard since 1986. ("Carbon Monoxide (CO) Pollution in Outdoor Air | US EPA", 2019) ("Florida's Air Quality | Florida Department of Environmental Protection", 2019)

Nitrogen Dioxide

Nitrogen dioxide (NO₂) 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. Nitrogen dioxide can place a strain on the heart and respiratory system and can increase a person's susceptibility to respiratory infections and diseases.

Monitors in Florida have never measured a violation of the ambient standard for NO₂. ("Nitrogen Dioxide (NO₂) Pollution | US EPA", 2019) ("Florida's Air Quality | Florida Department of Environmental Protection", 2019)

Sulfur Dioxide

Sulfur dioxide (SO₂) is produced by power plants and industries that burn fossil fuels containing sulfur, such as coal and oil, and by the phosphate industry through its production of sulfuric acid. Sulfur dioxide is irritating to the lungs and can result in a higher incidence of respiratory disease.

Florida has made great strides in controlling SO₂ since the early 1970s when control strategies were first implemented, but occasional violations of the ambient air standard do occur. (FDEP 2019) These are usually associated with accidental releases at industrial facilities. Through its regulatory program, the Florida Department of Environmental Protection requires that industries determine the cause of any upsets and mitigate to prevent future incidents.

Particulate Matter

Particle pollution, also known as particulate matter, 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 the small or 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. PM₁₀ or coarse particles describe particles that are greater than 2.5, but less than or equal to 10 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.

The U.S. Environmental Protection Agency has established two health-based air quality standards for particle pollution, one for PM_{2.5} and the other for PM₁₀. The Florida Department of Environmental Protection, in cooperation with several county air pollution control agencies, monitors particle pollution air quality throughout the state. ("Particulate Matter (PM) Pollution | US EPA", 2019) ("Florida's Air Quality | Florida Department of Environmental Protection", 2019)

Lead (Pb)

Sources of lead emissions include pipes, fuel, and paint, however, with the phasing-out of leaded fuel and paints for their safer unleaded counterparts in the past two decades lead emissions have dropped to an all-time low.

Ambient air concentrations of lead in Florida reflect the decrease in auto emissions. Except for locations very near a small number of stationary sources that emit significant amounts of lead - such as secondary lead smelters - lead concentrations in Florida's air are nearly zero. ("Lead Air Pollution | US EPA", 2019) ("Florida's Air Quality | Florida Department of Environmental Protection", 2019)

Greenhouse Gas Emissions

Greenhouse gases (GHGs) are gases that trap heat in the atmosphere. Major greenhouse gases 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.

Methodology

The Region of Influence (ROI) for this project in regards to air quality is defined by the U.S. Environmental Protection Agency's section 4 regulatory boundary as being that of MDC, Florida, which comprises all of the county from Homestead in the south to North Miami Beach in the north except for the military bases.

Framework

Federal Requirements

To protect the overall health and wellbeing of the public and to prevent further damage to the environment, Congress established the Clean Air Act of 1970 (amended 1990), which requires the EPA to set and implement the National Ambient Air Quality Standards (NAAQS) for six criteria pollutants: ozone, particulate matter, nitrogen dioxide, sulfur dioxide, carbon monoxide and lead.

The EPA 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. (USEPA 2019)

Regulatory Requirements

Under the Clean Air Act, EPA sets specific limits on certain outdoor air pollutants that have been scientifically proven to have deleterious health effects in all regions of the United States. The Clean Air Act also gives EPA the authority to limit emissions of air pollutants coming from sources like chemical plants, utilities, and steel mills. Individual states, counties, cities or tribes may have stronger air pollution laws, but they may not have weaker pollution limits than those set by the EPA.

To ensure the NAAQS are achieved and/or maintained, the Clean Air Act requires each state to develop an enforceable state implementation plan (SIP). 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.

Established under the Clean Air Act (section 176(c)(4)), the General Conformity rule ensures that the actions taken by federal agencies, do not interfere with a state's plans to attain and maintain national standards for air quality.

The Clean Air Act also establishes a national goal of preventing degradation or impairment in any federally-designated Class I area. Class I areas are defined as all national parks over 6,000 acres and all wilderness areas and memorial parks over 5,000 acres. In Class I areas, visibility impairment is defined as a reduction in visual range and atmospheric discoloration. In the context of the Prevention of Significant Deterioration (PSD) for air quality permitting, an applicant must provide a separate analysis of air quality impacts in any Class I area that may be impacted by the new or modified facility.

Every area of Florida is within 250 kilometers of at least one Class I area. Therefore, all PSD applications are required to include a Class I air quality impact analysis. (USEPA 2018)

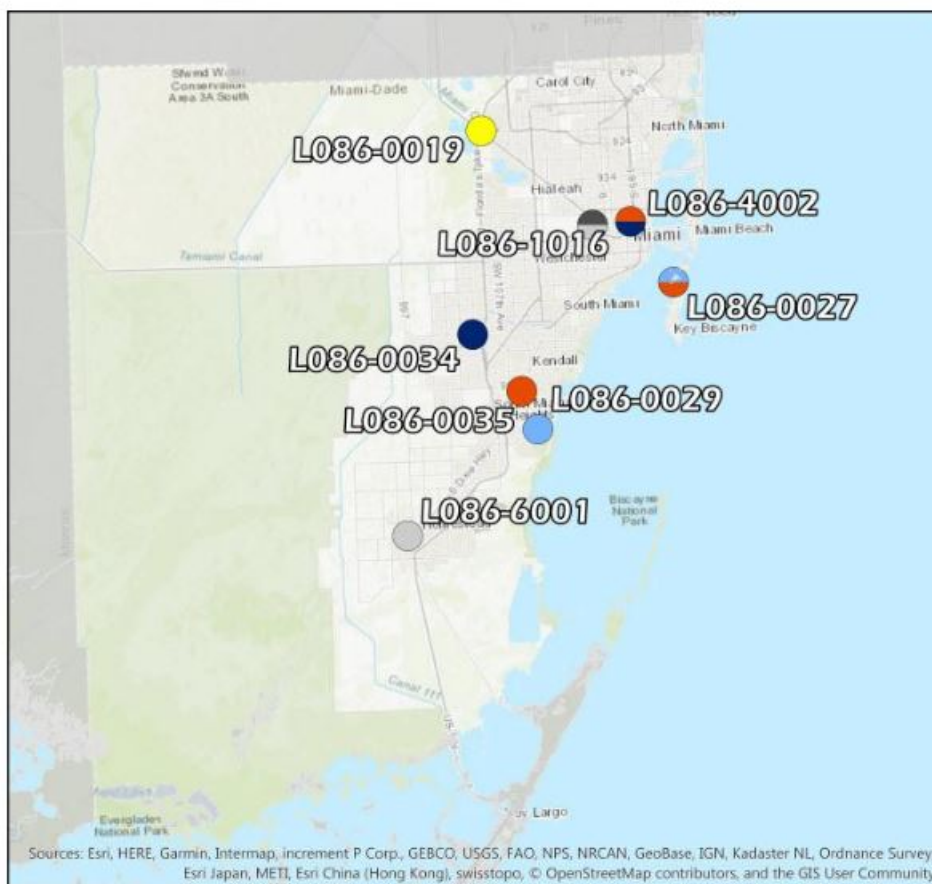
In accordance with Chapter 403 of the Florida Statutes, The Florida Department of Environmental Protection's Division of Air Resource Management is responsible for the protection and management of Florida's air resource, including air quality monitoring, permitting, and compliance. The FDEP manages a 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. (FDEP 2020)

Miami-Dade County is delegated permitting authority for the issuance of some FDEP permits. There are five types of state air permits: Construction Permits, Federally Enforceable State Operating Permits (FESOP), General Permits, Operational Permits and Title V Operational Permits. (Miami-Dade 2019) Facilities that emit or have the potential to emit greater than 1,000 pounds of lead per year, 25 tons of carbon monoxide, nitrous oxide, or sulfur dioxide, among other thresholds might require a FDEP air permit from the state.

Existing Conditions

Relevant Local Area

Florida's air quality has improved over the last two decades with monitored levels of criteria pollutants declining since 2000 and currently the lowest recorded on record. (FDEP 2020) Although there are 99 monitoring sites located throughout Florida and there are 8 air quality monitoring sites in MDC as shown in Figure 2-57.



- Ozone (O_3)
- Particulate Matter (PM_{10})
- Particle Pollution ($PM_{2.5}$)
- Sulfur Dioxide (SO_2)
- Nitrogen Dioxide (NO_2)
- Carbon Monoxide (CO)

Figure 2-54. Miami-Dade County Air Monitoring Stations

Miami-Dade County, Florida, which is on the southeastern coast of Florida is currently in attainment for all criteria pollutants according to EPA's Green Book. (USEPA 2019)

FDEP has an interactive map of active air-permitted facilities. Figure 2-58 shows the locations of all active facilities with current air permits within and adjacent to the study area. Title V Facilities include the North District Wastewater Treatment Plant, Central District Wastewater Treatment Plant, Eastern Aero Marine, Inc. Plant, Hialeah/Preston Water Treatment Plant, Flowers Baking Company of Miami, LLC., Derby Building Products, LLC., Release Boats, LLC., Renaissance Prowler, Invincible Boat Company, U.S. Foundry Manufacturing Corporation, and Sea

Enterprise Adventures. (FDEP 2020). Numerous non-title V permitted facilities also exist throughout MDC.

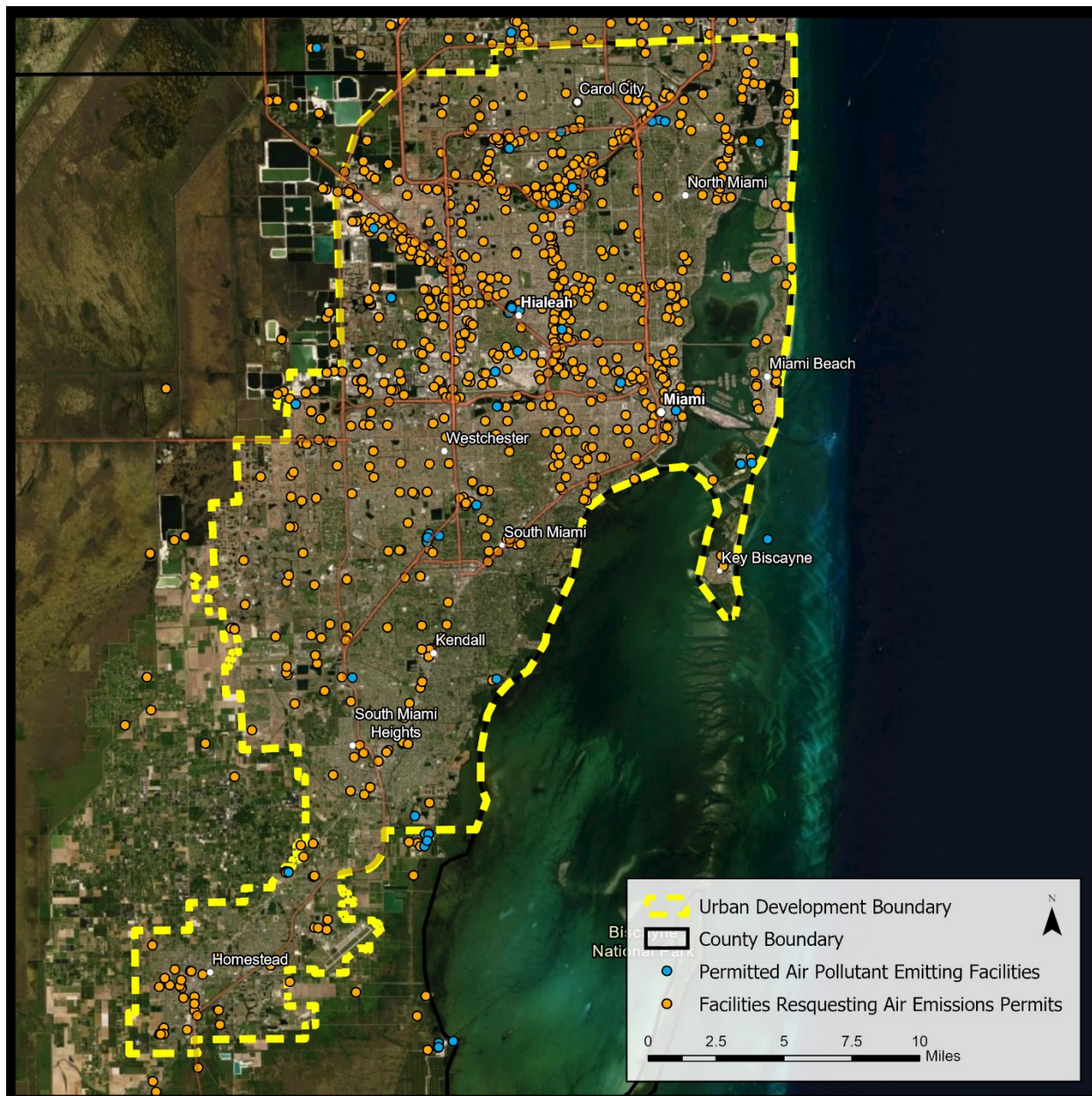


Figure 2-55. Florida Department of Environmental Protection Active Air Permitted Facilities.

According to AirNow, a collaborative effort between EPA and NOAA, the current conditions in the City of Miami as of January 30, 2020 at 1900 hours, is 44 AQI. (0-50 AQI is considered in the good range) (AirNow 2020)

Per the Federal Register 40 CFR Parts 52 and 81, MDC was designated as being in moderate nonattainment for 1-hour Ozone for the years of 1992-1994. The State of Florida, through the Florida Department of Environmental Protection (FDEP), submitted a maintenance plan and a

request to redesignate the Miami-Dade area from moderate nonattainment to attainment for ozone (O₃). EPA approved Florida's request on April 25, 1995 because it meets the maintenance plan and redesignation requirements set forth in the Clean Air Act (CAA). The approved maintenance plan will become a federally enforceable part of the State Implementation Plan (SIP) for the Miami-Dade Florida area. ("Federal Register 40 CFR Parts 52 and 81", 1995)

With the air quality improvements that came about from the SIP in the early 1990's and the fact that ozone formation and particulate matter are less likely to accumulate due to MDC favorable southeastern geographical position plus the addition of the near constant onshore tropical winds, ozone and particulate matter are less of a threat than they are in comparably sized metropolitan areas in other locations.

As the result of vehicle emissions controls and local measures to reduce traffic congestion, Florida has not recorded a violation of the carbon monoxide standard since 1986. Since gasoline has changed to unleaded only and with the exceptions of areas directly surrounding lead smelting facilities, Florida's ambient air concentrations of lead are nearly zero. Monitors in Florida have never measured a violation of the ambient standard for NO₂.

2.22 NOISE AND VIBRATION

Definition of Resource

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 and other health impacts, 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.

The normal human ear can detect sounds that range in frequency from about 20 Hz to 20,000 Hz. However, all sounds in this wide range of frequencies are not heard equally well by the human ear, which is most sensitive to frequencies in the range of 1,000 Hz to 4,000 Hz. This frequency dependence can be taken into account by applying a correction to each frequency range to approximate the human ear's sensitivity within each range. This is called A-weighting and is commonly used in measurements of community and transportation noise. The A-weighted sound pressure level (abbreviated as dBA) is the sound level with the "A-weighting" frequency correction and represents the approximate frequency response characteristic of the average young human ear. (Air Force Reserve Command 2010) For aquatic life, the hearing range can be significantly different. Reptiles tend to have a similar hearing range as fish, most

bird species have a hearing range similar to humans, while many mammals can hear much higher frequencies than humans.

In humans, noise levels can range from about 10 dBA for normal breathing, to 120 dBA for an ambulance siren, and as much as 150 dBA for a jet engine taking off. The National Institute for Occupational Safety and Health (NIOSH) states that noise levels prolonged over eight hours at 85 dBA or even one exposure over 140 dBA can result in hearing loss. (CHC 2019)

Noise impacts result from perceptible changes in the overall noise environment that increase “annoyance” or affect human health. Human health effects such as hearing loss, sleep disruption, disruption of daily activities, changes in cognition and mood can all result from noise impacts, often referred to as “noise annoyance.” (Basner 2013)

The National Ocean and Atmospheric Administration (NOAA) defines ocean noise as, “sounds made by human activities that can interfere with or obscure the ability of marine animals to hear natural sounds of the ocean.” (NOAA 2019) Sound travels more efficiently than light underwater. Aquatic species use sound to communicate such as to locate food, send a warning, navigate, etc. As noise pollution from human activities increases it is having direct impacts on the marine environment. Marine noise from recreational boating, commercial shipping vessels, cruise ships, etc. can result in “acoustic masking” as the low frequency from vessels matches that of certain marine animals. Acoustic masking is the result of when sounds from human activities interfere with an animal’s ability to detect, recognize, or understand natural sounds from other marine animals. (NPS 2018) It can interfere with finding food, navigation, mating, and cause stress, hearing loss, injury, or even death.

As noise levels on land are measured in units of decibels, underwater noise is also measured but in decibels that are referenced to 1 μ Pa. The standard unit of acoustic pressure in underwater sound is measured as the micro Pascal or 1 μ Pa. (NRC 2003) In water acoustic thresholds as defined under the Marine Mammal Protection Act (MMPA), use root-mean-square (rms) levels to determine harassment. For instance, behavioral disruption for impulsive noise such as impact pile driving has a threshold of 160dB_{rms} with decibels referenced to 1 μ Pa. (NRC 2003)

Methodology

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.

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

Framework

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. The Federal Aviation Administration (FAA) also regulates aviation noise and establishes noise level requirements for aircraft through various federal regulations.

The County of Miami-Dade has a noise ordinance, Code of Ordinances Part III Chapter 21 Article IV 21-28, "Noises; Unnecessary and Excessive Prohibited". This ordinance contains time restrictions on specific types of noise producing activities, such as construction, excessive residential noise, etc. and aims to protect citizens from offensively loud noise and vibration. Examples of which are the use of power tools, including lawnmowers, music, vehicles and their associated noise, pets, and others. It does not cover aircraft, which are regulated under applicable federal laws and regulations.

The City of Miami has ordinances regulating noise (Chapter 36) to include noise from pets, ships, boats, etc. and regulates the distance between noises that can occur near certain public buildings hospitals, schools, etc. as well as quiet hours. Other municipalities within MDC have similar ordinances regulating noise.

Existing Conditions

Miami-Dade County is a developed county with vast land use, with heavy industrial, commercial, military, and cargo ship traffic as well as significant recreational boating. The County and its associated municipalities incorporate various noise abatement and mitigation strategies to reduce noise levels.

Existing land uses in MDC consist of industrial features from the Port of Miami, Miami International Airport (MIA), military facilities, municipal parks, marinas, commercial businesses, and high-density residential land use. The Port of Miami is owned and operated by the Seaport Department of Miami-Dade County. It is located directly in downtown Miami in the Biscayne Bay and has ongoing terminal expansion and associated improvements projects. The port is a vital asset to the U.S. trade industry (in 2018, an estimated 1,000 cargo ships docked here with an estimated value of \$27 billion) and the cruise industry (in 2018 an estimated 1,220 cruise ships docked here). (PortMiami 2019) Many modes of transportation and industry are directly and indirectly associated with the port, for both people and goods, there are services such as intermodal rail, the airport, and tractor tug services, etc. Utilizing each of these modes of transportation inter-connected with port access also results in noise levels associated with this volume of industry. MIA is noted as one of the busiest international airports with over eighty airlines and an estimated 416,000 landings and takeoffs in 2018. (MIA 2019)

The City of Miami and its adjacent municipalities have many medical facilities, hospitals, universities, and schools as well as extensive residential and commercial areas where the noise ordinance standards apply. These areas have noise levels that are typical of such land uses.

The Federal Highway Administration (FHWA) and the Florida Department of Transportation (FDOT) collaborate on a number of transportation projects proximate to the study area. FHWA and FDOT are required to assess noise and vibration effects of their proposed improvements on adjacent communities for any Type 1 (defined under 23 CFR part 772) transportation projects along with the formulation of potential abatement measures. Type 1 projects include proposed and funded projects that involve either new alignment and/or major improvements to the existing highway. FDOT is responsible for implementing FHWA regulations in Florida. FDOT considers a traffic noise impact to occur if the projected noise levels are within 1 dB of the FHWA criteria. (FRA 2012) There have been several baseline noise studies within the ROI.

The waters of Biscayne Bay are a mix of residential, commercial, and industrial development with significant public beaches for public recreational use. As illustrated below, NOAA uses various mapping tools derived from data collected from NOAA, the United States Navy, and other partner agencies to measure sound levels in the water. Accessed from NOAA's SoundMap tool which provides maps of temporal, spatial, and frequency of underwater noise from human activities. SoundMap modeling focuses on coastal waters from 5m to 200 nautical miles with modeling conducted at discrete depths between 5m to 1000m. 2013 Annual Average Ambient Noise Modeling Global Shipping and Passenger Vessels – Summed Outputs (converted to decibel values) are shown in Figures 2-61, 2-62, and 2-63.

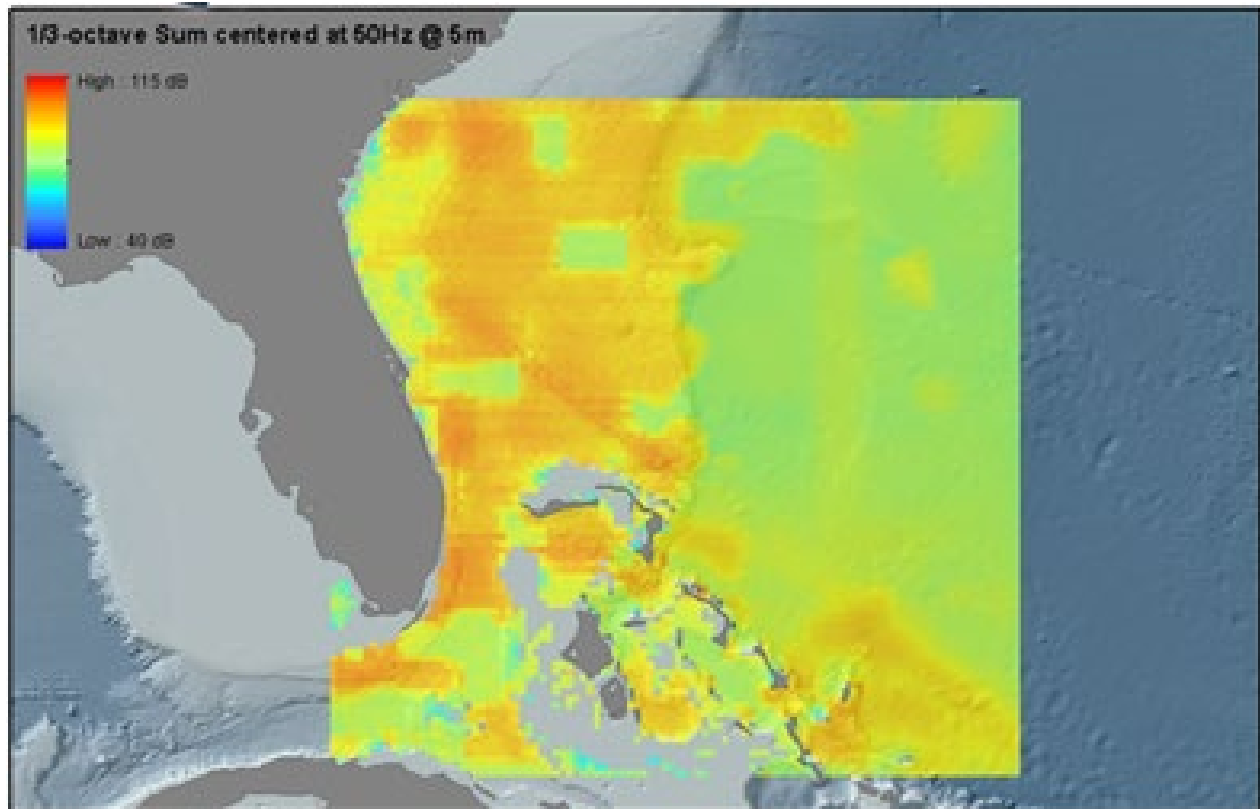


Figure 2-56. 2013 Annual Average Ambient Noise Modeling Global Shipping and Passenger Vessels @ 5m (NOAA 2019)

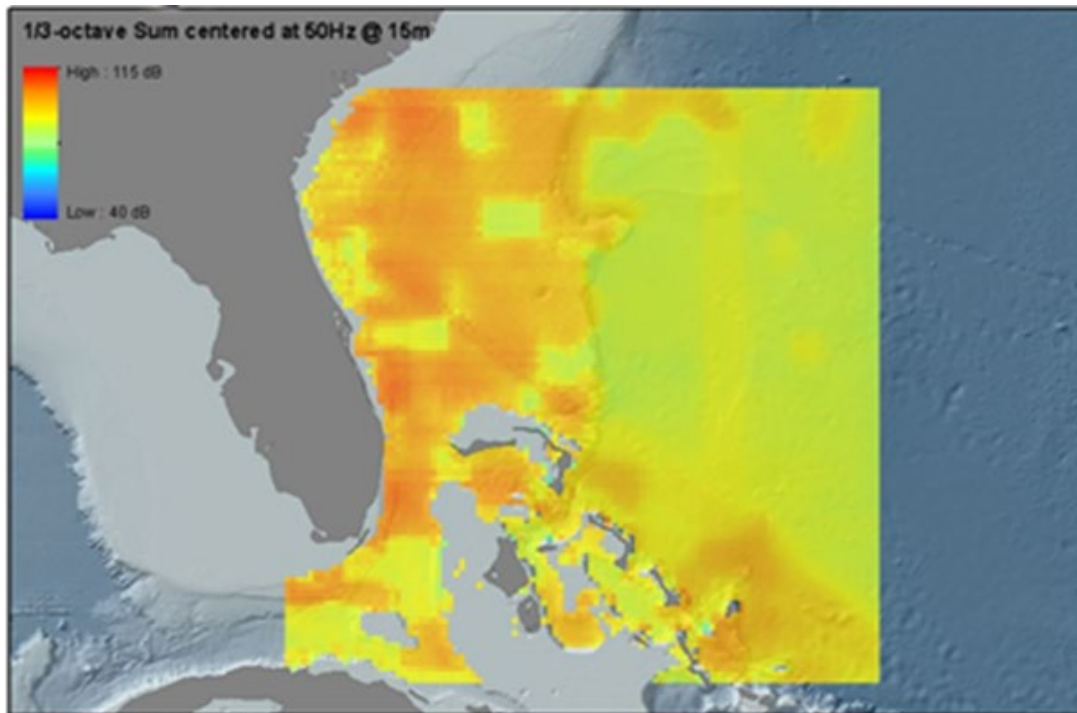


Figure 2-57. 2013 Annual Average Ambient Noise Modeling Global Shipping and Passenger Vessels @ 15m (NOAA 2019)

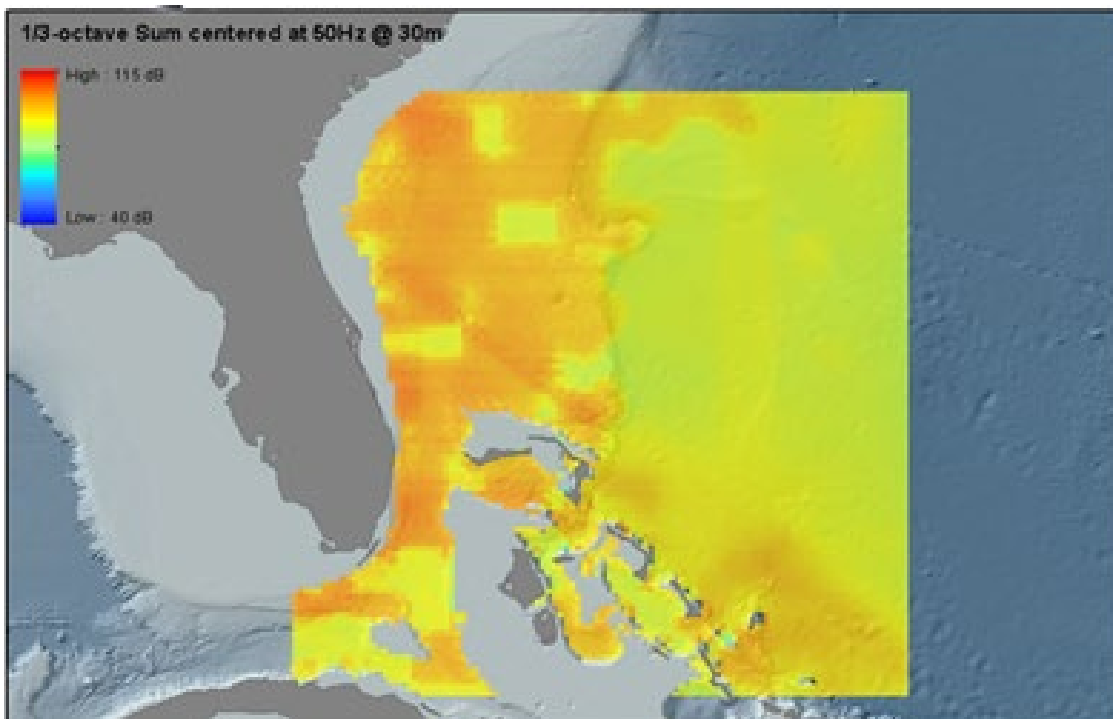


Figure 2-58. 2013 Annual Average Ambient Noise Modeling Global Shipping and Passenger Vessels @ 30m (NOAA 2019)

CHAPTER 3 PLANNING CONSIDERATIONS

The U.S. Army Corps of Engineers has a six-step iterative planning process which is used in water resource development studies conducted by Federal agencies. The first step in this process is identifying problems and opportunities followed by defining the objectives and constraints that will guide efforts to solve those problems and achieve those opportunities. The Project Delivery Team and the NFS held a charrette at Miami, Florida in November 2018 with various stakeholders to get feedback and discuss possible problems, opportunities, objectives, and constraints in the MDC area. The following sections cover the results as well as other planning considerations.

3.1 PROBLEMS AND OPPORTUNITIES

Problems are existing, negative conditions. Primary problems occurring in MDC with relation to coastal storm risk include:

1. The geographic location, low elevation, and high population of MDC make it vulnerable to storm surge from hurricanes and tropical storms.
2. Increasing high tides and king tides resulting from SLR result in recurrent flooding to roads and properties and exacerbate coastal storm risk.
3. Increasing flooding from rain events due to the higher ground water elevations and higher tailwater elevations from SLR threaten properties and infrastructure and exacerbate coastal storm risk.

Coastal storm risk, especially risk associated with storm surge flooding, contributes to specific problems related to the three primary coastal storm risk problems:

- Risks to human life and health
- Damage to development (structures) causing negative economic impacts to residents, the county, and the Nation
- Damage to critical facilities such as the port, airport, and power infrastructure and disruption of their service
- Decreasing level of service provided by the regional water management infrastructure
- Saltwater intrusion into freshwater supplies for drinking and agriculture
- Reduced bridge clearances along navigable rivers/canals which causes transportation disruptions
- Transportation disruptions including inundation of evacuation routes and increased risks to coastal causeways that reduces connectivity within the county

Opportunities are the desirable future outcomes which address the water resource problems and improve conditions in the study area. Opportunities identified for this analysis include:

1. Reduce the risk to human life and health due to coastal flooding, high flooding events or infrastructure failure
2. Reduce coastal storm-related economic damage and improve economic resiliency of the local economy and communities – particularly low-income communities and vulnerable populations
3. Increase resiliency, structural integrity, and reliability of critical infrastructure

4. Reduce transportation impacts due to high water events that make evacuation routes and other roadways impassable and threaten coastal causeways
5. Utilize available natural areas and open spaces for improving wave attenuation, water retention, water storage, and also create co-benefits supporting recreation, human health, public access to water, and tourism
6. Reduce flood risk and damage to residential, commercial, historic, cultural, and critical assets and infrastructure
7. Improve neighborhood cohesion and social fabric by reducing flooding risks and improving neighborhood connectivity (ex. greenways, new open space, and transportation improvements)
8. Improve community awareness about coastal storm risks.
9. Improve existing recreational opportunities to the full extent possible when planning for coastal storm risk management
10. Improve water quality and ecosystem quality to the full extent possible when planning for coastal storm risk management
11. Enhance and support Comprehensive Everglades Restoration Plan projects.
12. Reduce public and environmental health risks associated with failing septic systems affected by chronic and episodic flooding

3.2 OBJECTIVES

Objectives are statements that describe the results one wishes to achieve by solving the problems and taking advantage of the opportunities identified earlier. The goal of this study is to develop and evaluate CSRSM planning solutions consistent with the Federal objective of water and related land resources planning, which is to contribute to NED consistent with protecting the Nation's environment, in accordance with national environmental statutes, applicable executive orders, and other Federal planning requirements with the purpose of recommending an implementable suite of CSRSM measures for MDC to address damage due to flooding from coastal storm events. The following objectives will help to achieve the study goal:

1. Increase the resiliency of MDC to function effectively before, during, and after coastal storm events by decreasing the vulnerability of critical infrastructure to flooding damage from storm surge with consideration for SLR over the period of analysis.
2. Reduce economic damage to structures in MDC communities that have been identified as vulnerable to severe damage from storm surge with consideration for SLR over the period of analysis.

3.3 CONSTRAINTS

Constraints are conditions to be avoided or things that cannot be changed, which limit the development and selection of alternative plans. Specific constraints for this analysis include:

1. Avoid creating or exacerbating flooding within the project area, to other local municipalities, and to local military installations.
2. Avoid flooding solutions for the study area that would induce increased flooding issues in locations outside of the study area.

3. Avoid and/or minimize impacts to existing environmental and cultural/historic resources in the ROI (e.g. threatened and endangered species, water quality, Biscayne Bay Aquatic Preserve, Biscayne Bay National Park, and Miami Circle National Historic Landmark).
4. Cannot exacerbate saltwater intrusion which would negatively impact fresh water for drinking and agriculture.
5. Cannot reduce navigable channels
6. Evacuation capacities should not be reduced once the project is completed

Other planning considerations include:

1. Avoid creating or exacerbating existing social justice issues.
2. Minimize project impacts to the tax base of any municipality in MDC.
3. Avoid or mitigate impacts on neighboring counties (Broward, Collier, and Monroe County).
4. Navigation and port interests should not be negatively impacted
5. Structural measures may not be feasible on the barrier islands due to soil conditions and no high ground to tie into.

3.4 MULTIPLE LINES OF DEFENSE STRATEGY

Multiple lines of defense is a strategy that results in communities becoming more resilient. Residual risk is reduced as more lines of defense are used. In this study, a combination of structural measures, nonstructural measures, and NNBFs are being considered by USACE for coastal storm risk reduction. These measures will be strengthened by ongoing resiliency efforts by MDC. The following actions are a few of the additional lines of defense that will complement future coastal storm risk management efforts proposed by USACE. More actions are available in Chapter 3 of Appendix A.

Increased Freeboard Requirements

Freeboard is defined by FEMA as "An additional amount of height above the Base Flood Elevation (BFE) used as a factor of safety in determining the level at which a structure's lowest floor must be elevated or floodproofed to be in accordance with state or community floodplain management regulations."

Effective March 15, 2012, the Florida Building Code (FBC) required non-residential structures in the effective FEMA one percent annual chance flood (also called 100-year floodplain or BFE) to be built with an additional one foot of freeboard above the effective BFE. Category IV structures (critical or essential facilities such as fire, rescue, ambulance, police, etc.) were required two feet of additional freeboard above the effective FEMA BFE. Effective December 30, 2017, the one foot of freeboard was included for single family residences, duplexes, triplexes, and townhomes three stories or less.

These freeboard requires not only apply to new construction, but also any substantial improvements which is defined by FEMA as reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the start of construction of the improvement.

Southeast Florida Regional Climate Change Compact

Broward, Miami-Dade, Monroe, and Palm Beach Counties united to form this compact in January 2010 to coordinate mitigation and adaptation activities across county lines. This compact established a Climate Action Plan to help reduce greenhouse gas emission and adapting to the effects of climate change. More information can be found at their site below:

<https://southeastfloridacclimatecompact.org/>

Participating in National Flood Insurance Program

Community Rating System is a voluntary program for communities that participate in the NFIP. Community Rating System was formed to provide incentives such as flood insurance premium discounts for communities that went beyond minimum floodplain management requirements. CRS uses a class system with 10 being the lowest (no discount) and one the highest. Insurance premiums are discounted in five percent intervals for structures in the SFHA so a class of nine would be five percent discount and a class of one would be 45 percent discount.

As of May 1, 2019, 23 of the 34 municipalities (plus Unincorporated MDC) are part of the CRS program ranging from class five to class nine. According to the Miami-Dade County Local Mitigation Strategy, below are just some of the activities some municipalities in MDC are performing to participate in CRS:

- Maintain Elevation Certificates for New/Substantially Improved Buildings
- Enforce Floodplain Management Regulations
- Inspect/Repair/Maintain Drainage Systems
- Preserve Open Space in Floodplain
- Provide Flood Protection Assistance
- Provide Flood Zone Information
- Keep Old and Current FIRMs
- Produce/Distribute Property Protection Information to Repetitive Loss Areas
- Maintain Flood Protection Materials at Library

100 Resilient Cities Program

100 Resilient Cities (100RC) is a \$164 million effort founded by The Rockefeller Foundation in 2013. Its main goal is focusing on helping communities around the world build resilience to the many challenges of the 21st century. The Greater Miami and the Beaches, which includes MDC, the City of Miami and the City of Miami Beach, joined the 100RC in the spring of 2015. Although the 100 Resilient Cities organization disbanded the 100RC program on July 31, 2019, communities are continuing their resiliency efforts through other means.

Resilient305

In the spring of 2019, Greater Miami and the Beaches released the Resilient305 Strategy, a living document that addresses resilience challenges prioritized through intergovernmental and community collaboration. Throughout the process – in public meetings, surveys and focus groups – Greater Miami and the Beaches engaged thousands of stakeholders to help shape the strategy and make sure it reflected the input from a wide range of expertise, ages, ethnicities, cultures, income levels and geographic areas. The Resilient305 Strategy will help prepare for an

increasing occurrence of shocks, such as hurricanes, and infrastructure failures, as well as to better mitigate stresses, such as sea level rise and sunny day flooding, crippling traffic and severe economic inequities. More information can be found at <https://resilient305.com/>.

Applying for grants

The Florida Department of Economic Opportunity (DEO) selected MDC to receive \$4.5 million in Community Development Block Grant-Disaster Recovery funds to help eligible and interested property owners who were impacted by Hurricane Irma. The grant funds will help these residents, if they so choose, to relocate to less flood-prone areas and reduce future flood risk.

Local Mitigation Strategy

The Local Mitigation Strategy was developed to reduce or eliminate the long-term risk to human life and property from hazards. It is typically reviewed and needs re-approval every five years by FEMA. The current strategy plan is approved by FEMA, and maintains a list of projects that could potentially be funded in the future. Having a mitigation plan helps a CRS community obtain more points.

Rapid Action Plan

Miami-Dade County completed the Rapid Action Plan in 2017. The plan assessed the vulnerability of over 700 County owned assets and ranked them based on criticality.

3.5 PERIOD OF ANALYSIS

The period of analysis for all of the alternatives is a 50-year period from 2030 to 2079. Depending on the alternative, project implementation is expected to begin in the year 2025. The implementation period is the time period that construction is expected, which would run from 2025 to 2030. The base year is considered the year the alternatives have been implemented and benefits begin accruing which is assumed to be 2030. Future damage was calculated out to the year 2079 in order to evaluate plan performance over a period of 50 years.

The alternative that is selected as the TSP will be assessed for engineering and environmental performance out to 100 years from project implementation, which is estimated to be the year 2129. This 100 year period for consideration of coastal sustainability is in compliance with USACE Principle and Guidelines.

3.6 DEVELOPMENT / REDEVELOPMENT PROJECTIONS

According to MDC land use data (last updated October 2, 2020), eight percent of the total land in MDC is classed as vacant; however, 12 percent of those lands are protected. These are owned by the government or privately for Environmentally Endangered Lands (EEL) sites or under conservation / environmental mechanisms. There are also 25 pieces of currently vacant land approved for Major Projects. This results in vacant unprotected land, whether government owned or privately owned, to be seven percent of the land in all of MDC and six percent within the UDB. Due to the fact that MDC is 94 percent built out in the UDB, any significant development of land that is not already developed in some form is not expected. Any significant future developments are expected to be redevelopments. Any redevelopment is expected to be constructed to established higher standards including freeboard above the FEMA base flood

elevation or one percent annual chance flood. Figure 3-1 shows the land use map for MDC depicting the vacant lands still available for construction.

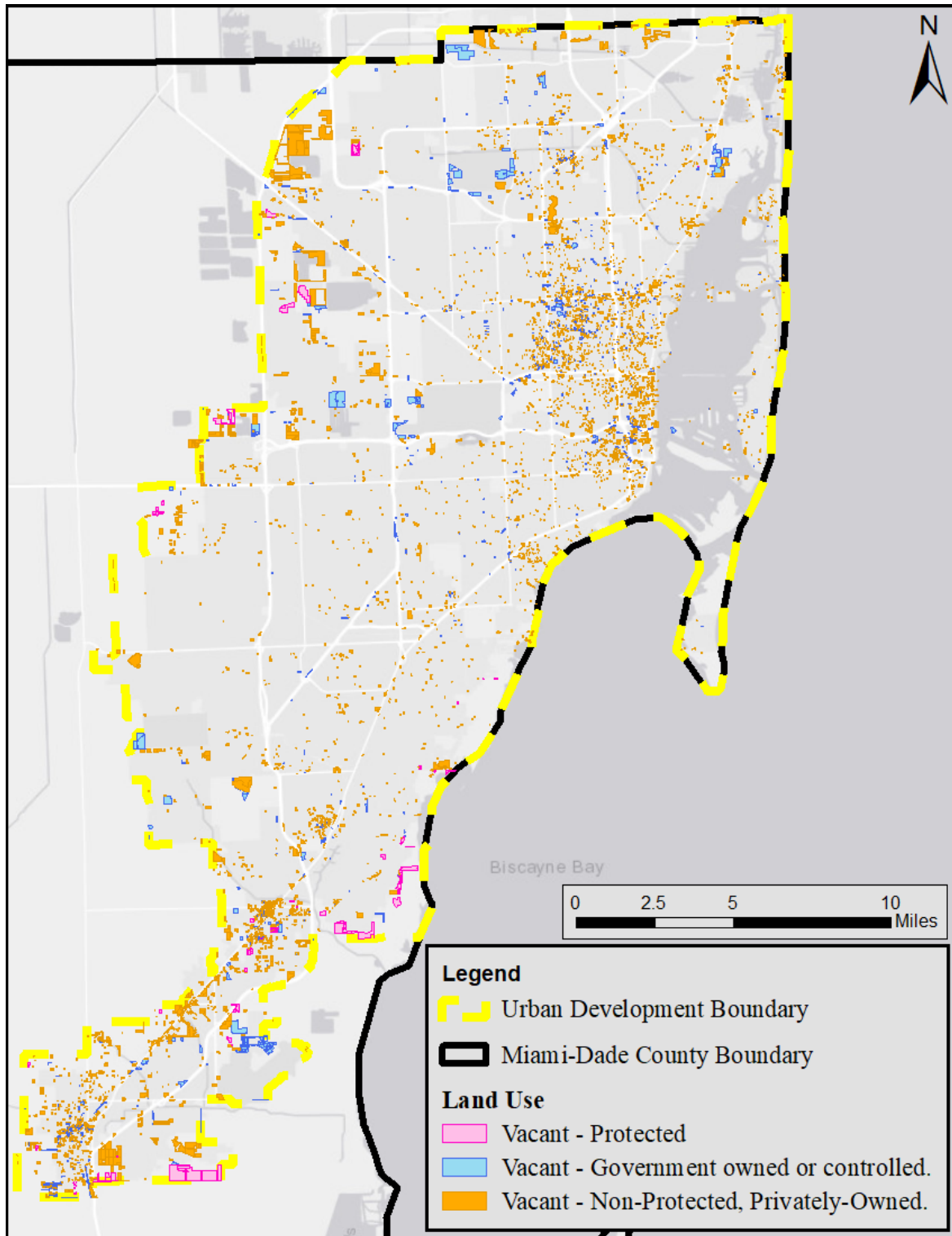


Figure 3-1. Vacant Capacity inside the Urban Development Boundary

Recognizing the Federal government's commitment to ensure no inducement of development in the floodplain pursuant to EO 11988, this project will identify in the Project Partnership Agreement (PPA) the need for the non-Federal sponsor to develop a floodplain management plan and a requirement for the sponsor to certify that measures are in place to ensure that the project does not induce development within the floodplain. The Policy Guidance Letter (PGL) No. 52, Flood Plain Management Plans, stipulates the requirement for the project sponsor to prepare a floodplain management plan within one year of the PPA execution. The floodplain management plan must also be implemented not more than a year after completion of project construction. Miami-Dade County, as the NFS, is expected to comply with the requirements of the EO 11988 and the PGL No. 52.

3.7 CRITICAL ASSUMPTIONS

In order to move forward in the risk-informed decision making process, the MDC Back Bay CSRM PDT made certain assumptions and simplifications while performing this study. 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:

Economics: Hazus modeling was used to refine focus areas and then analyzed on top of the Centers for Disease Control and Prevention's Social Vulnerability Index which is discussed more in depth in Chapter 3. Structure inventory required assumptions on foundation height per occupancy type taken from the National Structure Inventory 2.0. This was validated by comparing the calculated first floor elevations to elevation certificates where available. More information on this process is available in Appendix C.

Engineering: Existing information was used for geo-environmental and utilities. Additional surveys will occur in the Preconstruction, Engineering, and Design (PED) phase of the project. This includes topographic survey to capture new construction and road raising that have occurred since 2018, and hydrographic surveys in waterways where applicable due to possible shoaling.

Environmental: Interim impacts analysis was used from available existing surveys and data to inform the TSP selection with a more thorough analysis to be conducted during the PED. Detailed surveys to include Section 106 surveys, water quality modeling, wetlands jurisdictional determinations, and resource surveys (to map the presence and extent of coral, seagrasses, and other protected resources within the proposed impact areas) will be conducted during the PED once the exact locations and footprints of proposed structures has been determined.

Scenario planning is a purposeful examination of a range of potential futures that addresses 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 condition that provides the base condition for evaluation. For the MDC Back Bay CSRM analysis, RSLR and storm intensity were identified as the most important drivers that affect the performance of CSRM plans.

A table that provides a more comprehensive list of some of the important decisions, along with a qualitative assessment of the risks and consequences associated with those decisions, is included in Appendix A.

3.7.1 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) (See Chapter 4) developed coastal WSELs based on a suite of storms in order to estimate the probability of various storm surge WSELs. Lower probability events represent more extreme storms that produce higher WSELs.

3.7.2 RELATIVE SEA LEVEL RISE PROJECTIONS

This study is formulated to consider the impacts that 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". 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 MDC area. The resulting RSLR will impact future USACE coastal projects and system performances. 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 MDC includes a relative sea level change for the 50-year period of analysis of 2030 – 2079. According to the USACE Sea Level Rise Calculator, water levels will rise 0.59, 1.13, and 2.86 feet for the USACE low, intermediate and high curve estimates. Other entities have made RSLR predictions for the area. The National Oceanic and Atmospheric

Administration predicts higher rates of RSLR for the High curve than USACE. Sea level rise estimates are provided in Figure 3-2 and Table 3-1.

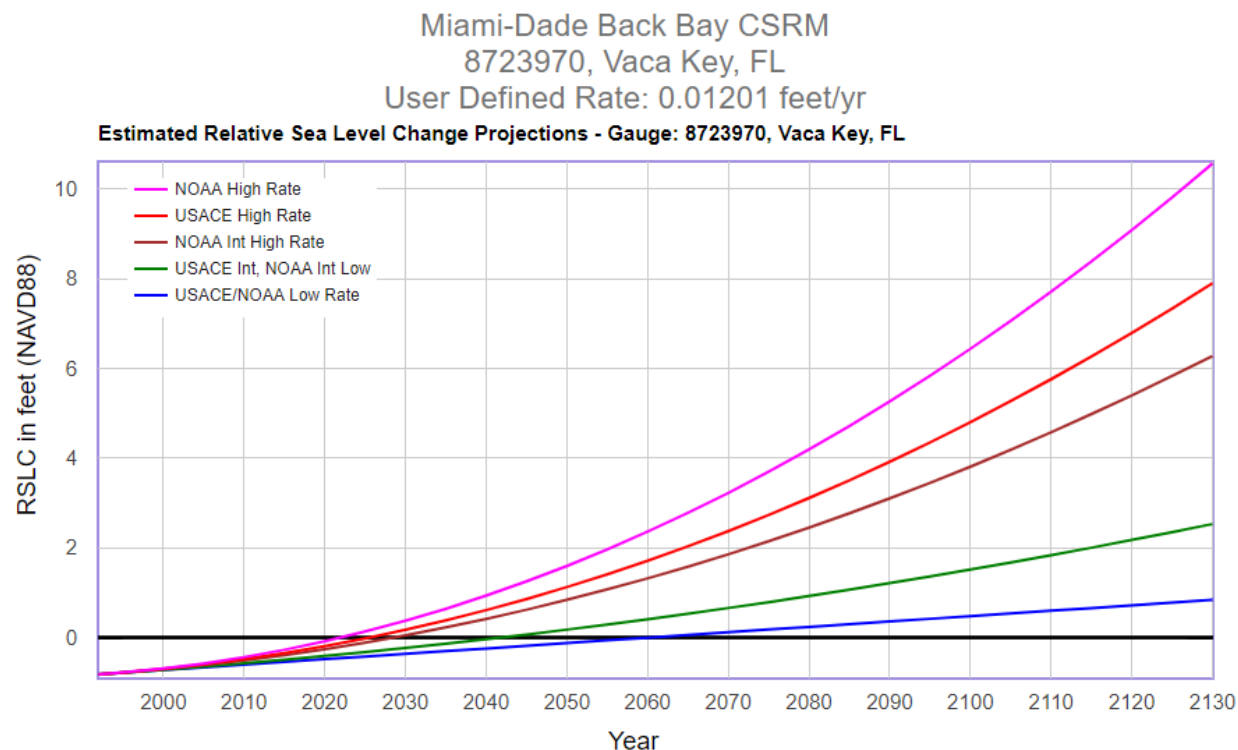


Figure 3-2. Relative Sea Level Rise at Vaca Key, Florida

The USACE high curve was selected for use in estimating future design water surface elevations as a starting point. This also falls in line with the Southeast Florida Climate Compact that the Miami-Dade County is a part of. The high curve is believed to represent a reasonable estimate of RSLR with the information available today and is recommended for use by MDC; however, the USACE low curve and intermediate curve will also be used to optimize the Tentatively Selected Plan once selected. Table 3-1 shows the RSLR rates for USACE Low, Intermediate, and High rates as well as NOAA Low, Intermediate Low, Intermediate High, and High rates.

Table 3-1. Estimate Relative Sea Level Rise (feet) at Vaca Key, Florida

Miami-Dade Back Bay CSRM - 8723970, Vaca Key, FL User Defined Rate: 0.01201 feet/year All values are expressed in feet relative to NAVD88 Miami-Dade Back Bay CSRM -					
Year	USACE Low	USACE Int	NOAA Int High	USACE High	NOAA High
	NOAA Low	NOAA Int Low			
1992	-0.82	-0.82	-0.82	-0.82	-0.82
1995	-0.78	-0.78	-0.78	-0.78	-0.78
2000	-0.72	-0.72	-0.71	-0.7	-0.69
2005	-0.66	-0.65	-0.62	-0.6	-0.58
2010	-0.6	-0.57	-0.51	-0.48	-0.44
2015	-0.54	-0.5	-0.39	-0.35	-0.27
2020	-0.48	-0.41	-0.26	-0.19	-0.08
2025	-0.42	-0.33	-0.11	-0.02	0.13
2030	-0.36	-0.24	0.05	0.17	0.37
2035	-0.3	-0.14	0.23	0.38	0.64
2040	-0.24	-0.04	0.42	0.61	0.93
2045	-0.18	0.07	0.62	0.86	1.25
2050	-0.12	0.18	0.84	1.12	1.6
2055	-0.06	0.29	1.07	1.41	1.96
2060	0	0.41	1.32	1.71	2.36
2065	0.06	0.53	1.58	2.03	2.78
2070	0.12	0.66	1.86	2.37	3.23
2075	0.18	0.79	2.15	2.73	3.7
2080	0.24	0.93	2.45	3.11	4.19
2085	0.3	1.07	2.77	3.5	4.72
2090	0.36	1.21	3.1	3.92	5.26
2095	0.42	1.36	3.45	4.35	5.84
2100	0.48	1.51	3.81	4.8	6.44
2105	0.54	1.67	4.19	5.27	7.06
2110	0.6	1.84	4.58	5.76	7.71
2115	0.66	2	4.98	6.27	8.39
2120	0.72	2.17	5.4	6.79	9.09
2125	0.78	2.35	5.83	7.34	9.81
2130	0.84	2.53	6.28	7.9	10.57

3.7.3 FUTURE SCENARIOS AND DESIGN WATER LEVELS FORMULATION

Future with project and without project scenarios were compared to aid decision making. The primary variables that were believed to have most impact on choosing the best TSP for the future were the storm intensity and the rate of sea level rise. The formulation for this project was to compare the performance of various alternatives from a time period of 2030 using the Federal Emergency Management Agency Region IV South Florida Storm Surge Study (FEMA SFLSSS) WSEL estimates and the USACE high SLR to 2079. Future without project and with project scenarios included assumptions about other future projects and conditions that are reasonably likely to occur in MDC.

A wide variety of potential solutions were preliminarily considered for reducing flood risk to MDC. Many of these solutions (e.g. surge barrier across the Miami River, Little River, and Biscayne Canal) would require regional coordination and cost sharing to not only expand the project authorization but to align with the fiscal realities of a project sponsor's financial capabilities. The authority of the MDC CSRSM Study identified MDC as the sole study sponsor. This means that MDC is not only responsible for assuming the sponsor study cost share but it is also the sole cost share partner for construction of the TSP.

Based on the study authority, economic benefits of the study plan were limited to those that accrue in the MDC. Flood risk management solutions were justified primarily on their benefits to the economy, with the benefits being weighed against costs for economic justification. Any plan that would provide a regional solution would require an expanded authorization that commits other municipalities in the region. For these reasons, the PDT felt that the most feasible path would be to investigate solutions within MDC that would be constructed independently and would function independently from one another. These are known as separable measures. These separable measures would meet study authority requirements and would also be at a scale that would be fiscally feasible for the MDC to cost share. More information on separable measures pertinent to this study are available in Chapter 6.

The low lying topography of MDC, along with interconnected waterways that run through the city, limit the options for providing flood risk management to the entire county with one large project (e.g. large floodwall or levees surrounding the urban Back Bay area). This means that topography would be required to keep floodwaters from overflowing one area and into another and potentially flanking a proposed measure.

Water surface elevation estimates for storm surge vary in different areas of the County. Generally the storm surge elevations increase from north to south. Table 3-2 and Figure 3-3 describe and show the WSEL frequencies used in the study and how they are estimated to vary across MDC (Figure 3-3).

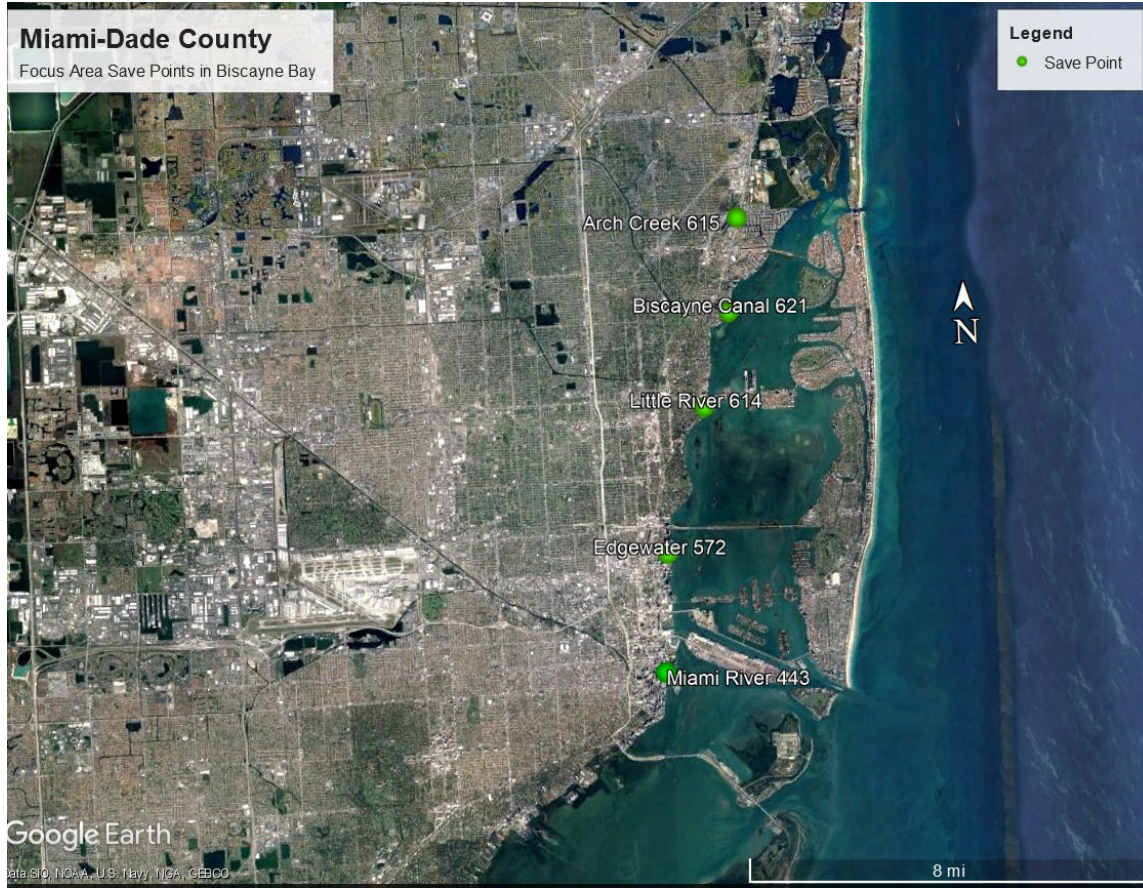


Figure 3-3. Miami-Dade County Save Point Locations

Table 3-2. Water Levels (in feet) for Miami-Dade County Save Points at 2018 without Sea Level Rise.

Annual Recurrence Interval (years)	Annual Exceedance Probability (AEP) in %	Miami River (Save Point 443)	Edgewater (Save Point 572)	Little River (Save Point 614)	Biscayne Canal (Save Point 621)	Arch Creek (Save Point 615)
20	5	4.37	3.86	3.8	3.89	3.78
50	2	6.09	5.14	5.04	5.24	5.07
100	1	7.31	6.15	5.95	6.19	6.13
200	0.5	8.66	7.44	6.88	7.12	7.71

Table 3-3. Water Levels (in feet) for Miami-Dade County Beach Reaches at 2079 with Sea Level Rise.

Annual Recurrence Interval (years)	Annual Exceedance Probability (AEP) in %	Miami River (Save Point 443)	Edgewater (Save Point 572)	Little River (Save Point 614)	Biscayne Canal (Save Point 621)	Arch Creek (Save Point 615)
20	5	7.66	7.15	7.09	7.18	7.07
50	2	9.38	8.43	8.33	8.53	8.36
100	1	10.6	9.44	9.24	9.48	9.42
200	0.5	11.95	10.73	10.17	10.41	11.00

Formulation for the Final Array of alternatives is based on the one percent annual exceedance probability (AEP) storm surge event. The Final Array are those alternatives that are compared against each other for economic, environmental, and social impacts. The Final Array plan that most reasonably maximizes net annual benefits is then selected as the TSP. The TSP is then optimized for performance assessment at the five percent, two percent, one percent, and 0.5 percent FEMA SFLSSS water surface elevations. Optimization assumes that the measures that make up the TSP will remain the same but the design parameters, such as wall height, may change. The final selected plan and design level is called the Recommended Plan (RP) and will be determined during the Agency Decision Milestone (ADM).

The Recommended Plan will be assessed for performance against two other scenarios in order to identify further risks and options for adaptability. The plan will be compared to a scenario in which the NOAA high RSLR curve is assumed in order to identify the risks associated with an unlikely and extreme event. The RP will also be assessed for risk and adaptability 100 years out to 2130 in order to see how the plan performs further out into the future.

