Water Partnership with CDM Smith

Miami Forever

Reducing Urban Flooding in the Face of Sea Level Rise

FSA Florida Stormwater Association

2019 Winter Conference

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City of Miami Overview

Incorporated in 1896

Area

- 56 square miles – Overall
- 36 square miles – Land Area

Population

- 471,000 (2nd in Florida/43rd in U.S.)
- 6th most densely populated city in the U.S.

Economy

- Cultural, economic, and financial center of South Florida
- Gross Metropolitan Product of $257 billion (11th in U.S.)

Tourism

- Home of the busiest cruise port in the world
- 15.9 million visitors, adding $26.1 billion to the economy

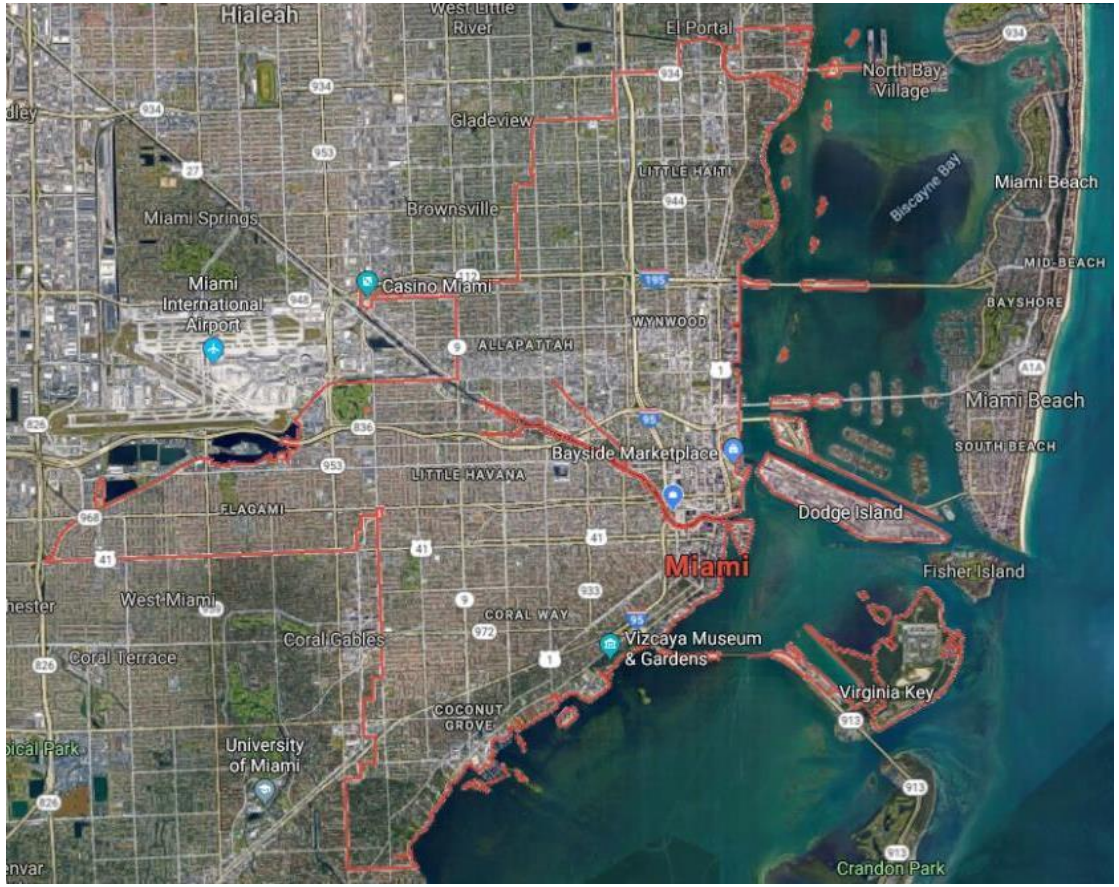
City of Miami Overview *(cont.)*

Climate
- Tropical monsoon climate
- Annual average rainfall of 62 inches

Geography
- Located on a broad plain between the Everglades and Biscayne Bay
- Average elevation is 6 feet above sea level (4.45 feet NAVD)
- Many roadways and high-value properties below 4.45 feet NAVD

Geology
- Situated on porous limestone with Biscayne Aquifer just below

Shoreline
- Seawalls – Bayside 41.85 miles
- Seawalls – Riverside 6 miles
- Natural Shorelines 40.59 miles



Stormwater Management

Existing Stormwater Management System	
Underground Pipe	100.3 Miles
Inlets/Catch Basins	28,152
Outfalls	486 (86 major)
Tidal Backflow Prevention Valves	40 (100 more planned)
Pump Stations	13
Grass Swales	15.5 Miles
Covered Ditches/ Conveyance Swales	43.8 Miles

Stormwater and Tidal Water Management Issues

- Undersized and inadequate infrastructure
- Drainage structures and wells below realized King Tide elevations
- Seawalls below King Tide elevations and in poor condition

Climate Adaptation

Revise Construction Standards and Codes

- Update waterfront and stormwater system design standards
- Revise seawall elevation requirements
- Require additional BMPs on new stormwater installations

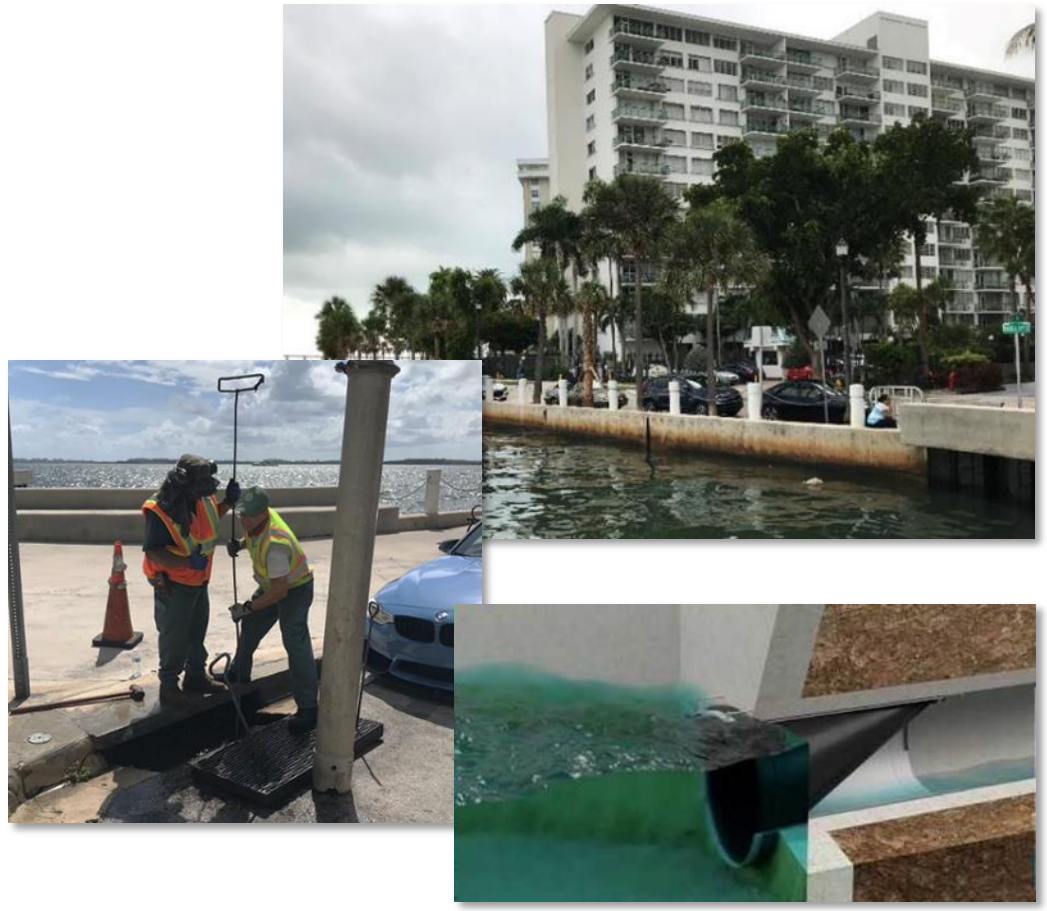
Improve Existing Stormwater Management System

- Add tidal valves to outfalls (40 complete / 100 more planned)
- Increase system cleaning frequency
- Line/replace outfall pipes and pipes connected to pump stations

Improve Water Quality in Miami River and Biscayne Bay

- Increase monitoring and enforcement of illicit discharges
- Increase frequency and coverage of street sweeping program
- Add inlet screens and pollution retardant baffles where appropriate

Implement Stormwater Master Plan Recommendations



City of Miami Stormwater Master Plan Mission

- Flood protection
- Water quality & environment
- Land use
- Sea level rise
- Storm surge
- Resilient coastal features
- Saltwater intrusion
- Changes in groundwater levels
- Protection of Biscayne Bay
- Current and future regulations

Allowing the City to establish a **policy framework** with **public support protecting** and **enhancing** the City's future over time.

