

CENTRAL AND SOUTHERN FLORIDA (C&SF) FLOOD RESILIENCY STUDY

Planning Charrette

11-12 January 2023

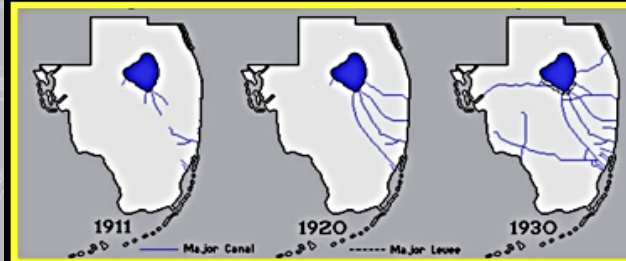
Working Today to Build a Better Tomorrow



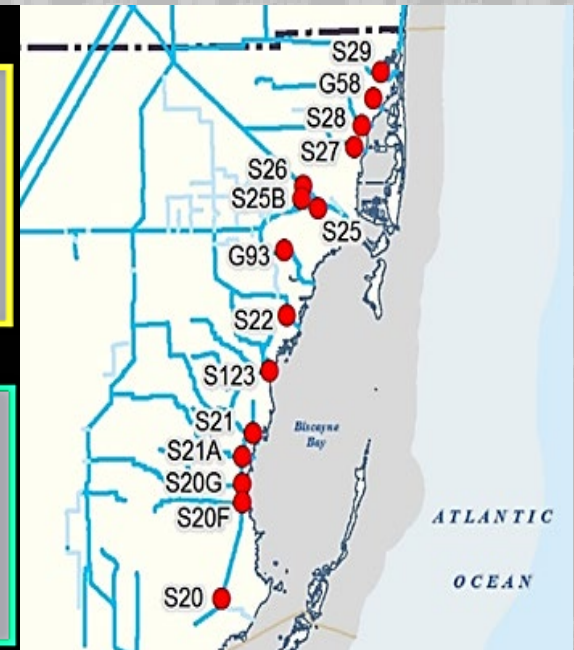
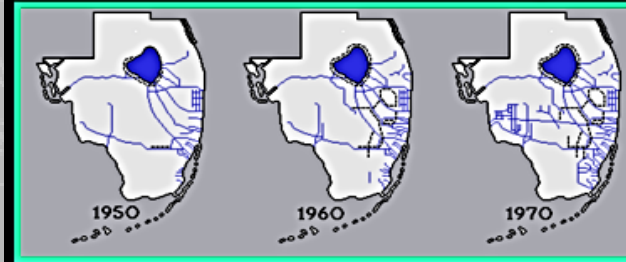
US Army Corps
of Engineers®



Pre-1948 Drainage Projects



Post-1948 C & S Florida Project



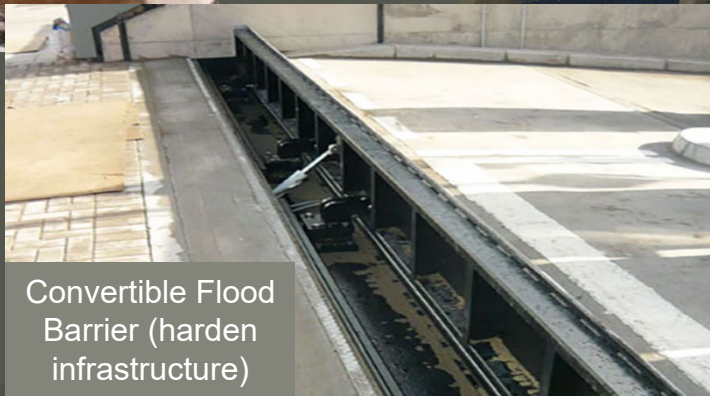
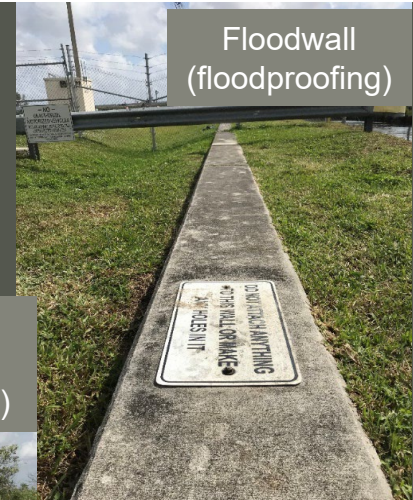
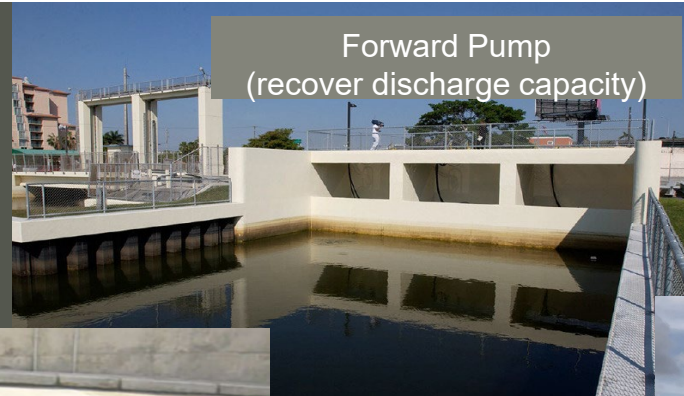


C&SF FLOOD RESILIENCY STUDY PLANNING CHARRETTE GOAL



The goal of this Planning Charrette is to understand the problems and opportunities in the study area in order to develop a focus list of preliminary measures and criteria for success.

Some measure examples:





AGENDA – DAY 1



Wednesday, 11 JAN 2022; 9:30 am – 3: 30 pm

Welcome, opening remarks and housekeeping items

9:30 - 9:45am

Morning Session

9:45 – 12:15pm

1.0 Study Overview

1.1 Integration Overview

1.2 Flood Risk Management Overview

2.0 Planning Process

2.1 County and Tribal Governments: challenges, issues, current efforts and desired outcomes in the area

2.2 C&SF system - regional challenges

3.0 Study Vision

Lunch

12:15 - 12:45pm

Afternoon Session

12:25 – 3:25pm

4.0 Problems, Opportunities, Objectives and Constraints

Wrap up

3:25 – 3:30pm



1.0 STUDY OVERVIEW

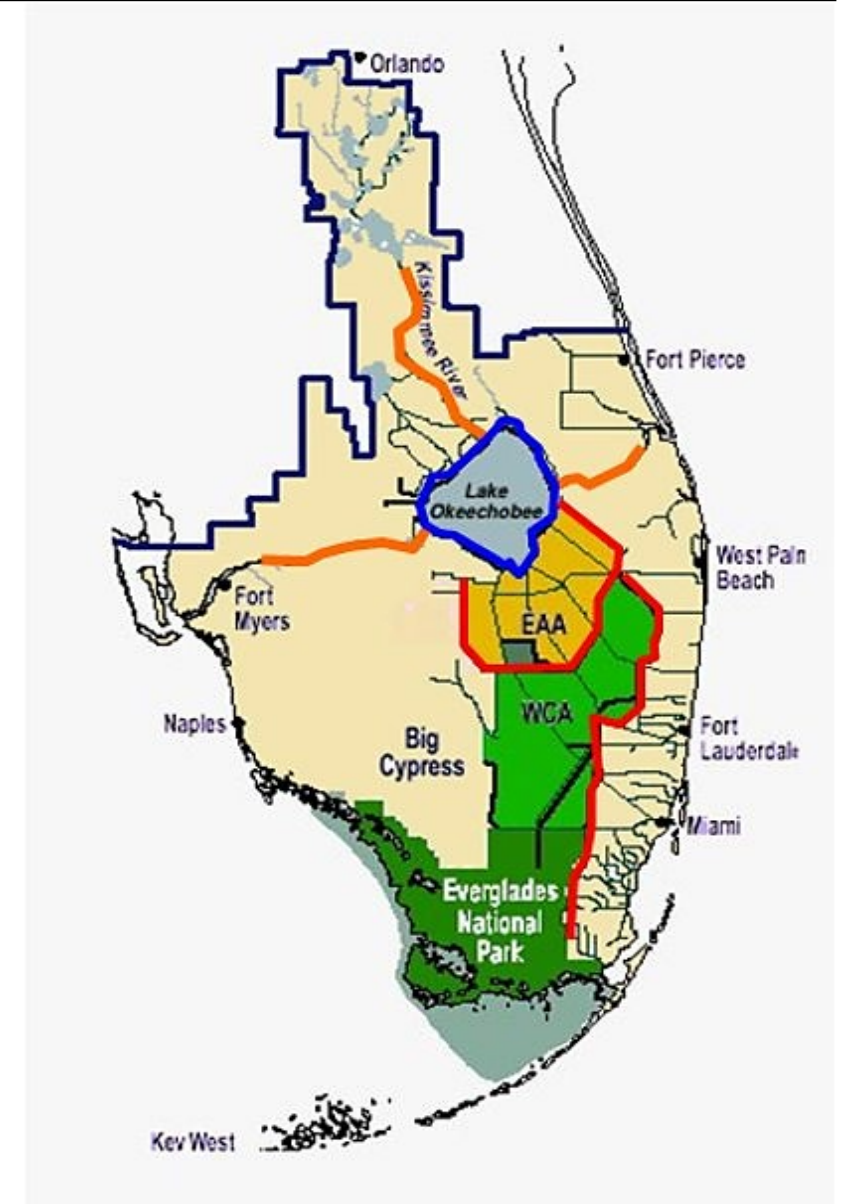
Presenter: Amy Thompson



C&SF MAJOR FEATURES AND PURPOSES



- Congressionally-authorized by the Flood Control Acts of 1948 and 1954
- Large multi-purpose water resources project
- System includes canals, levees/berms, pump stations and water control structures





C&SF FLOOD RESILIENCY STUDY OVERVIEW



Authority

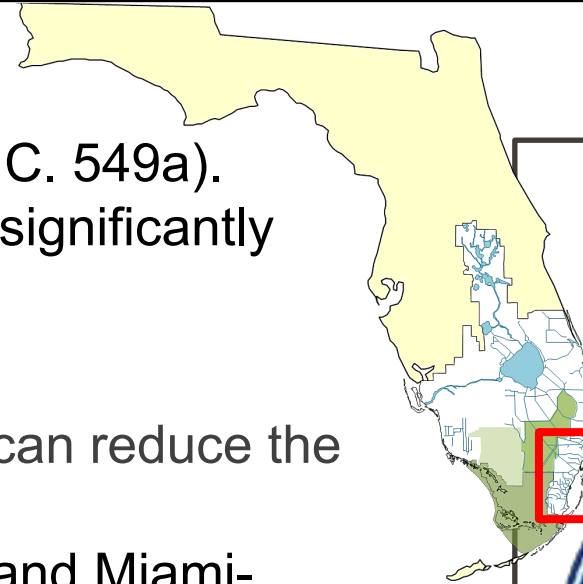
- Section 216 of the Flood Control Act of 1970 (33 U.S.C. 549a).
- Review of the existing C&SF infrastructure that have significantly changed due to physical or economic conditions.

Study Area

- Focus on the **highly vulnerable infrastructure** that can reduce the most immediate flood risks
- Lower East Coast – Southern Palm Beach, Broward and Miami-Dade counties.

Scope

- Evaluate existing Flood Risk Management (FRM) infrastructure and **recommend FRM measures and adaptation strategies to build flood resiliency** now and into the future in the communities served by the C&SF system
- Includes benefits to the other C&SF project purposes in addition to the FRM benefits.

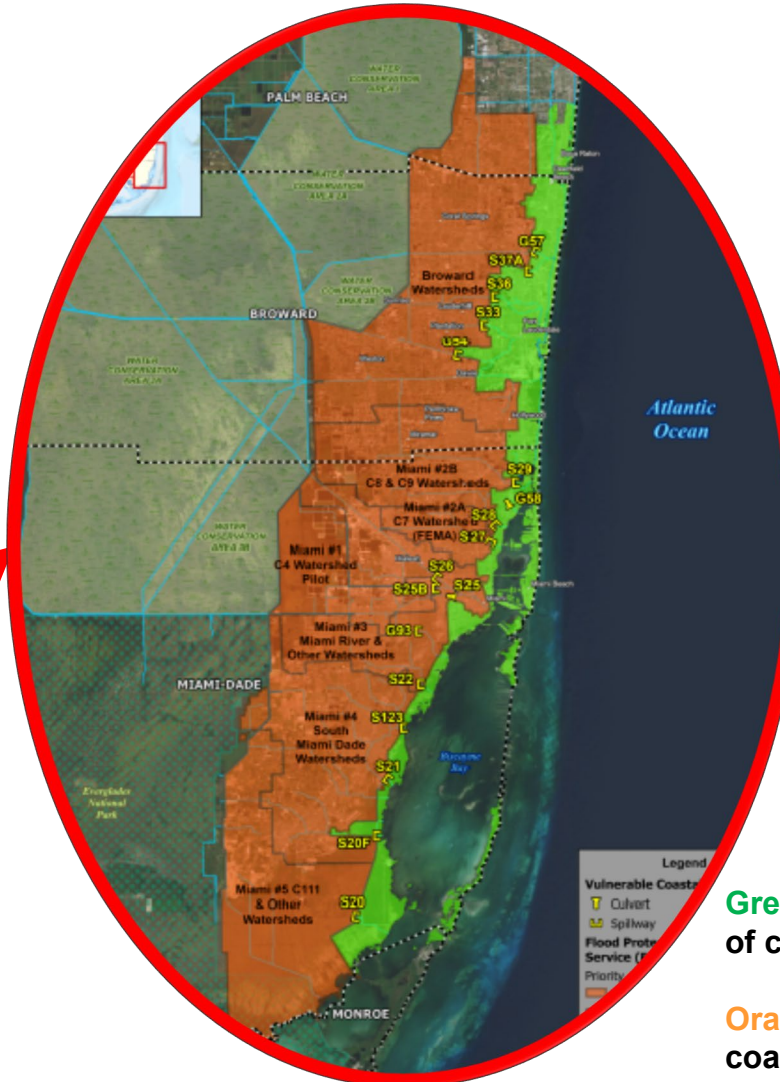
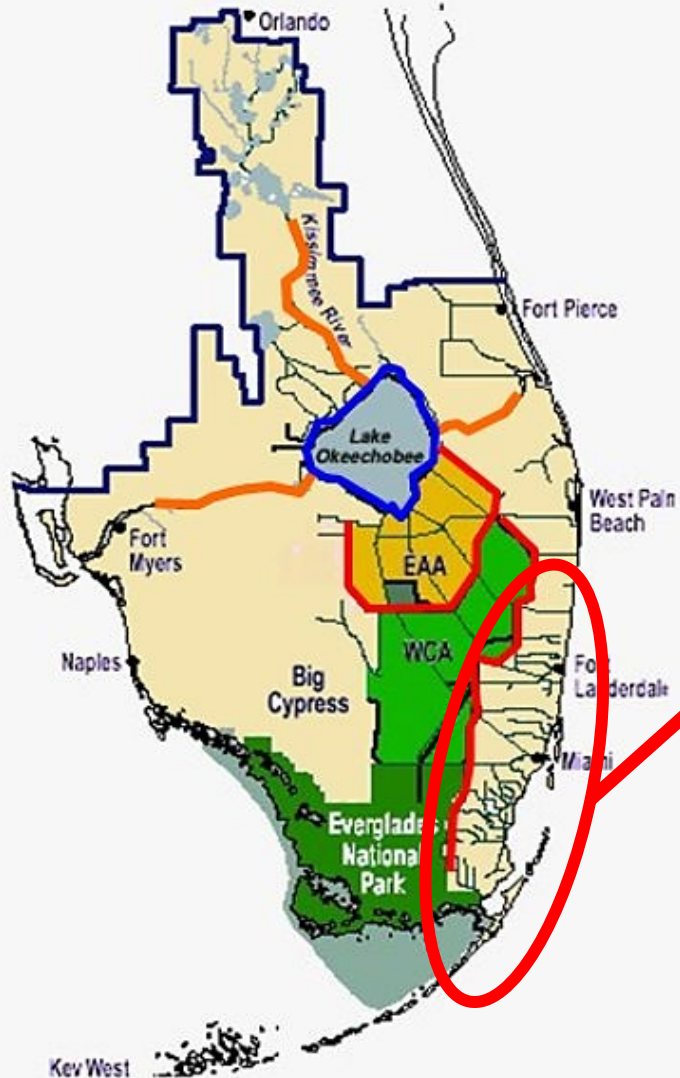


**Non-Federal
Sponsor**





HOW THIS EFFORT LINKS TO THE C&SF COMPREHENSIVE STUDY



WRDA 2022 contains an authority to conduct a comprehensive study of the C&SF system “for the purposes of flood risk management, water supply, ecosystem restoration (including preventing saltwater intrusion), recreation, and related purposes.”

Green = area downstream of coastal C&SF structures

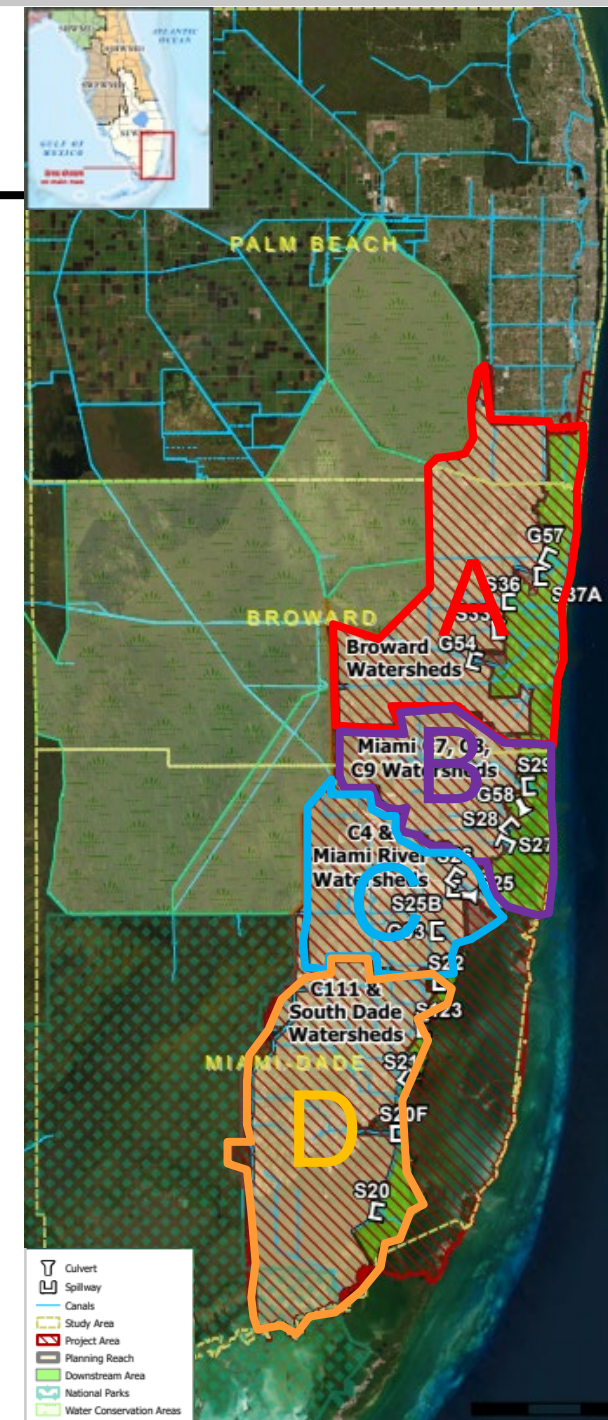
Orange = area upstream of coastal C&SF structures



PLANNING FOCUS AREAS

There are currently 4 planning focus areas identified for the study:

- Reach A: Broward and Hillsboro Basins
- Reach B: Little River and Nearby Basins
- Reach C: Miami River and Nearby Basins
- Reach D: South Miami Basins





1.1 INTEGRATION OVERVIEW

Presenter: Tim Gysan



STRATEGIC TOPICS



BUILDING COMMUNITY RESILIENCE: A COMPREHENSIVE AND COLLABORATIVE APPROACH

An Effective Resilience-focused Strategy Requires a Coordinated and Integrated Approach Across All Levels of the Public and Private Sectors





STRATEGIC TOPICS: SOUTHEAST FLORIDA PROJECT INTEGRATION

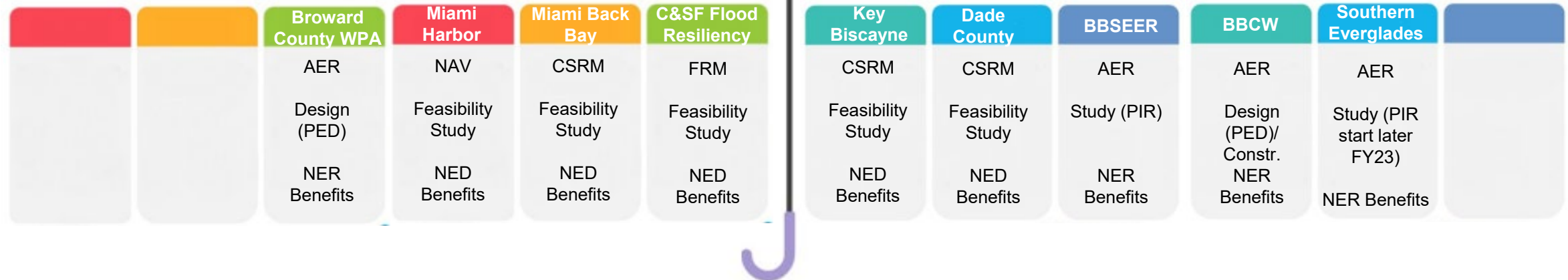


Integration Themes:

- Communication
 - Internal both between teams and with leadership
 - External with sponsors and stakeholders
- Technical
 - During Formulation including model assumptions and known features
 - After Formulation including comprehensive benefits

SAD

NAD



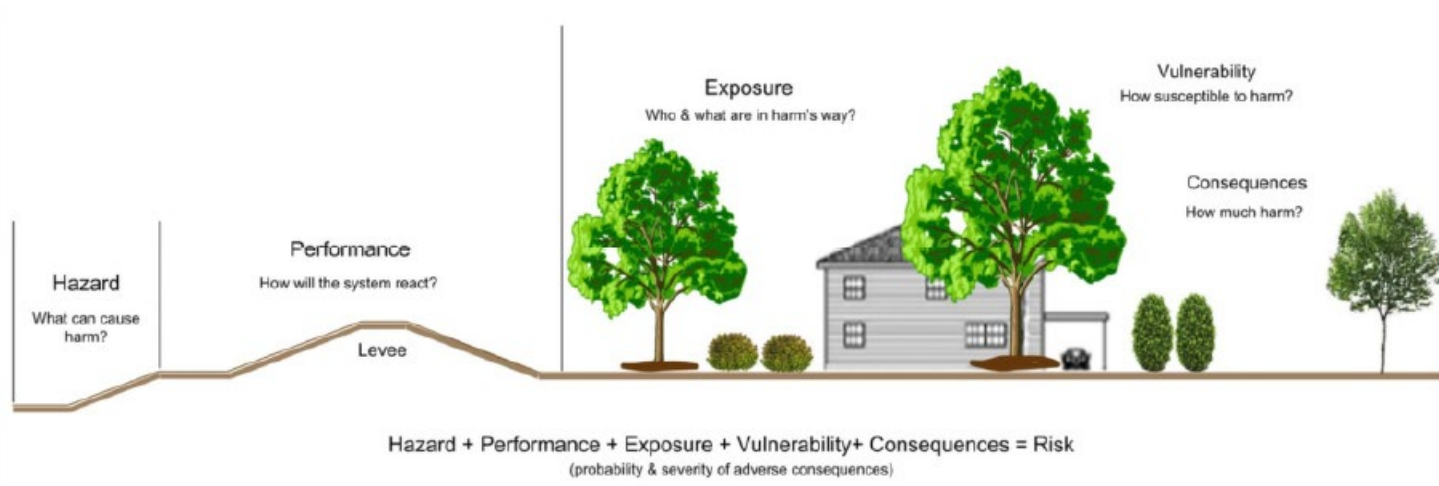


1.2 FLOOD RISK MANAGEMENT OVERVIEW

Presenter: Marci Jackson

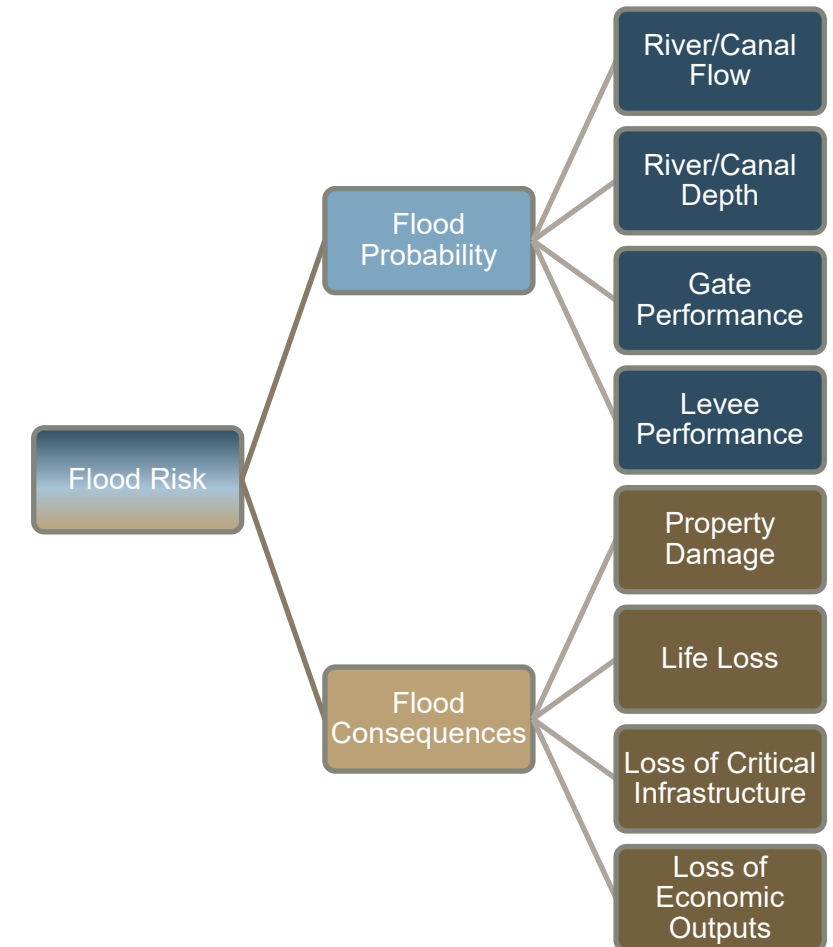


WHAT IS FLOOD RISK?



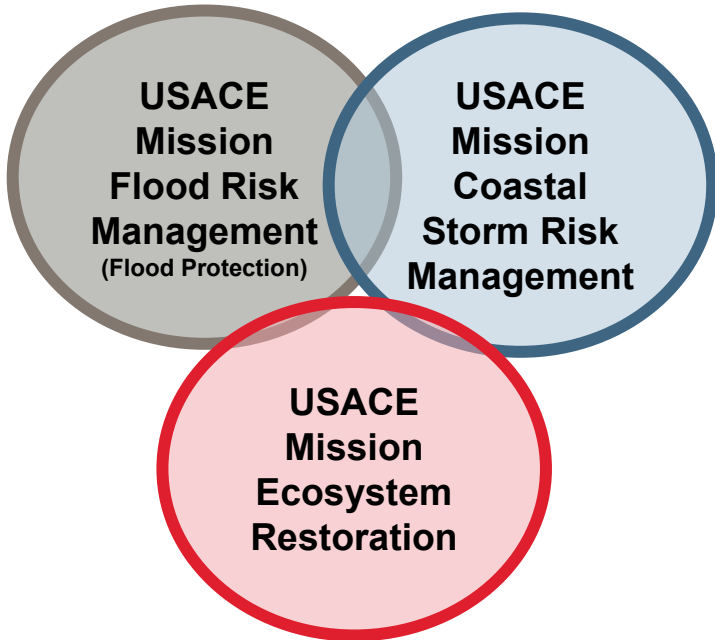
$\text{Risk} = f(\text{Hazard}, \text{Performance}, \text{Exposure}, \text{Vulnerability}, \text{Consequences})$

$\text{Flood Risk (simplified)} = \text{Flood Probability} \times \text{Flood Consequences}$





HOW THIS STUDY IS ONE PART OF THE REGIONAL EFFORTS



FRM study is different from other studies recently completed in South Florida but we will consider comprehensive benefits.

USACE Mission Area	Flood Risk Management (FRM)	Ecosystem Restoration	Coastal Storm Risk Management (CSRM)
Problems/Hazards	Inland Flooding	Degradation of habitat	Storm Surge, Coastal Flooding, Erosion, and Wave Attack
Benefits	Reduction of Flood Damages	Increase number of habitat units	Reduction of Flood Damages
H&H Models	Examples: HEC-RAS, HEC-HMS	Examples: RSM-Basin, RSM-GL	Examples: C-Shore
Economic Models/ Methodology	Examples: HEC-FDA, HEC-FIA, LifeSim	Examples: CE-ICA	Examples: Beach-Fx, G2CRM
Feasibility Studies in South Florida	None USACE studies since original C&SF	CEPP, BBSEER, Loxahatchee, LOWRP, WERP	Miami Dade County Coastal, Miami Dade County Back Bay, Pinellas, Collier County,

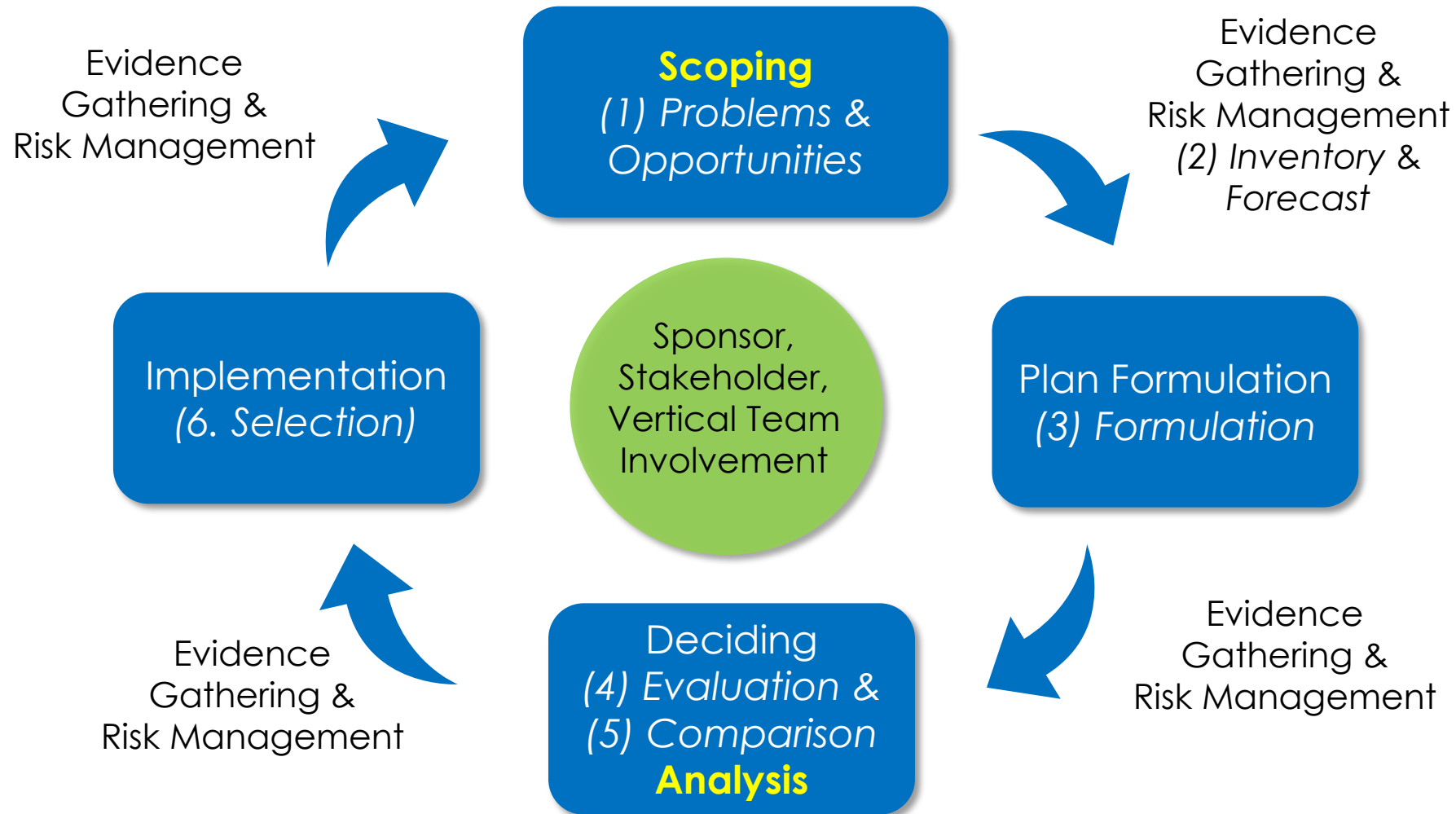


2.0 PLANNING PROCESS

Presenter: Amy Thompson



Risk-Informed Planning Process



(*) Shows the planning steps within the risk-informed planning process



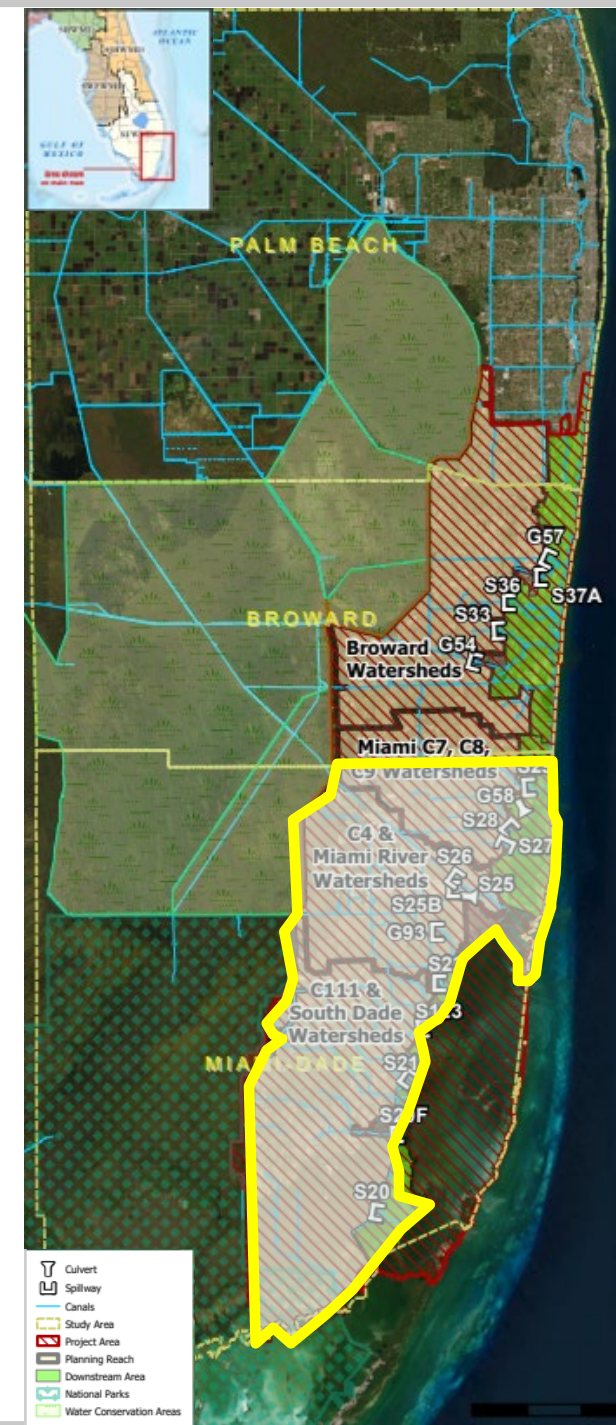
2.1 COUNTY AND TRIBAL GOVERNMENTS: CHALLENGES, ISSUES, CURRENT EFFORTS AND DESIRED OUTCOMES IN THE AREA

Presenter: All



MIAMI-DADE COUNTY

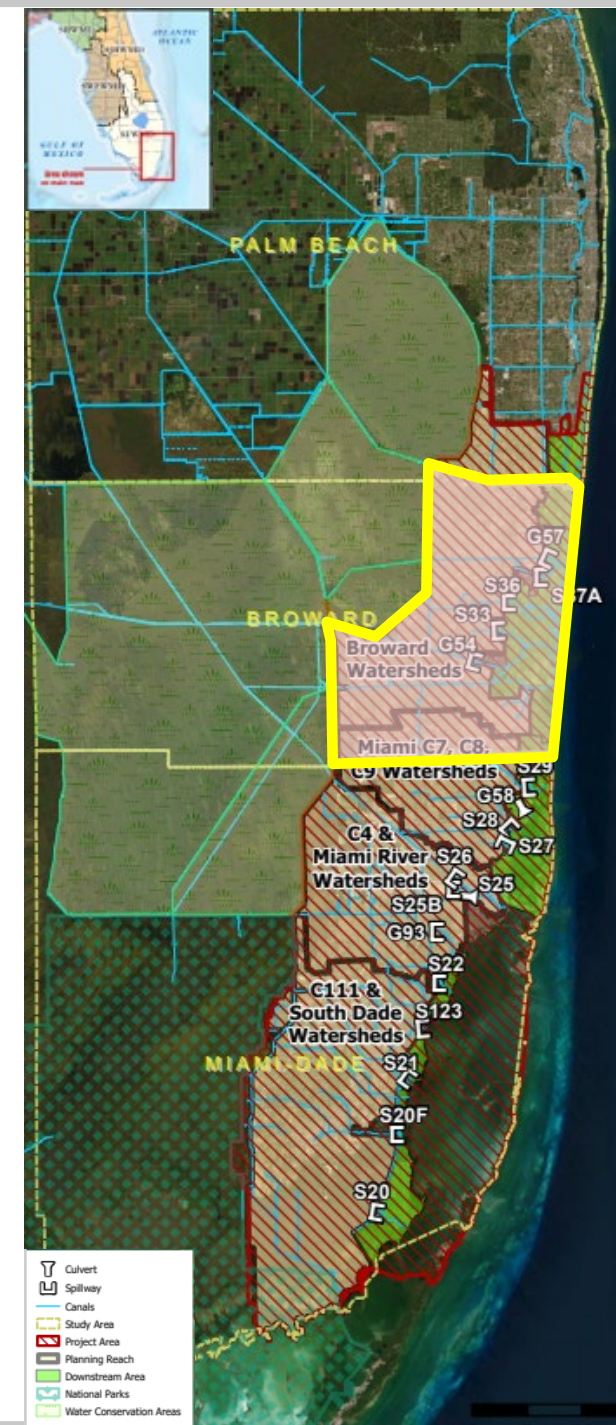
Presenter: Ana Fiotte





BROWARD COUNTY

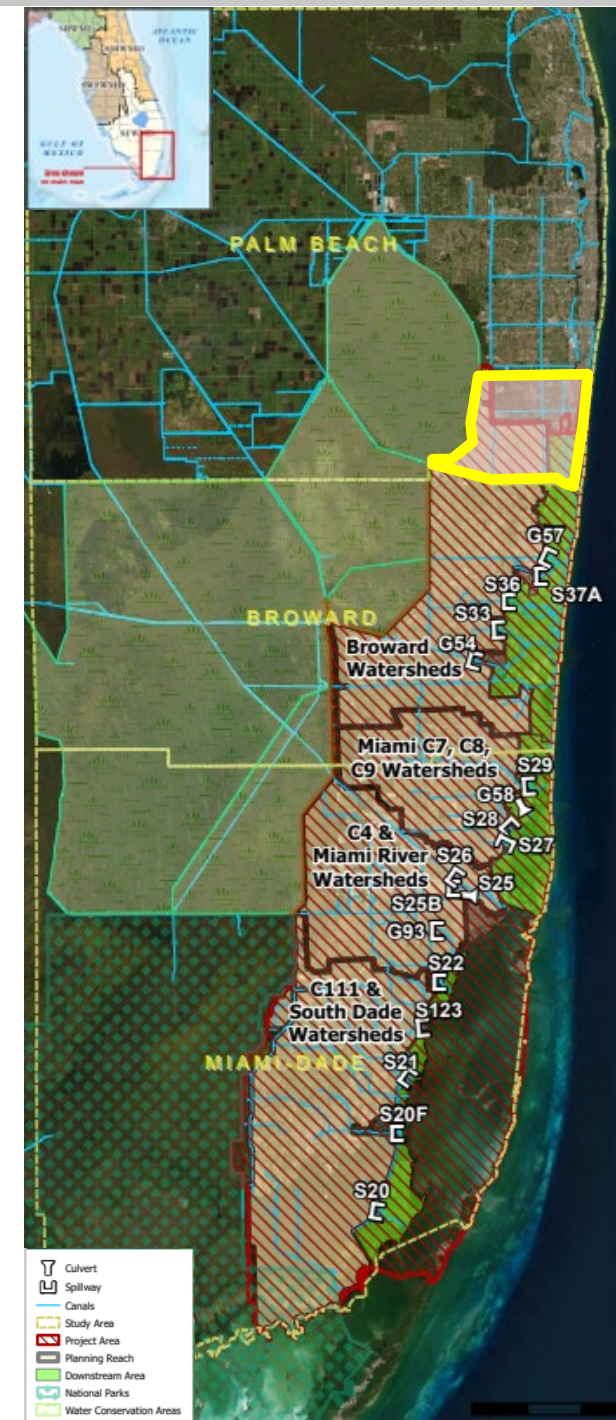
Presenter: Jennifer Jurado





PALM BEACH COUNTY

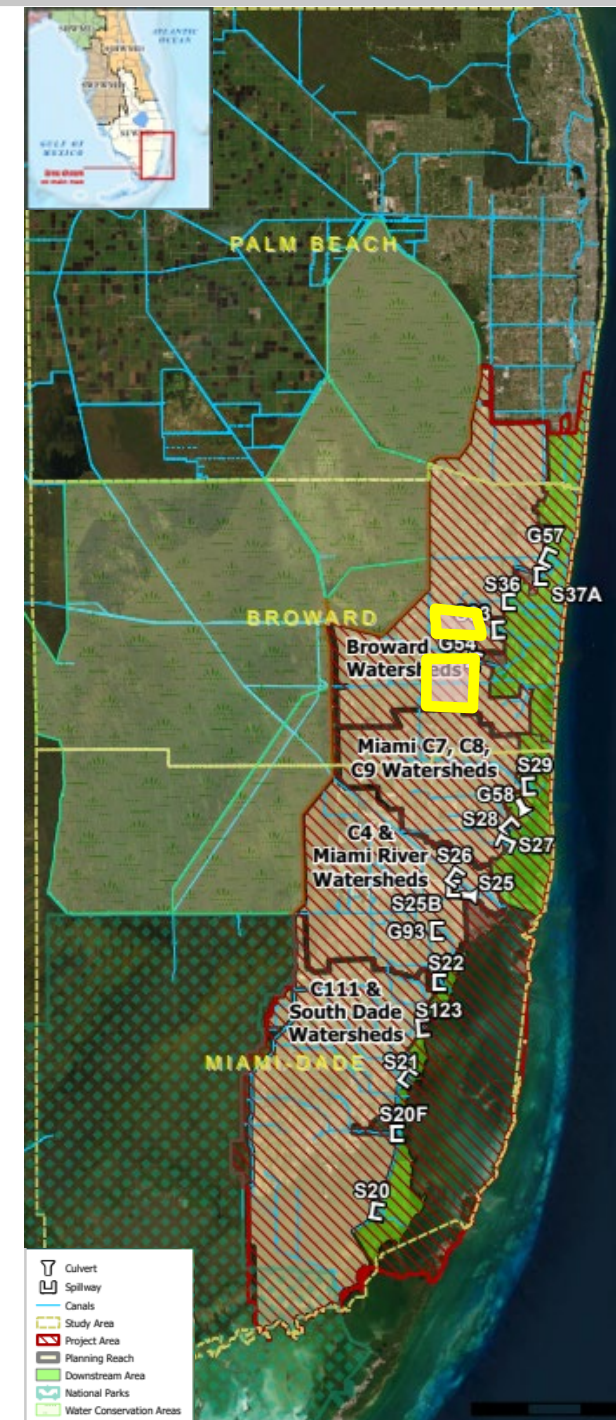
Presenter: Paul Linton / Megan Houston





SEMINOLE TRIBE OF FLORIDA

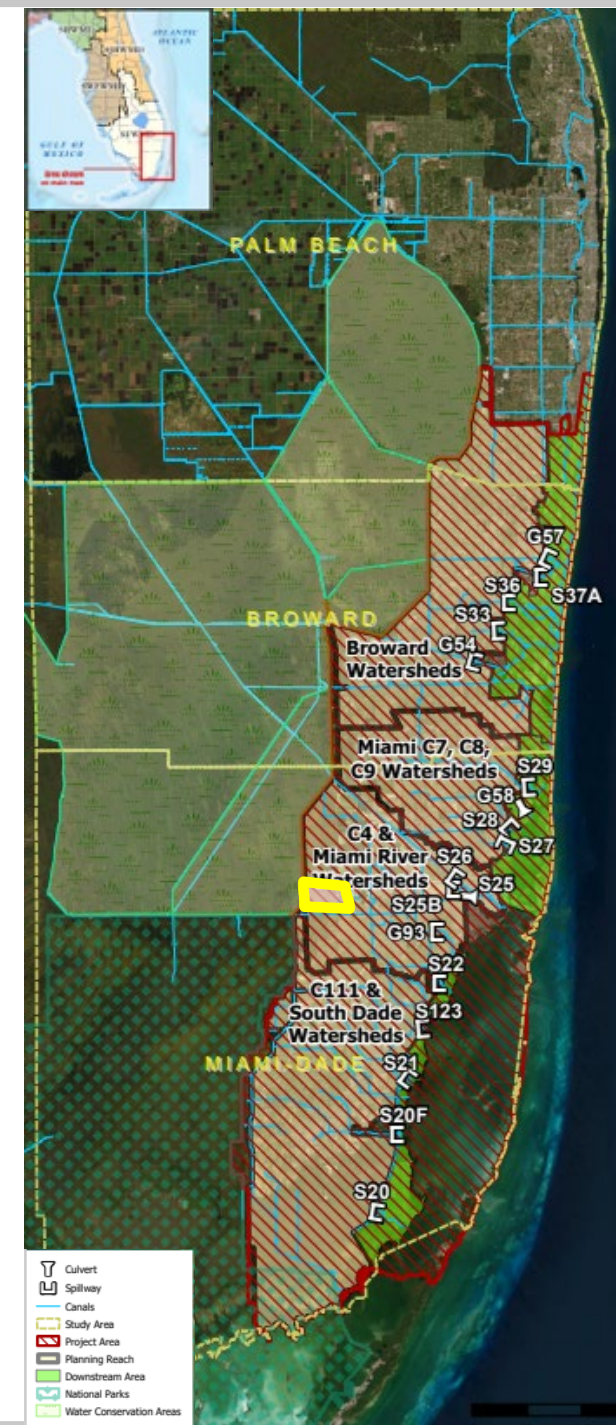
Presenter: Chris Murphy





MICCOSUKEE TRIBE OF FLORIDA

Presenter: Amy Castaneda / Kevin Cunniff





2.2 C&SF SYSTEM - REGIONAL CHALLENGES

Presenter: Carolina Maran



3.0 STUDY VISION

Facilitated by: Debby Scerno



VISION OVERVIEW



Purpose of the Vision Statement: Make sure everyone is going in the same direction.