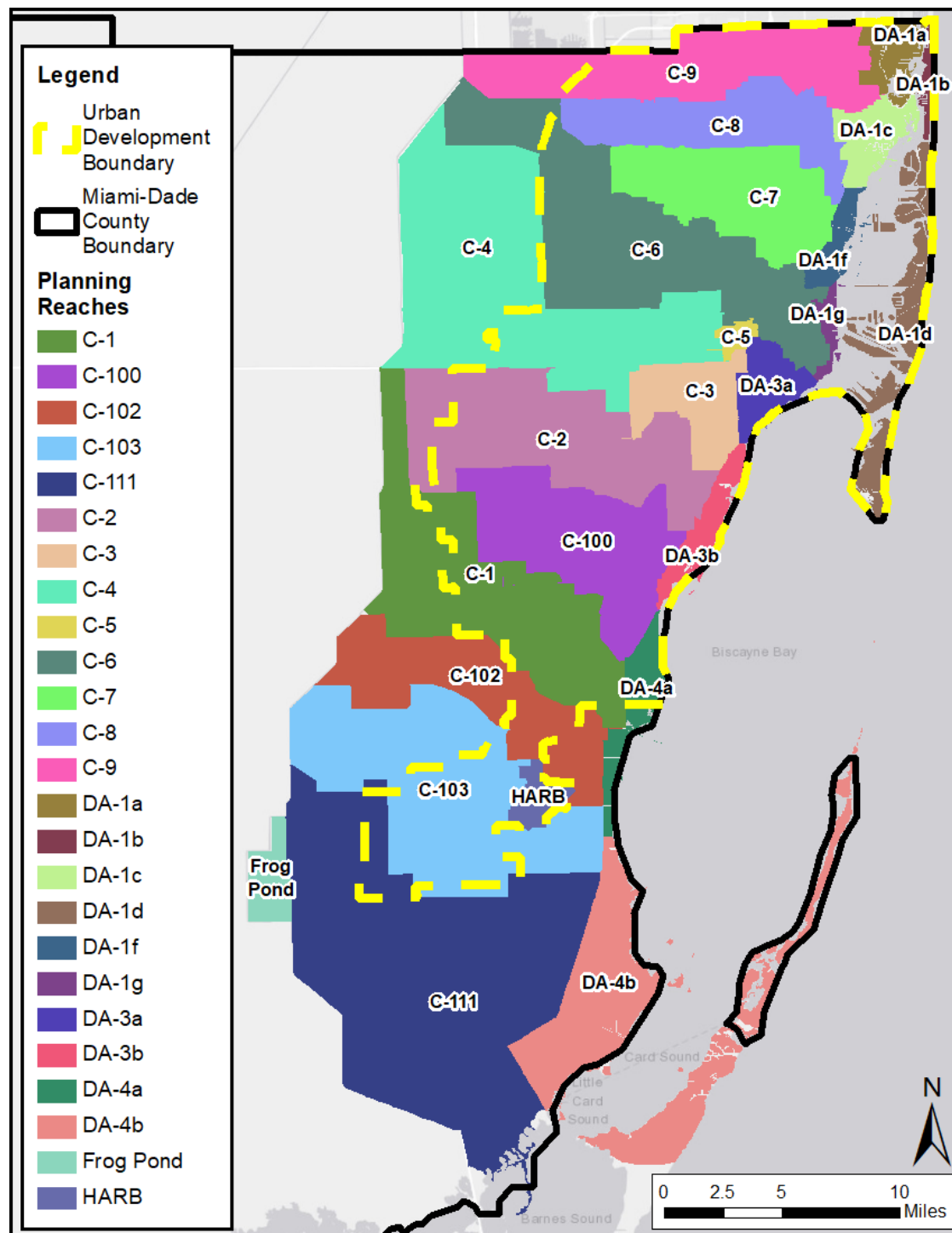
In order to formulate for an alternative that reasonably maximized net economic benefits, several project levels of design should be compared to find the most economically efficient variation. Three design WSELs that provide a low-medium-high range of flood risk management will be selected for analyzing a range of costs and benefits.

3.8 PLANNING REACHES

All areas of MDC were originally evaluated for coastal storm risk reduction through discussions with the NFS, team meetings, charrettes, stakeholder input, and public open houses. Planning reaches, ways to break down the entire study area, were first identified by using the UDB and a combination of HUC 10 (watershed) and South Florida Water Management District's basin boundaries shown in Figure 3-4. These were the study's original focus areas. The naming convention for some of the basins were slightly modified for simplicity and continuity of planning reaches depending on the area.

Basins are typically delineated by determining the design storm for which the stream and water control structures can accommodate without an unacceptable level of flooding occurring in the basin. The naming convention for these reaches are taken from the Central and Southern Florida Project (C&SF Project) which was authorized by Congress in the Flood Control Act of 1948 and subsequently through the Water Infrastructure Improvements for the Nation (WIIN)

Act of 2016. The C&SF project is a multi-purpose project that provides flood control; water supply for municipal, industrial, and agricultural uses; prevention of saltwater intrusion; water supply for the Everglades National Park (ENP); and protection of fish and wildlife resources. The reaches were first delineated by USACE in the 1950s as part of the C&SF project.



The reaches that begin with the letter C represent canals that the basin is associated with. The primary functions of the canals is to provide flood protection for the basins in which they are located. The secondary functions range from land drainage for agriculture to regulation of ground water table elevations to prevent saltwater intrusion into the local ground water. Table 3-4 shows the link between the reach name and the canal name if available.

Table 3-4. Reach Canals

Reach	Canal	Reach	Canal
C-1	Black Creek Canal	C-6	Miami Canal
C-100	Cutler Drainage	C-7	Little River Canal
C-2	Snapper Creek Canal	C-8	Biscayne Canal
C-3	Coral Gables Canal	C-9	Snake Creek Canal
C-4	Tamiami Canal	HARB	Homestead Air Force Base
C-5	Comfort Canal		

In conjunction with inundation layers, these planning reaches provide natural, hydrologic boundaries for delineating structural measures and create sensible boundaries for analysis of nonstructural measures. Using watershed boundaries for planning reaches also provides consistency for any reaches required for H&H and economic models.

3.8.1 REFINING FOCUS AREAS

Due to MDC having such a large geographic size, population, and complexity of coastal flooding risks, a countywide comprehensive look would not be possible under the budget and schedule of this study. The team developed a method to refine the focus areas using available tools and analysis methods to determine the most socially vulnerable economic damage centers.

FEMA's Hazus software (<https://www.fema.gov/hazus>) is a nationally applicable standardized methodology that contains models for estimating potential losses from earthquakes, floods, hurricanes, and tsunamis. Hazus uses GIS technology and the national structure inventory database to estimate physical, economic, and social impacts of disasters. Hazus was run in Miami-Dade County using FEMA's 1 percent annual chance flood and 1 percent annual chance of precipitation with 4 feet of sea level rise depth grid to determine areas at higher flood damage risk and identify preliminary damage to infrastructure. The MDC area was broken up into 4,000 square feet cells in GIS. All of the infrastructure damage within each cell was summed up to help visualize the data better. Figure 3-5 shows the results of the Hazus damage. The potential for refined focus areas were determined by looking at any areas showing at minimum two or more adjacent high damage cells. Seven such areas were identified through this analysis shown in red circles in Figure 3-5.

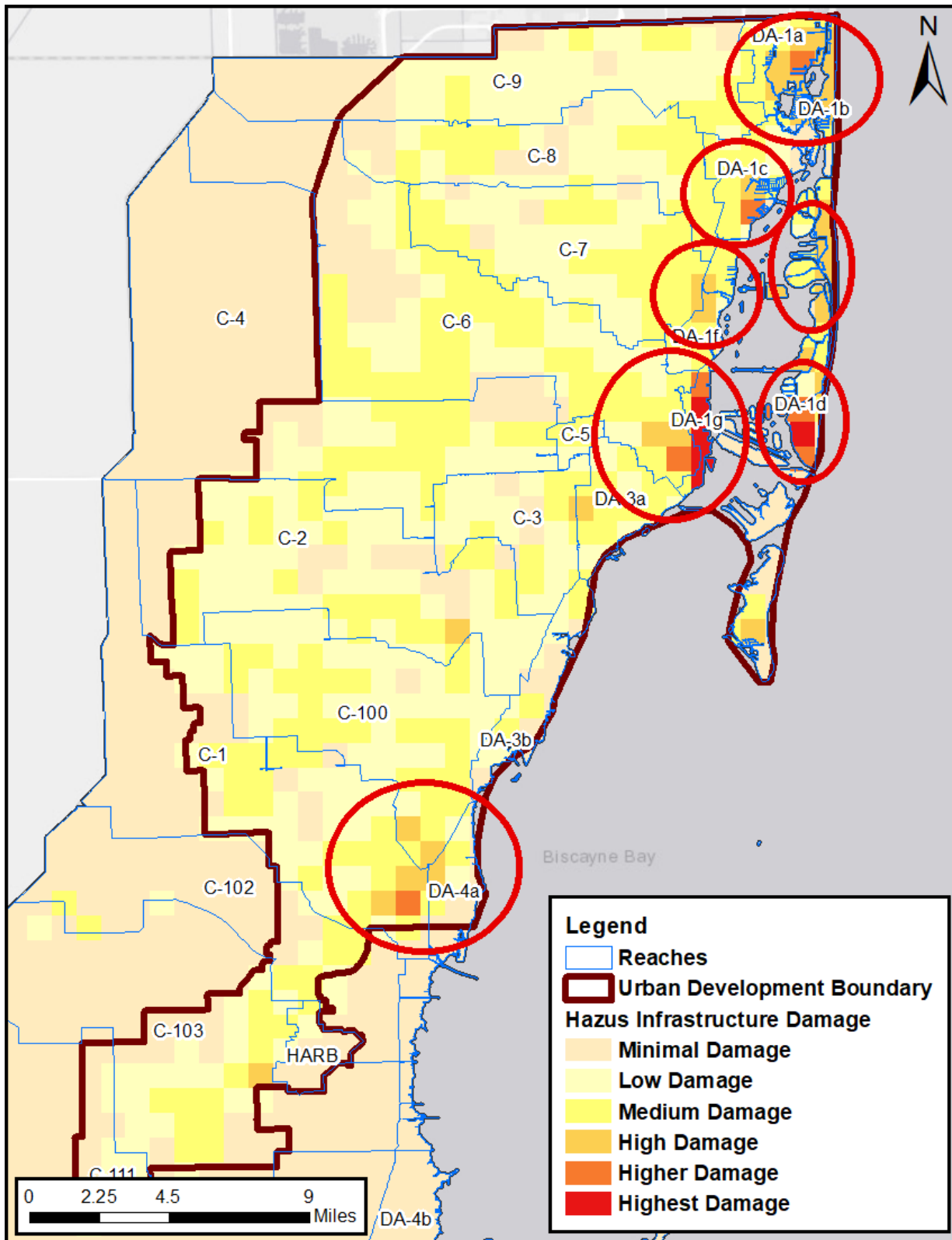


Figure 3-5. Potential Refined Focus Areas through Hazus Infrastructure Damage

The Centers for Disease Control and Prevention's SVI (<https://svi.cdc.gov/>) was used to look at socially vulnerable areas. According to CDC's *A Social Vulnerability Index for Disaster Management*, the SVI uses U.S. Census data to determine social vulnerability of every census tract based on four main themes which are broken down into their own social index factors shown in Table 3-5. Additional descriptions for each social index factor is provided in Appendix A.

Table 3-5 Centers for Disease Control and Prevention's Social Vulnerability Themes and Index Factor

Socioeconomic status	Household Composition & Disability	Minority Status & Language	Housing & Transportation
Below Poverty	Age 65 or older	Minority	Multi-unit structures
Unemployed	Aged 17 or younger	Speak English "less than well"	Mobile homes
Income	Civilian with a disability		Crowding
No high school diploma	Single-Parent Households		No vehicle
			Group quarters

Each theme and social index factor was ranked by the CDC to determine an overall ranking schematic. Additional information on CDC's ranking process and outcomes are available in Appendix A.

It was important for the team to also assess social vulnerability in the area. Through GIS analysis, the Hazus infrastructure damage was overlaid on top of the SVI data to determine areas of highest vulnerability through economic damage and social vulnerability. This analysis allowed the team to determine how the potential refined focus areas would fair against social vulnerability. Figure 3-6 shows the results of this analysis which shows the potential refined focus areas coincide with the most socially vulnerable, economic damage centers.

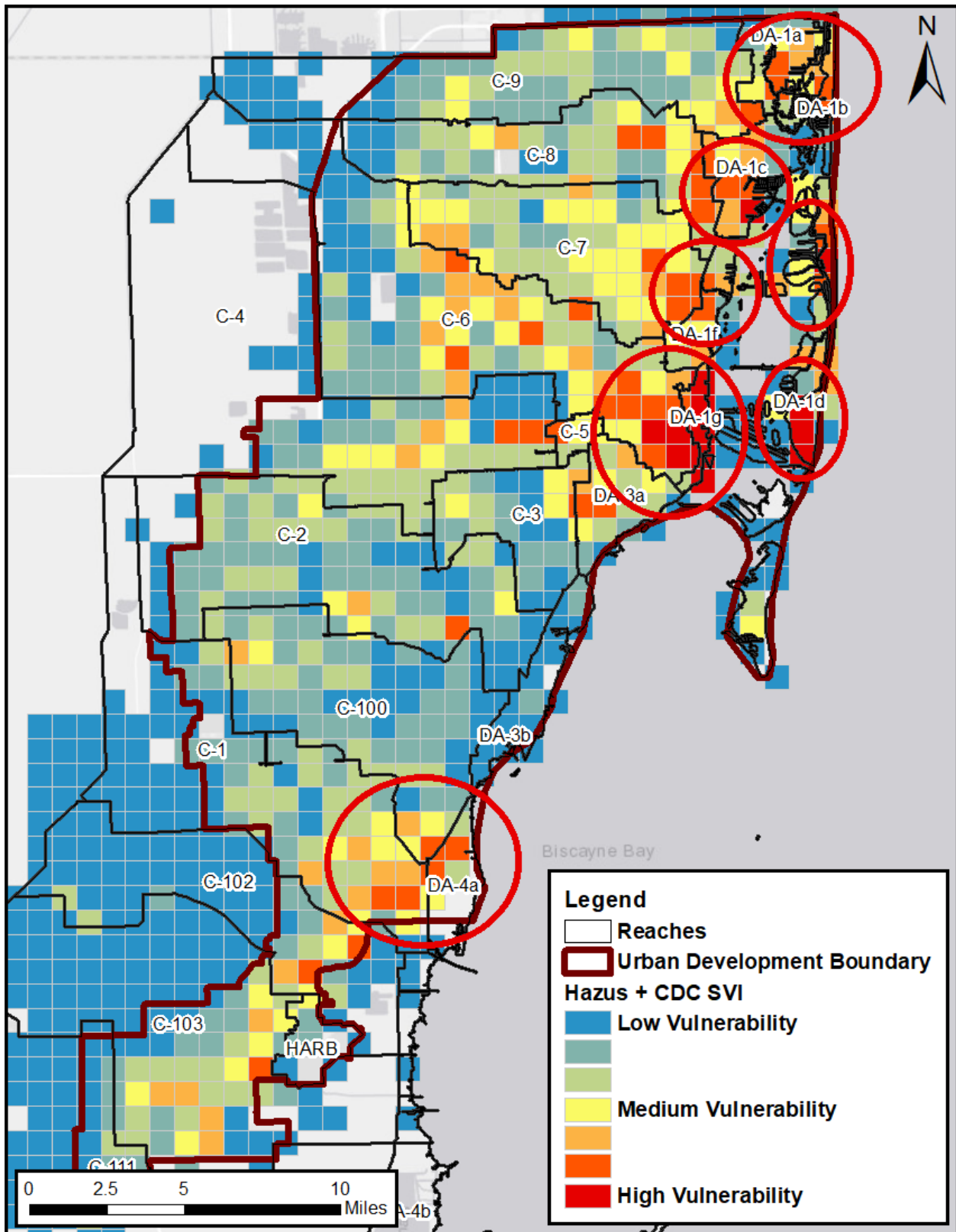


Figure 3-6. Socially Vulnerable Economic Damage Centers

With the help of the NFS and stakeholders during a charrette workshop session in March of 2019, this analysis was discussed and these seven areas were identified as the refined focus areas and named based on the area they were in which are Arch Creek, Aventura, Cutler Bay, Little River, Miami River, North Beach, and South Beach. Figure 3-7 shows these refined focus areas.

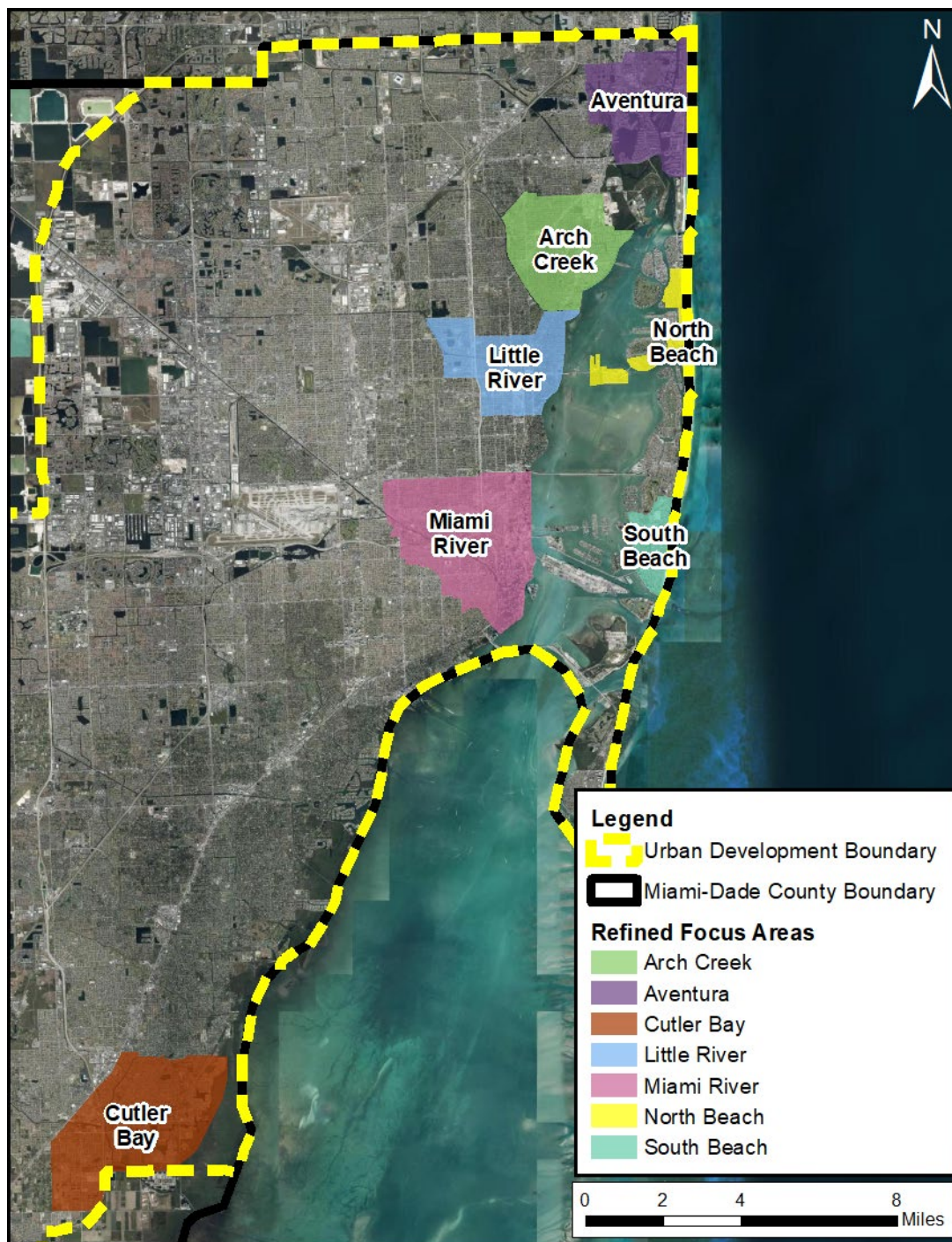


Figure 3-7. Refined Focus Areas in Miami-Dade County

It should be noted that the naming convention for these refined focus areas were based off of areas or municipalities nearby, but do not necessarily only or fully contain that area. For instance, the North Beach focus area covers the area of North Beach, which is a neighborhood of the city of Miami Beach, Florida, but it also contains the Normandy Isles, the Town of Surfside, and the City of North Bay Village. Delineation of the refined focus areas were based off of the following:

- First and foremost the data from the Hazus and social vulnerability analysis showing the most socially vulnerable, economic damage centers.
- Once the main areas were determined, planning reaches, previously mentioned in section 3.8 which were closely defined by the combination of HUC 10 (watershed) and South Florida Water Management District's basin boundaries, were used to make adjustments and ensure hydrologic continuity where possible.
- FEMA repetitive loss data from the National Flood Insurance Repetitive Loss Program was used to ensure that any cluster of repetitive loss structures in close proximity were incorporated into the focus area.

Federal lands were not a part of this study. Per ER 1105-2-100, no federal agency requested participation in the study throughout any of the public scoping processes. Protection of (non-Civil Works) Department of the Army lands shall be accomplished with military funds, not civil works funds unless, the lands are a minor part of the study area and if including them in a project is more cost effective than excluding them. There exists no qualifying federal lands within the refined focus areas.

CHAPTER 4 HYDROMODELING ANALYSIS

4.1 FEMA SOUTH FLORIDA STORM SURGE STUDY

For the MDC Back Bay CSRM, the PDT used FEMA SFLSSS Stillwater elevations for the project analysis and design. The FEMA SFLSSS includes the coastal counties of Miami-Dade, Collier, and Monroe. The purpose of the FEMA SFLSSS is to determine the flood risk from 50 percent (two year), 20 percent (five year), 10 percent (10 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 FEMA FIRMs. Data from the study was used to address coastal storm surge and flood risk to vulnerable populations, property, ecosystems, and infrastructure along the coast for this study.

4.1.1 MODELING OF SURGE LEVELS AND WAVE CHARACTERISTICS

A suite of high-fidelity numerical models were used for the FEMA SFLSSS. The FEMA SFLSSS incorporated existing and future forcing and potential future climate change to perform statistical analyses and numerical hydrodynamic modeling for the region. 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 interval (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.

4.1.2 DETERMINATION OF STORM SURGE WATER LEVEL FREQUENCIES

Floods are generally explained according to their likelihood of occurring in any given year at a specific location. The most commonly used definition is the “100-year flood”, which is also referred to as “one percent flood” or having a “recurrence interval” or “return period” of 100 years. The FEMA SFLSSS incorporated existing and future forcing and potential future climate change to perform statistical analyses and numerical hydrodynamic modeling for the region. The statistical analyses resulted in Stillwater level elevations as annual recurrence interval (ARI) for a 100 percent flood (one year flood), 50 percent flood (two year flood), 20 percent flood (five

year flood), 10 percent flood (10 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), 0.10 percent flood (1,000 year flood), for different confidence limits.

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 only means 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 of time. 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 (P) that one or more of a certain-size flood occurring during any period will exceed a given flood threshold can be estimated as:

$$P = 1 - \left[1 - \frac{1}{T}\right]^n$$

where T is the return period of a given flood (e.g., 100 years, 50 years, 25 years, etc.) and n is the number of years in the period". Due to 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 "one-percent-annual-exceedance-probability flood" or "one-percent chance- exceedance flood," which may be shortened to "one percent flood" as opposed to the "100-year flood." This report will use "percent flood" instead of "year flood". Therefore for the Stillwater elevations for storm frequencies mentioned above, this report will use the percent flood shown in Table 4-1.

Table 4-1. Recurrence Interval and Percent Chance of Occurrence

Recurrence Interval in Years	Percent Chance of Occurrence	Recurrence Interval in Years	Percent Chance of Occurrence
1	100%	50	2%
2	50%	100	1%
5	20%	200	0.5%
10	10%	500	0.2%
20	5%	1000	0.1%

4.1.3 DETERMINATION OF STRUCTURE HEIGHTS AND OVERTOPPING RATES

The risk-reducing capability of the MDC Back Bay CSRM project during hurricanes, tropical storms and extra tropical storms is dependent upon the floodwall's ability to resist against wave overtopping and subsequent water flow rates. Wave overtopping was analyzed using FEMA

SFLSSS Stillwater levels and wave heights. The analysis included the development of peak overtopping rates for return periods (five percent flood, two percent flood, one percent flood, and 0.5 percent flood) at Stillwater levels calculated for the year 2030 (start of the project analysis period) and for the year 2079 (end of the project analysis period). The Stillwater levels vary amongst the refined focus areas. These wave flow rates have the potential of causing scour and possible failure of the protective ability of the feature. Structures heights were adjusted and determined based on the overtopping rates. The specifics of the overtopping allowances are found in Chapter 5 Section 5.3 of the HH&C Sub Appendix. Chapter 5 in the Engineering Appendix has tables indicating the wall heights and elevations due to the overtopping analysis.

4.2 DETERMINATION OF INTERIOR FLOODING

The floodwall associated with an interior area is generally referred to as the line of protection. The line of protection excludes flood water originating from the exterior, but normally does not directly alleviate flooding that may subsequently occur from interior runoff. In fact, the line of protection can often aggravate the problem of interior flooding by blocking drainage outlets. In these cases drainage system enhancements such as flap gates, tide gates, and possibly pumps, will be needed. For the MDC Back Bay CSRM study, a preliminary interior flooding/drainage analysis using existing information and data was performed. The PDT utilized information from analyses performed through past MDC studies as well as performing new modeling analysis where needed. Please refer to Appendix B for more information on the interior flooding/drainage analysis.

4.3 RELATIVE SEA LEVEL RISE EFFECTS ON STRUCTURE HEIGHTS

Many CSRM design projects in the past typically took into consideration the effects of coastal forces from waves, tides, currents, and storm surges. However, many in the past have not taken into consideration the effects of SLR on a coastal structure. In recent years, as sea level rise and climate change become apparent, the impacts of existing structures now show the repercussions of not including the sea level. The rise in the sea level could potentially change the effects of coastal forces, due to the change in the water depths. Knowing the future coastal conditions of an area, engineers should design to include future potential impacts on coastal structures. Incorporating the effects of sea level rise in the initial design could also reduce the risk of failure in the future and reduce changing or making major adjustments for the structure in the future.

4.3.1 ADJUSTING FEMA SFLSSS DATA FOR THE STUDY

The FEMA SFLSSS water levels are referenced to the year 1992, the midpoint of the current National Tidal Datum Epoch (NTDE) (1983-2001). Therefore an adjustment was made to incorporate RSLR from 1992 to 2018, which is when the study began. Based on the USACE low scenario at the Vaca Key NOAA gage from 1992 to 2018, the RSLR increase during this time period was estimated to be 0.31 feet. This value was added to the FEMA SFLSSS results after the data was converted to NAVD88 (in feet).

4.3.2 INCORPORATING FUTURE RSLR

For the MDC Back Bay CSRM study, the anticipated increase of RSLR of 3.29 feet from 2018 to the end of the year 2079 (end of period of analysis) was added to the FEMA SFLSSS water

levels. With the adjusted water levels, including SLR, a top of wall height was determined and overtopping analysis performed to include the effects on the proposed structures for the project. Wave forces were also calculated from wave heights. It should also be noted that when including the calculated SLR that changes in the bathymetry (or ground elevation) are included. Please refer to Appendix B for more information of sea level rise.

4.4 VERTICAL CONTROLS AND DATUMS

The horizontal datum for this study and design is tied to the State Plane Coordinate System using North American Datum of 1983 (NAD83, Florida East, FIPS 901). Distances are in feet by horizontal measurement. Coordinates are Florida East Zone. The vertical datum for this study is tied to the NAVD88, a requirement of ER 1110-2-8160. Elevations stated in this report are in feet, NAVD88 unless otherwise noted.

CHAPTER 5 ECONOMIC APPLICATION

5.1 GEOGRAPHIC DATA

The study area is defined as MDC jurisdictional boundaries and within the Urban Development Boundary established by the County. The County is located in the South Miami-Dade watershed approximately 230 miles southeast of Orlando, FL and approximately 120 miles east of Naples, Florida. The County is bordered mostly by water with the Biscayne Bay in the center and the Atlantic Ocean to the east. The most populous county in Florida, MDC is home to 34 incorporated municipalities, cities, towns and villages, as well as to unincorporated communities and neighborhoods. Additional major water bodies that traverse the County include Miami River, Little River, and a large number of various canals and waterways. Due to the number of water bodies, approximately 81 miles of coastal shoreline, and varied land use, the city was divided based on SFWMD water basins into 24 unique hydrologic reaches to facilitate economic analysis of the project alternatives through the use of the G2CRM model. In addition, a separate study is analyzing the beach side and identified reaches along Atlantic coast for evaluation within Beach-fx.

5.2 DEVELOPMENT AND LAND USE PROJECTIONS

The U.S. Census totals the number of developed and undeveloped land within MDC as 1897 square miles. Established as a town in 1896, the city has grown rapidly and is nearly fully developed with only five percent remaining as undeveloped land. As a result of limited vacant space, the majority of new development is expected to be accomplished through redevelopment and intensification. Residential buildings make up the majority of the city with an aggregate total of 12.7 percent. It is important to note that a large portion of the county, approximately 71 percent, is composed of wetlands. This can be viewed in Table 5-1.

The County has established an UDB that discourages development outside its bounds. Due to the density of the structures in MDC and the very limited vacant land, a future development structure inventory was not included in the damage calculations. It is anticipated that the majority of future development will be the infill of structures on the limited vacant land, or redevelopment.

Table 5-1. 2019 Land Use in the Study Area

Land Use Classification	Acreage	Percentage of Total
Commercial	29,469.54	2.4%
Industrial	8,700.11	0.7%
Institutional	12,904.65	1.0%
Farms	23,241.74	1.9%
Vacant	58,443.59	4.7%
Recreational	14,802.26	1.2%
Residential	158,034.00	12.7%
Transportation	19,273.00	1.6%
Utilities	9,296.00	0.7%
Upland Forests	26,144.06	2.1%
Wetland	882,561.10	71.0%
Total	1,242,870.05	100.0%

5.3 STRUCTURE INVENTORY AND VALUATION

Parcel boundaries were provided by MDC 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, 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. In rare cases, for attributes that contained no information, National Structure Inventory 2.0 data was used to fill those gaps. To value the structures, the team utilized 2019 RSMeans cost per square footage estimator to derive depreciated replacement values of all structures. The depreciated replacement value captures the cost of reconstructing the structure and doesn't account for land valuation.

5.4 VEHICLE DATA

According to the Southeast Louisiana Evacuation Behavioral Report published in 2006 following Hurricanes Katrina and Rita, approximately 70 percent of privately owned vehicles are used for evacuation during storm events. The remaining 30 percent of the privately owned vehicles remain parked at the residences and are subject to flood damage. For non-residential structures, an assumption can be made that 50 percent of the vehicles are evacuated and 50 percent remain. For public vehicles, an assumption can be made that 100 percent of the public vehicles do not evacuate the County during a storm event. Vehicle monetary values cannot be obtained for this study from personal property tax records based on National Automobile Dealers Association (NADA) since Florida does not have a vehicle personal property tax. Further analysis will be done prior to the Agency Decision Milestone if this data is still needed for additional benefits.

5.5 EMERGENCY COST ESTIMATES

In addition to structural damage, a flooded community typically incurs a variety of other flood related costs including debris removal. The cost of the debris removal can vary according to the residential or non-residential occupancy type of the structure. The content-related debris includes white goods (refrigerators, stoves, dishwashers, etc.), electronics, and hazardous waste (paints, oil, household chemicals, poisons, etc.).

Interviews were conducted with experts in the fields of debris collection, processing, and disposal following Hurricanes Katrina and Rita. The experts were asked to provide a minimum, most likely, and maximum estimate for the cleanup costs associated with the two feet, five feet, and 12 feet depths of flooding. A prototypical structure size in square feet was used for the residential occupancy categories and for the non-residential occupancy categories. The experts were asked to estimate the percentage of the total cleanup caused by floodwater and to exclude any cleanup that was required by high winds.



Figure 5-1. Household Debris as a Result of Flood from Hurricane Katrina

Source: Nola.com

5.6 TRANSPORTATION

Roadway flooding is a common occurrence within the County. See Figure 4-2. Flooding causes residents and travelers to move their vehicles to higher ground or parking garages, travel alternate routes or risk losing their vehicle. While vehicles were included in the G2CRM model, additional travel time incurred by using alternate routes to avoid flooded roads was not included in this analysis. Future analyses may want to consider this additional benefit, however, it is not expected to significantly contribute to project benefits.



Figure 5-2. Hurricane Irma causes flooding on Brickell Avenue, September, 2017

Source: abcnews.com

5.7 STAGE-DAMAGE FUNCTIONS

The depth damage functions (DDFs) established within the NACCS Physical Depth Damage Function Summary Report were used for residential and non-residential structures. Functions developed as part of the Non-residential Flood Depth-Damage Functions Derived from Expert Elicitation Report in 2013 (2013) were included to provide a wider range of DDFs to more closely match the structure inventory. Vehicle depth-damage relationships were taken from Economic Guidance Memorandum (EGM), 09-04., Generic Depth-Damage Relationships for Vehicles. The DDFs developed for sedan automobiles was applied to vehicles associated with residential structures and DDFs developed for small trucks was applied to vehicles associated with non-residential structures. Both reports are available upon request.

5.8 STAGE-PROBABILITY DATA

Stage-probability relationships were provided for the existing (2030) without-project condition and future without project conditions (2079). Water surface profiles were provided for eight annual chance exceedance (ACE) events: 50 percent (two-year), 20 percent (five-year), 10 percent (10-year), five percent (20-year), two percent (50-year), one percent (100-year), 0.5 percent (200-year), and 0.2 percent (500-year). The without-project water surface profiles were based on ADCIRC Save Points published on the Coastal Hazards System.

5.9 ADDITIONAL ECONOMIC CONSIDERATIONS

5.9.1 RESIDUAL DAMAGE

Nonstructural and structural measures reduce flood risk and damage to buildings. No measure, except acquisition and removal, can eliminate all risk. Floodwalls, tide gates, structure elevation and floodproofing can be overtopped by a flood event or fail. Some measures don't address nuisance flooding. The risk that remains after a measure is implemented is defined as residual risk. Residual risk can be reduced by implementing multiple layers of protection, such as flood insurance, higher floodplain standards, evacuation, stormwater infrastructure investment, natural and nature-based features, etc. The purchase of flood insurance can reduce financial risk to a property owner should flooding occur. Higher floodplain standards, including freeboard, reduce the exposure of structures to flooding and the vulnerability of the community. Evacuation of an area, even behind a floodwall or tide gate, reduces the risk to lives should a measure fail, is overtopped, etc. Improved stormwater infrastructure can increase capacity of the system and reduce risk of flooding to roads and buildings. Natural and Nature-based features can reduce impervious surfaces and improve infiltration, thereby reducing runoff.

5.9.2 GROSS REGIONAL OUTPUT, EMPLOYMENT, AND EARNED INCOME IMPACTED

Regional Economic Development (RED) will be evaluated on the Recommended Plan during the next phase of this study. The RED measures the dependence between industries and workers in an economy. In other words, if a government agency invests in a certain area, how will the regional economy respond? The calculation is performed by a model developed by IWR, Michigan State University and the Louis Berger Group. Further detail on the RED development can be found in Appendix C.

CHAPTER 6 FORMULATION MANAGEMENT MEASURES AND ALTERNATIVES

6.1 PLAN FORMULATION PROCESS

Plan formulation has been conducted with a focus on achieving the federal objective of water and related land resources project planning, which is to contribute to NED consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other federal planning requirements. Plan formulation also considers all effects, beneficial or adverse, to each of the four evaluation accounts identified in the Principles and Guidelines described further in detail in section 6.10 which are:

1. **The National Economic Development (NED) Account**
2. **The Environmental Quality (EQ) Account**
3. **The Regional Economic Development (RED) Account**
4. **The Other Social Effects (OSE) Account**

The diagram in Figure 6-1 shows the plan formulation process used for the Miami-Dade Back Bay CSRM Study for selecting the TSP. The U.S. Army Corps of Engineers TSP Milestone Meeting was held on January 17, 2020. The North Atlantic Division (NAD), the decision-maker on this study, granted approval of the TSP which allowed the project delivery team to move forward with the draft feasibility report. The TSP will be going through District Quality Control review, Agency Technical Review (ATR), NAD review, public review, and an Independent Expert Peer Review (IEPR). All reviews involve responding to, and if needed, making any changes to any feedback or comments provided. The reviewers then had a second opportunity to acknowledge any comments or changes made. Once the review period is complete, and during the next phase to the ADM, the TSP will be assessed for optimization which includes checking the net benefits at different design water elevations as well as the USACE intermediate and low sea level change rates per ER 1100-2-8162 *Incorporating Sea Level Change in Civil Works Programs* and more recently Engineering Pamphlet 1100-2-1 *Procedures To Evaluate Sea Level Change: Impacts, Responses, and Adaptation*.

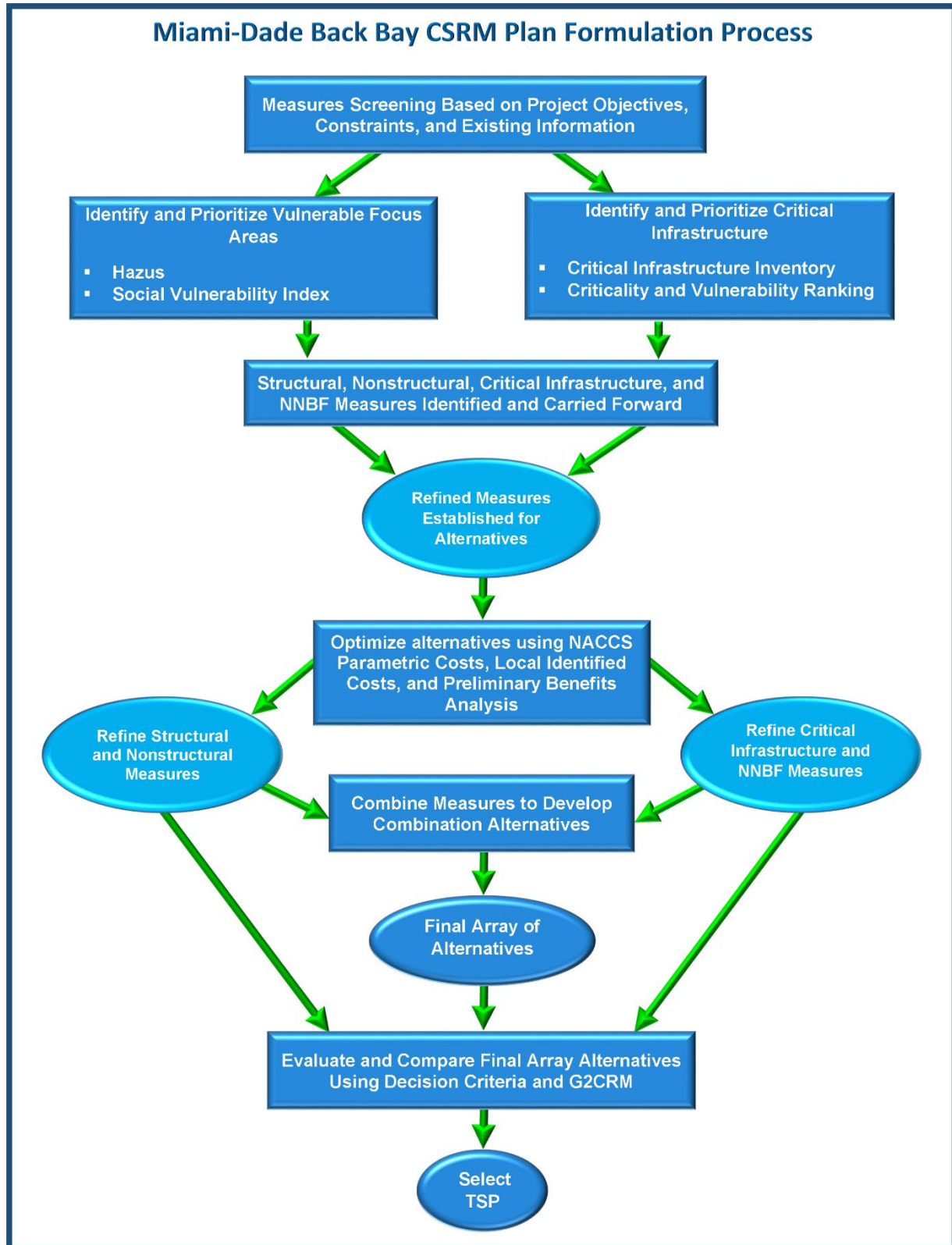


Figure 6-1. Miami-Dade Back Bay CSRM Plan Formulation Process

6.2 MEASURES FOR COASTAL STORM RISK MANAGEMENT

A measure is a feature or activity that can be implemented at a specific geographic site to address one or more planning objectives. Measures become more specific and better defined as planning progresses. Coastal storm risk management measures consist of three basic types: structural, nonstructural, and NNBF. This study will produce a combination of feasible coastal storm risk management alternatives that may consist of all three management measures. Following the USACE planning methodology, this approach would consider the engineering attributes of features and the dependencies and interactions among these features over both short term and long term scenarios.

6.3 STRUCTURAL MEASURES

Structural CSRM measures are man-made, constructed engineering solutions to manage flood risk and reduce damage from coastal storms by physically limiting flood water inundation. This includes measures such as storm surge barriers (which can include miter gates, sector gates, etc.), levees, and floodwalls/ringwalls that are implemented to protect people and property. Structural measures would have any associated pump stations that may be required to ensure there is no flooding being induced as a result of any measure. Additionally, real estate actions are anticipated as a result of the proposed implementation of structural measures. For more information please refer to the Real Estate Appendix, Appendix F.

6.4 NONSTRUCTURAL MEASURES

Nonstructural CSRM 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 risk (likelihood and consequences) of flooding instead of focusing on reducing the probability of flooding.

The following nonstructural measures represent techniques commonly utilized in reducing flood risk and the damage associated with flooding. These measures vary from removing an entire structure from the floodplain to insuring a structure which is permanently located within the floodplain. The costs associated with implementing a measure are variable, where reduction of flood damage is proportional to the cost of the measure (i.e. removal of a structure from the floodplain will eliminate all future damage associated with flooding, while purchasing flood insurance for a structure will assist in making the structure whole after a flood event, it does not eliminate future flood damage to that structure).

Elevating structures

This nonstructural measure involves lifting the lowest floor elevation of residential structures to at least equal to or greater than the one percent annual chance flood defined by FEMA. This can be done to structures whether they have a crawl, slab, or basement foundation which would require filling in the basement first.

Acquiring structures

This nonstructural measure involves buying out the residential structure and land. The structure is either demolished or relocated outside of the FEMA floodplain. No future development or redevelopment is allowed on the acquired property, and must remain open space. After

demolition of the structure, the area would be converted to green space or a park; any plantings would be done with native vegetation. Other compatible uses are acceptable such as parks, recreational areas, etc. as long as there would be no paved surface. Per USACE Planning Bulletins 2016-01 and 2019-03, a recommended plan involving acquisition as a nonstructural measure would now include retaining the use of eminent domain as a last resort, if necessary, by the non-Federal sponsor in order to have a complete plan.

Relocating structures

This nonstructural measure involves physically moving the structure to an area outside of the floodplain or a land parcel with higher ground elevation. The land would also be bought and would have to adhere to the same regulations as mentioned under acquiring structures. Depending on the location, this nonstructural measure may not be possible due to limitations of available land.

Floodproofing structures

Dry Floodproofing

This nonstructural measure involves making an area watertight so that no water can enter the structure. This can be done with the use of waterproof coatings, impermeable membranes, sealants, shields/gates applied to doors and windows. A sump pump can also be installed to help keep the area dry and prevent flooding. Because water's lateral force against a wall increases as the depth of water increases, the maximum allowable flood depth for floodproofing is approximately three feet. Tests showed that walls exposed to depths greater than three feet of water either collapsed or suffered serious structural damage (USACE 1988). Dry floodproofing is typically done to non-residential structures since the National Flood Insurance Program (NFIP) does not provide premium rate reductions for floodproofing done to residential structures. This concept does not work with basements nor does it work with crawl spaces. For buildings with basements and/or crawlspaces, the only way that dry floodproofing could be considered to work is for the first floor to be made impermeable to the passage of floodwater. Floodproofing is not permitted in FEMA Coastal High Hazard Areas – Areas subject to inundation by the 1-percent-annual-chance flood event with additional hazards due to storm-induced velocity wave action.

Wet floodproofing

Unlike dry floodproofing, this nonstructural measure involves allowing water to enter a structure. Wet floodproofing requires structures to be built with materials that are water resistant. Structures need to also be properly anchored, and all mechanical and utility equipment must also be elevated above a design water elevation. This measure is generally not applicable to large flood depths and high velocity flows. FEMA's Wet Floodproofing Requirements for Structures Located in Special Flood Hazard Areas in accordance with the National Flood Insurance Program Technical Bulletin 7-93 has more information on this measure.

Flood Warning Systems

This nonstructural measure relies upon local stream gage, rain gages, and hydrologic computer modeling to determine the impacts of flooding for areas of potential flood risk. A flood warning

system, when properly installed and calibrated, is able to identify the amount of time available for residents to implement emergency measures to protect valuables or to evacuate the area during serious flood events. A good example is the National Weather Service's Integrated Flood Observing and Warning System (IFLOWS) which sends emergency text messages during flash flood events.

6.5 NATURAL AND NATURE-BASED FEATURES

Natural and Natural-Based Features are either natural or constructed features that mimic natural features that provide coastal storm risk reduction benefits such as wave attenuation and storm surge reduction. In addition to more traditional structural and nonstructural features, NNBFs were evaluated to determine if they could potentially be used as stand-alone features or be used in tandem as a multi-dimensional feature with other structural or nonstructural features (measures) to help achieve project objectives.

6.6 SEPARABLE AND COMPLEMENTARY MEASURES

Separable measures are measures that can provide a level of risk reduction to an area on its own. Separable measures are individually justified and can be combined with other justified measures to form alternatives. For instance, several floodwalls may be recommended throughout an area, but each floodwall on its own could be a separable measure if it can provide a risk reduction on its own without needing to be connected to other floodwalls. This is usually possible if there is high ground available for the floodwall to tie into or if the measures are spread out throughout an area.

Complementary measures are those measures that provide risk reduction in the residual floodplains of structural measures in order to provide a uniform level of risk reduction throughout the county. For example, engineering constraints may limit the location of a structural measure such that a portion of a neighborhood is left unprotected. Providing a complementary measure, typically nonstructural, that will provide a similar level of risk reduction, allows for a more holistic approach to countywide flood risk reduction.

6.7 INVENTORYING AND SCREENING MEASURES

Screening is a form of decision-making based on criteria. Screening is necessary to keep the study focused on its goals and objectives. Screening criteria for this study included:

- Meeting the objectives of reducing damage to infrastructure from coastal storm risk and reduce the risk to health and human safety
- Avoiding military bases or other federally owned properties to avoid supplementing other Federal programs
- Avoid or minimize impacts to cultural and/or historic resources
- Minimize environmental impacts
- Ensure there is no inducing of flooding

Table 6-1 shows a list of some typical measures applicable for a CSRM study and whether or not they meet the objectives and criteria for this study.

Table 6-1. Measures Screening

Measure	OBJECTIVES		CRITERIA			
	#1 Reduce economic damage to structures ?	#2 Increase Resiliency by decreasing vulnerability of critical infrastructure ?	Minimize Impacts to Cultural / Historic Resources ?	Minimize Environ mental Impacts ?	Avoid creating or exacer bating Flooding ?	Reduce risk to human life and health due to coastal flooding ?
Acquisition (building removal) and relocation	Yes	N/A	Medium	High	High	High
Building retrofit (e.g., floodproofing, elevating structures)	Yes	Yes	High	High	High	Medium
Enhanced flood warning and evacuation planning	No	No	High	High	Medium	Medium
Land use management / conservation and preservation of undeveloped land, zoning, and flood insurance	No	No	High	High	Medium	Low
Floodwalls and/or levees	Yes	Yes	High	Medium	High	High
Shoreline stabilization	No	No	Medium	High	Low	Low
Storm surge barriers	Yes	Yes	High	Medium	High	High
Beach fill / dune creation	N/A	N/A	N/A	N/A	N/A	N/A
Beach restoration and breakwaters	N/A	N/A	N/A	N/A	N/A	N/A
Beach restoration and groins	N/A	N/A	N/A	N/A	N/A	N/A
Drainage improvements	Yes	No	Medium	Medium	Medium	Medium
Living shorelines	No	No	N/A	N/A	N/A	N/A
Over wash fans	No	No	N/A	N/A	N/A	N/A
Reefs	No	No	N/A	N/A	N/A	N/A
Vegetation / Mangroves / Wetlands	Yes	Yes	High	High	High	Medium

Using Table 6-1., the team determined most appropriate measures for this study to be acquisition, relocation, floodproofing, and/or elevation of structures; floodwalls; storm surge barriers; and vegetation, mangroves and/or wetlands.

6.8 DEFINING MEASURES PER REFINED FOCUS AREA

The Project Delivery Team originally determined potential measures with MDC, stakeholders, and other agencies at the planning charrette which was held November 8-9, 2018. The team then assessed which measures would be applicable to the refined focus areas and which ones would be screened out.

6.8.1 REFINED STRUCTURAL MEASURES

Measures that were applicable to the refined focus areas are shown in Table 6-2 which shows whether or not they were carried forward. These measures were also discussed at a March 2019 charrette workshop in Miami with the NFS and stakeholders.

Table 6-2. Screening of Specific Measures within Focus Areas

Measure	Carried Forward?	Discussion
Floodwalls on Barrier Islands	No	Due to the soil conditions and limited high ground to tie into.
Move levee at L-31	No	Would have negative impact on all South Florida drainage structures, limited high ground tie-in.
Edgewater Floodwall	Yes	Floodwall on Biscayne Bay in the Edgewater area of Miami.
Ringwalls	No	Possible life safety issue.
Miami River Channel Floodwall	No	This is a floodwall on the channel banks of the Miami River. Constructing a floodwall would induce flooding on the opposite side and there is limited high ground to tie in on the north bank.
Miami River Surge Barrier	Yes	Storm surge barrier located across the Miami River at or near the mouth of the river.
Little River Surge Barrier	Yes	Storm surge barrier located across Little River.
Biscayne Canal Surge Barrier	Yes	Storm surge barrier located across Biscayne Canal.
Brickell Floodwall	Yes	Seawall improvements or new floodwall. This is at the mouth of the Miami River going near River Walk Trail down to SE 15 th Rd.

As mentioned in Section 3.8 Planning Reaches, USACE built canals to manage the surface water in the 1950s as part of the Central and Southern Florida Project. The Central and Southern Florida Project is a multi-purpose project that provides flood control; water supply for municipal, industrial, and agricultural uses; prevention of saltwater intrusion; water supply for the ENP; and protection of fish and wildlife resources. The South Florida Water Management District operates these canal structures. Any structural measure would need to be coordinated with the SFWMD.

6.8.2 REFINING NONSTRUCTURAL MEASURES

The location of where nonstructural mitigation would occur was now fixated on the seven refined focus areas. Aventura, Cutler Bay, North Beach, and South Beach are the focus areas where only nonstructural measures would be applied. Arch Creek, Little River, and Miami River areas were also included for nonstructural consideration to determine if nonstructural measures were more feasible than the structural measures that were carried forward. Nonstructural measures were also considered for those three focus areas on the downstream side (or bayside) of any structural measures depending on the structure's location.

Table 6-3 shows the nonstructural measures that were screened or carried forward applicable in the refined focus areas.

Table 6-3. Nonstructural Measure Screening

Nonstructural Measure	Measure Carried Forward? (Yes/No)	Discussion
Elevation	Yes	Elevating the first floor elevation above the design water elevation allows for the structure and contents to receive less damage and remain intact. Evacuation is still highly recommended during a storm event when warranted.
Dry Floodproofing	Yes	Allows for flood risk reduction for the first few feet of elevation, typically up to 3 feet above grade.
Wet Floodproofing	Yes	Redesigning the first floor of a facility so that if it does flood there will not be significant damage to the building or contents.
Buyout / Acquisitions	Yes	Removes majority, if not all, risk associated with coastal storms and flooding.
Relocation	No	Due to limited new lands, this may not be possible.

6.8.3 REFINING NATURAL AND NATURE-BASED FEATURES

For this study, NNBFs considered included mangrove and native vegetation plantings at the Cutler Bay Site (east of Old Cutler Road and south of 184th street extending to southwest 188th street and extending to Biscayne Bay), enhancements or additional construction of dredged material spoil islands in Biscayne Bay, restoration of SAV in Biscayne Bay, and restoration of Bird Key in Biscayne Bay. Living shorelines and coral reefs were considered as well as possible NNBFs, however, no site-specific locations for these types of NNBFs were identified during plan formulation or during the Environmental Interagency Meetings so these NNBFs were not selected as potential NNBFs for this study and therefore, are not further discussed. Mangroves were determined to be the most feasible and cost effective NNBF measure for this project. Table 6-4 shows the applicable NNBF measures to the refined focus areas and which ones were carried forward.

Table 6-4. Natural and Natural-Based Features Measure Screening

Natural and Natural-Based (NNBF) Features Measure	Measure Carried Forward? (Yes/No)	Discussion
Cutler Bay Vegetation Enhancements (NNBF)	Yes	Carry forward mangroves and other native vegetation plantings potentially complement nonstructural measures or provide stand-alone storm surge dissipation.
Submerged Aquatic Vegetation (NNBF)	No	Submerged Aquatic Vegetation already present in portions of ROI. Submerged Aquatic Vegetation restoration already being conducted by other state and federal partners SAV was not selected as a potential NNBF for this project.
Enhance or Construct Dredge Material Spoil Islands (NNBF)	No	Existing spoil islands already contain extensive riprap protection. Anticipated non-feasibility of additional islands due to potential limitations in material availability and anticipated lack of cost effectiveness.
Restoration of Bird Key (NNBF)	No	Based on review of historical aerial imagery, there has not been any notable physical degradation/deterioration of the physical profile of the island.

The benefits of mangroves as a feature to reduce coastal storm risk has been well documented throughout the scientific literature. Mangroves serve to buffer the impacts of waves and storm surge via dissipation of wave energy. Mangroves have been documented to reduce surge heights, reduce water flow velocities, and reduce inundation levels caused by coastal storms (Dasgupta et al. 2019; Zhang et al. 2012; Krauss et al. 2009).

However, not until recently has systematic storm surge data collection coupled with modeling investigations been used to quantify coastal storm risk benefits of mangroves. Zhang et al. (2012) documented storm surge reduction benefits of mangroves along the southwestern coast of Florida from Sanibel Island to Key West based on field observations and numerical simulations with 2-Dimensional CEST Storm Surge Model coupled with the SLOSH model. Zhang et al. (2012) documented that the 6-30 km wide mangrove forest along the Gulf Course of Florida significantly attenuated storm surges from a Category 3 level hurricane and noted the importance of the width of the mangrove forest. Zhang et al. 2012 noted that mangroves reduce surge amplitudes by 26-76 percent and notably documented relationships of surge and inundation reduction in relationship with mangrove forest widths. Zhang et al. (2012) documented how red mangroves (*Rhizophora mangle*) are effective in dissipating surges because of their dense silt roots.

Sheng et al. (2017) documented a 66 percent reduction in surge and inundation from mangroves using the 3-Dimensional CH3D-SWAN Model along the southeastern coast of Florida. Sheng et al. (2017) noted that the 3-dimensional modeling approach best reflects the vertical and spatial varying mangrove canopy structures. Sheng et al. (2017) also noted how mangroves significantly reduced current magnitude from approximately 140 to 20 cm/s.

Taylor Engineering in coordination with the USACE, Jacksonville District (2018) utilized the 3-Dimensional ADCIRC-SWAN Model to simulate coastal storm risk benefits of mangrove vegetation and dune restoration in MDC. Various potential storm forcing conditions were simulated to assess mangrove effects to water levels in MDC. This study documented how mangroves attenuate storm surge reduction (from approximately 0.5 - 1.5 feet) along area of the shoreline and interior areas in Biscayne Bay. It was also noted that various storm tracks can have varying effects on the coastal storm risk effects of the NNBFs.

Native vegetation plantings at the Cutler Bay Site that would include mangroves was selected as the most viable NNBF for this project and was retained as a planning measure for the study. Because of the extent of SAV already in the project area and SAV restoration already being conducted by other state and federal partners, SAV restoration was not selected as a potential NNBF for this project. Enhancement or additional spoil island were not selected as NNBFs for this project as the existing spoil islands in Biscayne Bay already contain extensive riprap protection and because of the anticipated non-feasibility of additional islands due to potential limitations in material availability and anticipated lack of cost effectiveness of this potential feature. Based on historical aerial imagery evaluation of Bird Key, the team did not determine there to be significant deterioration/degradation of habitat, therefore, this potential NNBF was also screened out.

6.8.4 REFINING CRITICAL INFRASTRUCTURE

Reducing coastal storm risk to critical infrastructure was the only measure that was kept throughout all of MDC as a feasible countywide measure regardless of refined focus areas. The priority asset categories for critical infrastructure were determined through the following:

- A list of critical infrastructure was first acquired from Hazus which contains national data for essential facilities which typically includes hospitals, police stations, fire stations, schools and emergency operations centers.

- The Rapid Action Plan (RAP), created by Hazen & Sawyer for MDC, provided a ranking of County owned critical infrastructure asset categories. Any critical infrastructure identified as at risk from coastal storm surge from the RAP was considered for further analysis.
- The current effective FEMA 0.2 percent annual chance flood (500 year floodplain) or the USACE 0.2 percent annual chance flood plus the USACE high curve SLR to 2079 (whichever is greater) was used as a screening tool to refine the list of critical infrastructure. Critical infrastructure within those floodplains will be carried forward in analysis while those not in the areas will be screened out.
- Priority critical infrastructure asset categories were refined during the March 2019 charrette workshop in Miami with the NFS and stakeholders through a screening process. Several meetings and teleconferences were also held with the Airport, Seaport, Railroad, WASD, and MDC Staff to discuss critical infrastructure.

The asset categories that are recommended for inclusion of the feasibility study and those that are not, along with an explanation for that decision are shown in Table 6-5. The number of facilities shown in the table are from the Hazus database.

Table 6-5. Screening of Critical Infrastructure Priority Asset Categories

Asset Category	Include in Study (Y/N?)	Decision Notes	Number of facilities in Miami-Dade County
Fire Stations	Y	Identified as an asset category owned by the sponsor and stakeholder municipalities for improved flood resiliency. Use the MDC Rapid Action Plan to identify fire stations at risk.	103
Medical Facilities	Y	Significant hospital facilities (accessible to the general public) to be identified for improved flood resilience.	81
Police Stations	Y	Identified as an asset category owned by the sponsor and stakeholder municipalities for improved flood resiliency. Use the MDC Rapid Action Plan to identify police stations at risk.	83
Potable Water Facilities	Y	Identified as an asset category owned by the sponsor and stakeholder municipalities for improved flood resiliency. May include treatment plants, wellfield facilities, and storage tanks.	20
Evacuation Centers	Y	Shelters are not a defined category in Hazus; however, the possibility of identifying shelters for recovery assistance and staging may be	--

Asset Category	Include in Study (Y/N?)	Decision Notes	Number of facilities in Miami-Dade County
		necessary. Non-Federal sponsor has given evacuation center information, but due to privacy concerns, the number or locations will not be shared in this study.	
Wastewater Facilities	Y	Identified as an asset category owned by the sponsor and stakeholder municipalities for improved flood resiliency. May include treatment plants and pump stations. Use existing Water and Sewer Department studies to identify most at risk facilities which prioritized 190 of the 1,071 pump stations.	190
EOC Facilities	Y	Emergency Operations Center (EOC) Discuss if these are already covered by FEMA standards.	8 divisional
Airport Facilities	Y	Airport facility interests covered by the Federal Aviation Administration, private companies, and economic interests. This category is more of an economic related critical infrastructure category.	N/A
Bus Facilities	N	Bus facilities not considered critical for flood hazard mitigation.	12
Communications Facilities	N	Communications interests should fall under the responsibility of the FCC and private companies. Not part of RAP.	313
Electric Power Facilities	N	Electric power interests should fall under the responsibility of private companies, the Federal Energy Regulatory Commission (FERC) and the State of Florida Office of Energy. Not part of RAP.	47
HAZMAT Sites	N	HAZMAT should fall under the responsibility of FEMA and EPA. Not considered critical for flood hazard mitigation. Not part of RAP.	878
Nuclear Power Plant	N	The Turkey Point Nuclear Power Plant is managed by the Nuclear Regulatory Commission and Florida Power & Light (FPL). The ground elevation in the area ranges from 15	1

Asset Category	Include in Study (Y/N?)	Decision Notes	Number of facilities in Miami-Dade County
		to 20' NAVD88. FPL mentioned that their plant can withstand a surge of 16'. Not part of RAP.	
Schools	N	School facilities not considered critical for flood hazard mitigation unless also designated as an EOC.	1,473
Water Management Facilities	Y	Some facilities might be considered.	N/A
Ports	Y	Some facilities might be considered.	N/A
Critical Roads / Causeways	Y	Determine erosion on two critical high priority causeways: Rickenbacker Causeway and Venetian Way.	2
Air Force Base	N	Avoid augmenting other Federal programs. Not part of RAP.	N/A
Railway	Y	Electrical substations of railways will be considered.	N/A

6.9 FORMULATION OF ALTERNATIVES

Alternatives, also known as plans, is a set of one or more management measures functioning together to address one or more planning objectives. All measures carried forward were combined into alternatives to provide coastal storm risk reduction for the refined focus areas. As mentioned previously, analyzing critical infrastructure was kept in all alternatives throughout all of MDC regardless of refined focus area as a feasible countywide measure; however, it will be kept within the design water surface elevation inundation boundary where available. This resulted in the alternatives shown in Table 6-6 along with their brief descriptions. More detailed descriptions follow the table.