SWMP Vision and Metrics for Success

- Flood Control
- Water Quality Protection
- Aquifer Recharge and Water Supply
- Conservation and Harvesting
- Operation and Maintenance
- Long Term Financing
- Community Acceptance

Level of Service (LOS)

Adaptability, Resiliency, & Sustainability

THE CITY OF MIAMI FLORIDA INCORPORATED 1896

MIAMI FOREVER
GENERAL OBLIGATION BOND

Miami Stormwater Management Issues and Constraints

- Sensitive and protected receiving water Biscayne Bay
- Low and relatively flat terrain
- High groundwater table
- Near build-out development high impervious area
- Saltwater intrusion
- Increasing high tides and backflow with rising sea levels and tidal surge
- Need for increased maintenance of existing stormwater system
- Manatee access to stormwater systems

Miami Stormwater Management Opportunities

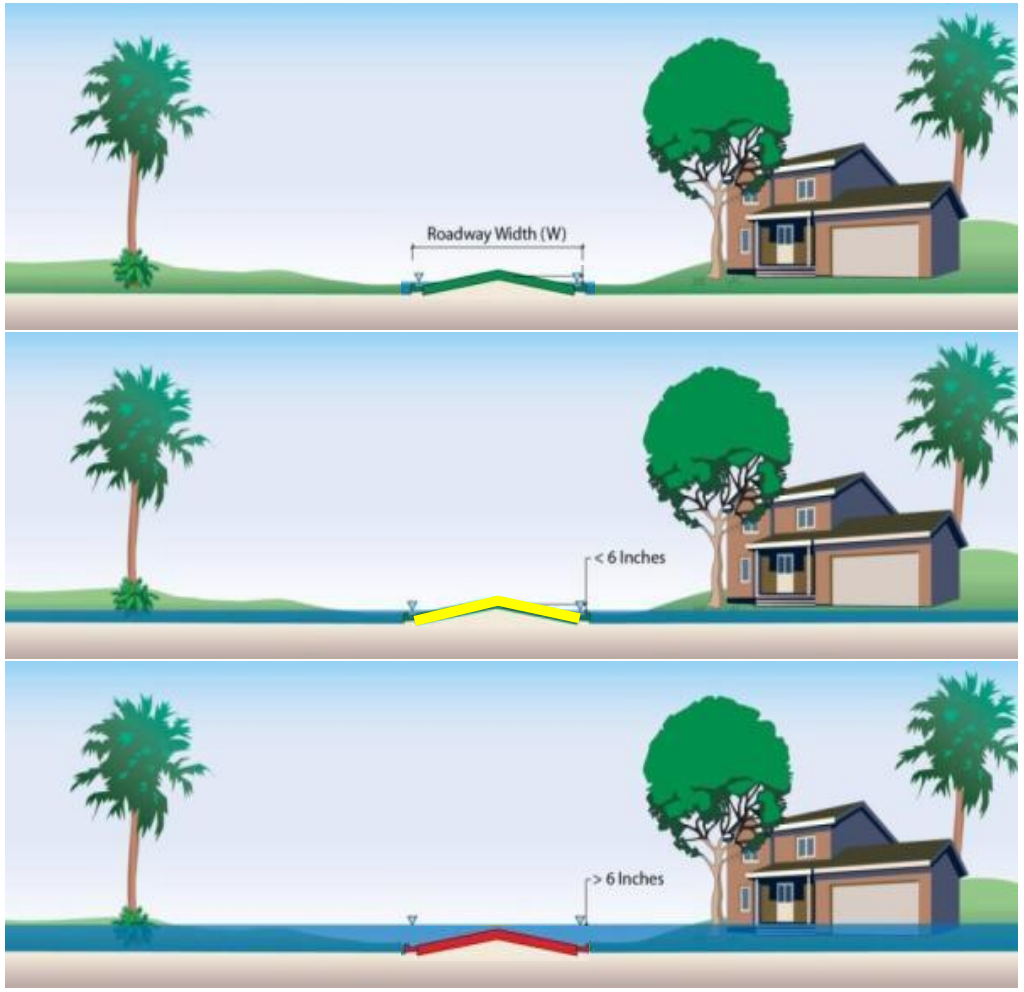
- Coordination of stormwater and coastal resilient infrastructure
- Coordination and collaboration with public and private partnerships
- Green infrastructure opportunities
  - Exfiltration
  - Recharge wells
  - Coordination with landscaping and bioswales
  - Retention and detention
  - Coastal features – grassed levees, sea grasses, mangroves
  - Stormwater harvesting (vaults and tanks, rooftops, sides of buildings)

Overview of the SWMP Process

- Establish comprehensive program goals
- Create a new stormwater asset geodatabase (GIS)
- Flood stage-gauge network plan
- Develop prioritized CIP recommendations for the desired LOS and funding
- Provide guidance with future policies
- Update stormwater design standards for developers and B&Z
- Develop data tools and training of City Staff

Defining Level of Service (LOS) for Flood Control

- Consider standards by FEMA, SFWMD, and FDOT
- Goals for Retrofit:
  - Keep flooding below homes and buildings
  - Keep roads passable for emergency and evacuation traffic
  - Evaluate 10-yr storm level of service
  - If not practicable, reduce depth and duration of flooding