EXAMPLE: Enhance **community resiliency** within the study area by addressing risk of flooding through a comprehensive structural and nonstructural plan.



LUNCH

30 minutes lunch



4.0 PROBLEMS, OPPORTUNITIES, OBJECTIVES & CONSTRAINTS

Presenter: Marci Jackson



PROBLEMS, OPPORTUNITIES, OBJECTIVES & CONSTRAINTS CONCEPTS



Problems

Description of the existing undesirable condition

Opportunities

Description of a future desirable condition

Objectives

Things we want to accomplish with a plan. Objectives need to be specific and measurable. It is a statement of what an alternative plan should try to achieve

Constraints

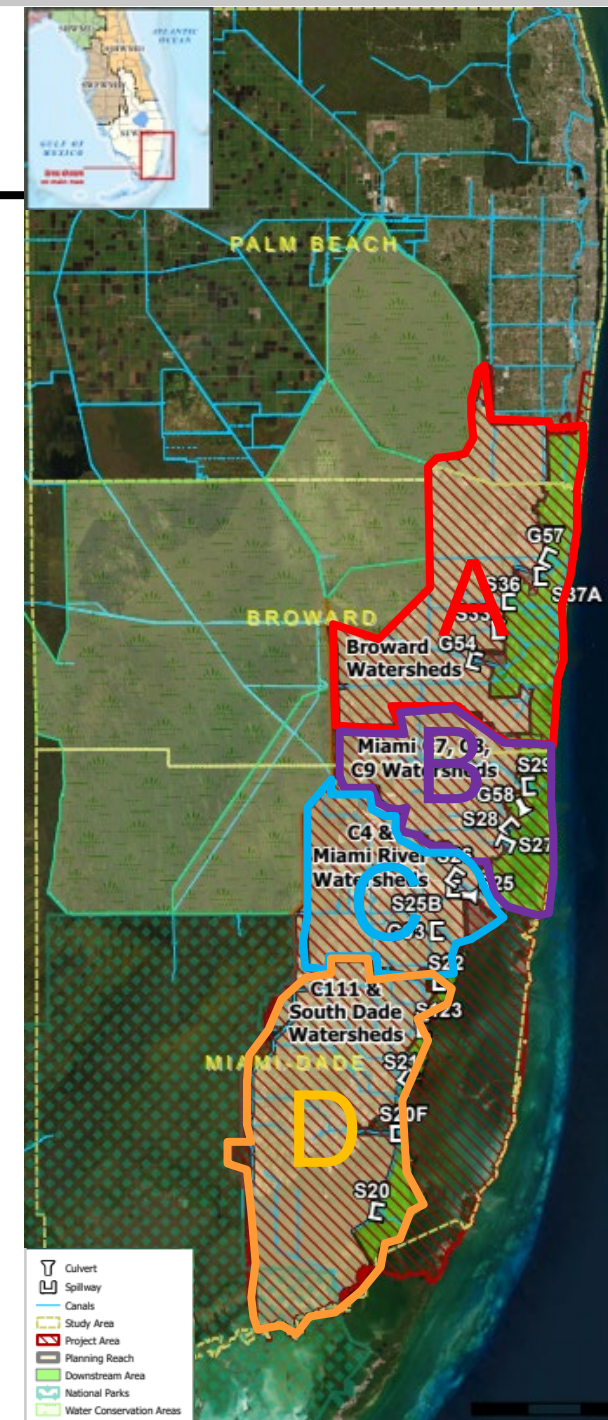
Things we want to avoid doing. Constraints are restrictions that limit the planning process. Constraints are designed to avoid undesirable changes between with and without project conditions



PLANNING FOCUS AREAS

There are currently 4 planning focus areas identified for the study:

- Reach A: Broward and Hillsboro Basins
- Reach B: Little River and Nearby Basins
- Reach C: Miami River and Nearby Basins
- Reach D: South Miami Basins





NOTES



(RAW INPUT CAPTURED DURING THE PLANNING CHARRETTE)

- Need to define flood / level of service for the study.
- There may be more coastal flooding/problems in Broward than Miami Dade
- Water budget, what are the means of disposal? All are insufficient.
 - Be cautious of wanting to dispose of water and the need to maximize use of water while providing flood protection.
- If water quality is not the focus, then the quantity doesn't matter.
- Fish and wildlife habitat – What do we mean when we say “protect” As conditions change our habitat changes.
- Constraints – federal laws and regulations
- Considerations –
- Life Safety Concern isn't that big of a concern because it is only a foot or two due to high tide. The limitation is the elevation of the sea wall and this may increase life safety risk. Storm surge conditions may be different.



PROBLEMS (RAW INPUT CAPTURED DURING THE PLANNING CHARRETTE)



DRAFT Problems	Reach A	Reach B	Reach C	Reach D
Flood damages produced by local runoff in the urban and ag areas within the study area	APPLIES	APPLIES	APPLIES	APPLIES
Flood damages produced by storm surge in the urban and ag areas within the study area	APPLIES	APPLIES	APPLIES	APPLIES
Flood damages produced by the propagation of high tides in the urban and ag areas within the study area	APPLIES	APPLIES	APPLIES	APPLIES



PROBLEMS

(RAW INPUT CAPTURED DURING THE PLANNING CHARRETTE)



DRAFT Problems	Reach A	Reach B	Reach C	Reach D
Insufficient water storage within the study area Notes: Means of disposal are insufficient, where to dispose	Applies	Applies	Applies	Applies
Flood damages to environmental justice communities including tribal lands within the study area	Applies	Applies	Applies	Applies
Loss of fish and wildlife habitats in the study area due to flooding and saline intrusion Notes: Biscayne Bay is suffering the worst for fish kills.	Applies	Applies	Applies	Applies
Loss of water supply as a result of saline intrusion within the study area Notes: Broward may be worse for	Applies	Applies	Applies	Applies



PROBLEMS

(RAW INPUT CAPTURED DURING THE PLANNING CHARRETTE)



DRAFT Problems	Reach A	Reach B	Reach C	Reach D
Loss of recreational activities due to flooding within the study area Notes: due to water quality & quantity	APPLIES	APPLIES	APPLIES	APPLIES
Loss of economic output due to increase in flood depths frequency within the study area Notes: due to water quality & quantity	APPLIES	APPLIES	APPLIES	APPLIES
Health and life safety risk currently exist due to flooding within the study area	APPLIES	APPLIES	APPLIES	APPLIES
All three conditions happening at once, inland flooding (runoff), storm surge and high tide = compound flooding Notes: more of a concern in Broward & Miami Dade	APPLIES	APPLIES	APPLIES	APPLIES
Groundwater	APPLIES	APPLIES	APPLIES	APPLIES



PROBLEMS (RAW INPUT CAPTURED DURING THE PLANNING CHARRETTE)



DRAFT Problems	Reach A	Reach B	Reach C	Reach D
Coastal ecology suffering from discharges (water quality)	Applies	Applies	Applies	Applies
Lack of space for storage, structures.	Applies	Applies	Applies	Applies
Lack of drainage capacity in the secondary and tertiary systems under future conditions	Applies	Applies	Applies	Applies
Extreme conditions in south Florida make it difficult to discharge Notes: increase in allowable discharge – consideration? Constraint?	Applies	Applies	Applies	Applies
Historical and cultural impacts due to flooding	Applies	Applies	Applies	Applies



NOTES:



(RAW INPUT CAPTURED DURING THE PLANNING CHARRETTE)

- Water moved to Everglades or natural areas has a water quality component.
- Expand the area Actively served by the C&SF system by including more of the tidally influenced areas
- C&SF – Missed opportunity. As we continue there may be more opportunities to tease out.



OPPORTUNITIES

(RAW INPUT CAPTURED DURING THE PLANNING CHARRETTE)



DRAFT Opportunities	Reach A	Reach B	Reach C	Reach D
Reduce local runoff flood risk and increase resiliency within the study area	Applies	Applies	Applies	Applies
Reduce storm surge flood risk and increase resiliency within the study area	Applies	Applies	Applies	Applies
Reduce high tide flood risk and increase resiliency within the study area	Applies	Applies	Applies	Applies



OPPORTUNITIES

(RAW INPUT CAPTURED DURING THE PLANNING CHARRETTE)



DRAFT Opportunities	Reach A	Reach B	Reach C	Reach D
Provide equitable benefits to economically-disadvantaged and minority communities	Applies	Applies	Applies	Applies
Increase natural and nature-based features (green infrastructure), fish and wildlife resiliency within the study area	Applies	Applies	Applies	Applies
Enhance recreational opportunities within the study area	Applies	Applies	Applies	Applies
Improve of zoning and building codes (local regulations/ ordinances) in order to provide adequate level of service or provide flood protection within the study area. Notes: Need to work with the team on this to add a qualifier.	Applies	Applies	Applies	Applies



OPPORTUNITIES

(RAW INPUT CAPTURED DURING THE PLANNING CHARRETTE)



DRAFT Opportunities	Reach A	Reach B	Reach C	Reach D
Protect water supply sources against saline intrusion notes: explore changes to the operations to the system without comprising the Flood system.	Applies	Applies	Applies	Applies
Improve freshwater releases at the right time and volumes to enhance or reduce damages to the coastal ecosystem	Applies	Applies	Applies	Applies
Increase Unify coordination and trust with stakeholders and the public	Applies	Applies	Applies	Applies
Integrate designs of the primary, secondary and tertiary systems	Applies	Applies	Applies	Applies
Increase and maintain water availability at the right time and volumes to the Everglades	Applies	Applies	Applies	Applies
Adapt dynamic planning	Applies	Applies	Applies	Applies
Improving the conveyance along the edge of the Everglades (north /south).	Applies	Applies	Applies	Applies
Enhancing urban habitat ands green space areas to reduce flood risk				



NOTES: (RAW INPUT CAPTURED DURING THE PLANNING CHARRETTE)



- Develop tools / database to increase awareness or ability to plan / operate.
- Consider Increase in energy from gravity system to pumps, etc.
- Increase renewable energy where it makes sense.
- Resiliency in energy (damage and disruption)
- **Need to be cautious not to add a purpose such as ecosystem and water supply. Relook if they are opportunities or objectives.**
- **Factor of safety... should be a robust, resilient, and adaptive system.**
- Increase in rainfall... need to look at a suite of different things not just one alternative/plan.
- Need to consider using local and regional data such as rainfall. SFWMD partnered with USGS to gather /analyze data/science on changing in rainfall.
- Team will work with FRM PCX and Climate CoP to discuss how to use regional and local data on changing in rainfall.



OBJECTIVES

Things we want to accomplish with a plan. Objectives need to be specific and measurable. It is a statement of what an alternative plan should try to achieve



DRAFT Objectives	Reach A	Reach B	Reach C	Reach D	How to Measure Success?
Decrease flood risks to private and public infrastructure (other assets?) due to runoff, storm surge and tidal influences under current and future changing climate and land use conditions within our planning reaches	Applies	Applies	Applies	Applies	<ul style="list-style-type: none">• Flood damages• Level of service due to tide• Level of service storms• Area inundated• Number of days flooded• Look at PLOS work to carry over into this study
Reduce flood risks to critical infrastructure susceptible to frequent rainfall events and sea level change conditions within our planning reaches	Applies	Applies	Applies	Applies	<ul style="list-style-type: none">• Evacuation routes

(RAW INPUT CAPTURED DURING THE PLANNING CHARRETTE)



OBJECTIVES (RAW INPUT CAPTURED DURING THE PLANNING CHARRETTE)



DRAFT Objectives	Reach A	Reach B	Reach C	Reach D	How to measure success?
Improve hydrology and hydraulics (storage, conveyance and operations) to enhance inland and coastal systems. (Note: integrated natural and fluvial system. Manmade and natural both. May consider splitting into two)	Applies	Applies	Applies	Applies	<ul style="list-style-type: none">Increasing # of wetlandsSalinity & health of coastal system.
Minimize flood risk to underserved and socially vulnerable communities (environmental justice) including tribal lands	Applies	Applies	Applies	Applies	
Maintain water supply capacity within our planning reaches	Applies	Applies	Applies	Applies	



OBJECTIVES (RAW INPUT CAPTURED DURING THE PLANNING CHARRETTE)



DRAFT Objectives	Reach A	Reach B	Reach C	Reach D	How to measure success?
Reduce economic damages due to increase in flood area, flood risk, depths, frequency, and durations within our project areas (note: every study in the region is addressing increase in rainfall, strong thought to keep “increase”)	Applies	Applies	Applies	Applies	<ul style="list-style-type: none">Achieve adequate level of service.
Reduce health and life safety risk due to flooding within the planning reaches	Applies	Applies	Applies	Applies	
Integrate solutions/studies	Applies	Applies	Applies	Applies	
Leverage point for the larger Comprehensive C&SF study	Applies	Applies	Applies	Applies	
Achieve an adequate or minimum Level of service	Applies	Applies	Applies	Applies	
Enhance fish and wildlife objective... something for the team to consider					
Enhance natural and nature-based features.					



NOTES:

(RAW INPUT CAPTURED DURING THE PLANNING CHARRETTE)



- Team will need to go back and sort through these. Local constraints vs. Federal constraints.
- Comprehensive Benefits: NED, RED, OSE, and EQ
- Can look at FWOP conditions overtime but will be complex.
- Different approaches:
 - Build big project up front and watch it degrade overtime
 - Build to the project overtime and adapt overtime.
 - Dynamic adaptability/planning overtime



CONSTRAINTS

(RAW INPUT CAPTURED DURING THE PLANNING CHARRETTE)



DRAFT Constraints	Reach A	Reach B	Reach C	Reach D
Do not adversely impact water supply conditions in the study area				
Minimize negative impacts to other Federal water resources projects in the study area (integration) (i.e., everglades, BBSEER, Miami back bay)				
Can't impact Water quality beyond standards				
Land availability				
Social equity – Older developments sit in lower elevations				
Impacts to cultural or historical resources				
Avoid transferring flood risk from one community/basin to another.				

The logo of the South Florida Water Management District is a circular seal. It features a map of Florida in the center, with a sun rising over the Gulf of Mexico to the left and the Atlantic Ocean to the right. The text "SOUTH FLORIDA WATER MANAGEMENT DISTRICT" is written around the top inner edge of the circle. Below the map, it says "DIVISION OF THE EVERGLADES STATE". At the bottom, there are three small stars.



WRAP UP

Presenter: Debby Scerno



PUBLIC COMMENT PERIOD



DAY 2:
MUSEUM OF DISCOVERY & SCIENCE
401 SW SECOND STREET

Planning Charrette: 12 JAN 2023



AGENDA – DAY 2



Thursday, 12 JAN 2022; 9:30 am – 3: 30 pm

Recap: Problems, Opportunities, Objectives & Constraints

9:30 - 9:45am

Morning Session

9:45 – 12:15pm

5.0 Forecasting the Future

6.0 Formulating Flood Risk Management Measures

6.1 Natural and Nature-Based Measures

6.2 Breakout session to formulate measures

Lunch

12:15 - 12:45pm

Afternoon Session

12:45 – 3:25pm

7.0 The Evaluation Process

8.0 Alternatives

Wrap up

3:25 – 3:30pm



RECAP: PROBLEMS, OPPORTUNITIES, OBJECTIVES & CONSTRAINTS

Presenter: Amy Thompson / Marci Jackson



FLOOD CONTROL ACT OF 1970, SECTION 216



"The Secretary of the Army, acting through the Chief of Engineers, is authorized to review the operation of projects the construction of which has been completed and which were constructed by the Corps of Engineers in the interest of navigation, flood control, water supply, and related purposes, when found advisable due to significantly changed physical or economic conditions, and to report thereon to Congress with recommendations on the advisability of modifying the structures or their operation, and for improving the quality of the environment in the overall public interest."



RECAP: PROBLEMS



(RECAP FROM DAY 1 INPUT. DRAFT AND SUBJECT TO CHANGE)

- Flood damages produced by local runoff in the urban and ag areas within the study area
- Flood damages produced by storm surge in the urban and ag areas within the study area
- Flood damages produced by the propagation of high tides in the urban and ag areas within the study area
- Insufficient water storage within the study area
- Flood damages to environmental justice communities including tribal lands within the study area
- Loss of fish and wildlife habitats in the study area due to flooding and saline intrusion
- Loss of water supply as a result of saline intrusion within the study area
- Loss of recreational activities due to flooding within the study area due to water quality and quantity
- Loss of economic output due to increase in flood depths frequency within the study area due to water quality & quantity
- Health and life safety risk currently exist due to flooding within the study area
- All three conditions happening at once, inland flooding (runoff), storm surge and high tide = compound flooding
- Groundwater flooding
- Coastal ecology suffering from discharges (water quality)
- Lack of space for storage, structures.
- Lack of drainage capacity in the secondary and tertiary systems under future conditions
- Impacts to historical and cultural resources due to flooding



RECAP: OPPORTUNITIES



(RECAP FROM DAY 1 INPUT. DRAFT AND SUBJECT TO CHANGE)

- Reduce local runoff flood risk and increase resiliency within the study area
- Reduce storm surge flood risk and increase resiliency within the study area
- Reduce high tide flood risk and increase resiliency within the study area
- Provide equitable benefits to economically-disadvantaged and minority communities
- Increase natural and nature-based features (green infrastructure), fish and wildlife resiliency within the study area
- Enhance recreational opportunities within the study area
- Improve local regulations/ ordinances in order to provide flood protection within the study area.
- Protect water supply sources against saline intrusion
- Improve freshwater releases at the right time and volumes to enhance or reduce damages to the coastal ecosystem
- Unify coordination and trust with stakeholders and the public
- Integrate designs of the primary, secondary and tertiary systems
- Increase and maintain water availability at the right time and volumes to the Everglades
- Adapt dynamic planning
- Improving the conveyance along the edge of the Everglades (north /south).
- Enhancing urban habitat and green space areas to reduce flood risk.



RECAP: OBJECTIVES



(RECAP FROM DAY 1 INPUT. DRAFT AND SUBJECT TO CHANGE)

- Reduce local runoff flood risk and increase resiliency within the study area
- Reduce storm surge flood risk and increase resiliency within the study area
- Reduce high tide flood risk and increase resiliency within the study area
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- Enhancing urban habitat and green space areas to reduce flood risk.



RECAP: CONSIDERATIONS & CONSTRAINTS



(RECAP FROM DAY 1 INPUT. DRAFT AND SUBJECT TO CHANGE)

- Extreme conditions in south Florida make it difficult to discharge
- Do not adversely impact water supply conditions in the study area
- Minimize negative impacts to other Federal water resources projects in the study area (integration) (i.e., everglades, BBSEER, Miami back bay)
- Can't impact Water quality beyond standards
- Land availability
- Social equity – Older developments sit in lower elevations
- Impacts to cultural and historical resources
- Avoid transferring flood risk from one community/basin to another.
- Impacts to navigation (Federal and non-Federal)



5.0 FORECASTING THE FUTURE

Presented by: Amy Thompson/Marci Jackson



FORECASTING THE FUTURE



What projects will be in place?

- CERP
- Coastal

Changes in conditions:

- Population
- Land use
- Climate Change

What Operational Schedules will be in place that impact this region?

- System wide operating manual volume 5

What are things people would do if the Corps did not implement this project?

- Municipal water supply
- SFWMD and other Actions
- Business and People Relocate



FORECASTING THE FUTURE (CONT.)

<https://vimeo.com/416090381/a11cead328>





6.0 FORMULATING FLOOD RISK MANAGEMENT MEASURES

Presenter: Marci Jackson



FLOOD RISK MANAGEMENT (FRM) MEASURES

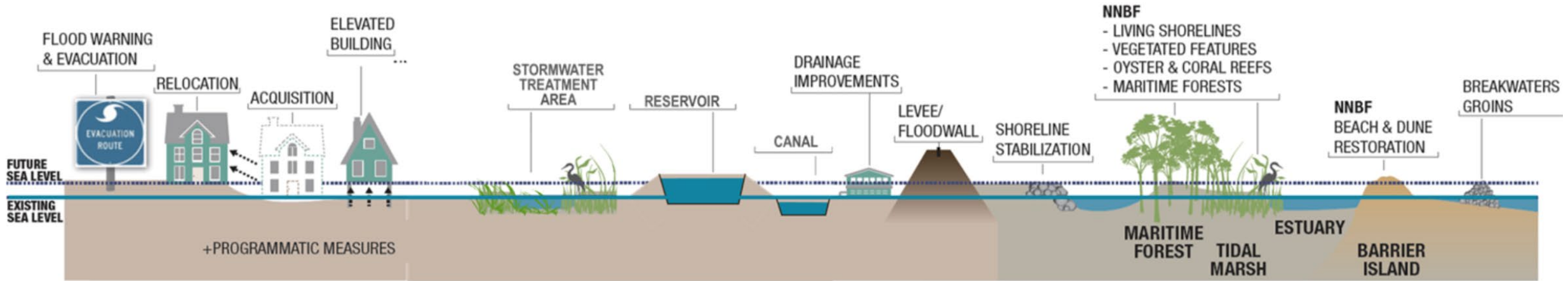


Type of measures:

- Structural
- Non-Structural
- Natural and Nature-Based Features (NNBF)

$$\text{Risk} = \text{Probability} \times \text{Consequences}$$

POTENTIAL MEASURES TO IMPROVE RESILIENCE AND SUSTAINABILITY



Graphic modified from https://ewn.el.erdc.dren.mil/nnbf/other/5_ERDC-NNBF_Brochure.pdf



EXAMPLE STRUCTURAL MEASURES

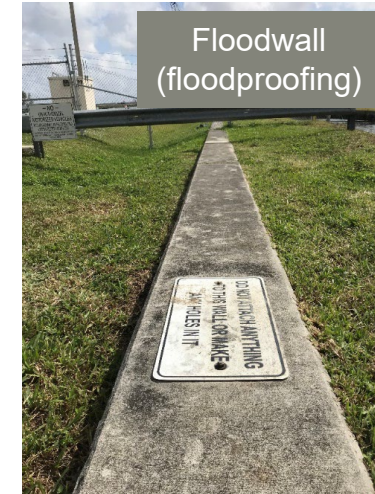


Structural Measures

Structural measures are physical modifications designed to reduce the frequency of damaging levels of flood inundation.

Some examples:

- Levees
- Floodwalls
- Channel modifications
- Storages areas
- Pumps





EXAMPLE NON-STRUCTURAL MEASURES



Non-Structural Measures

Non-structural measures reduce flood damage risks without significantly altering the nature or extent of the flooding by changing the use of floodplains or by accommodating existing uses to the flood hazard.

PHYSICAL

- Acquisition
- Elevation
- Relocation
- Dry Floodproofing
- Temporary Barriers
- Wet Floodproofing

NONPHYSICAL

- Education / Communication
- Flood Emergency Preparedness & Warning
- Flood Insurance
- Land Use Regulation (Zoning)
- Building Codes





6.1 NATURAL AND NATURE-BASED MEASURES

Presenter: Dr. Todd Bridges



6.2 BREAKOUT SESSION TO FORMULATE MEASURES



SUMMARY: FLOOD RISK MANAGEMENT



- Reduce flood risk including threats to life and property from flooding.
- The appropriate use of and resiliency of structures such as levees and floodwalls.
- Promote alternative resiliency approaches such as natural & nature-based and nonstructural solutions to flooding.

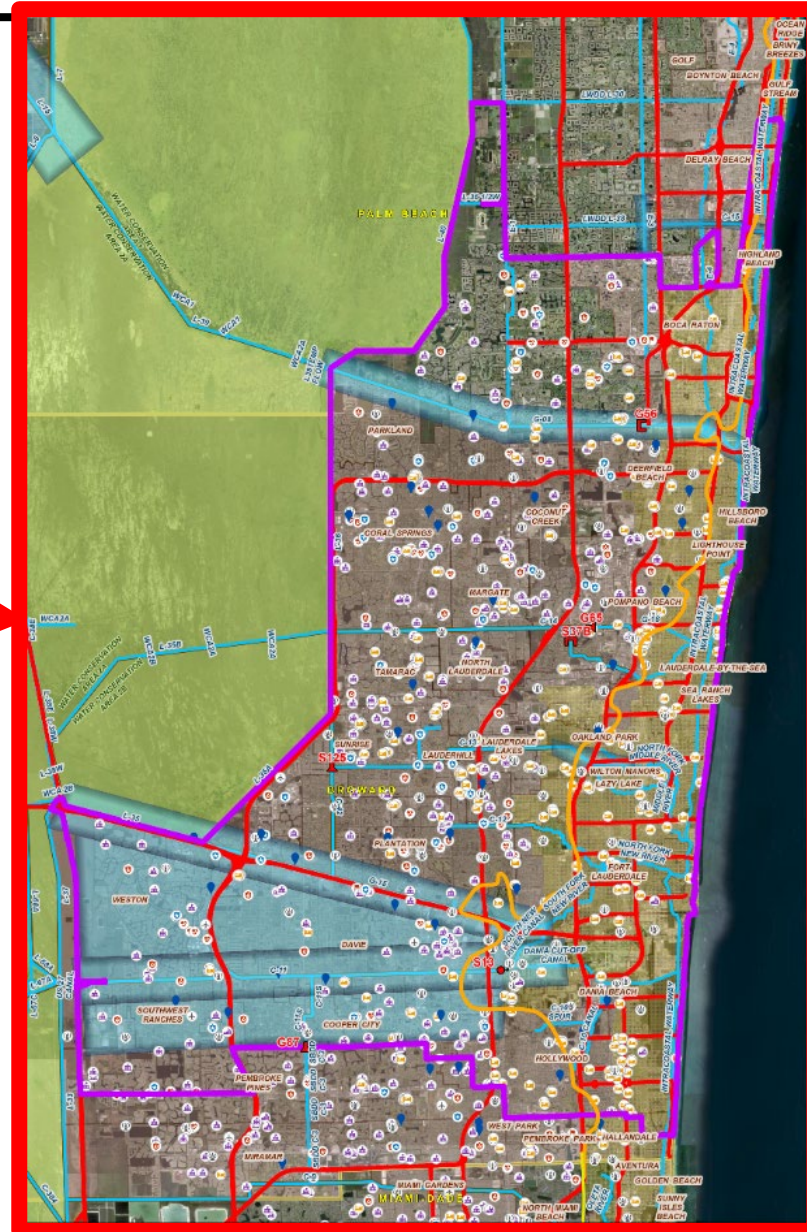
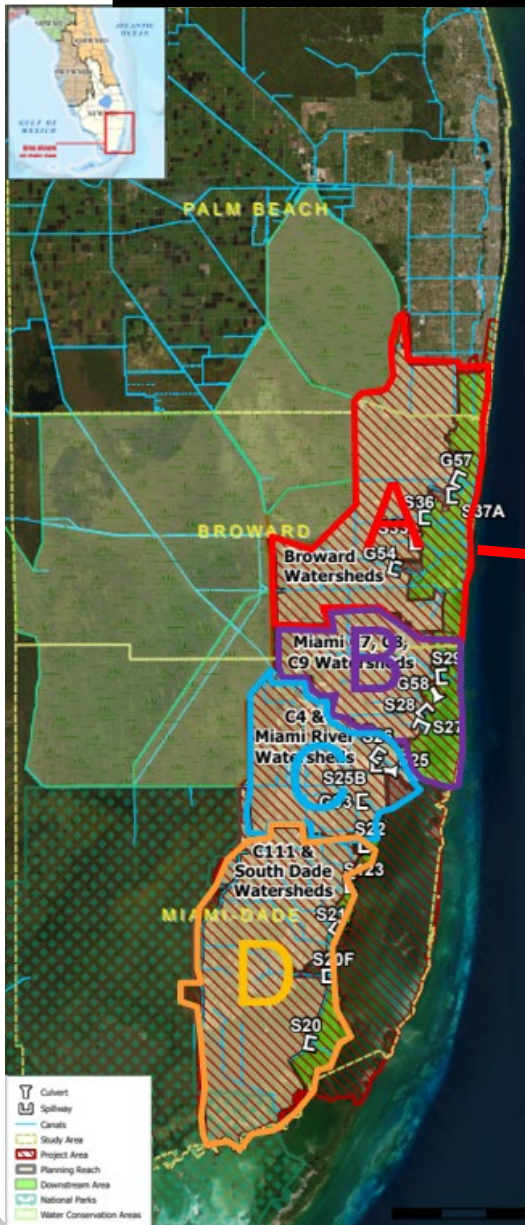
Risk = Probability x Consequences

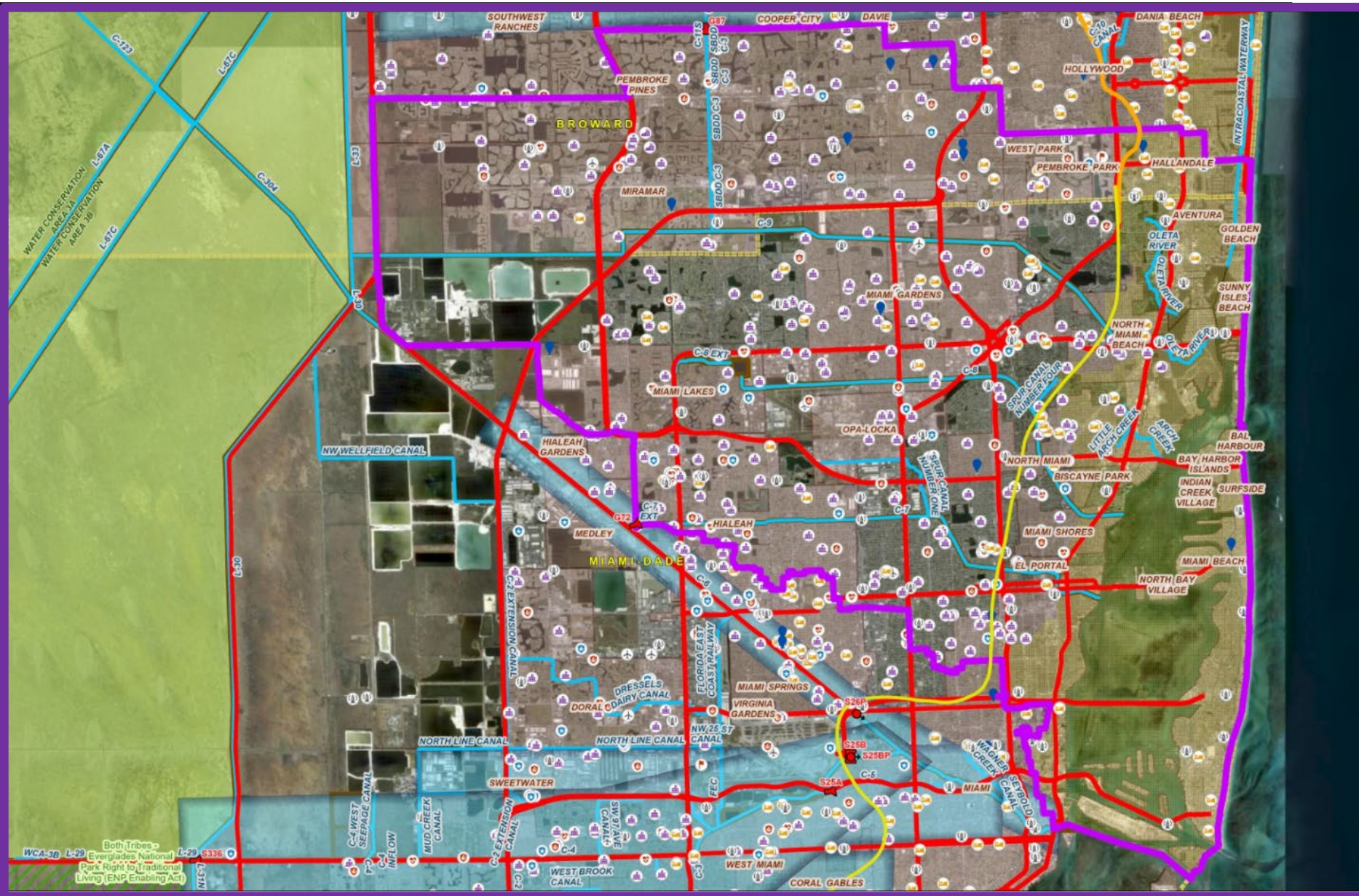
Examples:

- Structural Measures
 - Reservoirs
 - Channels Improvements
 - Levees and Floodwalls
 - Diversion
 - Pumps
- Non-structural Measures
 - Flood Proofing
 - House Raising
 - Relocation
 - Flood Warning & Evacuation
 - Floodplain Regulation
- Natural and Nature-based Features
 - Freshwater wetlands
 - Flood plains restoration



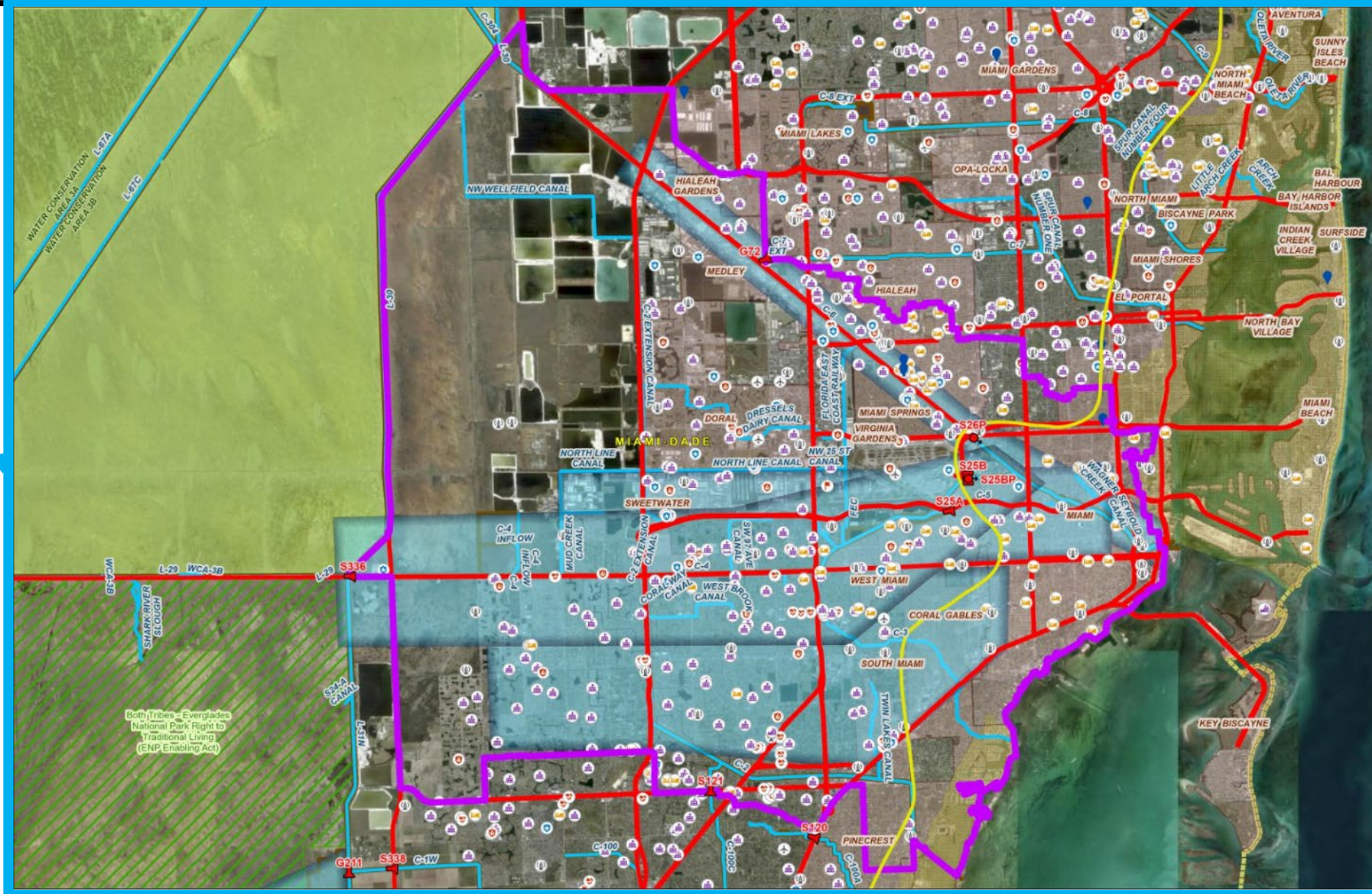
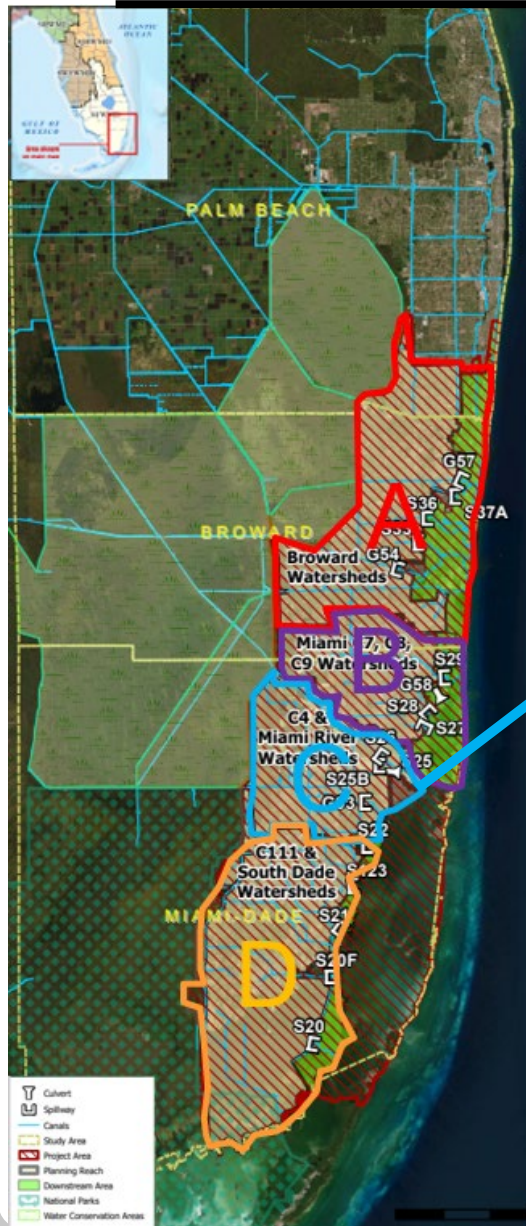
REACH A: BROWARD AND HILLSBORO BASINS