Table 6-6. Alternative Descriptions

Alternative Number	Alternative Name	Brief Description
1	No Action/Future Without Project	No action. Continue as-is without any recommendations.
2	Critical Infrastructure Only	Analyzing critical infrastructure throughout all of Miami-Dade County on priority asset categories. This includes wet and dry floodproofing.
3	Miami River Basin Structural + Alt. 2	Surge barrier at Miami River (plus associated pump stations) + Floodwalls (plus associated pump stations and riprap) + Nonstructural outside of surge barrier + Critical Infrastructure
4	Nonstructural + Alt. 2	Acquiring, elevating, and wet and dry floodproofing of structures in Arch Creek, Aventura, Cutler Bay, Little River, Miami River, North Beach, and South Beach areas + Critical Infrastructure
5	Inland Storm Surge Reduction (Structural) + Alt. 2	Surge barriers at Miami River, Little River, and Biscayne Canal (plus associated pump stations) + Floodwalls (plus associated pump stations and riprap) + Critical Infrastructure
6	Alt. 3 + 4 + 2	Miami River Basin + Nonstructural + Critical Infrastructure
7	Alt. 4 + 5 + 2	Nonstructural + Structural + Critical Infrastructure
8	Alt. 2 + Alt. 4 + Alt. 5 + Nonstructural at Edgewater – floodwall at Edgewater	Alt. 2 (Critical Infrastructure) + Alt. 4 (Nonstructural) + Nonstructural at Edgewater + Surge barriers at Miami River, Little River, and Biscayne Canal (plus associated pump stations) + Floodwalls (plus associated pump stations and riprap) - Floodwall at Edgewater

The No Action/Future without Project Alternative (Alternative 1) is required to be included and analyzed by the NEPA in an EIS. The No Action/Future without Project Alternative would involve no action from USACE to mitigate against coastal storm risk. Although this alternative would not accomplish the objectives of this study, it is required to be included in the analysis and can serve several purposes. First, it is warranted for situations where the impacts are great and the need is relatively minor. Second, it will be used as a benchmark, enabling decision makers to compare the magnitude of economic, environmental, and social effects of the actionable alternatives.

The Critical Infrastructure Only Alternative (Alternative 2) will investigate solutions for reducing coastal storm risk to priority asset categories throughout all of MDC. Risk reduction methods applicable to critical infrastructure include wet and/or dry floodproofing. Figure 6-2 shows a map of all the critical infrastructure carried forward for analysis. Note that pump stations and evacuation shelters are not shown in the map due to the vast number and due to privacy concerns respectively. Any critical infrastructure outside of the design water level inundation boundary and is not at risk to coastal storm risk will be screened during optimization described further in section 7.2.

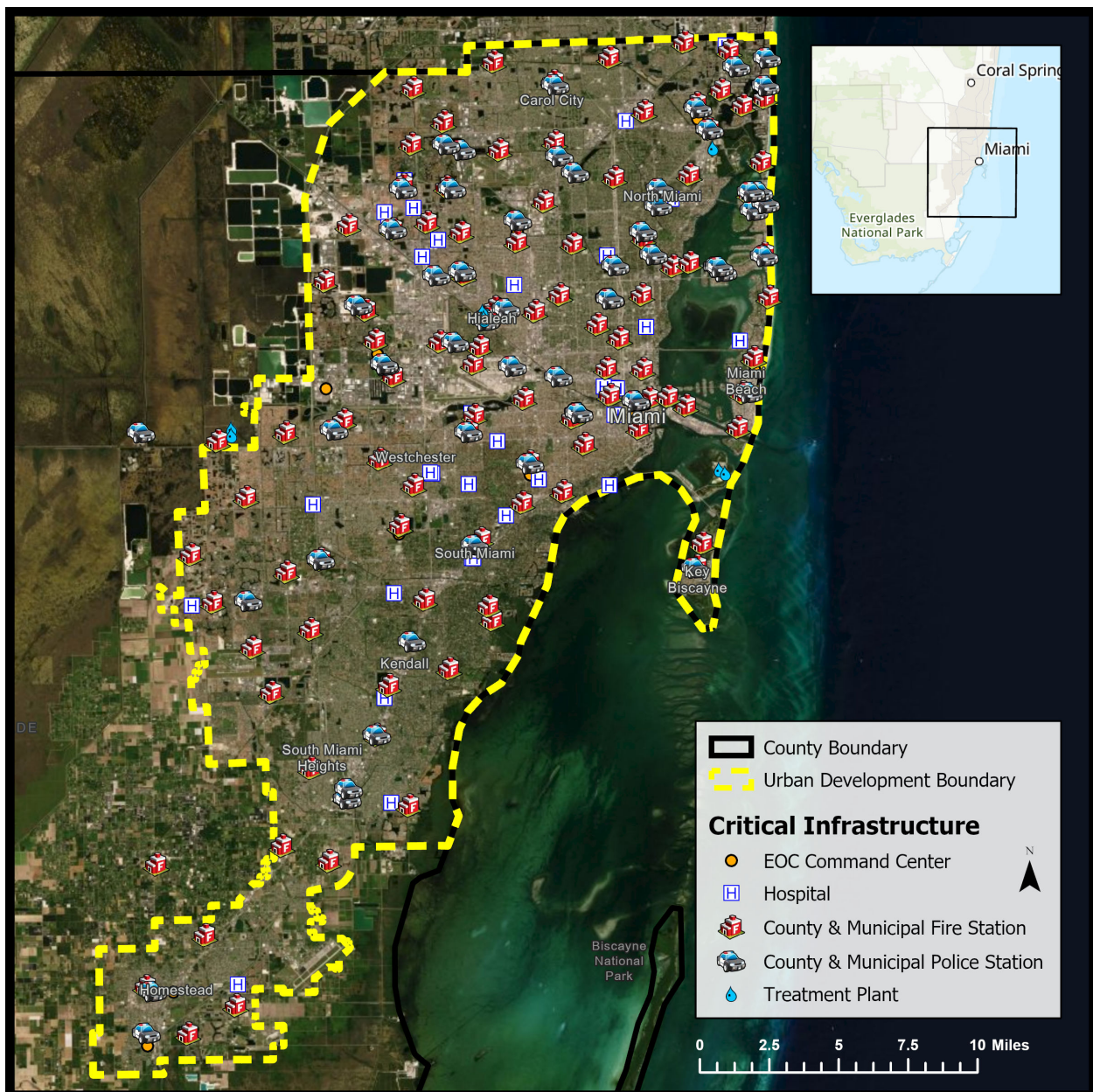


Figure 6-2. Critical Infrastructure Carried Forward

The Miami River Basin and Critical Infrastructure Alternative (Alternative 3) assumes solutions for the Miami River and its vicinity within the focus area. This includes a surge barrier

at the Miami River (and associated pump stations), floodwalls (and associated pump stations and riprap at the Brickell location in the Biscayne Bay), and nonstructural measures outside of the surge barrier (bayside). The associated floodwalls at the surge barriers are needed to connect to the surge barrier and to tie into high ground. The team analyzed multiple surge barrier plus floodwall alignments for the Miami River in order to avoid or limit any impacts to the Miami Circle National Historic Landmark site. One alignment was further east of Brickell Ave (Miami River Option 1) and one was further west (Miami River Option 2). This alternative includes analyzing critical infrastructure throughout all of MDC. This alternative also includes plantings of native vegetation including mangroves at the Cutler Bay NNBF Site.

The Nonstructural and Critical Infrastructure Alternative (Alternative 4) assumes solutions can be implemented by incorporating flood mitigation features at the individual property level in the seven socially vulnerable, economic damage center focus areas which include the areas of Arch Creek, Aventura, Cutler Bay, Little River, Miami River, North Beach, and South Beach. Converting acquired properties to parks or green space, elevating structures, and wet and dry floodproofing are the recommended solutions for nonstructural measures. Acquisition and elevation applies only to residential buildings whereas wet and/or dry floodproofing applies only to non-residential buildings. This alternative does not significantly change the overall floodplain, but it prevents and/or reduces the impact of inundation on these structures. 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. Nonstructural measures can be divided into physical and nonphysical measure categories. Physical nonstructural measures would include elevation, acquisition, or wet/dry floodproofing of structures. Nonphysical measures would include flood warning systems, flood preparedness and evacuation plans, zoning and flood insurance regulations, etc. Some nonphysical measures, such as zoning, are not implemented by the USACE, but instead are the responsibility of the local municipality. This alternative includes analyzing critical infrastructure throughout all of MDC. This alternative also includes plantings of native vegetation including mangroves at the Cutler Bay NNBF Site. The nonstructural measure of acquisition, demolition, and conversion to green space of residential structures is not currently anticipated as part of the TSP because elevation was determined to provide more net benefits than acquisition. However, acquisition is still being considered as a potential future measure and is therefore, further evaluated as a potential impact. This measure will continue to be considered as the study advances and additional neighborhood cohesive analysis is conducted.

The Inland Storm Surge Reduction (Structural) and Critical Infrastructure Alternative (Alternative 5) assumes structural solutions for the most socially vulnerable, economic damage centers of MDC where applicable. This includes surge barriers at Miami River, Little River, and Biscayne Canal (C-8) (and associated pump stations) and floodwalls (and associated pump stations and riprap at the Edgewater and Brickell sites where the floodwall occurs in the Biscayne Bay). Biscayne Canal falls within the Arch Creek focus area. All structural measures include any associated floodwalls, riprap (where the floodwalls occur in the Biscayne Bay) and pump stations. Types of surge barriers considered would include sector gates and miter gates.

More information regarding the surge barrier types are found in Appendix B. This alternative includes analyzing critical infrastructure throughout all of MDC. This alternative also includes plantings of native vegetation including mangroves at the Cutler Bay NNBF Site.

Alternative 6 is a combination of alternatives 2 and 3 and 4. This includes the surge barriers (and associated pump stations) at the Miami River, floodwalls (and associated pump stations and riprap), and nonstructural measures throughout all seven focus areas. This alternative also includes analyzing critical infrastructure throughout all of MDC. This alternative also includes plantings of native vegetation including mangroves at the Cutler Bay NNBF Site.

Alternative 7 is a combination of alternatives 2 and 4 and 5. This alternative is the all-inclusive alternative which combines all alternatives together. This alternative is similar to Alternative 6, but it also includes the surge barriers (and associated floodwalls and pump stations) at the Biscayne Canal and Little River (and associated pump stations), floodwalls (and associated pump stations and riprap). This alternative includes analyzing critical infrastructure throughout all of MDC. This alternative also includes plantings of native vegetation including mangroves at the Cutler Bay NNBF Site.

Alternative 8 is similar to Alternative 7, but with the Edgewater Floodwall removed and nonstructural measures at Edgewater proposed instead. This analysis was completed to be able to compare the structural versus nonstructural element at the Edgewater area. This area also had approximately 100 structures demolished within the last year which were replaced by a few high rise buildings which was not updated in the April 2019 structure inventory. This Alternative consists of nonstructural measures throughout all seven refined focus areas with the addition of the Edgewater area, and Surge barriers at Miami River, Little River, and Biscayne Canal (plus associated pump stations) + Floodwalls (plus associated pump stations and riprap). This alternative includes analyzing critical infrastructure throughout all of MDC. This alternative also includes plantings of native vegetation including mangroves at the Cutler Bay NNBF Site.

6.10 FOUR EVALUATION ACCOUNTS

In the 1970 Flood Control Act, Congress identified four equal national objectives for use in water resources development planning. They were: NED; RED; EQ; OSE. During the 1970s, two of these, NED and EQ, were actually national objectives. All four categories of plan effects remain important considerations of water resource projects.

6.10.1 NATIONAL ECONOMIC DEVELOPMENT (NED) ACCOUNT

The National Economic Development (NED) Account displays changes in the economic value of the national output of goods and services. It is referred repeatedly throughout the planning process and forms the basis of the Federal objective. Alternatives that reasonably provide the largest net NED benefits are referred as “NED plan”. Table 6-7 shows the economic results for each refined focus area.

The present value FWOP estimated damage shows the structure and content damage for each refined focus area over the economic period of analysis of 50 years. This is the damage the economic model G2CRM is showing would occur if no measures were implemented. The present value future with project (FWP) estimated damage shows the damage that would occur

if the particular measure was implemented over the same 50 years. This assumes construction is completed by the year 2030 which is when benefits, increases in the net value of national outputs (goods and services), start accruing.

Table 6-7. Future With and Without Project Condition Results

Measure	Refined Focus Area	Present value Future Without Project Estimated Damage (\$1000s)	Present value Future With Project Estimated Damage (\$1000s)	Benefits over 50 years (\$1000s)
Nonstructural	Arch Creek	\$1,700,000	\$599,000	\$1,101,000
	Aventura	\$4,509,000	\$2,150,000	\$2,359,000
	Cutler Bay	\$1,372,000	\$506,000	\$866,000
	Edgewater	\$700,000	\$5,000	\$695,000
	Little River	\$1,469,000	\$371,000	\$1,098,000
	Miami River	\$6,141,000	\$2,954,000	\$3,187,000
	North Beach	\$272,000	\$117,000	\$156,000
	South Beach	\$2,867,000	\$1,190,000	\$1,677,000
Structural	Biscayne Canal	\$3,875,000	\$493,000	\$3,382,000
	Edgewater	\$696,000	\$6,000	\$690,000
	Little River	\$5,490,000	\$2,049,000	\$3,441,000
	Miami River Option 1	\$38,437,000	\$3,229,000	\$35,208,000
	Miami River Option 2	\$35,852,000	\$5,520,000	\$30,332,000
Total*		\$103,380,000	\$19,189,000	\$84,192,000

*Structures under Nonstructural may be a part of the Structural for the purpose of this table

The FWP is based on the design water elevation from the 2079 one percent annual exceedance probability stillwater elevation level from the FEMA South Florida Storm Surge Study (includes tide, storm surge and USACE high curve sea level rise). The value varies according to different save points in the modeling areas. That value was used to determine the top of wall elevation for structural measures (with additional overtopping and wave analysis) as well as the elevation the first floor elevations that homes should be elevated to and structures be floodproofed to for nonstructural measures. Due to the limitations of floodproofing, previously mentioned in Section 6.4, the same design water elevation used may not be obtainable depending on the ground elevation at each structure. If a structure required, for example, 5' of floodproofing when typically only 3' is allowable due to engineering constraints, the team still recommended up to 3' in order to provide some level of coastal storm reduction. Any structures that were justifiable from a net benefit perspective was kept in the TSP described in Chapter 7. The same process will be used with different water levels during optimization to determine the final Recommended Plan that will have the most net benefits. This will be doing prior to the Agency Decision Milestone. See Economic Appendix C for more information.

The difference between the FWOP and FWP is the damage prevented – also called the benefits. Note that the information provided under nonstructural may overlap with information under structural for some of the refined focus areas. For instance, some structures under 'Nonstructural' in the Miami River refined focus area might be the same structures under the 'Structural' portion of Miami River. This was done to show the benefits of each measure, whether nonstructural or structural, per refined focus area. The final benefit calculations for the TSP will not have any double counting of benefits.

6.10.1.1 MEASURE COSTS

The costs used for measures are provided in the Total Project Cost Summary (TPCS) in the Engineering Appendix B – Cost Engineering Subappendix. The overall costs used for nonstructural mitigation are provided in the TPCS, but a more detailed description and comparison to FEMA costs is provided in the Economic Appendix C.

Nonstructural costs related to elevating structures and floodproofing of structures varied depending on the amount of elevation or floodproofing needed. For structures that were recommended for elevation, this was determined by subtracting the design water surface elevation (WSE) from the first floor elevation. This number was then rounded up. Elevation was limited to 13 feet from the ground due to structural stability and wind load issues. Any structures that needed more than 13 feet to meet the design WSE would be given a maximum of 13 feet; however, there were none that needed that limit for the current design WSE which is the USACE derived 2079 1 percent annual exceedance probability stillwater level from the FEMA South Florida Storm Surge Study (includes tide, storm surge and USACE high curve sea level rise). Table 6-8 shows the nonstructural costs for elevating structures on a per foot, per foundation, and per story basis. This data was taken from the New Orleans District 2012 Donaldson to the Gulf Study and the USACE National Nonstructural Committee Best Practice Guide 2020-01. The costs were updated using a locality adjustment based on RSMeans to Miami using a 2019 price level. It should be noted that the cost per square foot is based on the first floor square footage only and not the square footage of the entire structure. This would be just the square footage of the polygon multiplied by 90% to account for the wall thickness, errors

in polygon due to aerial imagery when making the polygon, and to account for the rooftop in some structures.

Table 6-8. Nonstructural Elevation Per Feet, per foundation, per story costs

RESIDENTIAL STRUCTURE RAISING COST CALCULATION				
Feet Raised	1 Story Slab (\$/sq. ft.)	2 Story Slab (\$/sq. ft.)	1Story Crawl / Pier (\$/sq. ft.)	2 Story Crawl / Pier (\$/sq. ft.)
1	83	91	73	81
2	83	91	73	81
3	85	93	76	84
4	88	100	76	84
5	88	100	76	84
6	89	101	78	86
7	89	101	78	86
8	92	105	80	88
9	92	105	80	88
10	92	105	80	88
11	92	105	80	88
12	92	105	80	88
13	95	110	81	89

Additional elevation costs included \$18,000 per structure based of relocation benefits provided to the homeowner for living arrangements during construction which is based on Miami hotel prices of an estimated \$200 a night. An additional \$2,000 per structure was added for administration cost for preparing deed restrictions stating the house cannot be lowered again, coordinating payments / right of entry, and for monitoring and crediting.

Table 6-9 shows the costs for floodproofing based on the square footage of the building. The square footage was only the square footage of the first floor as well, but it was not multiplied by 90% which was done for the square footage of structures being elevated since the outer perimeter of the building was needed. Floodproofing also included an additional \$1,000 per structure floodproofing fee for permitting.

Table 6-9. Nonstructural Floodproofing Costs

COMMERCIAL FLOODPROOFING COST CALCULATION	
Square Footage	Cost
0-30,000	\$151,247.17
30,000-100,000	\$357,380.41
100,000+	\$883,447.57

6.10.1.2 NET REMAINING BENEFITS PER REFINED FOCUS AREA

Benefit-cost analysis is a technique to evaluate in monetary terms what is achieved (benefits) in comparison to what is invested (costs). It is used to ensure that the value of the benefits exceeds the value of the costs, or, in other words, resources are allocated in the most efficient manner possible. When both benefits and costs can be measured in monetary terms, then benefit-cost analysis can help decision makers select the best solution. Table 6-10 shows the benefit-to-cost ratios (BCR) and net remaining benefits for all measures except for NNBF.

Table 6-10. Benefit-to-Cost Ratio and Net Benefits per Refined Focus Area

Measure	Refined Focus Area	Total Average Annual Benefits (\$1000s)	Total Average Annualized Cost (\$1000s)	Benefit-to-Cost Ratio	Net Remaining Benefits (\$1000s)
Nonstructural	Arch Creek	\$40,797	\$18,377	2.2	\$22,420
	Aventura	\$87,377	\$24,362	3.6	\$63,015
	Cutler Bay	\$32,086	\$13,354	2.4	\$18,732
	Edgewater	\$25,753	\$1,998	12.9	\$23,755
	Little River	\$20,295	\$40,681	2.0	\$20,386
	Miami River	\$21,537	\$118,067	5.5	\$96,530
	North Beach	\$5,771	\$1,745	3.3	\$4,026
	South Beach	\$62,123	\$17,989	3.5	\$44,134
Structural	Biscayne Canal	\$125,278	\$16,955	7.4	\$108,323
	Edgewater	\$25,562	\$35,012	0.73	(\$9,450)
	Little River	\$127,457	\$37,356	3.4	\$90,101
	Miami River Opt 1	\$1,304,145	\$52,614	24.8	\$1,251,531
	Miami River Opt 2	\$1,123,535	\$24,843	45.2	\$1,098,692

The total average annualized cost shows the total project cost, which includes interest during construction and operation and maintenance, annualized over the economic period of analysis

of 50 years. The total average annual benefits are the benefits from Table 6-8 multiplied by the capital recovery factor of 0.037, which is based on the interest rate of 2.75 percent, to get the benefits annualized. The benefit-to-cost ratio is the annualized benefit divided by the annualized cost. The benefit-to-cost ratio of a project must be greater than or equal to one in order for the Federal government to make an investment in a project. This can be obtained solely on damage reduction benefits, or a combination of one of the other four accounts described later in this section.

The Edgewater floodwall resulted in a BCR lower than 1, the minimum required to be justified as part of a Federal project; however, it was kept in and carried forward in case it may be required for the Miami River Option 1 storm surge barrier and floodwall system to work. There is high ground to the west of the Edgewater area ranging approximately 16' NAVD88 which provides natural risk reduction to areas west of it. Further analysis indicated that Miami River Option 1's floodwall could tie into the high ground which would result in the Edgewater floodwall no longer being required as part of Miami River Option 1's structural system and could be a separable measure. As previously mentioned in Section 6.9, the team developed Alternative 8 to determine if nonstructural measures such as home raising and nonresidential floodproofing in the Edgewater area would be more feasible than the Edgewater floodwall.

Even though the BCR of Miami River Option 2 is higher than Miami River Option 1, the team screened out Miami River Option 2 due to having a lower net remaining benefit than Miami River Option 1. This is due to the fact that the NED plan is the plan based on maximum net benefits and not the highest BCR. While it does look like the net remaining benefits are similar, they are approximately \$150 million apart which is an annual benefit over 50 years. All structures recommended for nonstructural mitigation had a BCR of 1 or greater on its own. This will allow for easier neighborhood cohesiveness analysis during optimization of the TSP discussed in Chapter 7. More in depth detail and tables regarding benefit calculation and annualization are provided in Economic Appendix C.

6.10.1.3 NET REMAINING BENEFITS PER ALTERNATIVE

Similar to the BCR of individual measures, the team also needs to determine which alternative produces the most benefits for every dollar of cost. Table 6-11 shows the economic analysis for all the alternatives previously discussed in Section 6.9. NNBFs are currently not included in this analysis, but will be added prior to the Agency Decision Milestone once that analysis has been performed. It should be noted that in Table 6-11, the nonstructural and critical infrastructure from Alternative 2 and 4 that repeat throughout the other alternatives are not being double counted. For instance, if a building is within the risk management area (the area where risk will be reduced from the structural measure) of a structural measure then data for that building will not be counted again under the nonstructural portion.

Table 6-11. Benefit-to-Cost Ratio and Net Benefits of All Alternatives

Alternative Number	Alternative Name	Total Average Annual Benefits (\$1000s)	Total Average Annualized Cost (\$1000s)	Project First Cost (\$1000s)	Benefit-to-Cost Ratio	Net Remaining Benefits (\$1000s)
1	No Action	\$0	\$0	\$0	N/A	\$0
2	Critical Infrastructure Only	\$9,330	\$3,710	\$94,500	2.5	\$5,620
3	Miami River Basin + Alternative 2	\$1,345,490	\$90,740	\$1,944,050	14.8	\$1,254,760
4	Nonstructural + Alternative 2	\$421,980	\$123,370	\$3,142,560	3.4	\$298,610
5	Inland Storm Surge Reduction (Structural) + Alternative 2	\$1,588,660	\$144,440	\$3,067,160	11.0	\$1,444,220
6	Alternative 3 + 4	\$1,614,330	\$186,860	\$4,392,630	8.6	\$1,427,470
7	Alternative 4 + 5	\$1,835,590	\$228,830	\$5,216,760	8.0	\$1,606,760
8	Alternative 7 + EW NS - EW FW*	\$1,835,780	\$195,810	\$4,585,650	9.4	\$1,639,970

*EW – Edgewater, NS – Nonstructural, FW – Floodwall

Table 6-11 shows that Alternative 8 is the alternative with the highest net remaining benefits which is the NED plan.

6.10.2 ENVIRONMENTAL QUALITY (EQ) ACCOUNT

The Environmental Quality (EQ) Account displays effects on significant natural and cultural resources. During plan formulation, avoidance and minimization of impacts to the human environment to the extent practical was considered an integral component of plan formulation. To the extent practical, floodwalls, surge barriers, and pump stations were sited on previously disturbed, developed sites such as roads to avoid potential environmental impacts as well as reduce potential impacts to real estate, aesthetics, and recreation. The siting of the Miami River Surge Barrier was sited to specifically avoid the designated Miami Circle Site which is a

significant cultural resource. To maximize potential coastal storm surge reduction benefits, minimize impacts to utilities and minimize real estate acquisition costs, there is some siting (up to approximately two miles of floodwalls that are approximately 50 feet in width) of floodwalls in the Biscayne Bay at the Edgewater and Brickell sites. The siting of floodwalls in the Biscayne Bay would result in adverse, major (significant) environmental impacts to natural resources, aesthetics, and recreation. Any unavoidable impacts to mangroves, SAV, and corals/hardbottom habitat would be mitigated as described in the Environmental Mitigation Plan in Appendix D.

6.10.3 REGIONAL ECONOMIC DEVELOPMENT (RED) ACCOUNT

The Regional Economic Development (RED) Account displays the regional and localized economic impacts 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. More information on this account is in Appendix C.

6.10.4 OTHER SOCIAL EFFECTS (OSE) ACCOUNT

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. Miami-Dade County and the PDT reviewed the focused array of six alternative plans in addition to the FWOP plan based on OSE metrics. The rating scheme used to rank the plans was based on the Institute for Water Resources' handbook for Applying Other Social Effects in Alternatives Analysis (2013). Table 6-12 summarizes the metrics used for comparison and evaluation of the alternative plans.

Table 6-12. Other Social Effects Comparison and Evaluation Metrics

Factor	Metric	Description
Health and Safety	Human Health	Issues affecting a person's physical health (e.g., air quality, diseases) or mental health such as anxiety and stress (e.g., threat of flooding, transportation concerns, noise)
	Life Safety	Safety issues that could cause bodily harm to a person (e.g., flood waters, crime)
Economic Vitality	Business Climate	Issues affecting the ability of a community to retain and attract businesses
	Tourism Revenue	Issues affecting the tourism industry (e.g., visitation numbers, hospitality industry)
	Real Estate Values	Issues affecting the value of property and real estate

Factor	Metric	Description
Social Connectedness	Community Cohesion	Issues affecting local social networks, including personal networks
	Local / Cultural Identity	Issues affecting sense of community, local, and/or cultural identity within a community (e.g., historical significance, cultural significance, how others see the area)
Resiliency (4 USACE Resilience Principles)	Prepare	Used to consider measures that reduce risks or costs under loading conditions beyond those required by technical standards
	Absorb	Used to consider adding system component robustness, redundancy, and increased reliability.
	Recover	Used to identify cost effective measures that allow for rapid repair or function restoration of a project component or system
	Adapt	Used to identify cost effective modifications to a project component or system that will maintain or improve future performance based on lessons learned from a specific loading condition or loadings associated with changed conditions
Environmental Justice	Socially Vulnerable Populations	Issues affecting socially vulnerable groups (e.g., low income, minority, elderly, children, disabled)
Recreation	Recreational Opportunities	Issues affecting access to, or availability of, recreational activities (e.g., parks, trails, water access)

This method uses a -3 to 3 scale with -3 representing the possible range of impacts and effects the proposed alternative has on the specific metric:

- | | |
|-----------------------------------|-----------------------------------|
| -3: Significant negative impacts | 1: Minor beneficial effects |
| -2: Moderate negative impacts | 2: Moderate beneficial effects |
| -1: Minor negative impacts | 3: Significant beneficial effects |
| 0: Negligible effects (no impact) | |

All metrics were scored for each of the eight alternatives with consideration as to how that particular alternative would impact the metric in the future. The scores for each metric were then summed to determine the total impact of each alternative, with a higher positive value indicating

the alternative with the most significant beneficial effects. The OSE matrix is displayed in Table 6-13. See Table 6-6 for descriptions of each alternative number.

Table 6-13. Other Social Effects Matrix

Factor	Metric	Alternatives								Reasoning
		1	2	3	4	5	6	7	8	
Health and Safety	Human Health	-3	1	3	2	3	3	3	3	Structural features prevent flood damages and associated human health impacts. Protection of critical infrastructure improves emergency response following a storm event.
	Life Safety	-3	-1	3	-1	3	3	3	3	Structural features provide for a reduction in life-loss. Protection of critical infrastructure improves emergency response following a storm event.
Economic Vitality	Business Climate	-2	2	3	2	3	3	3	3	Structural features provide the maximum protection to businesses as they would serve to prevent damages. Nonstructural features would protect businesses from damages. Protection of critical infrastructure improves recovery of businesses following a storm event.
	Tourism Revenue	-1	1	3	2	3	3	3	3	Structural features provide for maximum benefit and resilience of businesses as they prevent storm damages. Nonstructural features would protect businesses from damages. Protection of critical infrastructure improves recovery following a storm event.

Factor	Metric	Alternatives								Reasoning
		1	2	3	4	5	6	7	8	
	Real Estate Values	0	0	2,-2	2	2,-2	2,-2	2,-2	2,-2	Nonstructural measures alone provide the greatest benefit to real estate values. The floodwalls and surge barriers would reduce real estate values by obstructing water front views and access.
Social Connectedness	Community Cohesion	-1	1	2	1	2	2	3	3	The structural features would provide the maximum protection for prevention of damages to infrastructure and structures. Alternatives with the largest spatial coverage and structural features would provide the greatest benefits.
	Local / Cultural Identity	-1	0	1	1	2	2	3	3	Structural features would serve to prevent damages to museums and other important local cultural facilities. Protection of critical infrastructure improves recovery following a storm event. Alternatives with the largest spatial coverage and structural features would provide the greatest benefits.
Resiliency (4 USACE Resilience Principles)	Prepare	-3	2	2	2	3	3	3	3	Preparation with any of the action alternatives would be significantly improved. Structural features prevent flood damages and associated human health effects. Protection of critical infrastructure improves emergency recovery following a storm event.
	Absorb	-3	2	2	2	3	3	3	3	
	Recover	-3	2	2	2	3	3	3	3	
	Adapt	-2	2	2	2	3	3	3	3	

Factor	Metric	Alternatives								Reasoning
		1	2	3	4	5	6	7	8	
										Alternatives with the largest spatial coverage and structural features would provide the greatest benefits.
Environmental Justice	Socially Vulnerable Populations	-3	1	3,-3	2	3,-3	3,-3	3,-3	3,-3	The structural features would provide the maximum protection for prevention of damages to socially vulnerable populations. Acquisition and demolition could potentially adversely affect socially vulnerable populations.
Recreation	Recreational Opportunities	-2,1	1	-3,1	1	-3, 1	-3, 1	-3, 1	-3, 1	Recreational boating and water access would be most adversely affected by the structural features. The structural features provide maximum benefits to shopping areas, and museums. Acquisition areas would be converted to green space and/or parks.
Total Score:		-26	14	21	20	26	26	28	28	

This method uses a -3 to 3 scale with -3 representing the estimated range of impacts and effects

Notably, only the alternatives with structural features serve to reduce storm-related life loss, proving to be a significant benefit. The OSE matrix shows that Alternatives 5-8 score the highest with a value of 28 for Alternatives 7 and 8 which outrank all other alternatives. While Alternatives 5-8 all rank highly and have significant benefits, the alternative providing the

significant benefits to the largest area within the MDC would be Alternatives 7 and 8 as they are the most comprehensive in scope out of all action alternatives. The high scores for these alternatives are due to the significant positive impacts made on health and safety and resiliency. Alternatives 3, 4, and 5 have similar scores that also show significant beneficial effects in these categories, but are not as comprehensive in their scope. The No Action/Future without Project Alternative (Alternative 1) scored negatively primarily due to the fact that critical infrastructure, structures, and roadways would become flooded or experience worsening flooding during future storm events. These impacts would affect important commercial interests, residential and social communities, and would directly threaten life safety and human health.

This analysis was used in addition to other analyses performed throughout the study to inform the PDT's decision making process for choosing the alternative that best meets the project objectives and most reasonably maximizes economic benefits while minimizing adverse impacts.

CHAPTER 7 TENTATIVELY SELECTED PLAN

This study considered a range of structural, nonstructural and NNBF measures to reduce coastal storm risk in the study area. Through an iterative planning process, potential CSRM measures were identified, evaluated, and screened. Focus areas were then refined and applicable measures were determined. Those remaining measures were developed into numbered flood risk management alternatives. Using the four evaluation accounts, including potential environmental impacts, a plan was identified as the TSP. For purpose of this study, the TSP will also serve as the Preferred Alternative for the purposes of NEPA consideration of alternatives.

Study goals and objectives were developed to comply with the study authority and to respond to study area problems. Planning objectives were identified based on the problems, needs and opportunities as well as existing physical and environmental conditions present in the study area. The main goal is Contribute to NED by reducing the risk of flood damage caused by coastal 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. For this study, the TSP was also the NED plan.

7.1 DESCRIPTION OF THE TENTATIVELY SELECTED PLAN

Out of the eight alternatives considered from the final array of alternatives, Alternative 8 was selected as the TSP. As mentioned in Section 6.9 FORMULATION OF ALTERNATIVES, Alternative 8 was a combination of Alternatives 2, 4 and 5 with the Edgewater floodwall removed and replaced with nonstructural measures in the area. Table 7-1 shows what type of measures were carried forward in the TSP per focus area.

Table 7-1. Measures Carried Forward in the Tentatively Selected Plan

Tentatively Selected Plan (Alternative 8)				
Focus Area	Structural	Nonstructural	Critical Infrastructure	Nature and Natural Based Features
Arch Creek	✓	✓	✓	✗
Aventura	✗	✓	✓	✗
Cutler Bay	✗	✓	✓	✓
Little River	✓	✓	✓	✗
Miami River	✓	✓	✓	✗
North Beach	✗	✓	✓	✗
South Beach	✗	✓	✓	✗

The potential natural and nature-based features originally included a wide array of options that were under evaluation. Further analysis at this time has shown that the site with the greatest potential is in at the Cutler Bay Site. The proposed site would afford opportunities for mangrove restoration as well as restoration of other native vegetative species that would provide storm surge dissipation benefits.

The TSP was selected based off of the USACE derived 2079 1 percent annual exceedance probability stillwater level from the FEMA SFLSSS (includes tide, storm surge and USACE high curve SLR) which is the design WSEL. Section 7.2 OPTIMIZATION describes how the TSP will be optimized for different design water elevations. Figure 7-1 shows a map of the TSP. Critical infrastructure is not shown in the map for visual simplicity.

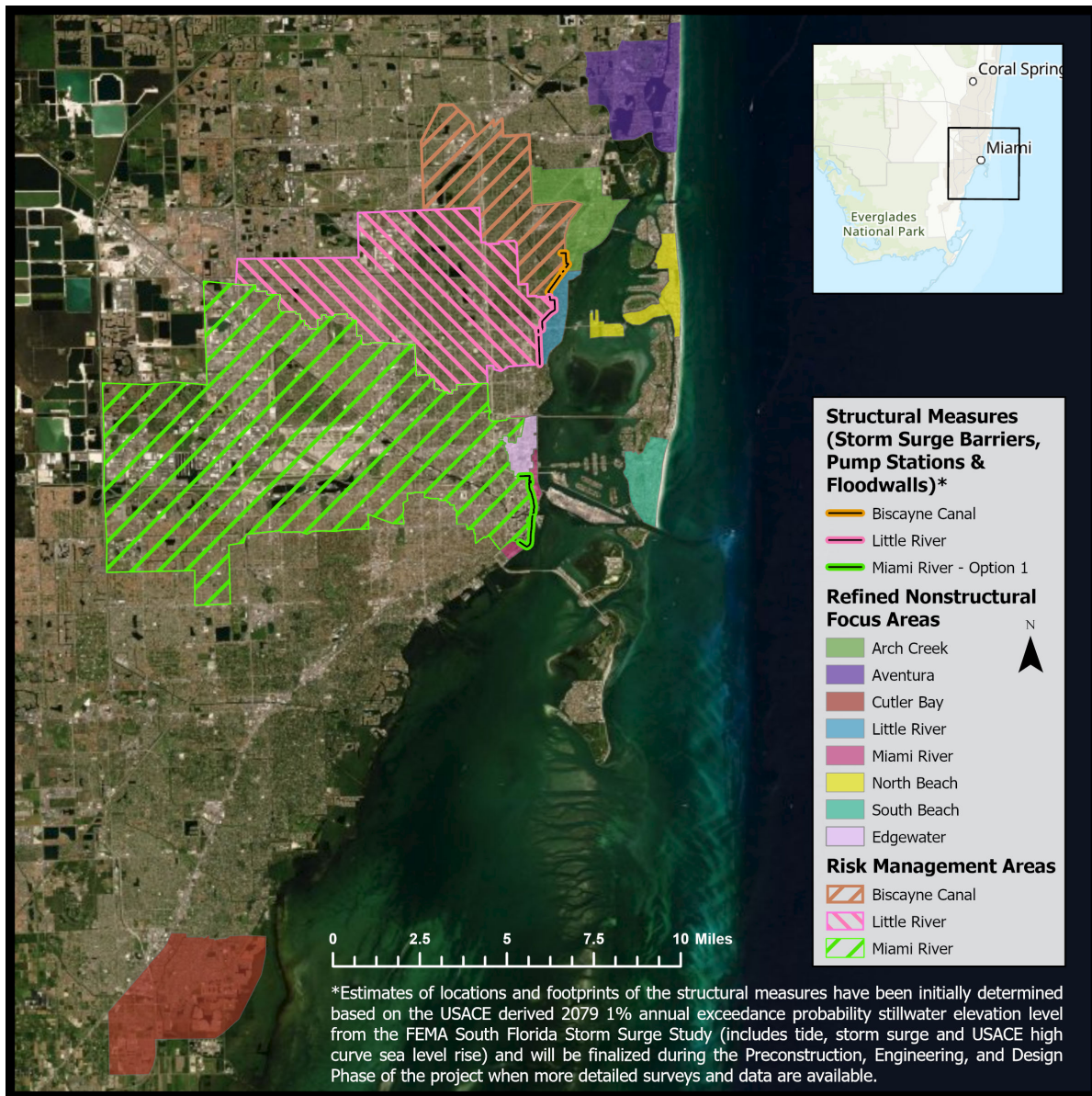


Figure 7-1. Map of the Tentatively Selected Plan (excluding critical infrastructure)

The TSP includes the following measures:

Structural measures in Arch Creek, Little River and Miami River focus areas. The Biscayne Canal falls within the Arch Creek focus area and consists of a surge barrier with associated floodwalls and pump station. Associated floodwalls are required to connect the surge barrier to high ground, and pump stations are required to ensure there is no inducing of flooding. The Little River consists of a surge barrier with associated floodwalls and pump station. The southern associated floodwall of Biscayne Canal and the northern associated floodwall of Little River are connected to create one complete system due to the low ground elevation in the area. This was required since H&H analysis for the design water elevation was showing flanking through the middle of the floodwall when not connected. The need for one system may differ depending on the design water surface elevation (WSE).

Miami River consists of a surge barrier (with associated floodwalls and pump station and riprap). The associated floodwall along the coast and on Brickell Avenue connects to the surge barrier. See Appendix B for further information regarding floodwall designs, heights, gate types, etc. in the focus areas. **Estimates of locations and footprints of the structural measures have been initially determined based on the USACE derived 2079 one percent annual exceedance probability Stillwater level from the FEMA South Florida Storm Surge Study (includes storm surge, tide, and sea level rise) and will be finalized during the PED Phase of the project when more detailed surveys and data are available.**

The intent of this project is to protect against coastal storm risk and not necessarily nuisance flooding from rainfall or smaller tidal events. This solution may not be configured to protect against long-term continuous need to discharge ground water depending on future conditions. The floodwalls used for the TSP are all T-walls which allow for adaptability in the future if higher wall heights will be required. Due to the nature of coastal flooding in the areas adjacent to the Bay, storm surge elevations on the exterior of the alignment are likely to see minimal impacts from the construction of a floodwall. This will be confirmed with further feasibility analysis and detailed analysis in the PED Phase in accordance with USACE policy. Considerations such as the foundation or design needed for a floodwall, seepage, effects of the floodwall on the interior drainage and adjacent areas, understanding the actual flood problem in MDC so that the solution will not aggravate the current issues, and how the canal systems operate were taken into account. These structural measures will be coordinated with SFWMD control structures during the PED phase. The proposed solutions are for a 10 percent design and may change when in the PED phase. For more insight on the proposed structures please refer to the Engineering Appendix. Additionally, real estate actions are anticipated as a result of the proposed implementation of structural measures. For more information please refer to the Real Estate Appendix, Appendix F.

Figure 7-2 displays the future without project condition inundation boundary based off the USACE derived 2079 1 percent annual exceedance probability stillwater level from the FEMA South Florida Storm Surge Study (includes tide, storm surge and USACE high curve sea level rise). This inundation boundary was created using Hydrologic Engineering Center's River Analysis System (HEC-RAS) for the areas where a structural measure was proposed.

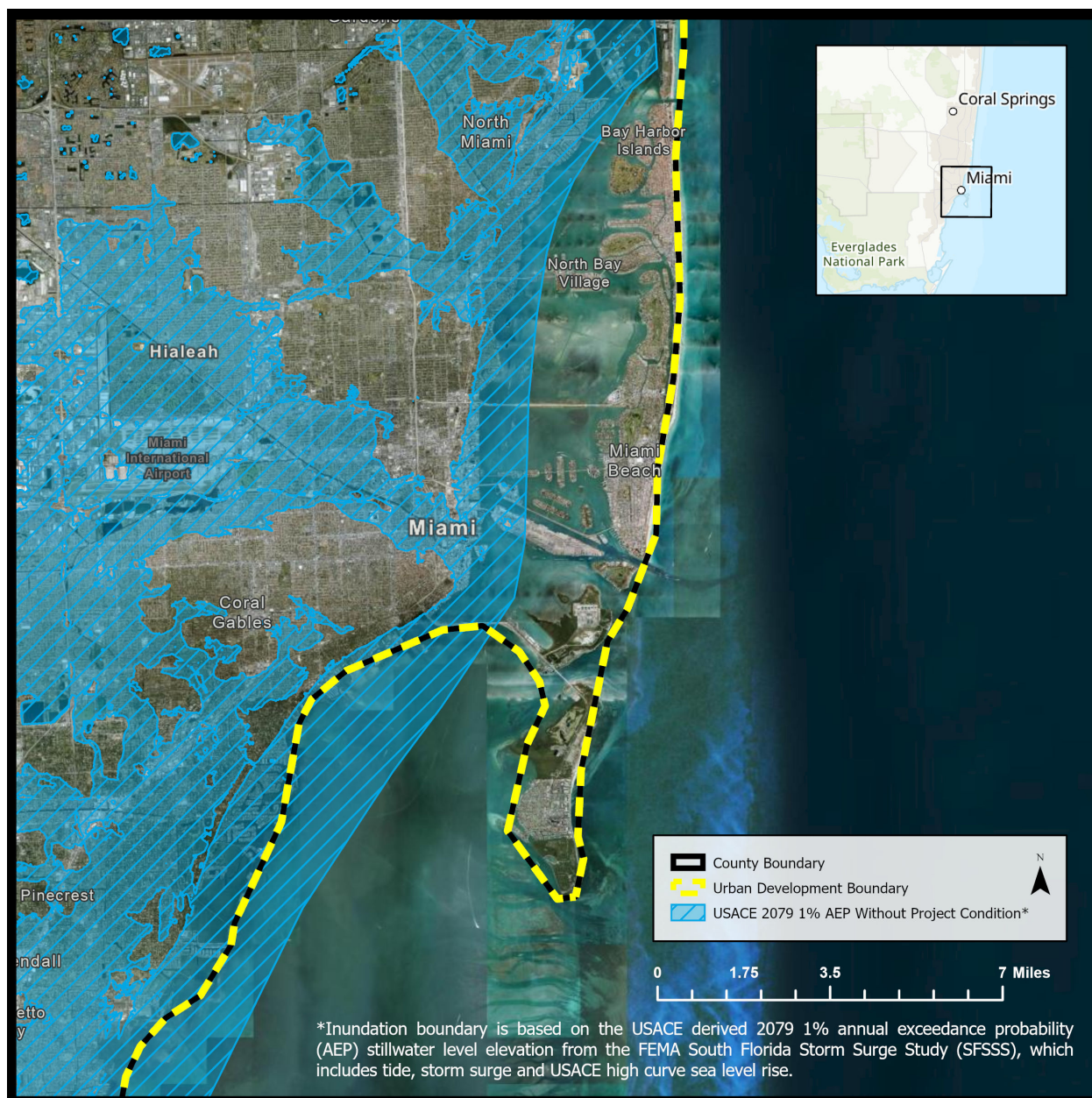


Figure 7-2. Future without Project Condition Inundation Boundary

Figure 7-3 displays the future with project condition inundation boundary based off the USACE derived 2079 1 percent annual exceedance probability stillwater level from the FEMA South Florida Storm Surge Study (includes tide, storm surge and USACE high curve sea level rise). This future with project condition includes the storm surge barrier plus any associated floodwalls and pump stations at the Biscayne Canal, Little River, and Miami River.

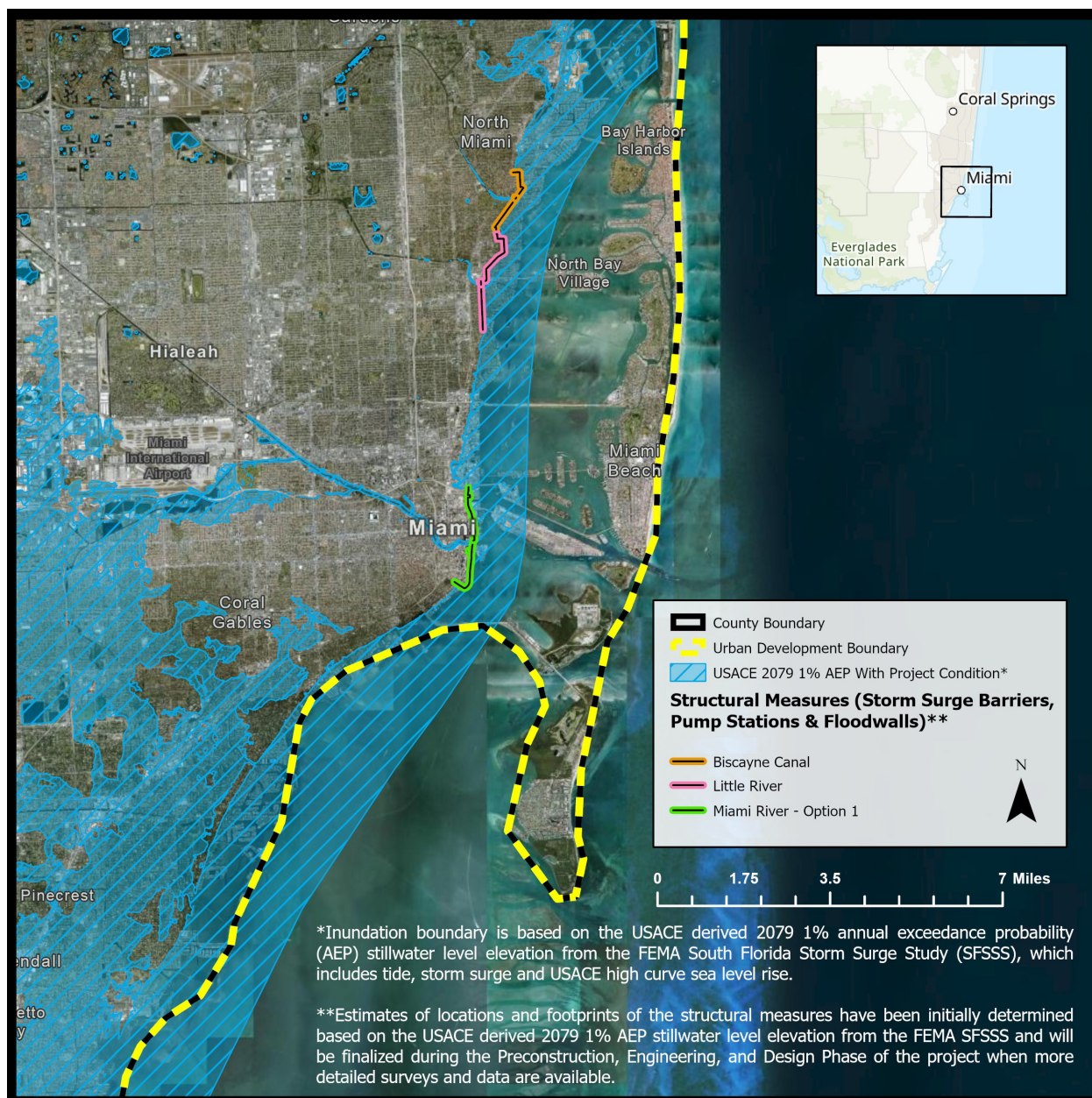


Figure 7-3. Future with Project Condition Inundation Boundary

During optimization, the team will take a closer look at the inundation near the southern part of Figure 7-3 to ensure it does not approach the risk management area of Miami River shown previously in Figure 7-1. Depending on the depth of flooding for that inundation, it is possible some additional measures may be recommended prior to the Agency Decision Milestone, but it is not identified at this time. The team will first have to optimize the TSP for different frequencies and sea level rates and determine the design water surface elevation that produces the most net benefits. Once that is determined, new inundation boundaries will be created and the team will determine if additional measures are needed or not.

Nonstructural measures in the seven focus areas of Arch Creek, Aventura, Cutler Bay, Little River, Miami River, North Beach, South Beach as well as the Edgewater area which is contained within the Miami River refined focus area. Nonstructural measures would consist of elevating or acquiring residential buildings, and dry and/or wet floodproofing non-residential buildings.

Analysis was done to determine if a residential structure would be elevated or acquired. This was done by comparing each structure's first floor elevations (FFE) with the design WSE. First floor elevations were determined either through calculations based on foundation height assumptions or using elevation certificates when available. Any structure whose FFE was greater than the design WSE was considered not at risk and was not analyzed any further. Structures whose FFE was lower than the design WSE were carried forward for further analysis. The economics model (G2CRM) provides infrastructure damage for each structure. Preventing this damage then becomes the benefit portion of any Benefit-to-Cost ratio (BCR) calculations. BCRs were calculated for each structure – once for elevation and again for acquisition. All structures that were carried forward started off as recommended for elevation. Any structures that were less costly to acquire than to elevate were then switched over to be recommended for acquisition instead of elevation. This is due to the fact that acquiring a structure provides maximum benefits since that structure is no longer receiving any damage for any and all storm frequencies thus maximizing net benefits. Further information on these calculations are available in Appendix C. Structures with a BCR greater than 1.0 were carried forward. Some structures below the 1.0 required BCR will be looked at again during optimization for neighborhood cohesiveness as long as the total grouping of structures' BCR is greater than 1.0. The number of structures recommended for elevation is approximately 2,300. The nonstructural measure of acquisition, demolition, and conversion to green space of residential structures is not currently anticipated as part of the TSP because elevation was determined to provide more net benefits than acquisition. However, acquisition is still being considered as a potential future measure and is therefore, further evaluated as a potential impact. This measure will continue to be considered as the study advances and additional neighborhood cohesive analysis is conducted. Real estate actions such as acquisition and easements would also be necessary for other structural and nonstructural measures of the plan and the impacts described in Chapter 8 as "acquisition" would be similar for those other types of real estate actions.

Analysis for the floodproofing of non-residential structures was conducted in a similar manner to that of residential structures. The difference is that floodproofing is only effective up to only three feet from the ground since static forces from standing water would make any floodproofing shield or door buckle under pressure. Structures that required more than three feet of floodproofing were still recommended for floodproofing up to three feet to obtain some level of risk reduction; however, this may not help with insurance reduction since that typically requires floodproofing to at least the FEMA BFE + 1'. Those with BCRs greater than 1.0 were carried forward. The number of structures recommended for floodproofing is approximately 3,850. It should be noted that floodproofing does not address nuisance flooding that may affect long-term property values depending on the location of the building. Dry floodproofing was also only for non-residential buildings, and those of which were not in FEMA coastal high-hazard areas (zone V), coastal A zones, or other high risk flood areas where flash floods, high velocity flows or

erosion occurs. These dry floodproofing limitations are consistent with the American Society of Civil Engineers (ASCE) 24-14 *Flood Resistant Design and Construction: Requirements and Limitations for Dry Floodproofing*.

Critical infrastructure asset categories are listed in Table 7-2. Only the critical infrastructure within the design water level inundation boundary are considered at risk from coastal storms and are the ones that will be considered.

Table 7-2. Priority Critical Infrastructure Asset Categories

Priority Critical Infrastructure Asset Categories	
Fire Stations	Erosion to Rickenbacker Causeway and Venetian Way
Medical Facilities	Railway Electrical Substations
Police Stations	Emergency Operations Center Facilities
Potable Water Facilities	Airport Facilities
Evacuation Centers	Water Management Facilities
Wastewater Facilities	Ports Facilities

7.2 NONSTRUCTURAL AND CRITICAL INFRASTRUCTURE IN TSP

Alternative 8 was selected as the Tentatively Selected Plan (TSP). Refined focus areas Aventura, Cutler Bay, North Beach, and South Beach only have nonstructural measures proposed; however, refined focus areas Arch Creek, Little River, and Miami River have structural measures such as surge barriers and floodwalls. All nonstructural measures in those three refined focus areas are on the “outside” of any structural measures. That is, the bay side of the structural measure. This is to avoid any double counting of benefits, and to ensure the refined focus area has risk management measures set in place to cover the entire area when feasible.

Table 7-3 shows all the structures recommended for nonstructural and critical infrastructure measures throughout the refined focus areas. Note that the numbers have been rounded up since these will be refined during optimization which will occur after the TSP and before the Agency Decision Milestone.

Table 7-3. Nonstructural Measures per Refined Focus Area in the TSP

Alternative 8 – TSP (Alt. 7 - Edgewater Floodwall + Edgewater Nonstructural)						
Refined Focus Area	Nonstructural Measure		Total NS ² Per Area	CI ³ FP	Total FP (NS and CI)	Total (NS + CI)
	Elevation	FP ¹				
Arch Creek	550	550	1,100	0	550	1,100
Aventura	650	750	1,400	0	750	1,400
Cutler Bay	400	700	1,100	50	750	1,150

Alternative 8 – TSP (Alt. 7 - Edgewater Floodwall + Edgewater Nonstructural)						
Edgewater	0	150	150	0	150	150
Little River	550	100	650	0	100	650
Miami River	0	50	50	0	50	50
North Beach	0	150	150	0	150	150
South Beach	150	1,400	1,550	0	1,400	1,550
Outside Refined Focus Area	0	0	0	150	150	150
Total	2,300	3,850	6,150	200	4,050	6,350

¹FP - Floodproofing

²NS - Nonstructural

³CI - Critical Infrastructure

Floodproofing to critical infrastructure, similar to nonstructural, will only be recommended to critical infrastructure on the “outside” of structural measures. Critical infrastructure was also looked at outside of the refined focus areas and within the design WSE inundation boundary which is the 1% frequency from the FEMA South Florida Storm Surge Study plus the USACE high curve sea level rise rate. This WSE will be optimized to look at an upper and lower bound.

Table 7-4 shows the number of structures recommended for nonstructural mitigation per measure type and per occupancy type in the Tentatively Selected Plan.

Table 7-4. Number of Nonstructural Measures per Occupancy Type in the TSP

Occupancy Type	Measure	# of structures *
Residential	Elevation	2,300
	Acquisition	0
Commercial	Floodproofing	400
Education		20
Government		60
High Rise		850
Hotels		30
Industrial		50
Nursing Home		10
Religious		10
Condominiums / Apartments		2,400
Total Nonstructural		6,150

*Numbers have been rounded up depending on the magnitude of the number.

7.3 RISK AND UNCERTAINTY

There is a medium risk that the environmental modeling to assess hydrology and water quality impacts may not fully capture all of the potential impacts that would occur from the surge barriers as this type of structure has not been implemented for surge protection in south Florida. This risk will be minimized by using approved hydrological and water quality models, modeling all parameters of concern (and discussing parameters of concerns with regulatory agencies), and allowing for an interagency as well as USACE technical review of the water quality report findings.

There is a medium to high risk of potentially not obtaining an Environmental Resource Permit or 401 Water Quality Certification from the FDEP or of not obtaining a Biological Opinion from the National Marine Fisheries Service due to the potentially significant environmental impacts that would occur to the Biscayne Bay Aquatic Preserve and to federally listed species and designated critical habitats from placement and operation of the surge barriers and floodwalls and associated pump stations. Placement of floodwalls in the Biscayne Bay was selected in order to maximize flood risk reduction benefits and to reduce potential adverse impacts to utilities, real estate, and roads (transportation), however it would potentially cause significant adverse impacts to seagrasses (including the federally listed Johnson's seagrass and Johnson's Seagrass Critical Habitat) and Manatee Critical Habitat, corals/hardbottom habitat (including seven federally listed species) and EFH. There would also be minor, adverse impacts to mangroves. Impacts to seagrass, corals/hardbottom, and mangroves would be mitigated to the extent practical, however, mitigation of Johnson's seagrass may not be successful as there are no male and female species and transplantation of existing seagrass may result in damage to the very limited extent of the native population that only occurs in Florida from St. Sebastian's Inlet to the Biscayne Bay. For this study we would consider the development of new vegetative reproduction laboratory methods as a potential new mitigation method to offset potential impacts to Johnson's seagrass. There is a high risk that we cannot fully mitigate for impacts to the Johnson's seagrass and Johnson's seagrass Critical Habitat to a negligible level of impact for the reason's previously described. However, the risk of not obtaining required authorizations and permits for this project has been minimized to the extent practical by frequent coordination with regulatory agencies and inclusion of mitigation measures including potentially new techniques to offset potential impacts. Detailed environmental seagrass and coral/hardbottom surveys would be conducted during the PED Phase to provide site-specific information needed for the Uniform Mitigation Assessment Method analysis to determine potential functional resources losses and required compensatory mitigation to offset potential losses.

For this feasibility study only limited site investigations to assess environmental impacts has been conducted and detailed environmental surveys of SAV, corals/hardbottom have not yet been conducted. A jurisdictional wetland determination has not yet been conducted. Some potential areas of impact do not have archeological or historic building surveys completed. Therefore, there is a medium risk that we potentially have underestimated or overestimated impacts in this programmatic NEPA document. Because this is meant to be a planning level NEPA document with only an approximate 10 percent level of design, detailed environmental and archeological and historic building surveys and a wetland jurisdictional analysis would not be conducted until the PED Phase of the project when designs are finalized. During that phase

additional analyses, tiered NEPA, and mitigation analyses would be conducted as needed. Risk has been minimized to the extent practical by using information gleaned from site visits, utilizing environmental geospatial data and data/information provided from regulatory agencies, and using a range of potential impacts in the programmatic NEPA analysis.

For this feasibility study a detailed Phase I Environmental Site Assessment has not been conducted; therefore, there is a medium risk that we have potentially underestimated potential sites with environmental contamination that may require remediation. However, we have reduced this risk to the extent practical by conducting discussions with county and city officials, regulatory agencies, and conducting desktop searches in federal and state databases with petroleum, hazardous material and waste storage sites, and spill and release data/information.

Geotechnical borings for construction of the floodwalls and surge barriers have not yet been collected. Therefore, there is a potential medium risk that subsurface stability is not suitable for construction of floodwalls. To minimize this risk, geotechnical borings will be collected during the PED Phase to determine the suitability of the subsurface geology for construction.

There is a medium to high risk associated with the use of the USACE Intermediate SLR curve. With any CSR project, the long term efficiency of the formulated plan and proposed measures and their ability to reduce the risk and vulnerability to coastal storms is dependent on the accuracy of SLR models and their ability to project water levels 50-100 years in the future. There is a degree of uncertainty involved with extrapolating sea level rise data and how deviations in the expected sea level can potentially change the effects of coastal forces, i.e. winds, tidal forces, and wave heights, due to the change in water depths. To mitigate this uncertainty within the 50 year economic period of analysis, the USACE High Curve was selected at a projected RSLR increase of 3.6 ft. from 1992 to 2079, providing 1.9 additional feet to the projection than the 1.35 feet/50 years extrapolated by the USACE Intermediate curve.

Section 7.5 discussed activities in PED and its associated mitigation of risk.

7.4 OPTIMIZATION

Optimization of the TSP will occur leading up to the ADM. The tasks for optimization are listed below:

- The economic model (G2CRM) was first run using the one-percent annual exceedance probability flood with the USACE high curve sea level change rate. ER 1100-2-8162 requires the consideration of alternatives to be formulated and evaluated represented by three SLR scenarios – typically the 'low', 'intermediate', and 'high' rates of USACE SLR. Since the TSP was calculated using the USACE high rate, the USACE low and intermediate sea level rise rates will be used to optimize the design water elevation. The National Oceanographic and Atmospheric Administration (NOAA) high sea level change rate will also be considered to have a higher bound than the USACE high rate; however, currently G2CRM does not have a function to incorporate NOAA sea level change rates into the model. If it will be included in the next version update prior to the Agency Decision Milestone then the TSP will also be optimized to that level.
- G2CRM will be optimized at different design water elevations. Since the TSP was based off of the 1-percent annual exceedance probability flood (100 year flood), optimization

will occur to the 0.5 percent and 2 percent floods for a lower and upper bound water level. These will then also be optimized to the USACE sea level rates mentioned above. There will be some overlap between the optimization water levels so any water levels that are close in elevation will only be run once in the model. For instance, the 1-percent flood plus the USACE intermediate sea level rate might be close in water elevation to the 2-percent flood plus USACE high sea level rate so this water level will be used only once for calculations.