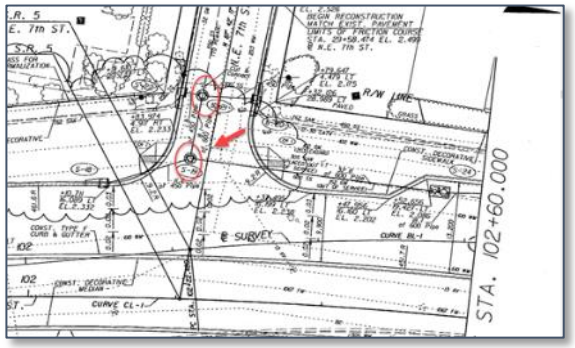
Data Collection and Evaluation Phase

Primary Stormwater System Pipes Inventory

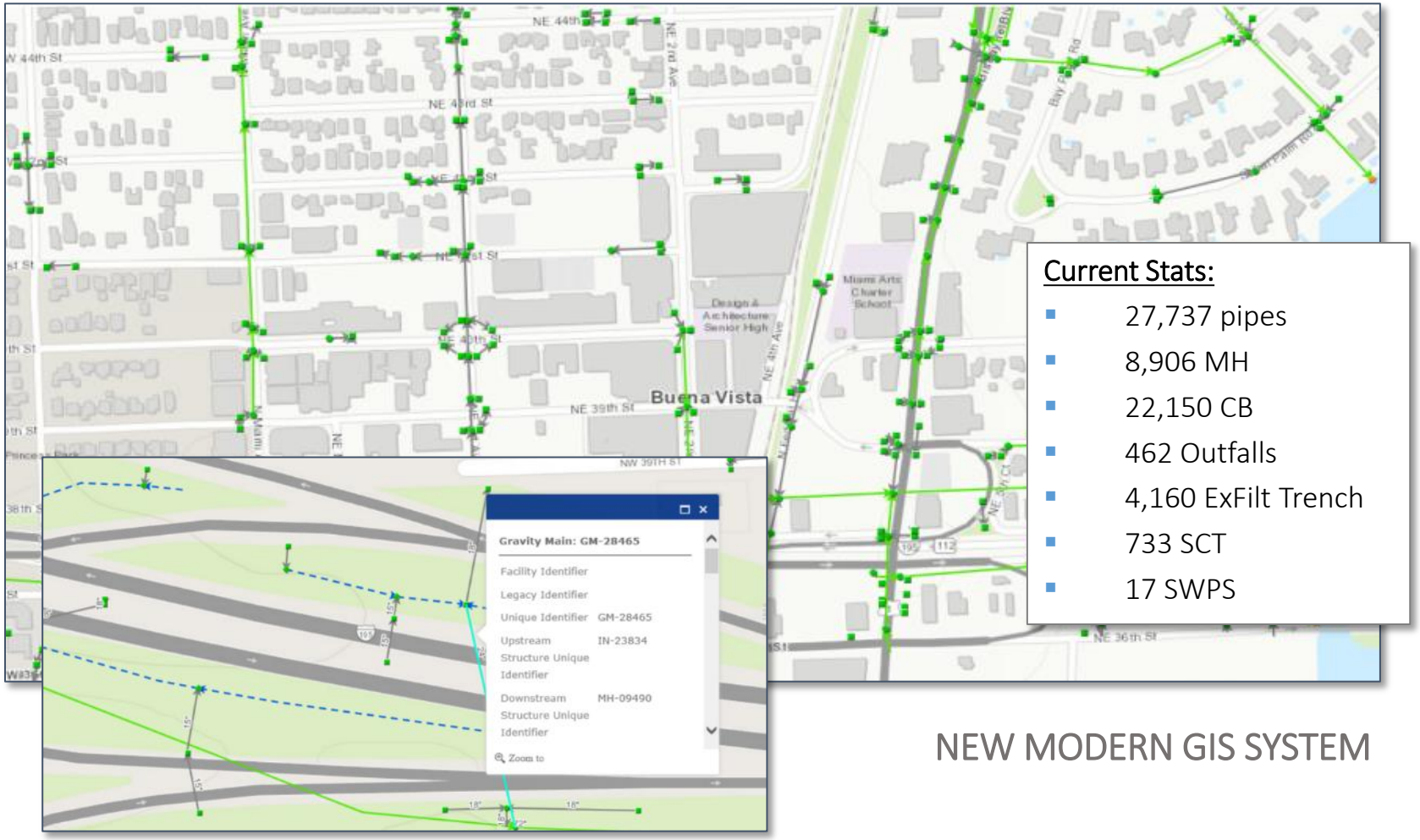
Digitizing of Approximately:

- 33,000 plan sheets of stormwater drainage systems
- 2,500 archived paper plans and documents
- Field survey verification program for:
  - Stormwater structures
  - Critical building finished floor elevations
  - Canal cross sections
  - Seawall Elevations
  - Land topography and evacuation routes
  - 462 outfalls and counting

Creating Digital Maps of Stormwater Assets Modernizing to GIS



CURRENT PAPER PLANS ARCHIVES



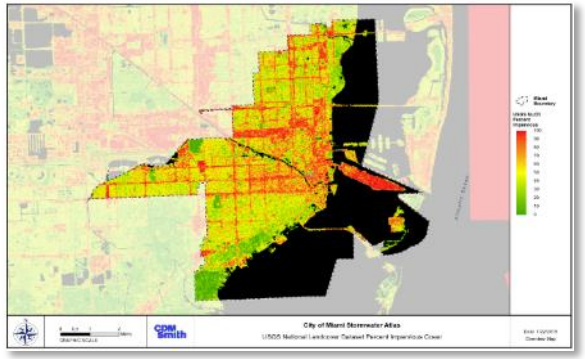
Current Stats:

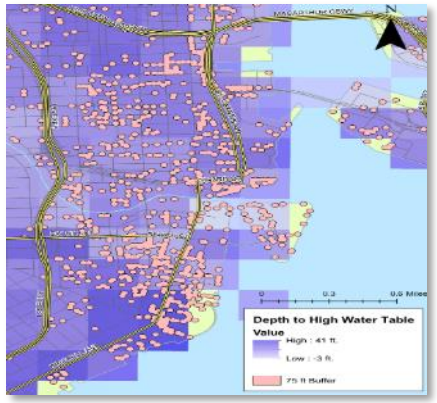
- 27,737 pipes
- 8,906 MH
- 22,150 CB
- 462 Outfalls
- 4,160 ExFilt Trench
- 733 SCT
- 17 SWPS

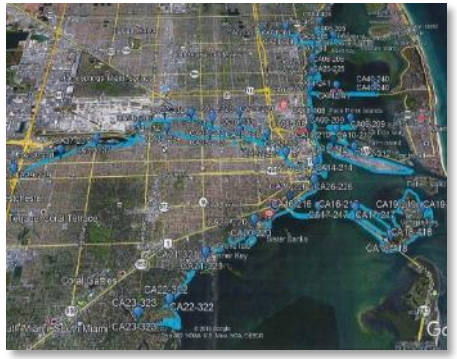
NEW MODERN GIS SYSTEM

Data Development Phase for Stormwater Model

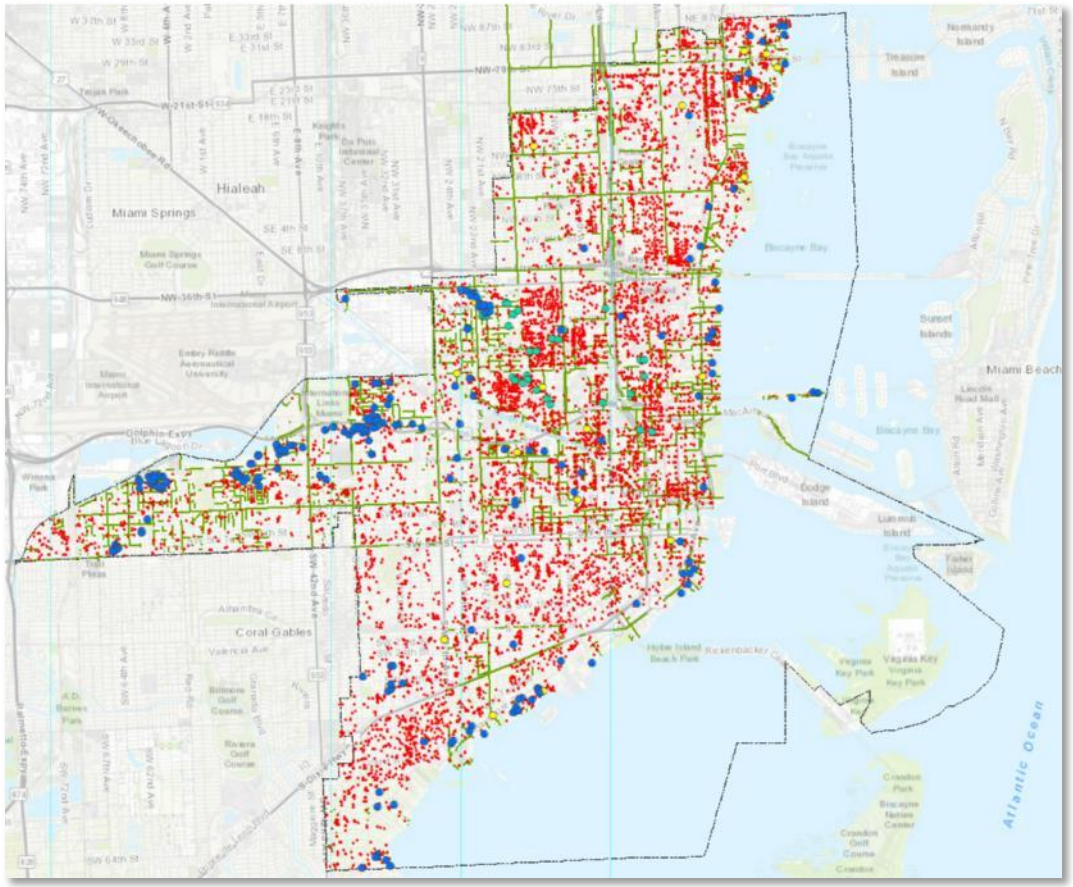
- SFWMD rainfall design storm data
- Impervious area coverages
- Digital LiDAR topography
- Soils and groundwater data
- Canal, pump station, and control gate data and operations
- County models coordination
- Seawall and shoreline data
- FEMA and MDC repetitive loss and flood elevation data
- Critical structure FF elevations