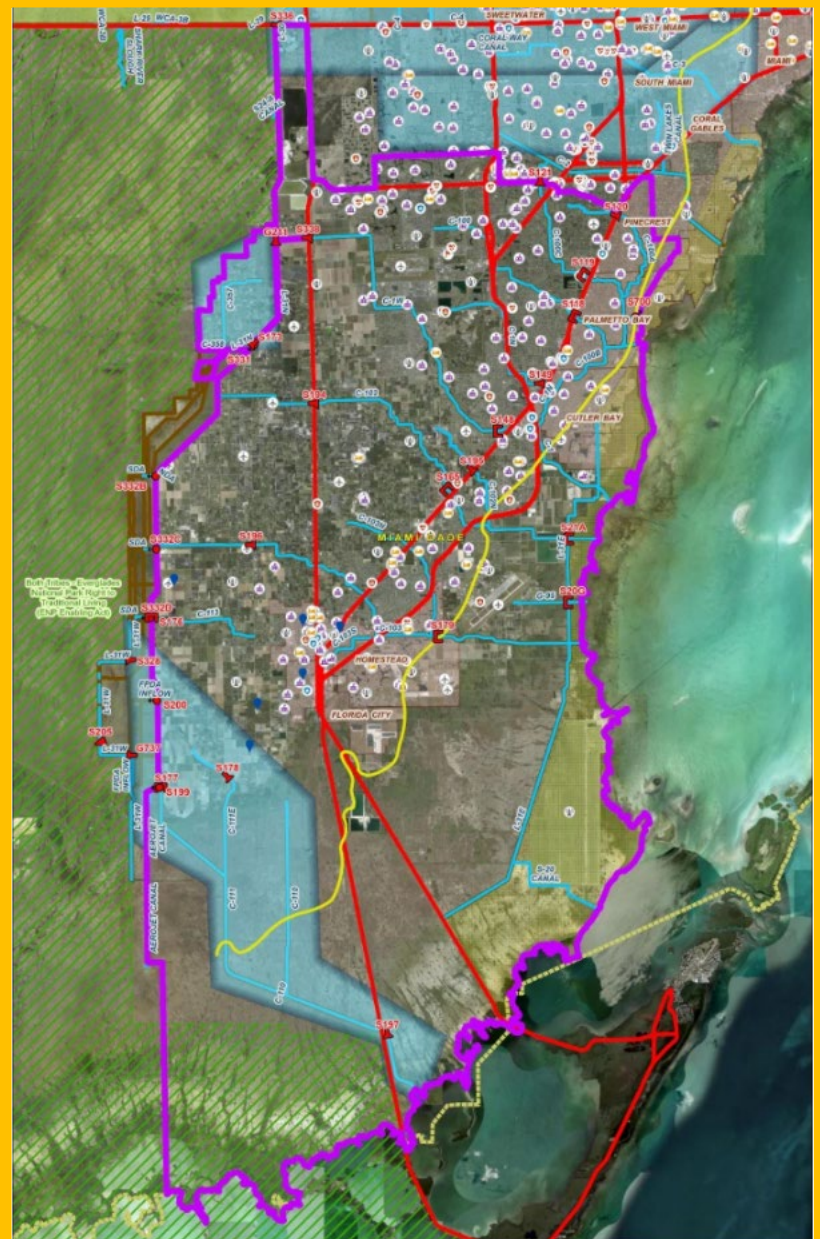
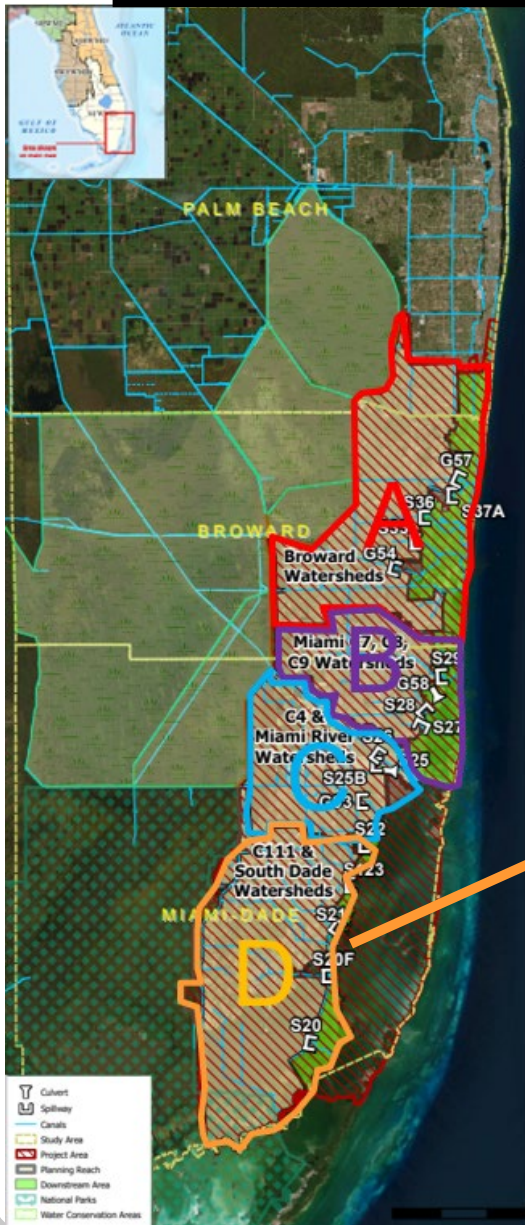


REACH C: MIAMI RIVER AND NEARBY BASINS





REACH D: SOUTH MIAMI BASINS





LUNCH

30 minutes lunch



7.0 THE EVALUATION PROCESS

Presenter: Kevin Wittmann / Erik Adamiec

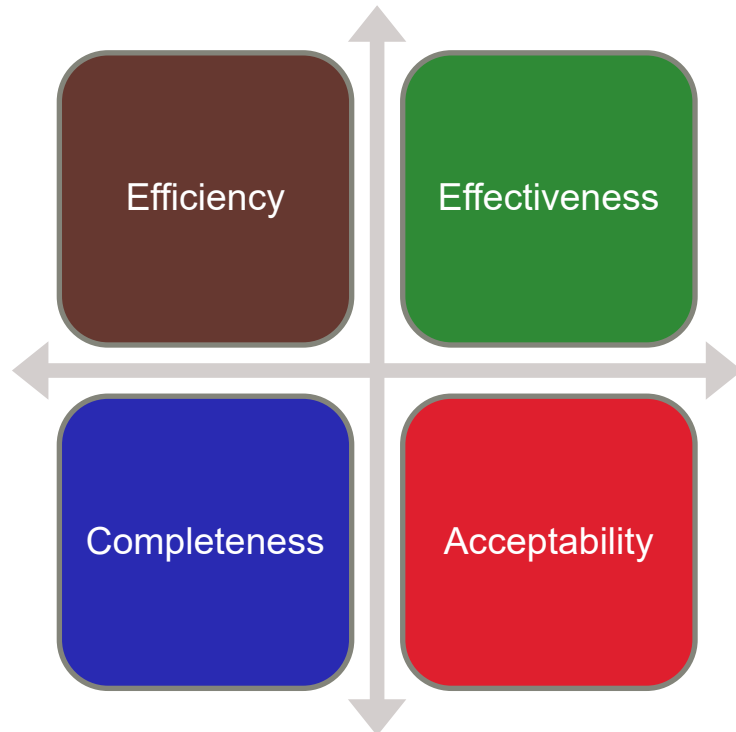


HOW THE CORPS MEASURE SUCCESS

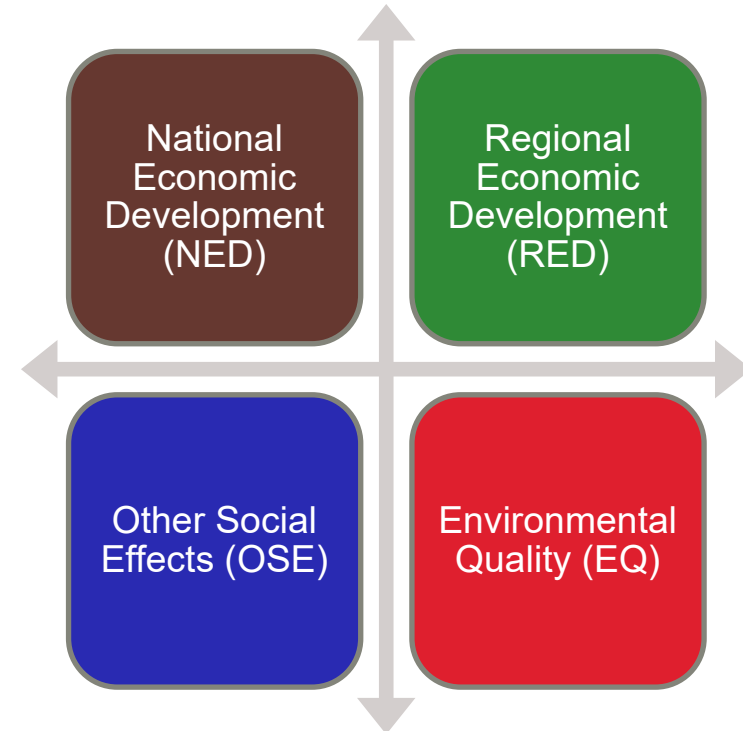


- **Different times in the process for evaluation:**
 - Screening
 - Full evaluation

Principles and Guidance (P&G)

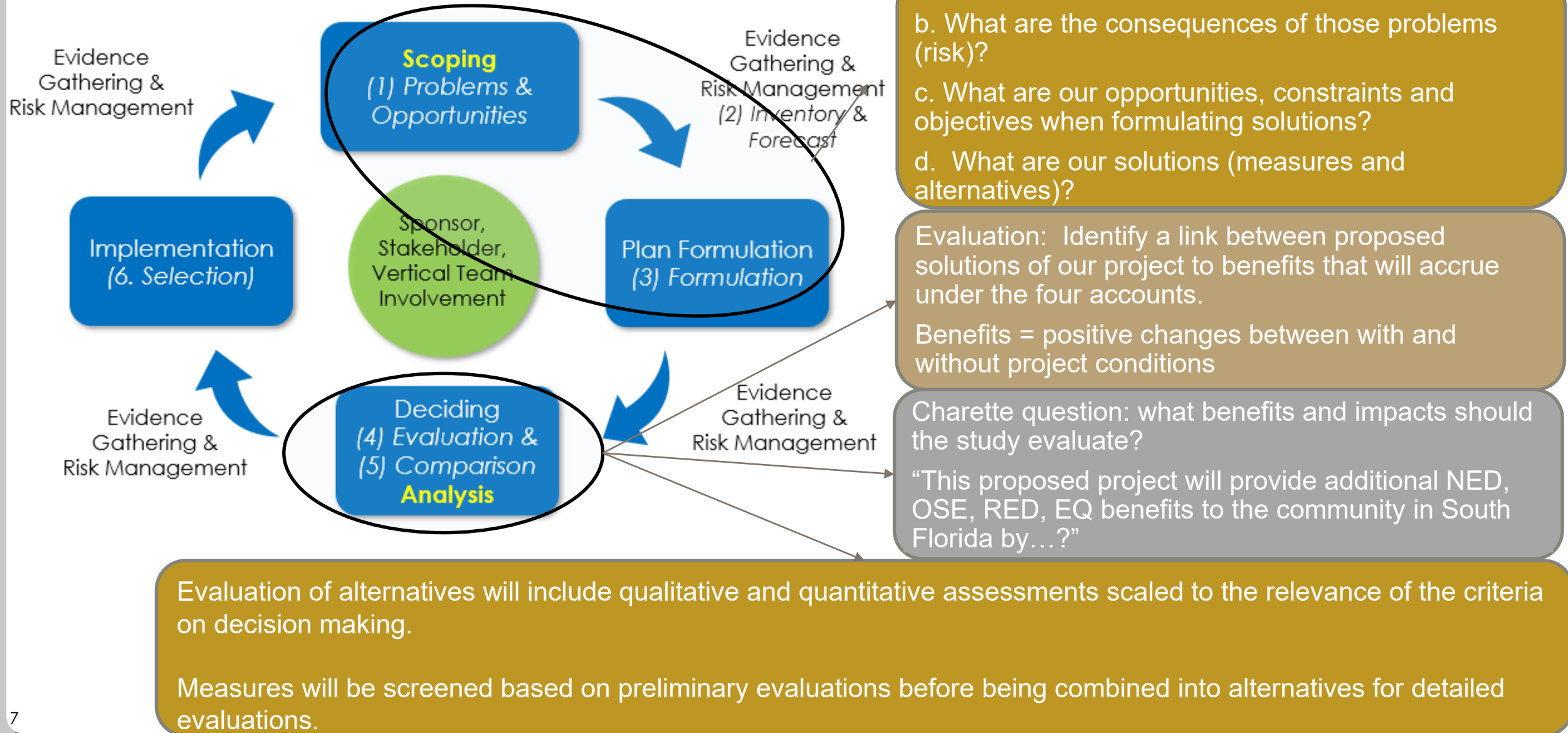


4 Accounts – Comprehensive Benefits





RISK INFORMED PLANNING ITERATIVE PROCESS





PLANNING CRITERIA EVALUATION & COMPARISON OF ALTERNATIVES



NATIONAL ECONOMIC DEVELOPMENT



Changes in the economic value of the national output of goods and services.

ENVIRONMENTAL QUALITY



Non-monetary effects on ecological, cultural, and aesthetic resources including positive and adverse effects of ecosystem restoration plans.

OTHER SOCIAL EFFECTS



Plan effects on social aspects such as community impacts, health and safety, displacement, energy conservation, and others.

REGIONAL ECONOMIC DEVELOPMENT



Changes in the distribution of regional economic activity, such as job creation.



EXAMPLES OF HOW PLAN FORMULATION DETERMINES HOW WE MEASURE SUCCESS



Strategy 1

Formulate for NED, display impacts to OSE, RED and EQ

Strategy 2

Formulate for NED, add minimal features for OSE/RED

Strategy 3

Formulate for all four accounts equally.

Strategy 4

Formulate for different combinations.



PLANNING & ECONOMIC CONSIDERATIONS



National Economic Development Plan (NED) – the plan that reasonably maximizes net benefits to the nation from cost savings.

- Primary benefits of Federal involvement in flood risk management projects involve reducing risk and damage to infrastructure, agriculture and human safety.
- NED damage reduction benefits accrue by:
 - Reducing frequency of damages to infrastructure and agriculture
 - Reducing severity of damages to infrastructure and agriculture
 - Reduced impacts on transportation
 - Reduced impacts on emergency services
 - Reduced impacts of flooding clean up

PRIMARY BENEFITS: TRANSPORTATION COST SAVINGS

$$\text{BENEFITS} = \text{ESTIMATED \$ Damages without Project} - \text{ESTIMATED \$ Damages WITH PROJECT}$$

$$\text{NET BENEFITS} = \text{BENEFITS} - \text{COSTS}$$

The NED Plan represents the alternative which most reasonably maximizes NED benefits and is environmentally acceptable

$$\frac{\text{BENEFITS}}{\text{COSTS}} > 1$$

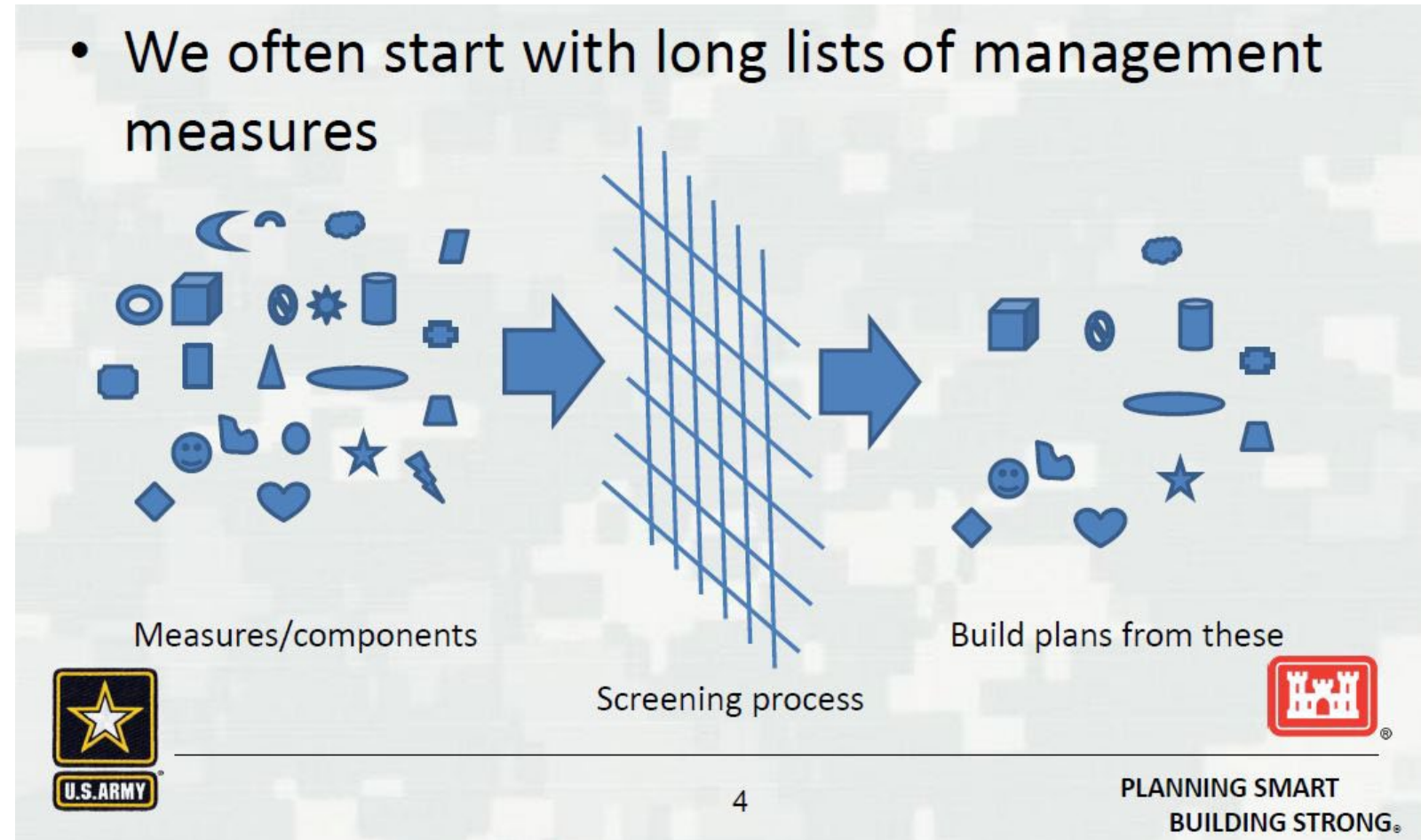
In addition, NED plans must have a benefit to cost ratio greater than 1.



8.0 ALTERNATIVES

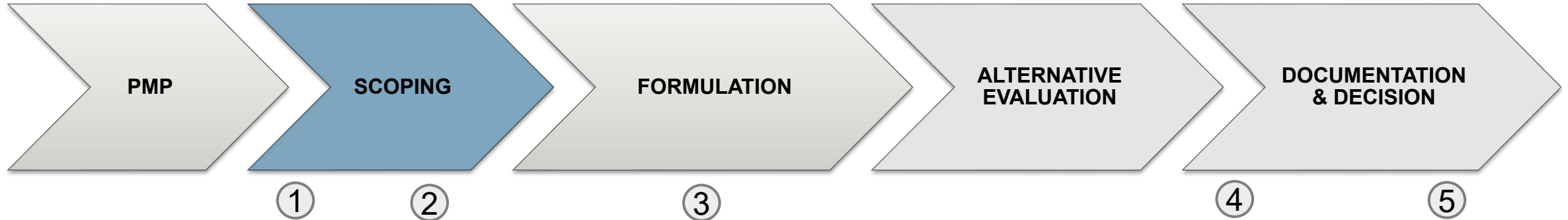
Presenter: Amy Thompson

- Combine measures into alternatives
- Formulate alternative for each focus area
- This will be a future activity
- May need to use multicriteria decision analysis





TIMELINE AND ENGAGEMENT OPPORTUNITIES



Note: Schedule is following 3x3x3 but will be subject to change based on team's discussions.

Public Engagement Opportunities	Date
① - Scoping Meetings	28 November 2022 [A]
② - Planning Charrette	January 2023
③ - Alternative Formulation & Evaluation Workshops	Multiple in 2023 -2024
④ - Draft Report - Public Comment Period	June 2024
⑤ - Final Report	May 2025

[A]=Actual/Completed



DAY 2:
PUBLIC COMMENTS
(2 MINUTES PER COMMENT)



Email:
CSFFRSComments@usace.army.mil



WRAP UP

Presenter: Debby Scerno



**COMMENTS TO BE RECEIVED BY EMAIL AT
CSFFRSCOMMENTS@USACE.ARMY.MIL**

**VISIT OUR WEBSITES FOR MORE UPDATES AND
STUDY DETAILS**

**USACE:
WWW.SAJ.USACE.ARMY.MIL/CSFFRS**

**SFWMD:
WWW.SFWMD.GOV/C&SF**





MIAMI-DADE
COUNTY

FLOOD RESILIENCE CHALLENGES & STRATEGIES

MIAMI-DADE COUNTY

January 11, 2023 | C&SF Flood Resiliency Study Charrette

Challenges

- Expanding green or hybrid green/grey infrastructure at scale in dense urban areas
- Quantifying project costs and comprehensive benefits for **water quality**
- How to adapt areas east of salinity control structures and other areas facing compound flood risk (surge, tidal, & stormwater, etc.)



Efforts

“

The County's key partners include all 34 municipalities in Miami-Dade

”

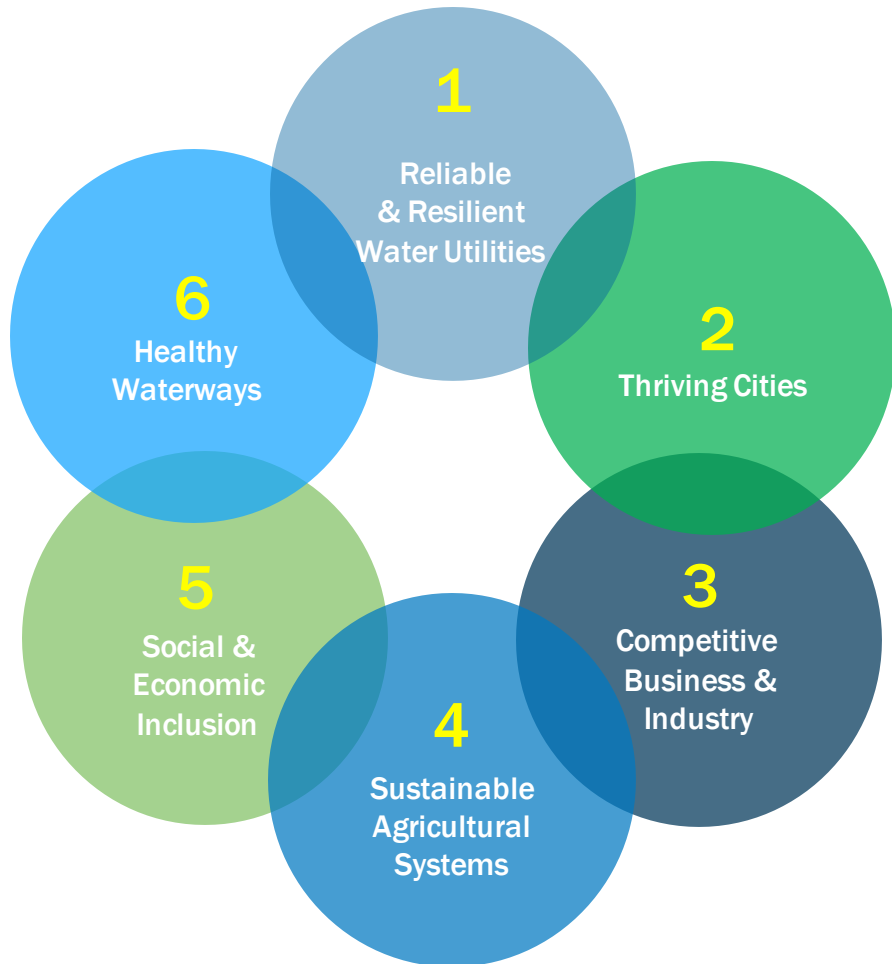
- Resilient305
- One Water Strategy
- Sea Level Rise Strategy
 - Adaptation Action Area Planning (C-7, C-8, etc.)
 - DEP Flood & SLR Vulnerability Assessment
- Stormwater Master Plan & Updated County Flood Criteria
- Biscayne Bay Reasonable Assurance Plan

Miami-Dade County Goals

- Finding **complementary solutions** with 'Back Bay' CSRM & Miami-Dade County Sea Level Rise Strategy
- Equitable stormwater projects that improve **water quality** and risk reduction (expand distributed green network)
- Cohesive planning framework & implementation process for unincorporated MDC & municipalities in most vulnerable canal basins
- Holistic water supply accounting for all users (Public, Agriculture, Nature)



Including a “One Water Approach”



The simple truth is that all water has value — drinking water, wastewater, stormwater, and everything in between — and should be managed in a sustainable, inclusive, integrated way.

We call this perspective **One Water**.
And while our focus is water, our goals are thriving local economies, vibrant communities, and healthy ecosystems.



GREATER MIAMI
& THE BEACHES

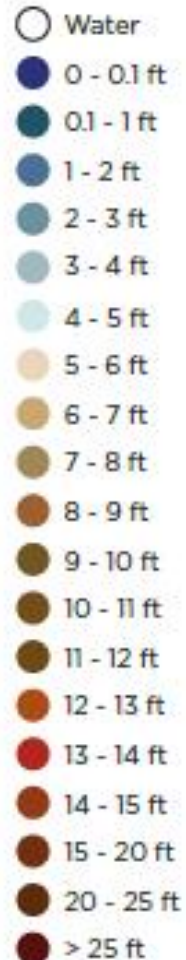


Ground Elevation

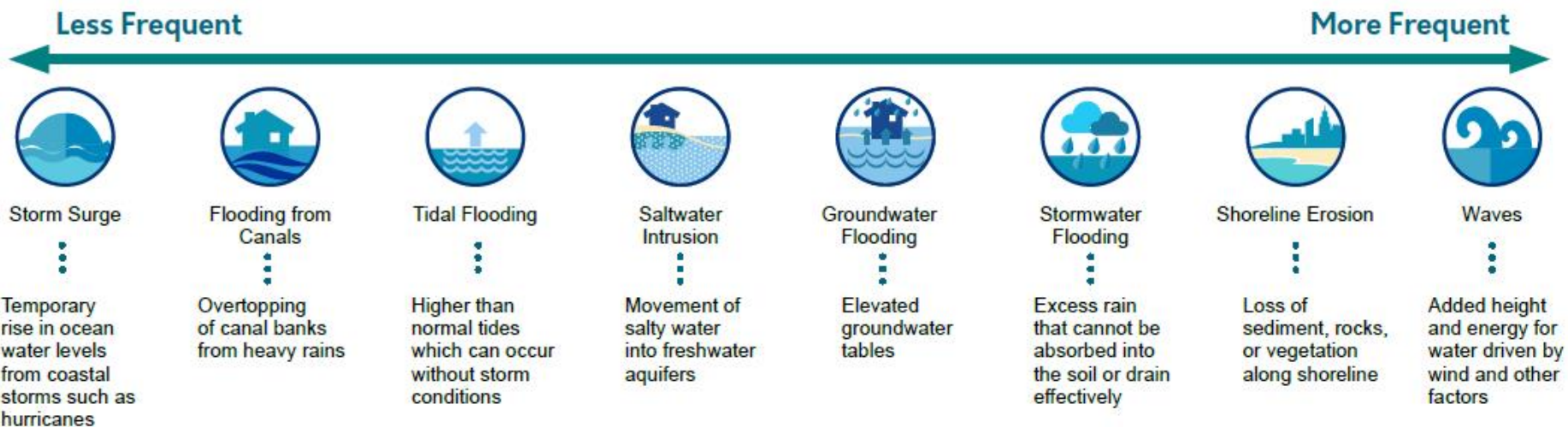
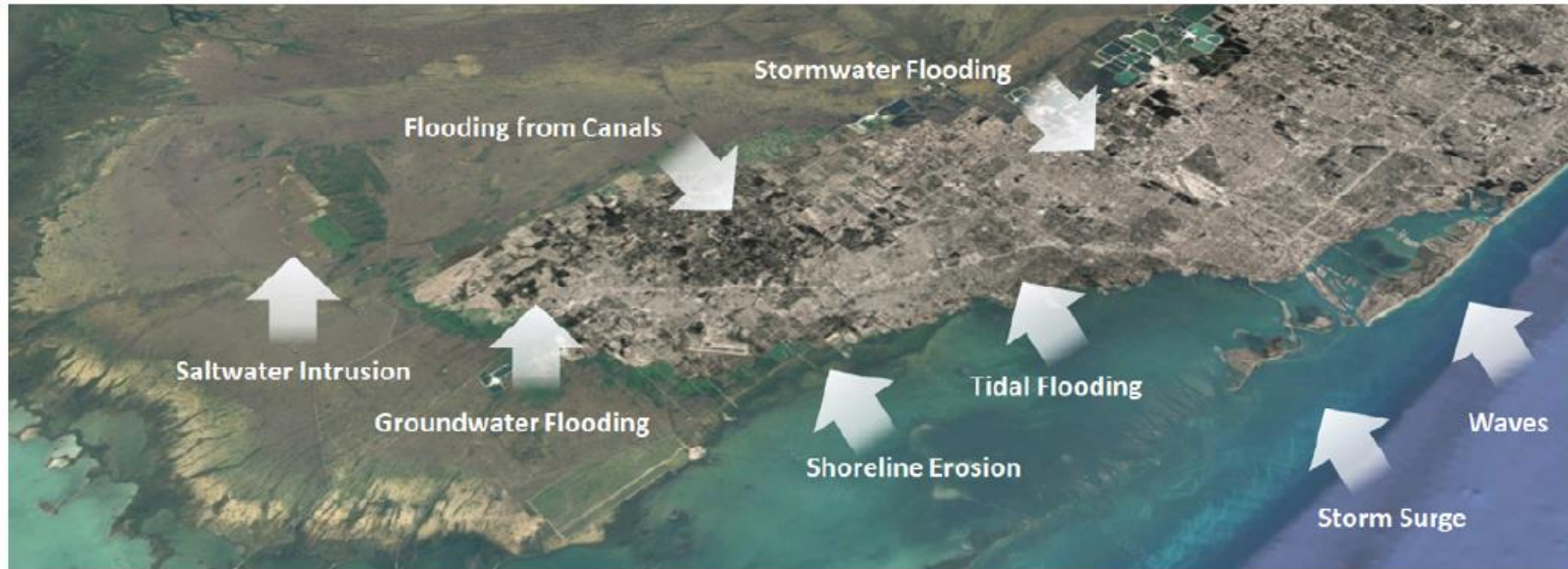
Average ground elevation in
Miami-Dade County is:

~ 7.0 ft above sea level

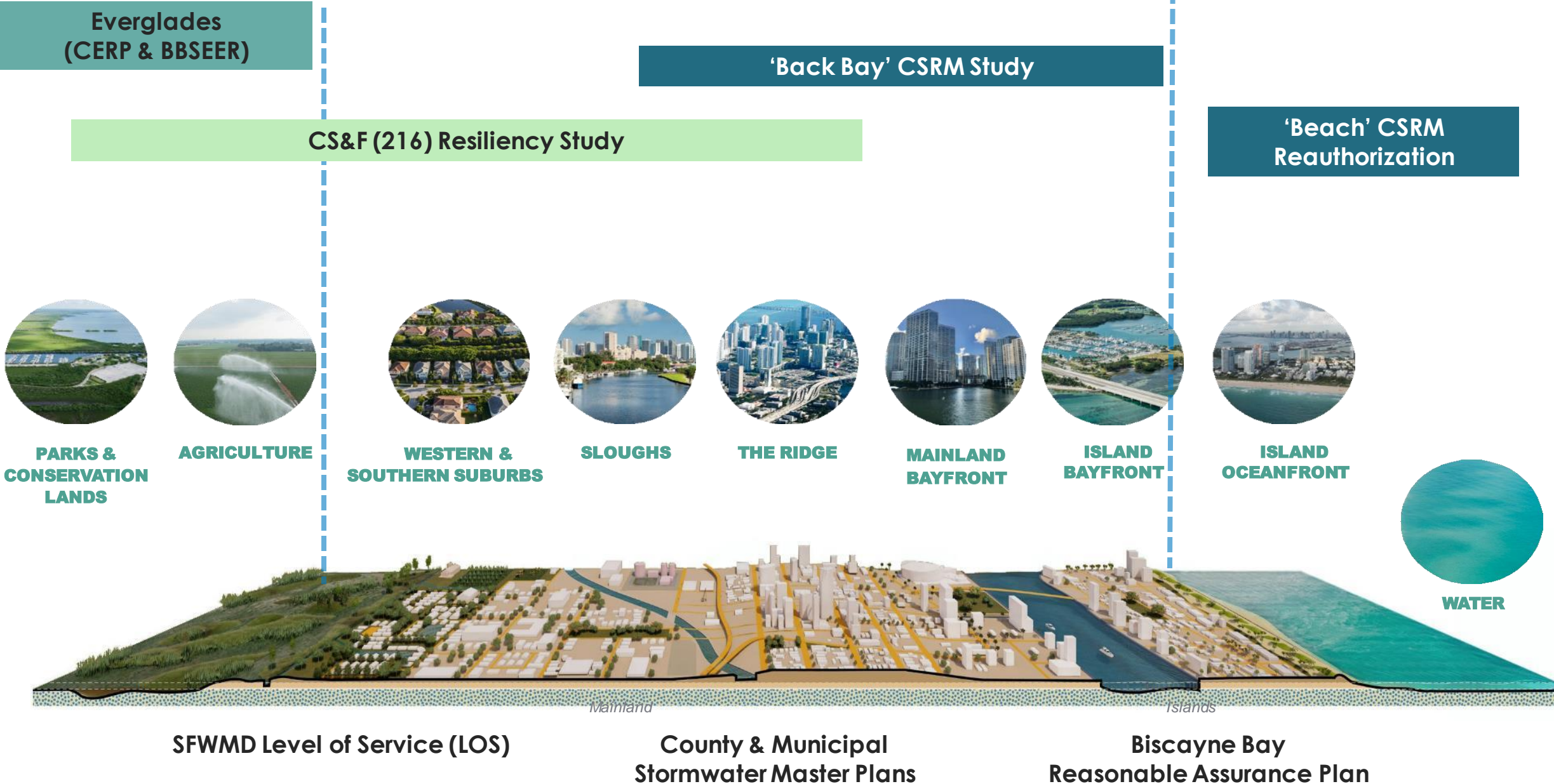
Little River AAA



Sea level rise will increase the frequency and impact for all flood other hazards



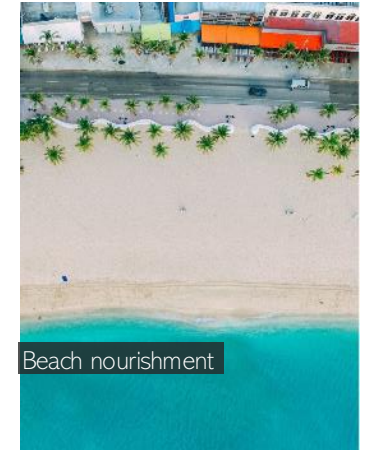
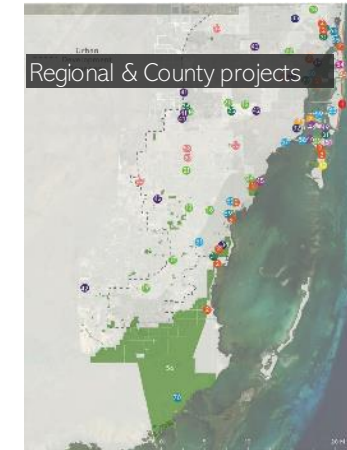
Coordinating Multiple 'Lines of Defense'



10 Key Actions

MDC Sea Level Rise Strategy

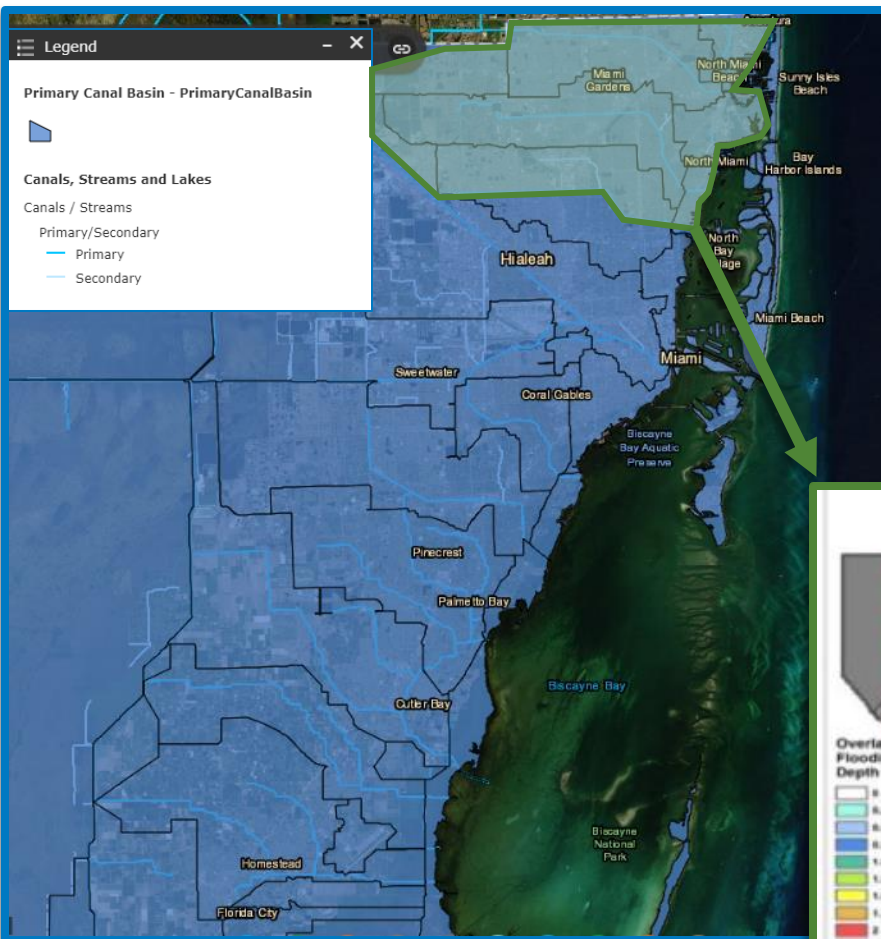
- 1 Accelerate Adaptation Action Areas across the County
- 2 Require County projects be designed for sea level rise
- 3 Establish safer building and seawall elevation standards
- 4 Ensure development avoids flooding neighboring properties
- 5 Enhance flood protection by expanding greenways and blueways
- 6 Flood-proof the County's most vulnerable critical facilities
- 7 Integrate green infrastructure into County projects
- 8 Prepare for disaster recovery to accelerate inclusive adaptation
- 9 Address vulnerable septic systems
- 10 Increase affordable, resilient housing on high ground within SMART Plan transit corridors



Guiding Principles from MDC Sea Level Rise Strategy

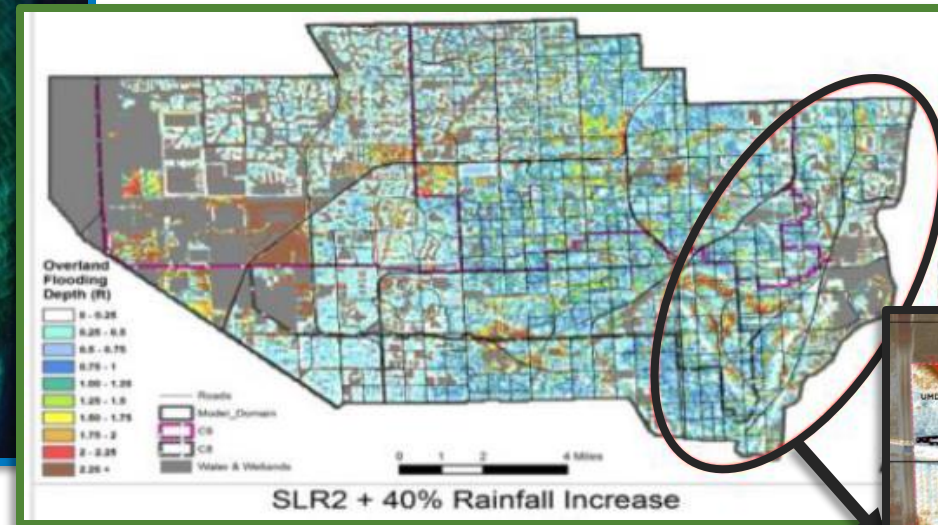
ALL ADAPTATION ACTIONS MUST :

- 1 Make us safer** over time by helping protect lives and incrementally protecting the community from storms and multiple flood risks. Actions should not increase vulnerability to other hazards.
- 2 Be equitable** by recognizing that historic, unjust discriminatory policies. Actions should be driven by inclusive engagement, fair policies, and direct investments and resources to target these disparities.
- 3 Reduce environmental pollution** by not adding greenhouse gas emissions or other pollutants to our air and waterways. Actions should not be implemented at the expense of the environment and human health.
- 4 Be flexible** and able to respond to changing conditions such as faster rates of sea level rise.
- 5 Build with nature** by working with natural processes and natural materials to address long-term flooding hazards.
- 6 Align with other initiatives** and plans such as the Miami- Dade County Comprehensive Development Master Plan, the Long-Range Transportation Plan, the Parks and Open Space Systems Master Plan, the Resilient305 Strategy, the Central and Southern Florida Flood Resiliency Study, and others.