- The team will assess storm surge reduction benefits resulting from vegetation dissipation benefits at the Cutler Bay NNBF Site.
- Nonstructural measures will be looked at more closely for neighborhood cohesiveness. Further analysis will be done to ensure all structures proposed for elevation meet all local building codes such as not having the top of the roof higher than a certain elevation, or ensuring the FFE is not higher than the maximum allowed. Analysis will be performed to ensure any historical structures proposed for nonstructural mitigation either has a higher cost contingency or is removed from further analysis.
- The TSP will be refined based on comments from the public and agency review.
- For the TSP, only dry floodproofing was considered for non-residential structures. Further analysis during optimization will be done to determine which structures may be eligible for wet floodproofing.
- All costs will be updated to reflect all the different design water elevations mentioned above. Net benefits will be calculated for all design water elevations. The water level producing the best net benefits will become the Recommended Plan for the Agency Decision Milestone.

7.5 COST ESTIMATE

Cost estimates are provided in the Cost Sub-Appendix which is a part of Appendix B.

7.6 ACTIVITIES IN PRE-CONSTRUCTION, ENGINEERING, AND DESIGN

Table 7-5 shows all the activities that will be pushed to or occurring in PED for this study.

Table 7-5. Activities Occurring in Pre-construction Engineering and Design

Activity Occurring in Pre-construction Engineering and Design	Pre-construction Engineering and Design Schedule	Cost Implication	Implementation of the Tentatively Selected Plan	Mitigation of Risk
Final siting of structural features and designs	Because of the limited level of design provided during feasibility (10%) and complexity of the project features and need for a detailed operational plan, time required for design could potentially cause an extended PED schedule of approximately six months.	No substantive increases as compared to other projects; designs are often finalized during PED.	A significant alternation in project design could potentially result in a need for a change report and could cause delays in the development of the site-specific NEPA.	Significant environmental issues have been identified in the programmatic EIS; the site-specific tiered EIS would focus on site-specific details pertinent to the phased design. Impact avoidance and minimization measures have been identified during the Feasibility Phase.

Activity Occurring in Pre-construction Engineering and Design	Pre-construction Engineering and Design Schedule	Cost Implication	Implementation of the Tentatively Selected Plan	Mitigation of Risk
Tiered, site-specific NEPA documents	Completing a tiered NEPA document could potentially cause up to a three month to one year delay in the implementation schedule.	Doing tiered NEPA is cost effective and would only focus on the site-specific details of the phased project.	A significant alternation in project design could potentially result in a need for a change report and could cause delays in the development of the site-specific NEPA.	Significant environmental issues have been identified in the programmatic EIS. Early coordination has been conducted with state and federal regulatory agencies. Tiered NEPA would be focused only on site-specific issues not addressed in the programmatic NEPA. Impact avoidance and minimization measures have been identified during the Feasibility Phase.
Clean Water Act 404, Wetland Jurisdictional Determination	Jurisdictional determinations are often done during PED and would not be anticipated to cause any significant delays to the PED Schedule.	Waiting for the final design is cost effective so that only one site investigation is required and is accurate for permitting purposes.	No noticeable effect.	Significant environmental issues have been identified in the programmatic EIS; a programmatic mitigation plan has been developed; early coordination has occurred with state and federal regulatory agencies.

Activity Occurring in Pre-construction Engineering and Design	Pre-construction Engineering and Design Schedule	Cost Implication	Implementation of the Tentatively Selected Plan	Mitigation of Risk
Geotechnical surveys	Geotechnical investigations often take place during PED so no significant impact to the schedule would be anticipated; the project would also be done in a phased approach which would allow for a reasonable amount of investigations to occur with each phase.	Waiting for the final design is cost effective so that only limited geotechnical investigations are required	No noticeable effect.	Significant environmental issues have been identified in the programmatic EIS.

Activity Occurring in Pre-construction Engineering and Design	Pre-construction Engineering and Design Schedule	Cost Implication	Implementation of the Tentatively Selected Plan	Mitigation of Risk
Endangered Species Act Section 7 Consultations	Higher level designs provided in PED would be needed to develop the ESA, Section 7 Consultation Package. Formal consultation would be required and take an estimated 180, potentially extending the project schedule during PED.	No substantive increase.	Because of the magnitude of the project and limited level of designs during feasibility, a programmatic followed by a phased, tiered NEPA implementation and consultation schedule is planned. Consultation could potentially result in a modification of a project feature or mitigation measure.	Significant environmental issues have been identified in the programmatic EIS; the site-specific tiered EIS would focus on site-specific details pertinent to the phased design. Substantive coordination with USFWS and NMFS to occur in Feasibility Phase. Avoidance and minimization measures have been identified in the Feasibility Phase.

Activity Occurring in Pre-construction Engineering and Design	Pre-construction Engineering and Design Schedule	Cost Implication	Implementation of the Tentatively Selected Plan	Mitigation of Risk
Magnuson-Stevens Fishery and Conservation Management Act	Higher level designs provided in PED would be utilized to develop the Essential Fish Habitat Consultation Package. Formal consultation would be required and take an estimated 100 days potentially extending the project schedule during PED.	No substantive increase.	Because of the magnitude of the project and limited level of designs during feasibility, a programmatic followed by a phased, tiered NEPA implementation and consultation schedule is planned.	Significant environmental issues have been identified in the programmatic EIS; the site-specific tiered EIS would focus on site-specific details pertinent to the phased design. Substantive coordination with NMFS to occur in Feasibility Phase. Avoidance and minimization measures have been identified in the Feasibility Phase.
Environmental benthic surveys	Higher level designs provided in PED would be utilized to develop the survey plans.	Conducting surveys during the PED Phase would be cost effective and would be required regardless of the NEPA pathway.	Because of the magnitude of the project and limited level of designs during feasibility, a programmatic followed by a phased, tiered NEPA implementation and consultation	Significant environmental issues have been identified in the programmatic EIS; the site-specific tiered EIS would focus on site-specific details pertinent to the phased design.

Activity Occurring in Pre-construction Engineering and Design	Pre-construction Engineering and Design Schedule	Cost Implication	Implementation of the Tentatively Selected Plan	Mitigation of Risk
			schedule is planned.	
Archeological and Historic Building Surveys	Higher level designs provided in PED would be utilized to identify locations requiring survey.	No substantive increases as compared to other projects; surveys are often finalized during PED.	Because of the magnitude of the project and limited level of designs during feasibility, a programmatic followed by a phased, tiered NEPA implementation and consultation schedule is planned.	Significant environmental issues have been identified in the programmatic EIS; the site-specific tiered EIS would focus on site-specific details pertinent to the phased design.

CHAPTER 8 ENVIRONMENTAL CONSEQUENCES

8.1 SUMMARY OF IMPACTS

The Affected Environment, Chapter 2, provides a baseline for the impact analysis by presenting an overview of the existing conditions for each resource. In this chapter, a detailed analysis of the potential impacts of each alternative to resources previously described in the Affected Environment Chapter is discussed. In total, there were seven alternatives originally proposed for this study which include: Alternative 1 (No Action/Future without Project), Alternative 2 (Critical Infrastructure), Alternative 4 (Critical Infrastructure and Nonstructural), Alternative 5 (Critical Infrastructure and Structural), Alternative 7 (Critical Infrastructure, Nonstructural, and Structural), and Alternative 8 (Critical Infrastructure, Nonstructural, and Structural (Without Edgewater Floodwall)). The Cutler Bay NNBF was included in all of the action alternatives (Alternatives 2-8). Individual discussions of impacts of Alternatives 3 and 6 are not included as impacts for these alternatives are addressed in Alternatives 5 and 7 respectively. Alternative 8 is similar to Alternative 7 except that Alternative 7 has the Edgewater Floodwall while Alternative 8 has nonstructural features only in the Edgewater Area.

This integrated feasibility study provides a programmatic, high-level planning document with an approximate 10 percent level of project design. The final designs and siting of project features would not occur until the PED Phase of the project when more detailed surveys and data are available. A wetland jurisdictional determination and detailed environmental surveys of benthic habitat (to include corals, hardbottom habitat, and SAV) would also be conducted during the PED Phase to define site-specific impact acreages, provide input data needed for the final UMAM analysis, and to determine required mitigation. Other important data collection that would occur during the PED Phase would include the archeological and historic building surveys. Topographic surveys and subsurface geotechnical investigations would also be conducted during the PED Phase. A detailed operational plan for the project structural features would be developed as well during the PED Phase.

A summary and comparison of resource impacts for the final array of project alternatives is provided in Table 8-1. The potential impacts of the action alternatives beyond the potential impacts of the No Action/Future without Project Alternative are described and compared.

Table 8-1. Summary of Impacts

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
Land Use	Over time, some land use may convert to other types of land use if structures are recurrently	Impacts from construction and maintenance activities would be adverse, temporary, and minor. Floodproofing	Impacts from construction and maintenance activities would be adverse, temporary, and minor. Acquisition and	Impacts from construction and maintenance activities would be adverse, temporary, and minor. While implementation of Alternative 5	Impact findings would be as those described for Alternative 4 and Alternative 5.	Impact findings would be as those described for Alternative 4 and Alternative 5.

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
	flooded. It is anticipated that coastal areas would increasingly and recurrently flood, which would potentially result in adverse, temporary to permanent and moderate impacts to land use.	would result in the ability for land use in the critical infrastructure areas to continue as intended following major storm events. Benefits to land use from implementation of Alternative 2 would be permanent and moderate.	demolition of residential properties would be very limited and would result in adverse and moderate impacts to land use. Floodproofing and structural elevations would result in the ability for land use to continue within affected areas to continue as intended following major storm events. Benefits to land use from implementation of Alternative 4 would be permanent and moderate.	would result in permanent, adverse impacts to land use, there would be storm surge protection provided to a large expanse of urbanized coastal, low lying areas in Miami-Dade County. Overall, this would result in both adverse and beneficial effects that would be temporary to permanent and range from minor to major impacts.		
Geology, Physio-graphy, and Topo-graphy	Erosion, subsidence, and flooding in Miami-Dade County would continue to occur. Flooding impacts would be anticipated to worsen over time. Impacts to topography and soils would be adverse,	Adverse impacts to soils from construction and maintenance would be temporary to permanent and minor. The Cutler Bay NNBF would provide beneficial, minor and permanent impacts to soils. There would be no	Adverse impacts to soils from construction and maintenance would be slightly higher but at the same threshold level of impact described as Alternative 2 (temporary to permanent and minor). The Cutler Bay NNBF would provide	Impacts to critical infrastructure outside of areas protected by surge barriers and floodwalls would be as those described for Alternative 2. Construction and maintenance of the floodwalls and surge barriers would result in adverse, temporary soil disturbances that are moderate. There would be	Impacts findings would be similar to those described for Alternative 4 and Alternative 5. As compared to Alternative 4 and Alternative 5 there would be less adverse soil impacts with the fewer number of nonstructural features. However, the overall impact findings would be the same as	Impacts would be similar to those described for Alternative 4 and Alternative 5. As compared to Alternative 5 and 7 there would be fewer impacts to geology without the Edgewater Floodwall. However, the overall impact findings for Alternative 8 would be the same as

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
	temporary to permanent and range from minor to moderate.	anticipated impacts to topography or geologic features. Impacts would be adverse to beneficial, temporary to permanent and minor.	beneficial, minor and permanent impacts to soils. There would be no anticipated impacts to topography or geologic features. Implementation of Alternative 4 would result in adverse to beneficial, temporary to permanent soil impacts that are minor.	adverse, permanent, and moderate impacts to soils and geology resulting in the permanent construction footprints of the structural features. Fill and grading done to construct project features would have an adverse, permanent, minor impact to topography. Implementation of the Cutler Bay NNBF would serve to provide beneficial, minor and permanent impacts to soils. Impacts to soils and geology would be adverse to beneficial and range from minor to moderate.	Alternative 4 and 5.	Alternative 4 and 5.
Bathymetry, Hydrology, and Tidal Processes	Adverse impacts resulting from climate change and associated sea level rise would be permanent and moderate.	Impacts associated with Alternative 2 would be localized to the critical infrastructure and surrounding areas and would result in no anticipated adverse impacts to bathymetry, hydrology and tidal processes.	Impacts associated with Alternative 2 would be localized to the critical infrastructure, structures, and surrounding areas and would result in no anticipated adverse impacts to bathymetry, hydrology and tidal processes.	Adverse impacts from the construction, operation and maintenance of the structural features on bathymetry, hydrology, and tidal processes would range from temporary to permanent impacts that are minor to moderate.	Impacts would be as those described for Alternative 4 and Alternative 5.	Overall impacts would be less without the Edgewater Floodwall. However, the overall impact findings would be the same as those for Alternative 4 and 5.

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
		The Cutler Bay NNBF would have beneficial, permanent and minor impacts to bathymetry and hydrology with restoration of mangroves but would be anticipated to have no effect on tidal processes.	The Cutler Bay NNBF would have beneficial, permanent and minor impacts to bathymetry and hydrology with restoration of mangroves but would be anticipated to have no effect on tidal processes.	<p>The floodwalls and pump stations would be anticipated to result in altered ground water flow and transport processes resulting in temporary to permanent and moderate impacts. Ground water flow and exchange would be anticipated to be partially restricted with the floodwalls. In addition, the pump stations located near the gate closures would have the potential to temporarily lower/alter ground water levels in their immediate vicinity during the operation of the pumps.</p> <p>Construction of the mangroves at the NNBF Cutler Bay Site would cause minor, permanent alternations in bathymetry and hydrology due to their alteration of bottom conditions. This return to a more natural condition would result in a beneficial, minor</p>		

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
				impact to bathymetry and hydrology.		
Water Quality	Water quality would be negatively impacted by climate change and possibly increasing human population in the Biscayne Bay Watershed. Impacts would be permanent, adverse (climate change and associated sea level rise), and minor to moderate on local water quality.	Construction and maintenance activities would be localized to the critical infrastructure and surrounding areas and would result in no anticipated adverse impacts to water quality. Plantings of native vegetation including mangroves at the Cutler Bay NNBF Site would serve to reduce erosion, trap sediments and filter stormwater runoff serving to improve water quality to the Biscayne Bay. The Cutler Bay NNBF Site would provide beneficial, permanent and minor impacts to water quality.	Construction and maintenance activities would be localized to the critical infrastructure, structures and surrounding areas and would result in no anticipated adverse impacts to water quality. Plantings of native vegetation including mangroves at the Cutler Bay NNBF Site would serve to reduce erosion, trap sediments and filter stormwater runoff serving to improve water quality to the Biscayne Bay. The Cutler Bay NNBF Site would provide beneficial, permanent and minor impacts to water quality.	Construction and maintenance of the surge barriers and floodwalls would result in temporary increases in turbidity and altered sediment deposition processes resulting in adverse, temporary, and minor to moderate impacts. Surge barrier openings could potentially result in a pulses of lower than normal salinity. The operation and testing of the surge barriers and pump stations would directly alter local water quality. Following storm events, plumes have the potential to alter water quality as it ultimately flows into offshore Biscayne Bay. Impacts would be temporary and range from minor to moderate. Plantings of native vegetation including mangroves at the Cutler Bay NNBF	Impacts would be as those described for Alternative 4 and Alternative 5.	Impacts would be similar to those described for Alternative 4 and 5. However, overall impacts would be less without the Edgewater Floodwall. However, the overall impact findings would be the same as those for Alternative 4 and 5.

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
				Site would serve to reduce erosion, trap sediments and filter stormwater runoff serving to improve water quality to the Biscayne Bay. The Cutler Bay NNBF Site would provide beneficial, permanent and minor impacts to water quality.		
Floodplains	<p>The development and urbanization of the Miami-Dade County has had an adverse, permanent impact to the historic, natural floodplain as construction of impervious areas along with loss of wetlands, mangroves, and SAV has caused a loss of water storage capacity as well as natural surge suppression in the natural floodplain. The development of the Miami-Dade County has had an</p>	<p>Use of nonstructural flood mitigation measures for critical infrastructure, dry and wet flood proofing, would provide beneficial, permanent, and major impacts with flooding to the community, unless the measures fail or the design flood level is exceeded.</p> <p>Protection of critical infrastructure would help the community to be more resilient and sustainable.</p> <p>Any potential adverse impacts to the floodplain resulting from construction</p>	<p>Protection of critical infrastructure would help the community to be more resilient and sustainable.</p> <p>Any potential adverse impacts to the floodplain resulting from construction and maintenance would be temporary to permanent and minor. Implementation of the Cutler Bay NNBF Site and demolished structures converted to parks or greenspace would provide a beneficial, minor impact to the floodplain</p>	<p>Protection of structures would help the community to be more resilient and sustainable.</p> <p>The structural features would prevent flood related damage to a substantive number of structures and infrastructure and provide life-loss benefits, serving to provide permanent, major benefits that provide a higher level of flood protection benefits than other coastal storm risk management features. Impacts to would include those described for Alternative 2.</p> <p>Sites restored to natural environmental</p>	<p>Impacts would be as those described for Alternative 4 and Alternative 5.</p>	<p>Impacts would be as those described in Alternative 4 and Alternative 5.</p>

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
	adverse, permanent, major impact to the natural floodplain. Flood risks to people, property, and the environment would continue and likely worsen over time due to climate change.	and maintenance would be temporary to permanent and minor. The Cutler Bay NNBF Site would provide a beneficial, minor impact to the floodplain serving to slow down and allow for natural infiltration of stormwater and increase overall water storage capacity of the floodplain.	serving to slow down and allow for more natural infiltration of stormwater and increase overall water storage capacity of the floodplain.	conditions following residential building acquisition and demolition and implementation of the Cutler Bay NNBF Site would provide a beneficial, minor impact to the floodplain serving to slow down and allow for natural infiltration of stormwater and increase overall water storage capacity of the floodplain.		
Wetlands and Mangroves	No effect from implementation of this alternative.	Construction, maintenance, and staging activities would result in temporary soil disturbance and potentially wetland and mangrove impacts that would be adverse, temporary, and minor. Potential permanent impacts to wetlands and mangroves would be mainly located in the areas surrounding the existing footprints of the critical infrastructure and would be	Construction, and disturbance activities could potentially result in temporary to permanent soil disturbance and potentially wetland and mangrove impacts that could be adverse, temporary, and minor. Impacts would be mitigated with onsite compensatory mitigation. The Cutler Bay NNBF would have beneficial, permanent and minor impacts to wetlands	Impacts to critical infrastructure outside of areas protected by surge barriers and floodwalls would be as those described for Alternative 2. Construction, maintenance, and staging activities would result in temporary soil disturbance and potentially wetland and mangrove impacts that would be adverse, temporary, and minor. Potential permanent impacts to wetlands and mangroves would	Impacts would be as those described for Alternative 4 and Alternative 5.	Impacts would be similar to Alternative 7 although adverse impacts to mangroves and onsite compensatory mitigation would be anticipated to be less without the Edgewater Floodwall impacts. However, overall impact findings would be expected to be as those described in Alternative 4 and Alternative 5.

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
		adverse and minor. Implementation of the Cutler Bay NNBF would have beneficial, permanent and minor impacts to wetlands and mangroves as it would serve to increase native vegetation at the NNBF Site. Impacts would be adverse to beneficial, temporary to permanent and minor.	and mangroves. Impacts would be adverse to beneficial, temporary to permanent and minor.	be mainly located in the areas surrounding the existing footprints of the critical infrastructure, structures being elevated, and in the permanent siting locations of the surge barriers, pump stations, and floodwalls and would be adverse and moderate. Impacts would be mitigated with onsite compensatory mitigation. Implementation of the Cutler Bay NNBF would have beneficial, permanent and minor impacts to wetlands and mangroves.		
Terrestrial Wildlife and Upland Vegetation	It is anticipated that terrestrial habitat areas would increasingly and recurrently flood, displacing terrestrial wildlife to higher ground; this would be an adverse, temporary, and minor impact to the	Construction and maintenance would result in minor disturbances and terrestrial habitat impacts that would be adverse, temporary, and minor. Any potential permanent impacts to terrestrial habitats would be mainly located in the areas	Construction and maintenance would result in minor disturbances and terrestrial habitat impacts that would be adverse, temporary, and minor to wildlife. Any potential permanent impacts to terrestrial habitats would be mainly located in the	Impacts from floodproofing critical infrastructure outside of areas protected by surge barriers and floodwalls would be as those described for Alternative 2. Construction, operation, and maintenance of the floodwalls and surge barriers would result in adverse, temporary disturbances to	Impacts would be similar to those described for Alternative 4 and Alternative 5. With Alternative 7 there would be less adverse impacts to wildlife resulting from the nonstructural features as compared to Alternative 4 as there would be a fewer number of nonstructural features.	Impacts would be similar to Alternative 4 and Alternative 5. With Alternative 8 there would be less impacts to wildlife resulting from the nonstructural features as compared to Alternative 4 as there would be a fewer number of nonstructural features; as compared to Alternative 7, Alternative 8 would have

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
	existing terrestrial wildlife.	surrounding the existing footprints of the critical infrastructure and would be adverse and minor. Planting of native vegetation at the Cutler Bay NNBF Site would serve to provide beneficial, minor and permanent impacts to wildlife by restoring and enhancing wildlife habitat.	areas surrounding the existing footprints of the critical infrastructure and structures and would be adverse and minor. Implementation of the Cutler Bay NNBF and lands converted to open space or parks would serve to provide beneficial, minor and permanent impacts to wildlife habitat and wildlife.	wildlife that are minor. Construction activities would increase ambient noise to levels greater than baseline. These adverse direct and indirect impacts to wildlife and terrestrial habitat have the potential to be minor and temporary to permanent in duration. There would be adverse, permanent, and moderate impacts to terrestrial habitat from the permanent construction footprints of the floodwalls. The Cutler Bay NNBF would result in, beneficial impacts to terrestrial habitat and wildlife that would be permanent and minor.	However, the overall level of impact findings would be as those described for Alternative 4 and Alternative 5.	slightly higher level of impact to terrestrial habitat and wildlife. However, overall impact findings would still be expected to be as those described in Alternative 4 and Alternative 5.
Plankton	Climatic change has the potential to affect the plankton species composition and abundance of plankton	No effect from implementation of this alternative.	No effect from implementation of this alternative.	There would be no effects to plankton from the nonstructural measures constructed on uplands. There is a potential for adverse, negligible to	Impacts would be as those described for Alternative 4 and Alternative 5.	Impacts would be similar to those described for Alternative 4 and 5. However, overall impacts would be less without the Edgewater Floodwall.

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
	populations within the ROI. Climate change has the potential to cause adverse, permanent, and moderate impacts to plankton populations in the ROI.			temporary, minor impacts to phytoplankton with construction, maintenance and operation of the structural features.		However, the overall impact findings would be the same as those for Alternative 4 and 5.
Fish and Fishery Resources	Climate change effects to fish resources and essential fish habitats may be increased stress and/or mortality. Climatic changes may also cause managed species and fish resources to migrate away from their nascent waters. Impacts would be adverse, permanent, and moderate to significant.	There would be no anticipated adverse effects. Planting of mangroves at the Cutler Bay NNBF would have beneficial, permanent and minor impacts to Essential Fish Habitat (EFH) and fish resources by enhancing fish foraging and nursery habitat.	There would be no anticipated adverse effects. Planting of mangroves at the Cutler Bay NNBF would have beneficial, permanent and minor impacts to EFH and fish resources by enhancing fish foraging and nursery habitat.	Direct impacts to EFH, including seagrass, mangroves, and coral reef/life/hardbottom habitats, as well as managed species and fish resources, would be adverse and major. Construction of the floodwalls and surge barriers would result in permanent habitat loss in their footprints. Turbidity plumes generated during construction and/or after storm events and during maintenance events could cause some temporary siltation of benthic communities. Other temporary impacts may result from	Impacts would be as those described for Alternative 4 and Alternative 5.	Impacts would be similar to those described for Alternative 4 and 5. However, overall impacts would be less without the Edgewater Floodwall. However, the overall impact findings would be the same as those for Alternative 4 and 5.

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
				<p>alterations in freshwater inputs and plumes caused by closures and subsequent openings of storm surge barriers during storm events.</p> <p>Adverse impacts to mangroves, SAV, and coral/hardbottom communities would require onsite compensatory mitigation.</p> <p>Planting of mangroves at the Cutler Bay NNBF would have beneficial, permanent and minor impacts to EFH and fish resources by enhancing fish foraging and nursery habitat.</p> <p>Impacts to EFH and fishery resources would range from adverse to beneficial impacts that would be temporary to permanent impacts that would range from minor to major impacts.</p>		

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
Benthic Resources	<p>It is anticipated that benthic habitat and associated fauna would experience negative impacts due to climate change and possibly increasing human population in the Biscayne Bay Watershed. With the implementation of the No Action/Future Without Project Alternative, impacts would be permanent and adverse and range from moderate to potentially major impacts to benthic resources.</p>	<p>There would be no anticipated adverse effects.</p> <p>Planting of mangroves at the Cutler Bay NNBF would have beneficial, permanent and minor impacts to benthic habitat and fauna.</p>	<p>There would be no anticipated adverse effects.</p> <p>Planting of mangroves at the Cutler Bay NNBF would have beneficial, permanent and minor impacts to benthic habitat and fauna.</p>	<p>Benthic habitat types anticipated to be impacted by construction and operation of the structural features would include SAV, corals/hardbottom habitat, oysters, mangroves, and open water bay/riverine habitat.</p> <p>Impacts would result from temporary water quality impacts during construction and during surge barrier and pump station operations to permanent loss of significant habitat from construction of the floodwalls and surge barriers.</p> <p>Onsite compensatory mitigation would be required for impacts to protected species and habitats.</p> <p>Planting of mangroves at the Cutler Bay NNBF would have beneficial, permanent and minor impacts to benthic resources.</p>	<p>Impacts would be as those described for Alternative 4 and Alternative 5.</p>	<p>Impacts would be similar to those described for Alternative 4 and 5. However, overall impacts would be less without the Edgewater Floodwall. However, the overall impact findings would be the same as those for Alternative 4 and 5.</p>

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
				Therefore, impacts to benthic resources would range from adverse to beneficial impacts that would be temporary to permanent impacts that would range from minor to major impacts.		
Special Status Species	It is anticipated that benthic habitat and associated fauna will experience negative impacts due to climate change and possibly increasing human population in the Biscayne Bay watershed. With the implementation of the No Action/Future Without Project Alternative, impacts would be permanent and adverse and range from moderate to potentially major impacts to benthic	This alternative would have considerably less adverse impacts to special status species than either implementation of Alternative 5 or 7 because impacts would be restricted to only those species that occur in terrestrial habitats and would only consist of modification of existing facilities in previously disturbed areas. For federally and state listed species and migratory birds, there could potentially be a negligible to minor, temporary disturbance to	This alternative would have a similar but slightly higher level of impacts to terrestrial special status species as those described in Alternative 2 but impact thresholds for terrestrial special status species would still be anticipated to be adverse, minor and temporary in nature. Restoration of demolition sites including native plantings would benefit migratory bird habitats providing permanent, negligible to permanent, minor benefits. Native	Impacts with Alternative 5 vary per species and designated critical habitat but are anticipated to be temporary and permanent impacts that range from negligible to significant, adverse impacts. For listed avian species and the Florida bonneted bat, the impacts would be may affect, not likely to adversely affect. For listed manatees, sea turtles, American crocodile, fish and corals the impacts would be anticipated to be may affect, likely to adversely affect. There would be anticipated adverse modification of Johnson's Seagrass Critical	Impacts would be as those described for Alternative 5. Impacts to aquatic Special Status Species would be more adverse with Alternative 7 than Alternative 8 because of the additional impacts resulting from the Edgewater Floodwall. However, the overall impact findings would be the same as those described for Alternative 5.	Alternative 8 would have less adverse impacts to aquatic special status species as this alternative does not include the Edgewater Floodwall. However, overall impact findings would be as those described for Alternative 5.

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
	habitat and fauna.	<p>them during construction where they could be potentially disturbed and flushed from construction and/or maintenance operations.</p> <p>Native plantings would enhance the habitat quality of the NNBF at the Cutler Bay Site and would be anticipated to improve migratory bird habitats. Benefits would be anticipated to be permanent and minor.</p>	<p>plantings would enhance the habitat quality of the NNBF at the Cutler Bay Site and would be anticipated to improve migratory bird habitats. Benefits would be anticipated to be permanent and minor.</p>	<p>Habitat and Manatee Critical Habitat. Onsite compensatory mitigation would be required for adverse impacts to listed corals and Johnson's seagrass. Mitigation would be risky and potentially not successful. Impacts to the bottlenose dolphin would be adverse.</p> <p>Restoration of demolition sites including native plantings would benefit migratory bird habits providing permanent, negligible to permanent, minor benefits. Native plantings would enhance the habitat quality of the NNBF at the Cutler Bay Site and would be anticipated to improve migratory bird habitats. Benefits would be anticipated to be permanent and minor.</p>		

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
Cultural Resources	Historic buildings would continue to be at risk of damage or destruction from coastal storm flooding. Archaeological sites could sustain adverse effects from flooding, but damages to historic buildings could make them unusable, and lead to their demolition.	Historic buildings would continue to be at risk of damage or destruction from coastal storm flooding. Archaeological sites could sustain adverse effects from flooding, but damages to historic buildings could make them unusable, and lead to their demolition. Floodproofing could potentially provide benefits to reduce flooding impacts to historic buildings.	Historic buildings may be subject to adverse effects from the implementation of nonstructural measures; archaeological sites would continue to have risks from flooding. Floodproofing and other nonstructural measures could potentially provide benefits to reduce flooding impacts to historic buildings.	Historic buildings and archeological sites may be subject to adverse effects from the implementation of floodproofing and structural measures. Floodproofing and structural measures could potentially provide benefits to reduce flooding impacts to archeological sites and historic buildings.	Impacts would be as those described for Alternative 4 and Alternative 5.	Impacts would be as those described for Alternative 4 and Alternative 5.
Recreational Resources	It is anticipated that coastal recreation areas would increasingly and recurrently flood, temporarily, but increasingly reduce recreation opportunities in the county; this would be an adverse, minor and temporary	There would be no anticipated adverse impacts. The implementation of the Cutler Bay NNBF has the potential to provide beneficial impacts to wildlife viewing and photography. Impacts would be beneficial, permanent, and minor.	There would be no anticipated adverse impacts. Residential properties that would be acquired and demolished would potentially be converted to parks and/or open spaces where the land was previously developed. This could potentially result in	Construction and maintenance activities could temporarily impact recreational opportunities resulting in adverse, minor impacts. The construction, operation, and maintenance of the structural features would permanently limit recreational access along the coast resulting in adverse,	Impacts would be as those described for Alternative 4 and Alternative 5.	Recreational impacts would be less adverse with Alternative 8 as compared to Alternative 5 or Alternative 7 without the adverse impacts resulting from the Edgewater Floodwall. However, the overall impact findings would be as those described for Alternative 4 and Alternative 5.

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
	<p>impact to existing recreation. The continued improvement of the recreation and open spaces in the Miami-Dade County the impacts would be beneficial, permanent, and minor. With the implementation of the No Action/Future Without Project Alternative, impacts would be adverse to beneficial, permanent to temporary and minor to moderate.</p>		<p>beneficial, minor impacts to recreation.</p> <p>The implementation of the Cutler Bay NNBF has the potential to provide beneficial impacts to wildlife viewing and photography. Impacts would be beneficial, permanent, and minor.</p>	<p>permanent, and major impacts.</p> <p>The surge barriers and pump stations would have adverse, moderate temporary as well as permanent impacts to recreational use of public waterways heavily used by recreational boaters.</p> <p>Implementation of Alternative 5 would also protect businesses providing recreational opportunities providing a beneficial, permanent, and moderate effect.</p> <p>The implementation of the Cutler Bay NNBF has the potential to provide beneficial impacts to wildlife viewing and photography. Impacts would be beneficial, permanent, and minor.</p>		

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
Aesthetics and Visual Resources	<p>Storm events would be anticipated to increase in frequency and would continue to affect the visual resources and aesthetics of public spaces, with debris and damaged structures and infrastructure . Effects would be anticipated to be minor and temporary in duration.</p>	<p>Construction and maintenance would result in adverse, temporary to permanent negligible to minor impacts to the viewshed.</p> <p>The reduction in damages to critical infrastructure would result in a beneficial, temporary, and moderate impact.</p> <p>The Cutler Bay NNBF Site would beautify the visual landscape providing beneficial, permanent, and minor aesthetic impacts.</p>	<p>Impacts to aesthetics for floodproofing of critical infrastructure and for the NNBF Site would be as those described in Alternative 2.</p> <p>Construction and maintenance has the potential to cause temporary, minor impacts to aesthetics.</p> <p>Elevating residential structures has the potential to produce adverse, minor to moderate, and permanent impacts to the viewshed. (For a discussion of potential aesthetic impacts to archeological resources, historic buildings, and historic districts please refer to the Cultural Resources Section.)</p> <p>The Cutler Bay NNBF Site and properties converted to parks and greenspace</p>	<p>Impacts to aesthetics for floodproofing of critical infrastructure and for the NNBF Site would be as those described in Alternative 2.</p> <p>The construction, operation, and maintenance of the structural features would have an adverse, temporary to permanent, and moderate to major impact to the character of the viewshed.</p> <p>The floodwalls as Brickell and Edgewater would have the most significant effect as they would be constructed at heights up to approximately 20 feet high from ground surface elevation and would extend approximately up to 50 feet into the Biscayne Bay. The floodwalls would significantly impact the visual character of the area and obstruct views of the Biscayne Bay from Miami.</p> <p>Implementation of Alternative 5 would prevent or</p>	<p>Impacts would be as those described for Alternative 4 and Alternative 5.</p>	<p>Aesthetic impacts would be less adverse with Alternative 8 as compared to Alternative 5 or Alternative 7 without the adverse impacts resulting from the Edgewater Floodwall. However, the overall impact findings would be as those described for Alternative 4 and Alternative 5.</p>

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
			<p>would serve to beautify the visual landscape providing beneficial, permanent, and minor impacts.</p> <p>Implementation of Alternative 4 would prevent or reduce visual disturbances to the landscape caused by storm surge including damaged infrastructure and buildings and debris. This would result in a beneficial, temporary, and moderate aesthetic impact.</p> <p>Overall, implementation of Alternative 4 would result in adverse to beneficial, minor to moderate aesthetic impacts.</p>	<p>reduce visual disturbances to the landscape caused by storm surge including damaged infrastructure and buildings and debris. This would result in a beneficial, temporary, and moderate aesthetic impact.</p> <p>Overall, implementation of Alternative 5 would have the potential to produce adverse to beneficial aesthetic impacts that are temporary to permanent and minor to major.</p>		

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
Socioeconomics	<p>Widespread areas within the City of Miami would be vulnerable to flooding, resulting in flooded roadways, power outages, and stranded residents. Substantive economic damage would be sustained following major storm events. Vulnerable portions of the population would not be able to evacuate during storm events and would be most impacted. Impacts would be adverse, temporary and minor to major depending on the level of severity of the storm event and its affect to the local community.</p>	<p>Resiliency of critical infrastructure would be greatly improved, however, the community would still potentially suffer damage and loss of property, loss of life, disruption of work, and both temporary and permanent displacement from major coastal storm events. Socially vulnerable segments of the population would be most impacted. There would be temporary employment opportunities. Socioeconomic benefits from implementation of Alternative 2 would be beneficial, temporary to permanent, and minor to moderate.</p>	<p>Socioeconomic impacts from floodproofing critical infrastructure would be those described in Alternative 2. Elevated residential homes may cause daily inconvenience and special hardships to the elderly and handicapped. Acquisition and demolition of residential properties would displace people and would break up neighborhoods, perhaps dislocating people to less desirable locations. Adverse impacts would be permanent and would be moderate.</p> <p>Implementation of Alternative 4 would also provide significant benefits to the community in that the nonstructural measures would serve to prevent substantive property damage</p>	<p>Socioeconomic impacts from floodproofing critical infrastructure would be those described in Alternative 2. Where away from the shoreline, the floodwalls would impede pedestrian and vehicular traffic, and change patterns of movement in the heart of the Miami metropolitan area. Adverse effects would be permanent and moderate.</p> <p>Implementation of Alternative 5 would provide significant benefits to the community in that the measures would serve to prevent life-loss, prevent substantive property damage, and would protect infrastructure from major coastal storm events. The resiliency of the local community in the areas protected by the structures would be significantly enhanced in that local businesses could rapidly</p>	<p>Impacts would be as those described for Alternative 4 and Alternative 5.</p>	<p>Impacts would be similar to those described for Alternative 7 although Alternative 8 would have more nonstructural benefits (and features) as compared to Alternative 7. However, the number of residential acquisitions would be the same for Alternative 7 and Alternative 8. Overall, the impact findings would be as those described for Alternative 4 and Alternative 5.</p>

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
			<p>resulting from major coastal storm events. Floodproofing of commercial structures would allow businesses to rapidly resume operations following major storm events. There would be temporary employment benefits. Beneficial impacts to socioeconomic s would be temporary to permanent and range from minor to major.</p> <p>Impacts would be adverse to beneficial and range from minor to major impacts.</p>	<p>resume operations following a major coastal storm event. There would be temporary employment benefits. Beneficial impacts to socioeconomic s would be temporary to permanent and range from minor to major.</p> <p>Overall, impacts to socioeconomic s would be adverse to beneficial, temporary to permanent, and would range from minor to major.</p>		
Hazardous, Toxic, and Radioactive Waste (HTRW)	<p>There would be no anticipated impact to HTRW with implementation of the No Action/Future Without Project Alternative.</p>	<p>Potential impacts to HTRW would be localized to disturbance of existing structures and surrounding areas.</p> <p>Any potential contamination would be mitigated and Best Management Practices (BMPs) would be followed for petroleum,</p>	<p>Potential impacts would be localized to disturbance of existing structures and surrounding areas.</p> <p>Any potential contamination would be mitigated and BMPs would be followed for petroleum, hazardous material and waste storage, and an</p>	<p>Potential impacts to HTRW would be located at proposed floodwall and surge barrier locations and associated pump station discharge locations and existing structures and surrounding areas. Any potential contamination would be mitigated and BMPs would be</p>	<p>Impacts would be as those described for Alternative 4 and Alternative 5.</p>	<p>Impacts would be as those described for Alternative 4 and Alternative 5.</p>

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
		hazardous material and waste storage, and an accident and spill prevention plan would be utilized. Any potential adverse, temporary impacts to HRTW during construction would be negligible.	accident and spill prevention plan would be utilized. Any potential adverse, temporary impacts to HRTW during construction would be negligible.	followed for petroleum, hazardous material and waste storage, and an accident and spill prevention plan would be utilized. Any potential adverse, temporary impacts to HRTW during construction would be negligible.		
Safety	Critical infrastructure damage and loss, property damage and losses, temporary to permanent displacement from flooding caused by coastal storms, and potentially life-loss would continue and would be anticipated to increase in level of impact in the future. Widespread areas within county would be vulnerable to flooding, leading to various potentially dangerous conditions	Construction activities have the potential to produce minor and adverse, temporary impacts to emergency services. There would be beneficial, permanent, and moderate impacts to the public and emergency services on safety through the protection of critical infrastructure. However, widespread areas would still be vulnerable to flooding and damages and destruction and damage of infrastructure and structures	Construction activities have the potential to produce minor and adverse, temporary impacts to emergency services. There would be beneficial, permanent, and moderate impacts to the public and emergency services on safety through the protection of critical infrastructure. However, widespread areas would still be vulnerable to flooding and damages and destruction and damage of infrastructure and structures	Safety impacts resulting from floodproofing critical infrastructure would be as those described in Alternative 2. Construction of the structural features would result in minor to moderate temporary, adverse safety impacts on the public and emergency services during construction. The opening and closing of the surge barriers would pose temporary safety risks to the public. To mitigate navigation safety risks, the surge barriers would be marked in	Impacts would be as those described for Alternative 4 and Alternative 5.	Impacts would be as those described in Alternative 4 and Alternative 5.

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
	such as flooded roadways, power outages, and stranded residents. Damaged structures could also potentially expose construction workers and residents to high levels of mold and mildew that could cause respiratory illnesses. Impacts would be adverse, temporary and minor to major depending on the level of severity of the storm event and its affect to the local community.	leading to various potentially dangerous conditions such as flooded roadways, power outages, and stranded residents. There would be no reductions in life-loss. Impacts to safety would be adverse to beneficial, temporary to permanent and range from minor to moderate.	leading to various potentially dangerous conditions such as flooded roadways, power outages, and stranded residents. There would be no reductions in life-loss. Impacts to safety would be adverse to beneficial, temporary to permanent and range from minor to moderate.	accordance with USCG requirements and identified on navigation charts. Potential impacts to safety could be adverse, temporary, and major in the event of a pump system and/or surge barrier system failure. There would be permanent, beneficial effects on safety, due to the prevention of widespread flooding during major storm events. There would be significant benefits to the community in that the measures would serve to prevent life-loss, prevent substantive property damage, and would protect infrastructure from major coastal storm events Beneficial impacts to safety would be temporary to permanent and range from minor to major.		
Transportation	Critical infrastructure damage and	There would be minimal construction	Impacts to transportation from	Impacts to transportation from	Impacts would be as those described for	Impacts would be as those described in

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
	<p>loss, property damage and losses, temporary to permanent displacement from flooding caused by coastal storms, and potentially life-loss would continue and worsen over time. Widespread areas within the City of Miami would be vulnerable to flooding, leading to various potentially dangerous conditions such as flooded roadways, power outages (with potential loss of the roadway traffic system), and stranded residents. Various improvements to infrastructure are planned in the future. Therefore, this alternative would result in impacts to</p>	<p>and maintenance activities limited to the critical infrastructure sites, Cutler Bay NNBF Site, and surrounding areas. Heavy equipment and vehicles entering and exiting the transportation network could potentially cause adverse, temporary, and negligible to minor travel delays.</p> <p>With implementation of Alternative 2 alone, widespread areas would still be vulnerable to flooding, leading to various potentially dangerous conditions during storm events such as flooded roadways, power outages (with potential loss of the roadway traffic system), and stranded residents.</p> <p>The implementation of Alternative 2</p>	<p>floodproofing critical infrastructure would be as those described in Alternative 2.</p> <p>Construction access from public roadways would be needed to access residential elevation and acquisition/demolition sites and the Cutler Bay NNBF Site. Heavy equipment and vehicles entering and exiting the transportation network would cause adverse, temporary, and negligible to minor travel delays.</p> <p>There would be no flood protection to the road network in Miami-Dade County. The increased nuisance flooding and susceptibility from other flooding with storm surge events can lead to various potentially dangerous</p>	<p>floodproofing critical infrastructure would be as those described in Alternative 2.</p> <p>Construction access from public roadways would be needed to access structural sites, residential elevation and acquisition/demolition sites, and the Cutler Bay NNBF Site. Heavy equipment and vehicles entering and exiting the transportation network would cause adverse, temporary, and minor to moderate travel delays.</p> <p>There would be temporary road closures and rerouting of traffic at the floodwall locations when the surge barriers are in the closed position resulting in adverse and moderate impacts to traffic.</p> <p>There would be flood protection to the road network in Miami-Dade County protected by the surge barriers and floodwalls.</p>	<p>Alternative 4 and Alternative 5.</p>	<p>Alternative 4 and Alternative 5.</p>

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
	transportation that are adverse to beneficial, temporary to permanent and minor to major.	would be anticipated to have an adverse, temporary and negligible to minor impact on transportation.	conditions such as flooded or damaged evacuation routes. Widespread areas within the county would continue to be vulnerable to flooding, leading to various potentially dangerous conditions such as flooded roadways, which could result in stranded residents. Overall, impacts to transportation with implementation of Alternative 4 would be adverse to beneficial, temporary, and range from negligible to minor.	The surge barriers with the floodwalls and associated pump stations and riprap would provide beneficial, permanent impacts on transportation as they are the measures that would serve to prevent flood damages to the roadways and associated traffic system. There would be significant benefits to public transportation safety and also to the roadway physical network itself. Benefits would be permanent and major. Impacts to transportation would be adverse to beneficial, temporary to permanent, and range from minor to major.		
Navigation	No effect from implementation of this alternative.	No effect from implementation of this alternative.	It is not anticipated that there would be any temporary or permanent impacts to navigation with the implementation of Alternative 4. Once the exact	Temporary and permanent impacts to navigation would result from the construction, maintenance, and operation of the surge barriers and floodwalls (and associated	Impacts would be as those described for Alternative 4 and Alternative 5.	Impacts would be similar but less adverse than those for Alternative 4 and Alternative 5 because there would be no navigation impacts at Edgewater. However, overall

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
			<p>siting and alignments are determined during the PED phase, this impact analysis would be re-evaluated to ensure that the demolition and/or restoration of acquired parcels would not result in temporary, minor impacts to navigation due to construction access for properties directly abutting waterways.</p>	<p>features including pump stations and riprap).</p> <p>The construction of the surge barriers, floodwalls (and associated pump stations and riprap), would temporarily increase the number of vessels transiting the proposed study area.</p> <p>The storm surge barriers would adversely affect navigation in the Biscayne Canal, Little River, and Miami River. To mitigate potential navigation safety risks, the surge barriers would be marked in accordance with U.S. Coast Guard requirements and identified on navigation charts to ensure that boaters were aware of the navigation hazard.</p> <p>The surge barriers would permanently narrow the navigational area in the Biscayne Canal, Little River, and Miami River.</p> <p>Overall, there would be</p>		<p>impact findings would be as those described for Alternative 4 and Alternative 5.</p>

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
				temporary to adverse impacts to navigation that would range from moderate to major impacts.		
Utilities	The increased and recurrent flooding events, would make existing utilities increasingly susceptible to damage caused by flooding and disruption of services. Impacts would be permanent, adverse, and moderate.	<p>Construction and maintenance activities resulting from floodproofing of critical infrastructure would result in the temporary loss of utilities which would result in adverse, temporary and minor impacts to utilities.</p> <p>Impacts due to the construction and maintenance on utilities would be localized to each facility and would be adverse, temporary and minor, but with beneficial, permanent, and moderate impacts resulting from the floodproofing of the critical infrastructure facilities.</p>	<p>Construction and maintenance activities resulting from floodproofing of critical infrastructure and implementing the nonstructural measures may result in the temporary loss of utility service which would result in adverse, temporary and minor impacts to utilities. However, any potential impacts would be localized to existing utilities and surrounding areas. Elevations of existing residencies would require utilities investigations as well as local alterations of utilities that service individual buildings. Such actions could potentially</p>	<p>Construction and maintenance activities may result in the temporary loss of utility service which would result in adverse, temporary and minor impacts to utilities.</p> <p>For the structural measures, there would be required permanent relocations of utilities. The Miami River has the greatest potential of the three waterways for adverse, minor to moderate, temporary to permanent, impacts to utilities (dependent on the final siting of the structural features). The proposed storm surge barrier across the Miami River abuts the underground (and underwater) power transmission line and care during construction will be needed to</p>	Impacts would be as those described for Alternative 4 and Alternative 5.	

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
			<p>include raising of local HVAC structures, power substation raising, and possibly relocating and/or altering water and sewer service lines. Prior to demolition, utility shutoff/removal would be conducted.</p> <p>There would be beneficial, permanent and moderate impacts to utilities resulting from the increased level of flood protection to critical infrastructure and structures.</p>	<p>ensure this line is not impacted.</p> <p>Utilization of BMPs would reduce the adverse impacts on utilities due to construction ranging from minor and moderate to that of temporary and permanent. Benefits to utilities from increased coastal storm protection, in particular stormwater management and the protection of critical infrastructure, would be moderate and beneficial.</p>		
Air Quality	No effect from implementation of this alternative.	There would be minimal construction and maintenance activities what would be located at and near the critical infrastructure. Direct air emissions would occur from the use of construction equipment, barges, and motor vehicles during	There would be minimal construction and maintenance activities what would be located at and near the critical infrastructure. Direct air emissions would occur from the use of construction equipment, barges, and motor vehicles during	Impacts to air quality from floodproofing critical infrastructure would be as those described in Alternative 2. Impacts would also occur from the construction and maintenance of surge barriers floodwalls and associated pump stations, and riprap. Direct air emissions would occur from the	Impacts would be as those described for Alternative 4 and Alternative 5.	Impacts would be as those described for Alternative 4 and Alternative 5.

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
		transportation of materials to the project site resulting in negligible to minor, temporary impacts to air quality.	transportation of materials to the project site resulting in negligible to minor, temporary impacts to air quality.	<p>use of construction equipment such as cranes, excavators, dump trucks, and other motor vehicles and barges/vessels during transportation of materials to the project site and other construction and maintenance activities resulting in minor, temporary impacts to air quality.</p> <p>Temporary and minor impacts to air quality would be anticipated with the operations of pump stations and back-up generators during testing events and/or when in operation during a storm event. However, the surge barriers would be operated only during major storm events that would likely be no more than five times per year for an average duration of approximately five days (and potentially up to 10 days). Therefore,</p>		

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
				<p>emissions would be very limited and not continuous.</p> <p>Air quality impacts resulting from implementation of Alternative 5 would be similar to Alternative 4 in addition to the construction and operation activities as described above. These impacts to air quality resulting from the implementation of Alternative 5 would be anticipated to be adverse, temporary, and minor.</p>		
Noise and Vibration	No effect from implementation of this alternative.	Noise generated from construction and maintenance from vehicles and construction equipment would be mainly restricted to the critical infrastructure and surrounding areas. There would also be minor increases in traffic noise from vehicles and	Noise and vibration impacts resulting from implementation of Alternative 4 would occur from construction and maintenance activities. Increases in noise levels would occur from the use of construction equipment such as excavators, dump trucks, and other motor vehicles	Noise impacts would occur from the use of construction and maintenance equipment to floodproof critical infrastructure and construct and maintain the project structural features. Direct increases in noise and vibration levels on land would occur from the use of vehicles and construction equipment such as excavators, dump trucks, and other motor	Impacts would be as those described for Alternative 4 and Alternative 5.	Impacts would be as those described for Alternative 4 and Alternative 5.

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
		<p>construction equipment traveling to the construction sites. A slight increase in noise levels would occur from the use of construction and maintenance equipment and motor vehicles during transportation of materials to the project site resulting in adverse, temporary and minor impacts to noise and vibration levels.</p>	<p>during transportation of materials to the project site and demolition activities resulting in minor, temporary increases in noise and vibration levels. There would also be increases in noise from vehicles and construction equipment traveling to the construction sites.</p> <p>Noise and vibration impacts resulting from implementation of Alternative 4 would be similar to Alternative 2 but at a higher duration to account for the additional construction and maintenance of the nonstructural features. Noise impacts resulting from construction and maintenance activities of Alternative 4 would be adverse,</p>	<p>vehicles during transportation of materials to the project site and other construction activities resulting in minor and temporary impacts. For the in-water construction of the surge barriers and floodwalls noise would be generated from vessels as well as equipment such as pile-driving equipment to install the structural features. There would also be increases in noise from vehicles, vessels/barges, and construction equipment traveling to the construction sites.</p> <p>The noise generated from the construction and maintenance of the surge barriers, floodwalls and associated pump stations and riprap would be typical of construction sites. Other noise would result from the operation of the pump stations</p>		

Resource	Alt. 1	Alt. 2	Alt.4	Alt 5 (Alt. 2 plus Structural)	Alt. 7 (Alt. 2, 4, and 5)	Alt. 8 (Alt. 2, 4, and 5 – without Edgewater Floodwall)
			temporary, and minor.	<p>which would operate during closure of the pump stations (as needed) and during test operations.</p> <p>There would be underwater adverse impacts to noise and vibration levels that would occur for any in water geotechnical testing and construction and maintenance activities; these impacts would be temporary and moderate.</p> <p>Construction, maintenance, and operation noise impacts would be adverse, temporary and moderate.</p>		

8.2 LAND USE

Alternative 1 - No Action/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.

Miami-Dade County would continue coastal and climate resiliency efforts, including the Sea Level Rise Strategy Project, which aims to identify and develop feasible mitigation and adaption strategies for sea level rise and coastal storms; implementation of project proposed in the Rapid Action Plan and Adaptation Action Areas; and continued implementation of the Environmentally Endangered Lands (EEL) Program (WEC - Miami-Dade County, n.d.). The SFWMD would also continue research and implementation of various projects and initiatives in response to climate change and sea level rise.

Planned stormwater improvements in the City of Miami would also help address flooding issues. Examples would include updating the stormwater management plans and long term strategies would include installation of tidal backflow valves, improvements to stormwater facilities, and increased public involvement.

The USACE would continue implementation of major ongoing projects within the Miami-Dade County. These projects would include, the Miami Harbor Deepening and Navigation Improvements Project, sponsored by the Port of Miami and Miami-Dade County; the Biscayne Bay Coastal Wetlands Project (Phase II Implementation), a component of the Comprehensive Everglades Restoration Plan (CERP), conducted in partnership with the SFWMD; and the Miami-Dade County Coastal Storm Risk Management Feasibility Study, (Beach Nourishment), sponsored by Miami-Dade County. These improvements and studies would continue into the future regardless of whether the Miami-Dade Back Bay Coastal Storm Risk Management Feasibility Study is implemented.

Existing upstream water management operations would continue.

It is expected that the overall available land for development would decrease over time due to increased population, the unchanging boundaries of federally owned lands (i.e. Everglades National Park), and the need for agricultural lands. These factors, along with the Urban Development Boundary (UDB) confine the land area for potential expansion of development. There is also potential for more acres of EEL or parks to be acquired and protected in the future, which would prevent development or redevelopment in areas within the UDB. Currently, the Comprehensive Development Master Plan (CDMP) has identified various land uses and development intensities that would be allowable between the years 2020 and 2030 (LUEC - Miami-Dade County n.d.). Aligning with the CDMP, the City of Miami's zoning code, Miami 21, emphasizes a dense, walkable urban core with green buildings and increased freeboard elevations in for potential climate change impacts. Over time, land use within the UDB is projected to become increasingly metropolitan and connected around urban core areas and public transportation systems. Expansion of the UDB may also occur in the future, which would provide more developable area in the county.

Predicted climate change impacts, such as increased ocean temperatures, ocean acidification, sea level rise, and changes in currents, upwelling, and weather patterns would have the potential to affect the nature and character of the estuarine and coastal ecosystem in the Region of Influence (ROI). Waters would continue to rise in the Biscayne Bay region, which would negatively impact Miami-Dade County by increasing flooding, both nuisance and during/after major storm events. Over time, some land use may convert to other types of land use if structures and infrastructure are recurrently flooded. It is anticipated that coastal areas would increasingly and recurrently flood, which would potentially result in adverse, temporary to permanent and moderate impacts to land use.

The No Action/Future Without Project Alternative is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects, including changes to land use and development considerations within Miami-Dade County. With the implementation of the No Action/Future without Project Alternative, impacts would be adverse, temporary to permanent, and moderate.

Alternative 2 – Critical Infrastructure

There would be minimal construction and maintenance activities and ground disturbance anticipated for the floodproofing of critical infrastructure. Implementation would include utility investigations and construction and maintenance of the dry or wet floodproofing materials. Staging of construction and/or maintenance materials may have the potential to cause adverse, temporary, minor impacts to land use. There would be no anticipated permanent impacts to land use with implementation of Alternative 2.

Impacts to land use from implementation of Alternative 2 would be adverse, temporary, and minor. Floodproofing would result in the ability for land use in the critical infrastructure areas to continue as intended following major storm events. Benefits to land use from implementation of Alternative 2 would be permanent and moderate.

Alternative 4 - Critical Infrastructure and Nonstructural

The evaluation of potential impacts to land use for Alternative 4 would include those described for Alternative 2 as well as the additional proposed nonstructural measures.

Implementation of the additional floodproofing and elevation of structures would result in impacts that are slightly higher but at the same level of impacts described as Alternative 2. Staging of construction and/or maintenance materials may have the potential to cause adverse, temporary, minor impacts to land use. Acquisition and demolition of residential properties and converting them to greenspace or parks would be very limited; this would result in adverse, permanent, and moderate impacts to land use. This would permanently alter the permissible development of acquired parcels to parks or open space.

Implementation of Alternative 4 would potentially result in adverse, temporary to permanent impacts that range from minor to moderate impacts. Floodproofing and structural elevations would result in the ability for land use to continue within affected areas to continue as intended following major storm events. Benefits to land use from implementation of Alternative 4 would be permanent and moderate.

Alternative 5 - Critical Infrastructure and Structural

Impacts for critical infrastructure outside of areas protected by surge barriers and floodwalls would be as those described for Alternative 2. Upon completion of construction, the floodwalls, surge barriers, and pump stations would change the land use within their footprints and necessary right-of-way for operations and maintenance. Buildings situated behind the structural measures would be protected from storm surge resulting from coastal storms. Land use in these areas would be less likely to change solely in response to climactic and environmental conditions. Staging of construction and/or maintenance materials may have the potential to cause adverse, temporary, minor impacts to land use.

While implementation of Alternative 5 would adversely and permanently affect the land use within the ROI, there would be storm surge protection provided to a large expanse of urbanized coastal, low lying areas in Miami-Dade County. Overall, the storm surge protection and floodwalls would produce both beneficial and adverse effects that range from temporary to permanent impacts to land use, and these effects would range from minor to major impacts.

Alternative 7 - Critical Infrastructure, Nonstructural, and Structural

Impact findings would be as those described for Alternative 4 and Alternative 5.

Alternative 8 - Critical Infrastructure, Nonstructural, and Structural (Without Edgewater Floodwall)

Impact findings would be as those described for Alternative 4 and Alternative 5.

Best Management Practices

For any of the action alternatives, avoidance and minimization practices would be employed to the maximum extent practicable for all potential impacts. Practicable is defined as, “if 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 to land use:

1. Avoid siting the structural measures on privately owned land to the maximum extent practicable.
2. To the extent practical, consolidate and minimize staging of construction materials to permanently impacted land parcels.
3. Following demolition of acquired properties, native vegetation would be planted to provide soil stability and also to allow for infiltration of stormwater during storm events.

Cumulative Impacts

There are a multitude of past, present and reasonably foreseeable future projects within the ROI. Regardless, if the above referenced alternatives are implemented, 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 would continue to be studied and implemented. 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. Most of these impacts would not directly affect existing land use within the ROI, though rising waters would temporarily increase storm and nuisance flooding.

Implementation of any of the action alternatives is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects.

8.3 GEOLOGY, PHYSIOGRAPHY, AND TOPOGRAPHY

Alternative 1 - No Action/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.

Miami-Dade County would continue coastal and climate resiliency efforts, including the Sea Level Rise Strategy Project, which aims to identify and develop feasible mitigation and adaption strategies for sea level rise and coastal storms; implementation of project proposed in the Rapid

Action Plan and Adaptation Action Areas; and continued implementation of the EEL Program (WEC - Miami-Dade County, n.d.). The SFWMD would also continue research and implementation of various projects and initiatives in response to climate change and sea level rise.

Planned stormwater improvements in the City of Miami would also help address flooding issues. Examples would include updating the stormwater management plans and long term strategies would include installation of tidal backflow valves, improvements to stormwater facilities, and increased public involvement.

The USACE would continue implementation of ongoing projects within the Miami-Dade County. These projects would include, the Miami Harbor Deeping and Navigation Improvements Project, sponsored by the Port of Miami and Miami-Dade County; the Biscayne Bay Coastal Wetlands Project (Phase II Implementation), a component of the CERP, conducted in partnership with the SFWMD; and the Miami-Dade County Coastal Storm Risk Management Feasibility Study, (Beach Nourishment), sponsored by Miami-Dade County. These improvements and studies would continue into the future regardless of whether the Miami-Dade Back Bay Coastal Storm Risk Management Feasibility Study is implemented.

Existing upstream water management operations would continue.

The topography in the ROI would largely go unchanged besides shoreline erosion and effects from coastal storm surge on the landscape. As sea level rises over time, the morphological processes of erosion and siltation would occur. With the No Action/Future without Project Alternative, erosion, subsidence (Oliver-Cabera 2018), and flooding in Miami-Dade County would continue to occur. Flooding impacts would be anticipated to worsen over time. Therefore, impacts to topography and soils would be adverse, temporary to permanent and range from minor to moderate.

Alternative 2 – Critical Infrastructure

Construction, maintenance, and staging activities would result in soil disturbance that would be adverse, temporary, and minor. Potential soil impacts would be mitigated with BMPs to the extent practical during construction and any unavoidable, temporary soil impacts would be restored upon completion of construction. Any potential permanent impacts to soils would be mainly located in the areas surrounding the existing footprints of the critical infrastructure and would be adverse and minor. Implementation of the Cutler Bay NNBF would serve to provide beneficial, minor and permanent impacts to soils. There would be no anticipated impacts to topography or geologic features. Therefore, impacts to soils from implementation of Alternative 2 would be adverse to beneficial, temporary to permanent and minor.

Alternative 4 - Critical Infrastructure and Nonstructural

Implementation of the additional floodproofing and elevation of structures would result in adverse impacts to soils that are slightly higher but at the same threshold level of impact described as Alternative 2 (temporary to permanent and minor). Implementation of the Cutler Bay NNBF and lands converted to open space or parks would serve to provide beneficial, minor and permanent impacts to soils. There would be no anticipated impacts to topography or

geologic features. Implementation of Alternative 4 would result in adverse to beneficial, temporary to permanent soil impacts that are minor.