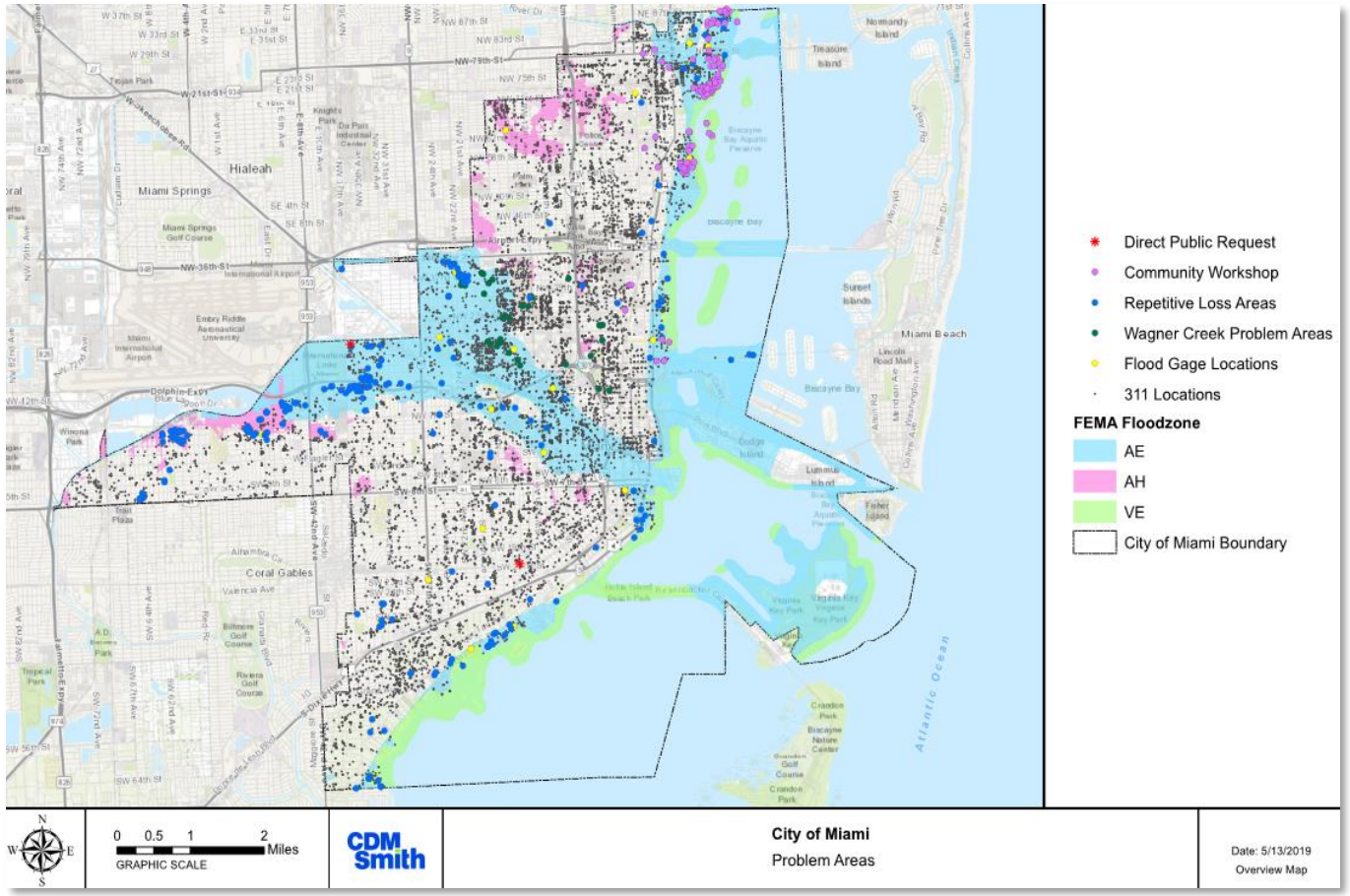






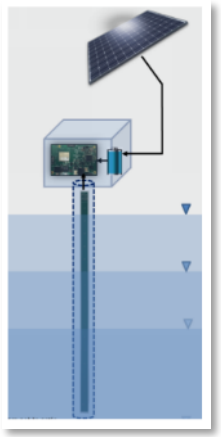
Problem Areas Identification (On-Going)

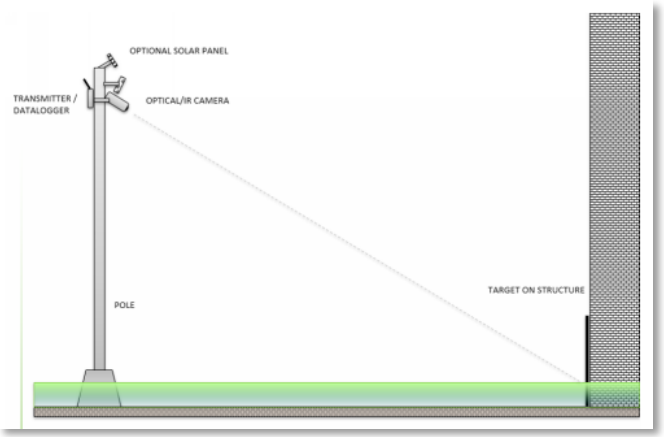


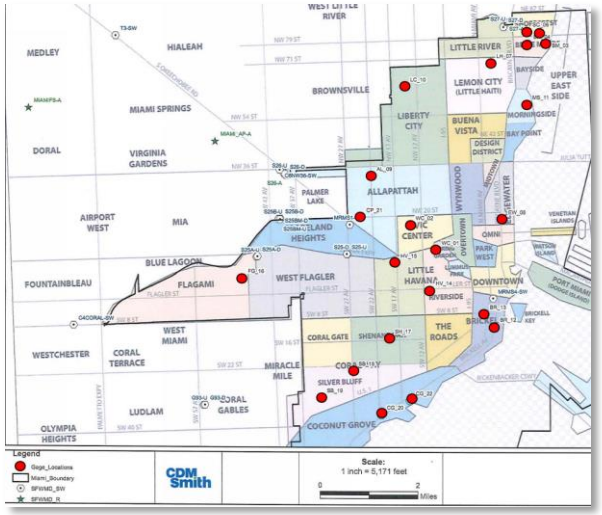


Citywide Flood Stage Gauge Network Pilot Program

- Urban core, dry-land application
- Electroconductive sensor circuit technology
- 22 node system (Pilot of 6)
- Citywide coverage in known flooding areas
- Realtime cloud-based data
- Can link to emergency management