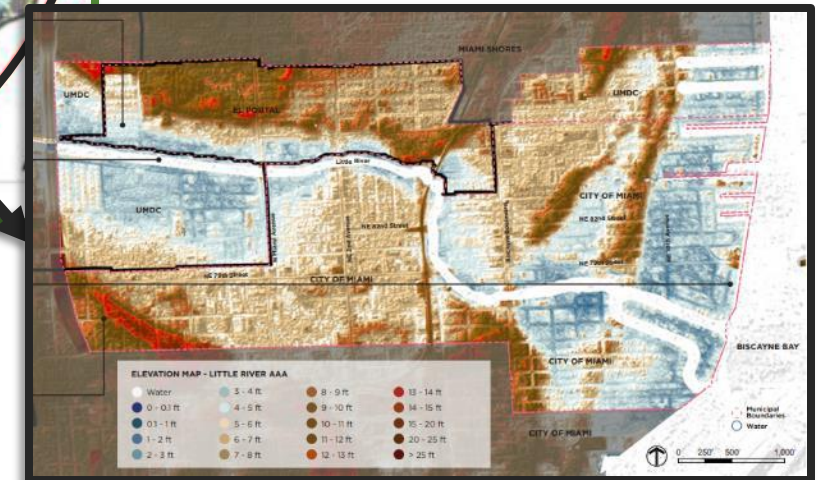


SFWMD Primary Canal Basins in County

Identifying Adaptation Action Areas (AAAs) within Primary Canal Basins



Basin-level Analysis for Compound Flood Risk (Sea Level Rise & Rainfall)



Focus Area within Basin for Feasibility Study and Potential AAA

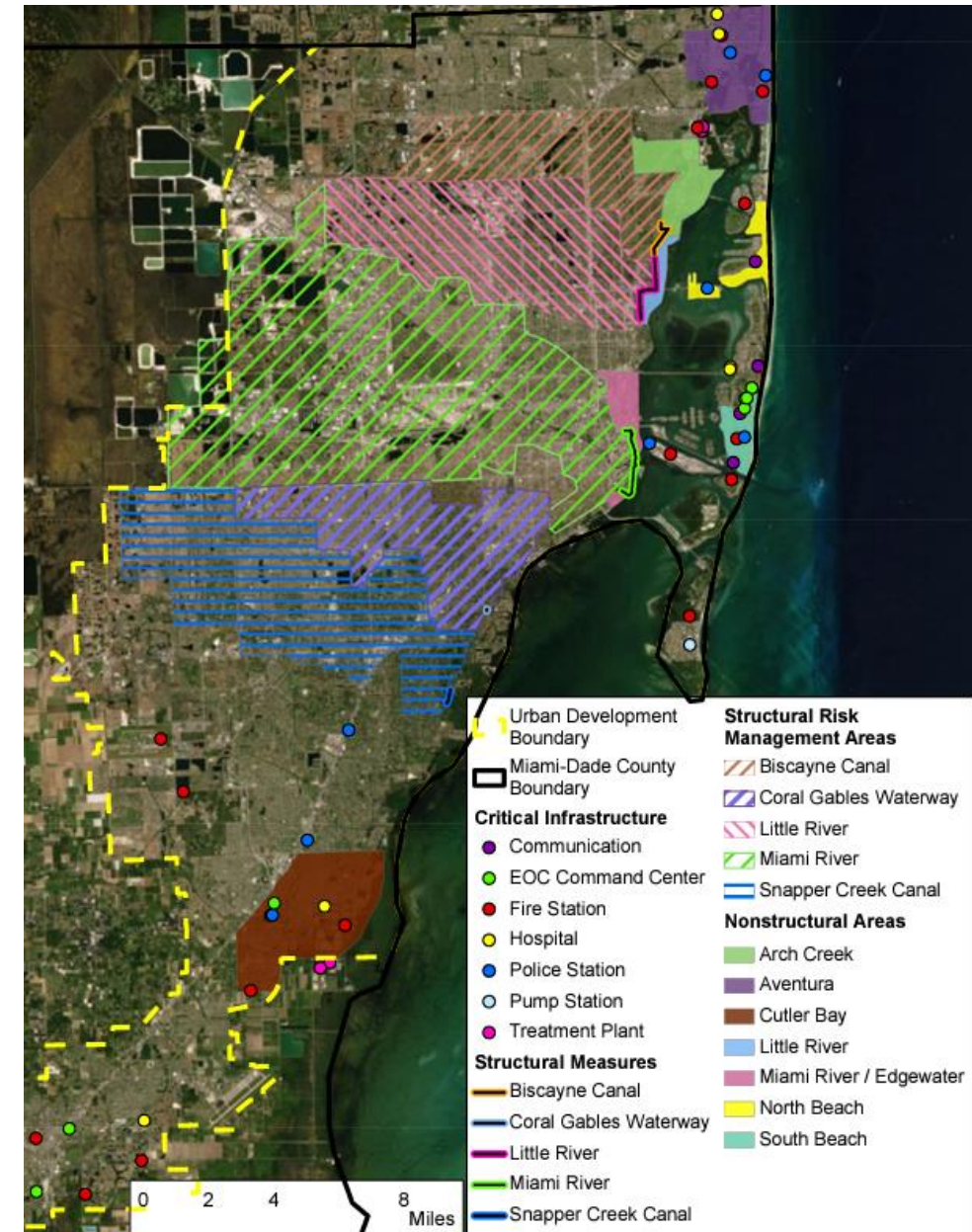
Miami-Dade “Back Bay” Coastal Storm Risk Management (CSRM) Study

Purpose:

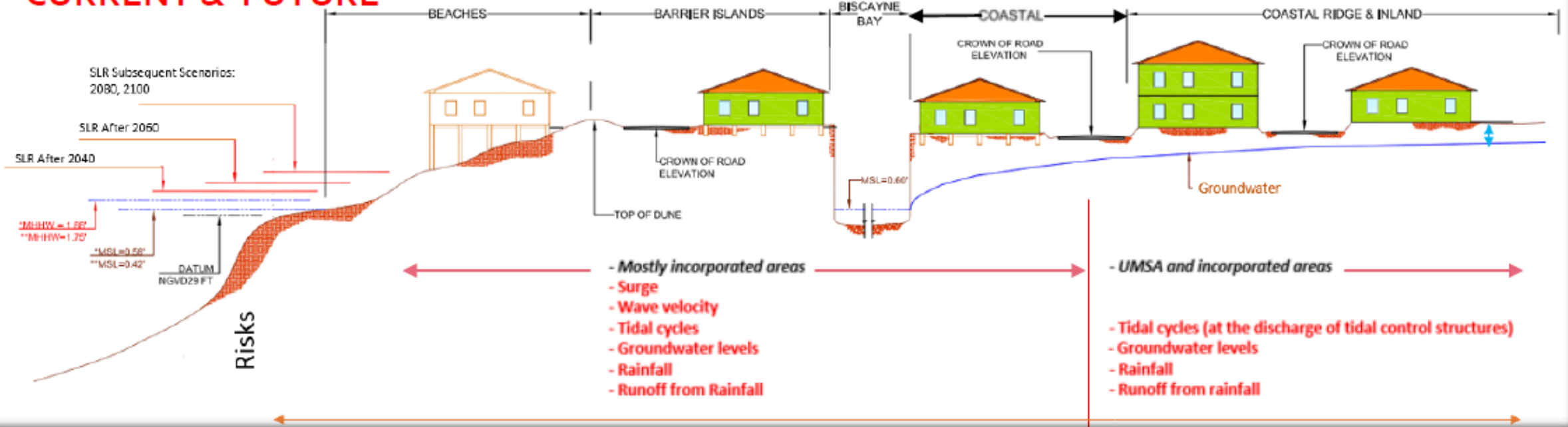
To reduce potential damages caused by coastal storms and improve human safety and coastal resiliency in the Miami-Dade County Back Bay.

November 2022 Charrette Week Themes:

- System-wide approach, layers of protection
- Comprehensive benefits (equity, environment, etc.)
- Acceptable level of protection & residual risk
- Hybrid natural & nature-based features
- Integration with other projects: C&SF, BBSEER, etc.



CURRENT & FUTURE

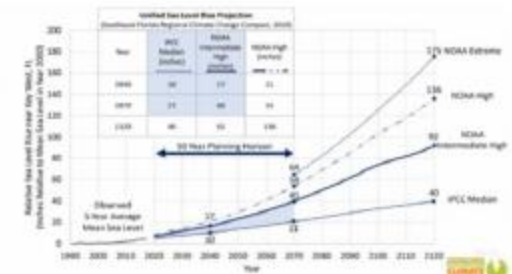


- ✓ Miami-Dade County Stormwater Master Plan has been recently updated, using Compact projections for Sea Level Rise (SLR) for 2040, 2060, 2080, and 2100



1. Year 2040 with outfall boundary conditions relevant to projected SLR in 2040 (tidal conditions for 2020 +0.5 ft of SLR), future land use (2030) and projected future ground water (2040).
2. Year 2060 with outfall boundary conditions relevant to projected SLR in 2060 (tidal conditions for 2020 +2.0 ft of SLR), future land use (2030) and projected future ground water (2040).
3. Year 2080 with outfall boundary conditions relevant to projected SLR in 2080 (tidal conditions for 2020 +4.0 ft of SLR), future land use (2030) and projected future ground water (2040).
4. Year 2100 with outfall boundary conditions relevant to projected SLR in 2100 (tidal conditions for 2020 +6.0 ft of SLR), future land use (2030) and projected future ground water (2040).

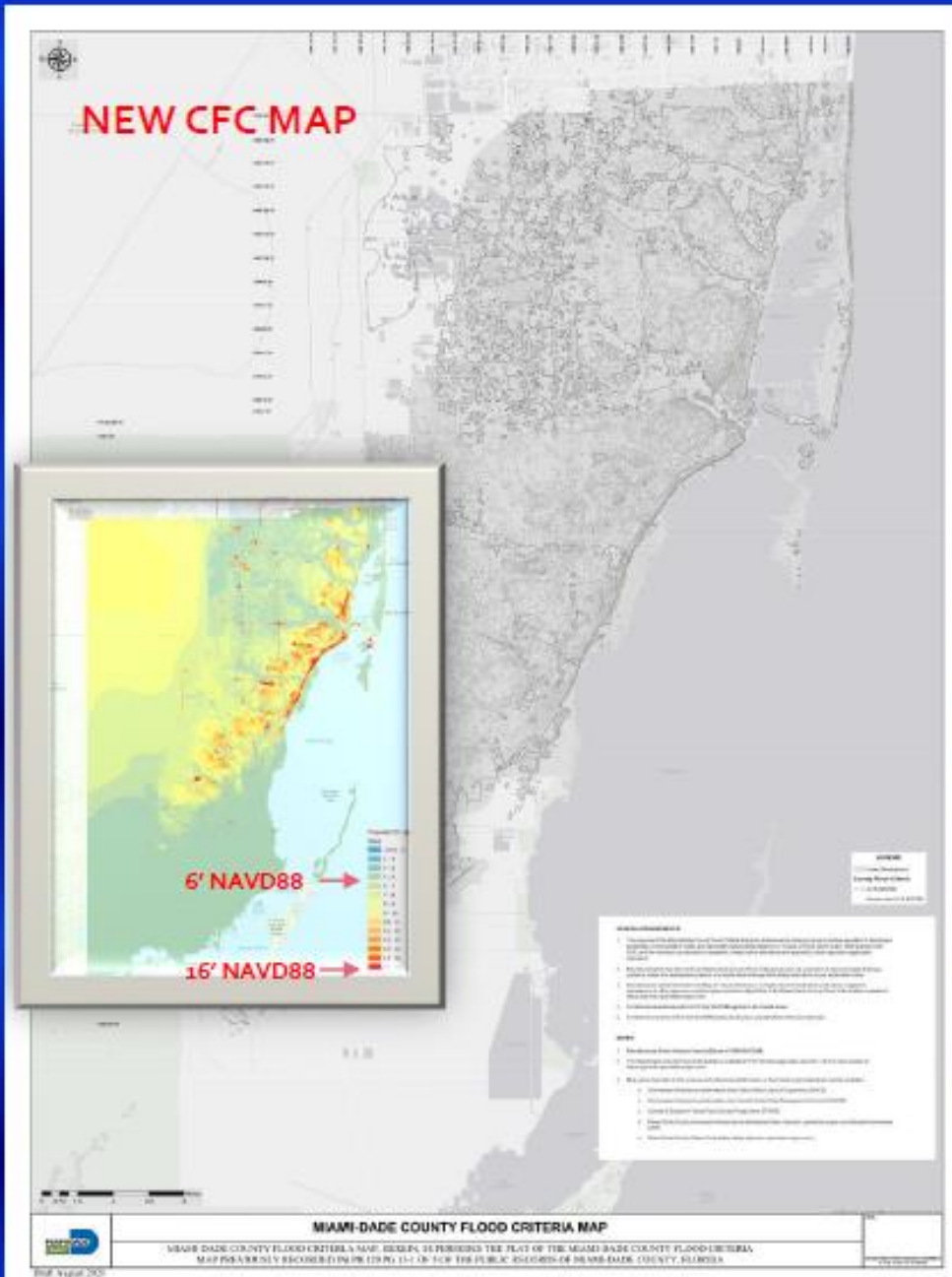
The Unified SLR Projections from the Southeast Florida Regional Climate Change Compact from 2015 and subsequent revision in 2019 (see Figure ES-2) were utilized for the future SLR scenarios. The tidal elevation current scenario used was the observed median sea level for the current NOAA epoch (ending in 2003), adjusted by adding the first harmonic constituent obtained from the Virginia Key NOAA tidal station. Using the increments from the Compact projections shown in Figure ES-2, the NOAA Intermediate High curve, was selected as a conservative approach for 2040, 2080, and 2100 SLR estimates.



Scenarios with the Southeast Florida Regional Climate Change Compact updated 2019 sea level rise projections for 2040, 2080, and 2100. These projections are based on the 2019 Compact, Southeast Florida Regional Climate Change Compact.

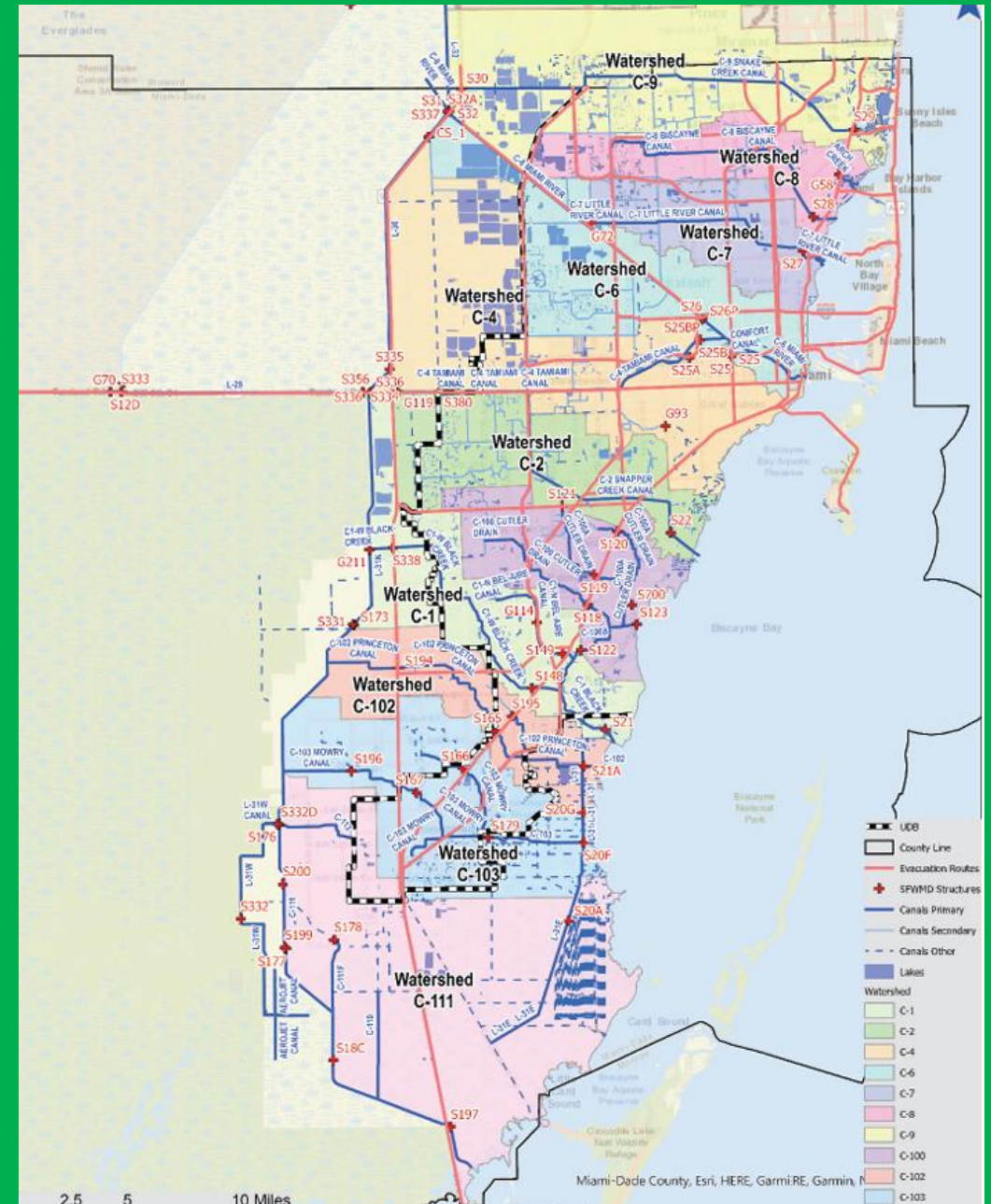
Figure ES-2. 2019 Unified Sea Level Rise Projections

Update of the County Flood Criteria (CFC)



✓ *Update uses the highest of:*

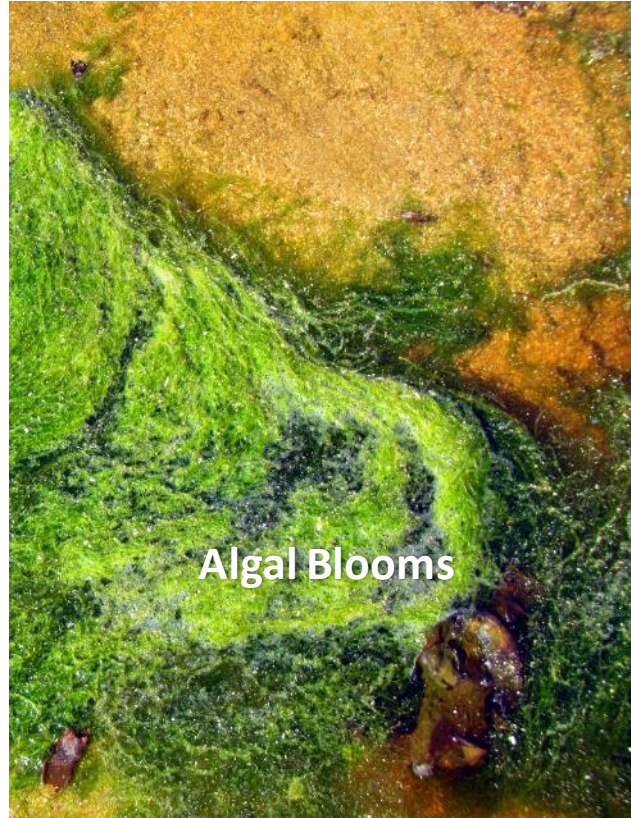
- 1) Surface water levels from the 10YR/24HR event, 2060 with SLR
- 2) Groundwater levels for 10YR/24HR event determined from nearly 30 years (1990 -2020) of daily groundwater stage observations
- 3) Current Miami-Dade CFC (PB 120 PG 13) based on a 10 Year/24 HR design event
- 4) Existing Topography (ground surface elevation)
- 5) Minimum elevation raised to 6' NAVD88 from 3.45' NAVD88 in the old map (east of the Conservation areas and the Everglades National Park)



We Can't Keep Moving Water The Same Way Anymore



Fish Kills
2020, 2021, 2022



Algal Blooms



Flooding in the AAAs



Growth | Urbanization
| Land Use

The CS&F 216 Resiliency Study must address **water quality** impacts to Biscayne Bay

Comprehensive Water Management Goals for a Healthy & Resilient Biscayne Bay

- Control & mitigation strategies are needed to improve water quantity & **water quality** – Level of Service (LOS)
- “Outflow” into the Bay during storm events is critical
- Long-term management is highly dependent on improvements to freshwater “inflow” (timing and quantity) and **water quality**



Biscayne Bay Reasonable Assurance Plan

- ❖ Miami-Dade County has prioritized the development of a Reasonable Assurance Plan for Biscayne Bay.
- ❖ Working with municipal partners to set nutrient pollution reduction goals and implementing projects to meet the goals.
- ❖ SFWMD is a key stakeholder in the RAP development process in the management of CS&F system management.

MDC Recommendations

- Raise structures as per Miami-Dade County's Sea Level Rise Strategy
- Identify vacant lands and public areas for water retention during storm events
- Enhancement of flood prediction tools to better manage large discharges into Biscayne Bay
- Incorporate and expand water treatment technologies to address nutrient reduction targets
- Dredging of canals and prioritize those with high levels of nutrient loads
- Include broader benefits to enhance water retention for use in natural system and build capacity for urban and agriculture



Thank you

Contact info

- James Murley – Chief Resilience Officer
- Irela Bagué – Chief Bay Officer
- Marina Pape-Blanco – Chief Water Management Division (DERM)
- Christian Kamrath – Resilience Program Manager Adaptation

Resilient Broward: Water Management Challenges, Strategies & Needs

USACE/SFWMD C&SF
Planning Charette

January 11, 2023

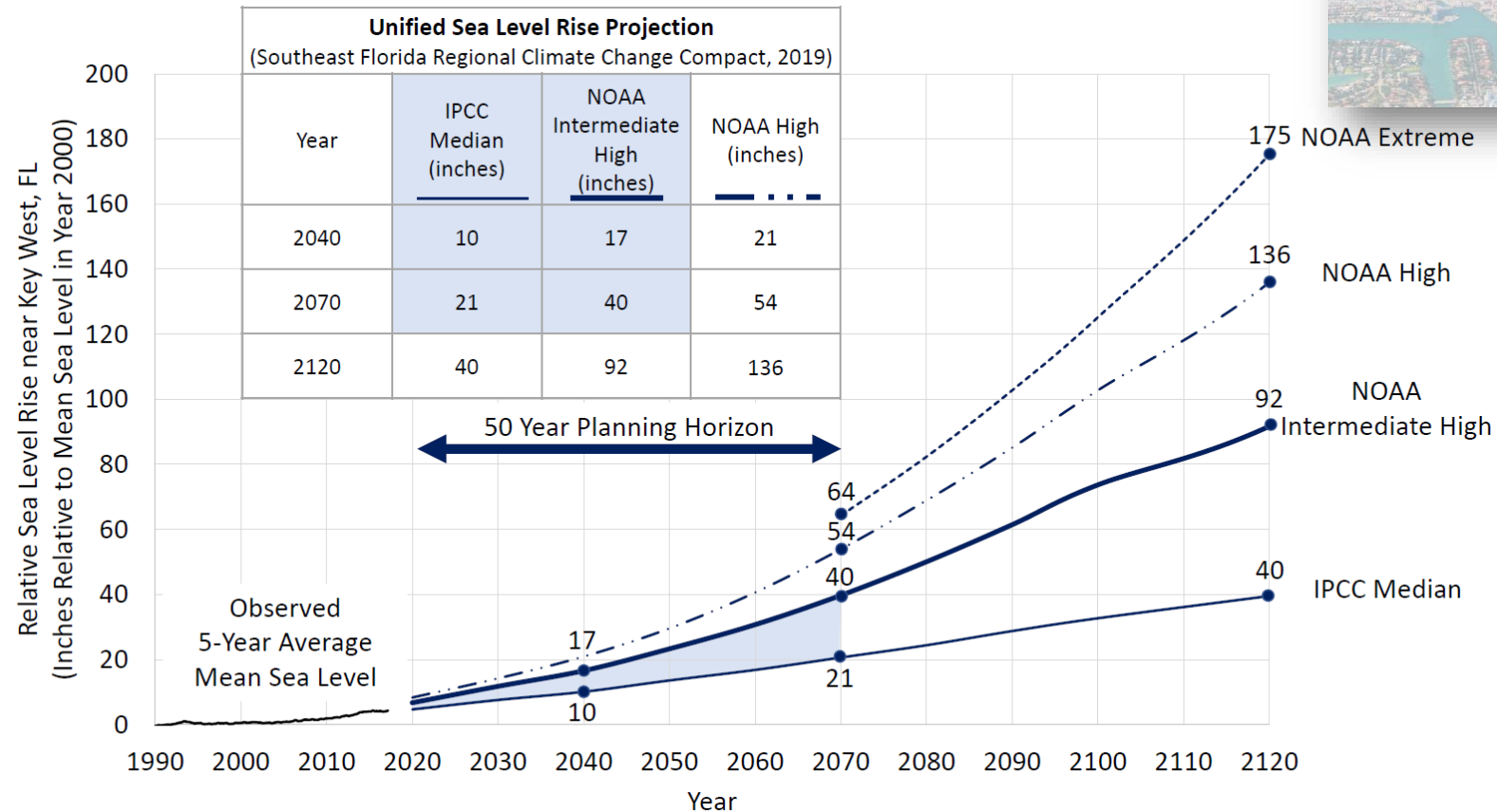
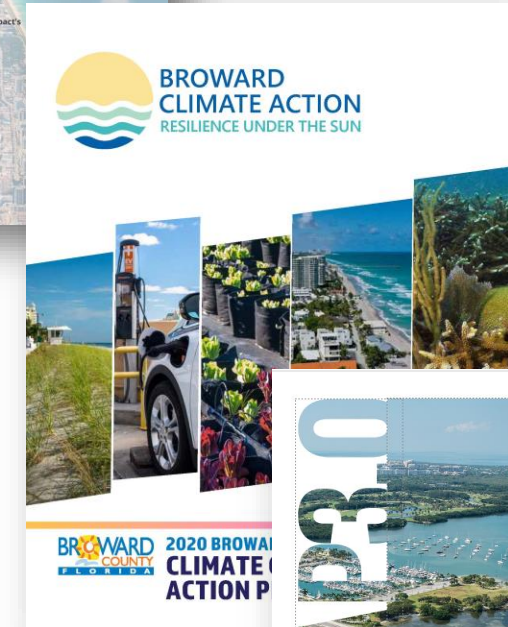
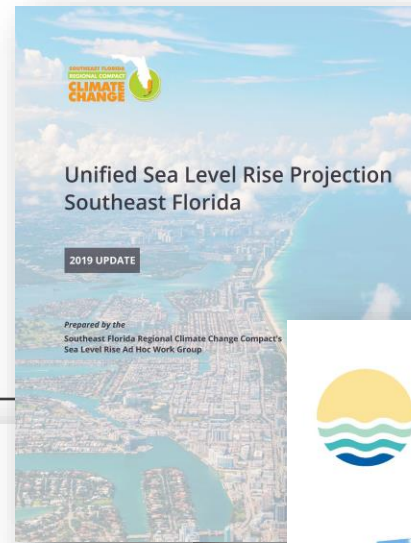


Community Resilience Challenges

- Rising sea level, rainfall and storm surge
- Increases in flood severity, impacts and disruptions
- Infrastructure damage and safety concerns
- Economic implications
- Quality of life considerations



Coordinated Planning



Water Management

G56 (Hillsborough River)

S13 Spillway (C-11 Canal)

S30 (C-9 Canal)

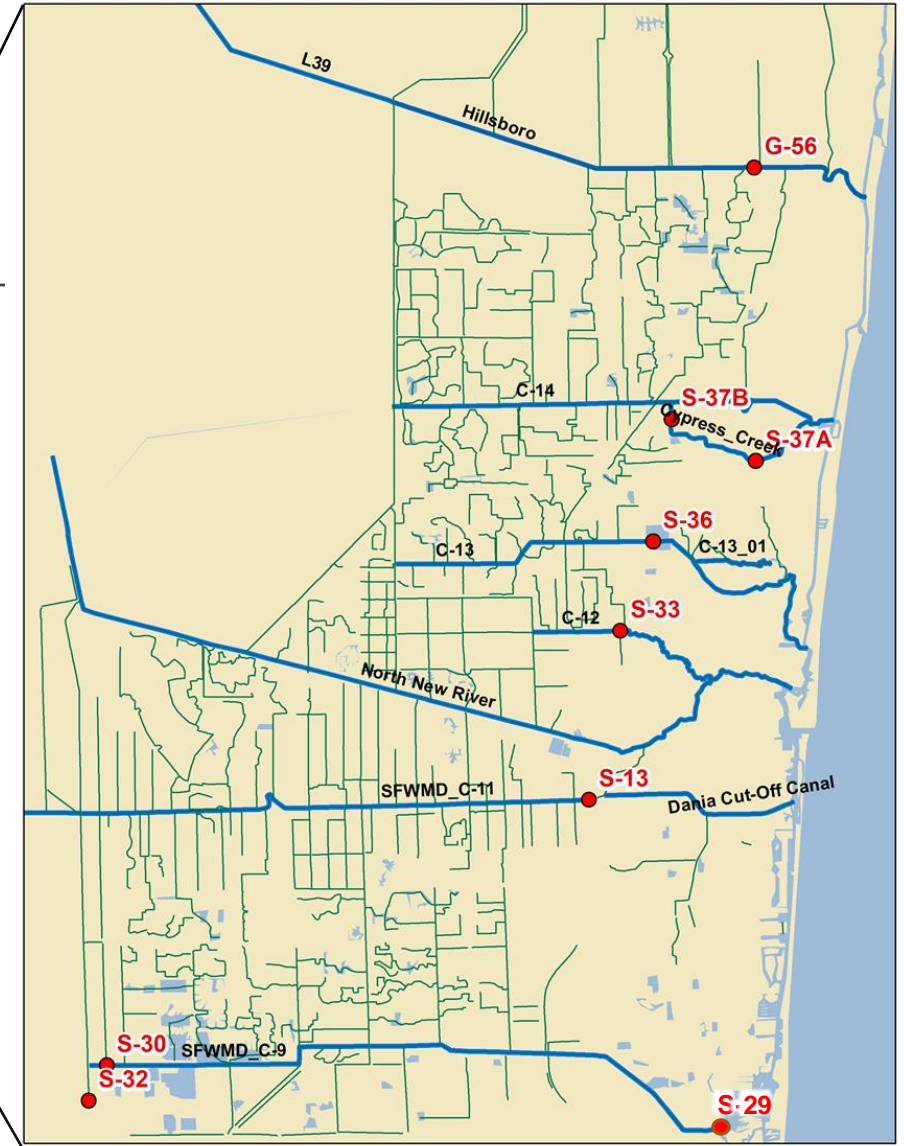
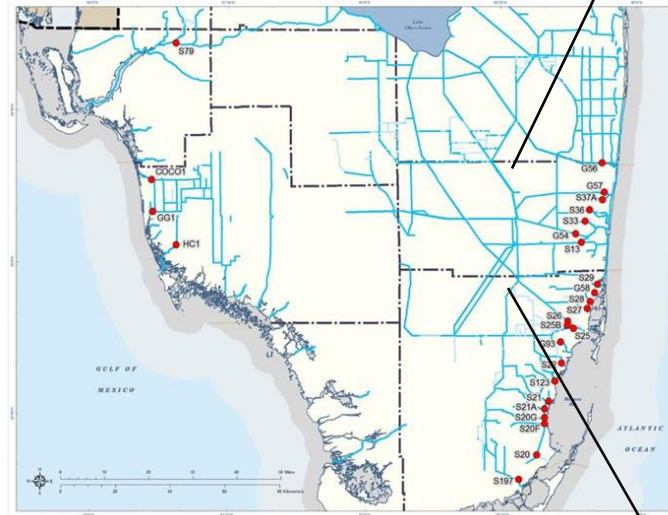
S32 (L-33 Canal)

S33 (C-12 Canal)

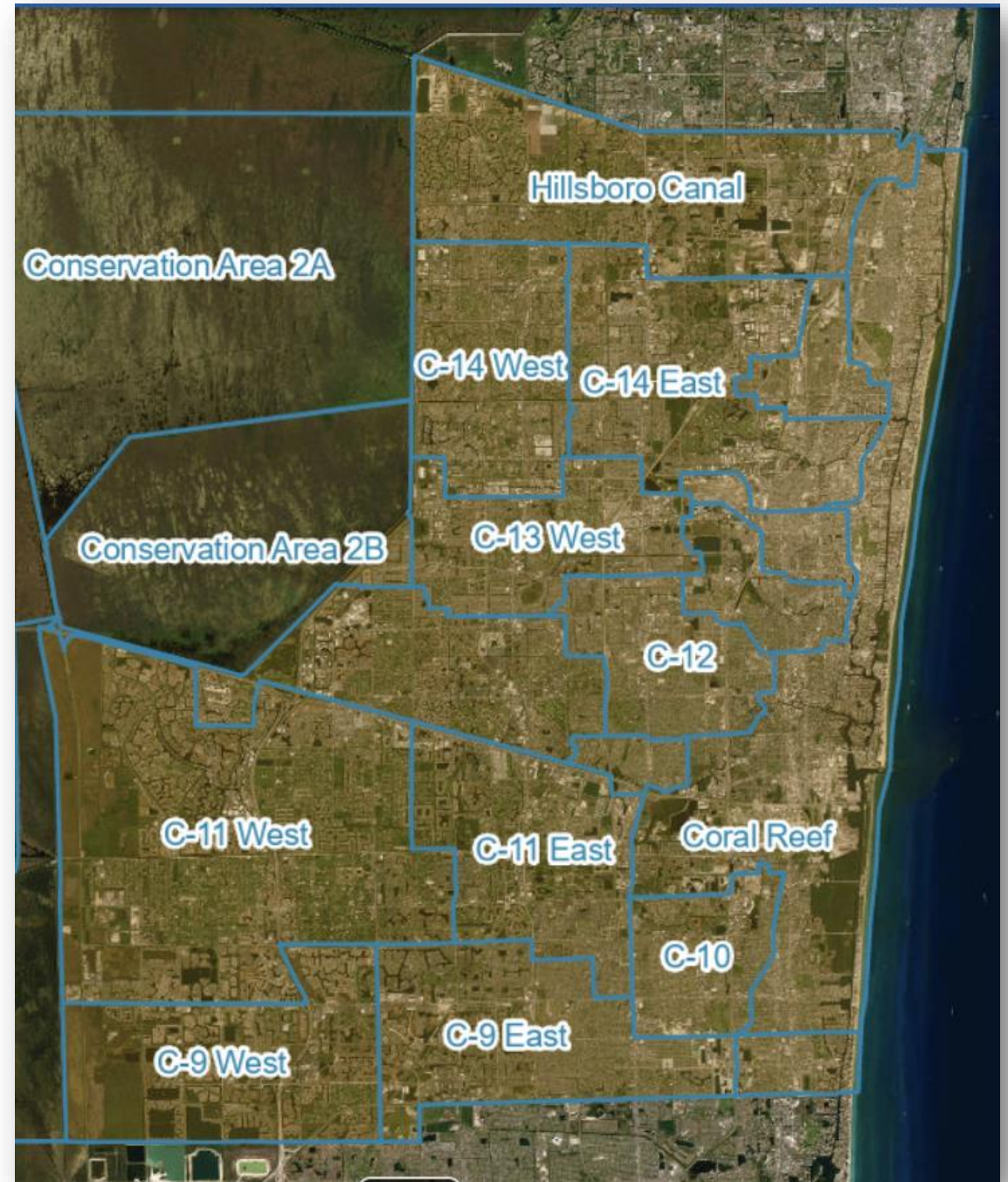
S36 (C-13 Canal)

S37A (C-14/Cypress Creek)

S37B (C-14/ Cypress Creek)