Alternative 5 - Critical Infrastructure and Structural

Impacts to critical infrastructure outside of areas protected by surge barriers and floodwalls would be as those described for Alternative 2. Construction and maintenance of the floodwalls and surge barriers would result in adverse, temporary soil disturbances that are moderate; potential soil impacts would be mitigated with BMPs to the extent practical during construction and any unavoidable, temporary soil impacts would be restored upon completion of construction. There would be adverse, permanent, and moderate impacts to soils and geology resulting in the permanent construction footprints of the floodwalls and surge barriers and associated features as portions of these features would be required to extend beneath the soil surface. Fill and grading done to construct project features would have an adverse, permanent, minor impact to topography. Implementation of the Cutler Bay NNBF would serve to provide beneficial, minor and permanent impacts to soils. Therefore, implementation of Alternative 5 would result in impacts to soils and geology that would be adverse to beneficial and range from minor to moderate.

Alternative 7 - Critical Infrastructure, Nonstructural, and Structural

Impacts findings would be similar to those described for Alternative 4 and Alternative 5. As compared to Alternative 4 and Alternative 5 there would be less adverse soil impacts with the fewer number of nonstructural features. However, the overall impact findings would be the same as Alternative 4 and 5.

Alternative 8 - Critical Infrastructure, Nonstructural, and Structural (Without Edgewater Floodwall)

Impacts would be similar to those described for Alternative 4 and Alternative 5. As compared to Alternative 5 and 7 there would be fewer impacts to geology without the Edgewater Floodwall. However, the overall impact findings for Alternative 8 would be the same as Alternative 4 and 5.

Best Management Practices

Best management practices (BMPs) would reduce ground disturbance to the extent practicable. Do not backfill the disturbed area behind surge barriers with soils that are not nascent. When backfill is necessary, fill with soils that are of a similar grade and composition of soils that are present in the ROI.

During construction, the contractor would be required to follow specific measures to minimize soil exposure, soil compaction and reduce potential impacts to stormwater; these measures would consist of the following:

- Install and monitor erosion-prevention BMPs, such as silt fences, sediment berms, and/or other equivalent sediment control measures as appropriate and in accordance with the approved Storm Water Pollution Prevention Plan;
- Apply permanent or temporary soil stabilization to denuded areas within seven days after final grade is reached on any portion of the site;

- Apply nutrients to landscaping areas in accordance with manufacturer's recommendations and do not apply nutrient during rainfall events;
- Inspect stormwater water BMPs and potential risks to stormwater (e.g. material stockpiles, silt fences, etc.) (i) at least once every four business days or (ii) at least once every five business days and no later than 48 hours following a measurable storm event. In the event that a measurable storm event occurs when there are more than 48 hours between business days, the inspection shall be conducted on the next business day; and
- Stabilize disturbed areas immediately whenever any clearing, grading, excavating, or other land-disturbing activities have permanently ceased on any portion of the site, or temporarily ceased on any portion of the site and would not resume for a period exceeding 14 days.

Cumulative Impacts

There are a multitude of past, present and reasonably foreseeable future projects within the ROI. Regardless, if the above referenced action alternatives are implemented, 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 would continue to be studied and implemented.

Miami-Dade County has many ongoing private and government funded construction projects. The building of the Miami Skyrise, construction improvements to existing businesses and residences, improvements to the Port of Miami, and ongoing roadway improvements may involve land disturbance, land clearing, and/or construction access and have the potential for temporary and/or permanent impacts to wetlands and/or mangroves. However, through the regulatory permitting process offsets to these impacts are required in the form of compensatory mitigation for wetland losses.

Climatic changes such as sea level rise and increasing global temperatures are predicted to continue over the next 50 years. Due to the synergistic effects from a combination of factors, and relative sea level rise, and an increase in the frequency and strength of storms, the risk from coastal inundation will rise in the coming years for Miami-Dade County.

Implementation of any of the action alternatives is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects.

8.4 BATHYMETRY, HYDROLOGY, AND TIDAL PROCESSES

Alternative 1 - No Action/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.

Miami-Dade County would continue coastal and climate resiliency efforts, including the Sea Level Rise Strategy Project, which aims to identify and develop feasible mitigation and adaption strategies for sea level rise and coastal storms; implementation of project proposed in the Rapid Action Plan and Adaptation Action Areas; and continued implementation of the EEL Program (WEC - Miami-Dade County, n.d.). The SFWMD would also continue research and

implementation of various projects and initiatives in response to climate change and sea level rise.

Planned stormwater improvements in the City of Miami would also help address flooding issues. Examples would include updating the stormwater management plans and long term strategies would include installation of tidal backflow valves, improvements to stormwater facilities, and increased public involvement.

The USACE would continue implementation of ongoing projects within the Miami-Dade County. These projects would include, the Miami Harbor Deeping and Navigation Improvements Project, sponsored by the Port of Miami and Miami-Dade County; the Biscayne Bay Coastal Wetlands Project (Phase II Implementation), a component of the CERP, conducted in partnership with the SFWMD; and the Miami-Dade County Coastal Storm Risk Management Feasibility Study, (Beach Nourishment), sponsored by Miami-Dade County. These improvements and studies would continue into the future regardless of whether the Miami-Dade Back Bay Coastal Storm Risk Management Feasibility Study is implemented.

Existing upstream water management operations would continue.

If the human population in the Biscayne Bay watershed continues to increase, there would be increasing pressure on the Bay due to stormwater runoff and increased nutrients from land-based activities unless these are well-controlled and improvements to water and waste management occur. This could have a minor impact on local hydrology, if a large enough volume of additional freshwater is released into Biscayne Bay.

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 affect the nature and character of the estuarine and coastal ecosystem and local waters in the ROI. Water would continue to rise in the Biscayne Bay, which would negatively impact Miami-Dade County by increased flooding, including both nuisance and during/after major storm events as well as altering the basic water chemistry of Biscayne Bay. Waters are likely to become warmer, and possibly more saline in the Bay due to a larger oceanic input. At the same time, precipitation may increase, which unless runoff is controlled, would likely cause harmful algal blooms to become more frequent. Local water circulation patterns may change as salinity and temperature change, though Biscayne Bay, due to its shallowness and extent of tidal exchange, is very unlikely to become stratified or experience significant changes in hydrodynamics due to climate change. One significant change will be that the tide would be anticipated to rise higher as sea level rise continues and accelerates over time into the future. Over time water depths would be anticipated to increase.

The No Action/Future without Project Alternative would not be predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects. With the implementation of the No Action/Future without Project Alternative, impacts are adverse, permanent and (climate change and associated sea level rise) and moderate on bathymetry, hydrology and tidal processes.

Alternative 2 – Critical Infrastructure

Impacts associated with Alternative 2 would be localized to the critical infrastructure and surrounding areas and would result in no anticipated adverse impacts to bathymetry, hydrology and tidal processes. Implementation of the Cutler Bay NNBF would have beneficial, permanent and minor impacts to bathymetry and hydrology with restoration of mangroves but would be anticipated to have no effect on tidal processes.

Alternative 4 - Critical Infrastructure and Nonstructural

Impacts associated with Alternative 2 would be localized to the critical infrastructure, affected structures and surrounding areas and would result in no anticipated adverse impacts to bathymetry, hydrology and tidal processes. Implementation of the Cutler Bay NNBF would have beneficial, permanent and minor impacts to bathymetry and hydrology with restoration of mangroves but would be anticipated to have no effect on tidal processes.

Alternative 5 - Critical Infrastructure and Structural

Construction of the structural features in the Biscayne Bay, Biscayne Canal, Little River, and the Miami River would result in temporary, minor increases in turbidity and alterations in sediment deposition that could potentially affect bathymetry and hydrology; however, turbidity control and stormwater BMPs during construction would be used to mitigate temporary impacts to the extent practical. Construction of the surge barriers, floodwalls, and associated pump stations would result in temporary to permanent impacts on bathymetry and hydrology that are minor to moderate. During major storm events when the surge barriers are in the closed position they would block flows of the Biscayne Canal, Little River, and Miami River to the Biscayne Bay. Although it is relatively uncertain and would depend on storm conditions, the closure would occur over an average time period of approximately five days (up to a maximum of approximately 10 days). This would adversely affect tidal exchange processes and sediment transport processes resulting in temporary, moderate impacts. Tidal processes would be further impacted by stormwater temporarily concentrated behind the surge barriers when they are in the closed position; although pump stations would be used to release stormwater upstream of the surge barriers, there would still likely be some alterations in salinities and tidal processes from the operation of the surge barriers during storm events and potentially during testing operations of the surge barriers. The subsequent openings post-storm and during post-testing conditions could potentially result in a pulse of lower than normal salinity water to Biscayne Bay at discharge points from surge barriers and pump stations. However, this impact would be temporary, and minor to moderate, as it would be expected that these waters would soon interchange with waters in the Biscayne Bay. The operation and maintenance of the floodwalls, surge barriers, and pump stations would potentially result in temporary to permanent alterations of sediment transport; the impacts would range from minor to potentially major. Sedimentation would potentially impact local bathymetry due to sediments infilling navigation channels, canals, or decreasing the depth of near shore waters where sediments from tide gate openings depositing. This plume has the potential to alter local hydrodynamics as it meets with Biscayne Bay waters.

The proposed structures would also alter the flow patterns and velocities of tidal currents. Changes to velocity would be anticipated to be adverse, temporary, and minor when surge

barriers would be in the open position (during non-storm conditions). Upon closure of surge barriers during a major storm event or during testing operations, velocities in the Biscayne Canal, Little River, and Miami River would drop to zero near the surge barriers, as there would temporarily be no tidal exchange or release of canal or river water to the Biscayne Bay. In addition, pump stations from the surge barriers and floodwalls would further alter local flow patterns and velocities at discharge points. Upon opening of the surge barriers (pump stations would also be turned off), velocities would quickly return to normal, although the most upriver reaches would experience minor fluctuations as the hydraulics return to pre-closure conditions. The change in velocity during the time the gates are closed (and pump stations may also be turned on) would be anticipated to be adverse, temporary, and moderate.

The floodwalls and pump stations would be anticipated to result in altered ground water flow and transport processes resulting in temporary to permanent and moderate impacts. Ground water flow and exchange would be anticipated to be partially restricted with the floodwalls. In addition, the pump stations would have the potential to temporarily lower/alter ground water levels in their immediate vicinity.

The relative effects of the surge barriers on hydrology, sediment transport, tidal processes, and water quality is uncertain, therefore, modeling will be conducted during the feasibility phase to better understand the magnitude and extent of potential impacts.

In summary, the adverse impacts from the construction, operation and maintenance of the structural features on bathymetry, hydrology, and tidal processes would range from temporary to permanent impacts that are minor to moderate and modeling will be conducted to better understand the extent and magnitude of potential impacts to hydrology, sediment transport, tidal processes, and water quality.

Construction of the mangroves at the NNBf Cutler Bay Site would cause minor, permanent alternations in bathymetry and hydrology due to their alteration of bottom conditions. This return to a more natural condition would result in a beneficial, minor impact to bathymetry and hydrology.

Alternative 7 - Critical Infrastructure, Nonstructural, and Structural

Impacts would be as those described in Alternative 4 and Alternative 5.

Alternative 8 - Critical Infrastructure, Nonstructural, and Structural (Without Edgewater Floodwall)

Impacts would be similar to those described for Alternative 4 and 5. However, overall impacts would be less without the Edgewater Floodwall. However, the overall impact findings would be the same as those for Alternative 4 and 5.

Best Management Practices

For of any of the action alternatives, avoidance and minimization practices would be employed to the maximum extent practicable for all potential impacts. Specific examples of best management practices to avoid and minimize impacts to local benthic fauna and habitat include:

1. Use of coffer dams, silt curtains and other sediment control methods to reduce sedimentation due to construction activities.

2. Avoid placing staging areas or structural measures in the water.

Cumulative Impacts

There are a multitude of past, present and reasonably foreseeable future projects within the ROI. Regardless, if the above referenced alternatives are implemented, 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 would continue to be studied and implemented. Climatic change effects such as sea level rise, decreasing pH of oceanic waters, 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 and water temperatures in the ROI. Rising waters and alterations of basic water chemistry due to climate change would alter the local bathymetry by deepening waters in Biscayne Bay, changes in salinity and freshwater input could alter local hydrodynamics, though this impact is likely to be minor.

Implementation of any of the action alternatives is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects.

8.5 WATER QUALITY

Alternative 1 - No Action/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.

Miami-Dade County would continue coastal and climate resiliency efforts, including the Sea Level Rise Strategy Project, which aims to identify and develop feasible mitigation and adaption strategies for sea level rise and coastal storms; implementation of project proposed in the Rapid Action Plan and Adaptation Action Areas; and continued implementation of the EEL Program (WEC - Miami-Dade County, n.d.). The SFWMD would also continue research and implementation of various projects and initiatives in response to climate change and sea level rise.

Planned stormwater improvements in the City of Miami would also help address flooding issues and serve to improve surface water quality. Examples would include updating the stormwater management plans and long term strategies would include installation of tidal backflow valves, improvements to stormwater facilities, and increased public involvement.

Efforts would continue to improve and contain sewage, focusing on removing homes from onsite sewage treatment and disposal systems, which are being compromised at this time or in the future by rising waters, and connecting these homes to central sewage treatment facilities.

The USACE would continue implementation of major ongoing projects within the Miami-Dade County. These projects include, the Miami Harbor Deepening and Navigation Improvements Project, sponsored by the Port of Miami and Miami-Dade County; the Biscayne Bay Coastal Wetlands Project (Phase II Implementation), a component of the CERP, conducted in partnership with the SFWMD; and the Miami-Dade County Coastal Storm Risk Management Feasibility Study, (Beach Renourishment), sponsored by Miami-Dade County. These

improvements and studies would continue into the future regardless of whether the Miami-Dade Back Bay Coastal Storm Risk Management Feasibility Study is implemented, and a number of them, if implemented, could maintain or perhaps improve water quality in Biscayne Bay.

Existing upstream water management operations would continue.

If the human population in the Biscayne Bay Watershed continues to increase, there would be increasing pressure on the Bay due to additional stormwater runoff and increased nutrients from land-based activities unless these would be well-controlled and improvements to water and waste management would occur. Increased pulsing of freshwater flows into Biscayne Bay, if they occur due to increased population pressure and development, especially from urban and agricultural runoff, would further degrade water quality in the Bay. Among other impacts would be increased Harmful Algal Blooms (HABs), both phytoplankton and macroalgal, degraded water clarity, and increased nutrients (eutrophication).

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 affect the nature and character of the estuarine and coastal ecosystem and local waters in the ROI. None of these impacts would be positive to water quality in ROI waters of Biscayne Bay. Water would continue to rise in the Biscayne Bay region, which would negatively impact Miami-Dade County by increased flooding, including both nuisance and during/after major storm events as well as altering the basic water chemistry of Biscayne Bay. Waters are likely to become warmer, and possibly more saline in the Bay due to a larger oceanic input. At the same time, precipitation may increase, which unless runoff is controlled, will likely cause HABs to become more frequent or require greater management actions to control and treat surface water prior to entering the Bay than efforts already planned. Local water circulation patterns may change as salinity and temperature change, though Biscayne Bay, due to its shallowness and extent of tidal exchange, is very unlikely to become stratified or experience significant changes in hydrodynamics due to climate change. If waters did become stratified, this would negatively impact local water quality and the entire Biscayne Bay ecosystem. One significant change would be that the tide will rise higher and higher as sea level rise continues and accelerates over time into the future. Higher tides may impact water quality due to increased flooding on land, which would result in transport of land-based pollutants and nutrients into the Bay from areas currently supratidal.

The No Action/Future without Project Alternative is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects, including changes to utility considerations within Miami-Dade County. It is anticipated that local water quality would be negatively impacted by climate change and possibly increasing human population in the Biscayne Bay Watershed. With the implementation of the No Action/Future without Project Alternative, impacts would be permanent, adverse (climate change and associated sea level rise), and minor to moderate on local water quality.

Alternative 2 – Critical Infrastructure

Construction and maintenance activities would be localized to the critical infrastructure and surrounding areas and would result in no anticipated adverse impacts to water quality; stormwater and erosion control BMPs would be implemented during construction and

maintenance activities to mitigate any potential impacts to surface water quality. Areas temporarily disturbed by construction and or maintenance activities would be restored to their original, pre-project state.

Plantings of native vegetation including mangroves at the Cutler Bay NNBF Site would serve to reduce erosion, trap sediments and filter stormwater runoff serving to improve water quality to the Biscayne Bay. The Cutler Bay NNBF Site would provide beneficial, permanent and minor impacts to water quality.

Alternative 4 - Critical Infrastructure and Nonstructural

Construction and maintenance activities would be localized to the critical infrastructure and structures and surrounding areas and would result in no anticipated adverse impacts to water quality; stormwater and erosion control BMPs would be implemented during construction and maintenance activities to mitigate any potential impacts to surface water quality. Areas temporarily disturbed by construction and or maintenance activities would be restored to their original, pre-project state.

Plantings of native vegetation including mangroves at the Cutler Bay NNBF Site would serve to reduce erosion, trap sediments and filter stormwater runoff serving to improve water quality to the Biscayne Bay. The Cutler Bay NNBF Site would provide beneficial, permanent and minor impacts to water quality.

Alternative 5 - Critical Infrastructure and Structural

Stormwater and erosion control BMPs would be implemented during construction and maintenance activities to mitigate potential impacts to surface water quality. Areas temporarily disturbed by construction and or maintenance activities would be restored to their original, pre-project state.

The construction of the surge barriers and floodwalls would result in temporary increases in turbidity and altered sediment deposition processes in the Biscayne Bay, Biscayne Canal, Little River, and Miami River resulting in adverse, temporary, and minor to moderate impacts to water quality. Other temporary, adverse impacts that may result would be caused by alterations in freshwater input due to closures of the storm surge barriers during major storm events and discharges of stormwater mixed with canal or river water from the pump stations of the surge barriers and floodwalls. Although pump stations would be used to release trapped stormwater upstream of the closed surge barriers and floodwalls, there would still be anticipated alterations in salinities and tidal processes from the operation of the surge barriers during storm events and potentially during testing operations of the surge barriers. The subsequent surge barrier openings post-storm and during post-testing conditions could potentially result in a pulse of lower than normal salinity water to Biscayne Bay, the Biscayne Canal, the Little River, and the Miami River. However, this impact would be temporary, and minor to moderate, as it would be expected that these waters would equilibrate rapidly with waters in the Biscayne Bay.

The operation and testing of the surge barriers and pump stations would directly alter local water quality by potentially altering local salinity, Total Suspended Solids and turbidity, Dissolved Oxygen and dissolved nutrients nitrogen (N) and phosphorus (P) which would degrade water quality. Although relatively uncertain the closure and openings of the surge

barriers may also have the potential to alter the water temperature adjacent to and upstream of the surge barriers. Following storm events, a pulse of water with altered salinity, total suspended solids (TSS) and turbidity, sediment levels, nutrients, and potentially other pollutants such as debris, dead fish and other organisms, would be potentially released into Biscayne Bay, the Biscayne Canal, Little River, and the Miami River. This plume has the potential to alter water quality as it ultimately flows into offshore Biscayne Bay waters. Impacts would be temporary and range from minor to moderate depending on the time the surge barriers remained in the closed position and also the severity of the storm and environmental conditions such as temperature, rainfall, and wind that would occur during a storm.

The relative effects of the surge barriers on water quality and sedimentation is uncertain, therefore, modeling will be conducted during the feasibility phase to better understand the magnitude and extent of potential impacts.

Plantings of native vegetation including mangroves at the Cutler Bay NNBF Site would serve to reduce erosion, trap sediments and filter stormwater runoff serving to improve water quality to the Biscayne Bay. The Cutler Bay NNBF would provide beneficial, permanent and minor impacts to water quality.

Alternative 7 - Critical Infrastructure, Nonstructural, and, Structural

Impacts would be as those described in Alternative 4 and Alternative 5.

Alternative 8 - Critical Infrastructure, Nonstructural, and Structural (Without Edgewater Floodwall)

Impacts would be similar to those described for Alternative 4 and 5. However, overall impacts would be less without the Edgewater Floodwall. However, the overall impact findings would be the same as those for Alternative 4 and 5.

Best Management Practices

For any of the action alternatives, avoidance and minimization practices would be employed to the maximum extent practicable for all potential impacts. Specific examples of best management practices to avoid and minimize impacts to local water quality include:

1. Avoid placing staging areas or structural measures in the water.
2. If stone is placed in or near the water, ensure it is clean stone free from dirt and debris.
3. Only close tide gates when necessary, otherwise they should be operated in the open position to allow waters to flow and circulate.
4. In the event of a closure, surge barriers should be opened as soon as possible to allow water in the canals to flow into Biscayne Bay.
5. Stormwater management BMPs would be used to prevent and mitigate erosion and sedimentation impacts that have the potential to cause short-term and long-term impacts to soils as well as water quality. Prior to construction, a Stormwater Pollution Prevention Plan approved by the Florida Department of Environmental Protection (FDEP) that includes erosion control practices, inspection procedures, and other BMPs would be required. An erosion and sediment control plan approved by the FDEP as authorized under the Erosion and Sediment Control Regulations shall be developed that minimizes

soil exposure and compaction during construction and controls stormwater discharges to minimize soil erosion.

During construction, the contractor would be required to follow specific measures to minimize soil exposure, soil compaction and reduce potential impacts to stormwater; these measures consist of the following:

- Install and monitor erosion-prevention BMPs, such as silt fences, turbidity curtains, coffer dams, sediment berms, and/or other equivalent sediment control measures as appropriate and in accordance with the approved Storm Water Pollution Prevention Plan;
- Apply permanent or temporary soil stabilization to denuded areas within seven days after final grade is reached on any portion of the site;
- Apply nutrients to landscaping areas in accordance with manufacturer's recommendations and do not apply nutrient during rainfall events;
- Inspect stormwater water BMPs and potential risks to stormwater (e.g. material stockpiles, silt fences, etc.) (i) at least once every four business days or (ii) at least once every five business days and no later than 48 hours following a measurable storm event. In the event that a measurable storm event occurs when there are more than 48 hours between business days, the inspection shall be conducted on the next business day; and
- Stabilize disturbed areas immediately whenever any clearing, grading, excavating, or other land-disturbing activities have permanently ceased on any portion of the site, or temporarily ceased on any portion of the site and would not resume for a period exceeding 14 days.

Cumulative Impacts

There are a multitude of past, present and reasonably foreseeable future projects within the ROI. Regardless, if the above referenced alternatives would be implemented, 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 would continue to be studied and implemented. Climatic change effects such as sea level rise, decreasing pH of oceanic waters, and increasing global temperatures would be 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, would have the potential to cause changes in the nature and character of the estuarine ecosystem, sea levels and surface land and water temperatures in the ROI. Rising waters, increasing water temperature and alterations of basic water chemistry due to climate change would negatively alter the local water quality.

Implementation of any of the action alternatives would not be predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects.

8.6 FLOODPLAINS

Alternative 1 - No Action/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.

Miami-Dade County would continue coastal and climate resiliency efforts, including the Sea Level Rise Strategy Project, which aims to identify and develop feasible mitigation and adaption strategies for sea level rise and coastal storms; implementation of project proposed in the Rapid Action Plan and Adaptation Action Areas; and continued implementation of the EEL Program (WEC - Miami-Dade County, n.d.). The SFWMD would also continue research and implementation of various projects and initiatives in response to climate change and sea level rise.

Planned stormwater improvements in the City of Miami would also help address flooding issues. Examples would include updating the stormwater management plans and long term strategies would include installation of tidal backflow valves, improvements to stormwater facilities, and increased public involvement.

The USACE would continue implementation of major ongoing projects within the Miami-Dade County. These projects include, the Miami Harbor Deeping and Navigation Improvements Project, sponsored by the Port of Miami and Miami-Dade County; the Biscayne Bay Coastal Wetlands Project (Phase II Implementation), a component of the CERP, conducted in partnership with the SFWMD; and the Miami-Dade County Coastal Storm Risk Management Feasibility Study, (Beach Renourishment), sponsored by Miami-Dade County. These improvements and studies would continue into the future regardless of whether the Miami-Dade Back Bay Coastal Storm Risk Management Feasibility Study is implemented, and a number of them, if implemented, could maintain or perhaps improve water quality in Biscayne Bay.

Existing upstream water management operations would continue.

Flooding is a temporary condition, where the impacts to the community are generally adverse, from negligible to major, depending on the level of 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 would need to continue flood mitigation activities in order to protect people and property. Although many of the communities participate in FEMA's Community Rating System, with the number of structures located in the floodplain 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.

The development and urbanization of the Miami-Dade County has had an adverse, permanent impact to the historic, natural floodplain as construction of impervious areas along with loss of wetlands, mangroves, and SAV has caused a loss of water storage capacity as well as natural surge suppression in the natural floodplain. The development of the Miami-Dade County has had an adverse, permanent, major impact to the natural floodplain.

Alternative 2 - Critical Infrastructure

Use of nonstructural measures, such as dry or wet floodproofing for critical infrastructure, usually apply to a single structure. Use of nonstructural measures for critical infrastructure would provide the following beneficial impacts to Miami-Dade County:

- a. Protecting critical infrastructure would help the community be more resilient and sustainable after a flood event occurs, a structure could possibly stay flood-free during its design life, which would be a permanent and major impact, unless the measure fails, the design level is exceeded, and/or or flooding occurs because of improper maintenance and operation.
- b. Usually the intent is not only flood protection, but also reducing the cost for flood insurance, which would be a permanent and major impact. For non-residential commercial structures only, dry floodproofing is recognized by FEMA, where a floodproofed building has been designed and constructed to be watertight. To receive an insurance rating based on the 1-percent-annual-chance flood, the building must be floodproofed to an elevation of one foot above the 1-percent-annual-chance flood. Insurance premiums may be lower if floodproofing exceeds this requirement if possible.

When wet floodproofing a building, if a second floor is present where the principal use of the building can be on the elevated floor, flood insurance premiums may be reduced if the first floor meets certain requirements as an enclosed area, including limitations on use (parking of vehicles, building access, or storage), use of flood damage-resistant materials, and installation of flood openings that allow automatic entry and exit of floodwater (i.e., free inflow and outflow in both directions) to equalize the hydrostatic flood loads.

- c. The mitigation actions could apply to FEMA's Community Rating System, as Miami-Dade County actively participates, thus reducing flood insurance premiums for its citizens, a permanent and major impact.

Implementation of the Cutler Bay NNBF Site would provide a beneficial, minor impact to the floodplain serving to slow down and allow for more natural infiltration of stormwater and increase overall water storage capacity of the floodplain, which may also apply to FEMA's Community Rating System.

The following are possible adverse impacts using nonstructural measures:

- a. If the mitigation measures fail, the flood level exceeds the design, and/or flooding occurs because of improper maintenance and operation, it could be difficult for a community or business to get back to normal after a flood event, especially if there are back-to-back flood events. Depending on the situation, the impacts would be temporary or permanent and range from minor to major, such as injury or death to a person and damage to contents within the building or the building itself. Community officials would need to evacuate a facility in advance in case flooding is forecasted.
- b. Before a flood event, identified items may need to be temporarily elevated or relocated to avoid possible flood damage. The number of items, weight, size, and advance time needed to move, could make the impacts range from a minor to major effort.
- c. Depending on the type of facility, what's contained or stored, and its location, if a building is flooded, there could possibly be some harm to the environment. Although temporary, the level and duration of flooding could cause the environmental impacts to range from minor to major.

- d. A public building that is mitigated using Federal funds would be required to have flood insurance for the possibility of future flood losses, which could be a temporary economic impact to the community and range from minor to major depending on the financial well-being of the community and the number of public buildings to be mitigated.
- e. If the cost to floodproof a building triggers a Substantial Improvement with respect to FEMA regulations, and the building is not in compliance with FEMA and local floodplain regulations, then the structure would need to be brought into compliance as technically feasible. In general, if the NED Plan is not in compliance, then the NFS would be required to pay the additional cost required to bring the building into compliance if technically feasible, which could be a temporary economic impact to the community and range from minor to major depending on the financial well-being of the community and the number of public buildings to be mitigated.
- f. Any potential impacts to the floodplain resulting from construction and maintenance would be temporary to permanent and minor.

As discussed in Chapter 2 under Section 2.5 Floodplains, Miami-Dade County would be required to prepare a Floodplain Management Plan that would address potential measures, practices and policies which would reduce the impacts of future residual flooding, help preserve levels of protection provided by the USACE project, and preserve and enhance natural flood plain values for post-project conditions.

Alternative 4 - Critical Infrastructure and Nonstructural

Impacts to Critical Infrastructure would be as those described for Alternative 2.

Use of nonstructural measures, such as elevation, acquisition, and dry or wet floodproofing, usually apply to a single structure. Nonstructural measures for residential and non-residential structures would provide the following beneficial impacts:

- a. Nonstructural measures would help keep neighborhoods and communities sustainable and resilient after a flood, where a residential or commercial structure could possibly stay flood-free during its design life, which would be a permanent and major impact, unless the measure fails, the design level is exceeded, and/or or flooding occurs because of improper maintenance and operation.
- b. Usually the intent is not only flood protection, but also reducing the cost or eliminating the need for flood insurance, which would be a permanent and major impact. FEMA recognizes elevation in reducing the cost for flood insurance for a structure. In general, for a residential structure that is elevated, the higher the lowest rated floor is above the 1-percent-annual-chance flood elevation, the cheaper the flood insurance would be.

For non-residential commercial structures only, dry floodproofing is recognized by FEMA, where a floodproofed building has been designed and constructed to be watertight. To receive an insurance rating based on the 1-percent-annual-chance flood, the building must be floodproofed to an elevation of one foot above the 1-percent-annual-chance flood. Insurance premiums may be lower if floodproofing exceeds this requirement if possible.

When wet floodproofing a non-residential building, if a second floor is present where the principal use of the building can be on the elevated floor, flood insurance premiums may be reduced if the first floor meets certain requirements as an enclosed area, including limitations on use (parking of vehicles, building access, or storage), use of flood damage-resistant materials, and installation of flood openings that allow automatic entry and exit of floodwater (i.e., free inflow and outflow in both directions) to equalize the hydrostatic flood loads.

For acquisition projects, FEMA recognizes the measure for eliminating the need for flood insurance for a structure. Usually targeted for repetitive loss structures, by purchasing property and demolishing a structure, the need for flood insurance is permanently eliminated and is a major impact for the property owner and the community. The community agrees to never develop the property, except for acceptable uses within a floodplain.

- c. An advantage of nonstructural measures when compared to structural measures is the ability of nonstructural measures to be sustainable over the long term with minimal costs for operation, maintenance, repair, rehabilitation, and replacement, which would be a permanent and major impact.
- d. Nonstructural projects are small in scale, such that any adverse floodplain impacts would be considered temporary to permanent and minor.
- e. The mitigation actions could apply to FEMA's Community Rating System, as Miami-Dade County actively participates, thus reducing flood insurance premiums for its citizens, a permanent and major impact.

Sites restored to natural environmental conditions following residential building acquisition and demolition and implementation of the Cutler Bay NNBF Site would provide a beneficial, minor impact to the floodplain serving to slow down and allow for natural infiltration of stormwater and increase overall water storage capacity of the floodplain, which may also apply to FEMA's Community Rating System.

The following are possible adverse impacts using nonstructural measures:

- a. If a flood mitigation measure fails, the flood level exceeds the design, and/or flooding occurs because of improper maintenance and operation, it could be difficult for a community or business to get back to normal after a flood event, especially if there are back-to-back flood events. Depending on the situation, the impacts could be temporary to permanent and range from minor to major, such as the amount and type of damage, loss of home or business, loss of employment, bankruptcy, health issues, deaths, etc. Community officials would need to educate and inform citizens to evacuate a structure in advance in case flooding is forecasted.
- b. Before a flood event, identified items may need to be temporarily elevated or relocated to avoid possible flood damage. The number of items, weight, size, and advance time needed to move, could make the impacts range from a minor to major effort.

- c. Depending on the type of facility, what's contained or stored, and its location, if a building is flooded, there could possibly be some harm to the environment. Although temporary, the level and duration of flooding could cause the environmental impacts to range from minor to major.
- d. Some property owners currently may not have flood insurance. A building that is mitigated using Federal funds would be required to have flood insurance for the possibility of future flood losses, which could be a temporary economic impact to the property owner and range from minor to major depending on the financial well-being of the property owner.
- e. If the cost to mitigate a structure triggers a Substantial Improvement with respect to FEMA regulations, and the structure is not in compliance with FEMA and local floodplain regulations, then the structure would need to be brought into compliance as technically feasible. In general, if the NED Plan is not in compliance, then the NFS would be required to pay the additional cost required to bring the building into compliance if technically feasible, which could be a temporary economic impact to the community and range from minor to major depending on the financial well-being of the community and the number of buildings to be mitigated.
- f. A large number of acquisitions could possibly affect a community's tax base to some degree, and if not properly implemented within a neighborhood, an unordered appearance of open space lots may be an eyesore to the adjacent neighbors and prospective buyers, such that property values may decrease, the neighborhood gets a bad reputation, homeowners file a lawsuit, etc. The impacts would be temporary and range from minor to moderate depending on the number involved, location, financial well-being of the community, etc.
- g. Some property owners may not agree with the use of eminent domain for an acquisition project, which would be a temporary impact, ranging from minor to major for a property owner. Relocation assistance, however, would be a beneficial, permanent, and major action for the property owner.
- h. Any potential impacts to the floodplain resulting from construction and maintenance would be temporary to permanent and minor.

Designated historical structures can use any type of nonstructural 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 Miami-Dade County's floodplain regulations.

As discussed in Chapter 2 under Section 2.5 Floodplains, Miami-Dade County would be required to prepare a Floodplain Management Plan that would address potential measures, practices and policies which would reduce the impacts of future residual flooding, help preserve levels of protection provided by the USACE project, and preserve and enhance natural flood plain values for post-project conditions.

Alternative 5 - Critical Infrastructure and Structural

Impacts to Critical Infrastructure would be as those described for Alternative 2.

Structural flood risk management projects, such as the storm surge barriers, are typically large scale projects. The high costs for these types of projects usually reflect the size and complexity of the flood protection system, including the storm surge barrier, tide gates, road closures, number of pumps needed for interior drainage, real estate needs for berms, floodwalls, closures, easements, and right-of-ways, engineering and design, etc. Structural measures can provide the following beneficial, permanent, and major impacts if the flood protection system is properly maintained and operated and never fails or overtopped:

- a. Structural measures would help keep neighborhoods and communities sustainable and resilient after a flood.
- b. Structural projects can protect a large number of structures.
- c. The flood protection system can last and function as designed during its project life.
- d. After a community experiences several flood events, the damages prevented can easily justify the costs for such a project.
- e. If the flood protection system is certified and accredited by FEMA for the 1-percent-annual-chance flood, then the Federal requirement for flood insurance is removed on the protected side, although lenders can still require flood insurance. Note, if the NED Plan provides less protection than the FEMA 1-percent-annual-chance flood and Miami-Dade County prefers a flood protection system that meets FEMA accreditation, then Miami-Dade County would need to pay the additional costs.
- f. The mitigation actions could apply to FEMA's Community Rating System, as Miami-Dade County actively participates, thus reducing flood insurance premiums for its citizens.

With structural measures, adverse flooding impacts to those on the protected side are possible when the system is not properly maintained and operated, fails, and/or overtopped. Depending on the type, amount, and duration of flooding, the human, economic, and environmental impacts could be temporary or permanent and range from minor to major, including the following:

- a. Health issues, deaths, loss of home or business, loss of employment, bankruptcy, loss of critical infrastructure, loss of cultural resources, loss of habitat, surface water, ground water, and soil pollution, etc.
- b. Damage from minor and gradual type flooding would be less severe than major and sudden flooding. Standing water over a long duration would only aggravate the flood situation, especially if back-to-back events occur. Recovery could take months or years for individuals, businesses, and the community, especially if those on the protected side do not have flood insurance. If the flood protection system is certified and accredited by FEMA for the 1-percent-annual-chance flood, then the Federal requirement for flood insurance is removed, although lenders can still require flood insurance.

- c. Damage and needed repairs to components of the flood protection system resulting from flooding would be an additional expense for Miami-Dade County.

Some property owners that may not want sell their property needed to build the flood protection system or upset that their views are obstructed by a floodwall, which could be adverse, temporary, and the impacts could range from minor to major. In addition, temporary road closures during annual project inspections could be adverse, disrupting travel plans for citizens or emergency personnel, where impacts could range from minor to major.

As discussed in Chapter 2 under Section 2.5 Floodplains, Miami-Dade County would be required to prepare a Floodplain Management Plan that would address potential measures, practices and policies which would reduce the impacts of future residual flooding, help preserve levels of protection provided by the USACE project, and preserve and enhance natural flood plain values for post-project conditions.

Any potential impact to the floodplain would be adverse, temporary to permanent and minor.

Alternative 7 - Critical Infrastructure, Nonstructural, and Structural

Impacts would be as those described in Alternative 4 and Alternative 5.

Alternative 8 - Critical Infrastructure, Nonstructural, and Structural (Without Edgewater Floodwall)

Impacts would be as those described in Alternative 4 and Alternative 5.

Best Management Practices to Avoid and Minimize Impacts on Floodplains:

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

1. Community officials would 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 may forget about past flood events or are not aware of the possible flooding.
2. Community officials would have a continuous outreach and education plan in place for local staff to understand the flood types, flood mitigation activities, operations and maintenance, design limitations, impacts, and their role in protecting citizens. Local staff may forget about past flood events or are not aware of the possible flooding.
3. Considering how vulnerable Miami-Dade County is to flooding, community officials would encourage citizens to have flood insurance, even if it is not required. Federal flood insurance is based on the 1-percent-annual-chance flood, but floods greater have and would occur in the future.
4. Please refer to the Water Quality Environmental Consequences Section for a detailed description of stormwater and erosion and sediment control BMPs.

Cumulative Impacts

There are a multitude of past, present, and reasonably foreseeable future projects within the ROI. The development and urbanization of Miami-Dade County has had an adverse, permanent impact to the historic, natural floodplain as construction of impervious areas along with loss of

wetlands, mangroves, and SAV has caused a loss of water storage capacity as well as natural surge suppression in the natural floodplain. Past and ongoing restoration efforts in Miami-Dade County would serve to provide beneficial, minor to moderate benefits to the floodplain. Regardless, if the above referenced alternatives are implemented, 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. 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, storm frequency, storm surge flooding, rainfall, 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. Most of these impacts will directly affect local flooding and people, property, and the environment. Implementation of any of the action alternatives would not be predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects.

8.7 WETLANDS AND MANGROVES

Potential impacts to submerged aquatic vegetation (SAV) is discussed in the Benthic Environmental Consequences Section, Section 8.11, and in Special Status Species Environmental Consequences Section 8.12. The potential impacts to uplands (terrestrial habitat) are discussed in the Wildlife and Terrestrial Habitat, Section 8.8.

Within the ROI, isolated mangroves occur along the existing floodwalls. At other areas along proposed surge barrier locations, there were observations of mowed and maintained vegetation along the rip-rapped shorelines at the Miami River. At the Little River and Biscayne Canal there were observed isolated vegetative species that had been planted and/or also grew opportunistically in an urban, maintained environment. Additional surveys during the PED Phase would be conducted to determine the extent and classification of the vegetation in these areas.

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. Aerial maps and National Wetland Inventory (NWI) maps were checked to determine an estimate of potential wetland areas within the study area. As 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.

Coordinated efforts would occur during the JD confirmation as well as application process with all other applicable regulatory agencies. An application for an Environmental Resource Permit would be submitted to FDEP during the PED Phase which is required for all projects that would involve the dredging and filling in wetlands or surface waters, construction of flood protection facilities, site grading, or other activities that have the potential to affect the State of Florida's waters. Impacts to wetlands and mangroves would be avoided and minimized to the extent practical during the development of the final designs during the PED Phase. Based on current aerial imagery and results of a site investigation conducted in January of 2020 it is estimated that mangrove impacts would be less than approximately 2,000 square feet. Any impacts to

jurisdictional wetlands or mangroves would be required to be evaluated with the Uniform Mitigation Assessment Method (UMAM). The UMAM would be used to determine the functional wetland loss and required mitigation ratio. The UMAM is required to determine compensatory mitigation ratios per the 62-345 Florida Administrative Code and is also an approved model for regional use in Florida by the USACE ECOPCX. Appendix D contains the Environmental Mitigation Plan for the project and would be updated during the PED Phase following the JD and detailed environmental surveys to determine mitigation needs and requirements. Appendix D also has more information about the UMAM.

Alternative 1 - No Action/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.

Miami-Dade County would continue coastal and climate resiliency efforts, including the Sea Level Rise Strategy Project, which aims to identify and develop feasible mitigation and adaption strategies for sea level rise and coastal storms; implementation of project proposed in the Rapid Action Plan and Adaptation Action Areas; and continued implementation of the EEL Program (WEC - Miami-Dade County, n.d.). The SFWMD would also continue research and implementation of various projects and initiatives in response to climate change and sea level rise. Miami-Dade County within the ROI also has many ongoing private and government funded construction projects.

Planned stormwater improvements in the City of Miami would also help address flooding issues. Examples would include updating the stormwater management plans and long term strategies would include installation of tidal backflow valves, improvements to stormwater facilities, and increased public involvement.

The USACE would continue implementation of ongoing projects within the Miami-Dade County. These projects would include, the Miami Harbor Deeping and Navigation Improvements Project, sponsored by the Port of Miami and Miami-Dade County; the Biscayne Bay Coastal Wetlands Project (Phase II Implementation), a component of the CERP, conducted in partnership with the SFWMD; and the Miami-Dade County Coastal Storm Risk Management Feasibility Study, (Beach Nourishment), sponsored by Miami-Dade County. These improvements and studies would continue into the future regardless of whether the Miami-Dade Back Bay Coastal Storm Risk Management Feasibility Study is implemented.

Existing upstream water management operations would continue.

If the human population in the Biscayne Bay watershed continues to increase, there would be increasing pressure on the Bay due to stormwater runoff and increased nutrients from land-based activities unless these are well-controlled and improvements to water and waste management occur. This could have a minor impact on local hydrology, if a large enough volume of additional freshwater is released into Biscayne Bay.

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 affect the nature and character of the estuarine and coastal ecosystem and local waters in the ROI. Water would continue to rise in the Biscayne Bay, which would negatively impact Miami-

Dade County by increased flooding, including both nuisance and during/after major storm events as well as altering the basic water chemistry of Biscayne Bay. Waters are likely to become warmer, and possibly more saline in the Bay due to a larger oceanic input. At the same time, precipitation may increase, which unless runoff is controlled, would likely cause harmful algal blooms to become more frequent. Local water circulation patterns may change as salinity and temperature change, though Biscayne Bay, due to its shallowness and extent of tidal exchange, is very unlikely to become stratified or experience significant changes in hydrodynamics due to climate change. One significant change will be that the tide would be anticipated to rise higher as sea level rise continues and accelerates over time into the future. Over time water depths would be anticipated to increase and would have the potential to affect the distribution and extent of mangroves and wetlands in the ROI.

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 wetland impacts would occur with this alternative.

Alternative 2 - Critical Infrastructure

Construction, maintenance, and staging activities would result in temporary soil disturbance and potentially wetland and mangrove impacts that would be adverse, temporary, and minor. Although not anticipated, any potential permanent impacts to wetlands and mangroves would be mainly located in the areas surrounding the existing footprints of the critical infrastructure and would be adverse and minor. Implementation of the Cutler Bay NNBF would have beneficial, permanent and minor impacts to wetlands and mangroves as it would serve to increase native vegetation at the NNBF Site. Stormwater and erosion control BMPs would be implemented during construction and maintenance activities to mitigate potential impacts to wetlands and mangroves. Areas temporarily disturbed by construction and or maintenance activities would be restored to their original, pre-project state. Therefore, impacts to wetlands from implementation of Alternative 2 would be adverse to beneficial, temporary to permanent and minor.

As noted above, a JD will be conducted during the PED Phase which would confirm the extent of any jurisdictional wetlands or mangroves in the ROI. Permits would be applied for and coordinated with FDEP for any potential impacts to wetlands. Any unavoidable potential temporary impacts would be conditioned in the permit to require restoration upon completion of construction activities. Although not anticipated, any permanent impacts to jurisdictional wetlands and/or mangroves functional impacts would be assessed with the UMAM and onsite compensatory mitigation would be conducted to offset any potential impacts.

Alternative 4 - Critical Infrastructure and Nonstructural

Construction, maintenance, and staging activities would result in temporary soil disturbance and potentially wetland and mangrove impacts that would be adverse, temporary, and minor. Although not anticipated, any potential permanent impacts to wetlands and mangroves would be mainly located in the areas surrounding the existing footprints of the critical infrastructure and structures being elevated and would be adverse and minor. Implementation of the Cutler Bay NNBF would serve to provide beneficial, minor and permanent impacts to wetlands and mangroves. Implementation of the Cutler Bay NNBF would have beneficial, permanent and minor impacts to wetlands and mangroves as it would serve to increase native vegetation at the

NNBF Site. Stormwater and erosion control BMPs would be implemented during construction and maintenance activities to mitigate potential impacts to wetlands and mangroves. Areas temporarily disturbed by construction and or maintenance activities would be restored to their original, pre-project state. Therefore, impacts to wetlands from implementation of Alternative 4 would be adverse to beneficial, temporary to permanent and minor.

As noted above, a JD will be conducted during the PED Phase which would confirm the extent of any jurisdictional wetlands or mangroves in the ROI. Permits would be applied for and coordinated with the FDEP for any potential impacts to wetlands. Any unavoidable potential temporary impacts would be conditioned in the permit to require restoration upon completion of construction activities. Although not anticipated, any permanent impacts to jurisdictional wetlands and/or mangroves functional impacts would be assessed with the UMAM and onsite compensatory mitigation would be conducted to offset any impacts.

Alternative 5 - Critical Infrastructure and Structural

Impacts to critical infrastructure outside of areas protected by surge barriers and floodwalls would be as those described for Alternative 2.

Construction, maintenance, and staging activities would result in temporary soil disturbance and potentially wetland and mangrove impacts that would be adverse, temporary, and minor. Potential permanent impacts to wetlands and mangroves would be mainly located in the areas surrounding the existing footprints of the critical infrastructure, structures being elevated, and in the permanent siting locations of the surge barriers, pump stations, and floodwalls and would be adverse and moderate. Implementation of the Cutler Bay NNBF would have beneficial, permanent and minor impacts to wetlands and mangroves as it would serve to increase native vegetation at the NNBF Site. Stormwater and erosion control BMPs would be implemented during construction and maintenance activities to mitigate potential impacts to wetlands and mangroves. Areas temporarily disturbed by construction and or maintenance activities would be restored to their original, pre-project state. Permanent functional impacts to jurisdictional wetlands and/or mangroves would be assessed with the UMAM and onsite compensatory mitigation would be conducted to offset any potential impacts.

Therefore, impacts to wetlands from implementation of Alternative 5 would be adverse to beneficial, temporary to permanent and moderate.

As noted above, a JD will be conducted during the PED Phase which would confirm the extent of any jurisdictional wetlands or mangroves in the ROI. Permits would be applied for and coordinated with FDEP for any potential impacts to wetlands. Any unavoidable potential temporary impacts would be conditioned in the permit to require restoration or onsite compensatory mitigation upon completion of construction activities.

Alternative 7 - Critical Infrastructure, Nonstructural, and Structural

Impacts would be as those described in Alternative 4 and Alternative 5.

Alternative 8 - Critical Infrastructure, Nonstructural, and Structural (Without Edgewater Floodwall)

Impacts would be similar to Alternative 7 although adverse impacts to mangroves and onsite compensatory mitigation would be anticipated to be less without the Edgewater Floodwall impacts. However, overall impact findings would be expected to be as those described in Alternative 4 and Alternative 5.

Best Management Practices to Avoid and Minimize Impacts on Wetlands:

As the design and engineering of the alignments advance, minor alignment shifts could be evaluated to avoid and minimize potential impacts to wetland vegetation. These considerations could be undertaken during the PED phase and coordinated with applicable agency partners during the associated permit application process. For any of these potential final alignments, avoidance and minimization practices will be employed to the maximum extent practicable for all potential impacts. Practicable is defined as, “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 to wetlands and NFC vegetation during temporary construction conditions:

1. During detailed design, temporary and permanent impacts to wetlands and mangroves will be avoided and minimized to the extent practicable. Unavoidable wetland impacts would be mitigated in accordance with the UMAM as described in the Environmental Mitigation Plan that is provided in Environmental Appendix D.
2. For a listing of the detailed stormwater, and erosion and sediment control BMPs, please refer to the Water Quality Environmental Consequences Section.
3. During construction and maintenance, no temporary staging of materials or equipment would be allowed in wetlands or mangroves.

Cumulative Impacts

There are a multitude of past, present and reasonably foreseeable future projects within the ROI. Regardless, if the above referenced action alternatives are implemented, 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 would continue to be studied and implemented.

Miami-Dade County has many ongoing private and government funded construction projects. The building of the Miami Skyrise, construction improvements to existing businesses and residences, improvements to the Port of Miami, and ongoing roadway improvements may involve land disturbance, land clearing, and/or construction access and have the potential for temporary and/or permanent impacts to wetlands and/or mangroves. However, through the regulatory permitting process offsets to these impacts are required in the form of compensatory mitigation for wetland losses.

Climatic changes such as sea level rise and increasing global temperatures are predicted to continue over the next 50 years. Due to the synergistic effects from a combination of factors, and relative sea level rise, and an increase in the frequency and strength of storms, the risk from coastal inundation will rise in the coming years for Miami-Dade County. Climate change has the potential to affect the extent and distribution of wetlands and mangroves in the ROI.

Implementation of any of the action alternatives is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects.

8.8 WILDLIFE AND TERRESTRIAL HABITAT

Alternative 1 - No Action/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.

Miami-Dade County would continue coastal and climate resiliency efforts, including the Sea Level Rise Strategy Project, which aims to identify and develop feasible mitigation and adaption strategies for sea level rise and coastal storms; implementation of project proposed in the Rapid Action Plan and Adaptation Action Areas; and continued implementation of the EEL Program (WEC - Miami-Dade County, n.d.). The SFWMD would also continue research and implementation of various projects and initiatives in response to climate change and sea level rise. Miami-Dade County within the ROI also has many ongoing private and government funded construction projects.

Planned stormwater improvements in the City of Miami would also help address flooding issues. Examples would include updating the stormwater management plans and long term strategies would include installation of tidal backflow valves, improvements to stormwater facilities, and increased public involvement.

The USACE would continue implementation of ongoing projects within the Miami-Dade County. These projects would include, the Miami Harbor Deeping and Navigation Improvements Project, sponsored by the Port of Miami and Miami-Dade County; the Biscayne Bay Coastal Wetlands Project (Phase II Implementation), a component of the CERP, conducted in partnership with the SFWMD; and the Miami-Dade County Coastal Storm Risk Management Feasibility Study, (Beach Nourishment), sponsored by Miami-Dade County. These improvements and studies would continue into the future regardless of whether the Miami-Dade Back Bay Coastal Storm Risk Management Feasibility Study is implemented.

Existing upstream water management operations would continue.

It is expected that the overall available land for terrestrial wildlife would decrease over time due to increased population and potential expansion of development outside the Urban Development Boundary (UDB). Development and various construction projects would result in adverse, permanent, and minor impacts to wildlife. There is also potential for more acres of EEL or parks to be acquired and protected in the future, which would prevent development or redevelopment on important wildlife habitat. This as well as other restoration projects in the ROI would result in beneficial, permanent, and minor impacts. Within the ROI, wildlife and wildlife habitat would continue to be managed by Dade County Parks, the EEL Program, private citizens (through volunteer opportunities), and various partners.

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 affect the nature and character of the estuarine and coastal ecosystem in the ROI. Waters

would continue to rise in the Biscayne Bay region, which would negatively impact Miami-Dade County by increasing flooding, both nuisance and during/after major storm events.

The No Action/Future without Project Alternative is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects. It is anticipated that terrestrial habitat areas would increasingly and recurrently flood, displacing terrestrial wildlife to higher ground; this would be an adverse, temporary, and minor impact to the existing terrestrial wildlife. With the implementation of the No Action/Future without Project Alternative, adverse impacts would range from temporary to permanent and would be minor.

Alternative 2 – Critical Infrastructure

Construction, maintenance, and staging activities would result in minor disturbances and terrestrial habitat impacts that would be adverse, temporary, and minor to wildlife. Potential impacts to terrestrial habitat would be mitigated with BMPs to the extent practical during construction and any unavoidable, temporary terrestrial habitat impacts would be restored upon completion of construction or maintenance. Any potential permanent impacts to terrestrial habitats would be mainly located in the areas surrounding the existing footprints of the critical infrastructure and would be adverse and minor.

Planting of native vegetation at the Cutler Bay NNBF Site would serve to provide beneficial, minor and permanent impacts to wildlife by restoring and enhancing wildlife habitat. Restoration of terrestrial habitats from properties acquired and demolished would result in impacts to terrestrial habitat and wildlife that would be permanent and minor. These properties would be planted with native vegetation and reverted to a park or natural habitat, providing fragmented wildlife habitat where it was previously adversely impacted by development. Therefore, impacts to wildlife from implementation of Alternative 2 would be adverse to beneficial, temporary to permanent and minor.

Alternative 4 - Critical Infrastructure and Nonstructural

Implementation of the additional floodproofing and elevation of structures would result in additional disturbances to wildlife and terrestrial habitat impacts that are slightly higher but at the same threshold level of impact described as Alternative 2 (adverse and temporary to permanent and minor).

Restoration of terrestrial habitats from properties acquired and demolished would result in, impacts to terrestrial habitat and wildlife that would be permanent and minor. These properties would be planted with native vegetation and reverted to a park or natural habitat, providing fragmented wildlife habitat where it was previously adversely impacted by development. Implementation of the Cutler Bay NNBF and lands converted to open space or parks would serve to provide beneficial, minor and permanent impacts to wildlife habitat and wildlife.

Therefore, overall impacts to terrestrial habitat and wildlife would range from adverse to beneficial impacts that are minor.

Alternative 5 - Critical Infrastructure and Structural

The proposed structural measures in terrestrial areas would be located in highly developed, urban areas of Miami-Dade County. These areas have limited space for terrestrial wildlife and

habitat. Miami-Dade County, within the UDB, is highly developed, therefore, most wildlife in the ROI is adapted to disturbed conditions.

Impacts to terrestrial habitat and wildlife from floodproofing critical habitat outside of areas protected by surge barriers and floodwalls would be as those described for Alternative 2. Construction, operation, and maintenance of the floodwalls and surge barriers would result in adverse, temporary disturbances to wildlife that are minor; terrestrial habitat impacts would be mitigated with BMPs to the extent practical during construction and maintenance activities and any unavoidable, temporary soil impacts would be restored upon completion of construction. Staging areas and/or heavy machinery could cause ground disturbance and also reduce available open space/habitat for wildlife; these disturbed grounds would be restored, to the maximum practical extent to a pre-project state upon completion of construction. Construction activities could potentially increase ambient noise to levels greater than baseline. These adverse direct and indirect impacts to wildlife and terrestrial habitat have the potential to be minor and temporary to permanent in duration.

There would be adverse, permanent, and moderate impacts to terrestrial habitat from the permanent construction footprints of the floodwalls and surge barriers as portions of these features would impact terrestrial habitats. Fill and grading done to construct and maintain project features would have an adverse, permanent, and moderate impact to terrestrial habitat.

Implementation of the Cutler Bay NNBF Site would serve to provide beneficial, minor and permanent impacts to wildlife habitat and wildlife. Implementation of Alternative 5 would also include the beneficial effects of protecting terrestrial habitats from storm surge flooding. As a result, temporary and/or permanent displacement of terrestrial wildlife may not occur as frequently. Impacts would be beneficial, temporary, and minor.

Therefore, overall impacts to terrestrial habitat and wildlife would range from adverse to beneficial impacts that are minor.

Alternative 7 - Critical Infrastructure, Nonstructural, and, Structural

Impacts would similar to those described for Alternative 4 and Alternative 5. With Alternative 7 there would be less adverse impacts to wildlife resulting from the nonstructural features as compared to Alternative 4 as there would be a fewer number of nonstructural features. However, the overall level of impact findings would be as those described for Alternative 4 and Alternative 5.

Alternative 8 - Critical Infrastructure, Nonstructural, and Structural (Without Edgewater Floodwall)

Impacts would be similar to Alternative 4 and Alternative 5. With Alternative 8 there would be less impacts to wildlife resulting from the nonstructural features as compared to Alternative 4 as there would be a fewer number of nonstructural features; as compared to Alternative 7, Alternative 8 would have slightly higher level of impact to terrestrial habitat and wildlife. However, overall impact findings would still be expected to be as those described in Alternative 4 and Alternative 5.

Best Management Practices

For any of the action alternatives, avoidance and minimization practices would be employed to the maximum extent practicable for all potential impacts. Specific examples of best management practices to avoid and minimize impacts to terrestrial wildlife and habitat include:

1. Planting native vegetative seed mixes on disturbed land after construction is complete.
2. Avoid placing staging areas or structural measures in established wildlife habitat.
3. For a detailed description of stormwater and erosion and sediment control BMPs, please refer to the Water Quality Environmental Consequences Section.

Cumulative Impacts

There are a multitude of past, present and reasonably foreseeable future projects within the ROI. Regardless, if the above referenced alternatives are implemented, 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 would continue to be studied and implemented. 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. Most of these impacts would not directly affect existing wildlife or wildlife habitat within the ROI, though rising waters would increase flooding, potentially changing the character of the already fragmented habitats.

Implementation of any of the action alternatives is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects.

8.9 PLANKTON

Alternative 1 - No Action/Future without Project

The No Action/Future without Project Alternative would involve no action from the USACE to mitigate against coastal storm risk. Due to the synergistic effects of a combination of factors, including land subsidence, Sea Level Rise (SLR), and an increase in the frequency and strength of storms, the risk from coastal inundation will rise in the coming years for Miami-Dade County. Phytoplankton populations will be affected by the numerous climatic changes with a No Action/Future without Project alternative. Existing upstream water management operations would continue.

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 ecosystem of Biscayne Bay. Climate change is anticipated to potentially increase nutrient loading into Biscayne Bay. The higher temperatures, lower dissolved oxygen levels, and increased phytoplankton productivity may result in more frequent hypoxic conditions (low dissolved oxygen conditions) in the water column. Storm surge has been found to induce nutrient runoff into Biscayne Bay and increase phytoplankton populations following a storm event. This was witnessed after Hurricane Katrina

(Zhang et al 2009) and after Hurricane Irma (Wachnicka et al. 2019). However, coastal storm surge may also have minimal long term effects on the populations of plankton in Biscayne Bay. One study found that phytoplankton increased in the weeks following the Hurricane Irma storm but were gradually outcompeted by diatoms in the succeeding months, suggesting that Biscayne Bay is resilient to tropical cyclones (Wachnicka A. et al, 2019). Climatic change has the potential to affect the plankton species composition and abundance of plankton populations within the ROI which in turn can affect higher level food chain composition and dynamics. The exact intensity and threshold to plankton populations resulting from climatic change is relatively uncertain but has the potential to substantially alter plankton populations in the ROI. In general, Biscayne Bay is already experiencing a regime shift from an ecosystem dominated by seagrass to one dominated by phytoplankton. Climate change has the potential to cause adverse, permanent, and moderate impacts to plankton populations in the ROI.

Alternative 2 – Critical Infrastructure

There would be no potential impacts to plankton from Alternative 2. The measures in this alternative are inland and would not impact plankton in Biscayne Bay.

Alternative 4 - Critical Infrastructure and Nonstructural

There would be no potential impacts to plankton from Alternative 4. The measures in this alternative are inland and would not impact plankton in Biscayne Bay.

Alternative 5 - Critical Infrastructure and Structural

There would be no effects to phytoplankton from the nonstructural measures constructed on uplands. There is a potential for minor adverse impacts to phytoplankton for the measures of surge barriers, floodwalls and pump stations at Miami River, Little River, and Biscayne Canal and in the Biscayne Bay. The direct impacts to plankton from the proposed measures such as surge barriers and/or gates, pump stations and/or floodwalls would be minor during a storm event. Phytoplankton populations would be affected by the storm surge itself more than the structural elements of a surge barrier or floodwall. However, discharge plumes from pump stations and releases of surge barriers may result in some nutrient enrichment and altered salinities and water quality that has the potential to cause adverse, temporary, and minor impacts to plankton populations. Many studies have shown phytoplankton increases after a flood event due to nutrient runoff. Phytoplankton populations are more abundant in areas near canal mouths likely due to eutrophication from freshwater runoff. Some canals in South Florida have high natural iron concentrations that affect turbidity and decreased dissolved oxygen (SFWMD 2016) and any of the water discharged from these canals already affect plankton populations. A pump station could affect the salinity and freshwater flows into Biscayne Bay but the effect on phytoplankton populations would be minor. The potential for impacts would depend on the duration of gate closures and the estimated number of closures per year. During construction of the structural measures, there could potentially be temporary, negligible to minor adverse impacts to phytoplankton because of the turbidity and disturbance during construction.

Therefore, effects to plankton populations would be adverse, temporary, and negligible to minor.

Alternative 7 - Critical Infrastructure, Nonstructural, and, Structural

Impacts would be as those described in Alternative 4 and Alternative 5.

Alternative 8 - Critical Infrastructure, Nonstructural, and Structural (Without Edgewater Floodwall)

Impacts would be similar to those described for Alternative 4 and 5. However, overall impacts would be less without the Edgewater Floodwall. However, the overall impact findings would be the same as those for Alternative 4 and 5.