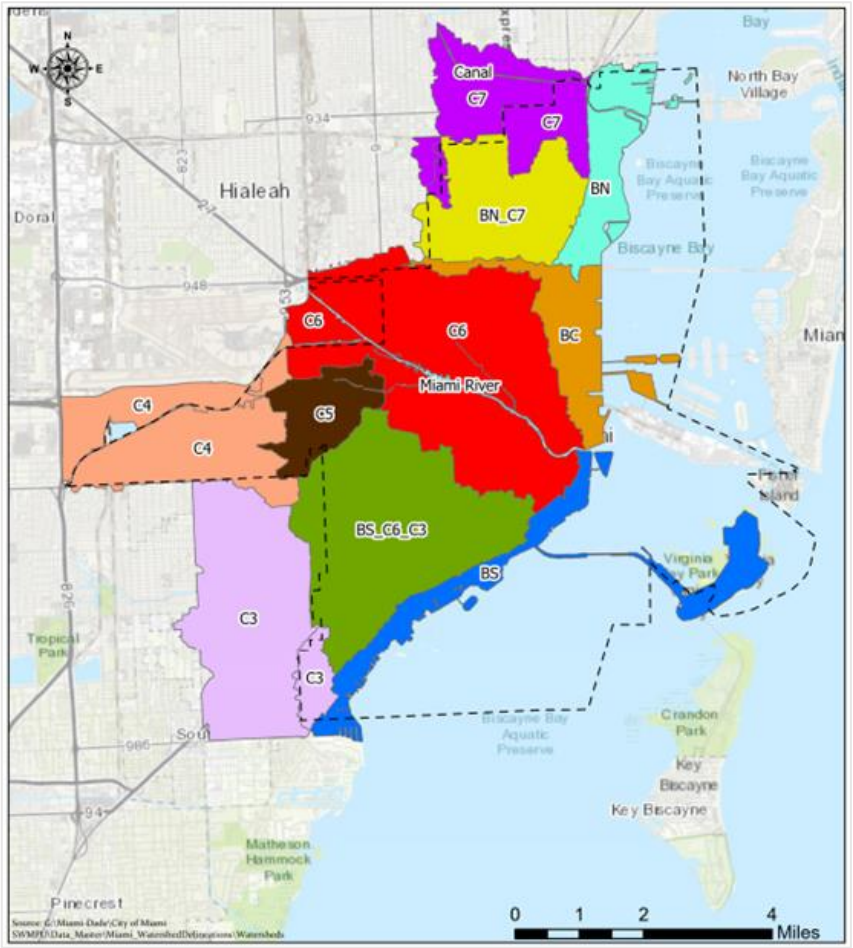






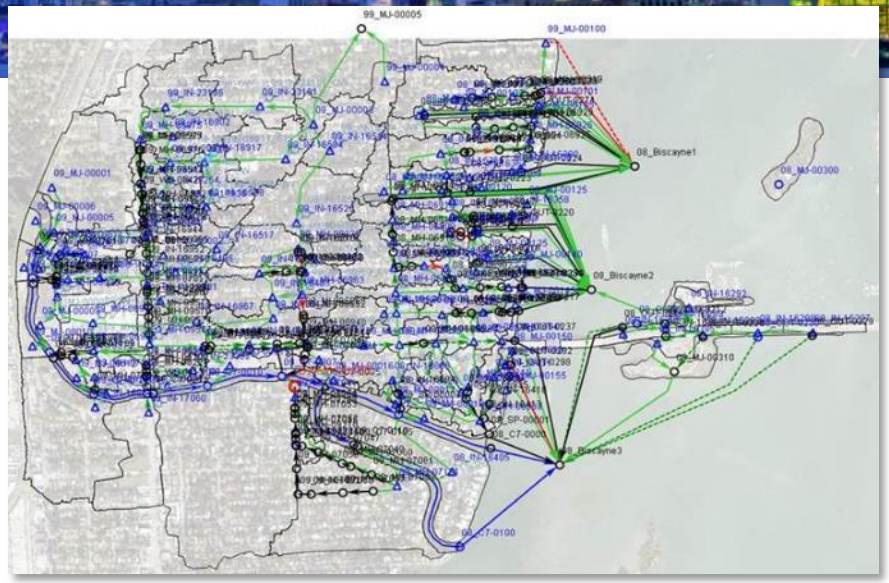
Stormwater Modeling Phase

- XP-SWMM (Dynamic) 1D Model
  - Hydrology and hydraulics
  - 1D overland flow channels and surface flooding
  - Faster run times and facilitates alternatives analyses
  - Consistent with Miami-Dade County models
- 8 watersheds based on PSMS and overland flow
- PSMS (>24”) and SSMS where necessary
- SFWMD Design Storms 5/24, 10/72, 25/72, 100/72
- “Worst case” storm adjusted for climate change



Stormwater Modeling Phase *(cont.)*

- SFWMD, FDOT, and MDC systems considered
- 20 City CIP projects incorporated
- Existing conditions model for LOS
- CIP model for improvements
- Cost benefit analysis using FEMA HAZUS
- Two SLR scenarios

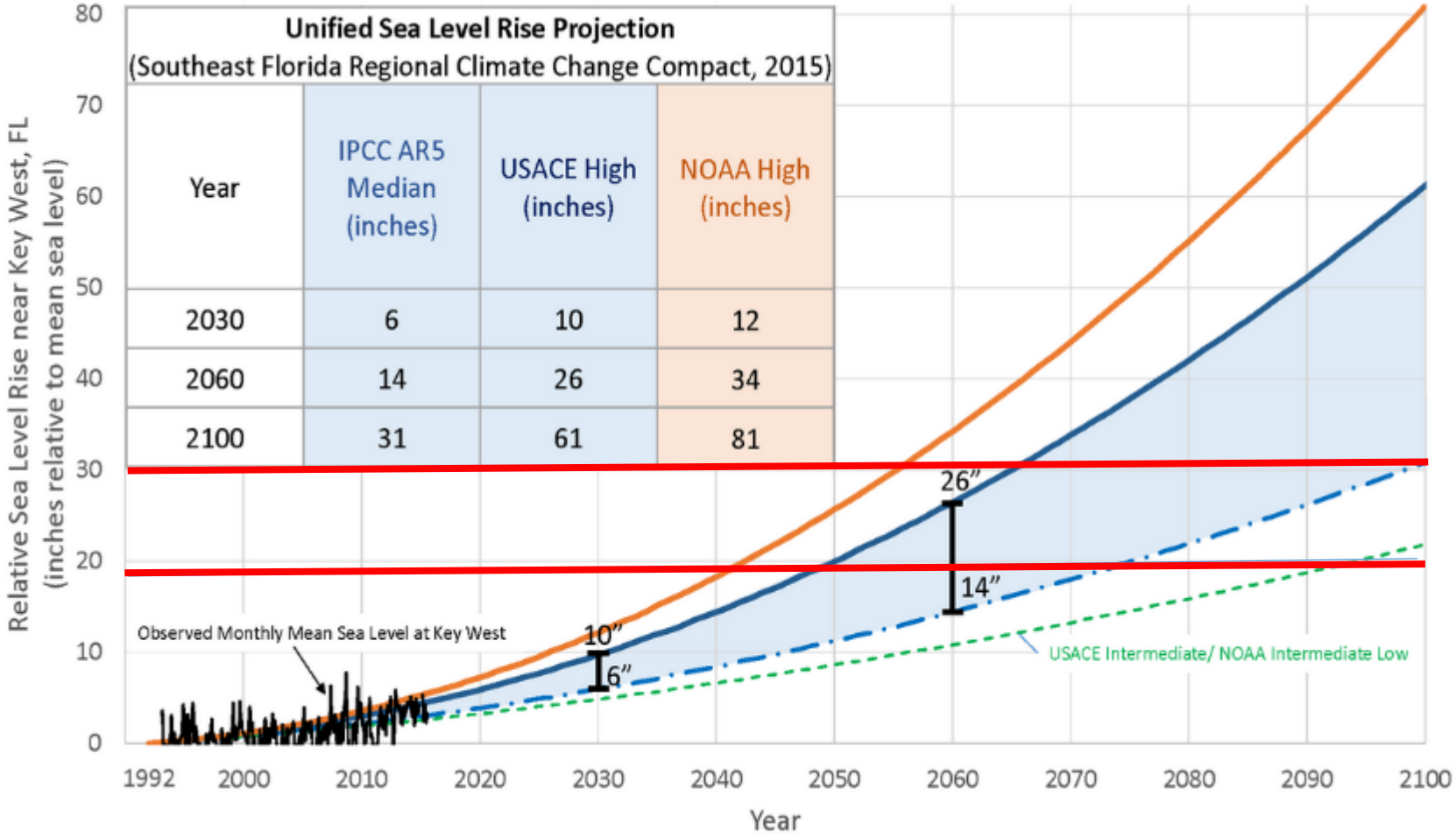


Sea Level Rise Considerations

- Plan considers sea level rise changes for two future sea level elevation scenarios
  - 1.5 ft (18 inches)
  - 2.5 ft (30 inches)
- Tailwater and water table conditions
- Tidal influence and surge