Actively Managed Basins with Allowable Discharges



Surface Water Management Permits

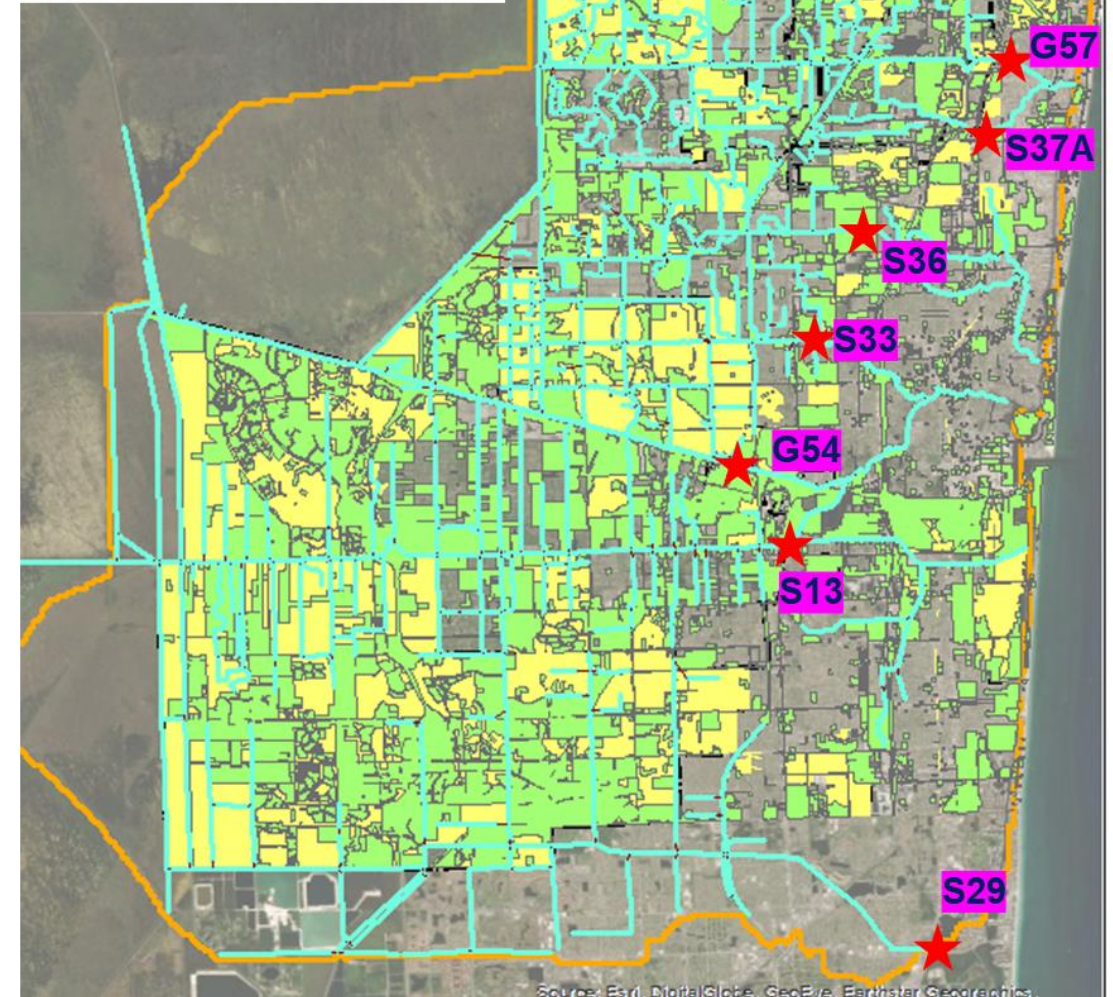
Permit Areas



>50 Acres



<50 Acres

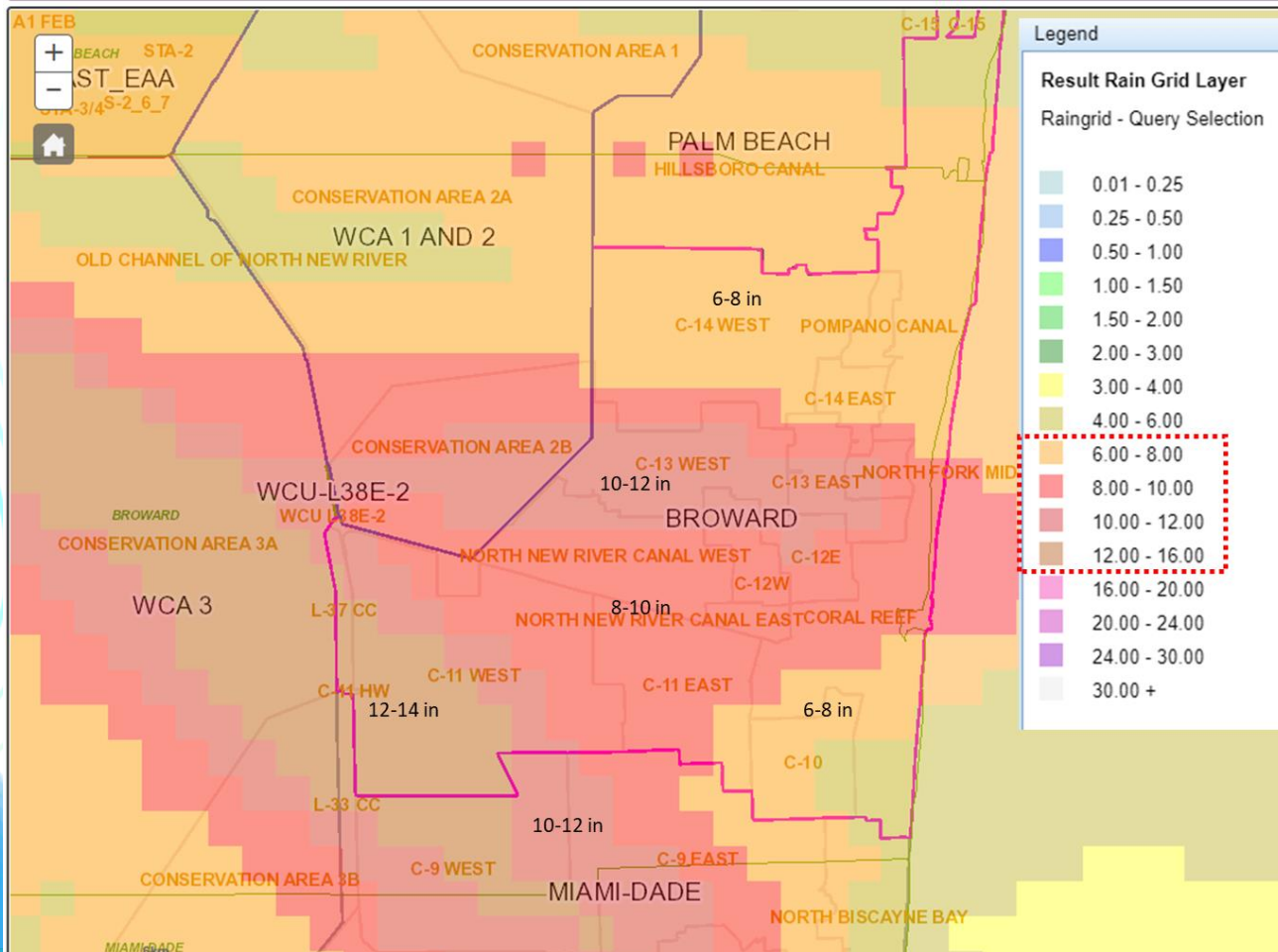


Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics,

Radar-based Rainfall: Tropical Storms Eta and Alex

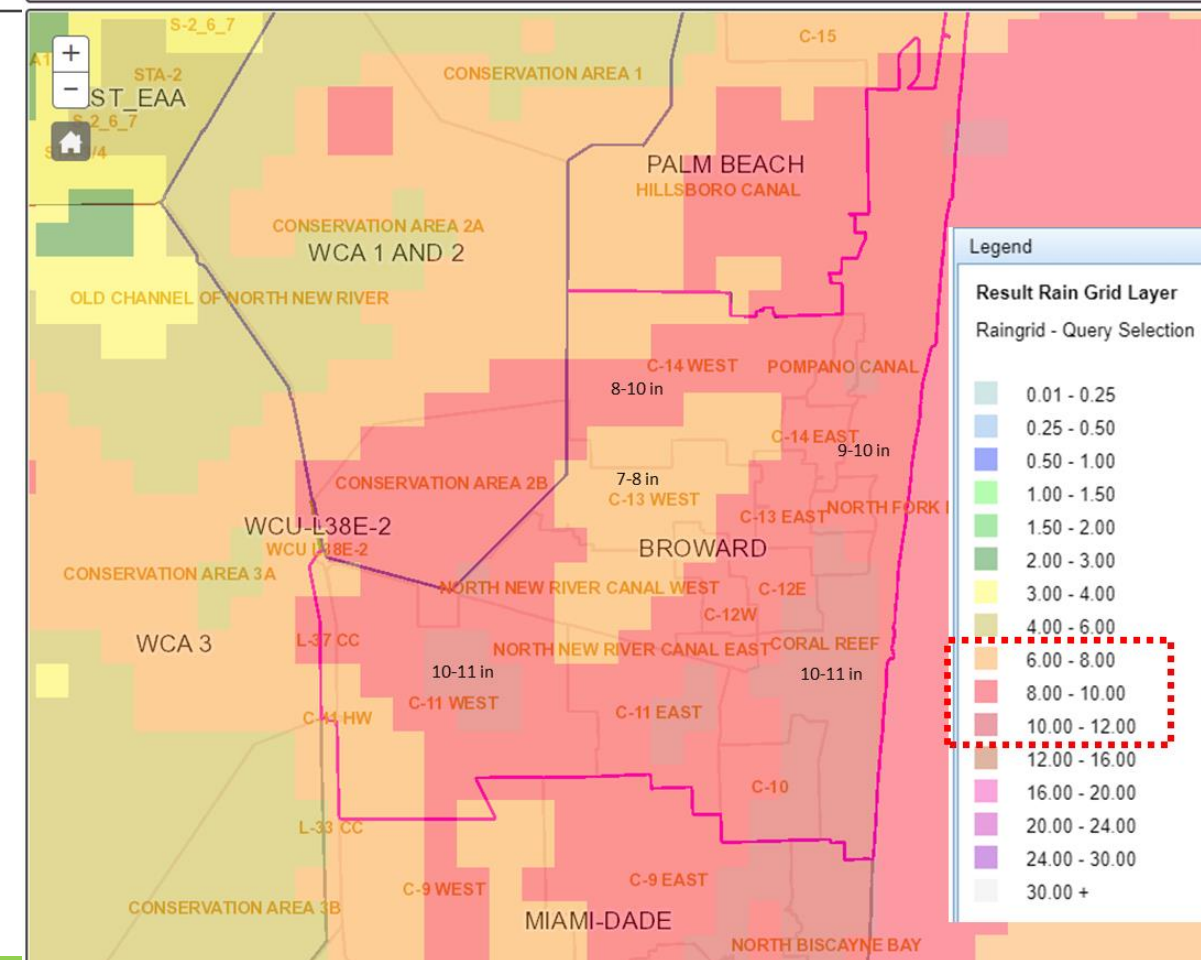
TS Eta – Nov 6-9, 2020

NEXRAD Viewer : RainGrid Radar Rainfall estimates from 11/6/2020 8:00:00 AM to 11/9/2020 8:00:00 AM- Report Run date : 12/28/2022, 1:57:56 PM

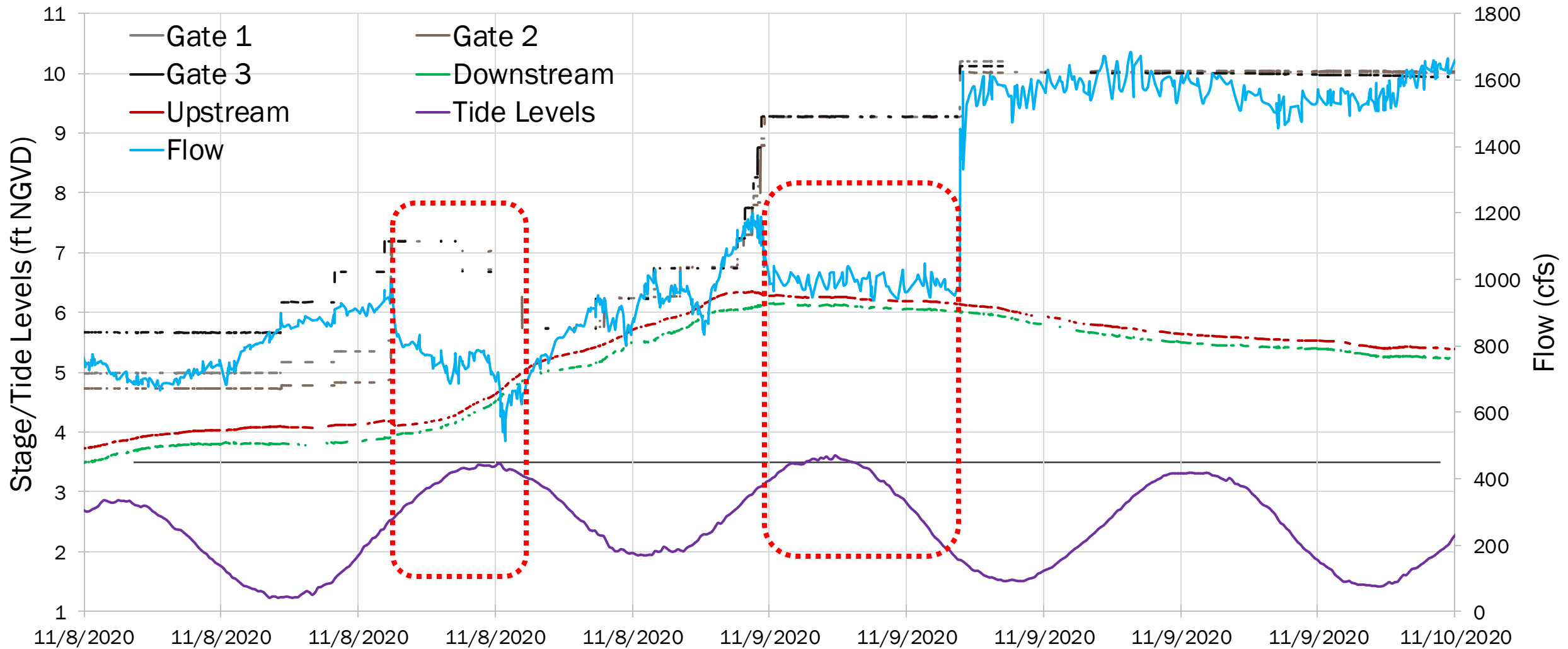


TS Alex – June 2-5, 2022

NEXRAD Viewer : RainGrid Radar Rainfall estimates from 6/2/2022 8:00:00 AM to 6/5/2022 8:00:00 AM- Report Run date : 12/1/2022, 1:21:42 PM



G-54 Outflows vs Tide Levels– Storm Eta, Nov 2020



Red boxes showing instances when high tide levels limited the outflows from the structure

North New River G-54 – SFWMD Modeling

Maximum Daily Discharge Capacity through the Primary Canals

Table 10-2: North New River Basin Inflow and Outflow Points and Discharge Capacity

Drainage Basin	Inflow	Outflow	Water Control Catchment Area (sq.mi)	Peak Discharge Capacity (cfs/sq.mi)			
				5-Yr	10-Yr	25-Yr	100-Yr
North New River	S-34	G-54	27.94	41.5	49.6	60.9	70.1

North New River Basin allowable discharge rate
= **70.8 cfs per sq mile** (25-yr)

Peak discharge capacity lower than the allowable discharge capacity is likely to result in elevated levels (for a longer duration) in primary canal limiting the drainage from secondary/tertiary system and thus causing flooding

North New River Canal Discharge Capacity – Current Conditions
Design Storm Events

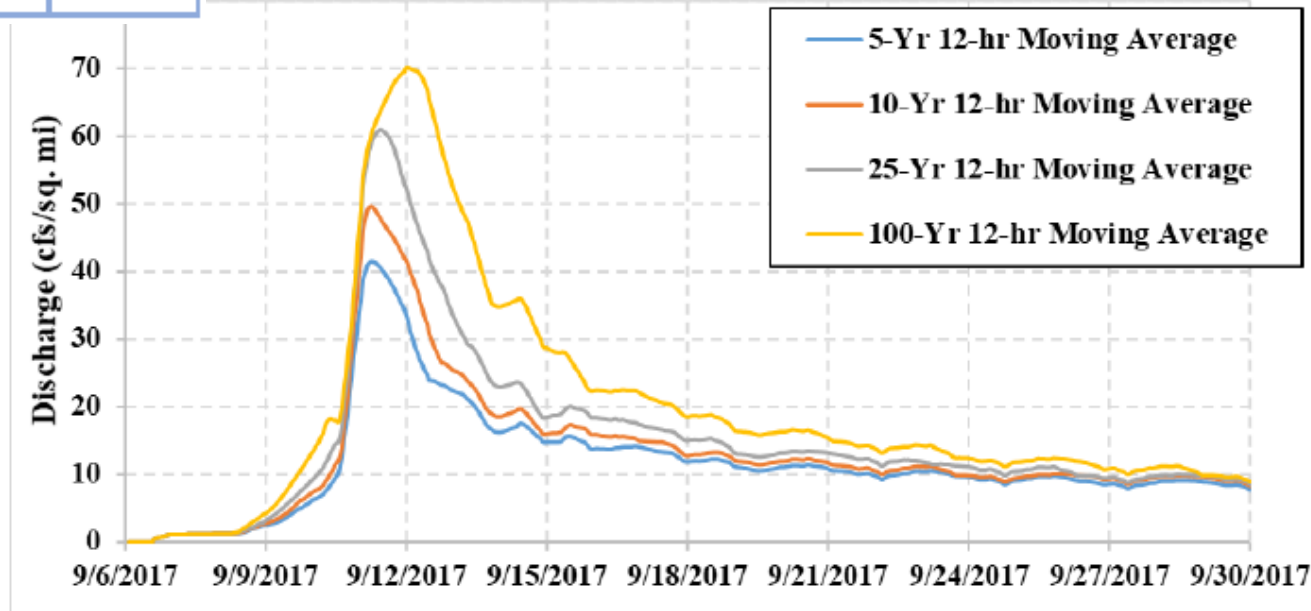


Figure 10.2-1: Area-Weighted Discharge Hydrographs for North New River Canal Structure G-54

Modeled Flood Risk (SFWMD)

Urban Area Flooded (>0.25 ft) for >12 hrs. during a 25-yr 72-hr storm

Structure/Basin	Current conditions
G-54 (North New River)	10.8%
S33 (C-12 West)	29.8%

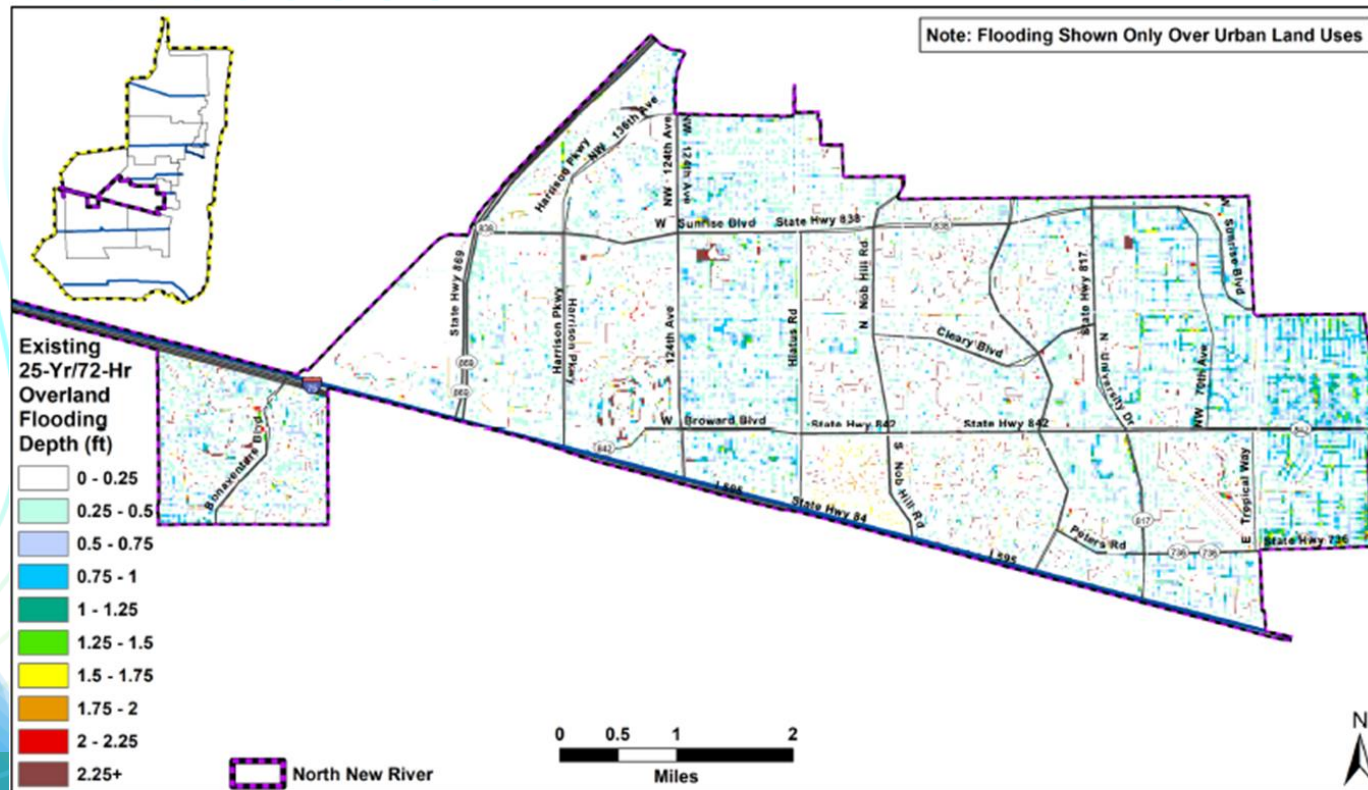


Figure 10.5-7: North New River Basin Flood Inundation Map for the 25-Year Design Storm Event in Urban Land Use Areas

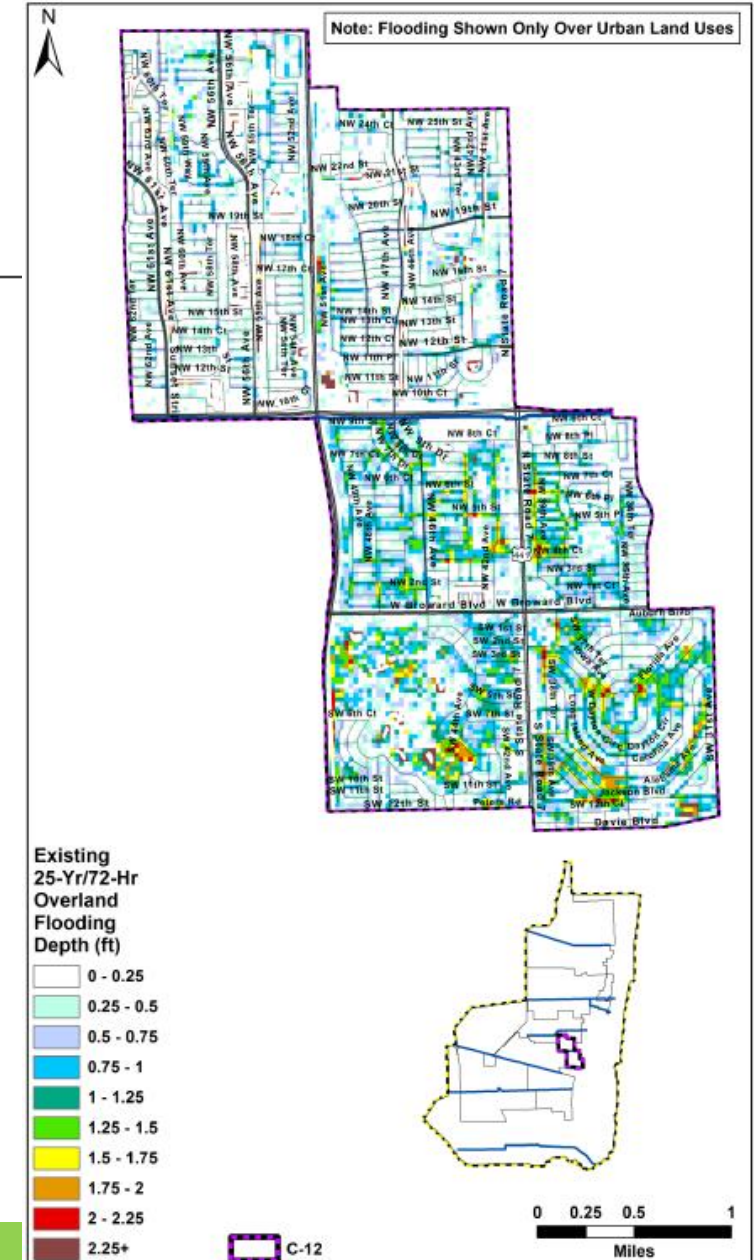


Figure 9.5-7: C-12 Basin Flood Inundation Map for the 25-Year Design Storm Event in Urban Land Use Areas

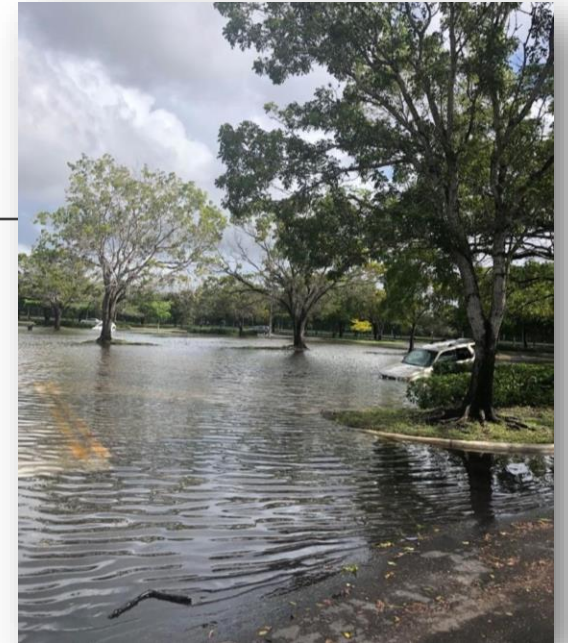
Realized Flood Conditions



Coral Springs, Jun 2017



Lauderhill, Nov 2017



Sunrise, Jun 2019



Dania Beach, Jun 2022

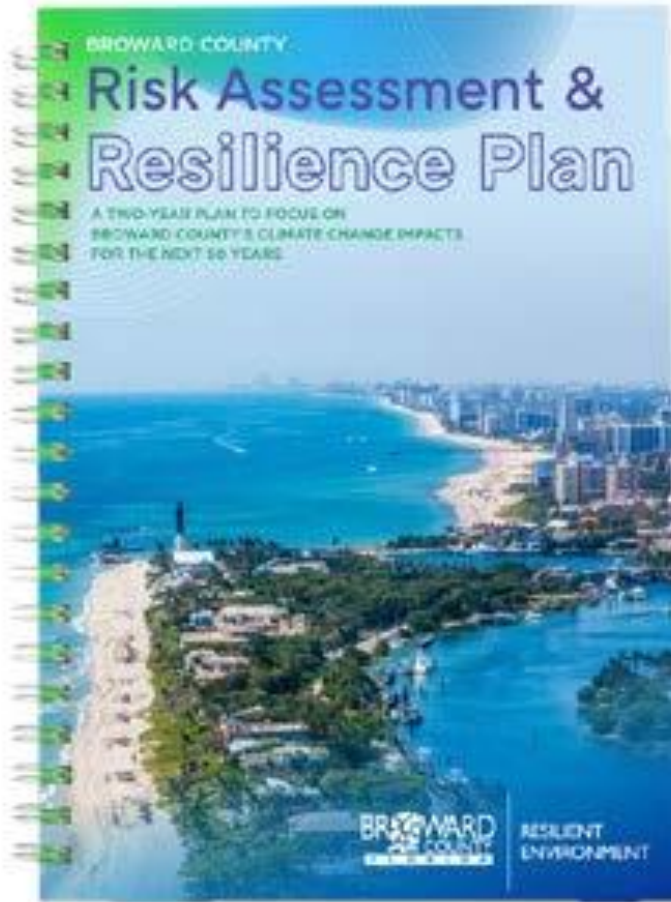


Fort Lauderdale, Nov 2020



Davie, Nov 2020

But Community Resilience Requires Coordinated Plans and Investments



COMMUNITY
OUTREACH



RISK
ASSESSMENT



ECONOMIC
MODELING

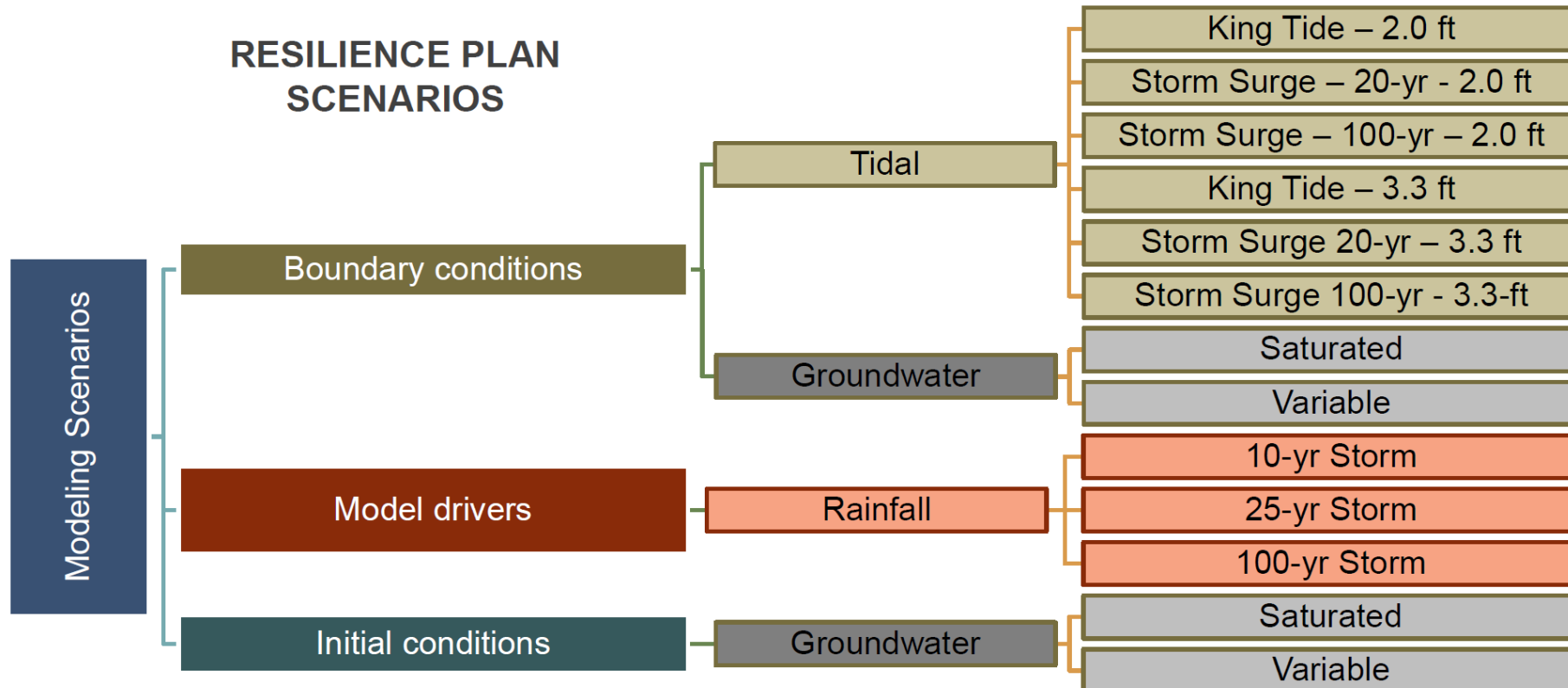


ADAPTION
PLAN



ONLINE
PLATFORM

Planning Scenarios



Ultimately, local resilience depends on regional system function

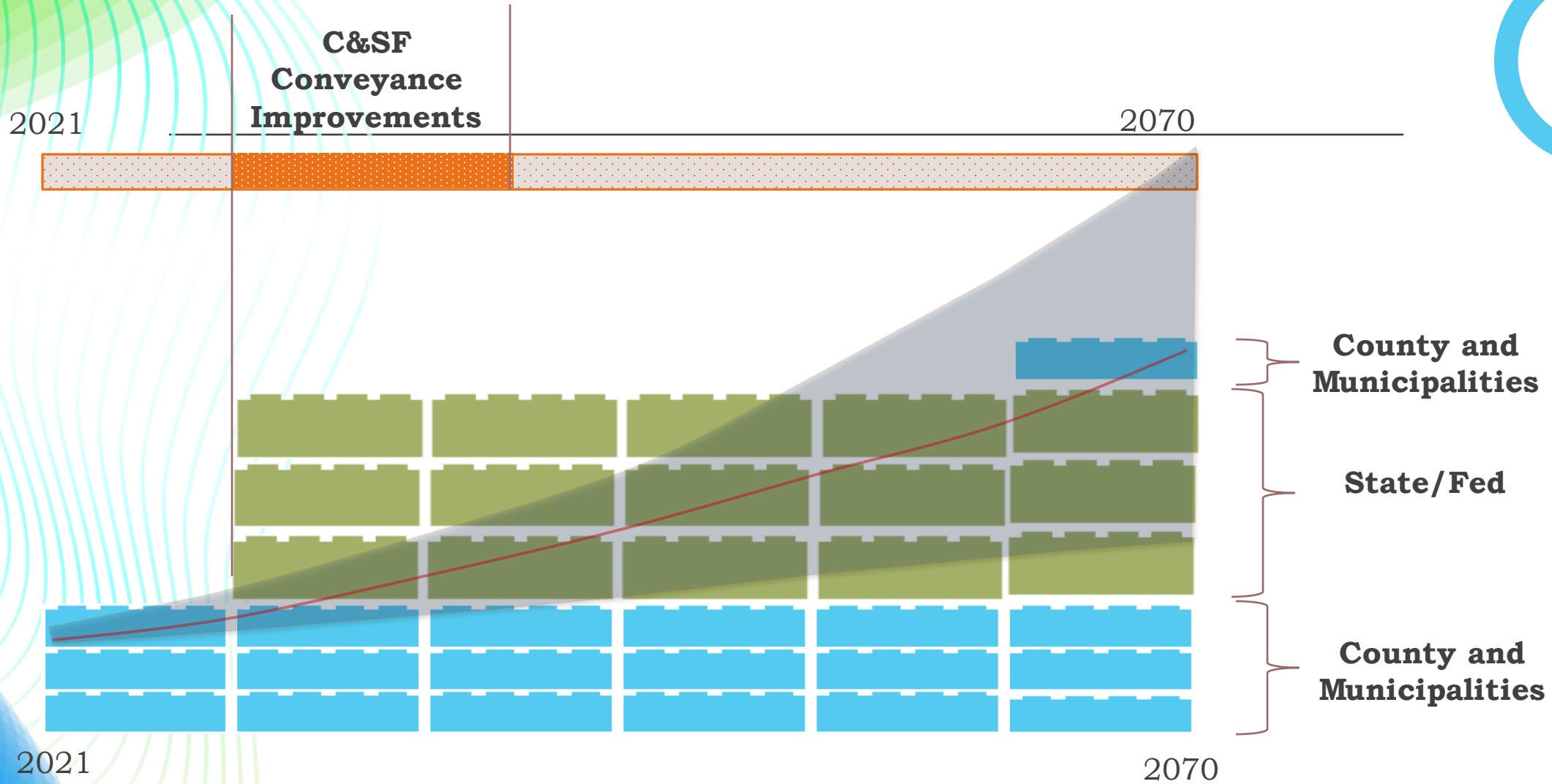


Event simulations, boundary conditions, outputs



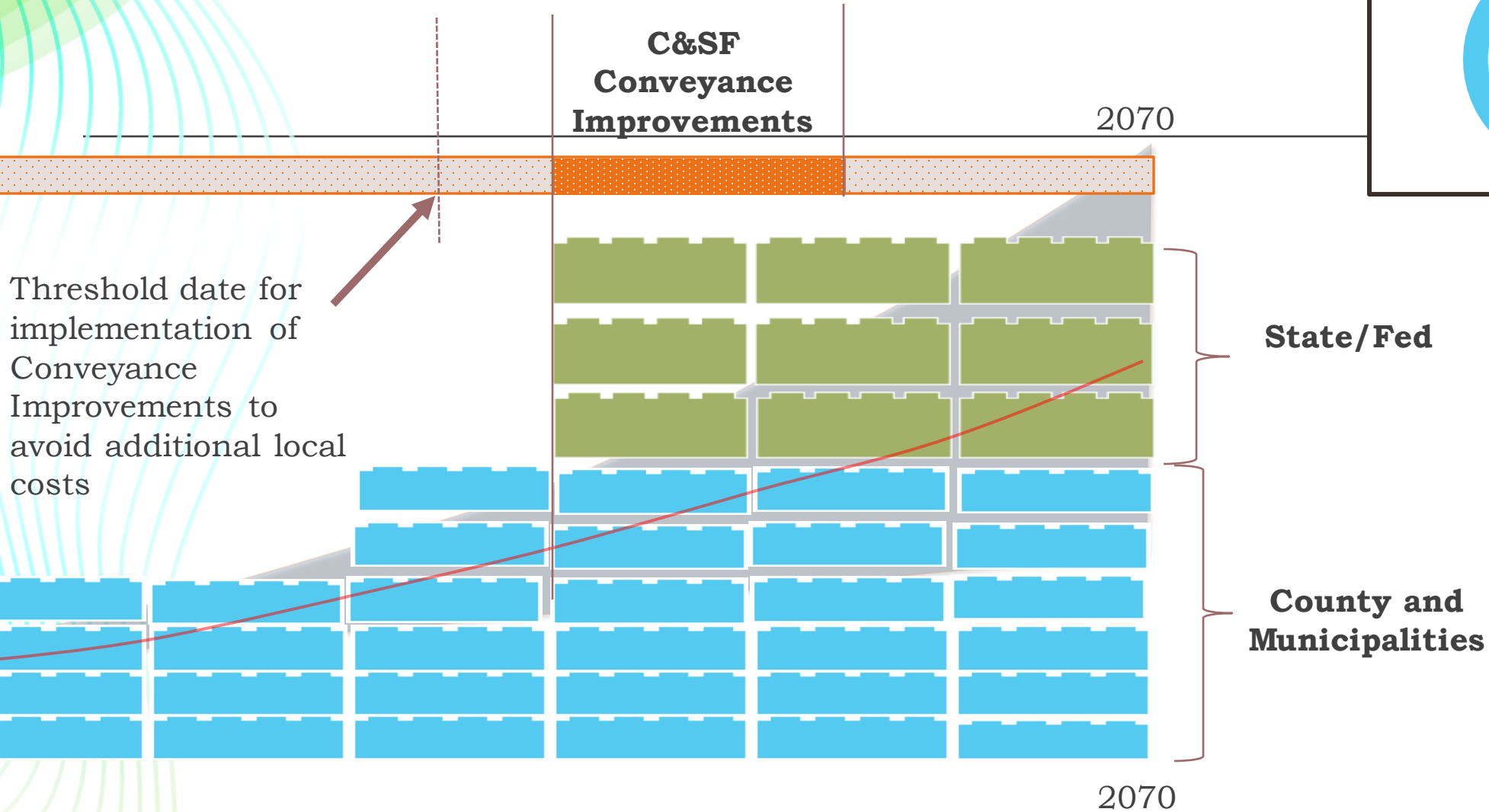
Sensitivity to the Implementation of Conveyance Improvements

Cost of Improvements

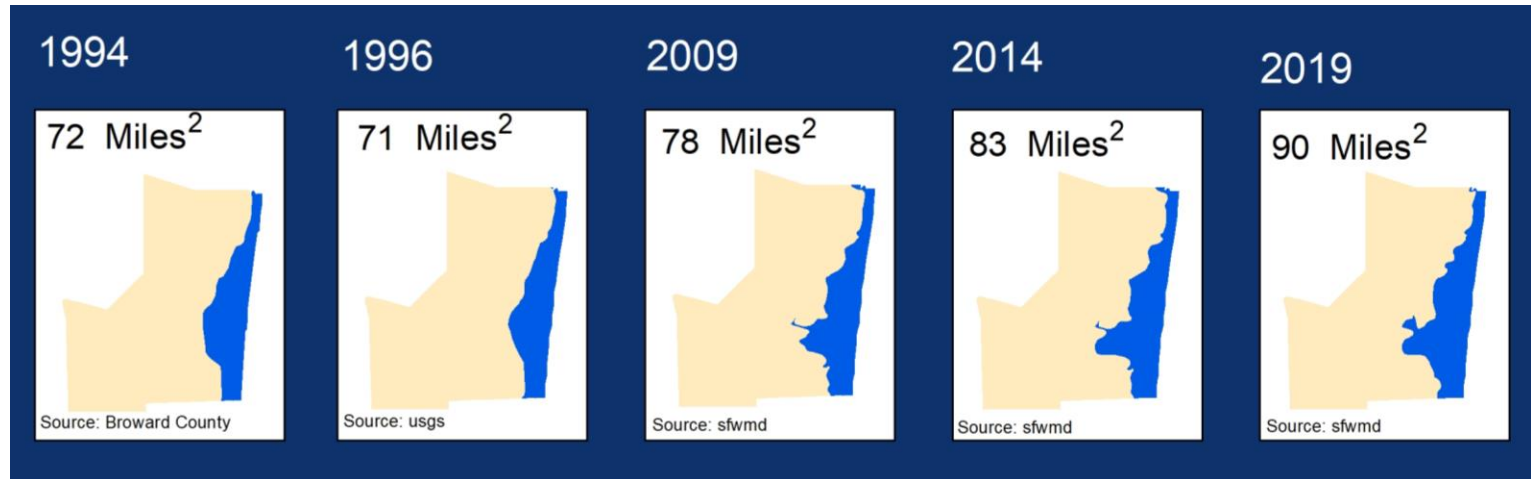


Sensitivity to the Implementation of Conveyance Improvements

Cost of Improvements

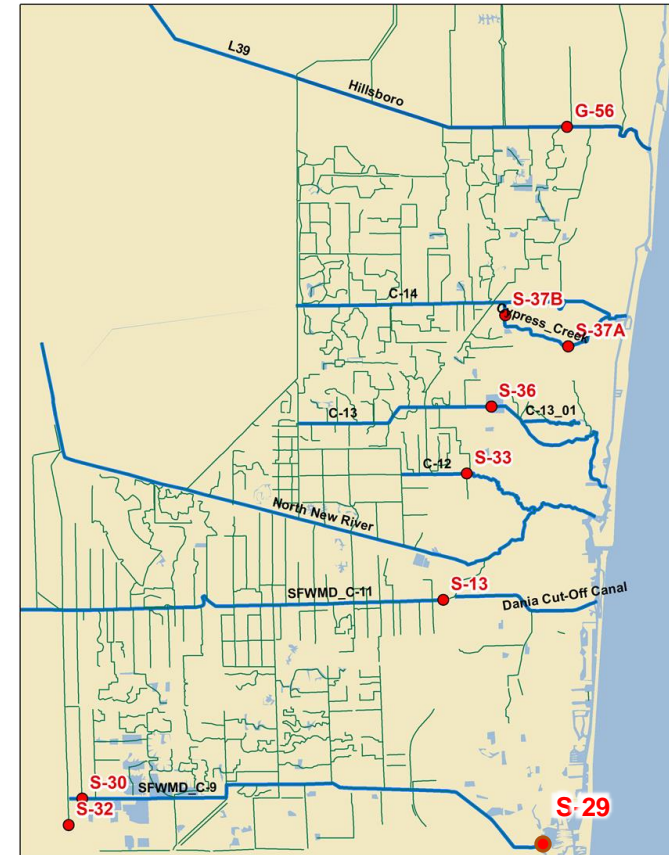


Let's Not Forget Water Supply



C&SF Resilience - Priority Needs

- Resilience improvements to meet level of service needs under conditions predicted for 2100
- Identification of specific structure improvements needed to preserve allowable discharges
 - Sea level rise
 - Surge
 - Tides
 - Rainfall
- Identification of initial system improvements to enhance level of service
 - Storage
 - Conveyance
 - Water quality
- Recommendations for expanded level of service analysis as part of comprehensive study
 - Eastward expansion of actively managed system
 - Initial recommendations for augmented/relocated infrastructure
 - Additional recommendations evolving from project findings but outside initial scope



Questions ?