Best Management Practices

The effect on plankton populations is negligible to minor for the alternatives listed for this project so best management practices are not applicable for this resource.

Cumulative Impacts

There are a multitude of past, present and reasonably foreseeable future projects within the ROI. Regardless, if the above referenced alternatives are implemented, 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 would continue to be studied and implemented. Climatic change effects such as sea level rise, decreasing pH of oceanic waters, 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 and water temperatures in the ROI. Rising waters and alterations of basic water chemistry due to climate change would alter the local bathymetry by deepening waters in Biscayne Bay, changes in salinity and freshwater input could alter local hydrodynamics, though this impact is likely to be minor.

Implementation of any of the action alternatives is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects.

8.10 ESSENTIAL FISH HABITAT, FISH AND FISHERY RESOURCES

Alternative 1 - No Action/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.

Miami-Dade County would continue coastal and climate resiliency efforts, including the Sea Level Rise Strategy Project, which aims to identify and develop feasible mitigation and adaption strategies for sea level rise and coastal storms; implementation of project proposed in the Rapid Action Plan and Adaptation Action Areas; and continued implementation of the EEL Program (WEC - Miami-Dade County, n.d.). The SFWMD would also continue research and implementation of various projects and initiatives in response to climate change and sea level rise.

Planned stormwater improvements in the City of Miami would also help address flooding issues. Examples would include updating the stormwater management plans and long term strategies

would include installation of tidal backflow valves, improvements to stormwater facilities, and increased public involvement.

The USACE would continue implementation of ongoing projects within the Miami-Dade County. These projects would include, the Miami Harbor Deeping and Navigation Improvements Project, sponsored by the Port of Miami and Miami-Dade County; the Biscayne Bay Coastal Wetlands Project (Phase II Implementation), a component of the CERP, conducted in partnership with the SFWMD; and the Miami-Dade County Coastal Storm Risk Management Feasibility Study, (Beach Nourishment), sponsored by Miami-Dade County. These improvements and studies would continue into the future regardless of whether the Miami-Dade Back Bay Coastal Storm Risk Management Feasibility Study is implemented.

Existing upstream water management operations would continue.

If the human population in the Biscayne Bay watershed continues to increase, there would be increasing pressure on the Bay due to stormwater runoff and increased nutrients from land-based activities unless these are well-controlled and improvements to water and waste management occur. This could have a minor impact on local hydrology, if a large enough volume of additional freshwater is released into Biscayne Bay.

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 affect the nature and character of the estuarine and coastal ecosystem in the ROI. Waters would continue to rise in the Biscayne Bay Region, which would adversely impact Miami-Dade County by increased flooding, including both nuisance and during/after major storm events as well as altering the basic water chemistry of Biscayne Bay. Waters are likely to become warmer, and possibly more saline in the Bay due to a larger oceanic input. At the same time, precipitation may increase, which unless runoff is controlled, will likely cause HABs (Harmful algal blooms) to become more frequent. Higher water temperatures will threaten many coral species in the ROI, as they are now near their upper thermal limit and will likely experience more coral bleaching events and die-offs. More acidic ocean waters will inhibit any marine life that deposits calcium carbonate as a shell, including corals, mollusks, and coralline algae. Submerged Aquatic Vegetation species may not be able to tolerate more frequent HAB as well as higher water temperatures. The effects to essential fish habitats may increase stress or mortality to managed species. Climatic changes may also cause managed species and fish resources to migrate away from their nascent waters.

The No Action/Future without Project Alternative is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects, including Essential Fish Habitat (EFH) or fish resources. With the implementation of the No Action/Future without Project Alternative, impacts would be adverse, permanent, and moderate to significant.

Alternative 2 – Critical Infrastructure

Impacts associated with Alternative 2 would be localized to the critical infrastructure and surrounding area and would result in no anticipated adverse impacts to EFH or fish resources in the ROI. Planting of mangroves at the Cutler Bay NNBF would have beneficial, permanent and minor impacts to EFH and fish resources by enhancing fish foraging and nursery habitat.

Alternative 4 - Critical Infrastructure and Nonstructural

Impacts associated with Alternative 4 would be localized to the critical infrastructure and structures and surrounding areas and would result in no anticipated impacts to EFH or fish resources in the ROI. Planting of mangroves at the Cutler Bay NNBF would have beneficial, permanent and minor impacts to EFH and fish resources by enhancing fish foraging and nursery habitat.

Alternative 5 - Critical Infrastructure and Structural

Direct impacts to EFH, including seagrass, mangroves, and coral reef/life/hardbottom habitats, as well as managed species and fish resources, would be adverse and major. Construction of the floodwalls, Biscayne Canal Surge Barrier, Little River Surge Barrier, and Miami River Surge Barrier would result in permanent habitat loss in their footprints. Turbidity plumes generated during construction and/or after storm events and during maintenance events could cause some siltation of benthic communities, though these effects would be temporary and sediments would settle relatively quickly due to the high sand content of sediment in the ROI. Other temporary impacts may result from alterations in freshwater inputs caused by closures and subsequent openings of storm surge barriers during storm events. This would potentially cause freshwater pulses into Biscayne Bay at the barriers' discharge points, which could impact benthic habitats near the discharge points, as they may not be tolerant of sudden, significant declines in salinity. These freshwater pulses have the potential to cause extirpation of seagrasses or even hardbottom habitat within or adjacent to the path of the freshwater pulse. The construction of the floodwalls would impact substantive quantities of existing coral communities located on the existing structures/bulkheads. Mangroves are also known to occur in limited locations along the existing bulkheads and would also potentially be impacted by the construction and operations of the floodwalls, surge barriers, and associated pump stations. Direct and indirect adverse impacts to mangroves, SAV, and coral/hardbottom communities would require onsite compensatory mitigation as described in Appendix D.

Turbidity and sedimentation may increase in the Biscayne Canal, Little River, Miami River, and Biscayne Bay during construction operation, and maintenance activities, though BMPs would be used to minimize these impacts. Construction activities would also increase ambient noise to levels greater than baseline, which would cause a temporary disturbance effect to managed and unmanaged fish species and EFH in the ROI; noise levels would reduce to normal levels at night and after construction, operation, and maintenance activities are completed.

Construction of the in-water structural measures may increase flow velocities by limiting the area where tidal ebb and flow could occur. Increased flow velocities may impede fish passage into or out of upstream waters, however, the extent of this effect is uncertain at this time. Additionally, activation of pump stations would increase risk of entrainment to fishes upstream of the surge barriers, though this is dependent on the rate at which water is being pumped out of the upstream areas.

Planting of mangroves at the Cutler Bay NNBF would have beneficial, permanent and minor impacts to EFH and fish resources by enhancing fish foraging and nursery habitat.

Therefore, impacts to EFH and fishery resources would range from adverse to beneficial impacts that would be temporary to permanent impacts that would range from minor to major impacts.

Alternative 7 - Critical Infrastructure, Nonstructural, and, Structural

Impacts would be as those described in Alternative 4 and Alternative 5.

Alternative 8 - Critical Infrastructure, Nonstructural, and Structural (Without Edgewater Floodwall)

Impacts would be similar to those described for Alternative 4 and 5. However, overall impacts would be less without the Edgewater Floodwall. However, the overall impact findings would be the same as those for Alternative 4 and 5.

Best Management Practices

For of any of the action alternatives, avoidance and minimization practices would be employed to the maximum extent practicable for all potential impacts. Specific examples of best management practices to avoid and minimize impacts to EFH, managed species, and Fish Resources include:

1. Conduct noise generating work in a way that minimizes acoustic effects and avoids injury to managed/unmanaged species and their habitat.
2. Avoid placing staging areas or structural measures in the water, wetlands, or mangrove habitats.
3. Limit the amount and extent of turbidity and sedimentation by using appropriate sedimentation and turbidity controls such as silt curtains, settling basins, cofferdams, and/or operational modifications such as conducting the work at low tide.
4. Minimize the amount of new impervious surfaces, and incorporate stormwater controls to minimize pollutants in aquatic habitats
5. Remove cofferdams or other diversion structures only after water quality is consistent with ambient levels outside the structure.
6. Ensure that construction vessels/barges are operated in adequate water depths to avoid propeller scour and grounding at all tides. Use shallow draft vessels that maximize the navigational clearance between the vessel and the benthos in shallow areas.

Cumulative Impacts

There are a multitude of past, present and reasonably foreseeable future projects within the ROI. Regardless, if the above referenced alternatives are implemented, 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 would continue to be studied and implemented. 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.

Implementation of any of the action alternatives is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects.

8.11 BENTHIC RESOURCES

Alternative 1 - No Action/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.

Miami-Dade County would continue coastal and climate resiliency efforts, including the Sea Level Rise Strategy Project, which aims to identify and develop feasible mitigation and adaption strategies for sea level rise and coastal storms; implementation of project proposed in the Rapid Action Plan and Adaptation Action Areas; and continued implementation of the EEL Program (WEC - Miami-Dade County, n.d.). The SFWMD would also continue research and implementation of various projects and initiatives in response to climate change and sea level rise.

Planned stormwater improvements in the City of Miami would also help address flooding issues. Examples would include updating the stormwater management plans and long term strategies would include installation of tidal backflow valves, improvements to stormwater facilities, and increased public involvement.

The USACE would continue implementation of ongoing projects within the Miami-Dade County. These projects would include, the Miami Harbor Deeping and Navigation Improvements Project, sponsored by the Port of Miami and Miami-Dade County; the Biscayne Bay Coastal Wetlands Project (Phase II Implementation), a component of the CERP, conducted in partnership with the SFWMD; and the Miami-Dade County Coastal Storm Risk Management Feasibility Study, (Beach Nourishment), sponsored by Miami-Dade County. These improvements and studies would continue into the future regardless of whether the Miami-Dade Back Bay Coastal Storm Risk Management Feasibility Study is implemented.

Existing upstream water management operations would continue.

If the human population in the Biscayne Bay watershed continues to increase, there would be increasing pressure on the Bay due to stormwater runoff and increased nutrients from land-based activities unless these are well-controlled and improvements to water and waste management occur. This could have a minor impact on benthic resources, if a large enough volume of additional freshwater is released into Biscayne Bay.

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 affect the nature and character of the estuarine and coastal ecosystem in the ROI. Waters would continue to rise in the Biscayne Bay Region, which would negatively impact Miami-Dade County by increased flooding, including both nuisance and during/after major storm events as well as altering the basic water chemistry of Biscayne Bay. Waters are likely to become warmer, and possibly more saline in the Bay due to a larger oceanic input. At the same time, precipitation may increase, which unless runoff is controlled, will likely cause HABs to become more frequent. Higher water temperatures will threaten many coral species in the ROI, as they

are now near their upper thermal limit and will likely experience more coral bleaching events and die-offs. More acidic ocean waters will inhibit any marine life that deposits calcium carbonate as a shell, including corals, mollusks, and coralline algae. Submerged Aquatic Vegetation species may not be able to tolerate more frequent HAB as well as higher water temperatures. Local benthic species may be displaced as more southern species migrate north as water temperatures become favorable to them. There are no anticipated beneficial impacts from climate change to local benthic fauna and benthic habitat types (Florida Oceans and Coastal Council 2009).

The No Action/Future without Project Alternative is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects, including changes to utility considerations within Miami-Dade County. It is anticipated that benthic habitat and associated fauna would experience negative impacts due to climate change and possibly increasing human population in the Biscayne Bay watershed. With the implementation of the No Action/Future without Project Alternative, impacts would be permanent and adverse and range from moderate to potentially major impacts to benthic resources.

Alternative 2 – Critical Infrastructure

Impacts associated with Alternative 2 would be localized to the critical infrastructure and surrounding area and would result in no anticipated adverse impacts to benthic habitat and fauna in the ROI. Planting of mangroves at the Cutler Bay NNBF would have beneficial, permanent and minor impacts to benthic habitat and fauna.

Alternative 4 - Critical Infrastructure and Nonstructural

Impacts associated with Alternative 4 would be localized to the critical infrastructure and structures and surrounding areas and would result in no anticipated impacts to benthic habitat and fauna in the ROI. Planting of mangroves at the Cutler Bay NNBF would have beneficial, permanent and minor impacts to benthic habitat and fauna by enhancing fish foraging and nursery habitat.

Alternative 5 - Critical Infrastructure and Structural

The impacts to benthic habitat and fauna from construction of the permanent footprint of the structural features (surge barriers and floodwalls) would be adverse, permanent, and major. Benthic habitat types anticipated to be impacted by construction of the structural features would include SAV, corals/hardbottom habitat, mangroves, and open water bay/riverine habitat. Construction activities would permanently reduce available habitat and also potentially increase ambient noise to levels greater than baseline. These direct and indirect impacts to benthic fauna and habitat have the potential to be significant and permanent in duration, though the impacts caused by noise levels and construction activity itself would be temporary.

Turbidity and sedimentation plumes generated during construction, operations, and/or after storm events and during maintenance events could cause some siltation of benthic communities, though these effects would be temporary and sediments would settle relatively quickly due to the high sand content of sediment in the ROI. Other temporary impacts may result from alterations in freshwater inputs caused by closures and subsequent openings of storm surge barriers during storm events and potentially during maintenance and testing events.

This would potentially cause freshwater pulses into the Biscayne Canal, Little River, Miami River, and Biscayne Bay at discharge points, which could impact benthic species near the discharge points, as they may not be tolerant of sudden, significant declines in salinity. These freshwater pulses have the potential to cause extirpation of seagrasses or even hardbottom habitat within or adjacent to the path of the freshwater pulse. This could also impact benthic fauna near the discharge points, and they may not be able to tolerate the sudden, significant decline in salinity.

The construction of the floodwalls would impact substantive quantities of existing coral communities located on the existing structures/bulkheads. Mangroves are also known to occur in limited sites of the floodwalls and would also potentially be impacted by the construction and operations of the floodwalls, surge barriers, and associated pump stations. Direct and indirect impacts to mangroves, SAV, and coral/hardbottom communities would require onsite compensatory mitigation as described in Appendix D. Surveys and a UMAM field site visit would be conducted during the PED Phase of the project to determine anticipated impacts and required mitigation quantities. Impacts to SAV, corals/hardbottom habitat, and mangroves would require onsite compensatory mitigation.

The maintenance and testing of the floodwalls, surge barriers, and pump stations would continue to impact local benthos near discharge points after storm events when tide gates are opened and a potential pulse of freshwater is released into Biscayne Bay. If this pulse impacts benthic fauna near the discharge point, it may cause an extirpation of local SAV and, if near enough, hardbottom habitat.

Modeling will be conducted during the Feasibility Phase to determine the extent and magnitude of potential impacts to hydrology and water quality caused by operation of the project structural features.

Planting of mangroves at the Cutler Bay NNBF would have beneficial, permanent and minor impacts to benthic resources by enhancing fish foraging and nursery habitat.

Therefore, impacts to benthic resources would range from adverse to beneficial impacts that would be temporary to permanent impacts that would range from minor to major impacts.

Alternative 7 - Critical Infrastructure, Nonstructural, and, Structural

Impacts would be as those described in Alternative 4 and Alternative 5.

Alternative 8 - Critical Infrastructure, Nonstructural, and Structural (Without Edgewater Floodwall)

Impacts would be similar to those described for Alternative 4 and 5. However, overall impacts would be less without the Edgewater Floodwall. However, the overall impact findings would be the same as those for Alternative 4 and 5.

Best Management Practices

For any of the action alternatives, avoidance and minimization practices would be employed to the maximum extent practicable for all potential impacts. Specific examples of best management practices to avoid and minimize impacts to local benthic fauna and habitat include:

1. Use of silt curtains and other sediment control methods to reduce sedimentation due to construction activities.
2. Avoid placing staging areas or structural measures in the water.

Cumulative Impacts

There are a multitude of past, present and reasonably foreseeable future projects within the Study Area. Regardless, if the above referenced alternatives are implemented, 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 would continue to be studied and implemented. Climatic change effects such as sea level rise, decreasing pH of oceanic waters, 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 and water temperatures in the ROI. All of these effects would negatively impact Biscayne Bay benthic habitat and fauna, as described in the No Action/Future without Project Alternative.

Implementation of any of the action alternatives is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects.

8.12 SPECIAL STATUS SPECIES

Alternative 1 - No Action/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.

Miami-Dade County would continue coastal and climate resiliency efforts, including the Sea Level Rise Strategy Project, which aims to identify and develop feasible mitigation and adaption strategies for sea level rise and coastal storms; implementation of project proposed in the Rapid Action Plan and Adaptation Action Areas; and continued implementation of the EEL Program (WEC - Miami-Dade County, n.d.). The SFWMD would also continue research and implementation of various projects and initiatives in response to climate change and sea level rise.

Planned stormwater improvements in the City of Miami would also help address flooding issues. Examples would include updating the stormwater management plans and long term strategies would include installation of tidal backflow valves, improvements to stormwater facilities, and increased public involvement.

The USACE would continue implementation of ongoing projects within the Miami-Dade County. These projects would include, the Miami Harbor Deeping and Navigation Improvements Project, sponsored by the Port of Miami and Miami-Dade County; the Biscayne Bay Coastal Wetlands Project (Phase II Implementation), a component of the CERP, conducted in partnership with the SFWMD; and the Miami-Dade County Coastal Storm Risk Management Feasibility Study, (Beach Nourishment), sponsored by Miami-Dade County. These improvements and studies would continue into the future regardless of whether the Miami-Dade Back Bay Coastal Storm Risk Management Feasibility Study is implemented.

Existing upstream water management operations would continue.

If the human population in the Biscayne Bay watershed continues to increase, there would be increasing pressure on the Bay due to stormwater runoff and increased nutrients from land-based activities unless these are well-controlled and improvements to water and waste management occur. This could have a minor impact on benthic resources, if a large enough volume of additional freshwater is released into Biscayne Bay.

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 affect the nature and character of the estuarine and coastal ecosystem in the ROI. Waters would continue to rise in the Biscayne Bay Region, which would negatively impact Miami-Dade County by increased flooding, including both nuisance and during/after major storm events as well as altering the basic water chemistry of Biscayne Bay. Waters are likely to become warmer, and possibly more saline in the Bay due to a larger oceanic input. At the same time, precipitation may increase, which unless runoff is controlled, will likely cause HABs to become more frequent. Higher water temperatures will threaten many coral species in the ROI, as they are now near their upper thermal limit and will likely experience more coral bleaching events and die-offs. More acidic ocean waters will inhibit any marine life that deposits calcium carbonate as a shell, including corals, mollusks, and coralline algae. Submerged Aquatic Vegetation species may not be able to tolerate more frequent HAB as well as higher water temperatures. Local benthic species may be displaced as more southern species migrate north as water temperatures become favorable to them. There are no anticipated beneficial impacts from climate change to local benthic fauna and benthic habitat types (Florida Oceans and Coastal Council 2009).

It is anticipated that benthic habitat and associated fauna will experience negative impacts due to climate change and possibly increasing human population in the Biscayne Bay watershed. With the implementation of the No Action/Future without Project Alternative, impacts would be permanent and adverse and range from moderate to potentially major impacts to benthic habitat and fauna.

The No Action/Future without Project Alternative would be anticipated to have no impact on special status species. No construction activities would occur with this alternative, and no impacts would occur. The No Action/Future without Project Alternative is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects.

Alternative 2 - Critical Infrastructure

There would be minimal construction and maintenance activities and limited, temporary additional ground disturbance anticipated for the dry and wet flood proofing of critical infrastructure facilities. Staging areas would be temporary and sited to avoid any potential impacts to wetlands or trees. No tree removal would be anticipated. Wet and dry floodproofing would occur within the footprint of already disturbed areas so no impacts to habitats used by special status species would be anticipated to be impacted with the wet and dry floodproofing.

This alternative would have considerably less adverse impacts to special status species than either implementation of Alternative 5 or 7 or 8 because impacts would be restricted to only those species that occur in terrestrial habitats and would only consist of modification of existing facilities in previously disturbed areas. For federally and state listed species and migratory birds, there could potentially be a negligible to minor, temporary disturbance to them during construction where they could be potentially disturbed and flushed from construction and/or maintenance operations. However, this would be unlikely and discountable because the features would not be constructed in preferred habitats for any of these species. For any of these species we would not anticipate any significant impacts and the implementation of Alternative 2 may affect but would not likely adversely affect the piping plover, the red knot, and the Florida bonneted bat. There would be no impact to the American crocodile, fish, corals, marine mammals, or sea turtles as there would be no construction of features that would occur in their habitats. There would be no impacts to manatee or Johnson's seagrass critical habitats. No anticipated impacts to bald eagle nesting sites or their associated primary or secondary buffers are anticipated with implementation of Alternative 2. No high, intermittent sound impacts associated with construction are anticipated to occur within 2,640 feet of any reported eagle nests. Therefore, bald eagle nesting is not likely to be disturbed by this project and no Bald Eagle Permit is anticipated to be required with implementation of this alternative.

Vegetation plantings would enhance the habitat quality of the NNBF at the Cutler Bay Site and would be anticipated to improve migratory bird habitats. Benefits would be anticipated to be permanent and minor.

Alternative 4 - Critical Infrastructure and Nonstructural

In addition to the impacts described for Alternative 2 this alternative would also include nonstructural measures including: elevation of existing structures in preexisting disturbed areas; acquisition and demolition of structures and potential restoration within demolition sites; and floodproofing of preexisting structures. This alternative would have a similar but slightly higher level of impacts to terrestrial special status species as those described in Alternative 2 but impact thresholds terrestrial special status species would still be anticipated to be adverse, minor and temporary in nature.

There would not be any anticipated significant impacts and the implementation of Alternative 2 may affect but would not likely adversely affect the piping plover, the red knot, and the Florida bonneted bat. There would be no impact to the American crocodile, fish, corals, marine mammals, or sea turtles as there would be no construction of features that would occur in their habitats. There would be no impacts to manatee or Johnson's seagrass critical habitats. No anticipated impacts to bald eagle nesting sites or their associated primary or secondary buffers are anticipated with implementation of Alternative 2. No high, intermittent sound impacts associated with construction are anticipated to occur within 2,640 feet of any reported eagle nests. Therefore, bald eagle nesting is not likely to be disturbed by this project and no Bald Eagle Permit is anticipated to be required with implementation of this alternative.

In addition to the adverse impacts to special status species described there would also be some potential permanent, minor benefits to migratory birds and with the potential restoration of limited habitats within the ROI from the demolished structure areas. Restoration of demolition

sites including native plantings would benefit migratory bird habits providing permanent, negligible to permanent, minor benefits. Native plantings would enhance the habitat quality of the NNBF at the Cutler Bay Site and would be anticipated to improve migratory bird habitats. Benefits would be anticipated to be permanent and minor.

Alternative 5 - Critical Infrastructure and Structural

Impacts to special status species resulting from critical infrastructure would be at the same impact threshold as those described in Alternative 2. Benefits to special status species resulting from implementation of the NNBF at the Cutler Bay Site would be the same as those described in Alternative 2.

Impacts to special status species resulting from structural measures would be the same as those described for Alternative 7. The overall, relative adverse impacts to special status species with implementation of Alternative 5 would be slightly less than with implementation of Alternative 7 because none of the nonstructural measures would be implemented with Alternative 5. Therefore, disturbance impacts to special status species that occur in terrestrial habitats would be slightly less. However, even though relative disturbance impacts would be slightly less for special status species that could be disturbed by construction of nonstructural features, the relative impact threshold and impact findings for special status species with implementation of Alternative 5 would remain at the same threshold level of impact as those described for Alternative 7. This is because the majority of the impacts to special status species occurs from the construction of the structural features, not the nonstructural features.

Alternative 7 - Critical Infrastructure, Nonstructural, and Structural

Impacts to aquatic Special Status Species would be more adverse with Alternative 7 than Alternative 8 because of the additional impacts resulting from the Edgewater Floodwall. However, the overall impact findings would be the same as those described for Alternative 8.

Alternative 8 - Critical Infrastructure, Nonstructural, and Structural (Without Edgewater Floodwall)

BIRDS

Piping Plover and Red Knot

Both the piping plover and red knot have the potential to forage and/or migrate through the Action Area but do not currently breed in the Action Area. Construction, operations, and maintenance of measures in the Preferred Alternative have the potential to slightly impact flight and foraging behaviors. Noise generated during construction and maintenance could produce disturbance effects, flushing both piping plovers and red knots from foraging and/or migrations. In addition, localized sediment disturbances caused by aquatic construction and operations have the potential to indirectly affect the foraging success of the piping plover and red knot by disturbing benthic invertebrates and fish. This could potentially impact prey species availability to piping plovers and red knots. Closure of the storm surge barriers and tide gates can result in upstream shifts in salinity, temperature, dissolved oxygen, and nutrients which could also temporarily limit prey species availability. However, it is anticipated that adverse impacts to these species would be temporary, negligible to minor and not significant.

Therefore, the implementation of the Preferred Alternative may affect, but is not likely to adversely affect the piping plover or the red knot.

FISH

Nassau Grouper and Smalltooth Sawfish

Because of their preference for near shore, shallow habitats it would be anticipated that juvenile Nassau grouper have the potential to occur in the Action Area and would be potentially affected by construction and operation of the project structural features. Smalltooth sawfish juveniles, subadults, and adults have the potential to occur in the Action Area and would potentially be affected by construction and operation of the project structural features. Potential direct and indirect impacts to the Nassau grouper and the smalltooth sawfish would include the following:

During surge barrier operations, tidal fluxes in water could potentially cease for a period of time, potentially altering water quality including: temperature, salinity, and dissolved oxygen (DO), while increasing the number of harmful nutrients in the water. The changes in water quality could potentially have compound and/or cumulative interactions, causing increased stress levels to listed fish species and their prey, which may lead to increased susceptibility to disease or even a mortality event, though this is relatively uncertain at this time. Additionally, closure of the storm surge barriers and tide gates could result in a trapping effect, by impeding passage to listed fish species and prey species that move in and out of upstream areas to feed. Although it is uncertain, listed fish species and prey species may swim into closed barriers causing injury to themselves. Activation of pump stations would increase risk of entrainment to listed fish species and their prey trapped upstream of the surge barriers, though this is dependent on the rate at which water is being pumped out of the upstream areas. Therefore, due to the trapping as well as water quality impacts and potential effects to the listed fish species and their prey, this could potentially result in potentially significant, adverse effects to listed fish species.

There is a potential for vessel interactions to occur with dredging vessel/equipment directly and/or to occur indirectly from vessels transiting the Action Area. We would expect barges containing construction materials to travel at speeds of approximately 10 knots or less that would allow subadult and adult listed fish species enough time to avoid most strike impacts. Also, we would expect that because the barges would not be deep draft vessels that contact with the benthic environment would be very limited. Therefore, because of the limited speed of the vessels and the drafting nature of the vessels, we would anticipate that no significant strike hazards would occur.

Turbidity plumes generated at aquatic construction sites (i.e. Construction of surge barriers/tide gates) are not expected to be significant to listed fish species due to the limited area and time in which construction would occur. Additionally, turbidity plumes are expected to settle and/or dissipate within hours of sediment disruption. Therefore, turbidity plumes would have an adverse but not likely significant impact to listed fish species and their prey.

Temporary and intermittent noise generated from marine construction, maintenance, and operation and maintenance of structures may cause a disturbance effect where listed fish species flush out of the area. This could potentially affect their daily movement patterns,

migration, and foraging in the Action Area. We would anticipate this to be a temporary, adverse but likely insignificant effect.

Construction of the project structural features may affect benthic prey species and habitats utilized by listed fish species within the ROI; these effects may limit available habitat and food availability, these effects would range from temporary to permanent and could range from minor to potentially significant, adverse impacts with loss of seagrass as well as sand flats which are known preferential habitats of the smalltooth sawfish.

Surge barriers may increase flow velocities by limiting the area where tidal ebb and flow can occur. Increased flow velocities may affect fish passage, though the effects of this are relatively uncertain at this time.

Construction of the floodwall may cause permanent destruction to mangroves located in located locations along the floodwall. Mangroves are a known preferential habitat of the juvenile smalltooth sawfish. Therefore, this would result in permanent, minor impacts to juvenile sawfish. A jurisdictional determination would be conducted during the PED Phase of the project to determine any potential impacts on mangroves. During PED a UMAM analysis would be conducted to determine any functional loss of mangroves and onsite compensatory mitigation would be conducted to offset any potential impacts to mangroves as described in the Environmental Mitigation Plan provided in Appendix D.

Implementation of the Cutler Bay NNBF would serve to increase mangrove habitat which is a preferential habitat of juvenile smalltooth sawfish. This would help to increase foraging as well as structural habitat for this species. This would provide permanent, minor benefits to the smalltooth sawfish.

Therefore, implementation of the Preferred Alternative may affect, and is likely to adversely affect the smalltooth sawfish.

CORALS

Boulder Star, Elkhorn, Lobed Star, Mountainous Star, Pillar, Rough Cactus, and Staghorn

The ROI provides potential habitat for boulder star, elkhorn, lobed star, mountainous star, pillar, rough cactus, and staghorn coral. However, the relative presence of these species in the Action Area is uncertain. Therefore, detailed site surveys would be conducted during the PED Phase to determine the presence, extent, and density of any potential listed coral species in the Action Area. During PED a UMAM analysis would be conducted to determine any functional loss of corals and onsite compensatory mitigation would be conducted to offset any potential impacts to corals as described in the Environmental Mitigation Appendix provided in Appendix D.

The construction and operations of the surge barriers and floodwalls could potentially result in temporary to permanent adverse impacts to listed coral species. The construction of the floodwall would result in permanent habitat loss and potentially direct impacts to listed coral species if they are present. During surge barrier closures, tidal fluxes in water could potentially cease for a period of time, potentially affecting water quality such as salinity and DO, while increasing the number of harmful nutrients in the water. There could also potentially be

temperature fluctuations as well resulting from the surge barrier operations both east and west of the surge barrier and in the Biscayne Bay Aquatic Preserve. Potential changes in water quality, salinity, DO, nutrients, and temperature could potentially have compound and/or cumulative interactions, causing increased stress levels to near shore bottom habitat and other coral populations occurring both west and east of the surge barriers and into the Biscayne Bay Aquatic Preserve, which may lead to increased susceptibility to coral disease or even a mortality event, though this is relatively uncertain at this time. During pumping operations water quality discharged to the Biscayne Bay could potentially have altered salinity, DO, and nutrient concentrations as well as temperature fluctuations that could result in increased stress conditions and potentially mortality to near shore hardbottom habitat and other coral populations east of the surge barriers and in the Biscayne Bay Aquatic Preserve.

Turbidity plumes generated at aquatic construction sites (i.e. construction of surge barriers/tide gates) are could potentially cause sedimentation on existing near shore bottom habitat and other coral populations. Turbidity plumes could also potentially result in stress to existing near shore bottom habitats and/or coral populations and could potentially cause mortality as well. Overall, potential impacts to listed coral species have the potential to be adverse, temporary to permanent, and potentially significant.

Therefore, implementation of the Preferred Alternative may affect and is likely to adversely affect listed coral species.

MAMMALS

Florida Bonneted Bat

There are no known maternal roosting colonies or hibernacula in the Action Area. There is a potential for tree removal including mangroves with construction of the floodwalls and surge barriers. As final siting of the floodwalls and surge barriers would not occur until the PED Phase of the project, the acreage of potential tree removal is uncertain. The noise impacts from construction, maintenance, and operation of the structural features may produce a temporary, disturbance effect to the Florida bonneted bat. It is anticipated that if bats are in the area they would flush away from the noise and disturbance impacts. However, the Action Area is not a preferred roosting habitat of the Florida bonneted bat so it would be anticipated that occurrence of the Florida bonneted bat in the Action Area would be unlikely and any potential effects would likely be discountable.

Therefore, implementation of the Preferred Alternative may affect, but is not likely to adversely affect the Florida bonneted bat.

West Indian Manatee

Closure of the storm surge barriers could result in a trapping effect, by impeding passage to manatees that have the potential to be in the Action Area. This could potentially affect their daily movement patterns, migrations in and out of the Action area, and potentially could also impact their foraging in the Action Area. We would not expect any manatee mortality and this would be

a temporary affect as the storm surge barriers and tidal gates would not likely be closed for a period of more than a week at a time.

The construction, operation, and maintenance of the structures may result in the permanent loss of SAV that would affect the foraging habitat for manatees. This could potentially result in an adverse and potentially significant impact to manatees.

Although it is uncertain, manatees may swim into closed barriers causing injury to themselves.

The construction, maintenance, and operation of the structures will likely result in a disturbance effect to the manatees where they will move away from the turbidity, noise, and visual disturbances. This could result in an adverse, temporary effect in their daily movement patterns, migration, or foraging in the Action Area.

With implementation of the Preferred Alternative, there is a slightly increased risk that a vessel interaction with a manatee could occur as we would have barges used to construct the features in waters where sea turtles are known to occur. A risk of a vessel strike would be low because of the very limited amount of time barges or vessels would be in the water associated with construction and maintenance of features and likely due to the limited speed of the vessels. It is estimated that during most operating conditions the barges would travel at a speed of approximately 10 knots or less. Therefore, we would anticipate any potential vessel interactions with manatees as a result of implementation of the Preferred Alternative to be highly unlikely and discountable.

We would not expect entrainment of manatees when the pumping stations are running for the storm surge barriers and floodwalls. This is because the pipes would be fitted with trash prevention devices that have grates that are approximately three inches in size which would prevent entrainment of any manatees due to the size of the grates.

Detailed site surveys would be conducted during the PED Phase to determine the presence, extent, and density of any SAV in the ROI. During PED a UMAM analysis would be conducted to determine any functional loss of SAV and onsite compensatory mitigation would be conducted to offset any potential impacts to SAV as described in the Environmental Mitigation Appendix provided in Appendix D.

Therefore, because of the potential trapping effect of the storm surge barriers and the potential impacts associated with the construction and maintenance of the structural features, implementation of the Preferred Alternative may affect, and is likely to adversely affect the West Indian Manatee. Implementation of the Preferred Alternative has the potential to adversely modify West Indian Manatee Critical Habitat.

REPTILES

American crocodile

Closure of the storm surge barriers could potentially result in a trapping effect, by impeding passage to crocodiles that have the potential to be in the Action Area. This could potentially affect their daily movement patterns, migrations in and out of the Action area, and potentially could also impact their foraging in the Action Area. Because of the potential adverse water quality effects, the prey base may be adversely affected which could potentially limit foraging

opportunities in the Action Area while crocodiles are trapped behind the storm surge barriers. Based on the potential habitat in the Action Area the trapping of crocodiles would a likely and adverse effect that could occur when the storm surge barriers are closed. We would not expect any crocodile mortality and this would be a temporary affect as the storm surge barriers and tidal gates would not likely be closed for a period of more than a week at a time.

The construction, operation, and maintenance of the structures may result in the loss of foraging habitat for crocodiles. This could potentially result in an adverse and potentially significant impact to crocodiles.

Although it is uncertain, crocodiles may swim into closed barriers causing injury to themselves.

The construction, maintenance, and operation of the structures will likely result in a disturbance effect to crocodiles where they will move away from the turbidity, noise, and visual disturbances. This could result in an adverse effect in their daily movement patterns, migration, or foraging in the Action Area.

With implementation of the Preferred Alternative, there is a slightly increased risk that a vessel interaction with a crocodile could occur as we would have barges used to construct the features in waters where sea turtles are known to occur. A risk of a vessel strike would be low because of the very limited amount of time barges or vessels would be in the water associated with construction and maintenance of features and likely due to the limited speed of the vessels. It is estimated that during most operating conditions the barges would travel at a speed of approximately 10 knots or less. Therefore, we would anticipate any potential vessel interactions with crocodiles as a result of implementation of the Preferred Alternative to be highly unlikely and discountable.

We would not expect entrainment of crocodiles when the pumping stations are running for the storm surge barriers and floodwall. This is because the pipes would be fitted with trash prevention devices that have grates that are approximately three inches in size which would prevent entrainment of any sea turtles due to the size of the grates.

Therefore, because of the potential trapping effect of the storm surge barriers and the potential impacts associated with the construction and maintenance of the structural features, implementation of the Preferred Alternative may affect, and is likely to adversely affect the American crocodile.

SEA TURTLES

Green, Kemp's ridley, Hawksbill, Leatherback, and Loggerhead Sea Turtles

Closure of the storm surge barriers could result in a trapping effect, by impeding passage to sea turtles that have the potential to be in the Action Area. This could potentially affect their daily movement patterns, migrations in and out of the Action area, and potentially could also impact their foraging in the Action Area. Because of the potential adverse water quality effects, the prey base may be adversely affected which could potentially limit foraging opportunities in the Action Area while turtles are trapped behind the storm surge barriers. Based on the potential habitat in the Action Area the trapping of sea turtles would a likely and adverse effect that could occur

when the storm surge barriers are closed. We would not expect any sea turtle mortality and this would be a temporary affect as the storm surge barriers and tidal gates would not likely be closed for a period of more than a week at a time.

The construction, operation, and maintenance of the structures may result in the loss of SAV and near shore hardbottom and other coral habitats that would potentially affect the foraging habitat for sea turtles. This could potentially result in an adverse, temporary to permanent, and potentially significant impact to sea turtles.

Although it is uncertain, sea turtles may swim into closed barriers causing injury to themselves.

The construction, maintenance, and operation of the structures will likely result in a disturbance effect to the sea turtles where they will move away from the turbidity, noise, and visual disturbances. This could result in an adverse effect in their daily movement patterns, migration, or foraging in the Action Area.

With implementation of the Preferred Alternative, there is a slightly increased risk that a vessel interaction with a sea turtle could occur as we would have barges used to construct the features in waters where sea turtles are known to occur. A risk of a vessel strike would be low because of the very limited amount of time barges or vessels would be in the water associated with construction and maintenance of features and likely due to the limited speed of the vessels. It is estimated that during most operating conditions the barges would travel at a speed of approximately 10 knots or less. Therefore, we would anticipate any potential vessel interactions with sea turtles as a result of implementation of the Preferred Alternative to be highly unlikely and discountable.

We would not expect entrainment of sea turtles when the pumping stations are running for the storm surge barriers and floodwalls. This is because the pipes would be fitted with trash prevention devices that have grates that are approximately three inches in size which would prevent entrainment of any sea turtles due to the size of the grates.

Therefore, implementation of the Preferred Alternative may affect, and is likely to adversely affect the green, Kemp's ridley, leatherback, loggerhead, and hawksbill sea turtle.

SEAGRASS

Johnson's Seagrass

The construction, operation, and maintenances of the surge barriers and floodwalls may result in the direct and indirect loss of Johnson's seagrass. Construction of the surge barriers and floodwalls may result in temporary as well as permanent loss of Johnson's seagrass. Operation and maintenances of the surge barriers may result in turbidity plumes as well as salinity, DO, nutrient, and temperature impacts to water quality. The water quality impacts in turn could potentially result in impacts to Johnson's seagrass that would range from temporary to permanent impacts that could range from minor to significant adverse impacts. For impacts to SAV, onsite compensatory mitigation would be required and is described in the Environmental Mitigation Plan located in the Environmental Appendix D. During PED, a UMAM analysis w to

harvest and plant seeds as a potential mitigation method. Laboratory methods to vegetatively reproduce Johnson's seagrass in a laboratory setting are not currently developed so another potential mitigation would be to develop such methods and work to transplant vegetatively reproduce Johnson's seagrass to the Biscayne Bay. However, this type of mitigation would require some harvesting of seagrass in the natural population so this type of mitigation would be risky, could potentially damage the limited, natural population, and potentially could result in some mortality/stress to the natural population. Therefore, mitigation of the Johnson's seagrass would be risky and potentially not successful.

Table 8-2 provides a summary of the Endangered Species Act, Section 7 Federally Listed Species and Critical Habitat Conclusion Table.

Table 8-2. Endangered Species Act, Section 7 Federally Listed Species and Critical Habitat Conclusion Table

Taxonomic Category/Common Name	Status	Endangered Species Act, Section 7 Finding
Birds		
Piping plover	T	May affect, not likely to adversely affect
Red knot	T	May affect, not likely to adversely affect
Fish		
Nassau grouper	T	May affect, likely to adversely affect
Smalltooth sawfish	E	May affect, likely to adversely affect
Invertebrates		
Boulder star coral	T	May affect, likely to adversely affect
Elkhorn coral	T	May affect, likely to adversely affect
Lobed star coral	T	May affect, likely to adversely affect
Mountainous star coral	T	May affect, likely to adversely affect
Pillar coral	T	May affect, likely to adversely affect
Rough cactus coral	T	May affect, likely to adversely affect
Staghorn coral	T	May affect, likely to adversely affect

Taxonomic Category/Common Name	Status	Endangered Species Act, Section 7 Finding
Mammals		
Florida bonneted bat	E	May affect, not likely to adversely affect
West Indian manatee	T	May affect, likely to adversely affect
West Indian manatee critical habitat		Potential adverse modification of critical habitat
Reptiles		
American crocodile	E	May affect, likely to adversely affect
Green sea turtle (North and South Atlantic DPS)	T	May affect, likely to adversely affect
Hawksbill sea turtle	E	May affect, likely to adversely affect
Kemp's ridley sea turtle	E	May affect, likely to adversely affect
Leatherback sea turtle	E	May affect, likely to adversely affect
Loggerhead sea turtle (Northwest Atlantic Ocean DPS)	T	May affect, likely to adversely affect
Seagrass		
Johnson's seagrass	T	May affect, likely to adversely affect
Johnson's seagrass critical habitat		Potential adverse modification of critical habitat

T=Threatened; E = Endangered

****Please note that species presence and conclusions are tentative and subject to change based on results of detailed hard bottom/coral and Submerged Aquatic Vegetation surveys and final siting of project features that would be conducted during the Preconstruction, Engineering, and Design Project Phase***

MARINE MAMMALS

Bottlenose Dolphins

Closure of the storm surge barriers could result in a trapping effect, by impeding passage to dolphins that have the potential to be in the Action Area. This could potentially affect their daily movement patterns, migrations in and out of the Action area, and potentially could also impact their foraging in the Action Area. We would not expect any dolphin mortality and this would be a temporary affect as the storm surge barriers and tidal gates would not likely be closed for a period of more than a week at a time.

The construction, operation, and maintenance of the structures may result in the temporary to permanent loss of habitat for prey species of the dolphin. This could potentially result adverse, minor impacts to dolphins.

Although it is uncertain, dolphins may swim into closed barriers causing injury to themselves.

The construction, maintenance, and operation of the structures would likely result in a disturbance effect to the dolphins where they will move away from the turbidity, noise, and visual disturbances. This could result in an adverse, temporary effect in their daily movement patterns, migration, or foraging in the Action Area.

With implementation of the Preferred Alternative, there is a slightly increased risk that a vessel interaction with a dolphin could occur as we would have barges used to construct the features in waters where sea turtles are known to occur. A risk of a vessel strike would be low because of the very limited amount of time barges or vessels would be in the water associated with construction and maintenance of features and likely due to the limited speed of the vessels. It is estimated that during most operating conditions the barges would travel at a speed of approximately 10 knots or less. Therefore, we would anticipate any potential vessel interactions with dolphins as a result of implementation of the Preferred Alternative to be highly unlikely and discountable.

We would not expect entrainment of dolphins when the pumping stations are running for the storm surge barriers and floodwalls. This is because the pipes would be fitted with trash prevention devices that have grates that are approximately three inches in size which would prevent entrainment of any dolphins due to the size of the grates.

Overall, with implementation of the Preferred Alternative potential impacts to dolphin would range from temporary to permanent adverse impacts that would be minor.

Other Migratory Birds and State Listed Species

For other state listed, migratory birds we would anticipate for impacts to be as those described for the piping plover and red knot. No anticipated impacts to bald eagle nesting sites or their associated primary or secondary buffers are anticipated with implementation of Alternative 2. No high, intermittent sound impacts associated with construction are anticipated to occur within 2,640 feet of any reported eagle nests. Therefore, bald eagle nesting is not likely to be disturbed by this project and no Bald Eagle Permit is anticipated to be required with implementation of this alternative.

In addition to the adverse impacts to migratory birds described there would also be some potential permanent, minor benefits to migratory birds and with the potential restoration of limited habitats within the ROI from the demolished structure areas. Restoration of demolition sites including native plantings would benefit migratory bird habits providing permanent, negligible to permanent, minor benefits. Native plantings would enhance the habitat quality of the NNBF at the Cutler Bay Site and would be anticipated to improve migratory bird habitats. Benefits would be anticipated to be permanent and minor.

Disturbance from terrestrial construction, operations, and maintenance has the potential to affect the Everglades mink. However, it would be anticipated than any adverse effects would be negligible to minor and temporary.

Best Management Practices to Avoid and Minimize Impacts on Special Status Species:

For any potential final alignments, avoidance and minimization practices will be employed to the maximum extent practicable for all potential impacts. Specific examples of best management practices to avoid and minimize impacts to air quality during temporary construction conditions:

1. Barges will be operated at approximately 10 knots or less to reduce any potential interactions with marine mammals and sea turtles.
2. Pass-through devices or equivalent measures will be used in the surge barrier designs to prevent entrainment of marine mammals and sea turtles.
3. A visual inspection of the surge barriers will be done prior to closure to ensure no marine mammals, sea turtles, or crocodiles are crushed/injured during closure operations.
4. Storm surge barrier pumping station discharge pipes would be fitted with trash prevention devices that have grates that are approximately three inches in size which would prevent entrainment of any sea turtles or marine mammals due to the size of the grates.
5. The Standard Manatee Conditions for In-Water Work would be followed (USFWS 2011).
6. Siltation barriers shall be made of material in which a crocodile or smalltooth sawfish cannot become entangled, be properly secured, and be regularly monitored to avoid protected species entrapment. Barriers may not block crocodile or smalltooth sawfish entry to or exit from designated critical habitat without prior agreement from the National Marine Fisheries Service's Protected Resources Division.
7. All vessels associated with the construction project shall operate at "no wake/idle" speeds at all times while in the construction area and while in water depths where the draft of the vessel provides less than a four foot clearance above the bottom. All vessels will preferentially follow deep-water routes (e.g. marked channels) whenever possible.
8. If a crocodile or smalltooth sawfish is seen within 100 yards of the active daily construction operation or vessel movement, all appropriate precautions shall be implemented to ensure its protection. These precautions shall include cessation of operation of any moving equipment closer than 50 feet of a crocodile or smalltooth sawfish. Operation of any mechanical construction equipment shall cease immediately if a crocodile or smalltooth sawfish is seen within a 50-ft radius of the equipment. Activities may not resume until the protected species has departed the project area of its own volition.

Cumulative Impacts

Past, current, and future development and navigation within the Miami-Dade County would continue to impact terrestrial and aquatic ecosystems in the Action Area. Special status species and habitats have been significantly affected in the past by habitat loss resulting from development. Continued stressors to the American crocodile, marine mammals and sea turtles in a highly navigated waterway of Biscayne Bay include threats of vessel strikes and ongoing noise impacts from vessels and marine development activities.

It is assumed that USACE would continue implementation of major ongoing projects within the Miami-Dade County. These projects include, the Miami Harbor Deeping and Navigation Improvements Project, sponsored by the Port of Miami and Miami-Dade County; the Biscayne Bay Coastal Wetlands Project (Phase II Implementation), a component of the Comprehensive Everglades Restoration Plan (CERP), conducted in partnership with the SFWMD; and the Miami-Dade County Coastal Storm Risk Management Feasibility Study, (Beach Renourishment), sponsored by Miami-Dade County. If the human population in the Biscayne Bay watershed continues to increase, there will be increasing pressure on the Bay due to stormwater runoff and increased nutrients from land-based activities unless fully mitigated.

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 affect the nature and character of the estuarine and coastal ecosystem in the Region of Influence. Waters would continue to rise in the Biscayne Bay region, which would negatively impact Miami-Dade County by increased flooding, including both nuisance and during/after major storm events as well as altering the basic water chemistry of Biscayne Bay. Waters are likely to become warmer, and possibly more saline in the Bay due to a larger oceanic input. At the same time, precipitation may increase, which unless runoff is controlled, will likely cause Harmful algal blooms to become more frequent. Higher water temperatures will threaten many coral species in the ROI, as they are now near their upper thermal limit and will likely experience more coral bleaching events and die-offs. More acidic ocean waters will inhibit any marine life that deposits calcium carbonate as a shell, including corals, mollusks, and coralline algae. Submerged Aquatic Vegetation species may not be able to tolerate more frequent HAB as well as higher water temperatures. Coral disease and SAV die offs have significantly affected coral populations and have the potential to continue in the future in the ROI. Local benthic species may be displaced as more southern species migrate north as water temperatures become favorable to them. There are no beneficial impacts from climate change to local benthic fauna and benthic habitat types (Florida Oceans and Coastal Council 2009).

Implementation of the alternatives is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects.

8.13 CULTURAL RESOURCES

Alternative 1 - No Action/Future without Project

In the future without project condition historic buildings would continue to be at risk of damage or destruction from coastal storm flooding. Archaeological sites could sustain adverse effects

from flooding, but damages to historic buildings could make them unusable, and lead to their demolition.

Alternative 2 - Critical Infrastructure

While in most cases critical infrastructure is not listed or eligible for the NRHP, there may be exceptions, such as fire stations. Floodproofing of any potential historic critical infrastructure could potentially result in adverse effects; however, the floodproofing would also help to preserve the structure providing benefits as well. Some measures may involve ground disturbance, which could potentially adversely impact archaeological sites. Planting at the Cutler Bay NNBF Site would involve minor ground disturbance which could potentially adversely affect archeological sites if they are present. For areas not yet surveyed, potential impacts are relatively uncertain; therefore, archeological surveys would be conducted as needed during the PED Phase.

Alternative 4 - Critical Infrastructure and Nonstructural

Potential impacts to historic buildings and archeological resources from critical infrastructure measures and plantings at the Cutler Bay NNBF Site would be as those described in Alternative 2. Nonstructural measures, i.e., wet and dry floodproofing, elevating structures would potentially cause adverse effects to the historic characters of buildings, but make them viable for the future in the face of flood risks. Plantings at the Cutler Bay NNBF Site would involve minor ground disturbance which could potentially adversely affect archeological sites if they are present. For areas not yet surveyed, potential impacts are relatively uncertain; therefore, archeological surveys would be conducted as needed during the PED Phase. For areas not yet surveyed, potential impacts are relatively uncertain; therefore, archeological surveys would be conducted as needed during the PED Phase.

Alternative 5 - Critical Infrastructure and Structural

Potential impacts to historic buildings and archeological resources from critical infrastructure measures and plantings at the Cutler Bay NNBF Site would be as those described in Alternative 2. Construction of floodwalls and surge barriers could potentially cause adverse impacts to unrecorded archaeological sites. The seawalls would be approximately up to two miles total in length, of that all has had some level of archaeological survey, mostly with an architectural survey. There are no recorded archaeological sites near the proposed inland seawalls and surge barriers. The design of the floodwalls and surge barrier at the mouth of the Miami River intentionally avoids any impact to archaeological resources at the Brickell Point Site, although visual effect of the wall might still be a potential adverse effect the landscape. The seawalls total about 8,100 meters in length, of that all but about 1,800 meters (22%) has had some level of archaeological survey, mostly with an architectural survey. During the PED Phase when the designs and structural alignments would be finalized, potential impacts would be reevaluated during the design phase. For areas not yet surveyed, potential impacts are relatively uncertain; therefore, archeological surveys would be conducted as needed during the PED Phase.

Alternative 7 - Critical Infrastructure, Nonstructural, and, Structural

Impacts would be as those described in Alternative 4 and Alternative 5.

Alternative 8 - Critical Infrastructure, Nonstructural, and Structural (Without Edgewater Floodwall)

Impacts would be as those described in Alternative 4 and Alternative 5.

Programmatic Agreement

While there has been considerable cultural resources survey in the project area, both archaeological and architectural, the level of survey may not be sufficient to assess the effects of this project and the surveys may be out of date by current standards. The large number of nonstructural measures cannot be identified at this time. Because of these limitations the completion of the identification of historic properties, determination of effects, and mitigation measures are being deferred to the PED Phase of the project through a Programmatic Agreement. The document is in Appendix E.

Cumulative Impacts

Past, current, and future development and navigation within the Miami-Dade County would continue to impact terrestrial and submerged archaeological sites in the Action Area. Areas within structural protections could see accelerated development impacting both archaeological sites and historic buildings.

It is assumed that USACE would continue implementation of major ongoing projects within the Miami-Dade County. These projects include, the Miami Harbor Deeping and Navigation Improvements Project, sponsored by the Port of Miami and Miami-Dade County; the Biscayne Bay Coastal Wetlands Project (Phase II Implementation), a component of the Comprehensive Everglades Restoration Plan (CERP), conducted in partnership with the SFWMD; and the Miami-Dade County Coastal Storm Risk Management Feasibility Study, (Beach Renourishment), sponsored by Miami-Dade County. These projects would mostly impact archaeological resources.

8.14 RECREATIONAL RESOURCES

Alternative 1 - No Action/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.

Miami-Dade County would continue coastal and climate resiliency efforts, including the Sea Level Rise Strategy Project, which aims to identify and develop feasible mitigation and adaption strategies for sea level rise and coastal storms; implementation of project proposed in the Rapid Action Plan and Adaptation Action Areas; and continued implementation of the EEL Program (WEC - Miami-Dade County, n.d.). The SFWMD would also continue research and implementation of various projects and initiatives in response to climate change and sea level rise.

Planned stormwater improvements in the City of Miami would also help address flooding issues. Examples would include updating the stormwater management plans and long term strategies would include installation of tidal backflow valves, improvements to stormwater facilities, and increased public involvement.

The USACE would continue implementation of ongoing projects within the Miami-Dade County. These projects would include, the Miami Harbor Deeping and Navigation Improvements Project, sponsored by the Port of Miami and Miami-Dade County; the Biscayne Bay Coastal Wetlands Project (Phase II Implementation), a component of the CERP, conducted in partnership with the SFWMD; and the Miami-Dade County Coastal Storm Risk Management Feasibility Study, (Beach Nourishment), sponsored by Miami-Dade County. These improvements and studies would continue into the future regardless of whether the Miami-Dade Back Bay Coastal Storm Risk Management Feasibility Study is implemented.

Existing upstream water management operations would continue.

It is expected that implementation of the Parks and Open Space System Master Plan (OSMP) would continue to be implemented over its 50-year concept of a sustainable and accessible system of parks and open spaces. There is also potential for more acres of EEL to be acquired and protected in the future, which would increase the number of natural areas within the county. Within the ROI, the management of recreational opportunities would continue to be managed by Parks, Recreation and Open Spaces as well as various partners.

Additionally, the Port of Miami plans to implement its 2035 Master Plan, a sub-element of the CDMP, which aims to expand port capacity for both cargo and cruise ships. As a part of the master plan, new berthing spaces and cruise terminals will be created for cruise ships.

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 affect the nature and character of the estuarine and coastal ecosystem in the ROI. Flooding events would adversely affect businesses providing recreation (shopping for example), arts (museums and art districts), and inland parks and open space from storm surge flooding. Adverse effects would be temporary, and moderate.

The No Action/Future without Project Alternative is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects, including changes to utility considerations within Miami-Dade County. It is anticipated that coastal recreation areas would increasingly and recurrently flood, temporarily, but increasingly reduce recreation opportunities in the county; this would be an adverse, minor and temporary impact to existing recreation. The continued improvement of the recreation and open spaces in the Miami-Dade County the impacts would be beneficial, permanent, and minor. With the implementation of the No Action/Future without Project Alternative, impacts would be adverse to beneficial, permanent to temporary and minor to moderate.

Alternative 2 – Critical Infrastructure

Construction and maintenance activities for Alternative 2 would be localized to the critical infrastructure and surrounding areas and would result in no anticipated impacts to recreation.

The implementation of the Cutler Bay NNBF has the potential to provide beneficial impacts to wildlife viewing and photography. Impacts would be beneficial, permanent, and minor.

Alternative 4 - Critical Infrastructure and Nonstructural

Construction and maintenance for critical infrastructure floodproofing and raising of residential structures would be localized to the critical infrastructure and structures and surrounding areas and would result in no anticipated impacts to recreation.

Residential properties that would be acquired and demolished would potentially be converted to parks and/or open spaces where the land was previously developed. This could potentially result in beneficial, minor impacts to recreation.

The implementation of the Cutler Bay NNBF has the potential to provide beneficial impacts to wildlife viewing and photography. Impacts would be beneficial, permanent, and minor.

Alternative 5 - Critical Infrastructure and Structural

Impacts to recreation from floodproofing critical infrastructure would be as those described for Alternative 2.

Staging areas and/or heavy machinery could cause ground disturbance and temporarily reduce available parks and/or open space utilized for recreation; these disturbed grounds would be restored, to the maximum practical extent to a pre-project state upon completion of construction. Construction and maintenance activities could temporarily impact ease of access to recreational opportunities caused by road closures or rerouting of traffic; this would adversely affect businesses by reducing the number of visitors to museums, shopping centers, or restaurants. Adverse, temporary impacts to recreation would be minor.

The construction, operation, and maintenance of the structural features would permanently limit access to parks and open space along the coast, reducing acreage available for recreation, reducing available docks and/or piers, inhibiting ingress/egress along waterways (Miami River, Little River, Biscayne Canal, and Biscayne Bay), as well as permanently altering the Riverwalk at Edgewater. Approximately up to two miles of floodwalls would be constructed along the Biscayne Bay and would result in permanent loss of water access, recreational boating areas and docks, and wildlife viewing. These recreational impacts would be adverse, significant and major.

The construction of the surge barriers would result in adverse, temporary access to recreation vessels in the Biscayne Canal, Little River, and Miami River. This would result in an adverse, temporary, and moderate impacts to recreational boating. The footprint of the surge barriers would permanently reduce boating access to the miter or sector gate opening resulting in an adverse, permanent, moderate impact. During major storm events and testing operations the surge barriers would close, restricting all ingress and egress of recreational boats from the Biscayne Canal, Little River, and Miami River to the Biscayne Canal resulting in adverse, temporary, and moderate impacts.

Implementation of Alternative 5 would also include the beneficial effects of protecting businesses (shopping for example), arts (museums and art districts), and inland parks and open space from storm surge flooding. As a result, temporary and/or permanent closure of the businesses and open spaces may not occur as frequently. This would be a beneficial, moderate effect to recreation.

The implementation of the Cutler Bay NNBF has the potential to provide beneficial impacts to wildlife viewing and photography. Impacts would be beneficial, permanent, and minor.

Impacts to recreation with implementation of Alternative 5 would be both adverse and beneficial, temporary to permanent and range from minor to significant.

Alternative 7 - Critical Infrastructure, Nonstructural, and, Structural

Impacts would be as those described in Alternative 4 and Alternative 5.

Alternative 8 - Critical Infrastructure, Nonstructural, and Structural (Without Edgewater Floodwall)

Recreational impacts would be less adverse with Alternative 8 as compared to Alternative 5 or Alternative 7 without the adverse impacts resulting from the Edgewater Floodwall. However, the overall impact findings would be as those described for Alternative 4 and Alternative 5.

Best Management Practices

For any of the action alternatives, avoidance and minimization practices would be employed to the maximum extent practicable for all potential impacts. Specific examples of best management practices to avoid and minimize impacts to recreation include:

1. During construction, do not impede vessel ingress/egress through navigation channels adjacent to proposed structural measures to the maximum extent practicable.
2. Avoid placing staging areas or structural measures in areas used for recreational purposes, i.e. parks, walkways, boating facilities, etc.
3. Inform business owners about temporary road closures prior to construction.

Cumulative Impacts

There are a multitude of past, present and reasonably foreseeable future projects within the Study Area. Regardless, if the above referenced alternatives are implemented, 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 would continue to be studied and implemented. 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. Most of these impacts would not directly affect recreation within the ROI.

Implementation of any of the action alternatives is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects.

8.15 AESTHETICS AND VISUAL RESOURCES

Alternative 1 - No Action/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.

Miami-Dade County would continue coastal and climate resiliency efforts, including the Sea Level Rise Strategy Project, which aims to identify and develop feasible mitigation and adaption strategies for sea level rise and coastal storms; implementation of project proposed in the Rapid Action Plan and Adaptation Action Areas; and continued implementation of the EEL Program (WEC - Miami-Dade County, n.d.). The SFWMD would also continue research and implementation of various projects and initiatives in response to climate change and sea level rise.

Planned stormwater improvements in the City of Miami would also help address flooding issues. Examples would include updating the stormwater management plans and long term strategies would include installation of tidal backflow valves, improvements to stormwater facilities, and increased public involvement.

The USACE would continue implementation of ongoing projects within the Miami-Dade County. These projects would include, the Miami Harbor Deeping and Navigation Improvements Project, sponsored by the Port of Miami and Miami-Dade County; the Biscayne Bay Coastal Wetlands Project (Phase II Implementation), a component of the CERP, conducted in partnership with the SFWMD; and the Miami-Dade County Coastal Storm Risk Management Feasibility Study, (Beach Nourishment), sponsored by Miami-Dade County. These improvements and studies would continue into the future regardless of whether the Miami-Dade Back Bay Coastal Storm Risk Management Feasibility Study is implemented.

Existing upstream water management operations would continue.

It is expected that implementation of the Parks and Open Space System Master Plan (OSMP) would continue to be implemented over its 50-year concept of a sustainable and accessible system of parks and open spaces. There is also potential for more acres of EEL to be acquired and protected in the future, which would increase the number of natural areas within the county. Within the ROI, the management of recreational opportunities would continue to be managed by Parks, Recreation and Open Spaces as well as various partners.