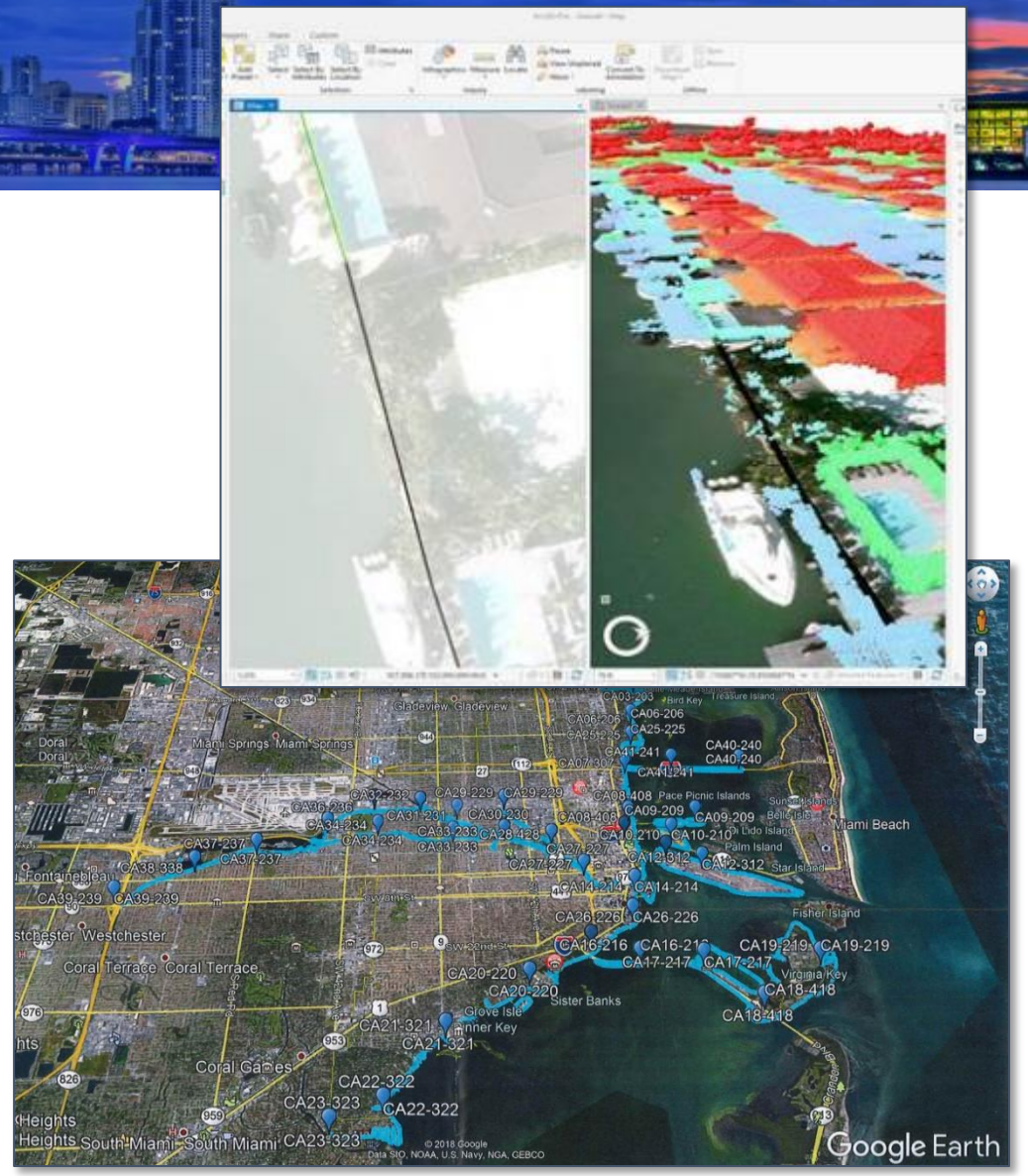
Unified Sea Level Rise Projection
(Southeast Florida Regional Climate Change Compact, 2015)

Year	IPCC AR5 Median (inches)	USACE High (inches)	NOAA High (inches)
2030	6	10	12
2060	14	26	34
2100	31	61	81



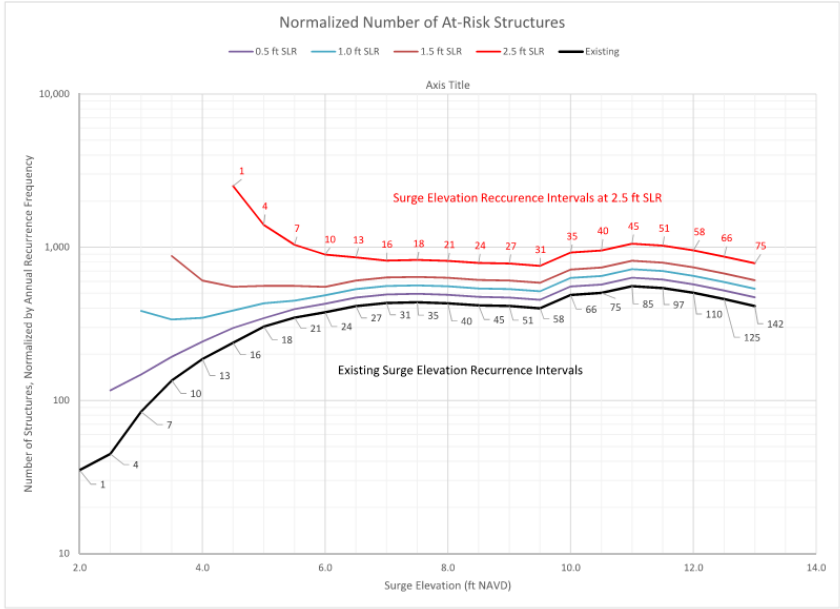
Citywide Seawall Survey

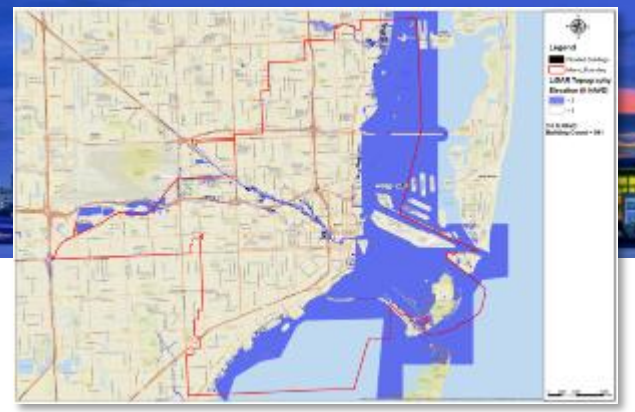
- Drone and aerial photogrammetry and LiDAR and survey
- Approx. 90 miles of seawall
- Various owners, materials and heights
- Some perimeter with no seawall or rip rap
- Merged through GIS into SWMM Models