DR. JENNIFER JURADO

Chief Resilience Officer, Deputy Director
Resilient Environment Department

jjurado@broward.org
954-519-1464



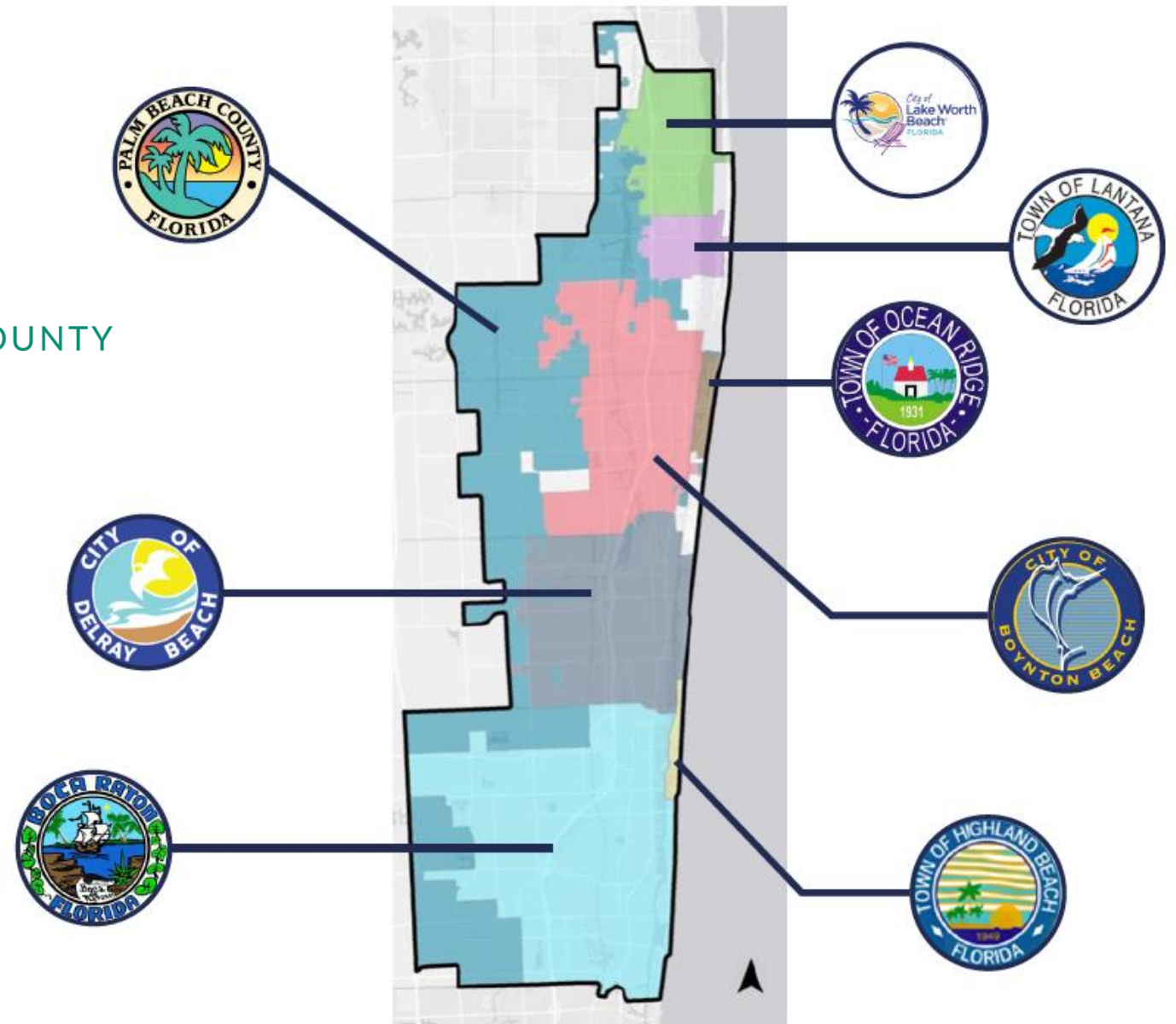
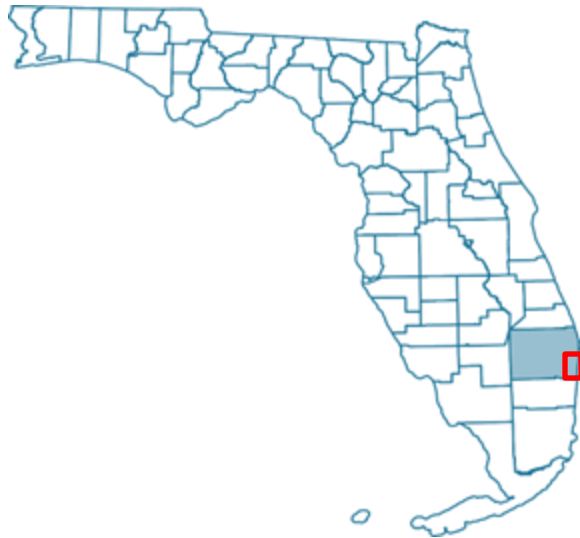
RESILIENT
ENVIRONMENT



COASTAL RESILIENCE PARTNERSHIP

SOUTHEAST PALM BEACH COUNTY

Multi-Jurisdictional Climate Change Vulnerability Assessment



THIS MAP REPRESENTS THE STUDY AREA FOR THE COASTAL RESILIENCE PARTNERSHIP
OF SOUTHEAST PALM BEACH COUNTY CLIMATE CHANGE VULNERABILITY ASSESSMENT



**COASTAL
RESILIENCE
PARTNERSHIP**

SOUTHEAST PALM BEACH COUNTY

Climate Threats Assessed

* Analyses involving sea level rise used the 2017 NOAA intermediate-low and NOAA intermediate-high projections to 2040 and to 2070 to comply with Section 380.093, F.S.



High Winds



**Rainfall-Induced
Flooding**



**Harmful Algal
Blooms**



**Pest & Disease
Outbreaks**



Extreme Heat



Drought



Wildfire



**Shoreline
Recession**



Tidal Flooding



Storm Surge



**Groundwater
Inundation**



**Saltwater
Intrusion**

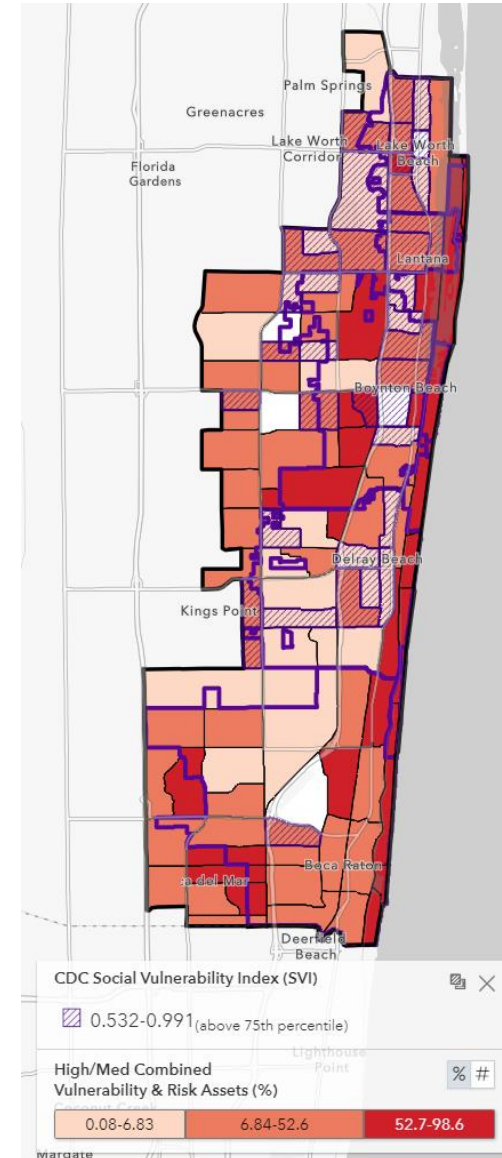


Rainfall Induced Flooding

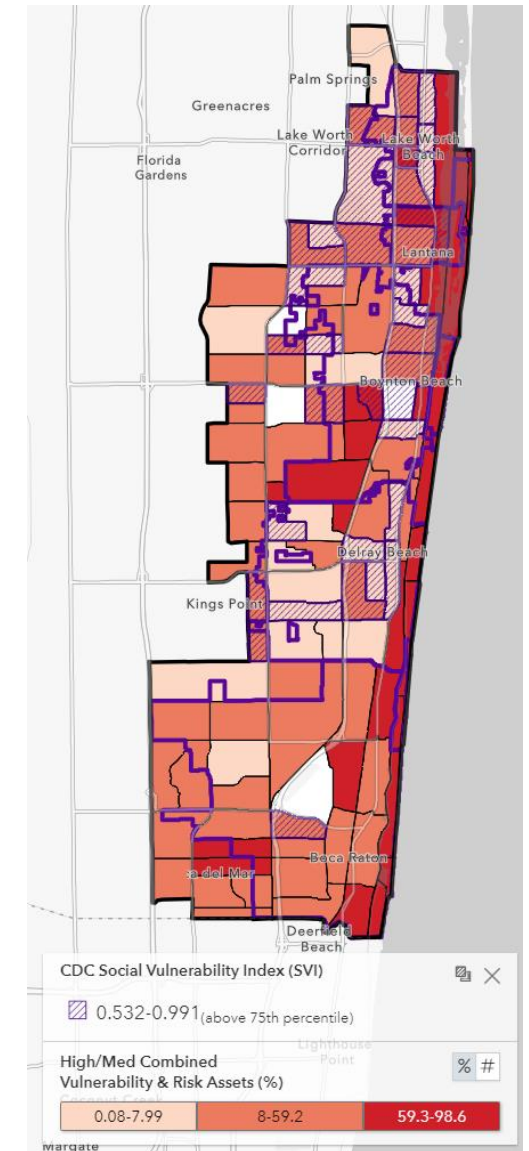
Flooding on normally dry land caused by changes in rainfall patterns



+5" (2040)



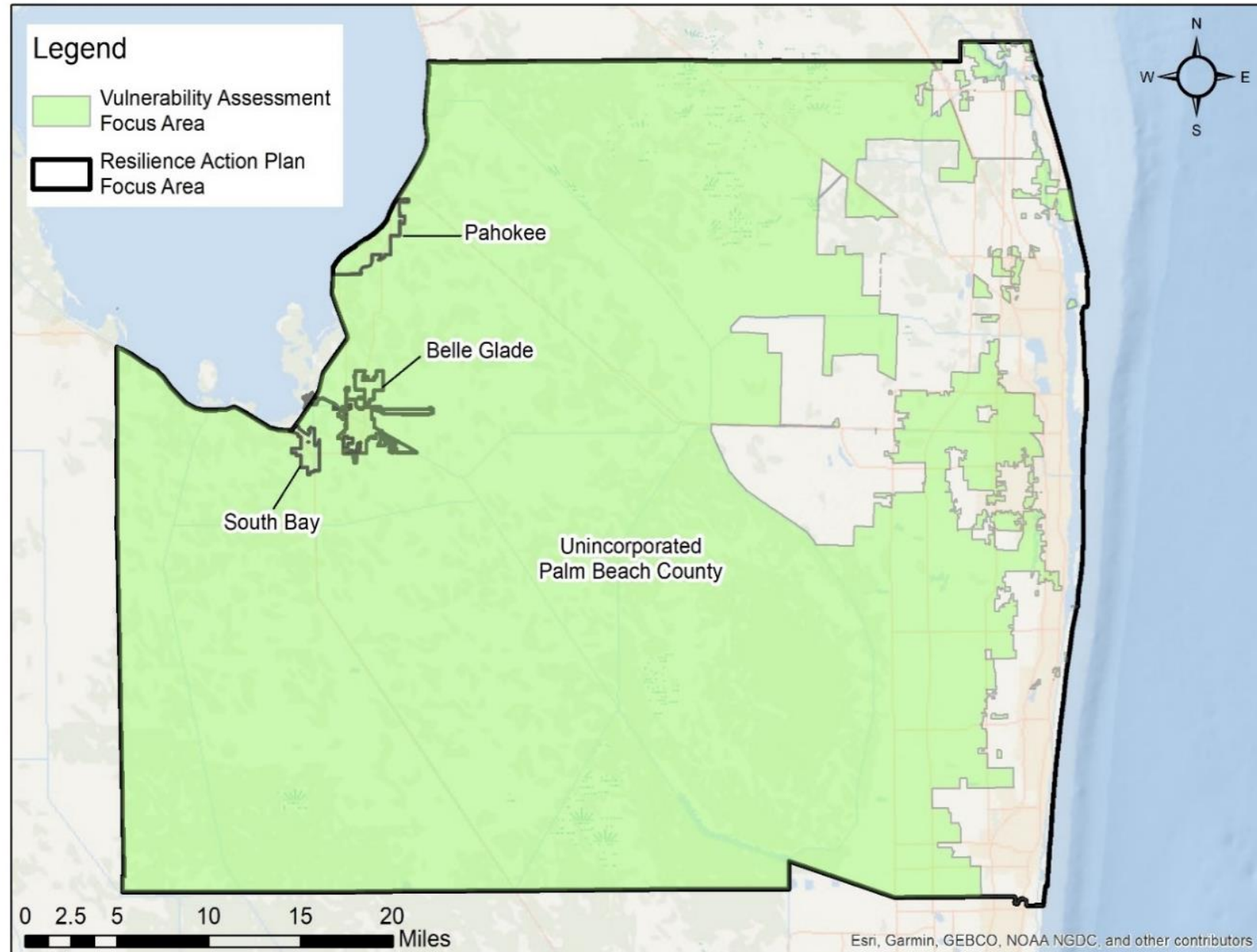
+13" (2070)





PBC Vulnerability Assessment & Resilience Action Plan (VARAP)

- Rebuild Florida CDBG-MIT Grant Funding: \$800,000
- FDEP Resilient Florida Grant Funding: \$500,000
- Palm Beach County Supplemental Funding: \$500,000





PBC VARAP Project Scope

1. Vulnerability Assessment

- Includes Unincorporated PBC
- Select Assets
- Identify Climate Threats
- Calculate Risks
- Incorporate Social Vulnerability
- Resilient Florida Compliant
- Create Visualization Tool

2. Resilience Action Plan

- Includes Whole County
- Prioritized Project List
- Detailed Project Descriptions
- Equity Considered
- Net Zero Feasibility



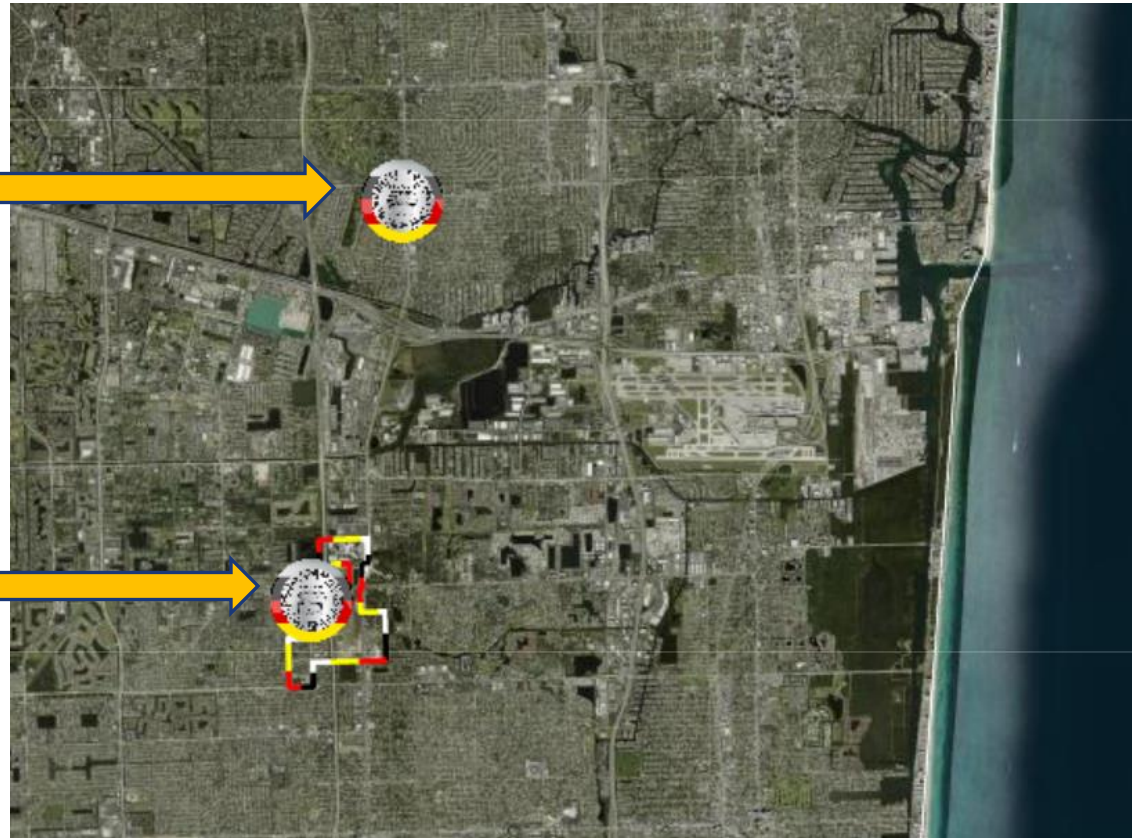
C&SF FLOOD RESILIENCY

SEMINOLE TRIBE OF FLORIDA RESERVATIONS

COCONUT CREEK
RESERVATION



HOLLYWOOD
RESERVATION



ERMD

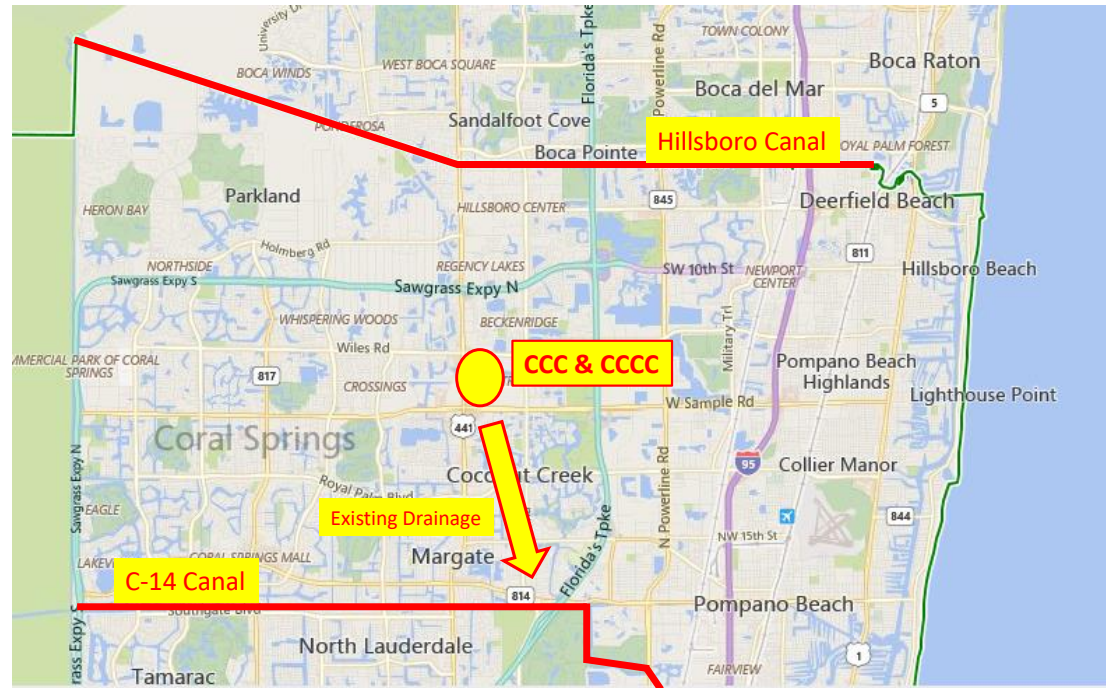
SEMINOLE TRIBE OF FLORIDA
AH-TAH-THI-KI
M U S E U M
A PLACE TO LEARN. A PLACE TO REMEMBER.



C&SF FLOOD RESILIENCY

Coconut Creek Reservation

Existing Drainage Route



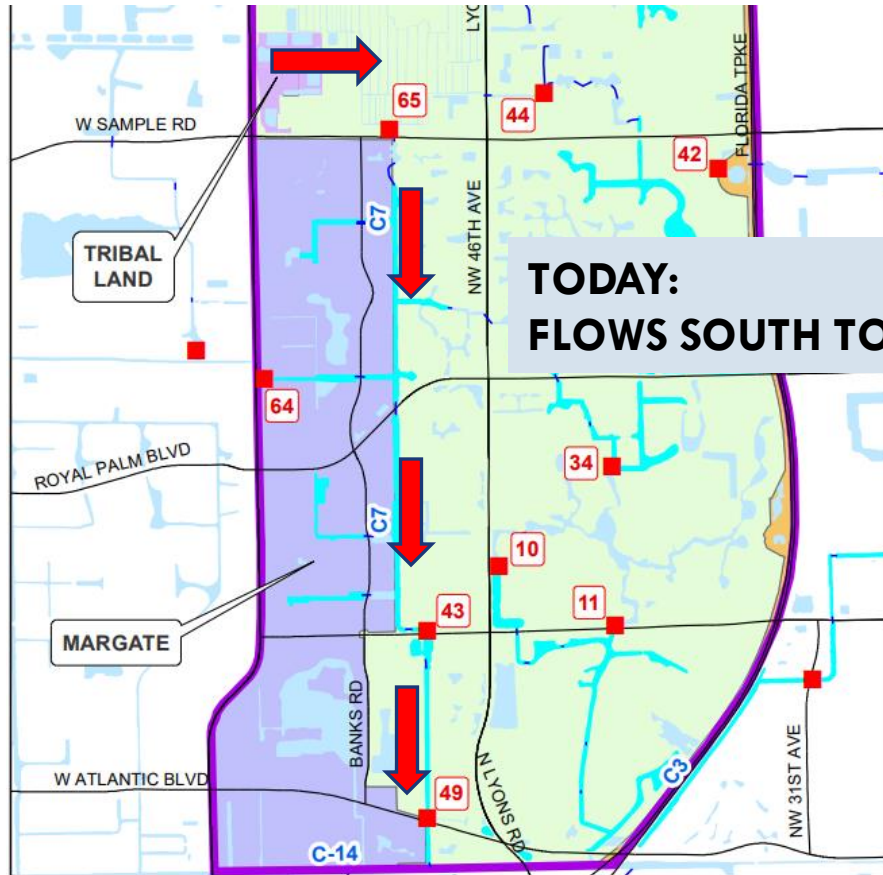
ERMD

SEMINOLE TRIBE OF FLORIDA
AH-TAH-THI-KI
MUSEUM
A PLACE TO LEARN. A PLACE TO REMEMBER.

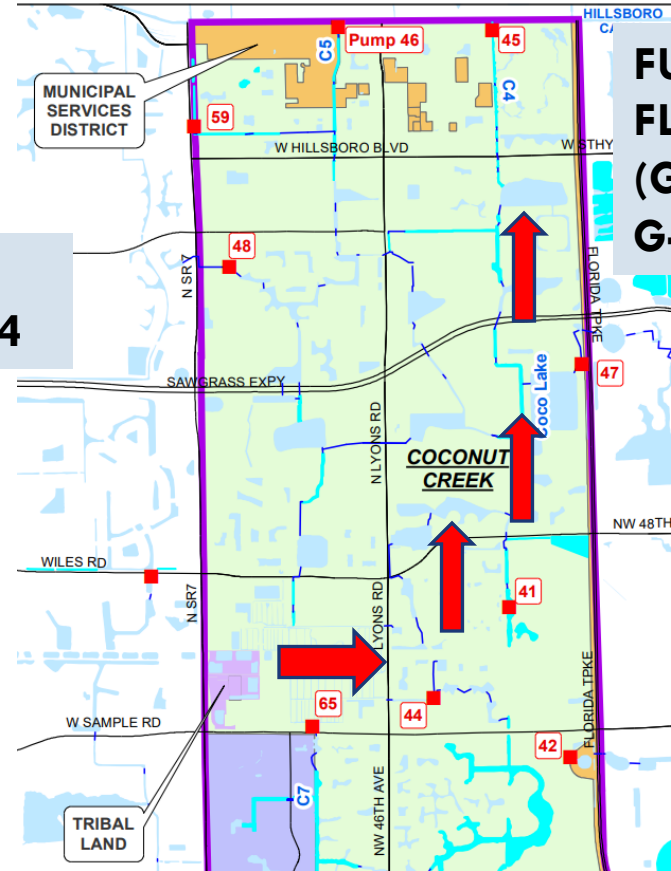


C&SF FLOOD RESILIENCY

Coconut Creek Reservation Flow Paths



**TODAY:
FLOWS SOUTH TO C-14**



**FUTURE?:
FLOW NORTH TO HILLSBORO
(G-08) CANAL/RIVER
G-56 STRUCTURE**

ERMD

SEMINOLE TRIBE OF FLORIDA
AH-TAH-THI-KI
MUSEUM
A PLACE TO LEARN. A PLACE TO REMEMBER.

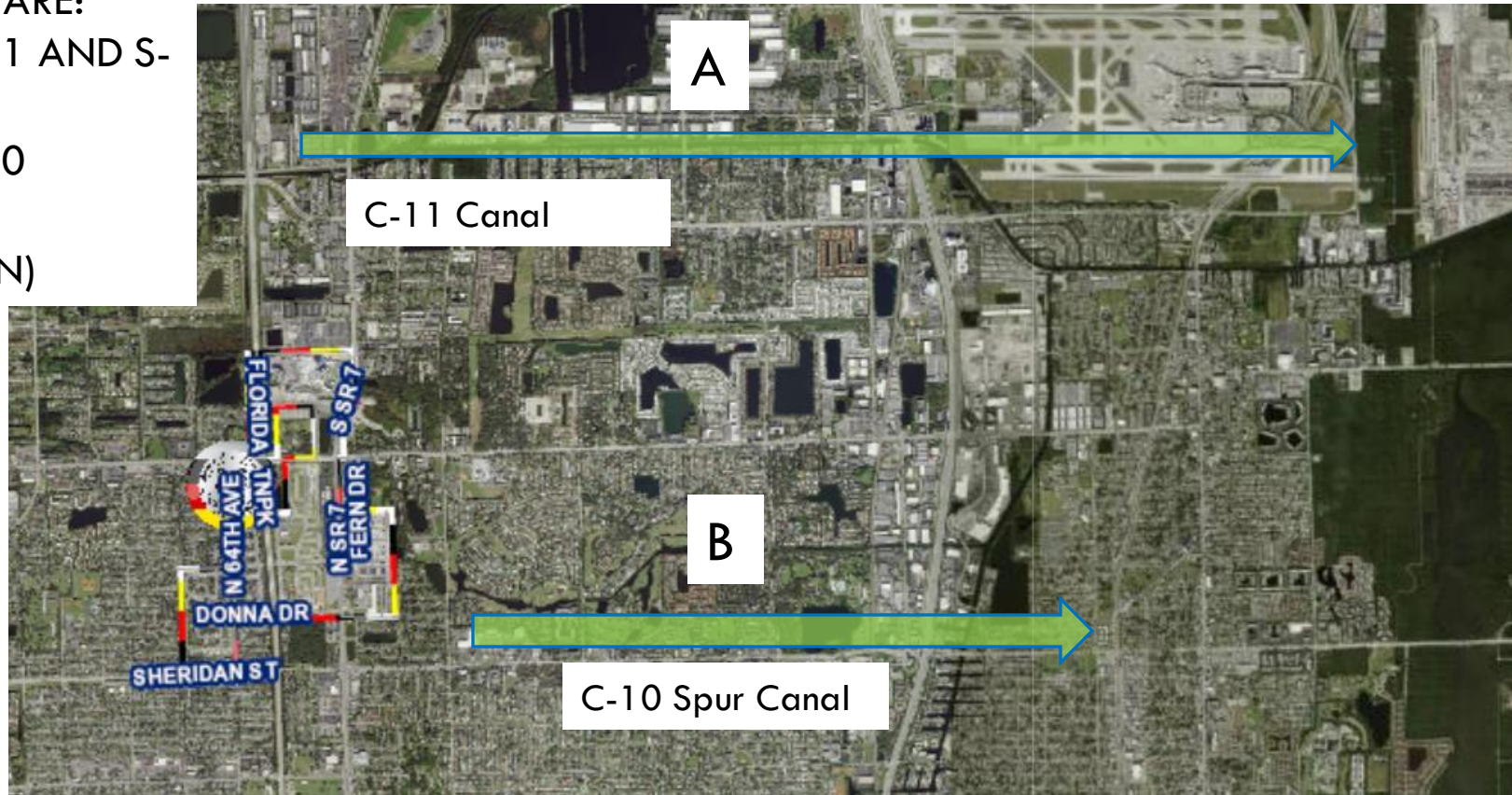


C&SF FLOOD RESILIENCY

HOLLYWOOD RESERVATION DRAINAGE

FLOW OPTIONS ARE:

- A. EAST VIA C-11 AND S-13 PUMP
- B. EAST VIA C-10 (FUTURE CONNECTION)



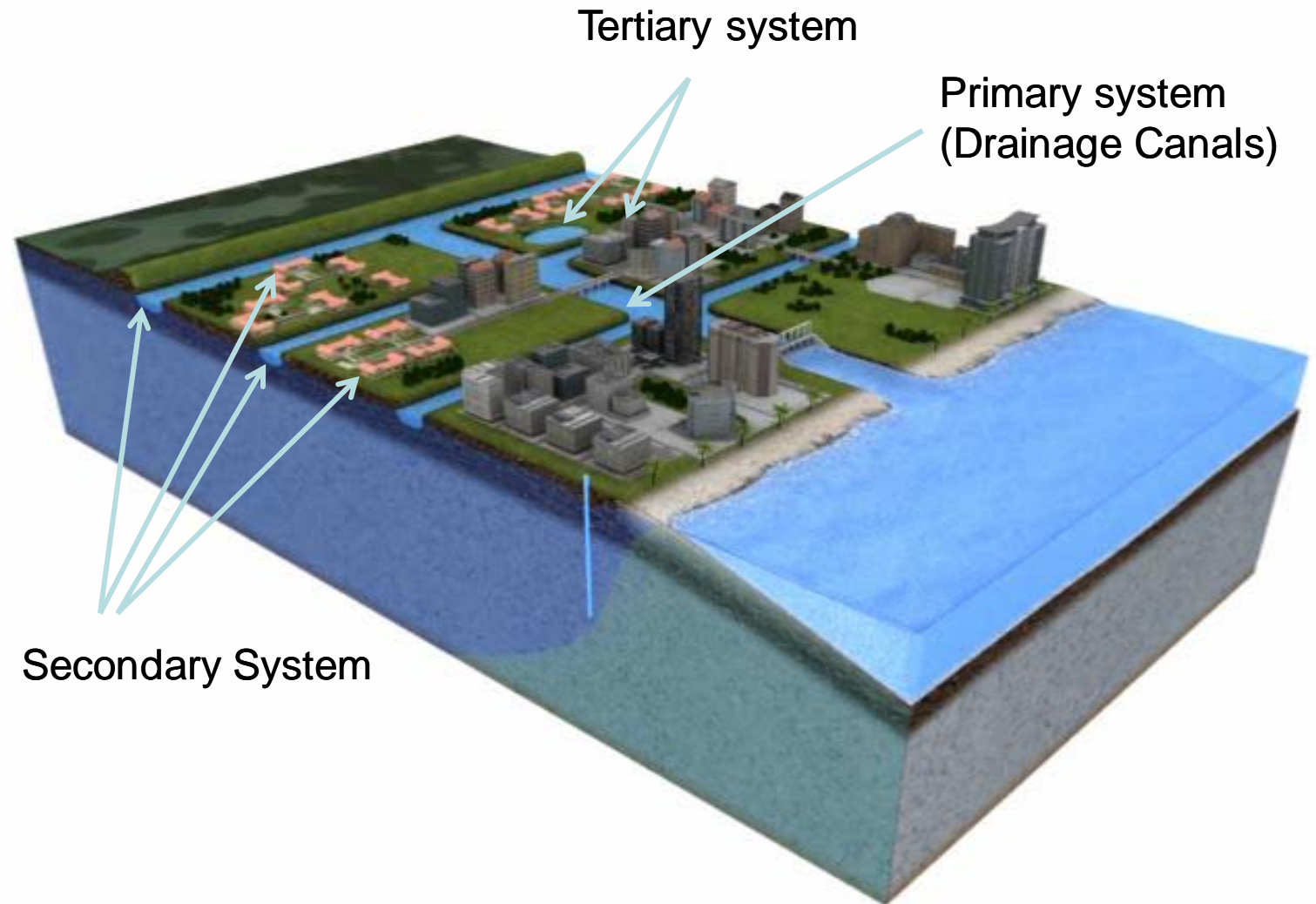
ERMD

SEMINOLE TRIBE OF FLORIDA
AH-TAH-THI-KI
MUSEUM
A PLACE TO LEARN. A PLACE TO REMEMBER.



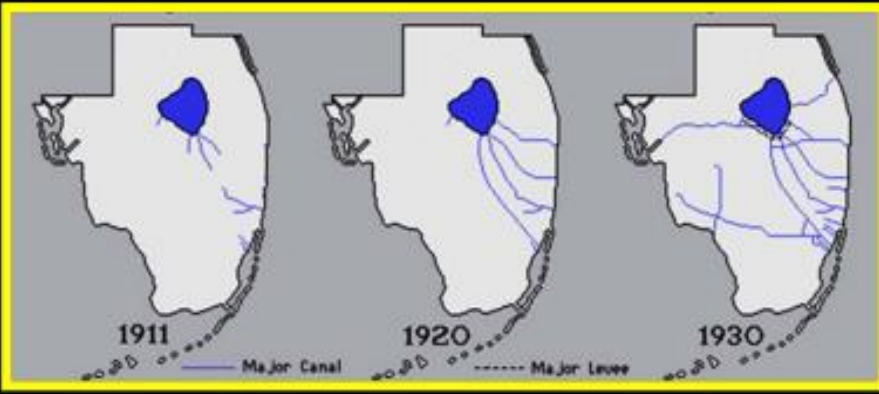
Joint Flood Protection Responsibility

- Primary
 - USACE
 - SFWMD
- Secondary
 - Local Governments
 - Special Districts
- Tertiary
 - Homeowners Associations
 - Private Landowners



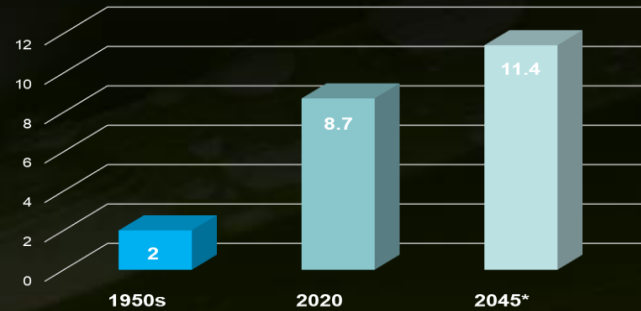
Recognizing Changed Conditions

Pre-1948 Drainage Projects

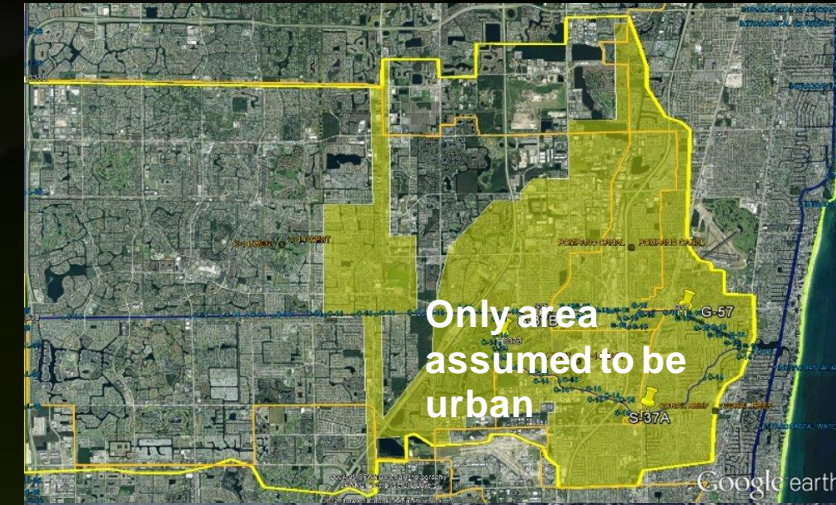


POPULATION GROWTH

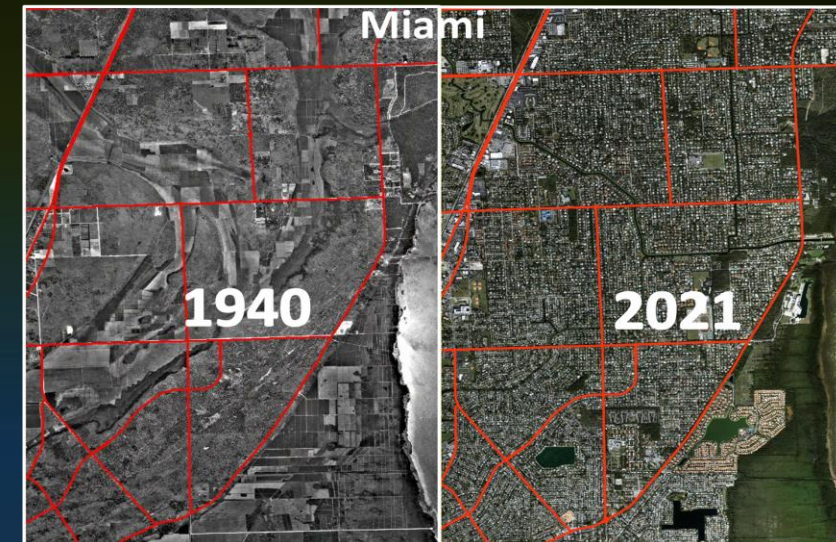
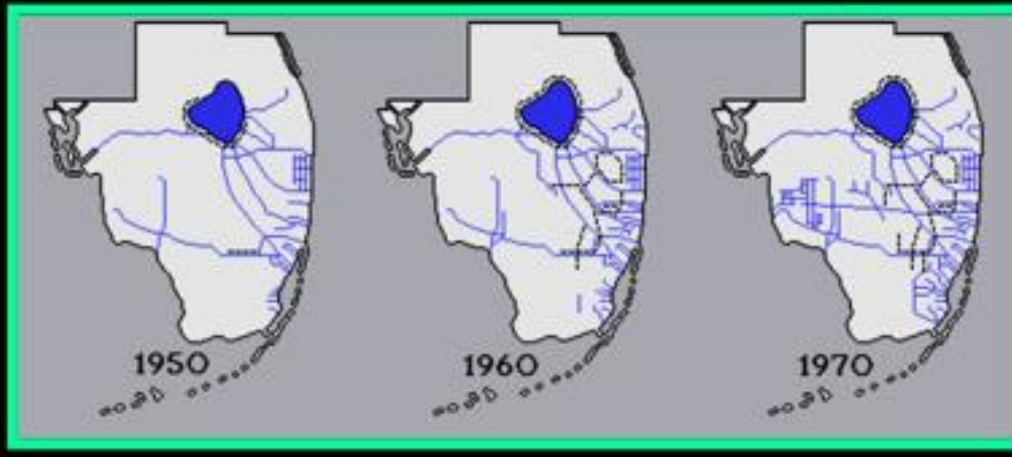
Population (million)



* Estimate taken from BEBR 2017 publication (Median, SFWMD boundaries)



Post-1948 C & S Florida Project

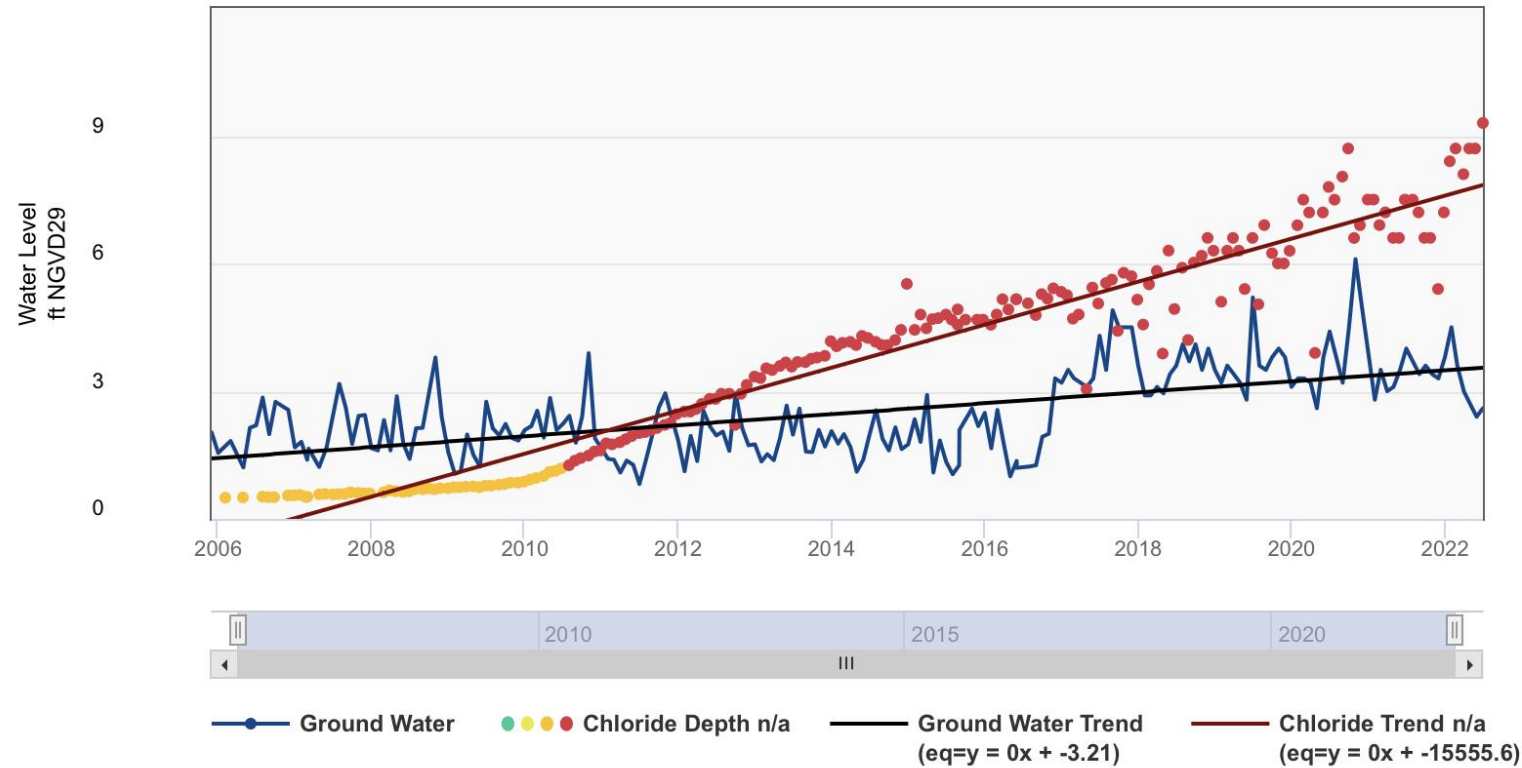


Recognizing Changed Conditions: Emerging Trends in Regional Resiliency

HALLANDALE

As of Thursday, July 28, 2022 at 7:00:49 PM GMT-04:00

Zoom 6m 1y All

Chloride Level
mg/L

SFWMD Data and Support



DBHydro Insights

DBHYDR is the South Florida Water Management District's corporate environmental database that stores hydrologic, meteorologic, hydrogeologic and water quality data.