Coastal storm surge would continue to adversely affect Miami-Dade under the No Action Alternative. It is predicted that there would be an increase in the frequency/instances of Category 4 and 5 storms in the ROI (Miami-Dade 2019). Future storm events would continue to affect the visual resources and aesthetics of public spaces, as debris often accumulates in public spaces after storm events. In addition, the visual impacts of damaged structures and infrastructure would adversely affect the visual landscape. After Hurricane Irma, debris piles were cleared by the Right-of-Way Aesthetic and Assets Management Division (R.A.A.M.) staff in public spaces such as the Metromover stations pedestrian walkway and pathways (Miami-Dade 2017). The RAAM was created by the County to maintain the county's rights of way, parks, recreation and other open spaces in order to ensure a safe and aesthetically pleasing environment. The County would continue to remove debris after storm events in the future to preserve the visual resources and aesthetics of the ROI.

The City of Miami proposed initiatives to increase the mitigation effects of parks and open spaces by reducing the urban heat island effect. One plan that the city is considering is to increase tree canopy coverage city-wide to 30% (Miami-Dade 2019b). Green infrastructure is an important aspect of visual resources and aesthetics and is also identified by Miami-Dade as a

mitigation measure for parks and open spaces to act as a storm resilience measure. The City of Miami has a Museum Volunteers for the Environment (MUVE) program to restore living shorelines on Virginia Key and the City's Stormwater Master Plan identifies green and natural infrastructure as a way to reduce flooding impacts. Miami-Dade has stated that the City would continue to maximize green space, living shorelines and tree canopies to increase flood protection (Miami-Dade 2019b).

Though there are adverse, temporary, minor impacts to aesthetics and visual resources, Implementation of the No Action/Future without Project Alternative is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects.

Alternative 2 – Critical Infrastructure

Temporary construction and maintenance staging areas has the potential to cause temporary, minor impacts to aesthetics. These areas would be returned to a pre-project aesthetic condition following construction or maintenance activities. Visual impacts to critical infrastructure from floodproofing may cause some adverse, permanent aesthetic impacts. Construction and maintenance of the wet and dry floodproofing of critical infrastructure has the potential to produce adverse, temporary to permanent negligible to minor impacts to the viewshed.

The Cutler Bay NNBF Site would provide additional plantings of native vegetation that would serve to further beautify the visual landscape providing beneficial, permanent, and minor aesthetic impacts.

Alternative 4 - Critical Infrastructure and Nonstructural

Impacts to aesthetics for floodproofing of critical infrastructure would be as those described in Alternative 2. Temporary construction and maintenance staging areas has the potential to cause temporary, minor impacts to aesthetics. These areas would be returned to a pre-project aesthetic condition following construction or maintenance activities.

Elevating residential structures has the potential to produce adverse, minor to moderate, and permanent impacts to the viewshed, depending on the height to which the buildings are raised. (For a discussion of potential aesthetic impacts to archeological resources, historic buildings, and historic districts please refer to the Cultural Resources Section.)

Residential properties that would be acquired, demolished, and converted to parks and greenspace would serve to beautify the visual landscape providing beneficial, permanent, and minor aesthetic impacts. The Cutler Bay NNBF Site would provide additional plantings of native vegetation that would serve to further beautify the visual landscape providing beneficial, permanent, and minor aesthetic impacts.

Implementation of Alternative 4 would prevent or reduce visual disturbances to the landscape caused by storm surge including damaged infrastructure and buildings and debris. This would result in a beneficial, temporary, and moderate aesthetic impact.

Overall, implementation of Alternative 4 would result in adverse to beneficial, minor to moderate aesthetic impacts.

Alternative 5 - Critical Infrastructure and Structural

Aesthetic impacts resulting from floodproofing of critical infrastructure would be those as described in Alternative 2.

Structures including floodwalls, surge barriers, and pump stations would substantially alter the visual character in the ROI. The floodwalls along the Brickell, Edgewater, and Miami Riverwalk areas would have the most significant, adverse impact to the viewshed. In these locations, the floodwalls could potentially be up to 20 feet from ground surface elevation and extend up to approximately 50 feet into the Biscayne Bay. The floodwall would affect the view from the Miami Riverwalk along the Miami River. Due to the high volume of people inhabiting and commuting through Miami-Dade, the importance of the visual landscape of the Miami-River walk for the public, the importance of the Biscayne Bay as a visual resource, as well as the small volume of natural green space along the shoreline, the visual sensitivity is high. For the public utilizing the Biscayne Bay much of the Miami visual landscape would not be visible from the Biscayne Bay as well. The floodwalls would limit views to the Biscayne Bay from Miami. Therefore, construction, operation, and maintenance of the structural features would have an adverse, permanent, and major impact to the character of the viewshed.

Construction of the floodwalls and pump stations on either side of the Biscayne Canal and Little River Surge Barrier occur in previously disturbed and highly urbanized landscapes and the floodwalls would be anticipated to be less than approximately ten feet tall in these areas. Therefore, construction, operation, and maintenance impacts to these areas would range from temporary to permanent impacts that are moderate.

The Cutler Bay NNB Site would provide additional plantings of native vegetation that would serve to beautify the visual landscape providing beneficial, permanent, and minor aesthetic impacts.

Overall, implementation of Alternative 5 would have the potential to produce adverse to beneficial aesthetic impacts that are temporary to permanent and minor to major.

Alternative 7 - Critical Infrastructure, Nonstructural, and, Structural

Impacts would be as those described in Alternative 4 and Alternative 5.

Alternative 8 - Critical Infrastructure, Nonstructural, and Structural (Without Edgewater Floodwall)

Aesthetic impacts would be less adverse with Alternative 8 as compared to Alternative 5 or Alternative 7 without the adverse impacts resulting from the Edgewater Floodwall. However, the overall impact findings would be as those described for Alternative 4 and Alternative 5.

Best Management Practices

Best Management Practices to ensure that visual resources and aesthetics of the area are impacted to a lesser extent are:

1. Site floodwalls, pump stations, and surge barriers into existing developed areas with existing visual disturbances to the extent practical
2. Incorporate structural measures into the existing viewshed as seamlessly as possible;

3. Create a floodwall or surge wall design that fits the aesthetic of the River Walk;
4. Minimize the use of obtrusive signs on or near the flood wall or surge barriers;
5. Whenever feasible, use colors on the design that integrate with the existing visual landscape.

Cumulative Impacts

Due to the synergistic effects from combination of factors, including land subsidence, global and relative Sea Level Rise (SLR), and an increase in the frequency and strength of storms, the risk from coastal inundation would rise in the coming years for Miami-Dade County. However, implementation of the alternatives is not predicted to substantially cumulatively or synergistically interact with climate change and/or other effects in the ROI to affect visual resources.

8.16 SOCIOECONOMICS

Alternative 1 - No Action/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.

Miami-Dade County would continue coastal and climate resiliency efforts, including the Sea Level Rise Strategy Project, which aims to identify and develop feasible mitigation and adaption strategies for sea level rise and coastal storms; implementation of project proposed in the Rapid Action Plan and Adaptation Action Areas; and continued implementation of the EEL Program (WEC - Miami-Dade County, n.d.). The SFWMD would also continue research and implementation of various projects and initiatives in response to climate change and sea level rise.

Planned stormwater improvements in the City of Miami would also help address flooding issues. Examples would include updating the stormwater management plans and long term strategies would include installation of tidal backflow valves, improvements to stormwater facilities, and increased public involvement.

The USACE would continue implementation of ongoing projects within the Miami-Dade County. These projects would include, the Miami Harbor Deeping and Navigation Improvements Project, sponsored by the Port of Miami and Miami-Dade County; the Biscayne Bay Coastal Wetlands Project (Phase II Implementation), a component of the CERP, conducted in partnership with the SFWMD; and the Miami-Dade County Coastal Storm Risk Management Feasibility Study, (Beach Nourishment), sponsored by Miami-Dade County. These improvements and studies would continue into the future regardless of whether the Miami-Dade Back Bay Coastal Storm Risk Management Feasibility Study is implemented.

Existing upstream water management operations would continue.

With the No Action/Future without Project Alternative the community in Miami-Dade County would continue to suffer critical infrastructure damage and loss, property damage and losses, temporary to permanent displacement from flooding caused by coastal storms, and potentially life-loss. Miami-Dade County is already experiencing substantial impacts from nuisance flooding, to include high tides and king tides, as well as storm surges from storm related events. With the No Action Alternative/Future Without Project Alternative, erosion, subsidence, and

flooding in Miami-Dade County is anticipated to continue to occur which will put the public at risk. Widespread areas within the City of Miami would be vulnerable to flooding, leading to various potentially dangerous conditions such as flooded roadways, power outages, and stranded residents. Substantive economic damage would be sustained following major storm events. Certain segments of the population, focused on some geographic areas as described in the Socioeconomics Affected Environment Section, would be more vulnerable due to the inability to evacuate during storm events and would be most impacted. Impacts would be adverse, temporary and minor to major depending on the level of severity of the storm event and its affect to the local community.

Alternative 2 - Critical Infrastructure

Providing continuity of critical infrastructure such as utilities, hospitals, and emergency services would greatly improve resilience, the ability to for the community to return to normal after a coastal storm. Yet, the community would still potentially suffer damage and loss of property, loss of life, disruption of work, and both temporary and permanent displacement from major coastal storm events. Socially vulnerable segments of the population, such as the elderly and low income portions of the population would be most impacted. Construction and maintenance of the floodproofing for the critical infrastructure would provide some beneficial effects to the local economy creating temporary employment opportunities. Socioeconomics benefits from implementation of Alternative 2 would be beneficial, temporary to permanent, and minor to moderate.

Alternative 4 - Critical Infrastructure and Nonstructural

Socioeconomic impacts from floodproofing critical infrastructure would be those described in Alternative 2. Elevated residential homes may cause daily inconvenience and special hardships to the elderly and handicapped that have difficulty walking up multiple flights of stairs. Acquisition and demolition of residential properties would displace people and would break up neighborhoods, perhaps dislocating people to less desirable locations. Socially vulnerable segments of the population could potentially be impacted. However, acquisitions would be anticipated to be very limited. Adverse impacts associated with acquisitions would be permanent and would be moderate. Implementation of Alternative 4 would also provide significant benefits to the community in that the nonstructural measures would serve to prevent substantive property damage resulting from major coastal storm events. Floodproofing of commercial structures would allow businesses to rapidly resume operations following major storm events. Construction and maintenance of the project features would provide temporary employment benefits. Beneficial impacts to socioeconomics would be temporary to permanent and range from minor to major.

Therefore, with implementation of Alternative 4 impacts would be adverse to beneficial and range from minor to major impacts.

Alternative 5 - Critical Infrastructure and Structural

Socioeconomic impacts from floodproofing critical infrastructure would be those described in Alternative 2. Where away from the shoreline, the floodwalls would impede pedestrian and vehicular traffic, and change patterns of movement in the heart of the Miami metropolitan area.

Socially vulnerable segments of the population would be most adversely impacted. Adverse effects would be permanent and moderate.

Implementation of Alternative 5 would provide significant benefits to the community in that the measures would serve to prevent life-loss, prevent substantive property damage, and would protect infrastructure from major coastal storm events in the sections of Miami-Dade County protected by the structural features. The resiliency of the local community in the areas protected by the structures would be significantly enhanced in that local businesses could rapidly resume operations following a major coastal storm event. Construction and maintenance of the project features would provide temporary employment benefits. Beneficial impacts to socioeconomics would be temporary to permanent and range from minor to major.

Overall, impacts to socioeconomics would be adverse to beneficial, temporary to permanent, and would range from minor to major.

Alternative 7 - Critical Infrastructure, Nonstructural, and Structural

Impacts would be as those described for Alternative 4 and Alternative 5.

Alternative 8 - Critical Infrastructure, Nonstructural, and Structural (Without Edgewater Floodwall)

Impacts would be similar to those described for Alternative 7 although Alternative 8 would have more nonstructural benefits (and features) as compared to Alternative 7. However, the number of residential acquisitions would be the same for Alternative 7 and Alternative 8. Overall, the impact findings would be as those described for Alternative 4 and Alternative 5.

Best Management Practices

Best Management Practices to ensure that potential socioeconomics are impacted to a lesser extent are:

1. There would be strict adherence to the Uniform Relocation Act (URA).
2. Adverse effects on socioeconomics would be minimized through regular communication and coordination with affected residents.
3. Attempt to accommodate the citizens, particularly the elderly, disabled, minority, and low-income residents, to the extent reasonable and practicable and in accordance with law and regulation.

Cumulative Impacts

There are a multitude of past, present and reasonably foreseeable future projects within the ROI. Regardless, if the above referenced alternatives are implemented, 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 would continue to be studied and implemented. 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. Most of these impacts would not directly affect recreation within the ROI.

Implementation of any of the action alternatives is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects.

8.17 HAZARDOUS, TOXIC, AND RADIOACTIVE MATERIALS AND WASTES

Alternative 1 - No Action/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.

Miami-Dade County would continue coastal and climate resiliency efforts, including the Sea Level Rise Strategy Project, which aims to identify and develop feasible mitigation and adaption strategies for sea level rise and coastal storms; implementation of project proposed in the Rapid Action Plan and Adaptation Action Areas; and continued implementation of the EEL Program (WEC - Miami-Dade County, n.d.). The SFWMD would also continue research and implementation of various projects and initiatives in response to climate change and sea level rise.

The USACE would continue implementation of ongoing projects within the Miami-Dade County. These projects would include, the Miami Harbor Deeping and Navigation Improvements Project, sponsored by the Port of Miami and Miami-Dade County; the Biscayne Bay Coastal Wetlands Project (Phase II Implementation), a component of the CERP, conducted in partnership with the SFWMD; and the Miami-Dade County Coastal Storm Risk Management Feasibility Study, (Beach Nourishment), sponsored by Miami-Dade County. These improvements and studies would continue into the future regardless of whether the Miami-Dade Back Bay Coastal Storm Risk Management Feasibility Study is implemented.

Existing upstream water management operations would continue.

With the No Action/Future without Project plan, FDEP would continue to monitor their inventory of generators and sites of HTRW within the study area. The EPA would continue to regulate facilities and brownfield sites contaminated by HTRW in the ROI under the No Action/Future without Project. Miami-Dade County would continue to monitor the water quality of the Biscayne Aquifer from potential sources of contamination from HTRW under the county's Wellfield Protection Areas program (Miami-Dade, n.d).

There would be no anticipated impact to HTRW with implementation of the No Action/Future without Project Alternative. There would be no anticipated cumulative effects.

Alternative 2 – Critical Infrastructure

Potential impacts to HTRW would be localized to disturbance of existing structures of varying ages and surrounding areas. The potential exists for some structures and surrounding areas to contain lead-based paint, asbestos containing material, or polychlorinated biphenyls. In addition, some facilities being floodproofed could potentially contain or have previously contained petroleum products, hazardous materials and/or hazardous waste. Prior to construction, a Phase I Environmental Site Assessment (ESA) (and additional phased ESA investigations beyond the Phase I as needed) would be conducted to determine the potential presence of any

contamination. Any potential contamination would be required to be mitigated in accordance with state and federal regulations. All wastes would be disposed of at a certified waste disposal facility in accordance with state and federal requirements.

The construction contract would include requirements to properly manage, store, and dispose of all petroleum products, and hazardous materials, and/or wastes generated by or used for the project. Accident and spill prevention plans would be required and would be a requirement in the contract specifications and would prevent most spills.

Any potential contamination would be mitigated and BMPs would be followed for petroleum, hazardous material and waste storage, and an accident and spill prevention plan would be utilized during project construction. Therefore, any potential adverse, temporary impacts to HRTW during construction would be negligible.

Alternative 4 - Critical Infrastructure and Nonstructural

Potential impacts would be localized to disturbance of existing structures of varying ages and surrounding areas. The potential exists for some structures and surrounding areas to contain lead-based paint, asbestos containing material, or polychlorinated biphenyls. In addition, some structures being elevated or floodproofed could potentially contain or have previously contained petroleum products, hazardous materials and/or hazardous waste. Prior to construction, a Phase I ESA (and additional phased ESA investigations beyond the Phase I as needed) would be conducted to determine the potential presence of any contamination. Any potential contamination would be required to be mitigated in accordance with state and federal regulations. All wastes would be disposed of at a certified waste disposal facility in accordance with state and federal requirements.

The construction contract would include requirements to properly manage, store, and dispose of all petroleum products, and hazardous materials, and/or wastes generated by or used for the project. Accident and spill prevention plans would be required and would be a requirement in the contract specifications and would prevent most spills.

Any potential contamination would be mitigated and BMPs would be followed for petroleum, hazardous material and waste storage, and an accident and spill prevention plan would be utilized during project construction. Therefore, any potential adverse, temporary impacts to HRTW during construction would be negligible.

Alternative 5 - Critical Infrastructure and Structural

Potential impacts to HTRW would be located at proposed floodwall and surge barrier locations and associated pump station discharge locations and existing structures and surrounding areas. Some of the structures and surrounding areas have the potential to contain lead-based paint, asbestos containing material, or polychlorinated biphenyls. In addition, some structures could potentially contain or have previously contained petroleum products, hazardous materials and/or hazardous waste.

As shown in Figure 1 and 2, EPA regulated sites for HTRW are not directly in the vicinity of the proposed surge barriers, floodwalls, or pump stations, reducing the potential risk of contamination.

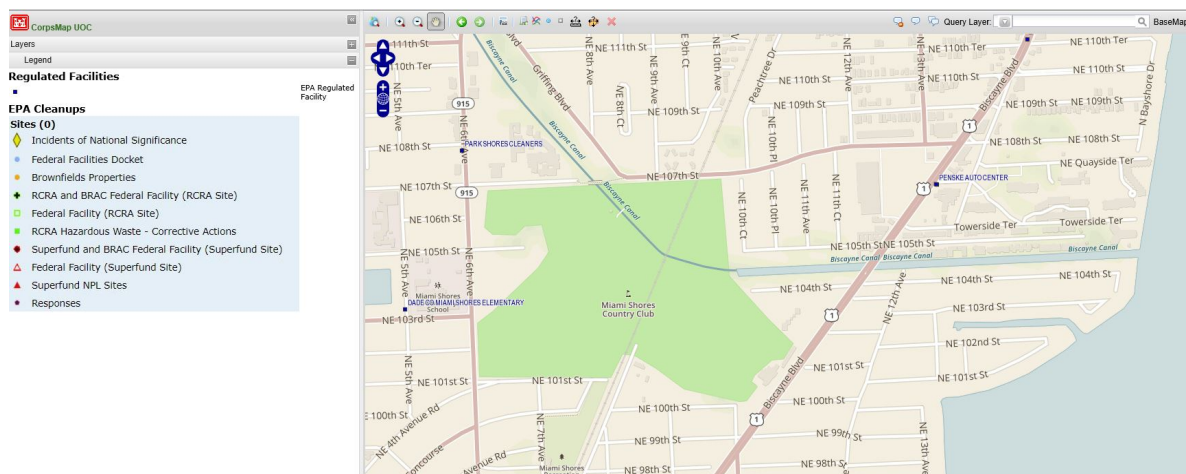


Figure 8-1. EPA regulated facilities by Little River

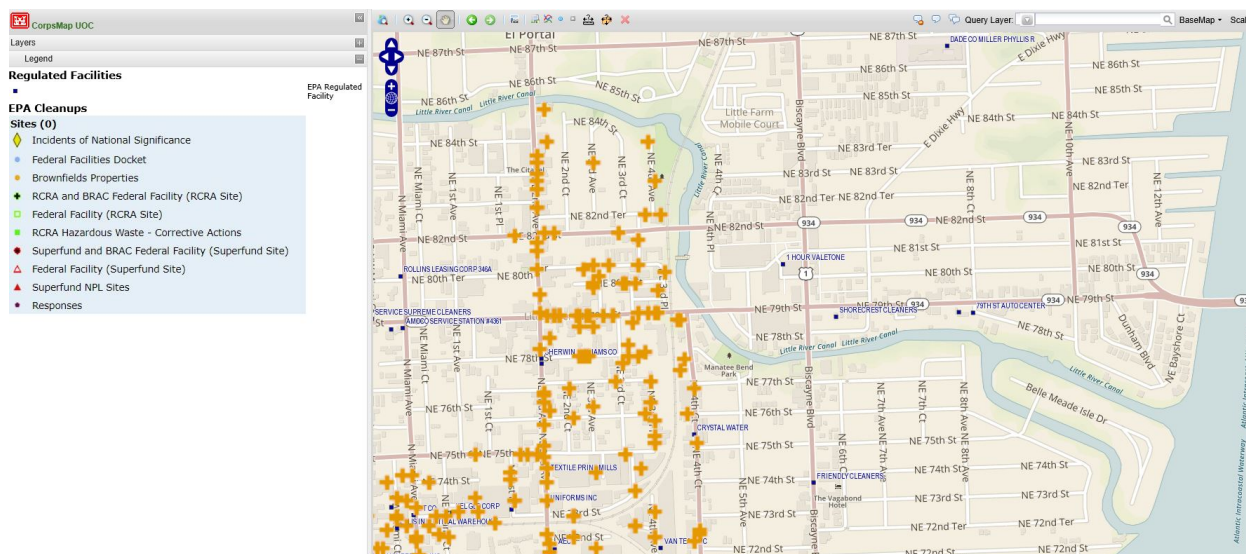


Figure 8-2. EPA regulated facilities by Biscayne Canal

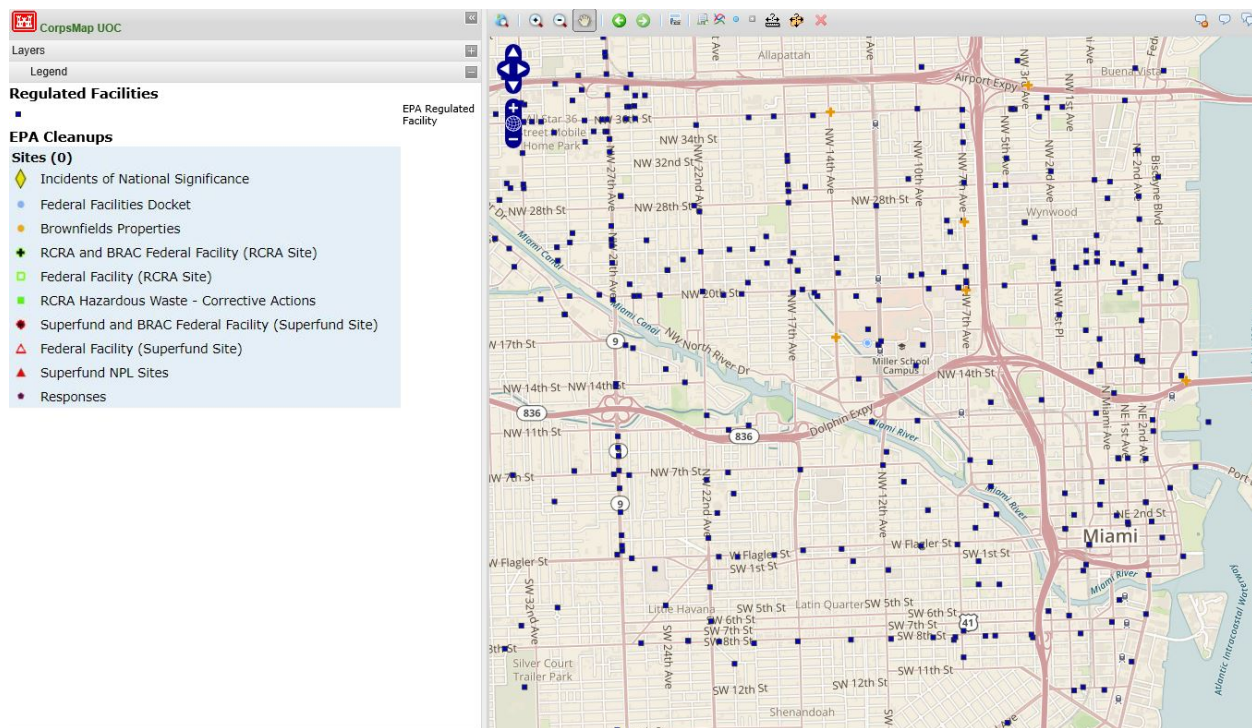


Figure 8-3. EPA Regulated facilities by Miami River

Prior to construction, a Phase I ESA (and additional phased ESA investigations beyond the Phase I as needed) would be conducted to determine the potential presence of any contamination. Any potential contamination would be required to be mitigated in accordance with state and federal regulations. All wastes would be disposed of at a certified waste disposal facility in accordance with state and federal requirements.

The construction contract would include requirements to properly manage, store, and dispose of all petroleum products, and hazardous materials, and/or wastes generated by or used for the project. Accident and spill prevention plans would be required and would be a requirement in the contract specifications and would prevent most spills.

Any potential contamination would be mitigated and BMPs would be followed for petroleum, hazardous material and waste storage, and an accident and spill prevention plan would be utilized during project construction. Therefore, any potential adverse, temporary impacts to HRTW during construction would be negligible.

Alternative 7 - Critical Infrastructure, Nonstructural, and, Structural

Impacts would be as those described in Alternative 4 and Alternative 5.

Alternative 8 - Critical Infrastructure, Nonstructural, and Structural (Without Edgewater Floodwall)

Impacts would be as those described in Alternative 4 and Alternative 5.

Best Management Practices

For any of the action alternatives, avoidance and minimization practices would be employed to the maximum extent practicable for all potential impacts. Specific examples of best management practices to avoid and minimize impacts to HRTW include:

1. A Phase 1 ESA (and additional phased ESA phased investigations as needed) would be conducted at all project areas with potential soil disturbance.
2. If HRTW materials or abandoned USTs are found, the project specifications will include procedures that require that they be handled and disposed of in accordance with state and federal regulations.
3. The project specifications would include an accident and spill prevention control plan. If unanticipated hazardous material or waste is encountered during project construction, efforts would be made to contain the material/waste and work with state and federal authorities to determine the appropriate methodology to dispose of the material/waste.
4. All materials would be disposed of in accordance with state and federal regulations; all wastes would be disposed of at certified disposal facilities.

Cumulative Impacts

There are a multitude of past, present and reasonably foreseeable future projects within the ROI. Regardless, if the above referenced alternatives are implemented, 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. 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.

Implementation of any of the action alternatives is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects.

8.18 SAFETY

Alternative 1 - No Action/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.

Miami-Dade County would continue coastal and climate resiliency efforts, including the Sea Level Rise Strategy Project, which aims to identify and develop feasible mitigation and adaption strategies for sea level rise and coastal storms; implementation of project proposed in the Rapid Action Plan and Adaptation Action Areas; and continued implementation of the EEL Program (WEC - Miami-Dade County, n.d.). The SFWMD would also continue research and implementation of various projects and initiatives in response to climate change and sea level rise.

Planned stormwater improvements in the City of Miami would also help address flooding issues. Examples would include updating the stormwater management plans and long term strategies would include installation of tidal backflow valves, improvements to stormwater facilities, and increased public involvement.

The USACE would continue implementation of ongoing projects within the Miami-Dade County. These projects would include, the Miami Harbor Deeping and Navigation Improvements Project, sponsored by the Port of Miami and Miami-Dade County; the Biscayne Bay Coastal Wetlands Project (Phase II Implementation), a component of the CERP, conducted in partnership with the SFWMD; and the Miami-Dade County Coastal Storm Risk Management Feasibility Study, (Beach Nourishment), sponsored by Miami-Dade County. These improvements and studies would continue into the future regardless of whether the Miami-Dade Back Bay Coastal Storm Risk Management Feasibility Study is implemented.

Existing upstream water management operations would continue.

With the No Action/Future without Project Alternative the community in Miami-Dade County would continue to suffer critical infrastructure damage and loss, property damage and losses, temporary to permanent displacement from flooding caused by coastal storms, and potentially life-loss. Miami-Dade County is already experiencing substantial impacts from nuisance flooding, to include high tides and king tides, as well as storm surges from storm related events. With the No Action Alternative/Future Without Project Alternative, erosion, subsidence, and flooding in Miami-Dade County is anticipated to continue to occur which will put the public at risk. Widespread areas within the City of Miami would be vulnerable to flooding, leading to various potentially dangerous conditions such as flooded roadways, power outages, and stranded residents. Damaged structures could also potentially expose construction workers and residents to high levels of mold and mildew that could cause respiratory illnesses. Certain segments of the population, focused on some geographic areas as described in the Socioeconomics Affected Environment Section, would be more vulnerable due to the inability to evacuate during storm events and would be most impacted. Impacts would be adverse, temporary and minor to major depending on the level of severity of the storm event and its affect to the local community.

Alternative 2 - Critical Infrastructure

Construction activities associated with the flood proofing have the potential to produce minor and adverse, temporary impacts to emergency services. However, coordinated plans would be in place prior to construction to minimize any potential, temporary disruption to these facilities.

Implementation of this alternative would better protect critical infrastructure facilities within Miami-Dade County from flooding events. Alternative 2 would provide beneficial, permanent, and moderate impacts to the public and emergency services on safety through the protection of critical infrastructure and structures from flooding events. However, with implementation of Alternative 2 alone, widespread areas would still be vulnerable to flooding and damages and destruction and damage of infrastructure and structures leading to various potentially dangerous conditions such as flooded roadways, power outages, and stranded residents. The implementation of Alternative 2 alone would not be anticipated to reduce life-loss associated with major coastal storm events.

During construction and maintenance activities there would be potential safety risks to personnel that could potentially include:

- Trip and fall hazards;
- Electrical hazards;
- Eye hazards;
- Equipment hazards;
- Fire hazards; and
- Confined space entry.

Contractors are required to prepare an Accident Prevention Plan (APP) for review by USACE safety staff prior to begin given notice to proceed with work (U.S. Army Corps of Engineers. EM-385-1-1). The APP specifies the safety and occupational health plan, responsible personnel and their OSHA certifications, safety training for all personnel, protective equipment, Clothing and Personal Protective Equipment (PPE) are typically required for workers. PPE includes:

- Appropriate clothing for weather conditions
- Steel toed boots
- Hard hat
- Protective eyewear matched to work type (e.g., cutting or welding)
- Work vest/personal floatation device (for work when on vessels)
- Hearing protection if exposed to various decibel levels for a scale of time periods

While there would be some risk of safety to personnel performing construction and maintenance, this impact would be largely mitigated by following the APP.

Therefore with implementation of Alternative 2 impacts to safety would be adverse to beneficial, temporary to permanent and range from minor to moderate.

Alternative 4 - Critical Infrastructure and Nonstructural

Construction activities associated with the flood proofing have the potential to produce minor and adverse, temporary impacts to emergency services. However, coordinated plans would be in place prior to construction to minimize any potential, temporary disruption to these facilities.

Implementation of this alternative would better protect critical infrastructure and structures within Miami-Dade County from flooding events. Alternative 4 would provide beneficial, permanent, and moderate impacts to the public and emergency services on safety through the protection of critical infrastructure facilities from flooding events. However, with implementation of Alternative 4 alone, widespread areas would still be vulnerable to flooding and damages and destruction to roadways could potentially result in stranded residents and inabilities of emergency responders to reach various areas of the county. The implementation of Alternative 4 alone would not be anticipated to reduce life-loss associated with major coastal storm events.

During construction and maintenance activities there would be potential safety risks to personnel that could potentially include:

- Trip and fall hazards
- Electrical hazards

- Eye hazards
- Equipment hazards
- Fire hazards
- Confined space entry

Contractors are required to prepare an Accident Prevention Plan (APP) for review by USACE safety staff prior to begin given notice to proceed with work (U.S. Army Corps of Engineers. EM-385-1-1). The APP specifies the safety and occupational health plan, responsible personnel and their OSHA certifications, safety training for all personnel, protective equipment, Clothing and Personal Protective Equipment (PPE) are typically required for workers. PPE includes:

- Appropriate clothing for weather conditions
- Steel toed boots
- Hard hat
- Protective eyewear matched to work type (e.g., cutting or welding)
- Work vest/personal floatation device (for work when on vessels)
- Hearing protection if exposed to various decibel levels for a scale of time periods

While there would be some risk of safety to personnel performing construction and maintenance, this impact would be largely mitigated by following the APP.

Therefore with implementation of Alternative 2 impacts to safety would be adverse to beneficial, temporary to permanent and range from minor to moderate.

Alternative 5 - Critical Infrastructure and Structural

Safety impacts resulting from floodproofing critical infrastructure would be as those described in Alternative 2.

Construction of the structural features would cause minor to moderate temporary, adverse safety impacts on the public (motorists, boaters, and pedestrians) and emergency services during construction. Construction areas will have to be secured, in addition to worker safety as prescribed by the Occupational Safety and Health Act (OSHA) and in accordance with the USACE APP.

The opening and closing of the surge barriers would pose temporary safety risks to the public. The storm surge barriers would affect navigation flow/passage in the Biscayne Canal, Little River, and Miami River; however, to mitigate any potential navigation risks the surge barriers would be marked in accordance with U.S. Coast Guard requirements and identified on navigation charts to ensure that boaters were aware of the navigation hazard. U.S. Coast Guard safety requirements and precautions for construction in navigable waters would be followed. To address this safety hazard and other aspects of the project, coordination would be conducted with local, state, and federal applicable agencies in regards to emergency management, emergency services, evacuation zones, and navigation (where applicable). Specific public outreach to all citizens within these areas to address these issues would be conducted. An operation and maintenance manual would also be developed to address the safe operation of the gates and backup/redundant power sources for operation of the gates and pump stations. Impacts to public safety would be adverse, temporary to permanent, and minor.

Following closure of the storm surge barriers, pump stations would be utilized to pump out any unintentional seepage from the Biscayne Bay and from stormwater trapped behind the surge barriers. However, if pump stations could not keep up with stormwater and seepage inputs and the gates could not be opened during a storm event, it could potentially cause significant induced flooding impacts behind (west of) the surge barriers that could result in significant infrastructure and property damage and life-loss. However, this would be mitigated by designing pump stations that could accommodate the anticipated storm events and seepage and by having redundant power sources that operate the surge barrier gates and pump stations. However, potential impacts to safety could be adverse, temporary, and major in the event of a system failure.

The implementation of Alternative 5 would also have the potential for long-term beneficial effects on safety, due to the prevention of widespread flooding during major storm events. This alternative would provide significant benefits to the community in that the measures would serve to prevent life-loss, prevent substantive property damage, and would protect infrastructure from major coastal storm events in the sections of Miami-Dade County protected by the structural features. However, residents still potentially could become trapped or prevented from reaching areas of the Miami-Dade County not protected by the surge barriers and floodwalls. Beneficial impacts to safety would be temporary to permanent and range from minor to major.

During construction and maintenance activities there would be potential safety risks to personnel that could potentially include:

- Trip and fall hazards
- Electrical hazards
- Eye hazards
- Equipment hazards
- Fire hazards
- Confined space entry

Contractors are required to prepare an APP for review by USACE safety staff prior to begin given notice to proceed with work (U.S. Army Corps of Engineers. EM-385-1-1). The APP specifies the safety and occupational health plan, responsible personnel and their OSHA certifications, safety training for all personnel, protective equipment, Clothing and PPE are typically required for workers. PPE includes:

- Appropriate clothing for weather conditions
- Steel toed boots
- Hard hat
- Protective eyewear matched to work type (e.g., cutting or welding)
- Work vest/personal floatation device (for work when on vessels)
- Hearing protection if exposed to various decibel levels for a scale of time periods

While there would be some risk of safety to personnel performing construction and maintenance, this impact would be largely mitigated by following the APP.

Overall, impacts to safety with Alternative 5 would be adverse to beneficial, temporary to permanent and range from minor to major.

Alternative 7 - Critical Infrastructure, Nonstructural, and Structural

Impacts would be as those described in Alternative 4 and Alternative 5.

Alternative 8 - Critical Infrastructure, Nonstructural, and Structural (Without Edgewater Floodwall)

Impacts would be as those described in Alternative 4 and Alternative 5.

Best Management Practices to Avoid and Minimize Impacts on Safety:

As the design and engineering of the alignments advance, minor alignment shifts and detailed coordination could be evaluated to avoid and minimize potential impacts to safety. These considerations could be undertaken during the PED phase and coordinated with applicable agency partners during the associated permit application process. For any potential final alignments, avoidance and minimization practices will be employed to the maximum extent practicable for all potential impacts. Specific examples of best management practices to avoid and minimize impacts on safety include:

1. Safety plans in accordance with current regulations would be strictly adhered to during construction.
2. Coordination with all applicable emergency service agencies, local, state, and federal regulatory agencies, and the general public would be conducted to ensure that safety concerns are all addressed, to include those specific to evacuation measures.
3. Contractors are required to prepare an Accident Prevention Plan (APP) for review by USACE safety staff prior to begin given notice to proceed with work (U.S. Army Corps of Engineers. EM-385-1-1).
4. U.S. Coast Guard safety requirements and precautions for construction in navigable waters would be followed; navigation signage would be used to alert boaters of navigation hazards and the surge barriers would be marked on navigation charts.
5. Public access would be prohibited in construction zones.

Cumulative Impacts

There are a multitude of past, present and reasonably foreseeable future projects within the ROI. Regardless, if the above referenced alternatives are implemented, 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. 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.

Implementation of any of the action alternatives is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects.

8.19 TRANSPORTATION

Alternative 1- No Action/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.

Miami-Dade County would continue coastal and climate resiliency efforts, including the Sea Level Rise Strategy Project, which aims to identify and develop feasible mitigation and adaption strategies for sea level rise and coastal storms; implementation of project proposed in the Rapid Action Plan and Adaptation Action Areas; and continued implementation of the EEL Program (WEC - Miami-Dade County, n.d.). The SFWMD would also continue research and implementation of various projects and initiatives in response to climate change and sea level rise.

Planned stormwater improvements in the City of Miami would also help address flooding issues. Examples would include updating the stormwater management plans and long term strategies would include installation of tidal backflow valves, improvements to stormwater facilities, and increased public involvement. This would serve to help protect critical infrastructure from interior, stormwater-induced flooding.

The USACE would continue implementation of ongoing projects within the Miami-Dade County. These projects would include, the Miami Harbor Deeping and Navigation Improvements Project, sponsored by the Port of Miami and Miami-Dade County; the Biscayne Bay Coastal Wetlands Project (Phase II Implementation), a component of the CERP, conducted in partnership with the SFWMD; and the Miami-Dade County Coastal Storm Risk Management Feasibility Study, (Beach Nourishment), sponsored by Miami-Dade County. These improvements and studies would continue into the future regardless of whether the Miami-Dade Back Bay Coastal Storm Risk Management Feasibility Study is implemented.

Existing upstream water management operations would continue.

The Florida Department of Transportation (FDOT), FHWA, and local municipalities have a multitude of current roadway improvement projects and ones that are planned for the future under long range transportation projects. Some of these roadway projects are also funded through public private funded initiatives. There are planned improvements to the metro, rail, and the Miami Airport, among others. Miami-Dade County within the ROI also has many ongoing private and government funded construction projects to include improvements to the Port of Miami that include aspects of transportation. These improvements and studies would continue into the future regardless of whether the Miami-Dade Back Bay Coastal Storm Risk Management Feasibility Study is implemented.

With the No Action/Future without Project Alternative, the community in Miami-Dade County would continue to suffer critical infrastructure damage and loss, property damage and losses, temporary to permanent displacement from flooding caused by coastal storms, and potentially life-loss. The increased nuisance flooding and susceptibility from other flooding with storm surge events can lead to various potentially dangerous conditions such as flooded or damaged evacuation routes. Widespread areas within the City of Miami would be vulnerable to flooding, leading to various potentially dangerous conditions such as flooded roadways, power outages

(with potential loss of the roadway traffic system), and stranded residents. Miami-Dade County is already experiencing substantial impacts from nuisance flooding, to include high tides and king tides, as well as storm surges from storm related events. With the No Action Alternative/Future Without Project Alternative, erosion, subsidence, and flooding in Miami-Dade County is anticipated to continue to occur which will put the public at risk.

Therefore, this alternative would result in impacts to transportation that are adverse to beneficial, temporary to permanent and minor to major.

Alternative 2 - Critical Infrastructure

There would be minimal construction and maintenance activities limited to the critical infrastructure sites, Cutler Bay NNBF Site, and surrounding areas. Any potential construction access areas needed on public roadways would be very limited and in most cases not be required. Staging areas would not directly affect roadways, however, heavy equipment and vehicles entering and exiting the transportation network could potentially cause adverse, temporary, and negligible to minor travel delays.

With implementation of Alternative 2 alone, widespread areas would still be vulnerable to flooding, leading to various potentially dangerous conditions during storm events such as flooded roadways, power outages (with potential loss of the roadway traffic system), and stranded residents.

The implementation of Alternative 2 would be anticipated to have an adverse, temporary and negligible to minor impact on transportation.

Alternative 4 - Critical Infrastructure and Nonstructural

Impacts to transportation from floodproofing critical infrastructure would be as those described in Alternative 2.

Construction access from public roadways would be needed to access residential elevation and acquisition/demolition sites and the Cutler Bay NNBF Site. Staging areas would not directly affect roadways, however, heavy equipment and vehicles entering and exiting the transportation network would cause adverse, temporary, and negligible to minor travel delays.

Acquisition of flood-prone residences may permanently reduce the future number of residents needing to evacuate on the transportation network prior to storm events.

With Alternative 4, there would be no flood protection to the road network in Miami-Dade County. The increased nuisance flooding and susceptibility from other flooding with storm surge events can lead to various potentially dangerous conditions such as flooded or damaged evacuation routes. Widespread areas within the City of Miami would continue to be vulnerable to flooding, leading to various potentially dangerous conditions such as flooded roadways, which could result in stranded residents.

Overall, impacts to transportation with implementation of Alternative 4 would be adverse to beneficial, temporary, and range from negligible to minor.

Alternative 5 - Critical Infrastructure and Structural

Impacts to transportation from floodproofing critical infrastructure would be as those described in Alternative 2.

Construction access from public roadways would be needed to access structural sites, residential elevation and acquisition/demolition sites, and the Coter Bay NNBF Site. Staging areas would not be anticipated to directly affect roadways, however, heavy equipment and vehicles entering and exiting the transportation network would cause adverse, temporary, and minor to moderate travel delays.

Acquisition of flood-prone residences may permanently reduce the future number of residents needing to evacuate on the transportation network prior to storm events. There would be flood protection to the road network in Miami-Dade County protected by the surge barriers and floodwalls, however, the remainder of the county would still be subject to potential roadway damage/destruction (including evacuation routes), power losses, and potentially stranded residents.

The surge barriers with the floodwalls and associated pump stations and riprap would provide beneficial, permanent impacts on transportation as they are the measures that would serve to prevent flood damages to the roadways and associated traffic system. There would be significant benefits to public transportation safety and also to the roadway physical network itself. Benefits would be permanent and major.

There would be temporary road closures and rerouting of traffic at the floodwall locations when the surge barriers are in the closed position resulting in adverse and moderate impacts to traffic. Detailed traffic studies and a reexamination of the evacuation routes would be conducted during the PED Phase when the final siting of the floodwalls and surge barriers would be determined. Additional coordination would be conducted with local, state, and federal applicable agencies in regards to emergency management, emergency services, evacuation zones, and transportation. Specific public outreach to all citizens within these areas to address these issues would be conducted.

Overall, impacts to transportation would be adverse to beneficial, temporary to permanent, and range from minor to major.

Alternative 7 - Critical Infrastructure, Nonstructural, and Structural

Impacts would be as those described in Alternative 4 and Alternative 5.

Alternative 8 - Critical Infrastructure, Nonstructural, and Structural (Without Edgewater Floodwall)

Impacts would be as those described in Alternative 4 and Alternative 5.

Best Management Practices to Avoid and Minimize Impacts on Transportation:

Avoidance and minimization practices will be employed to the maximum extent practicable for all potential impacts. Specific examples of best management practices to avoid and minimize impacts to transportation include:

1. Prior to construction, a transportation plan would be developed by USACE and approved by FDOT and Miami-Dade County for any temporary impacts on traffic.
2. Prior to construction, schedules would be coordinated with FDOT and Miami-Dade 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.
5. Any potential temporary disruptions to designated evacuation routes or zones would be developed by USACE and approved by FEMA, FDEM, Miami-Dade County and other applicable agencies to ensure that known and agreed upon alternate routes would be publicized. Any potential impacts would be minimized to the maximum extent practicable.

Cumulative Impacts

There are a multitude of past, present and reasonably foreseeable future projects within the ROI. Regardless, if the above referenced alternatives are implemented, 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. 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.

Miami-Dade County within the ROI has many ongoing private and government funded construction projects. There are a multitude of long range plans for transportation that include the study area and overlap in their initiatives. Miami-Dade County's Comprehensive Development Master Plan (CDMP) lays out its general objectives and policies addressing development and land use over the next 10-20 years. (Miami-Dade County 2018) The Port of Miami is also part of multiple long range transportation plans with its own 2035 Master Plan, which is a sub-element of the CDMP. The long range plan is focused on improving processes while anticipating an unprecedented growth in its cargo traffic and cruise travel operations. All of these improvement and developmental projects can have temporary and/or permanent impacts to transportation within the study area.

Climatic changes such as sea level rise and increasing global temperatures are predicted to continue over the next 50 years. Due to the synergistic effects from a combination of factors, and relative sea level rise, and an increase in the frequency and strength of storms, the risk from coastal inundation will rise in the coming years for Miami-Dade County. Regardless of whether any of the alternatives are adopted, existing coastal storm risk management resilience efforts in Miami-Dade County, as described in previous sections of this chapter, would continue to be implemented and maintained. This could include physical efforts such as secondary and tertiary road raisings. Development within Miami-Dade County is anticipated to continue to grow; however, they would be subject to floodplain regulations, any applicable mitigation requirements, and Miami-Dade County requirements.

Implementation of the action alternatives would not be predicted to substantially, cumulatively, or synergistically interact with other past, present, and future effects on transportation. Cumulative effects to transportation from implementation of Alternative 5 or 7 are predicted to be minor to moderate and beneficial. Therefore, with implementation of any of the action alternatives we would anticipate that impacts to transportation in the future related to the project would be adverse and temporary during construction, range from minor and moderate depending on the exact locations and designs once determined for the structural measures, but are anticipated to be less than significant. The benefits to public transportation safety with the combination of the alternatives discussed above to include the protection of critical infrastructure, nonstructural features implemented, surge barriers, and the floodwall would be beneficial and major and would provide the greatest protection for the public, property, and critical infrastructure within Miami-Dade County.

8.20 NAVIGATION

Alternative 1 - No Action/Future without Project

With the No Action/Future without Project Alternative, Miami-Dade County would continue to change over time as expected with improvement projects and upgrades to existing projects to aid with coastal resiliency and climate change. These improvements will continue to be made that are already planned by the Miami-Dade County and its associated municipalities independent of the USACE project.

Miami-Dade County would continue coastal and climate resiliency efforts, including the Sea Level Rise Strategy project, which aims to identify and develop feasible mitigation and adaptation strategies for sea level rise and coastal storms and implementation of project proposed in the Rapid Action Plan and Adaptation Action Areas. (WEC - Miami-Dade County, n.d.) Stormwater improvement projects currently being implemented through the City of Miami to combat sea level rise would continue. The South Florida Water Management District (SFWMD) is also involved in research and implementation of various projects and initiatives in response to climate change and sea level rise.

There are numerous dredging and construction projects and studies in Miami-Dade County that include aspects of navigation. It is assumed that USACE would continue implementation of major ongoing projects within the County. These projects include, the Miami Harbor Navigation Improvements Project, sponsored by the Port of Miami and Miami-Dade County in coordination with USACE's Jacksonville District (SAJ); the Biscayne Bay Coastal Wetlands Project (Phase II Implementation), a component of the Comprehensive Everglades Restoration Plan (CERP), conducted in partnership with the SFWMD; and the Miami-Dade County Coastal Storm Risk Management Feasibility Study, (Beach Nourishment), sponsored by Miami-Dade County. USACE SAJ has completed construction for the Miami Harbor Deepening Project, which was the first Federal navigation project in the southeast built to a 50-foot depth to accommodate the present day shipping needs. There are also other ongoing smaller projects in the Biscayne Bay and surrounding waterways to include beach erosion control projects, shoreline stabilization projects, and eco-restoration projects.

Existing upstream water management operations would continue.

Miami-Dade County within the ROI also has many ongoing private and government funded construction projects to include improvements to the Port of Miami that would continue.

These improvements and studies would continue into the future regardless of whether the Miami-Dade Back Bay Coastal Storm Risk Management Feasibility Study is implemented. The No Action Alternative would involve no additional action from current or planned future actions to mitigate against coastal storm risk. This alternative would be anticipated to have no impacts to navigation.

Alternative 2 - Critical Infrastructure

Construction and maintenance to floodproof critical infrastructure would be located on uplands or in areas in the immediate vicinities of coastlines and would not be anticipated to impact navigation. Mangrove plantings at the NNBF site would be adjacent to existing, very shallow mangrove habitat and would not be anticipated to impact navigation.

Therefore, with implementation of Alternative 2 there would be no anticipated impacts to navigation.

Alternative 4 - Critical Infrastructure and Nonstructural

Construction and maintenance to floodproof critical infrastructure and to elevate or acquire and demolish residential structures would be located on uplands or in areas in the immediate vicinities of coastlines and would not be anticipated to affect navigation. Mangrove plantings at the NNBF site would be adjacent to existing, very shallow mangrove habitat and would not be anticipated to impact navigation.

Therefore, with implementation of Alternative 4 there would be no anticipated impacts to navigation.

Alternative 5 - Critical Infrastructure and Structural

There would be no anticipated impacts to navigation from implementation of the critical infrastructure, nonstructural, and Cutler Bay NNBF measures.

Temporary and permanent impacts to navigation would result from the construction, maintenance, and operation of the surge barriers and floodwalls (and associated features including pump stations and riprap).

There would not be a permanent increase in the number of vessels transiting the ROI. The construction of the surge barriers, floodwalls (and associated pump stations and riprap), however, would temporarily increase the number of vessels transiting the proposed study area, which is already highly utilized by commercial and recreational vessels for the Miami River and for recreational vessels for the Little River and Biscayne Canal.

Although relatively uncertain and dependent on environmental conditions, the storm surge barriers would only be anticipated to be closed during major storm events which would be approximately up to five times per year. Closure times would be dependent on environmental conditions but would be anticipated to be on average of five days but could occur up to approximately ten days.

The storm surge barriers would adversely affect navigation in the Biscayne Canal, Little River, and Miami River. To mitigate potential navigation safety risks, the surge barriers would be marked in accordance with U.S. Coast Guard requirements and identified on navigation charts to ensure that boaters were aware of the navigation hazard. U.S. Coast Guard safety requirements and precautions for construction in navigable waters would be followed.

During the PED Phase, coordination with the USCG, and state and federal agencies would occur to obtain required permits and authorizations.

Surge barrier and associated floodwalls at Biscayne Canal

The Biscayne Canal waterway is mainly used by recreational vessels. The construction area within the waterway would need to be isolated for safety purposes, and restrictions and/or closures of the waterway may be necessary. There may also be a need to utilize open space areas near the potential surge barrier locations for staging, during construction, and as a result, there may be temporary disruption of navigable access. Some areas may be temporarily inaccessible to boats that pull up and moor there during construction as well. There would be adverse, temporary, and moderate impacts to navigation and mooring during construction of the structural features.

Storm surge gates would still allow for recreational boat traffic when they are in the open position, however, the navigational area would be permanently narrowed to the gate openings which may result in reductions in vessel speeds, and vessel congestion and delays. The storm surge gates would close prior to major storm events temporarily impeding all potential navigation. In addition, periodic testing of the operation, as well as maintenance of the storm surge gates would occur which would result in temporary cessation of navigation. Due to potential safety concerns, boating areas would be temporarily restricted at pump station discharge points during maintenance, testing, and operation of the pump stations. Impacts resulting from maintenance, operating, and testing of the structural features would be adverse, temporary to permanent, and moderate.

Surge barrier and associated floodwalls at Little River

The Little River waterway is used mainly by recreational vessels. The Little River is only navigable up the intersection of the Route 1 Bridge.

The construction area within the waterway would need to be isolated for safety purposes, and restrictions and/or closures of the waterway may be necessary. There may also be a need to utilize open space areas near the potential surge barrier locations for staging, during construction, and as a result, there may be temporary disruption of navigable access. Some areas may be temporarily inaccessible to boats that pull up and moor there during construction as well. There would be adverse, temporary, and moderate impacts to navigation and mooring during construction of the structural features.

Storm surge gates would still allow for recreational boat traffic when they are in the open position, however, the navigational area would be permanently narrowed to the gate openings which may result in reductions in vessel speeds, and vessel congestion and delays. The storm surge gates would close prior to major storm events temporarily impeding all potential navigation. In addition, periodic testing of the operation, as well as maintenance of the gates

would occur which would result in temporary cessation of navigation. Due to potential safety concerns, boating areas would be temporarily restricted at pump station discharge points during maintenance, testing, and operation of the pump stations. Impacts resulting from maintenance, operating, and testing of the structural features would be adverse, temporary to permanent, and moderate.

Surge barrier at Miami River

The Miami River, a designated federal navigation channel, is a narrow, heavily trafficked channel and navigation traffic must already travel slowly and carefully through this area. The Miami River has a depth of -15 feet mean low tide and is used as a narrow shipping corridor as well as for recreational boating by residents, marinas, and visitors. Recreational vessels that use this section of the river include mega yachts.

The construction area within the waterway would need to be isolated for safety purposes, and restrictions and/or closures of the waterway may be necessary. There may also be a need to utilize open space areas near the potential surge barrier locations for staging, during construction, and as a result, there may be temporary disruption of navigable access. Some areas may be temporarily inaccessible to boats that pull up and moor there during construction as well. There would be adverse, temporary, and moderate impacts to navigation and mooring during construction of the structural features.

Access to the construction site may be difficult in and around the Miami River due to the narrowness of the channel and lack of accessible land that is not private property on the east bank and protected resources, the Miami Circle, on the west bank. In areas where there is limited space between the proposed locations, some of the construction may have to be done from barges in these difficult-to-reach locations, but these would require extensive coordination as to not completely restrict navigation during construction.

Navigation would be allowed when the surge barrier gates are in the open position, however, the navigational area would be permanently narrowed to the gate openings which may result in reductions in vessel speeds, and vessel congestion and delays. The storm surge gates would close prior to major storm events temporarily impeding all navigation. In addition, periodic testing of the operation, as well as maintenance of the gates would occur which would result in temporary cessation of navigation. Due to potential safety concerns, boating areas would be temporarily restricted at pump station discharge points during maintenance, testing, and operation of the pump stations. Impacts resulting from maintenance, operating, and testing of the structural features would be adverse, temporary to permanent, and moderate.

The Miami River is also used as a boat evacuation route. The construction, maintenance and testing operations of the surge barrier could potentially have adverse, temporary, and moderate to major impacts on operations of existing navigation by impeding or limiting access upstream. The construction schedule would need to be coordinated with local agencies, marina owners, and the general public to minimize these impacts. Recreational vessels using this as a boat evacuation route during an impending storm could potentially also be adversely impacted and timing of any closure of gates would need to be coordinated with local agencies, USCG, and the general public.

Proposed Floodwalls at Brickell and Edgewater in the Biscayne Bay

The floodwalls would not be anticipated to impact the federal navigation channel nor the Intracoastal Waterway.

Within the footprint of the floodwalls, navigation would be permanently restricted and no docking or mooring of vessels would be allowed. This would result in an adverse, permanent and major impacts to navigation. The floodwalls would also result in vessels being required to permanently slow their speed adjacent to the floodwall and potentially alter their direction.

During construction and maintenance operations there would be additional temporary impacts to navigation beyond the footprint of the floodwalls extending into Biscayne Bay (approximately an additional 10 feet beyond the floodwalls). During construction, there would be temporary disruption of navigable access and certain areas may be temporarily inaccessible to boats that pull up and moor in these locations.

Access to the construction site may be difficult in and around it would be anticipated that some of the construction would have to be done from barges, but this would require extensive coordination to safely mark and secure the in-water construction areas. The use of temporary cofferdams would be anticipated for any in-water construction as well.

Due to potential safety concerns, boating areas would be temporarily restricted at pump station discharge points during maintenance, testing, and operation of the pump stations. Impacts resulting from maintenance, operating, and testing of the structural features would be adverse, temporary to permanent, and moderate.

Overall, there would be temporary to adverse impacts to navigation that would range from moderate to major impacts.

Summary

Overall the impacts to navigation from Alternative 5 would be adverse, temporary to permanent and range from moderate to major.

Alternative 7 - Critical Infrastructure, Nonstructural, and Structural

Impacts would be as those described in Alternative 4 and Alternative 5.

Alternative 8 - Critical Infrastructure, Nonstructural, and Structural (Without Edgewater Floodwall)

Impacts would be similar but less adverse than those for Alternative 4 and Alternative 5 because there would be no navigation impacts at Edgewater. However, overall impact findings would be as those described for Alternative 4 and Alternative 5.

Best Management Practices to Avoid and Minimize Impacts on Navigation:

As the design and engineering of the alignments advance, alignment shifts could be evaluated to avoid and minimize potential impacts to navigation. These considerations could be undertaken during the PED phase and coordinated with applicable agency partners during the associated permit application process. For any of these potential final alignments, avoidance and minimization practices will be employed to the maximum extent practicable for all potential

impacts. Practicable is defined as, “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 to navigation include:

1. In depth coordination and approval procedures would be conducted with all applicable agencies to include USCG, FIND, Miami-Dade County, FWC, and others to ensure minimizing the potential impact to vessels during any construction.
2. Coordination plans and detailed schedules for closures that could alter navigation access during construction would be posted and the public notified well in advance.
3. Clear markings and signage to allow boaters safe navigation access during active construction would be utilized in coordination with agency guidelines and permit conditions.
4. To mitigate potential navigation safety risks, the surge barriers would be marked in accordance with U.S. Coast Guard requirements and identified on navigation charts to ensure that boaters were aware of the navigation hazard. U.S. Coast Guard safety requirements and precautions for construction in navigable waters would be followed.

Cumulative Impacts

There are a multitude of past, present and reasonably foreseeable future projects within the Study Area. Regardless, if the above referenced alternatives are implemented, 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.

Miami-Dade County within the ROI has many ongoing private and government funded construction projects. There are a multitude of long range plans for navigation that include the study area and overlap in their initiatives. Miami-Dade County's Comprehensive Development Master Plan (CDMP) lays out its general objectives and policies addressing development and land use over the next 10-20 years. (Miami-Dade County 2018) The Port of Miami is also part of multiple long range transportation plans with its own 2035 Master Plan, which is a sub-element of the CDMP. The long range plan is focused on improving processes while anticipating an unprecedented growth in its cargo traffic and cruise travel operations. All of these improvement and developmental projects can have temporary and/or permanent impacts to navigation within the study area.

Climatic changes such as sea level rise and increasing global temperatures are predicted to continue over the next 50 years. Due to the synergistic effects from a combination of factors, and relative sea level rise, and an increase in the frequency and strength of storms, the risk from coastal inundation will rise in the coming years for Miami-Dade County. However, implementation of the alternatives would not be predicted to substantially, cumulatively, or synergistically interact with climate change and/or effects from other actions in the ROI, with respect to navigation. Cumulative adverse effects to navigation from implementation of Alternative 5 or 7 are predicted to range from moderate to major impacts that are temporary to permanent in duration.

8.21 UTILITIES

Alternative 1 - No Action/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.

Miami-Dade County would continue coastal and climate resiliency efforts, including the Sea Level Rise Strategy Project, which aims to identify and develop feasible mitigation and adaption strategies for sea level rise and coastal storms; implementation of project proposed in the Rapid Action Plan and Adaptation Action Areas; and continued implementation of the EEL Program (WEC - Miami-Dade County, n.d.). The SFWMD would also continue research and implementation of various projects and initiatives in response to climate change and sea level rise.

Planned stormwater improvements in the City of Miami would also help address flooding issues. Examples would include updating the stormwater management plans and long term strategies would include installation of tidal backflow valves, improvements to stormwater facilities, and increased public involvement.

The USACE would continue implementation of ongoing projects within the Miami-Dade County. These projects would include, the Miami Harbor Deeping and Navigation Improvements Project, sponsored by the Port of Miami and Miami-Dade County; the Biscayne Bay Coastal Wetlands Project (Phase II Implementation), a component of the CERP, conducted in partnership with the SFWMD; and the Miami-Dade County Coastal Storm Risk Management Feasibility Study, (Beach Nourishment), sponsored by Miami-Dade County. These improvements and studies would continue into the future regardless of whether the Miami-Dade Back Bay Coastal Storm Risk Management Feasibility Study is implemented.

Existing upstream water management operations would continue.

It is expected that the overall demand for utilities would increase over time into the future due to population increases and redevelopment. It can be expected that utility providers for other services (power, telecommunications, and gas) would anticipate demand and plan for it to ensure Miami-Dade County has full utility services available to all residents and commercial enterprises.

Within the project ROI, utilities would be repaired and upgraded as needed. The local managed utilities and/or private entities that control the various utilities would be expected to continue to upgrade and maintain them as needed. This would also include some relocations as infrastructure and needs change over time.

Power infrastructure improvements are also planned through FPL's "Storm Secure Underground Program" and other initiatives. The main improvements include hardening of main power lines that service critical community facilities and services and undergrounding all main power lines by the end of 2024. (FPL 2019) The majority of the No Action/Future without Project Condition projects would likely result in the temporary or permanent relocation of utilities to coincide with the other initiatives currently taking place and those projected to occur. During construction, there would likely be temporary, pre-approved, scheduled, and controlled utility service

interruptions; however, upon the completion of construction these temporary service interruptions would cease.