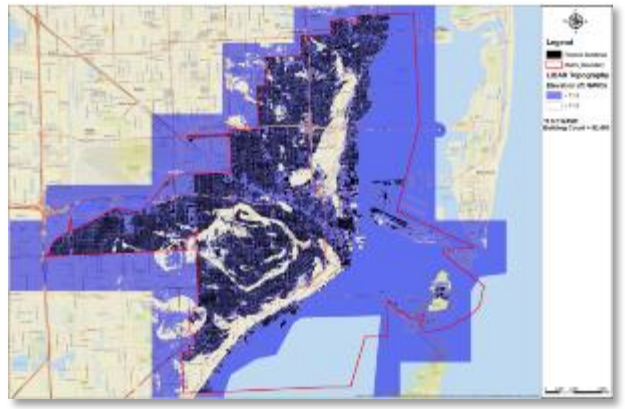


Inundation Scenarios and Surge Analysis

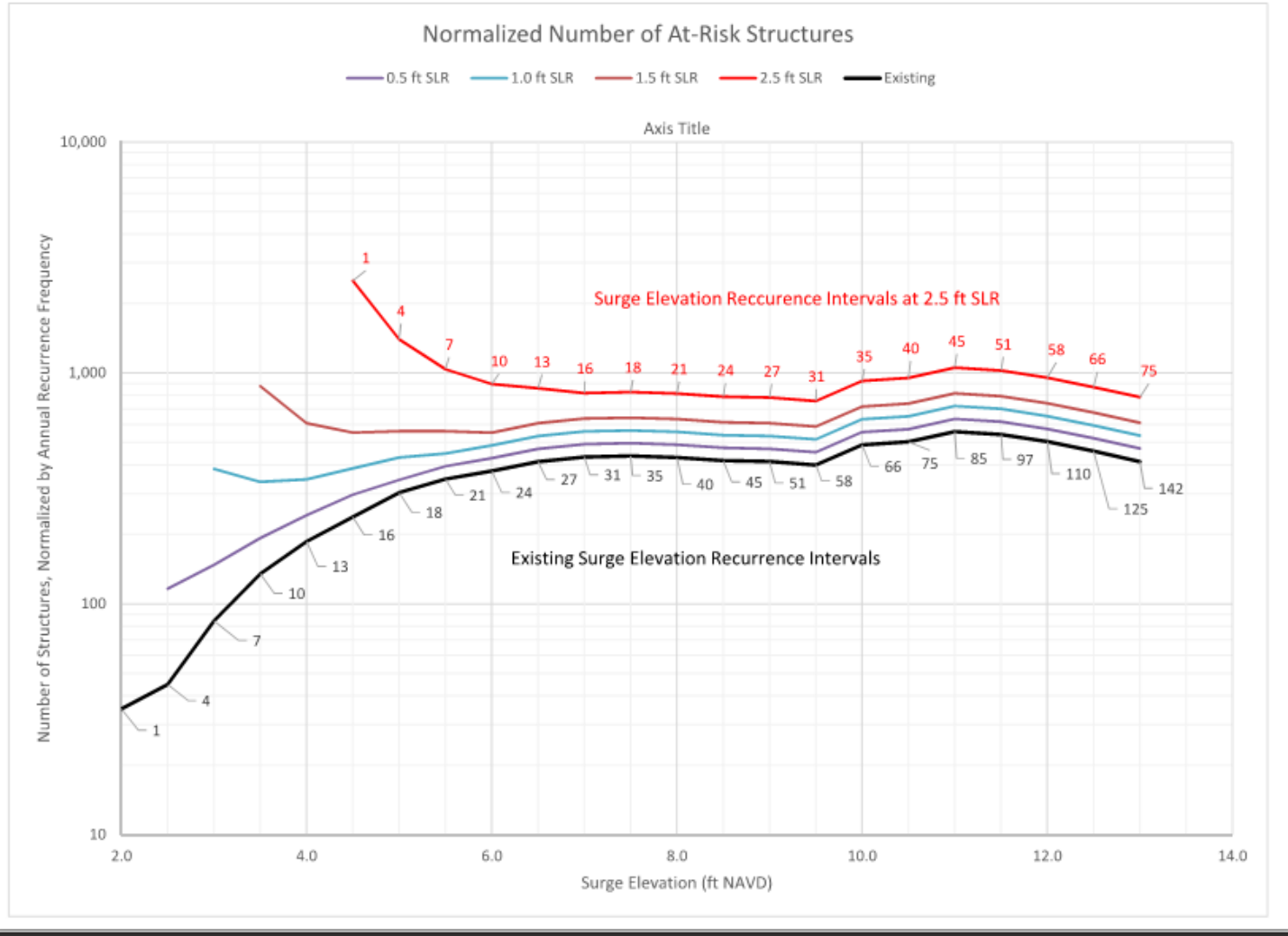
- Seawall height analysis for surge and sea level rise
- Identifies extent of flooding and at-risk structures
- Consideration for depth of flooding and property loss
- Guidance for policy makers for seawall ordinance







Inundation Scenarios and Surge Analysis *(cont.)*



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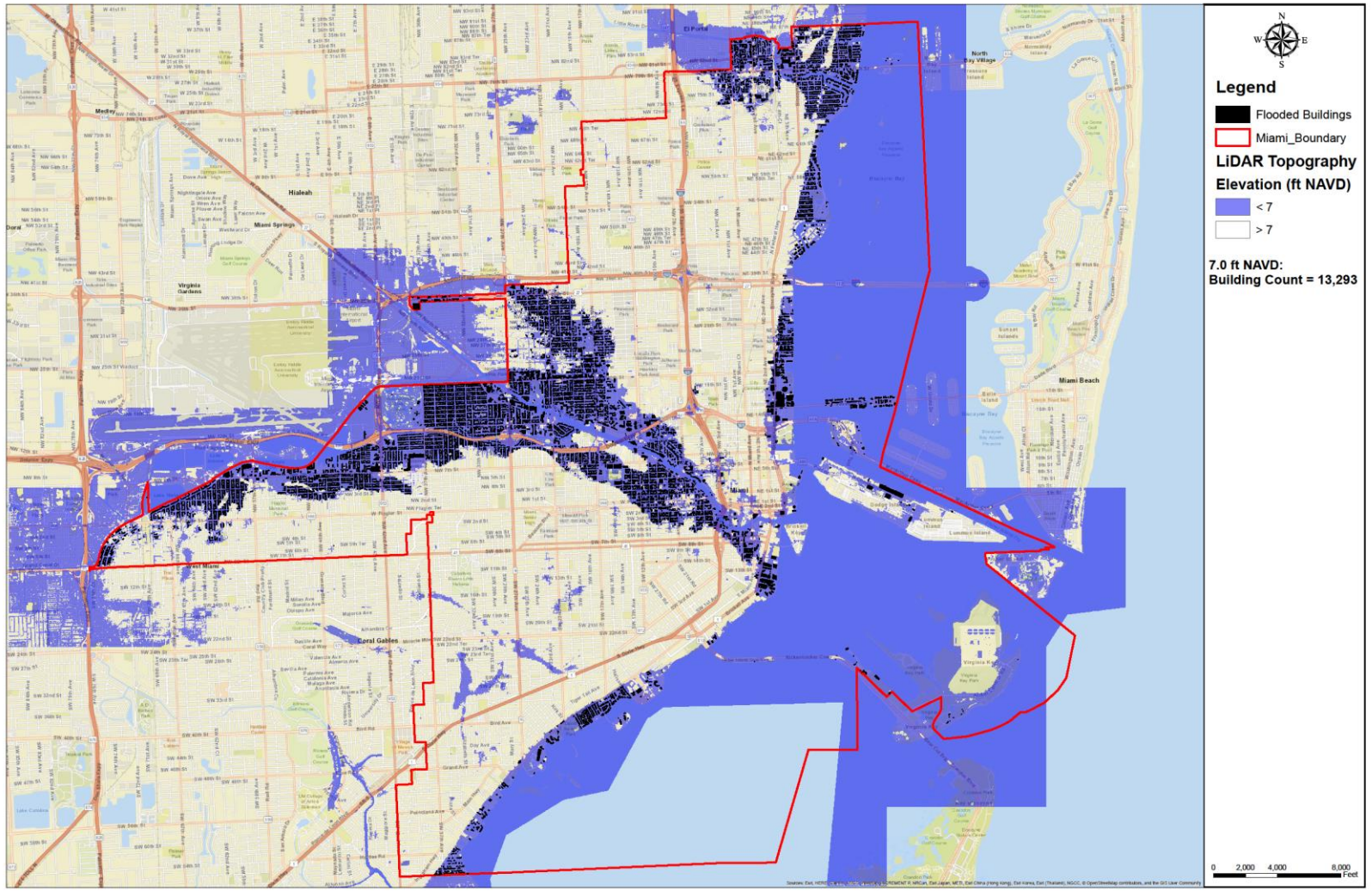