[Details](#)[View](#)

SFWMD GIS Open Data Hub

Our Open Data site is where our publicly available spatial datasets can be viewed and downloaded. Additional Web Apps and Story Maps are featured to explore and learn more about the data.

[Details](#)[View](#)

As the South Florida Water Management District works to Achieve More Now For Florida's Environment, we are pleased to present the 2021 South Florida Environmental Report (SFER).

[Details](#)[View](#)

Local Agencies' Information

Local Agencies are using their resources to help us understand the potential risks that come with Coastal Resiliency efforts.



Resiliency

es to build
f scales, internally
ons, and county-
ons with
nally across

[Main Page](#)

Miami-Dade County Sea Level Rise Strategy

Miami-Dade County faces an unprecedented challenge in the coming decades to adapt to climate change and sea level rise.

[Details](#)[Main Page](#)

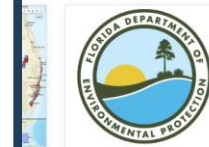
Palm Beach County Office of Resilience

The Office of Resilience (OOR) works to ensure that Palm Beach County remains a great place to live, work, and play while addressing physical, social, and economic challenges including climate change.

[Details](#)[Main Page](#)

Federal and State Agencies' Information

re using their resources to help us understand the potential risks that come with Coastal Resiliency efforts.



FDEP

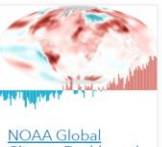
Florida Resilient Coastlines Program

The Florida Department of Environmental Protection is committed to marshaling resources to prepare Florida's coastal communities and habitats for the effects of climate change, especially rising sea levels.

[Details](#)[View](#)

NOAA Resilience HUB

This page is a hub for NOAA-related resilience resources. Here you can peruse the agency's related assets, explore ELP-funded resilience projects, and learn more about our grantee community. The ELP Community Resilience Education Theory of Change can also be found on this hub.

[Details](#)[View](#)

NOAA Global Climate Dashboard

NOAA Climate.gov provides timely and authoritative scientific data and information about climate science, adaptation, and mitigation.

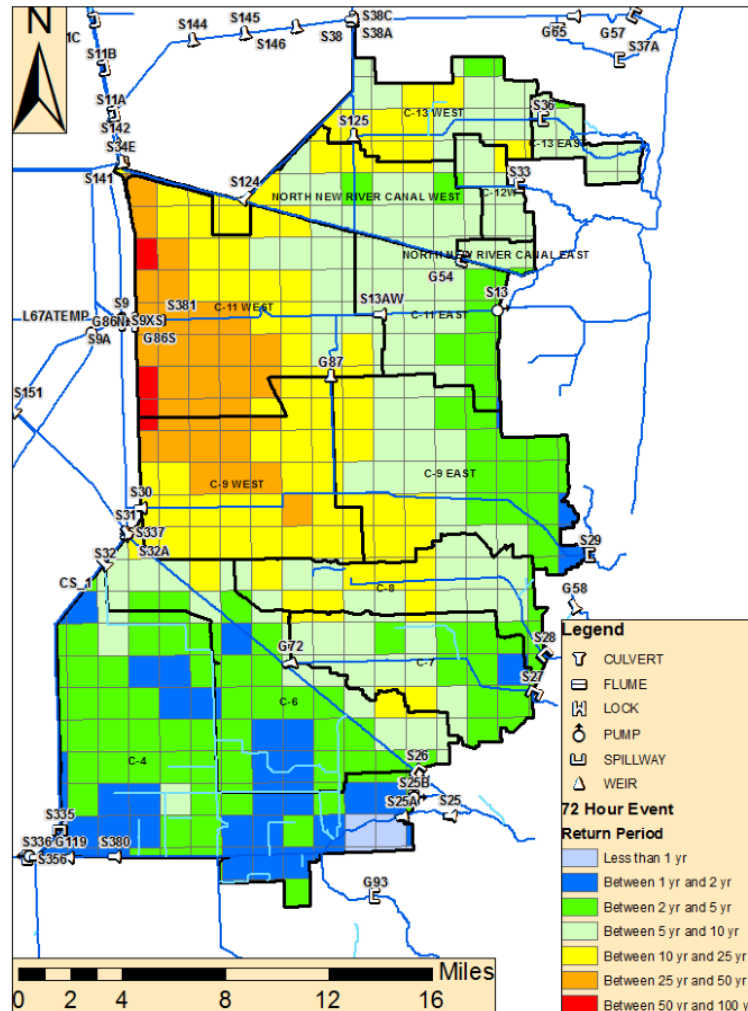
[Details](#)[Explore](#)

Current Limitations in C&SF Operation

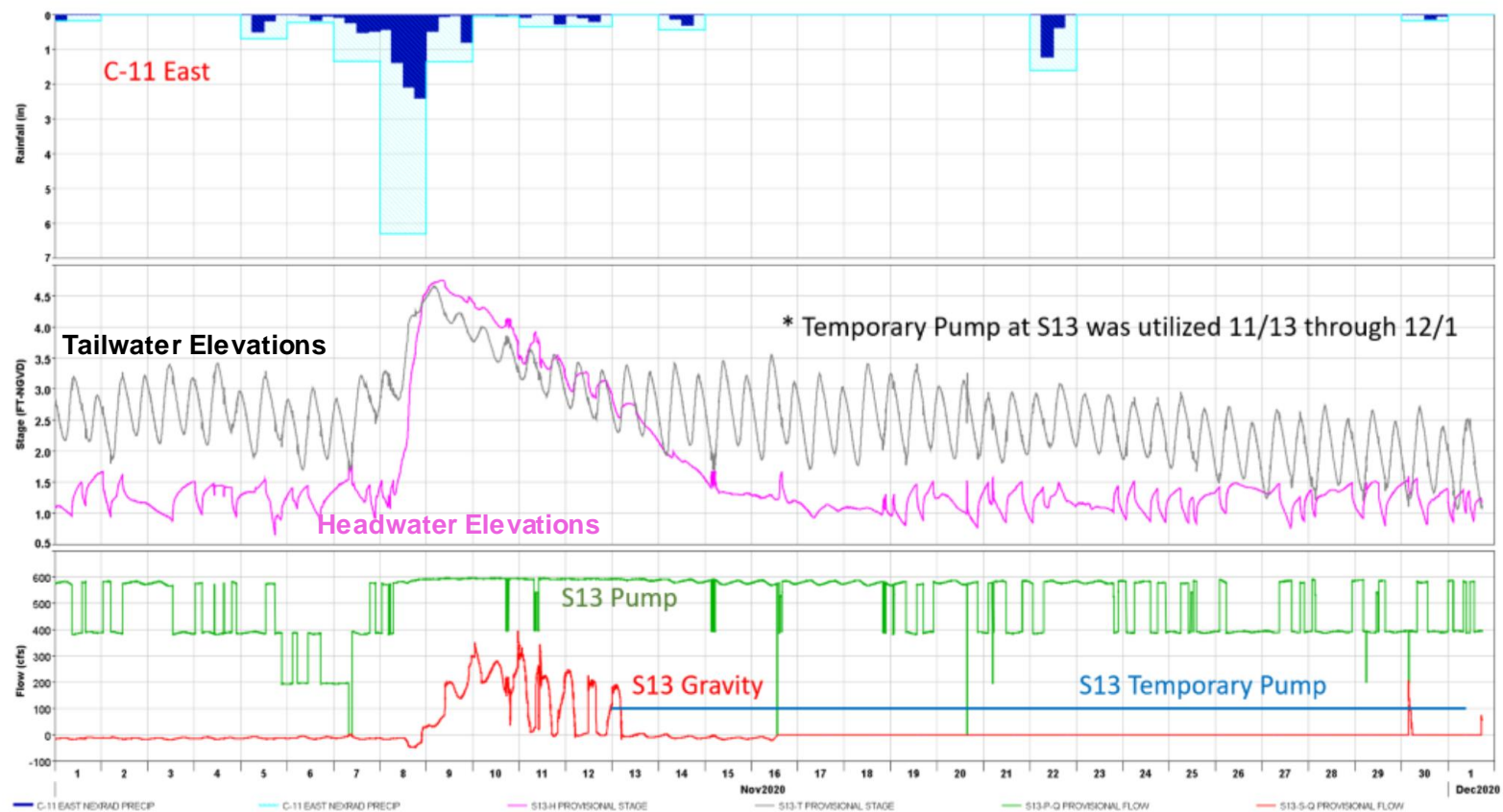
Reduction in Discharge Capacity as a Result of SLR



TS Eta: Compound Flooding Factors



Nov/Dec 2020: significant rainfall occurrences, following 300% above average rainfall (high water table) and King Tides



Flood Protection Level of Service Program

District strategy for assessing the impacts of urban development and changing climate on flood control

- Evaluate current and future flood risks to communities in South Florida
 - Based on 6 performance metrics: canal stages, discharge capacity, overland flood inundation and duration
 - Considers rainfall, groundwater levels, tides, storm surge and sea level
- Support decision making on prioritizing investment for improvements and adaptation

www.sfwmd.gov/our-work/flood-protection-level-service

Legend

□ AHED Watersheds

Structures

Y CULVERT

⬆ PUMP

⬆ SPILLWAY

Status

XXX Completed

XXX Future

Ongoing

Future Level of Service

100-Year Event

25-Year Event

10-Year Event

5-Year Event

< 5-Year Event

No Results

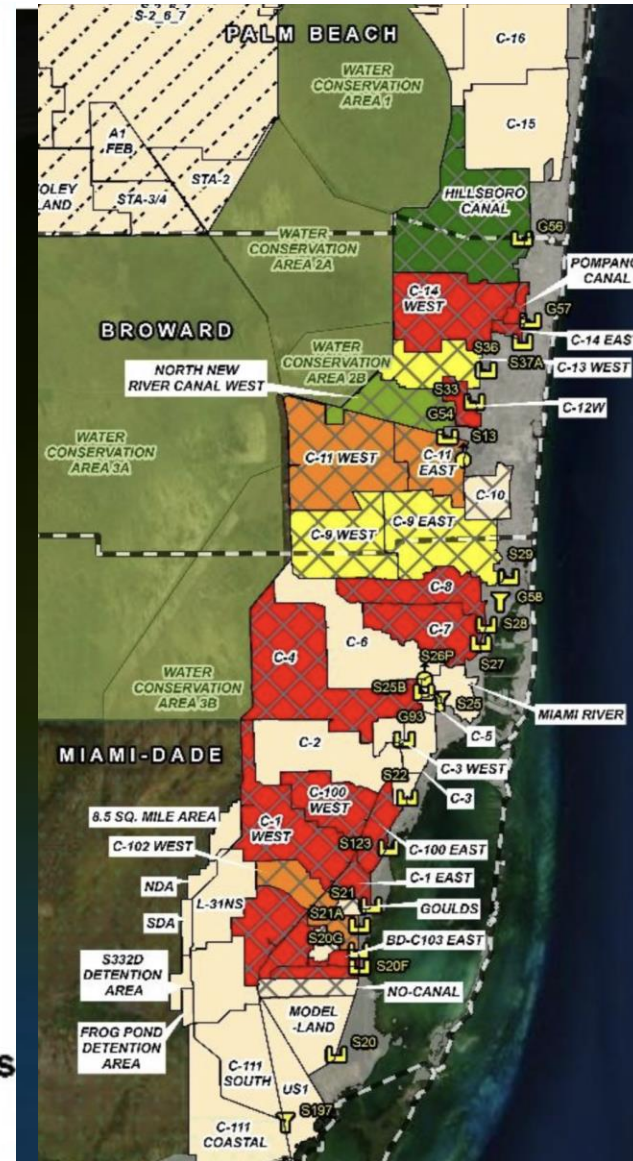
Downstream Areas

Gray

Water Conservation Areas

Light Green

Dark Green





Engineering With Nature for a More Resilient and Sustainable Future

Dr. Todd S. Bridges
Senior Research Scientist (ST), Environmental Science
National Lead, USACE Engineering With Nature®
Todd.S.Bridges@usace.army.mil

Central & South Florida Study
12 January 2023



US Army Corps
of Engineers



The Multi-Hazard World



Mt. Saint Helens, 1980



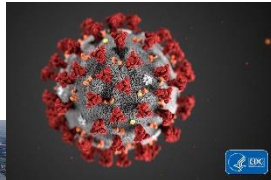
David Johnston, USGS



New Madrid Seismic Zone



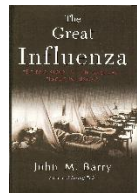
San Francisco, 1906



COVID-19, 2020-X



HABs, Lake Erie; 2008-2017



H1N1, 1918-1919



Dust Bowl, 1930s



Camp Fire; CA 2018



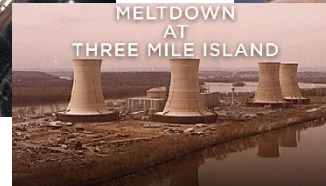
Offutt AFB, 2019



Beirut, Lebanon; 2020



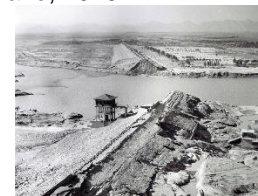
Fukushima, 2011



Three Mile Island, 1979



Deepwater Horizon, 2010



Banqiao dam failure; China, 1975



Hurricane Katrina, 2005



2020 record-setting storm season



9/11

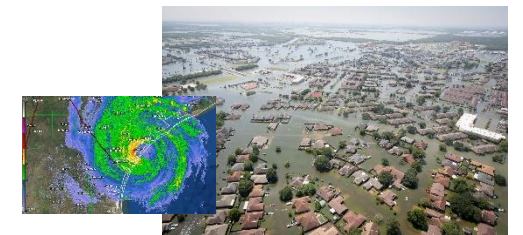


Civil unrest, 2020

Medfly "bio-attack"; CA, 1989



Flood of 1927; Tallulah, LA

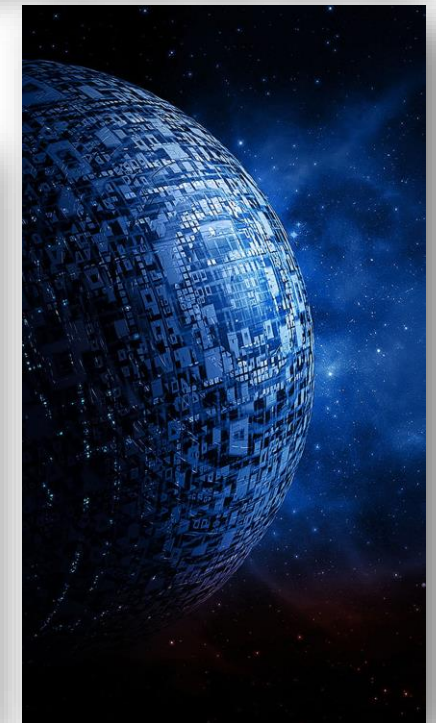
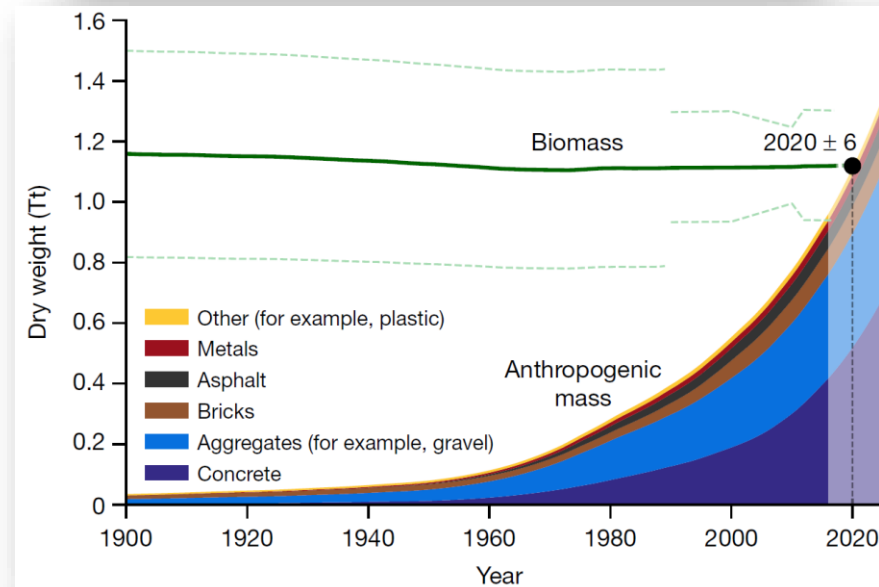


Hurricane Harvey; landfall and Houston, 2017

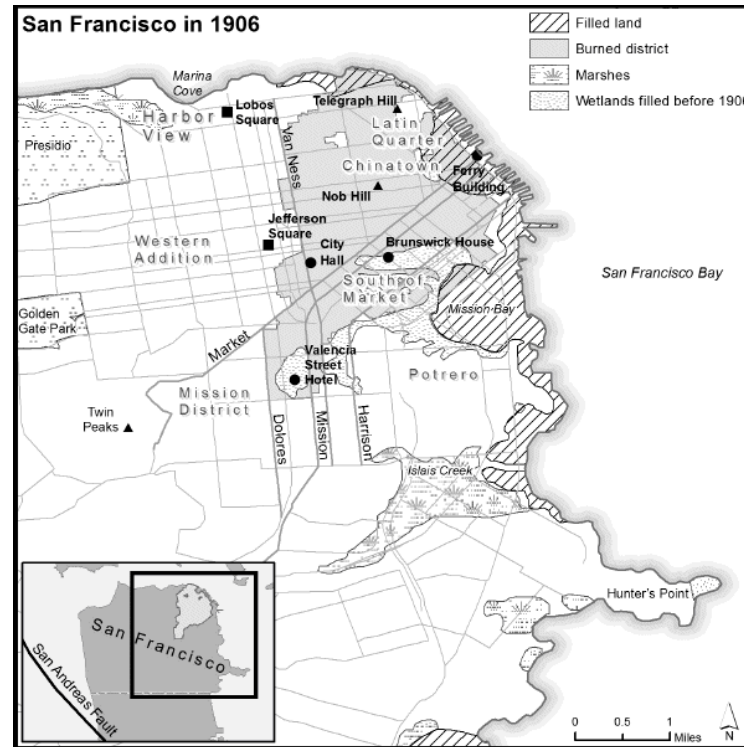
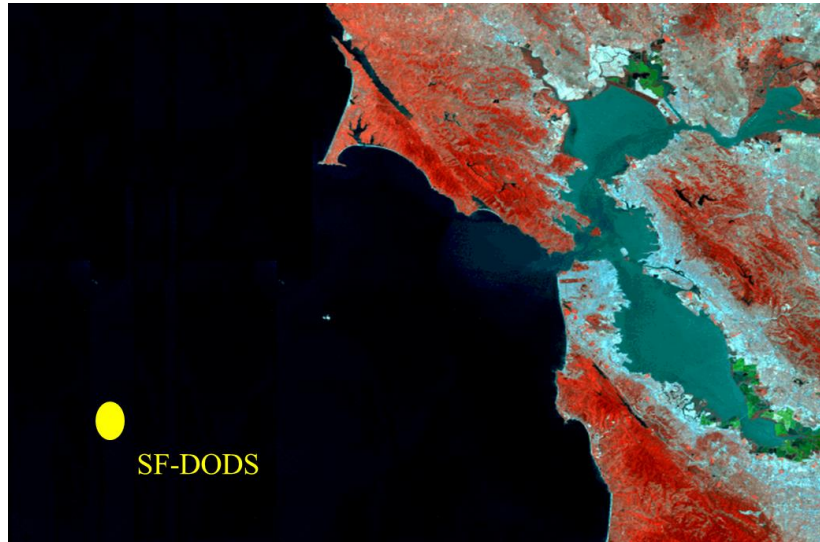
1900-2000: The Century of Infrastructure (US)

- 4,071,000 miles of roadway
 - 47,182 miles in the Interstate system
- 149,136 miles of mainline rail
- 640,000 miles of high-voltage transmission lines
- 614,387 bridges
- 90,580 dams
- >30,000 miles of flood levee
- 155,000 public drinking water systems
- ~5,000 military installations
- 926 ports, 25,000 miles of navigation channel

Elhacham et al. 2020. Global human-made mass exceeds all living biomass. Nature 588:442-444



San Francisco Bay

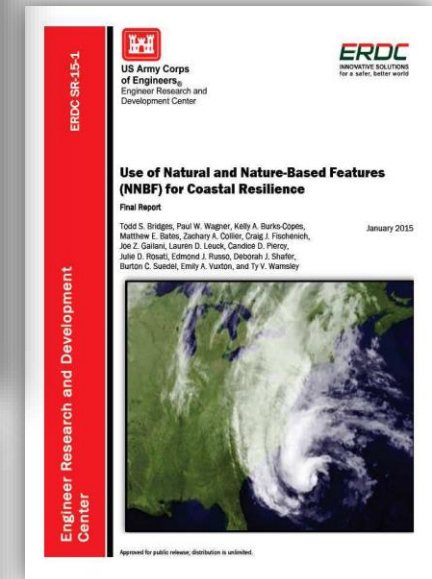
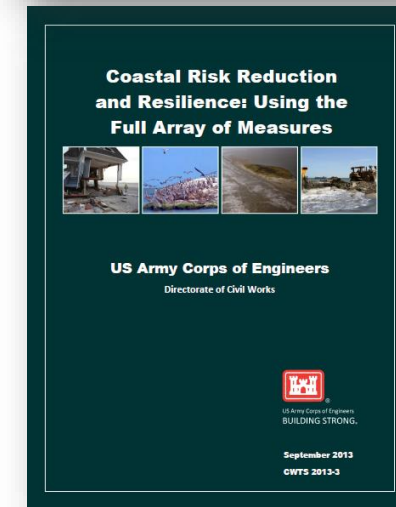
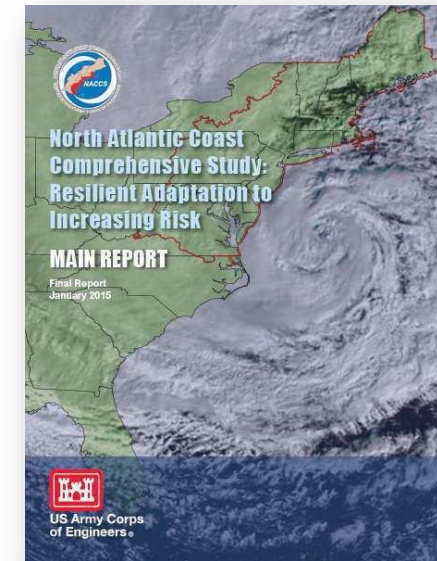


US Army Corps of Engineers • Engineer Research and Development Center

Resilience Through Integrated Solutions

“The USACE planning approach supports an integrated strategy for reducing coastal risks and increasing human and ecosystem community resilience through a combination of the full array of measures: natural, nature-based, nonstructural, and structural. This approach considers the engineering attributes of the component features and the dependencies and interactions among these features over both the short and long term. It also considers the full range of environmental and social benefits produced by the component features.”

Coastal Risk Reduction and Resilience. Todd Bridges, Roselle Henn, Shawn Komlos, Debby Scerno, Ty Wamsley, and Kate White. CWTS 2013-3. Washington, DC: Directorate of Civil Works, US Army Corps of Engineers.



Water Infrastructure Improvements for the Nation Act (WIIN Act) 2016

SEC. 1184. Consideration of measures.

(a) Definitions.—In this section, the following definitions apply:

(1) NATURAL FEATURE.—The term “natural feature” means a feature that is created through the action of physical, geological, biological, and chemical processes over time.

(2) NATURE-BASED FEATURE.—The term “nature-based feature” means a feature that is created by human design, engineering, and construction to provide risk reduction in coastal areas by acting in concert with natural processes.

(b) Requirement.—In studying the feasibility of projects for flood risk management, hurricane and storm damage reduction, and ecosystem restoration the Secretary shall, with the consent of the non-Federal sponsor of the feasibility study, consider, as appropriate—

- (1) natural features;
- (2) nature-based features;
- (3) nonstructural measures; and
- (4) structural measures.



Leadership Intent on Nature-Based Solutions...

“My vision for the future is driven by a sense of urgency. I’d like the Army Corps, a capable and talented organization, to be innovative in developing new strategies and to build climate resilience to better protect and prepare communities for some of the challenges they’re facing. We need to take advantage of nature-based infrastructure and figure out how we can bring multiple benefits to our projects so that we’re not just doing flood risk and coastal storm management but are also helping to further environmental restoration and even augment water supply where we can.”

**Michael Connor, ASA(CW)
Municipal Water Leader, May 2022**

“Serious consideration of NNBFs is non-negotiable.”

**Eric L. Bush, SES
Chief, Planning and Policy (HQUSACE)
July, 2022**

Nature-Based Solutions: A White House Priority

2022
Earth Day EO



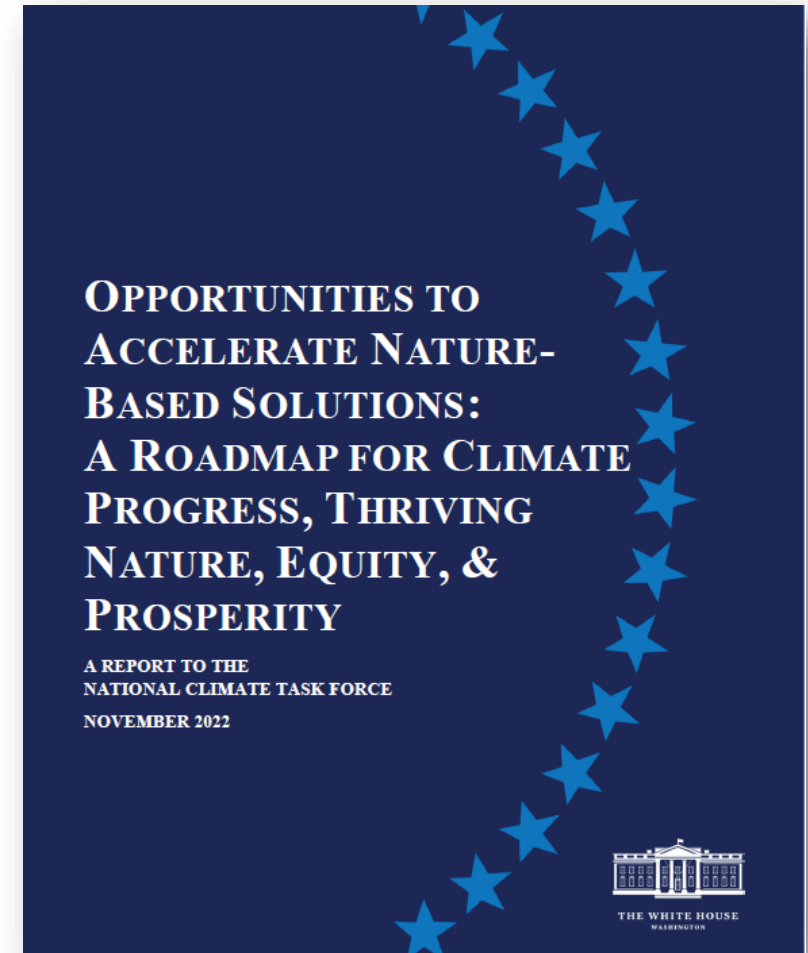
BRIEFING ROOM

Executive Order on Strengthening the Nation's Forests, Communities, and Local Economies

APRIL 22, 2022 • PRESIDENTIAL ACTIONS

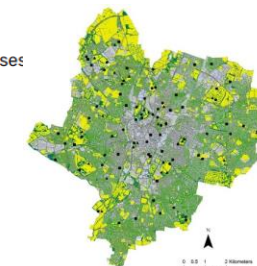
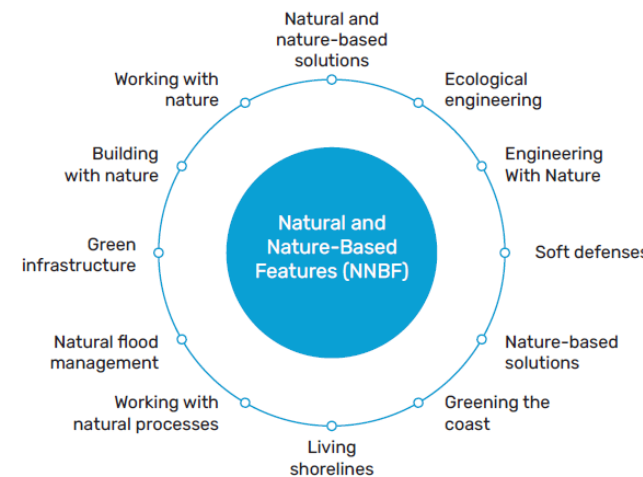
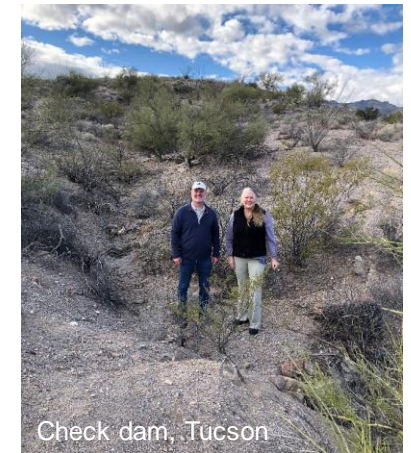
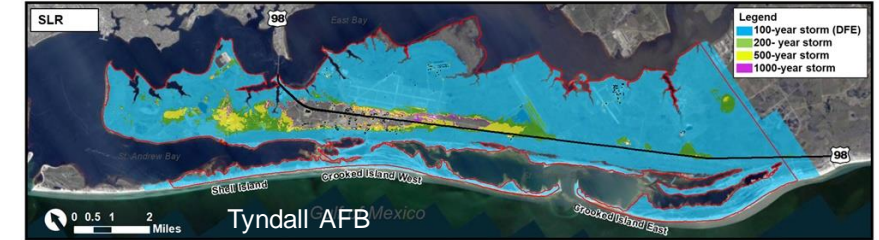
EO 14072, Sec. 4. Deploying Nature-Based Solutions to Tackle Climate Change and Enhance Resilience: *"To further amplify the power of nature, including its ability to absorb climate pollution and increase resilience in all communities, today's Executive Order calls for the following:"*

- 1) **Report on Nature-Based Solutions**
- 2) **Guidance on Valuing Nature**
- 3) **First U.S. National Nature Assessment**



Nature-Based Solutions: *Conserving, restoring, and engineering nature for the benefit of people and nature*

- **Coastal Storm Risk Management**; e.g., an island-wetland complex that attenuates storm surge and waves.
- **Inland Flood Risk Management**; e.g., a restored inland floodplain that provides space for high flows.
- **Surface Heat Reduction**; e.g., creation of green space, forest restoration.
- **Drought and Wildfire Resilience**; e.g., restored native vegetation + grazing + 'slow-water' interventions + ecological forest management.
- **Water Resilience**; a constructed freshwater wetland that absorbs excess nutrients and recharges depleted groundwater aquifers.
- **Climate Change Mitigation**; e.g., restored native grasslands / plant communities that sequester carbon in soils.

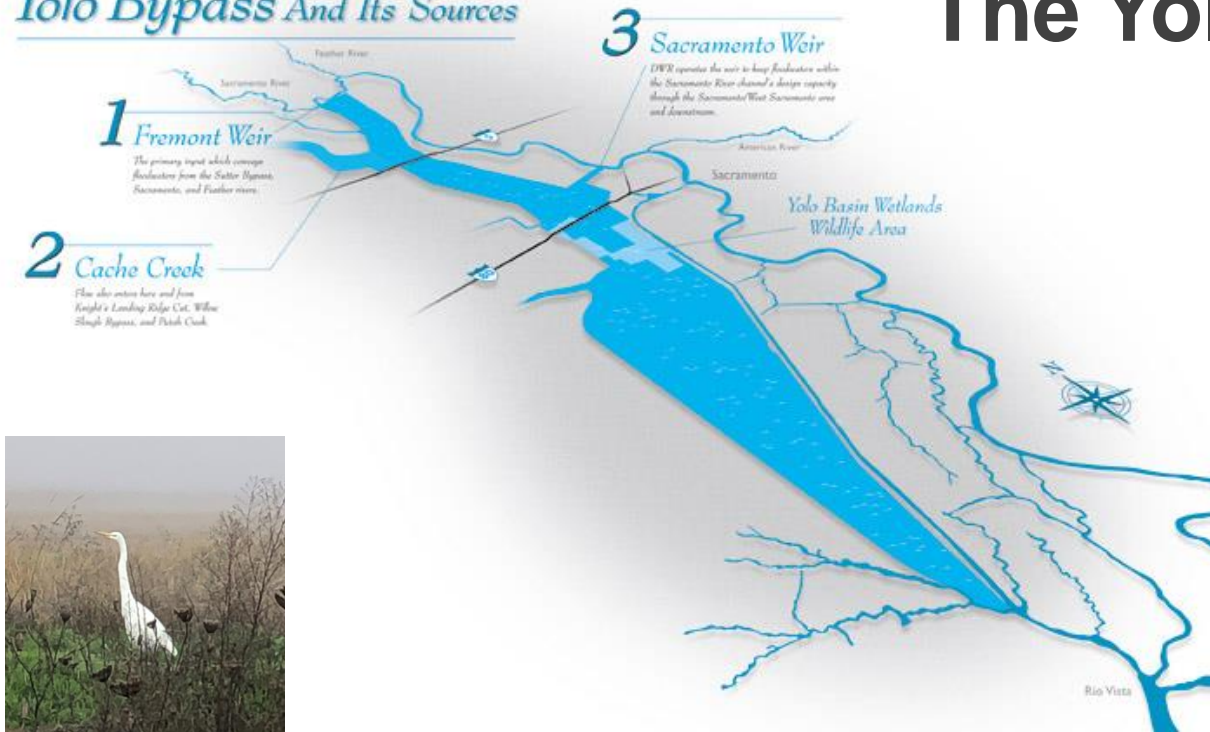


Soil surface temperatures reveal moderation of the urban heat island effect by trees and shrubs

J. L. Edmondson, J. Scott, Z. G. Davies, K. J. Gaston & J. R. Leake
Scientific Reports 6, Article number: 33708 (2016) | Download Citation &
1398 Accesses | 20 Citations | 17 Altmetrics | Metrics 39

The Yolo Bypass, California (1911)

Yolo Bypass And Its Sources



Yolo Bypass Wildlife Area



Sacramento Weir



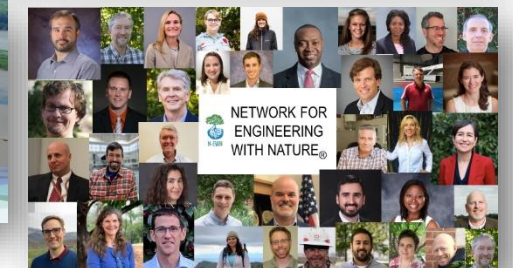
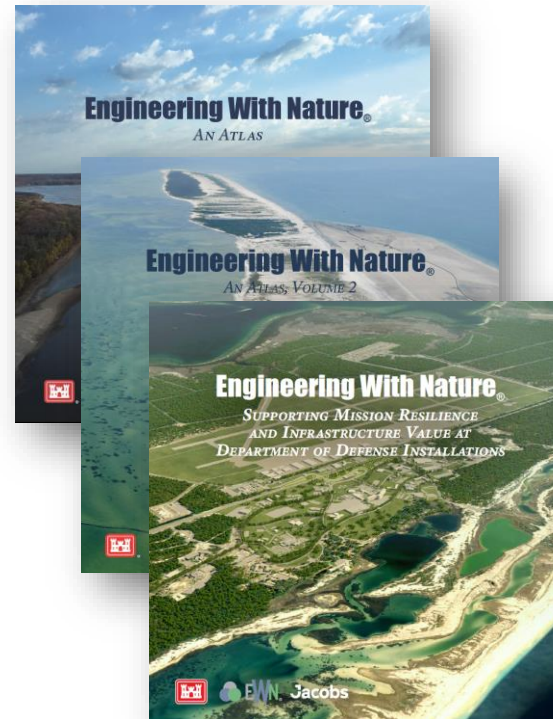
Yolo Bypass, 2017

Engineering With Nature®

...the intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environmental and social benefits through collaboration.

Key Elements:

- Science and engineering that produces operational efficiencies
- Using natural process to maximum benefit
- Increase and diversify infrastructure value
- Science-based collaboration to organize and focus interests, stakeholders, and partners



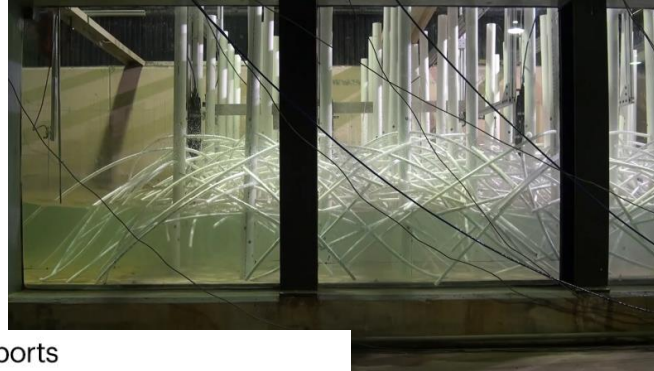
“We absolutely want to do more engineering with nature everywhere we work across the Corps, you have my commitment.”

— LTG Scott A. Spellmon, 55th Chief of Engineers, to the House Committee on Transportation & Infrastructure, Water Resources & Environment Subcommittee (24 June 2021)

US Army Corps of Engineers • Engineer Research and Development Center

The Science of Nature-Based Solutions: *Using Multiple Lines-of-Evidence*

- Physical Modeling
- Numerical Modeling
- Natural Analogs
- Scaled Demonstration
- Experience
 - Project Monitoring
 - Traditional Ecological Knowledge
 - Engineering Judgment



scientific reports

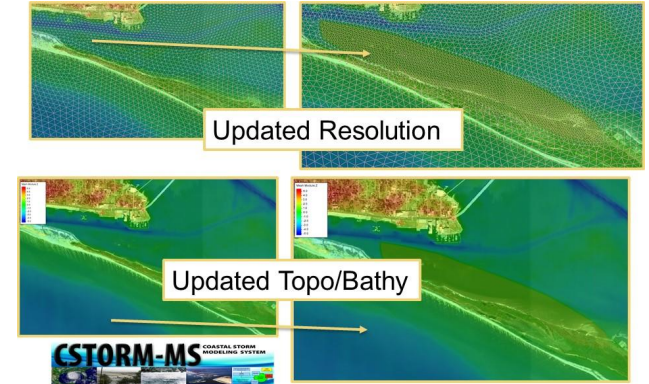
OPEN Resistance, resilience, and recovery of salt marshes in the Florida Panhandle following Hurricane Michael

Katherine A. Castagno^{1,2,*}, Tori Tomczek³, Christine C. Shepard⁴, Michael W. Beck⁵, Allison A. Bowden⁶, Kiera O'Donnell⁷ & Steven B. Scyphers¹

Characterizing the fragility, resistance, and resilience of marshes is critical for understanding their role in reducing storm damages and for helping to manage the recovery of these natural defenses. This study uses high-resolution aerial imagery to quantify the impacts of Hurricane Michael, a category 5 hurricane, on coastal salt marshes in the Florida Panhandle, USA. Marsh damage was classified into several categories, including deposition of sediment or wrack, fallen trees, vegetation loss, and conversion to open water. The marshes were highly resistant to storm damages even under extreme conditions; only 2% of the 173,259 km² of marshes in the study area were damaged—failure rate much lower than that of artificial defenses. Marshes may be more resistant than resilient to storm impacts; damaged marshes were slow to recover, and only 10% of damaged marshes had recovered 6 months after landfall. Marsh management mattered for resistance and resilience; marshes on publicly-managed lands were less likely to be damaged and more likely to recover quickly from storm impacts than marshes on private land, emphasizing the need to incentivize marsh management on



EWN Toolkit in CSTORM



Huamantanga, Peru. People use and maintain 1,400-year-old amunas, canals. Credit: Diego Pérez/Forest Trends

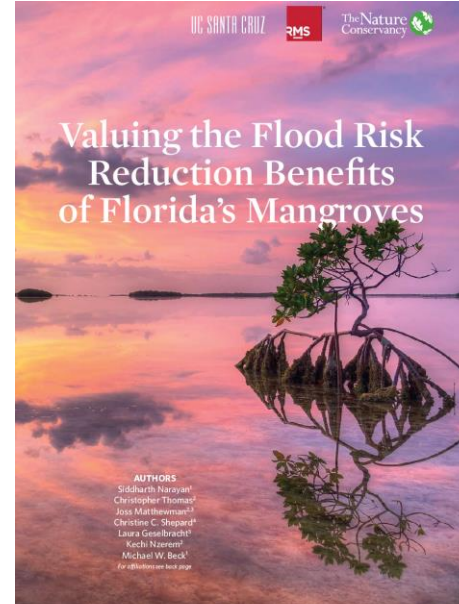
400 publications in the NBS library @ https://ewn.erd.c.dren.mil/?page_id=368

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Leveraging Nature for Engineering Value: *Mangroves*

Florida Mangroves Study:

- Used an insurance industry catastrophe model to quantify the flood reduction benefits of mangroves across Florida
- During Hurricane Irma:
 - Mangroves averted \$1.5 billion dollars in flood damages to properties
 - 25% savings in counties with mangroves
 - >600,000 people living behind mangrove forests saw reduced flooding across Florida



Menendez et al., 2020. *The Global Flood Protection Benefits of Mangroves*.
<https://www.nature.com/articles/s41598-020-61136-6>

The Engineering Value of Mangroves

“In summary, this work presents a case study in which standardized damage assessments were performed for 262 coastal structures and 332 shorelines in Key West and Big Pine Key, Florida, after Hurricane Irma.”