Predicted climate change impacts, such as increased ocean temperatures, ocean acidification, sea level rise, and changes in currents, upwelling, and weather patterns, would have the potential to affect the nature and character of the estuarine and coastal ecosystem in the ROI. Waters would continue to rise in the Biscayne Bay region, which would negatively impact Miami-Dade County by increased flooding, including both nuisance and after major storm events. During and following flooding events utilities would be potentially damaged or temporarily not functional resulting in adverse, temporary, and moderate impacts.

The No Action/Future without Project Alternative is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects, including changes to utility considerations within Miami-Dade County. It is anticipated that utility resiliency efforts and improvements by Miami-Dade County, its' municipalities, SFWMD, and private entities would continue as a reaction to both imminent and forecasted needs. The increased and recurrent flooding events, would make existing utilities increasingly susceptible to damage caused by flooding and disruption of services. With the implementation of the No Action/Future without Project Alternative, impacts would be permanent, adverse, and moderate.

Alternative 2 - Critical Infrastructure

Construction and maintenance activities resulting from floodproofing of critical infrastructure would result in the temporary loss of utilities which would result in adverse, temporary and minor impacts to utilities. However, any potential impacts would be localized to existing utilities and surrounding areas. When proposed construction would occur near overhead electrical transmission lines, low clearance equipment and work platforms would be utilized to avoid damage to electrical lines and increase worker safety. During the PED Phase site-specific field investigations would be conducted to verify the locations of all utilities.

Impacts due to the construction and maintenance on utilities would be localized to each facility and would be adverse, temporary and minor, but with beneficial, permanent, and moderate impacts resulting from the floodproofing of the critical infrastructure facilities. Any potential impacts to utilities would be fully mitigated to ensure the same level of utility service is provided as to that prior to construction.

Alternative 4 - Critical Infrastructure and Nonstructural

The evaluation of potential impacts to utilities for Alternative 4, includes those in Alternative 2, plus the consideration of proposed nonstructural measures. Similar to Alternative 2, most of these construction measures would only require local investigations for existing for gas, water, sewage and power utilities but would also include where applicable underground service lines. Construction and maintenance activities resulting from floodproofing of critical infrastructure and implementing the nonstructural measures may result in the temporary loss of utility service which would result in adverse, temporary and minor impacts to utilities. However, any potential impacts would be localized to existing utilities and surrounding areas. Elevations of existing residencies would require utilities investigations as well as local alterations of utilities that service individual buildings. Such actions could potentially include raising of local HVAC

structures, power substation raising, and possibly relocating and/or altering water and sewer service lines. Prior to demolition, utility shutoff/removal would be conducted. During the PED Phase site-specific field investigations would be conducted to verify the locations of all utilities.

There would be beneficial, permanent and moderate impacts to utilities resulting from the increased level of flood protection to critical infrastructure and structures. Any potential impacts to utilities would be fully mitigated to ensure the same level of utility service is provided as to that prior to construction.

Alternative 5 - Critical Infrastructure and Structural

Construction and maintenance activities may result in the temporary loss of utility service which would result in adverse, temporary and minor impacts to utilities. Elevations of existing residences would require utilities investigations as well as local alterations of utilities that service individual buildings. Such actions could potentially include raising of local HVAC structures, power substation raising, and possibly relocating and/or altering water and sewer service lines.

For the structural measures, there would be required permanent relocations of utilities. The Miami River has the greatest potential of the three waterways for adverse, minor to moderate, temporary to permanent, impacts to utilities (dependent on the final siting of the structural features). The proposed storm surge barrier across the Miami River abuts the underground (and underwater) power transmission line and care during construction will be needed to ensure this line is not impacted. Once the exact placement and design of the surge barrier is confirmed in the next phase, coordination with other agencies and local utilities would need to occur as within the proposed ROI, there are also existing waste management facilities, electric generating units, and an electric substation within this section of the Miami River. If pile driving and/or geotechnical surveys are needed, utility location investigations would be undertaken for all areas in order to avoid any underground/underwater service lines. When proposed construction would occur near overhead electrical transmission lines, low clearance equipment and work platforms would be utilized to avoid damage to electrical lines and maximize worker safety. In the next phase, if the proposed surge barrier or pump station location is moved closer to the existing bridge crossing, utility location investigations would be undertaken as utilities are often suspended underneath bridges.

There is the potential that underground or underwater power transmission lines and/or other associated utilities might be located in the Little River or Biscayne Canal, within their proposed pump station locations, or their associated floodwalls, and further surveys in the next phase will be required to avoid or minimize the potential for any impacts to utilities. During the PED Phase site-specific field investigations would be conducted to verify the locations of all utilities.

Utilization of BMPs would reduce the adverse impacts on utilities due to construction ranging from minor and moderate to that of temporary and permanent. Benefits to utilities from increased coastal storm protection, in particular stormwater management and the protection of critical infrastructure, would be moderate and beneficial. Any potential impacts to utilities would be fully mitigated to ensure the same level of utility service is provided as to that prior to construction.

Alternative 7 - Critical Infrastructure, Nonstructural, and Structural

Impacts would be as those described in Alternative 4 and Alternative 5.

Alternative 8 - Critical Infrastructure, Nonstructural, and Structural (Without Edgewater Floodwall)

Impacts would be as those described in Alternative 4 and Alternative 5.

Best Management Practices to Avoid and Minimize Impacts on Utilities:

For any potential final alignments, avoidance and minimization practices will be employed to the maximum extent practicable for all potential impacts. Specific examples of best management practices to avoid and minimize impacts on utilities include:

1. Once final alignments are confirmed, a detailed survey and coordinated effort with local utilities and agency partners would take place to accurately document the location of existing utilities.
2. Care would be taken in construction activities both for worker safety and the general public to safeguard any temporarily exposed or relocated utility features.
3. 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.

Cumulative Impacts

There are a multitude of past, present and reasonably foreseeable future projects within the ROI. Regardless, if the above referenced alternatives are implemented, 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. 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. Most of these impacts will not directly affect utilities, though rising waters will increase flooding, and the need to elevate utility services and structures on the ground level will increase.

Implementation of any of the action alternatives is not predicted to substantially cumulatively or synergistically interact with climate change and/or other cumulative effects.

8.22 AIR QUALITY

Alternative 1 - No Action/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.

The air quality in Miami-Dade County would continue to change over time as expected as improvements and upgrades will continue to be made that are already planned by the Miami-Dade County and its associated municipalities independent of the USACE project.

Miami-Dade County would continue coastal and climate resiliency efforts, including the Sea Level Rise Strategy Project, which aims to identify and develop feasible mitigation and adaption strategies for sea level rise and coastal storms; implementation of project proposed in the Rapid Action Plan and Adaptation Action Areas; and continued implementation of the EEL Program (WEC - Miami-Dade County, n.d.). The SFWMD would also continue research and implementation of various projects and initiatives in response to climate change and sea level rise.

Planned stormwater improvements in the City of Miami would also help address flooding issues. Examples would include updating the stormwater management plans and long term strategies would include installation of tidal backflow valves, improvements to stormwater facilities, and increased public involvement.

The USACE would continue implementation of ongoing projects within the Miami-Dade County. These projects would include, the Miami Harbor Deeping and Navigation Improvements Project, sponsored by the Port of Miami and Miami-Dade County; the Biscayne Bay Coastal Wetlands Project (Phase II Implementation), a component of the CERP, conducted in partnership with the SFWMD; and the Miami-Dade County Coastal Storm Risk Management Feasibility Study, (Beach Nourishment), sponsored by Miami-Dade County. These improvements and studies would continue into the future regardless of whether the Miami-Dade Back Bay Coastal Storm Risk Management Feasibility Study is implemented.

Existing upstream water management operations would continue.

As noted in the Air Quality Affected Environment Section, the air quality in Florida has improved over the past 20 years and is currently the lowest on record. These improvements would continue into the future regardless of whether or not any USACE/Miami-Dade County project is implemented.

The No Action/Future without Project Alternative would have no impact on air quality in the region. No construction activities would occur with this alternative, and no increase in air emissions would occur.

Alternative 2 - Critical Infrastructure

There would be minimal construction and maintenance activities what would be located at and near the critical infrastructure. Direct air emissions would occur from the use of construction equipment, barges, and motor vehicles during transportation of materials to the project site resulting in negligible to minor, 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 or other construction related activities for any of the alternatives discussed below.

The need for an air quality permit would be fully evaluated and coordinated with the FDEP during the PED Phase of the project. It is anticipated that no air quality permit would likely be

required because the project is located within an attainment area and any potential emissions would not be anticipated to trigger regulatory thresholds; EPA's General Conformity Rule to implement Section 176(c) of the Clean Air Act does not apply and a conformity determination would not be required.

Alternative 4 - Critical Infrastructure and Nonstructural

There would be minimal construction and maintenance activities what would be located at and near the critical infrastructure and structural features. The evaluation of potential impacts to air quality for Alternative 4 are similar to Alternative 2, plus the additional emissions associated with construction of the nonstructural measures. Therefore this alternative would have a higher level of construction related emissions.

Air quality impacts resulting from implementation of Alternative 4 would occur from the use of construction equipment to elevate or demolish existing structures, as determined necessary. 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 sites and demolition activities resulting in minor, temporary impacts to air quality. However, emissions would be localized and expected to disperse quickly.

During construction and/or associated demolition activities and haul roads utilized for upland disposal, dust could be generated. The contractor would be required to control dust through periodically wetting dust prone work areas or through application of an approved dust retardant agent.

Air quality impacts resulting from implementation of Alternative 4 would be similar to Alternative 2. These impacts to air quality resulting from construction equipment emissions and other construction activities as described above would be adverse, temporary, and minor.

The need for an air quality permit would be fully evaluated and coordinated with the FDEP during the PED Phase of the project. It is anticipated that no air quality permit would likely be required because the project is located within an attainment area and any potential emissions would not be anticipated to trigger regulatory thresholds; EPA's General Conformity Rule to implement Section 176(c) of the Clean Air Act does not apply and a conformity determination would not be required.

Alternative 5 - Critical Infrastructure and Structural

Impacts to air quality from floodproofing critical infrastructure would be as those described in Alternative 2. Impacts would also occur from the construction and maintenance of surge barriers floodwalls and associated pump stations, and riprap. Direct air emissions would occur from the use of construction equipment such as cranes, excavators, dump trucks, and other motor vehicles and barges/vessels during transportation of materials to the project site and other construction and maintenance activities resulting in minor, temporary impacts to air quality. However, emissions would be localized and expected to disperse quickly.

During construction and/or associated demolition activities and haul roads utilized for upland disposal, dust could be generated. The contractor would be required to control dust through

periodically wetting dust prone work areas or through application of an approved dust retardant agent.

Temporary and minor impacts to air quality would be anticipated with the operations of pump stations and back-up generators during testing events and/or when in operation during a storm event. However, the surge barriers would be operated only during major storm events that would likely be no more than five times per year for an average duration of approximately five days (and potentially up to 10 days). Therefore, emissions would be very limited and not continuous.

Air quality impacts resulting from implementation of Alternative 5 would be similar to Alternative 4 in addition to the construction and operation activities as described above. These impacts to air quality resulting from the implementation of Alternative 5 would be anticipated to be adverse, temporary, and minor.

The need for an air quality permit would be fully evaluated and coordinated with the FDEP during the PED Phase of the project. It is anticipated that no air quality permit would likely be required because the project is located within an attainment area and any potential emissions would not be anticipated to trigger regulatory thresholds; EPA's General Conformity Rule to implement Section 176(c) of the Clean Air Act does not apply and a conformity determination would not be required.

Alternative 7 - Critical Infrastructure, Nonstructural, and Structural

Impacts would be as those described in Alternative 4 and Alternative 5.

The need for an air quality permit would be fully evaluated and coordinated with the FDEP during the PED Phase of the project. It is anticipated that no air quality permit would likely be required because the project is located within an attainment area and any potential emissions would not be anticipated to trigger regulatory thresholds; EPA's General Conformity Rule to implement Section 176(c) of the Clean Air Act does not apply and a conformity determination would not be required.

Alternative 8 - Critical Infrastructure, Nonstructural, and Structural (Without Edgewater Floodwall)

Impacts would be as those described in Alternative 4 and Alternative 5.

The need for an air quality permit would be fully evaluated and coordinated with the FDEP during the PED Phase of the project. It is anticipated that no air quality permit would likely be required because the project is located within an attainment area and any potential emissions would not be anticipated to trigger regulatory thresholds; EPA's General Conformity Rule to implement Section 176(c) of the Clean Air Act does not apply and a conformity determination would not be required.

Best Management Practices to Avoid and Minimize Impacts on Air Quality:

For any potential final alignments, avoidance and minimization practices will be employed to the maximum extent practicable for all potential impacts. Specific examples of best management practices to avoid and minimize impacts to air quality during temporary construction conditions:

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.

Cumulative Impacts

There are a multitude of past, present and reasonably foreseeable future projects within the ROI. Regardless, if the above referenced alternatives are implemented, 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. Resilience efforts that include construction and the use of mobile construction equipment would temporarily contribute to air quality impacts; however, these would be temporary, negligible to minor impacts and phased across years.

Miami-Dade County within the ROI has many ongoing private and government funded construction projects. The building of the Miami Skyrise, construction improvements to existing businesses and residences, improvements to the Port of Miami, and ongoing roadway improvements conducted by the Florida Department of Transportation (FDOT) which all necessitate the use of heavy construction equipment which can also temporarily impact air quality. However, emissions from construction equipment and associated construction activities would be expected to disperse quickly resulting in a negligible to minor impact to air quality.

Climatic changes such as sea level rise and increasing global temperatures are predicted to continue over the next 50 years. Due to the synergistic effects from a combination of factors, and relative sea level rise, and an increase in the frequency and strength of storms, the risk from coastal inundation will rise in the coming years for Miami-Dade County. However, implementation of alternatives would not predicted to substantially cumulatively or synergistically interact with climate change and/or effects from other actions in the ROI, with respect to air quality. Cumulative adverse effects to air quality from implementation of Alternative 7 are predicted to be negligible to minor and localized, and temporary and would have no effect on the region's attainment status.

8.23 NOISE AND VIBRATION

Alternative 1 - No Action/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.

Miami-Dade County would continue coastal and climate resiliency efforts, including the Sea Level Rise Strategy Project, which aims to identify and develop feasible mitigation and adaption strategies for sea level rise and coastal storms; implementation of project proposed in the Rapid Action Plan and Adaptation Action Areas; and continued implementation of the EEL Program (WEC - Miami-Dade County, n.d.). The SFWMD would also continue research and implementation of various projects and initiatives in response to climate change and sea level rise.

Planned stormwater improvements in the City of Miami would also help address flooding issues. Examples would include updating the stormwater management plans and long term strategies would include installation of tidal backflow valves, improvements to stormwater facilities, and increased public involvement.

The USACE would continue implementation of ongoing projects within the Miami-Dade County. These projects would include, the Miami Harbor Deeping and Navigation Improvements Project, sponsored by the Port of Miami and Miami-Dade County; the Biscayne Bay Coastal Wetlands Project (Phase II Implementation), a component of the CERP, conducted in partnership with the SFWMD; and the Miami-Dade County Coastal Storm Risk Management Feasibility Study, (Beach Nourishment), sponsored by Miami-Dade County. These improvements and studies all of which could result in increased noise and/or vibration during construction would continue into the future regardless of whether the Miami-Dade Back Bay Coastal Storm Risk Management Feasibility Study is implemented.

Existing upstream water management operations would continue.

If the Preferred Alternative is not implemented, the current ambient noise levels in Miami-Dade County and its associated municipalities would remain the same from existing building construction, jet flight path, airport operations, roadway noise and traffic, cargo and cruise vessels, and normal Port of Miami activities.

The Future without Project/No Action Alternative would have no impact on noise and vibration levels. No construction activities or additional sources of ambient noise would occur with this alternative.

Alternative 2 - Critical Infrastructure

There would be minimal construction and vibration noise from the floodproofing of critical infrastructure including maintenance operations. Noise generated from construction and maintenance from vehicles and construction equipment would be mainly restricted to the critical infrastructure and surrounding areas. There would also be minor increases in traffic noise from vehicles and construction equipment traveling to the construction sites. A slight increase in noise levels would occur from the use of construction and maintenance equipment and motor vehicles during transportation of materials to the project site resulting in adverse, temporary and minor impacts to noise and vibration levels.

Typical levels of such noise on site are described as follows:

- Backhoe (maximum noise level: 80.0 dBA¹⁰)
- Compactor (maximum noise level: 80.0 dBA)
- Dozer (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)
- Tractor (maximum noise level: 84.0 dBA)

Based on this, these noise levels exceed those typically encountered in residential areas, recreational, commercial and industrial areas. It is possible that the typical city noise in these

areas exceeds the city noise ordinance levels, as high-density urban areas can average up to 78 dBA and average density urban areas can average up to 65 dBA during the day and early evening (EPA 1978). Construction could potentially take place within a few hundred feet of residential areas and noise sensitive zones in a number of locations. Other locations would be in commercial or industrial areas. Noise abates at a level of -6 dBA per 50 feet away from the source if no obstructions (buildings, vegetation, etc.) are present to further reduce noise transmittance. Construction would also take place only during normal business hours. At these times, however, noise will approach that of an industrial area within 100 feet of the construction. Noise due to construction will likely be 10dBA higher than ambient noise up to 400 feet away from the construction site. Sound can be abated by vegetation and objects (including buildings) that are between the location and a direct line-of-sight of the construction. Although the construction would result in temporary and localized noise increases during construction, these activities would be limited to normal business hours and not occur at night, early mornings, or on Sundays.

Any associated construction activities will be in compliance with all local regulations regarding noise and vibration levels. Best management practices would be followed to ensure construction noise is minimized to the extent practicable.

Impacts to noise from Alternative 2 would be adverse, temporary, and minor.

Alternative 4 - Critical Infrastructure and Nonstructural

Noise and vibration impacts resulting from implementation of Alternative 4 would occur from construction and maintenance activities. Direct increases in noise levels 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 demolition activities resulting in minor, temporary increases in noise and vibration levels. There would also be increases in noise from vehicles and construction equipment traveling to the construction sites. Best management practices would be followed to ensure construction noise is minimized to the extent practicable.

Noise and vibration impacts resulting from implementation of Alternative 4 would be similar to Alternative 2 (see Alternative 2 for a listing of typical construction-related noise levels) but at a higher duration to account for the additional construction and maintenance of the nonstructural features. Noise impacts resulting from construction and maintenance activities of Alternative 4 would be adverse, temporary, and minor.

Alternative 5 - Critical Infrastructure and Structural

Noise impacts would occur from the use of construction and maintenance equipment to floodproof critical infrastructure and construct and maintain the project structural features. Direct increases in noise and vibration levels on land would occur from the use of vehicles and construction equipment such as excavators, dump trucks, and other motor vehicles during transportation of materials to the project site and other construction activities resulting in minor and temporary impacts. For the in-water construction of the surge barriers and floodwalls noise would be generated from vessels as well as equipment such as pile-driving equipment to install the structural features. There would also be increases in noise from vehicles, vessels/barges, and construction equipment traveling to the construction sites. However, noise levels from

construction and maintenance would be localized and expected to return to normal levels after the cessation of construction or maintenance.

The noise generated from the construction and maintenance of the surge barriers, floodwalls and associated pump stations and riprap would be typical of construction sites. Typical levels of such noise on site are described as follows:

- Backhoe (maximum noise level: 80.0 dBA¹⁰)
- Compactor (maximum noise level: 80.0 dBA)
- Dozer (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)
- Tractor (maximum noise level: 84.0 dBA)

Based on this, these noise levels exceed those typically encountered in residential areas, recreational, commercial and industrial areas. It is possible that the typical city noise in these areas exceeds the city noise ordinance levels, as high-density urban areas can average up to 78 dBA and average density urban areas can average up to 65 dBA during the day and early evening (EPA 1978). Construction could potentially take place within a few hundred feet of residential areas and noise sensitive zones in a number of locations. Other locations would be in commercial or industrial areas. Noise abates at a level of -6 dBA per 50 feet away from the source if no obstructions (buildings, vegetation, etc.) are present to further reduce noise transmittance. Construction would also take place only during normal business hours. At these times, however, noise will approach that of an industrial area within 100 feet of the construction. Noise due to construction will likely be 10dBA higher than ambient noise up to 400 feet away from the construction site. Sound can be abated by vegetation and objects (including buildings) that are between the location and a direct line-of-sight of the construction. Although the construction would result in temporary and localized noise increases during construction, these activities would be limited to normal business hours and not occur at night, early mornings, or on Sundays. Construction of the surge barriers would include the driving of large concrete pilings, the equipment necessary to do this can produce noise as loud as 110 dBA (impact pile driver). This construction would potentially occur in proximity to residential structures and/or noise-sensitive. Most of the pile-driving would occur offshore in the rivers and the Biscayne Bay. Other noise would result from the operation of the pump stations which would operate during closure of the pump stations (as needed) and during test operations.

There would be underwater adverse impacts to noise and vibration levels that would occur for any in water geotechnical testing and construction and maintenance activities; these impacts would be temporary and moderate. However, coordination, obtaining required permits, and/or concurrence would occur during the PED phase with all applicable agencies to include NMFS, USFWS, and FDEP.

Construction, maintenance, and operation noise impacts would be adverse, temporary and moderate.

Alternative 7 - Critical Infrastructure, Nonstructural, and Structural

Impacts would be as those described in Alternative 4 and Alternative 5.

Alternative 8 - Critical Infrastructure, Nonstructural, and Structural (Without Edgewater Floodwall)

Impacts would be as those described in Alternative 4 and Alternative 5.

Best Management Practices to Avoid and Minimize Impacts on Noise and Vibration Levels:

For any potential final alignments, avoidance and minimization practices will be employed to the maximum extent practicable for all potential impacts. Specific examples of best management practices to avoid and minimize impacts to noise and vibration levels during temporary construction conditions:

1. No unnecessary idling of trucks or other construction equipment shall occur when not in use during construction.
2. Construction equipment would be properly maintained to minimize the effects of the noise and to reduce any associated noise impacts.
3. Coordination prior to inland construction activities beginning would be conducted to ensure compliance with all local regulations regarding noise and vibration levels.
4. Any associated drilling and blasting activities that are required would be conducted in strict accordance with local, state and Federal procedures and coordinated during the PED phase.

Cumulative Impacts

There are a multitude of past, present and reasonably foreseeable future projects within the ROI. Regardless, if the above referenced alternatives are implemented, 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. Resilience efforts that include construction and the use of mobile construction equipment would temporarily contribute to noise and vibration impacts; however, these impacts would be negligible, temporary and phased across years.

Miami-Dade County within the ROI has many ongoing private and government funded construction projects. The building of the Miami Skyrise, construction improvements to existing businesses and residences, improvements to the Port of Miami, and ongoing roadway improvements conducted by the Florida Department of Transportation (FDOT) which all necessitate the use of heavy construction equipment which can also temporarily impact noise and vibration levels.

Climatic changes such as sea level rise and increasing global temperatures are predicted to continue over the next 50 years. Due to the synergistic effects from a combination of factors, and relative sea level rise, and an increase in the frequency and strength of storms, the risk from coastal inundation will rise in the coming years for Miami-Dade County. However, implementation of alternatives would not predicted to substantially cumulatively or

synergistically interact with climate change and/or effects from other actions in the ROI, with respect to noise and vibration levels.

CHAPTER 9 ENVIRONMENTAL COMPLIANCE

This chapter discusses the status of coordination and compliance of the Tentatively Selected Plan with environmental requirements. As stated in Chapter 1, this document has been prepared as an integrated feasibility study/Programmatic EIS. The level of detail in this programmatic NEPA document is sufficient to allow an informed decision among planning-level alternatives; however, full compliance with several laws and EOs listed below would not be achieved until successive project phases. Because of the limited design information available at this time (during the feasibility study only approximately a 10% level of design is provided), certain consultations, for example, consultations required under Section 7 of the ESA and the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), would be conducted during the Preconstruction, Engineering, and Design (PED) phase of the project. Tiered NEPA documents prepared in the future would be coordinated with local, state, and federal regulatory agencies, tribal governments, and the public and would demonstrate full environmental compliance.

The compliance status for the project measures considered in the Tentatively Selected Plan are identified for relevant environmental laws and EOs in Tables 9-1 and 9-2, respectively. Anticipated future environmental permits/authorizations are identified in Table 9-3.

Table 9-1. Environmental Compliance

Title of Law	U.S. Code	Compliance Status
<i>Abandoned Shipwreck Act of 1987</i>	<i>43 United States Code (U.S.C.) 2101</i>	<i>Coordination with federal and state agencies is ongoing</i>
<i>American Bald and Golden Eagle Protection Act of 1962, as amended</i>	<i>16 U.S.C. 668</i>	<i>Coordination with USFWS is ongoing</i>
<i>Anadromous Fish Conservation Act of 1965</i>	<i>16 U.S.C. 757 a et seq</i>	<i>There are no resources within the ROI. N/A</i>
<i>Archaeological and Historic Preservation Act of 1974</i>	<i>Public Law 93-291 and 16 U.S.C. 469-469c</i>	<i>Pending, full compliance is anticipated with execution of PA with SHPO during PED</i>

Title of Law	U.S. Code	Compliance Status
<i>Archaeological Resources Protection Act of 1979</i>	<i>16 U.S.C. 470aa–470mm</i>	<i>Pending, full compliance is anticipated with execution of PA with SHPO during PED phase</i>
<i>Clean Air Act of 1970, as amended</i>	<i>42 U.S.C. 7401 et seq.</i>	<i>Pending, full compliance is anticipated</i>
<i>Clean Water Act of 1972, as amended</i>	<i>33 U.S.C. 1251 et seq</i>	<i>Pending, full compliance would be achieved upon receipt of water quality certification obtained during PED</i>
<i>Coastal Barrier Resources Act and Coastal Barrier Improvement Act of 1990</i>	<i>Public Law 113-314 and 16 U.S.C. 3501 et seq</i>	<i>There are no resources within the ROI. N/A</i>
<i>Coastal Zone Management Act of 1972, as amended</i>	<i>16 U.S.C. 1451 et seq</i>	<i>Coordination with FDEP is ongoing; full compliance anticipated during PED phase</i>
<i>Comprehensive Environmental Responses, Compensation and Liability Act of 1980</i>	<i>42 U.S.C. 9601</i>	<i>Pending, full compliance is anticipated</i>
<i>Deepwater Port Act of 1974, as amended</i>	<i>33 U.S.C. 1501</i>	<i>Pending, full compliance is anticipated</i>
<i>Endangered Species Act of 1973</i>	<i>16 U.S.C. 1531</i>	<i>Coordination with USFWS is ongoing</i>
<i>Estuary Protection Act of 1968</i>	<i>16 U.S.C. 1221 et seq</i>	<i>N/A</i>

Title of Law	U.S. Code	Compliance Status
<i>Farmland Protection Act of 1981</i>	<i>N/A</i>	<i>N/A</i>
<i>Federal Water Project Recreation Act</i>	<i>N/A</i>	<i>N/A</i>
<i>Fish and Wildlife Coordination Act of 1958, as amended</i>	<i>16 U.S.C. 661</i>	<i>Coordination with USFWS is ongoing</i>
<i>Flood Control Act of 1970</i>	<i>33 U.S.C. 549</i>	<i>Pending, full compliance is anticipated</i>
<i>Land and Water Conservation Act</i>	<i>16 U.S.C. 460</i>	<i>Pending, full compliance is anticipated</i>
<i>Magnuson-Stevens Fishery Conservation and Management Act</i>	<i>16 U.S.C. 1801</i>	<i>Coordination with NMFS is ongoing; EFH Assessment anticipated would be submitted to NMFS during PED phase</i>
<i>Marine Mammal Protection Act of 1972, as amended</i>	<i>16 U.S.C. 1361</i>	<i>Coordination with NMFS is ongoing</i>
<i>Migratory Bird Conservation Act of 1928, as amended</i>	<i>16 U.S.C. 715</i>	<i>Pending, full compliance is anticipated upon completion of coordination with USFWS</i>
<i>Migratory Bird Treaty Act of 1918, as amended</i>	<i>16 U.S.C. 703</i>	<i>Pending, full compliance is anticipated</i>

Title of Law	U.S. Code	Compliance Status
<i>National Environmental Policy Act of 1969, as amended</i>	<i>42 U.S.C. 4321 et seq</i>	<i>Full compliance upon signature of the ROD</i>
<i>National Historic Preservation Act of 1966, as amended</i>	<i>16 U.S.C. 470 and 54 U.S.C. § 300101</i>	<i>Pending, full compliance is anticipated with execution of PA with SHPO during PED</i>
<i>National Historic Preservation Act Amendments of 1980</i>	<i>16 U.S.C. 469a</i>	<i>Pending, full compliance is anticipated with execution of PA with SHPO during PED</i>
<i>Noise Control Act of 1972, as amended</i>	<i>42 U.S.C. 4901</i>	<i>Pending, full compliance is anticipated</i>
<i>Resource Conservation and Recovery Act of 1976</i>	<i>42 U.S.C. 6901 et seq</i>	<i>Pending, full compliance is anticipated</i>
<i>Rivers and Harbors Act of 1899</i>	<i>33 U.S.C. 401 et seq</i>	<i>Pending, full compliance is anticipated</i>
<i>Submerged Lands Act of 1953</i>	<i>43 U.S.C. 1301 et seq</i>	<i>Pending, full compliance is anticipated</i>
<i>Uniform Relocation and Assistance and Real Property Acquisition Policies Act</i>	<i>42 U.S.C. 4601 et seq</i>	<i>Pending, full compliance is anticipated</i>

Table 9-2. Executive Orders

Title of Executive Order	Executive Order Number	Compliance Status
Coral Reef Protection	13089	Pending, full compliance is anticipated
Floodplain Management	11988	Pending, full compliance is anticipated
Protection of Wetlands	11990	Pending, full compliance is anticipated
Federal Compliance with Pollution Control Standards	12088	Pending, full compliance is anticipated
Federal Compliance with Right-to-Know Laws and Pollution Prevention	12856	Pending, full compliance is anticipated
Federal Actions to Address Environmental Justice and Minority and Low-income Populations	12898	Pending, full compliance is anticipated
Protection of Children from Environmental Health Risks and Safety Risks	13045	Pending, full compliance is anticipated
Invasive Species	13112	Pending, full compliance is anticipated

Title of Executive Order	Executive Order Number	Compliance Status
Marine Protected Areas	13158	Pending, full compliance is anticipated
Consultation and Coordination with Indian Tribal Governments	13175	Pending, full compliance is anticipated
Responsibilities of Federal Agencies to Protect Migratory Birds	13186	Coordination with USFWS is ongoing
Preparing the United States for Impacts of Climate Change	13659	Pending, full compliance is anticipated
Establishing Discipline and Accountability in the Environmental Review and Permitting Process for Infrastructure Projects (One Federal Decision)	13807	Pending, full compliance is anticipated upon signature of the ROD
Efficient Federal Operations	13834	Pending, full compliance is anticipated
Planning for Federal Sustainability in the Next Decade (2015)	13693	Pending, full compliance is anticipated

Table 9-3. Permitting and/or Coordination Requirements

Law	Agency Responsible	Permit, Agreement, Authorization, or Notification Required
American Bald and Golden Eagle Protection Act of 1962, as amended	U.S. Fish and Wildlife Service (USFWS)	"Take" permit if any eagles are accidentally harmed or killed; no take permit is required
Clean Water Act, Section 401*	FLDEP	401 Water Quality Certification (Will be obtained during PED)
Clean Water Act, Section 404	There is potential that FDEP will assume Section 404 from USACE. The measure has passed the Florida state legislature but is still in development	IF FDEP assumes the Section 404 program; permit verification would be obtained during PED
Coastal Zone Management Act (CZMA)	FLDEP	Concurrence with Federal Consistency Determination would be obtained during PED
Endangered Species Act of 1973	NMFS	Biological Opinion with Incidental Take statement (Formal Consultation Anticipated during PED)
Endangered Species Act of 1973	USFWS	Full Concurrence Determination anticipated

Law	Agency Responsible	Permit, Agreement, Authorization, or Notification Required
		(Informal Consultation) would be obtained during PED
Fish and Wildlife Coordination Act (FWCA)	USFWS	FWCA Memorandum of Agreement that coordination is to be completed with NEPA reviews
Magnuson-Stevens Fishery Conservation and Management Act	NMFS	Notification of any noncompliance; none anticipated
Marine Mammal Protection Act of 1972, as amended	NMFS	Pending, need for take authorizations would be determined during PED
Marine Protection, Research, and Sanctuaries Act of 1972*	USEPA	Concurrence documentation would be obtained during PED
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 Department of Historic Resources	Programmatic Agreement would be coordinated
Resource Conservation and Recovery Act of 1976	USEPA, FLDEP	Testing, quantification, and notification for any hazardous materials

Law	Agency Responsible	Permit, Agreement, Authorization, or Notification Required
Rivers and Harbors Act of 1899	U.S. Coast Guard	Permits to construct storm surge barriers, for channel closures or restrictions, and aids to navigation would be obtained during PED
Submerged Lands Act of 1953, as amended	FDEP	Compliance documentation would be obtained during the PED

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, and design phase

9.1 NATIONAL ENVIRONMENTAL POLICY ACT OF 1969

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 environmental impact statement (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.

This document has been prepared as an integrated feasibility study/Programmatic EIS. The term “programmatic” indicates this is a broad or high-level NEPA document not a site-specific NEPA document. Therefore, during successive phases of the project, additional site-specific NEPA documents (each one would be considered a tiered NEPA document) would be prepared and coordinated with local, state, and federal regulatory agencies, tribal governments, and the public. Tiering expedites the resolution of more substantive impacts to the human environment in the programmatic NEPA document so that subsequent tiered NEPA documents can focus on site-specific impacts and issues.

Because of the limited design information available at this time (during the feasibility study only approximately a 10% level of design will be provided), the Endangered Species Act, Section 7 and the Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat

consultations would be conducted during the Preconstruction, Engineering, and Design (PED) Phase of the project. During this feasibility phase of the project, a Programmatic Agreement is being prepared to ensure compliance under Section 106 of the National Historic Preservation Act.

During the PED Phase, a wetland jurisdictional determination, detailed environmental surveys, and cultural and historic building surveys and data gathering would be conducted to support the site-specific future tiered NEPA document as each phase progresses. The level of detail in this programmatic NEPA document is sufficient to allow an informed decision among planning-level alternatives and to develop broad mitigation strategies. Additional, more detailed site-specific mitigation assessments would be conducted in future phases of the project. This is especially relevant and an appropriate mitigation strategy for this project as some of required mitigation would be for ephemeral species and habitats such as corals/hardbottom habitat and Submerged Aquatic Vegetation (SAV) whose extent and densities can vary considerably over time.

As previously stated, the USACE used this process to comply with NEPA and focus this integrated feasibility study/Programmatic 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 Section 1.8, Public, Agency, and Tribal Coordination. The draft integrated feasibility study/Programmatic EIS will undergo a 45-day agency, tribal, and public review period. All comments/edits will be addressed in the development of the Final integrated feasibility study/Programmatic EIS, and will include responses to the comments. The Final integrated feasibility study/Programmatic EIS, including all appendices and supporting documentation will fulfill requirements of the NEPA for the Miami-Dade Back Bay Coastal Storm Risk Management Study. Upon completion of the integrated feasibility study/Programmatic EIS, which is signified by the signing of the Record of Decision, the project will be in full compliance with the NEPA.

9.2 CLEAN WATER ACT OF 1972

The USACE would obtain a Water Quality Certification from the Florida Department of Environmental Protection pursuant to the Clean Water Act (CWA) during the PED phase. This integrated feasibility study/Programmatic EIS will contain sufficient information to demonstrate that the Tentatively Selected Plan is in compliance with the CWA. All construction activities would 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.

9.2.1 WETLANDS

Section 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. Minor to moderate impacts to jurisdictional wetlands are anticipated with implementation of this project. A wetland delineation would be completed during the PED Phase of the project, once real estate access is secured and the project design is more finalized. Final impact amounts would be determined upon more complete design of the project. The plan would be finalized as wetland impacts are determined in greater detail. However, it is noted that wetland mitigation would also be required to be done

in compliance with the requirements under State and Federal laws, regulations, and requirements.

The Environmental Mitigation Plan is found in Appendix D and mitigation requirements would be further evaluated during the PED Phase of the project when the UMAM is conducted and mitigation requirements would be finalized.

9.3 RIVERS AND HARBORS ACT OF 1899

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.

The floodwall and the storm surge barriers constitute crossings by definition, therefore, a permit must be obtained from the USCG once the barriers are designed. The USACE or the County would go through the permit process and obtain approval prior to construction. The project must also be compliant with Section 10 of the 1899 Rivers and Harbors Act.

9.4 COSATAL ZONE MANAGEMENT ACT OF 1972

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 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, National Oceanic and Atmospheric Administration (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.

Upon publication of the draft EIS, coordination for the Federal Consistency Determination (FCC) will be initiated. (The Federal Consistency Determination with the CZMA is provided in Appendix D). Full compliance is anticipated during PED.

A Federal Consistency Determination will be submitted to FDEP during the PED Phase. Future Concurrence from FDEP is expected; therefore compliance with the CZMA is anticipated.

9.5 CLEAN AIR ACT OF 1970

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 EPA to establish National Ambient Air Quality Standards (NAAQS) to protect public health and public welfare and to regulate emissions of hazardous air pollutants.

Miami-Dade County is designated as an attainment area for Federal air quality standards under the CAA. This area was once designated as moderate nonattainment for ozone standards under the criteria provided in the CAA of 1990. Miami-Dade County is classified by FDEP as an attainment/maintenance area for the pollutant ozone. Ambient air quality data is also collected for four additional pollutants (carbon monoxide, nitrogen dioxide, particulate matter and sulfur dioxide) in Miami-Dade County. FDEP does not regulate marine or mobile emission sources (dredge and construction equipment) within Miami-Dade County.

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 however, emissions would be reevaluated during the PED Phase of the project once designs and sitings of structures are finalized to determine if a permit is required; EPA'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 OF 1958

The project is undergoing coordination with the U.S. Fish and Wildlife Service and the State of Florida. A Memorandum of Agreement will be signed by the USACE and the USFWS stating that Fish and Wildlife Coordination Act will be integrated with the NEPA review process.

9.7 ENDANGERED SPECIES ACT OF 1973

A Biological Assessment evaluating the potential impacts of the proposed action on endangered and threatened species would be completed during the PED Phase. Critical habitat has been designated for some of the species that occur in the action area. Coordination with the USFWS and the NMFS pursuant to Section 7 of the ESA for the species provided in Table 9.4 is ongoing.

Formal consultation with the USFWS and the NMFS is anticipated because of the potential, adverse effects to federally listed species and potential adverse modification of critical habitats (Table 9.4). Other effects to federally listed species include no affect or may affect, and not

likely to adversely affect determinations. The analysis and findings are described in detail in the Special Status Species Environmental Consequences Section.

Table 9-4. Federally Listed Species Known or with the Potential to Occur in the Action Area.

Taxonomic Category/Common Name	Status	Endangered Species Act, Section 7 Finding
Birds		
Piping plover	T	May affect, not likely to adversely affect
Red knot	T	May affect, not likely to adversely affect
Fish		
Nassau grouper	T	May affect, likely to adversely affect
Smalltooth sawfish	E	May affect, likely to adversely affect
Invertebrates		
Boulder star coral	T	May affect, likely to adversely affect
Elkhorn coral	T	May affect, likely to adversely affect
Lobed star coral	T	May affect, likely to adversely affect
Mountainous star coral	T	May affect, likely to adversely affect
Pillar coral	T	May affect, likely to adversely affect
Rough cactus coral	T	May affect, likely to adversely affect
Staghorn coral	T	May affect, likely to adversely affect
Mammals		
Florida bonneted bat	E	May affect, not likely to adversely affect
West Indian manatee	T	May affect, likely to adversely affect
West Indian manatee critical habitat		Potential adverse modification of critical habitat
Reptiles		

Taxonomic Category/Common Name	Status	Endangered Species Act, Section 7 Finding
American crocodile	E	May affect, likely to adversely affect
Green sea turtle (North and South Atlantic DPS)	T	May affect, likely to adversely affect
Hawksbill sea turtle	E	May affect, likely to adversely affect
Kemp's ridley sea turtle	E	May affect, likely to adversely affect
Leatherback sea turtle	E	May affect, likely to adversely affect
Loggerhead sea turtle (Northwest Atlantic Ocean DPS)	T	May affect, likely to adversely affect
Seagrass		
Johnson's seagrass	T	May affect, likely to adversely affect
Johnson's seagrass critical habitat		Potential adverse modification of critical habitat

T = Threatened; E = Endangered; Y = Yes

****Please note that species presence and conclusions are tentative and subject to change based on results of detailed hard bottom/coral and Submerged Aquatic Vegetation surveys and final siting of project features that would be conducted during the Preconstruction, Engineering, and Design Project Phase.***

9.8 MAGNUSON-STEVENS FISHER 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). In accordance with the 1999 NMFS Finding on EFH Consultations, this integrated report and NEPA document contain sufficient information to satisfy the requirements in Section 600.920(g). This document includes: 1) a description of the proposed action; 2) an analysis of individual and cumulative effects on EFH, Federally managed fisheries, and associated species such as major prey species, including affected life history stages; 3) the District's views regarding effects; and, 4) proposed mitigation, if applicable.

The USACE evaluated potential project impacts on NMFS-managed fish species and their Essential Fish Habitats. Coordination with the NMFS is ongoing, and an EFH Assessment would be submitted to NMFS during the PED phase. Text referring to EFH can be found in

Sections 2.6, 8.7 (Vegetation, Wetlands, and Submerged Aquatic Vegetation); 2.9, 8.10; (EFH and Fishery Resources); and 2.10, 8.11 (Benthic Resources).

9.9 MARINE MAMMAL PROTECTION ACT

The Marine Mammal Protection Act (MMPA) prohibits the take of marine mammals including the West Indian manatee, and all cetaceans found in the ROI. The project is being coordinated with USFWS and NMFS, and coordination would continue into the PED phase. The appropriate authorizations would be obtained if it is later determined that marine mammal “takes” would occur.

9.10 NATIONAL HISTORIC PRESERVATION ACT OF 1966

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]).

Coordination is ongoing with the Florida State Historic Preservation Office (SHPO). A Programmatic Agreement is planned for execution during the Feasibility Phase and additional archeological and historic building surveys and coordination would occur during the PED Phase.

9.11 RESOURCE CONSERVATION AND RECOVERY ACT

The Resource Conservation and Recovery Act (RCRA) RCRA controls the management and disposal of hazardous waste. “Hazardous and/or toxic wastes”, classified by the Resource Conservation and Recovery Act (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).

Any potential disposal of hazardous waste would be done in accordance with state and federal laws at a certified disposal facility. Full compliance with RCRA is anticipated.

9.12 COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT

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 would be no anticipated impacts to CERCLA or Superfunds sites.

9.13 BISCAYNE BAY AQUATIC PRESERVE, FLORIDA RULE 18-18

The Biscayne Bay as described in Florida Rule 18-18.002, Florida Administrative Code, was established to preserve and enhance Biscayne Bay and natural waterways tidally connected to the bay in a natural condition so that its biological and aesthetic values may continue for future generations. This rule requires that a project “is designed so that the structure or structures to be built in, on, or over submerged lands are limited to structures necessary to conduct water dependent activities; and no other reasonable alternative exists which would allow the proposed project to be constructed or undertaken outside the preserve.” The intent is to protect and enhance the waters of the preserve so that the public may continue to enjoy the traditional recreational uses of those waters including swimming, boating and fishing.

To the extent practical, the placement of the floodwalls and pump stations has been aligned to occur in previously disturbed areas in uplands. However, to maximize flood protection, reduce real estate costs and impacts to utilities, placement of the surge barriers and Brickell and Edgewater floodwalls and associated pump stations and riprap would occur in the Biscayne Bay and tidally connected waterways. Full compliance is anticipated and further avoidance and minimization of impacts to the Biscayne Bay and tidally connected waterways would be considered during the PED Phase of the project when the final designs and project siting would be completed.

9.14 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 primary purpose of Section 103 of the MPRSA is to limit and regulate adverse environmental impacts of ocean placement of dredged material. Dredged material proposed for ocean placement must comply with 40 CFR 220-228 (Ocean Dumping Regulations) and 33 CFR 320-330 and 335-338 (USACE Regulations for discharge of dredged materials into waters of the U.S.) prior to being issued an ocean placement permit. The technical evaluation of potential contaminant-related impacts that may be associated with ocean placement of dredged material is conducted in accordance with 40 CFR 220-228, the Ocean Testing Manual, and the Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore.

There is no planned open water disposal of dredged material for this project and therefore, this regulation is not applicable.

9.15 EXECUTIVE ORDER 13089, CORAL REEF PROTECTION

The proposed action may affect U.S. coral reef ecosystems as defined in the Executive Order (E.O.). 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 EO also directs Federal Agencies to expand their own research, preservation, and restoration efforts.

Coordination is ongoing and full compliance is anticipated during the PED phase.

9.16 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 (1-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. Under the EO, USACE is required to provide leadership and take action to: a. Avoid development in the Base Flood Plain unless it is the only practicable alternative; b. Reduce the hazard and risk associated with floods; c. Minimize the impact of floods on human safety, health and welfare; and d. Restore and preserve the natural and beneficial values of the Base Flood Plain. For critical facilities, the 0.2-percent- annual-chance flood plain is typically evaluated.

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.** Due to location, type, and nature of the proposed action involving flood risk management, all alternatives are located in the Base Flood Plain.
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.** Chapter 6 discusses 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 shown in Chapter 1, Section 1.8, as part of NEPA, a public scoping meeting was held on September 10, 2019 to solicit public comments on the study scope, identify potential measures to be included in the study, and to discuss potential issues to be addressed during the environmental impact analysis for the study. Forty-nine people attended the public meeting. Comments received from the public are provided in Appendix D.

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.** Protection of 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 minor to major depending on the level of flooding. If no failure or the design is not exceeded, 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.** Most of the study area is developed, such that the purpose of the proposed action is not to induce development, but to help existing development be resilient and sustainable. New development is likely to occur without the proposed action.
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.** Due to location, type, and nature of the proposed project involving flood risk management, all alternatives are located in the Base Flood Plain.
8. **Recommend the plan most responsive to the planning objectives established by the study and consistent with the requirements of the Executive Order and Planning and Guidance pertaining to the National Economic Development Plan.**

Full compliance is anticipated with the goals of this Executive Order during the PED Phase.

9.17 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.

If it is determined that jurisdictional wetlands would be impacted, compensatory mitigation in accordance with the 2008 Mitigation Rule would be provided as well as compliance with all other applicable federal, state, and local guidelines governing the protection of wetland areas. Full compliance with this EO is anticipated during the PED phase.

9.18 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.

9.19 EXECUTIVE ORDER 12898, FEDERAL ACTIONS TO ADDRESS ENVIRONMENTAL JUSTICE IN MINORITY POPULATIONS AND LOW INCOME POPULATIONS

In accordance with this EO, the USACE has determined that no group of people would bear a disproportionately high share of adverse environmental consequences resulting from the proposed work.

9.20 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. 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.

9.21 EXECUTIVE ORDER 13807, ESTABLISHING DISCIPLINE AND ACCOUNTABILITY IN THE ENVIRONMENTAL REVIEW AND PERMITTING PROCESS FOR INFRASTRUCTURE PROJECTS

This EO requires Federal agencies to stream-line their environmental review process and decisions collaboratively as One Federal Decision (OFD). The EO sets specific timelines and goals for the concurrence process and NEPA review, requiring the NEPA process to be complete within two years of the date that the Notice of Intent (NOI) was published in the Federal Register. Full compliance with this EO is anticipated.

9.22 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.

Negligible to a minor level of impact is expected on local migratory birds, no significant impacts to migratory birds is expected as a result of project implementation. Full compliance with this EO is anticipated

CHAPTER 10 CONCLUSIONS AND RECOMMENDATIONS

The Bipartisan Budget Act of 2018, Public Law 115-123, provided nearly \$17.4 billion to the U.S. Army Corps of Engineers for disaster recovery. This study was funded by this Act to reduce risk to communities damaged by storm events.

This study evaluated current studies, scientific consensus, guidelines and design standards to recommend a project that will reduce damage and risk from impacts of sea level change and coastal storms. Analyses included assessments of engineering feasibility, costs, economic benefits, and impacts to the environment and local communities. Based on all of the analysis, the team recommends a combination of measures that include structural, nonstructural (which includes reducing risk to critical infrastructure), and natural and nature-based features that are described as the TSP. The TSP is a large project with a total project first cost of \$4.6 billion. The project will provide flood risk reduction for residents, businesses, and critical infrastructure as well as other incidental risk reductions such as to vehicles, roads and utilities in Miami-Dade County.

It is unlikely that funding for construction would be available all at once due to the large size and cost of the TSP. The Project Delivery Team and the Miami-Dade County will discuss the need to develop a strategy for implementation and sequencing of the TSP once the final recommended plan is determined during the Agency Decision Milestone (ADM). This would allow earlier preparation if construction funds were made available and allow proper communication of construction priority to stakeholders. The following sections will describe a recommended path forward for project implementation once the ADM has been completed which is currently scheduled for August 2020.

10.1 CONSTRUCTION SEQUENCING STRATEGY FOR THE RECOMMENDED PLAN

A construction sequencing strategy will be developed by the USACE Project Delivery Team and the Miami-Dade County. **(To be completed after ADM)**

10.2 PLAN IMPLEMENTATION

The implementation process would carry a plan that is recommended through the PED phase of a project, including development of plans and specifications, and construction. Funding by the Federal Government to support these activities would have to meet traditional civil works budgeting criteria.

10.2.1 CONSISTENCY WITH LAWS AND POLICY

This draft feasibility report 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;
- and the costs and cost-sharing to support a Project Partnership Agreement (PPA).

This report demonstrates that the TSP is economically justified, environmentally compliant, and technically feasible. The report also identifies that the TSP has benefits greater than costs. The Environmental Impact Statement has been prepared to meet the requirements of NEPA and demonstrate that the TSP 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 total project costs include the value of lands, easements, rights-of-way and relocations, and disposal/borrow areas (LERRDs), which are estimated to be \$405 million. The non-Federal sponsor will be required to provide all LERRDs necessary for the project and will receive credit for the value of those LERRDs against its required cost-share.

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.

Project First Cost is the constant dollar cost of the TSP at current 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. Total Project Cost is the cost estimate used in Project Partnership Agreements for implementation of design and construction of a project. 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. The TSP First Cost is estimated to be \$4,586,000,000.

Table 10-1. First Cost Apportionment Table

Total Project Cost (rounded, \$1000s)	Total Federal Share (65%, rounded, \$1000s)	Total Non-Federal Share (35% plus relocation, rounded, \$1000s)	100% Lands and Damages (rounded, \$1000s)	Cash Balance (rounded, \$1000s)
\$4,586,000	\$2,980,700	\$1,605,000	405,000	\$1,200,000

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 \$12.6 million per year. The Federal government is responsible for preparing and providing an OMRR&R manual to the sponsor.

10.2.3 PROJECT PARTNERSHIP – LOCAL SPONSOR RESPONSIBILITIES

A Project Partnership Agreement (PPA) package will be prepared, coordinated, and executed subsequent to the approval of this document. The PPA serves as the agreement for the next phase of the project after the study phase.

As the non-Federal project partner, MDC must comply with all applicable Federal laws and policies and other requirements, including but not limited to:

1. In addition to providing 35 percent of the costs of initial project construction, in accordance with Federal cost-sharing requirements:

- I. provide all lands, easements, rights of way and relocations (LERR), including suitable borrow areas, uncontaminated with hazardous and toxic wastes, and perform or ensure performance of any relocations determined by the Federal Government to be necessary for the initial construction, operation, and maintenance of this project;
 - II. perform, or cause to be performed, any investigations for hazardous substances as are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law (PL) 96-510, as amended, 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for the construction, operation, and maintenance of the Project. However, for lands that the Federal Government determines to be subject to the navigational servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal project partner with prior specific written direction, in which case the non-Federal project partner shall perform such investigations in accordance with such written direction;
 - III. coordinate all necessary cleanup and response costs of any CERCLA-regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the construction, operation, or maintenance of the project;
 - IV. and cost-share of the cost of mitigation and data recovery activities associated with historic preservation, that are in excess of 1 percent of the total amount authorized to be appropriated for the project.
2. For fifty years, operate, maintain, repair, replace, and rehabilitate the completed project, or functional portion of the project, at no cost to the Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and any specific directions prescribed by the Government in the Operations, Maintenance, Replacement, Repair and Rehabilitation (OMRR&R) manual and any subsequent amendments thereto.
 3. Provide the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal project partner, now or hereafter, owns or controls for access to the project for the purpose of inspection, and, if necessary after failure to perform by the non-Federal project partner, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project. No completion, operation, maintenance, repair, replacement, or rehabilitation by the Federal Government shall operate to relieve the non-Federal project partner of responsibility to meet the non-Federal project partner's obligations, or to preclude the Federal Government from pursuing any other remedy at law or equity to ensure faithful performance.

4. Hold and save the United States free from all damage arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project related betterments, except for damage due to the fault or negligence of the United States or its contractors.
5. Keep, and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the Project in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal regulations (CFR) Section 33.20.
6. As between the Federal Government and the non-Federal project partner, the non-Federal project partner shall be considered the operator of the project for the purpose of CERCLA liability. To the maximum extent practicable, operate, maintain, repair, replace and rehabilitate the project in a manner that will not cause liability to arise under CERCLA.
7. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, required for the construction, operation, and maintenance of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.
8. Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense directive 5500.11 issued pursuant thereto, as well as Army regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army."
9. Participate in and comply with applicable Federal flood plain management and flood insurance programs and comply with the requirements in Section 402 of the Water Resources Development Act of 1986, as amended.
10. Not less than once each year inform affected interests of the extent of storm risk management afforded by the project.
11. Publicize flood plain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the flood plain and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with the degree of storm risk management provided by the project.

12. Prevent obstructions of or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) which might hinder its operation and maintenance, or interfere with its proper function, such as any new development on project lands or the addition of facilities which would degrade the benefits of the project.
13. Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms.
14. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal project partner has entered into a written agreement to furnish its required cooperation for the project or separable element.
15. Quarterly and after storm events, perform surveillance of the project to determine project maintenance or repair needs and provide the results of such surveillance to the Federal Government.

10.2.4 DESIGN AND CONSTRUCTION CONSIDERATIONS AND SCHEDULE

In order for PED to be initiated, USACE must sign a PPA with a non-Federal sponsor to cost share PED and construction. This project would require congressional authorization for PED and construction. 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.

The draft schedule for plan implementation was developed for planning and cost estimating purposes. Actual construction timelines are subject to future project approval and funding requirements. See the APPENDIX B: ENGINEERING APPENDIX for the proposed construction schedule. **(Appendix section will include this information when available.)**

10.2.5 REAL ESTATE REQUIREMENTS

USACE projects require the non-Federal sponsor provide LERRDs for a project. Currently, the TSP will require the non-Federal sponsor to acquire temporary and permanent easements for construction. Total LERRDs cost is estimated to be \$405 million. Details are provided in the APPENDIX F: REAL ESTATE PLAN APPENDIX.

10.2.6 VIEWS OF THE NON-FEDERAL SPONSOR AND OTHER AGENCIES

The non-Federal sponsor, MDC, has indicated their support for releasing this report for public and agency input. The non-Federal sponsor's support for the TSP will be confirmed through a Letter of Support following Public and Agency reviews.

10.3 PATH FORWARD

The information contained in this report, “Draft Miami-Dade Back Bay Coastal Storm Risk Management Feasibility Report and Programmatic Environmental Impact Statement,” is in draft form and will be undergoing modifications and additions until approval of the final report. The draft report will undergo review by USACE technical teams, an independent technical team from the National Academy of Sciences, and an independent international reviewer familiar with coastal storm risk management. Prior to submission of the final version of this report to Congress, the report will also undergo review by national policy reviewers, other local, state, and federal agencies, non-governmental organizations, and the public. All comments submitted by the aforementioned parties will be addressed. Review comments and responses to those comments will be documented in the final version of this report or as a supplement to this report.

A Report of the U.S. Army Corps of Engineers Chief of Engineers (“Chief’s Report”) is developed when a water resources project would require 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 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, “draft Miami-Dade Back Bay Coastal Storm Risk Management Feasibility Report and Programmatic Environmental Impact Statement” is scheduled to be submitted to USACE Headquarters in April 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 MDC 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 on-going projects/studies, post-authorization change reports, or new authorizations).

10.4 RECOMMENDED ACTIONS FOR OTHERS

While the USACE TSP provides a significant suite of measures to reduce flood risk in MDC, the plan will not solve all of MDC flooding problems. This study identified, focused on, and provided risk reduction measures for the seven socially vulnerable economic damage centers. There are still areas outside of the aforementioned seven focus areas that may be at risk as well as residual risk from flooding beyond the design limitations. Nonstructural areas will still see impacts to roadways, utilities and the environment due to flooding. The USACE recognizes that the USACE authority and formulation methodology is limited in what it can provide, therefore, the study includes recommended actions for sponsor and other entities to consider in a holistic approach to risk mitigation and overall resiliency.

10.4.1 NONSTRUCTURAL RECOMMENDATIONS

SECTION TO BE UPDATED AFTER OPTIMIZATION (PRIOR TO ADM)

10.4.2 COMMUNITY EDUCATION

SECTION TO BE UPDATED PRIOR TO AGENCY DECISION MILESTONE

10.5 LIST OF AGENCIES, ORGANIZATIONS AND PERSONS CONSULTED

Name	Contribution/Education
<i>Federal</i>	
Environmental Protection Agency	Ntale Kajumba; Alya Singh-White; Jamie Higgins
Federal Emergency Management Agency	Brandon Bolinski
National Marine Fisheries Service	Noah Silverman; Pace Wilber; Sarah Futak; Melissa Alvarez; Jamie Rhome; Robert Molleda; Brian Rosegger; Jennifer Schull; Pablo Santos
National Park Service	Erik Stabenau; Robert Johnson
U.S. Fish and Wildlife Service	Heather Hitt; Jeffrey Howe
U.S. Coast Guard	Bradley Clare; Hector Schmidt; David Lentine; Michael Capelli; Paul Lehmann; Samuel Rodriguez-Gonzalez; John-David Lentine; Andrew Brooks; Wayne Miller;
<i>State</i>	
Florida Department of Transportation	Andrew Jungman; Elizabeth Fulcher; James Wolfe; Steven James;
Florida Division of Emergency Management	Andrew Sussman
Florida Department of Environmental Protection	Roxanne Dow; Joanna Walczak; Gregory Garis; Chris Stahl; Kelly Egan; Eric Buck; Francisco Pagan; Lainie Edwards; Laura Eldredge
Florida Fish and Wildlife Commission	Erin McDevitt; Maria Merrill; Christine Raininger
State Historic Preservation Officer	Jason Aldridge
<i>Regional</i>	
South Florida Water Management District	Honging Zhao; Akin Owosina; Ann Springston; Carolina Ana Maran

County	
Miami-Dade	Katherine Hagemann; Monica Gregory; James Murley; Pamela Sweeney; Craig Grossenbacher; Lisa Spadafina; Jessica Blackwell; Noel Stillings; Kimberly Brown; Josh Mahoney
Locality	
City of Miami Beach	Margarita Kruff; Elizabeth Wheaton

10.6 LIST OF REPORT PREPARERS

Name	Contribution/Education	Years of Experience
Bryan Adkins	Civil Engineering/BS, Certified Cost Accountant	6
Faraz Ahmed, CFM	Project Planning/ME, Civil Engineering	7
Andrew Brooks, P.E.	Geotechnical Engineering/MS, Civil Engineering	8
Ji Cha, EIT	Structural Engineering/BS, Civil Engineering	3
Laura Frank	Economics/BA, Economics	15
Lee Fuerst	Environmental Analyst/MA, Energy & Mineral Resources	14
John Haynes	Cultural Resources/MA, Anthropology	35
Holly Carpenter, P.E.	Project Management/MS, Environmental Engineering	10
Daniel Hughes, Ph.D.	Project Planning/Ph.D. Applied Anthropology	28
Alicia Logalbo	Environmental Analysis/MS, Biology	23
Wayne Miller, P.E.	Structural Engineering, MS, Civil Engineering	20
Paul Moye, P.E.	Floodplain Management/BS, Civil Engineering	32
Abbegail Preddy	Project Planning/BS, Biological Systems Engineering	1.5
Miranda Ryan	Environmental Analyst/GIS Mapping/BS, Biology	4
David Schulte	Environmental Analysis/MS, Marine Science	20

Name	Contribution/Education	Years of Experience
Jennifer Shunfenthal	Environmental Analysis/MS, Environmental Management	5
Robin Williams, P.E.	H&H Engineering/BS, Civil Engineering	32
Justine Woodward	Environmental Analysis/MS, Marine Science	11
Brett Zank	Real Estate/BS, Business Administration	10

10.7 STATEMENT FROM THE DISTRICT ENGINEER

I concur with the findings of the Norfolk District PDT and advise the Tentatively Selected Plan, as fully detailed in this Integrated Feasibility Study 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 impacts to the natural and human environment 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 the Miami-Dade 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 partner, the State, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

Patrick V. Kinsman, PE
Colonel, U.S. Army
Commanding

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