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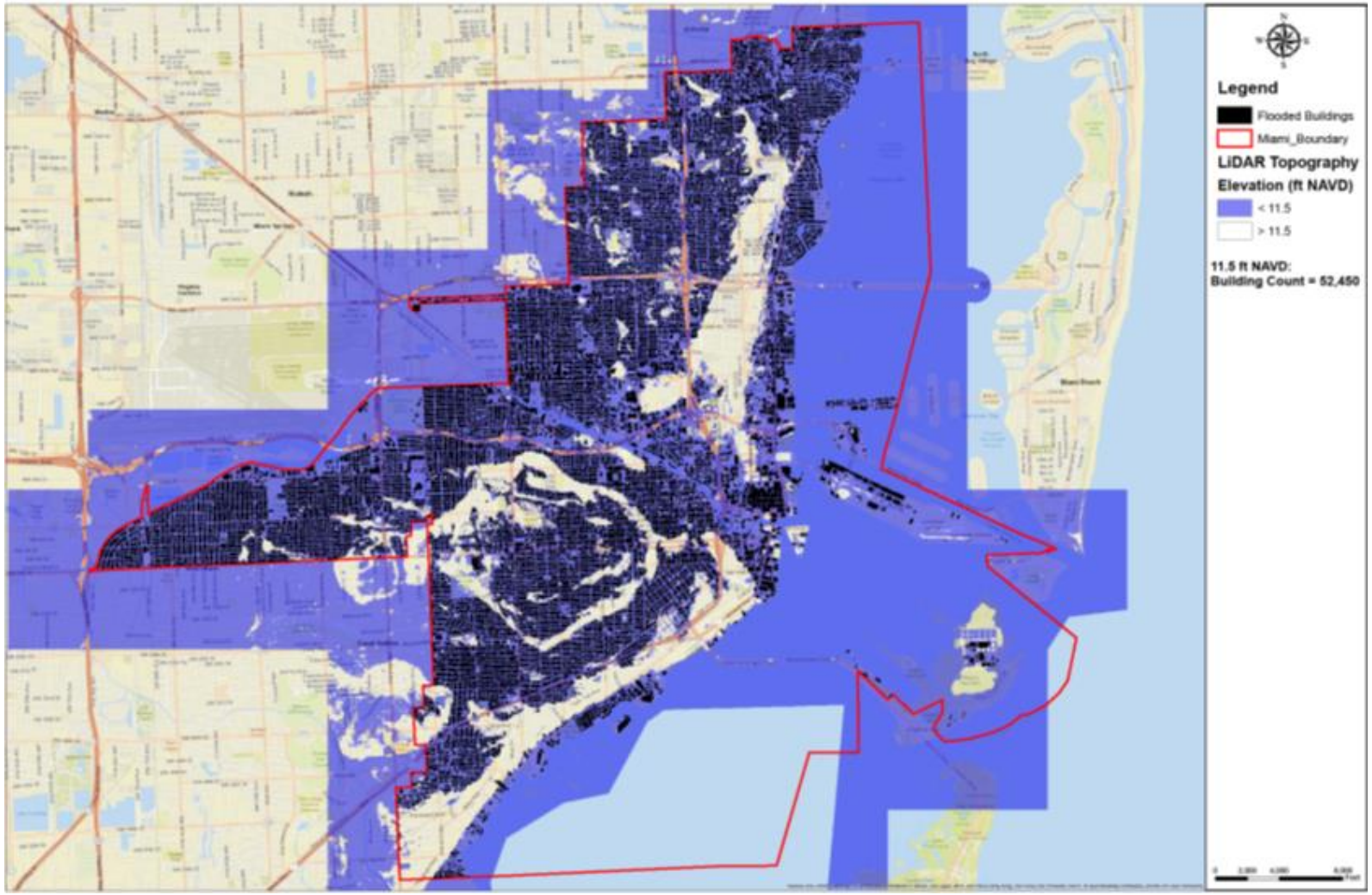
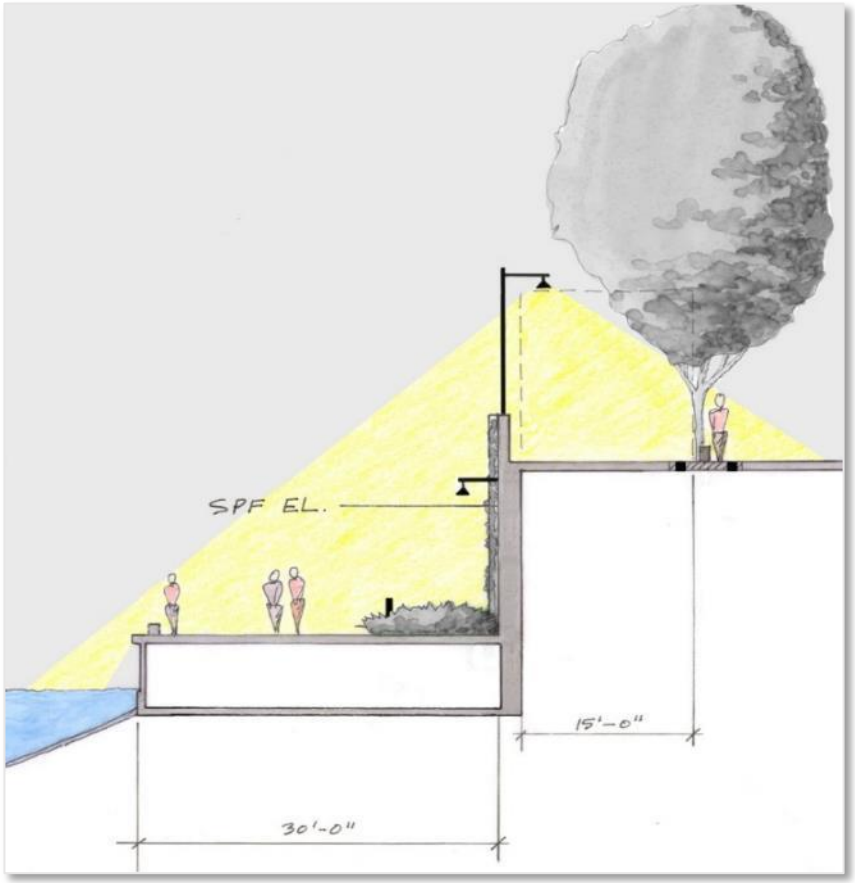


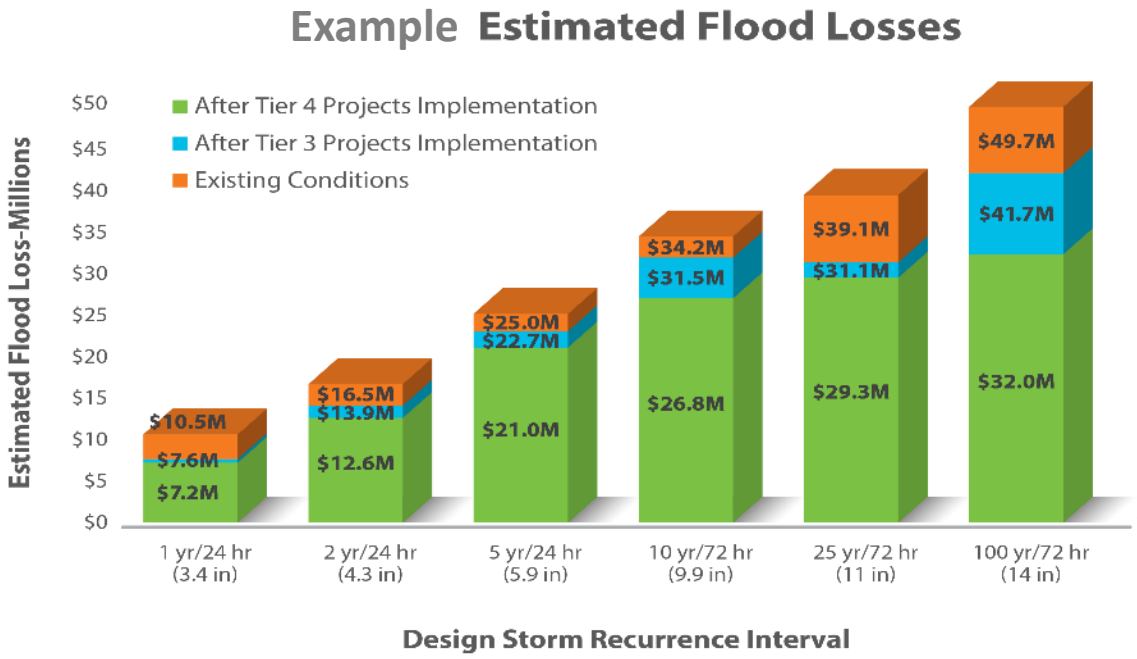
Waterfront Resilience Strategies Providing Adaptable Community-Based Features in a Phased Approach

- **Hardening/armoring** the perimeter
  - Seaside parks along coastal protection features
  - Seawalls and bulkheads
  - Stormwater outfall backflow preventers
  - Individual buildings and critical roadways
  - Emergency pumps
- **Raising or flood-proofing** critical at-risk infrastructure
  - Evacuation routes
  - Hospitals and housing
  - Police and fire
  - Emergency management facilities
  - Pump stations, water, sewer, gas, and telecommunications
- **Re-locating** at-risk population and infrastructure that cannot be cost-effectively flood protected
- **Combination**



Identify the "Best Value" Option for the City by Comparing Benefit vs. Cost

- Select most cost-effective alternatives to meet LOS, WQ, and other goals
- Benefit-cost analyses and decision support tools FEMA HAZUS
- Life cycle costs and benefits (B/C)
- Prioritization Matrix
  - Flood mitigation, Public safety, protection of critical infrastructure
  - Regulatory requirements
  - Triple bottom line - Environmental impacts, Social and recreational, Economic benefits



"This is more than just a stormwater plan. This is the City's roadmap towards resilience."

QUESTIONS?

Contact Us!

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