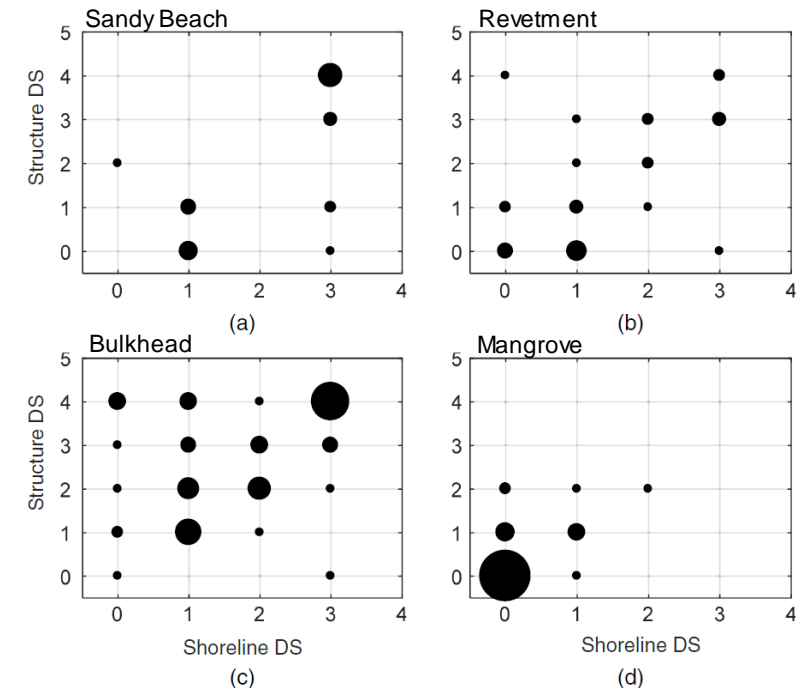
“Specifically, structures located behind mangrove shorelines were observed to experience lower damage states for higher hindcast values of the wave-crest elevation above the lowest horizontal structural member.”

“Therefore, shorelines should be designed with a holistic approach that can incorporate engineered shoreline protection that complements and builds upon the benefits of natural infrastructure.

Rapid Damage Assessments of Shorelines and Structures in the Florida Keys after Hurricane Irma **ASCE**

Tori Tomiczek, M.ASCE¹; Kiera O'Donnell²; Kelsi Furman³; Brittany Webbmartin⁴; and Steven Scyphers⁵

Nat. Hazards Rev., 2020, 21(1): 05019006



Fort Pierce City Marina, Florida



Katwijk Dune and Parking Garage, Netherlands



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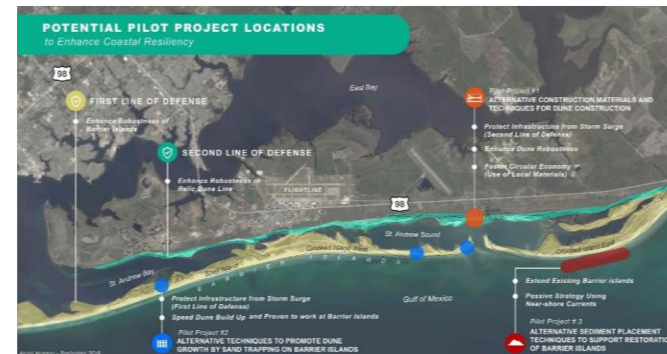
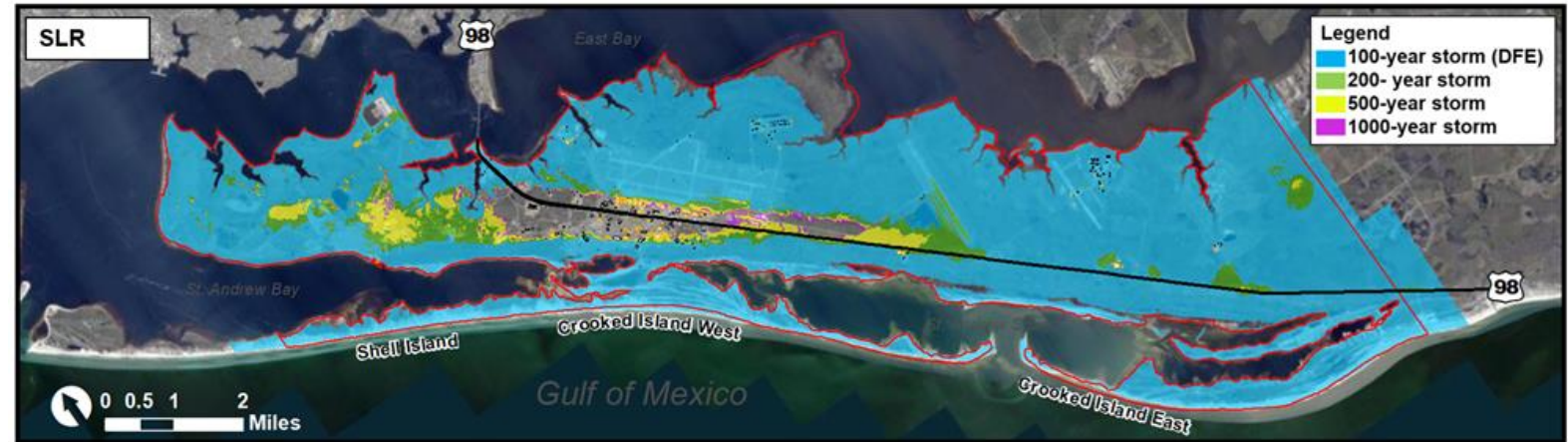
The Belgian SigmaPlan



EWN[®] Applied to Tyndall Air Force Base for Coastal Resilience

"By exploring a diverse menu of nature-based solutions we are in a better position to sustain, restore, and modernize natural infrastructure, ensuring the capability of Air Force lands to support the mission of the installation."

- Lieutenant Colonel Brandy Smart, Commander of the 325th Civil Engineer Squadron



[Tyndallcoastalresilience.com](https://tyndallcoastalresilience.com)

Winner of 2021

UK Environment Agency Flood & Coast
International Excellence Award

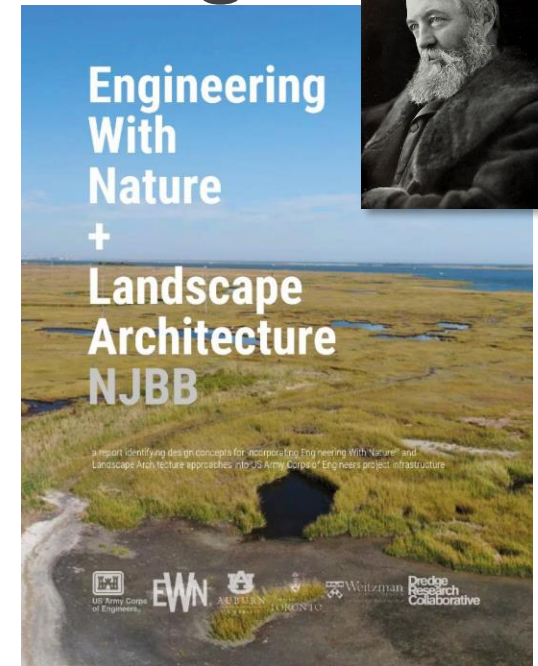
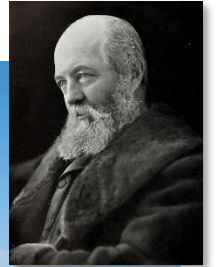


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Create Space and Partnerships for Innovating

Seven Mile Island Innovation Laboratory

- Collaboration and partnership that is building first-of-their-kind NBS projects in coastal New Jersey
 - Began in conversation
 - Accelerated by a storm (Sandy)
 - Progressed through piloting
 - Now in full-scale implementation



US Army Corps
of Engineers®



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Prepare Yourself and Your Project for the Principles, Requirements, and Guidelines

“Project delivery teams (PDTs) must identify and analyze benefits in total and equally across a full array of benefit categories.” RD James, ASA(CW); Comprehensive Benefits Memo, JAN 5, 2021

“We urge your immediate action... In the Water Resources Development Act of 2020, Congress directed the Corps to issue final agency procedures necessary to implement the new Principles, Requirements, and Guidelines (PR&G).” Cong. DeFazio, Napolitano, Garcia, FEB 10, 2022

“In this proposed regulation, the Corps intends to increase consistency and compatibility in Federal water resources investment decision making to include considerations such as **analyzing a broader range of long-term costs and benefits**, enhancing collaboration, including a more thorough and transparent risk and uncertainty analyses, and improving resilience for dealing with emerging challenges, including climate change.” OIRA-OMB, JUN 2022

<https://www.reginfo.gov/public/do/eAgendaViewRule?pubId=202110&RIN=0710-AB41>

PR&G Guiding Principles

1. Healthy and Resilient Ecosystems
2. Sustainable Economic Development
3. Floodplains
4. Public Safety
5. Environmental Justice
6. Watershed Approach

Evaluate Comprehensive Nature Benefits

Policy Research: Current federal alternative evaluation process does not comprehensively value economic, environmental, and social benefits. These constraints screen out or exclude Nature-Based Solutions (NBS) and could lead to outcomes inconsistent with the Administration's priorities around community resilience and equity.

Approach:

- **Summarize** historical and current alternative evaluation policies and practices
- **Identify** 6 historical planning studies that considered NBS alternatives suitable for case study analysis
 1. Jacksonville Harbor (NAV, South East)
 2. Jamaica Bay Reformulation (CSRM, North East)
 3. Southwest Coastal (CSRM, Gulf Coast)
 4. South Platte River and Tributaries (FRM, North West)
 5. West Sacramento (FRM, Pacific)
 6. South San Francisco Bay Shoreline (FRM, Pacific)
- **Review** updated valuation methods and planning frameworks that incorporate environmental and social benefits
- **Analyze** case studies using updated methods and exploratory analysis to look beyond current policy constraints

National Summit: Measuring What Matters
November 30, 2022; Washington D.C.



"It matters because it matters to the President."

"Our sponsors no longer want to see 'off the shelf' solutions."

"We can't value everything, but we need to value what we can."

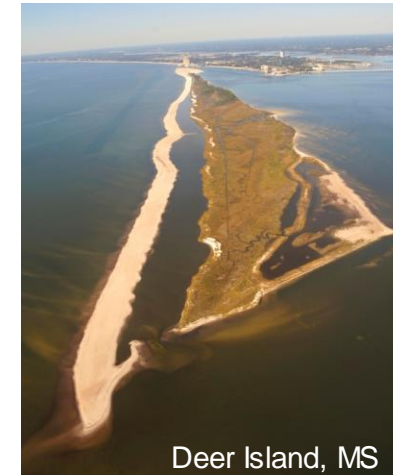
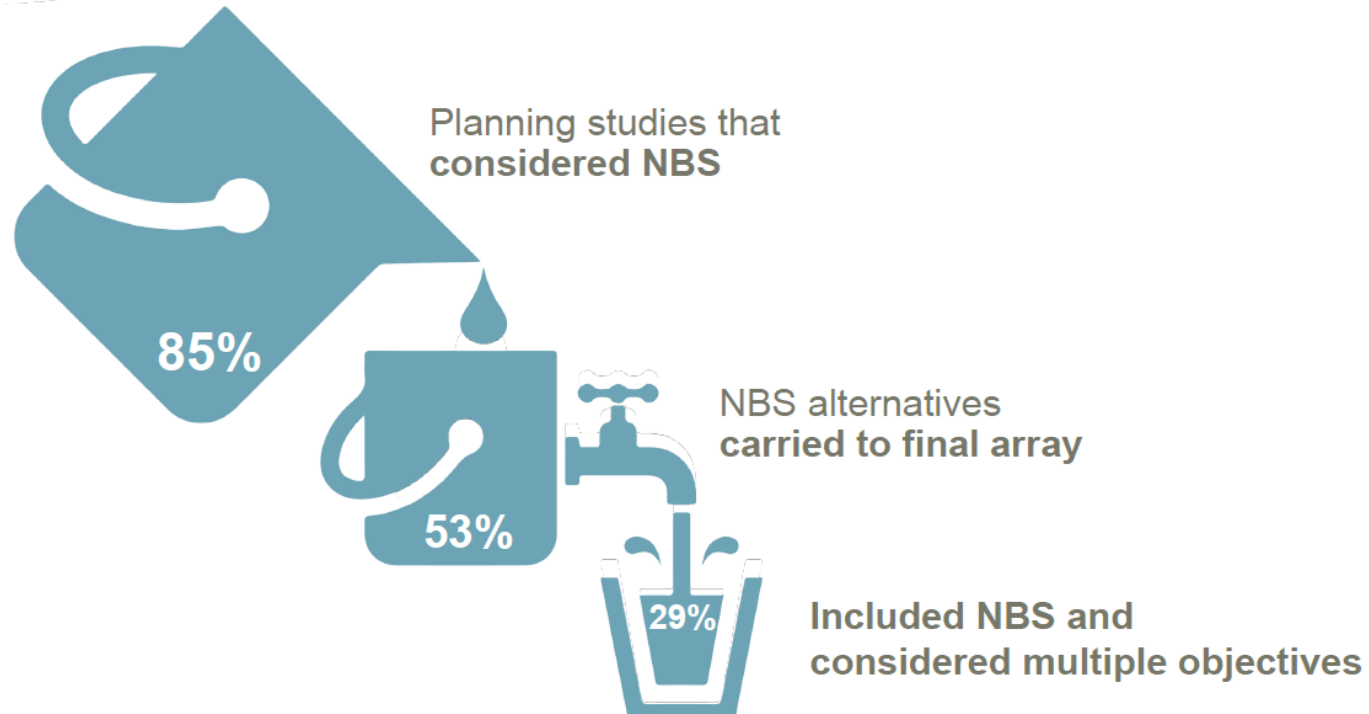
Michael L. Connor, ASA(CW)

Evaluate Comprehensive Nature Benefits



FINDING

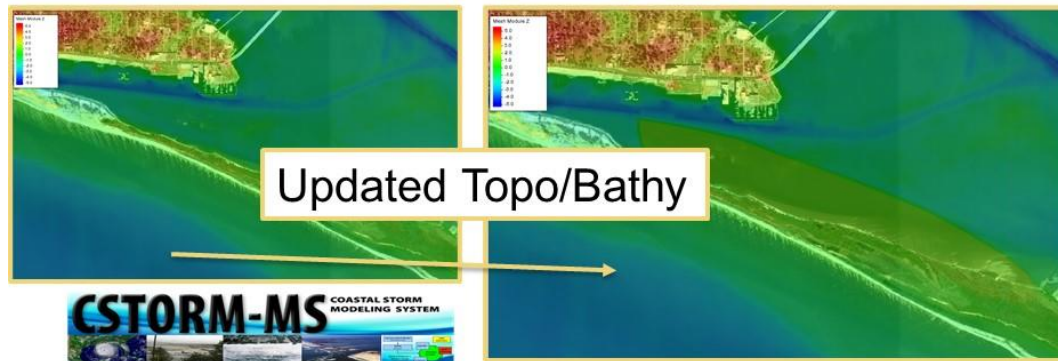
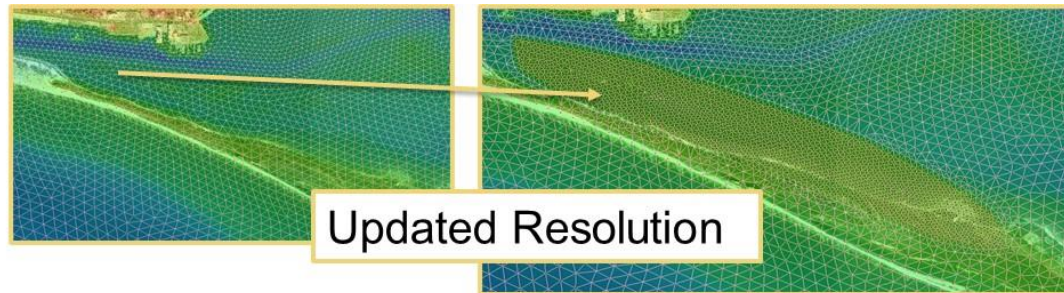
SCOPING WITHIN SEPARATE MISSION AREAS LIMITS NBS OPPORTUNITIES



Advancing Technical Tools

Numerical and Physical Modeling

EWN Toolkit for CSTORM

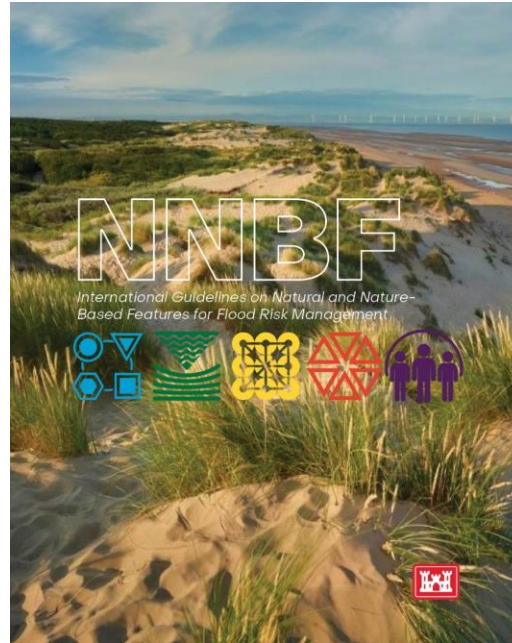


Develop Guidance: *International Guidelines on Natural and Nature-Based Features for Flood Risk Management*

NNBF Guidelines Table of Contents

- Chapter 1. Introduction
- Chapter 2. Principles, Frameworks, and Outcomes
- Chapter 3. Community Engagement
- Chapter 4. Systems Approach
- Chapter 5. Performance
- Chapter 6. Benefits and Costs of NNBF
- Chapter 7. Adaptive Management
- Chapter 8. Introduction to Coastal Systems
- Chapter 9. Beaches and Dunes
- Chapter 10. Coastal Wetlands and Intertidal Areas
- Chapter 11. Islands
- Chapter 12. Reefs
- Chapter 13. Plant Systems
- Chapter 14. Environmental Enhancements
- Chapter 15. Introduction to Fluvial Systems
- Chapter 16. Fluvial Systems and Flood Risk Management
- Chapter 17. Benefits and Challenges of NNBF in Fluvial Systems
- Chapter 18. Fluvial NNBF
- Chapter 19. Fluvial NNBF Case Studies
- Chapter 20. The Way Forward

Winner, Environment Agency Flood & Coast International Excellence Award, 2022



https://ewn.erd.c.dren.mil/?page_id=4351

NNBF Guidelines

- >1,000 pages, 5-year effort
- >70 multi-sector organizations
- >170 authors and contributors

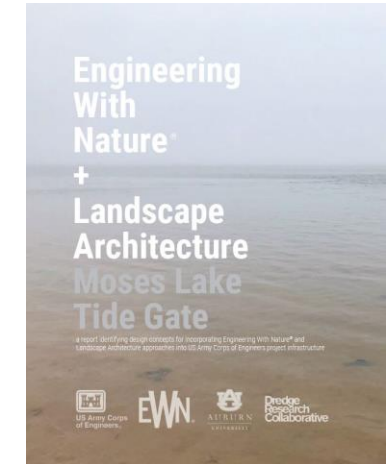


www.engineeringwithnature.org



“The guidelines do not contain or represent the policy commitments or policy positions of the organizations that participated in their development. Policy development is the sole purview of each organization and the laws and procedures that govern their activities.” Pages xi-xii.

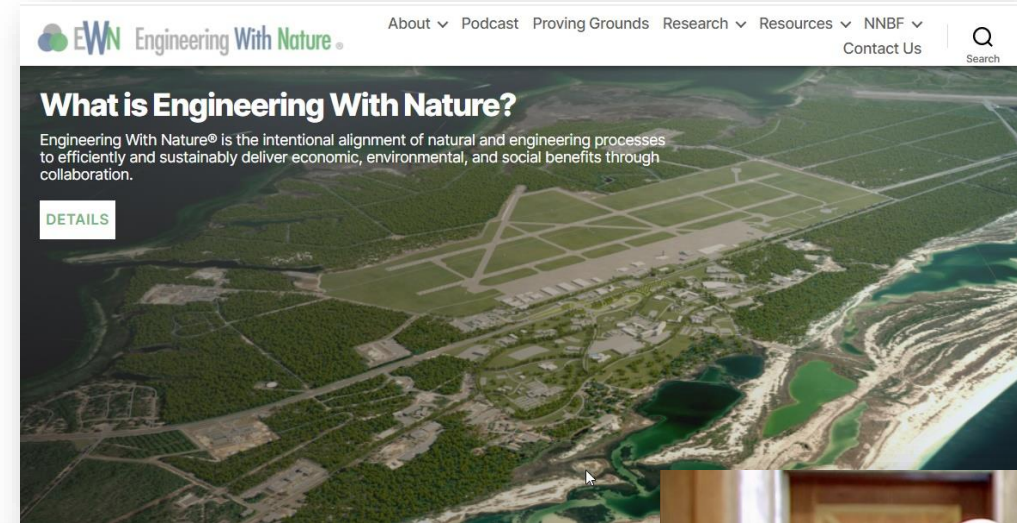
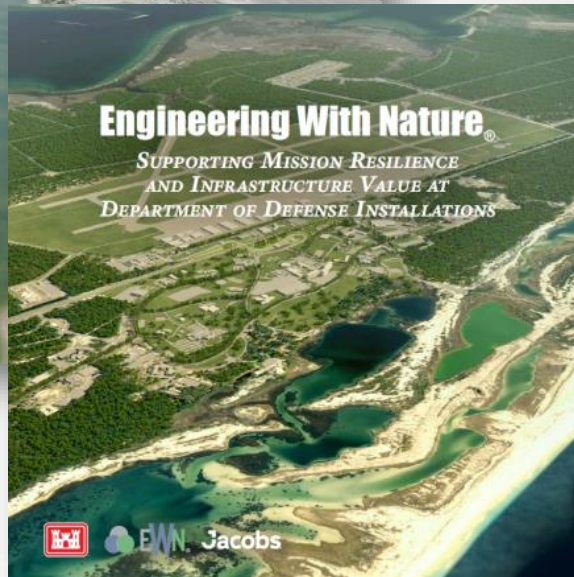
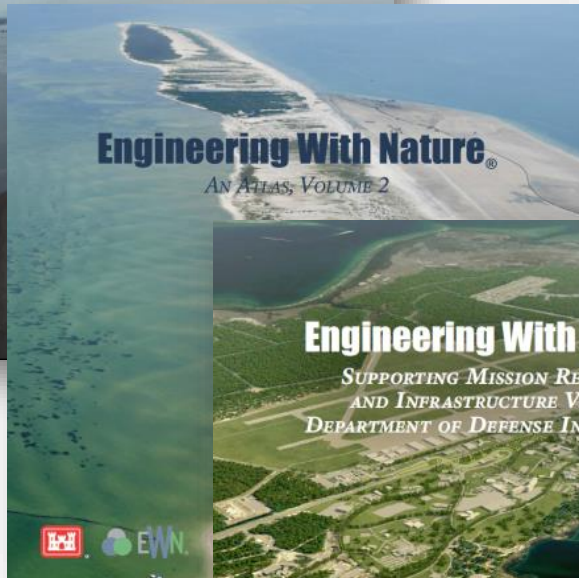
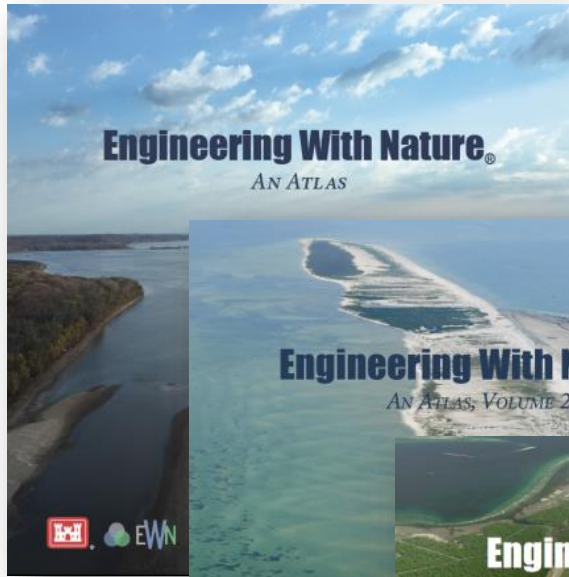
Design with 'Nature-First Thinking'



https://ewn.erd.c.dren.mil/?page_id=81

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Spark Conversation, Thinking, and New Ideas



<https://ewn.erd.cren.mil/?p=3586>



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Restoring Balance for Comprehensive Resilience

U.S. NEWS

Ian was one of the most lethal hurricanes in decades. Many of the deaths were preventable.



People

Water

**Nature-Based
Solutions**

Carbon

Biodiversity

Endangered status sought for manatees as hundreds starve

By CURT ANDERSON November 21, 2022



Here, there, everywhere: Red tide plagues SWFL after Hurricane Ian

WGPU | By Tom Bayles

Published November 22, 2022 at 6:17 AM EST

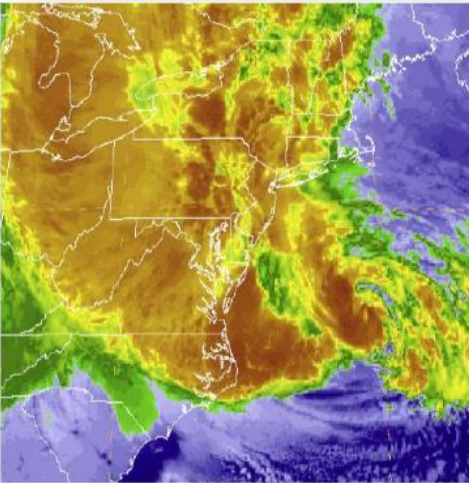


Supplementary Content

Leveraging Nature for Engineering Value: *Wetlands*

Wetland Value During Hurricane Sandy:

- Risk industry tools used to quantify the economic benefits of coastal wetlands
 - Temperate coastal wetlands averted more than \$625 million in flood damages.
 - In Ocean County, New Jersey, salt marsh conservation can significantly reduce average annual flood losses by more than 20%.



COASTAL WETLANDS AND FLOOD DAMAGE REDUCTION

Using Risk Industry-based Models
to Assess Natural Defenses in the Northeastern USA

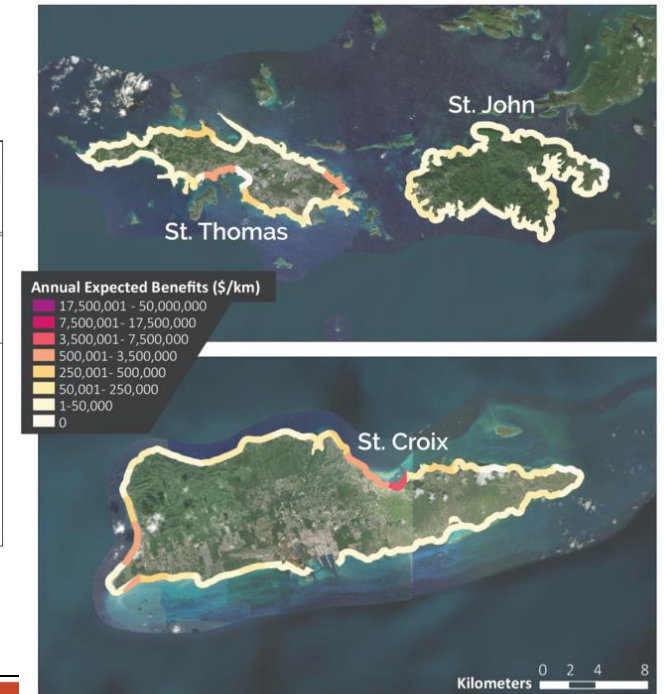
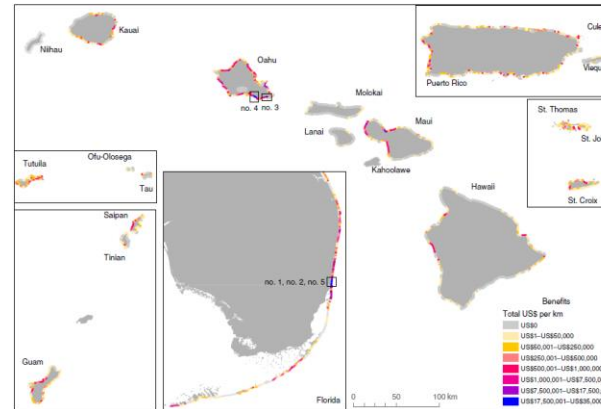
October 2016



Leveraging Nature for Engineering Value: *Coral Reefs*

Coral Reefs and Flood Risk Reduction Value:

- Coral reefs line >3,100 km of US and US Trust Territory shorelines
 - Provide >\$1.8B in annual flood risk reduction benefits
 - Highly developed coastlines in FL and HI receive annual benefits of \$10M per km of coral reef
- Loss of the top-most meter of coral reefs:
 - An additional 50,000 people would experience flooding
 - \$3B in additional damage to structures



The annual expected benefits (\$/km) coral reefs provide in coastal flood reduction.

nature
sustainability

The value of US coral reefs for flood risk reduction

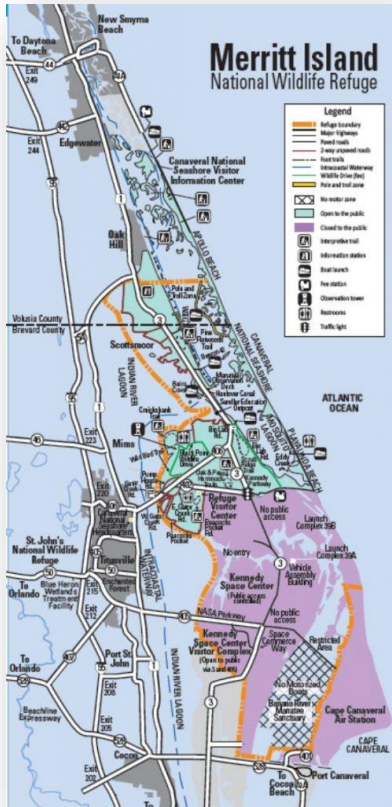
Borja G. Reguero¹, Curt D. Storlazzi², Ann E. Gibbs², James B. Shope¹, Aaron D. Cole³, Kristen A. Cumming² and Michael W. Beck¹

Habitats, such as coral reefs, can mitigate increasing flood damages through coastal protection services. We provide a fine-scale, national valuation of the flood risk reduction benefits of coral habitats to people, property, economies and infrastructure. Across 3,100 km of US coastline, the top-most 1 m of coral reefs prevents the 100-yr flood from growing by 23% (113 km²), avoiding flooding to 53,800 (62%) people, US\$2.7 billion (90%) damage to buildings and US\$2.6 billion (49%) in indirect economic effects. We estimate the hazard risk reduction benefits of US coral reefs to exceed US\$1.8 billion annually. Many highly developed coastlines in Florida and Hawaii receive annual benefits of over US\$10 million km², whereas US reefs critically reduce flooding of vulnerable populations. This quantification of spatial risk reduction can help to prioritize joint actions in flood management and environmental conservation, opening new opportunities to support reef management with hazard mitigation funding.

https://www.usgs.gov/centers/pcrmc/science/value-us-coral-reefs-risk-reduction?qt-science_center_objects=0#qt-science_center_objects

https://www.nature.com/articles/s41893-021-00706-6.epdf?sharing_token=okXPN9-3ruX1jz_oFQdrNRgN0jAjWel9jnR3ZoTv0P34Lz-UrliB_uD-zEph5yVw_5H6pLrLbdyFo9uxURsA1vaOBZYqEISlkmfDYbell1BcoZ0xZ9MDHv4a4G9NQ31nT1-vVMdJuUizvbQuw_5XBAz_76ysNf6gB1qNwKbD-A%3D

The Federal Complex at Merritt Island



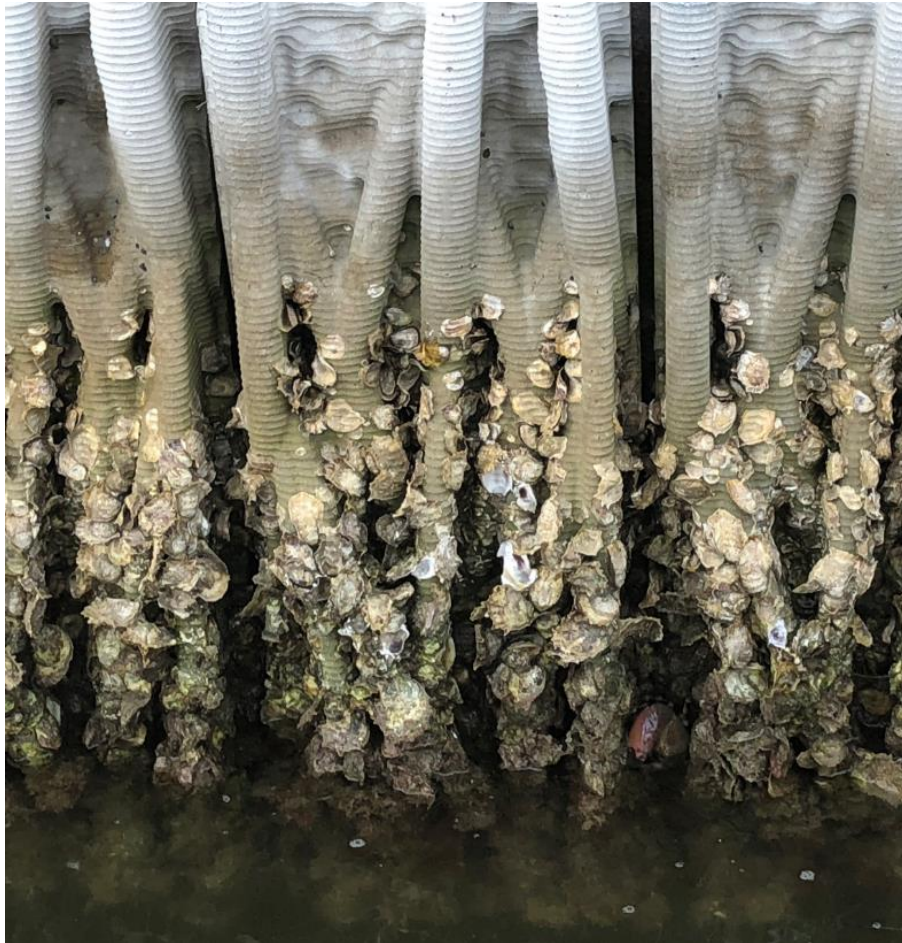
[EWN On the Road: The Dune Protecting Artemis](#)



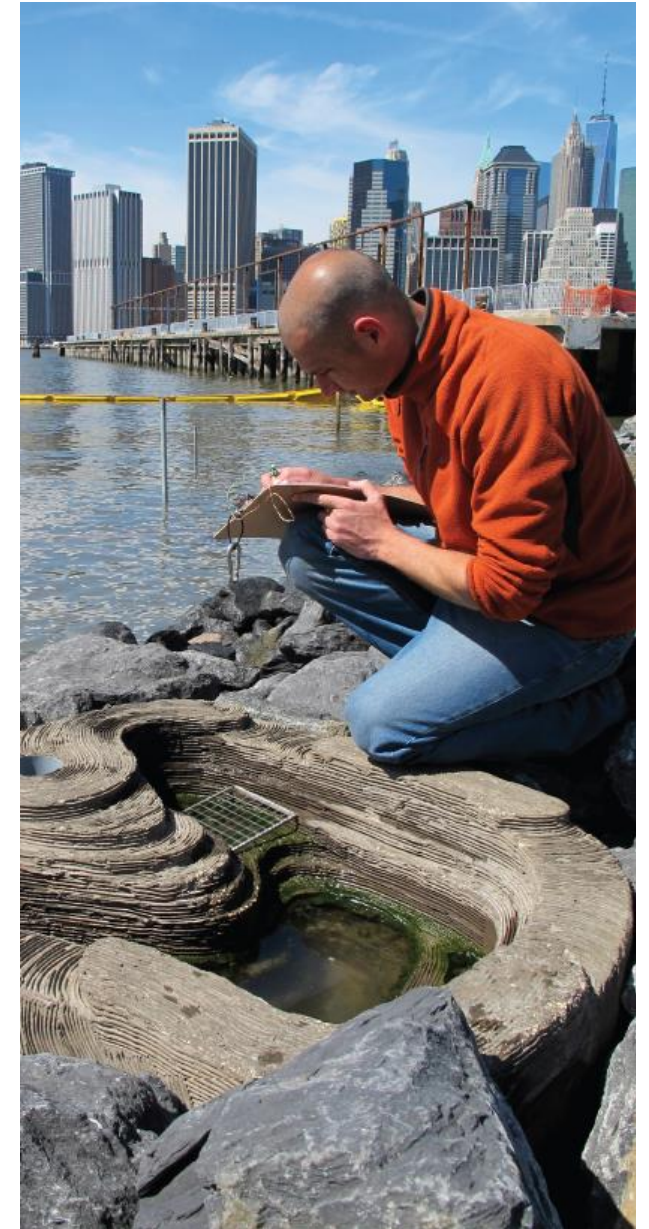
Seattle's New Seawall



Mangrove Reef Walls, Englewood and Fort Pierce, Florida



Brooklyn, NY Tide Pools



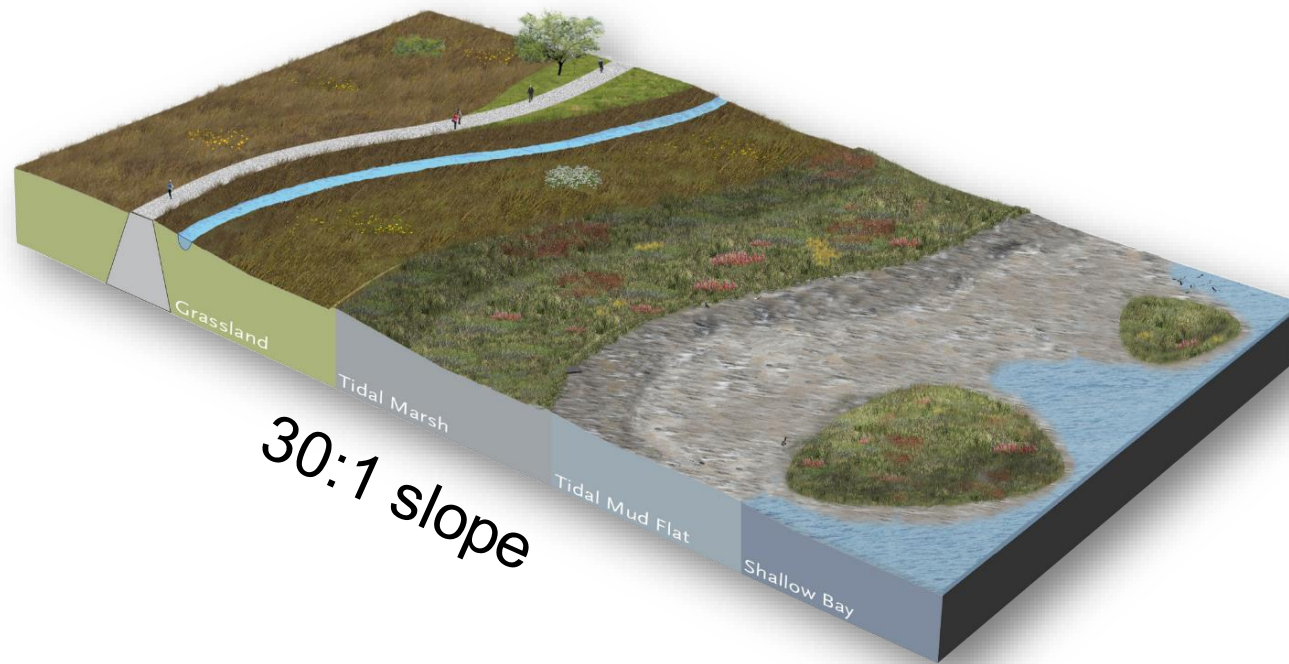
Hunter's Point, New York



Source: Moffatt and Nichol

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Ecotone Levee



South San Francisco Bay Shoreline Project

