City of Miami Beach – Public Works Department

Stormwater Master Plan Update

2024 Florida Stormwater Association (FSA) Winter Conference

December 5, 2024

Updating City of Miami Beach's Stormwater Master Plan: Proactive and Adaptive Planning in the Face of Climate Change

Giancarlo Peña, PE, CGC
Assistant City Engineer – City of Miami Beach

Robert Eustice, PE
Water Resources Engineer – AECOM

Erik M. Alcantara, PE, PMP, ENV SP
Client Service Manager/Sr. PM – AECOM

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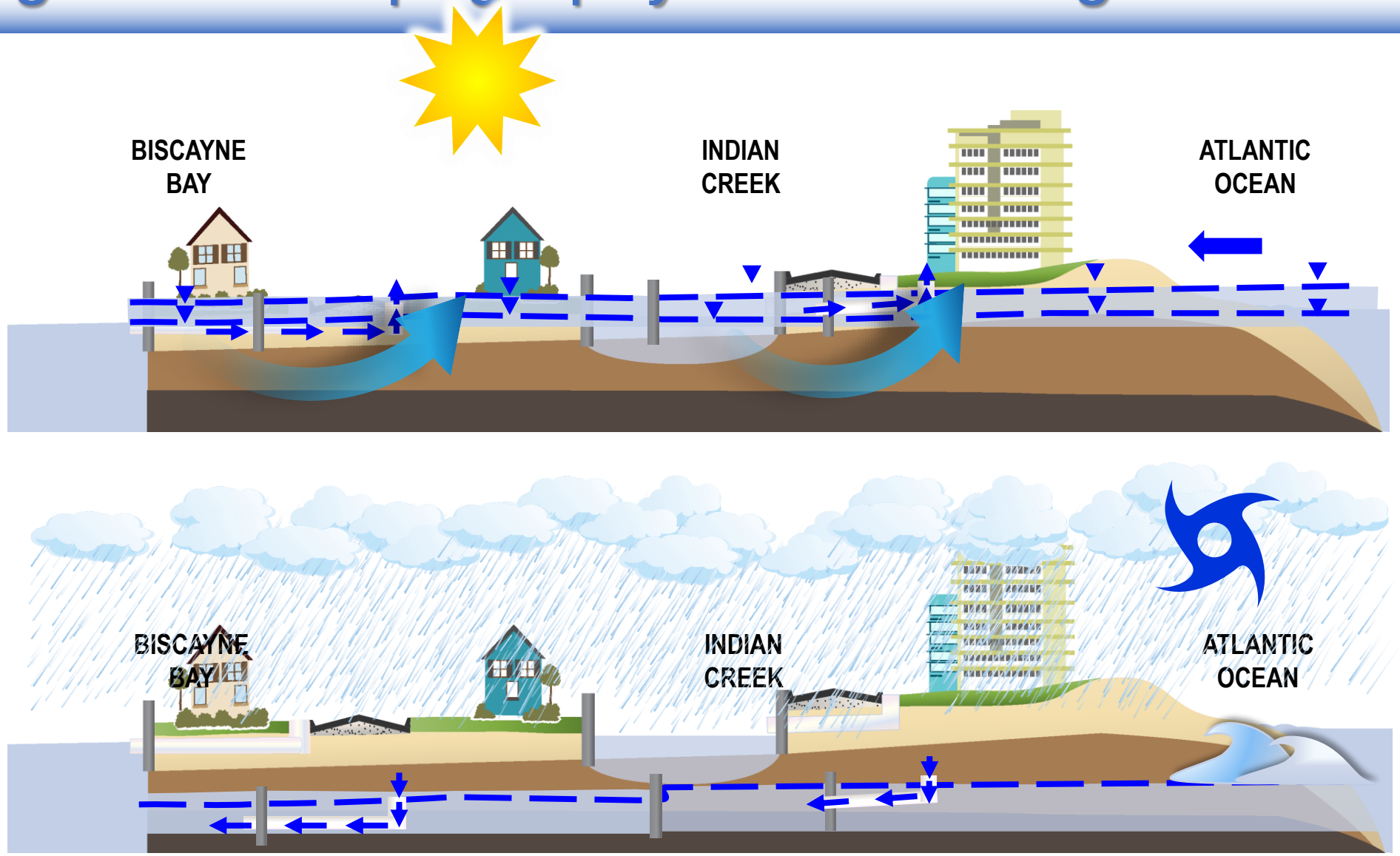
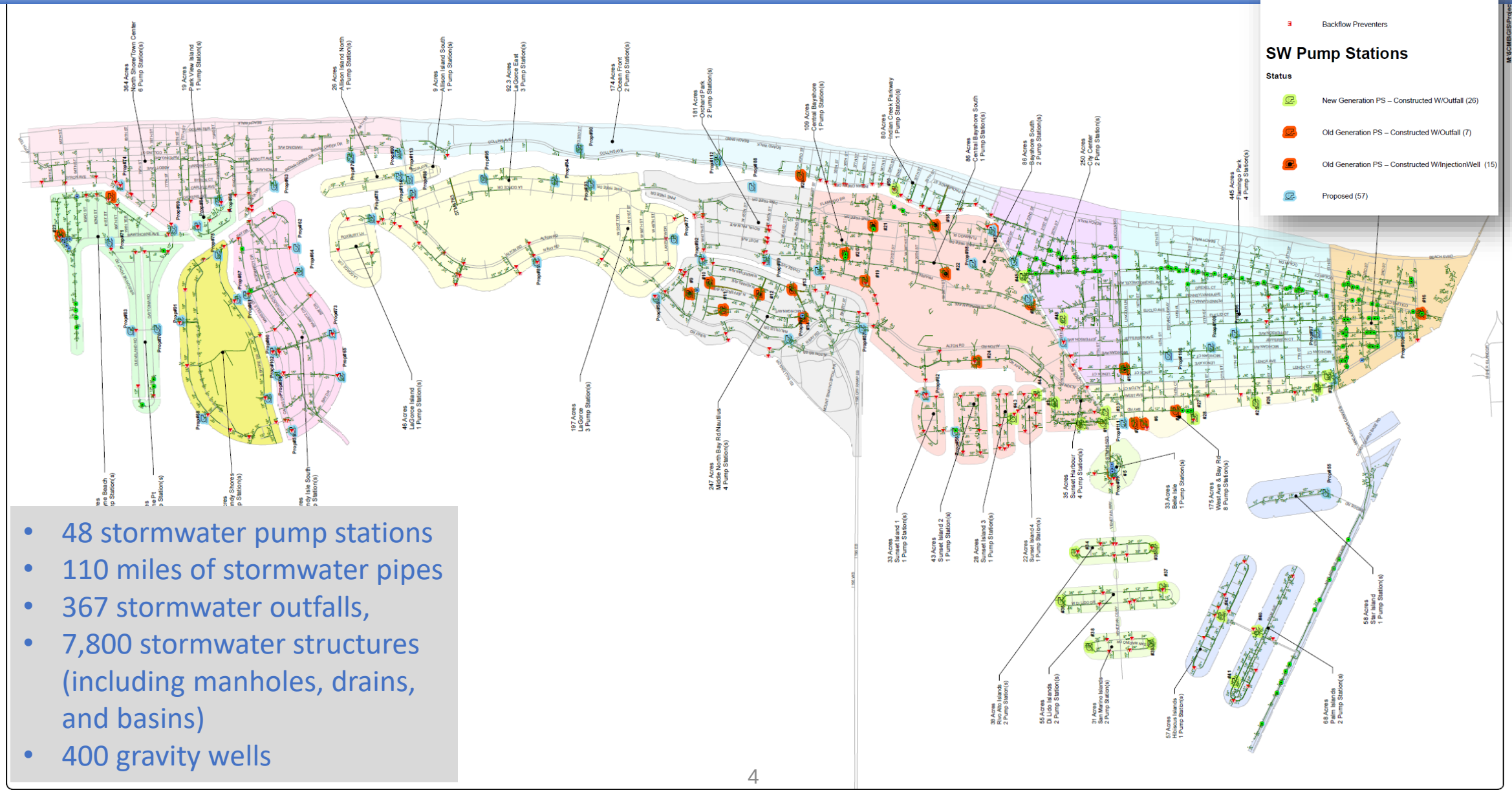
Agenda

1. Background
2. Stormwater Master Plan Approach and Recommendations
3. Hydraulic Model Overview
4. Implementation Plan: Neighborhood, Critical Needs and Water Quality Improvement Projects
5. Water Quality Treatment Approach

Background – Topography and Flooding at CMB



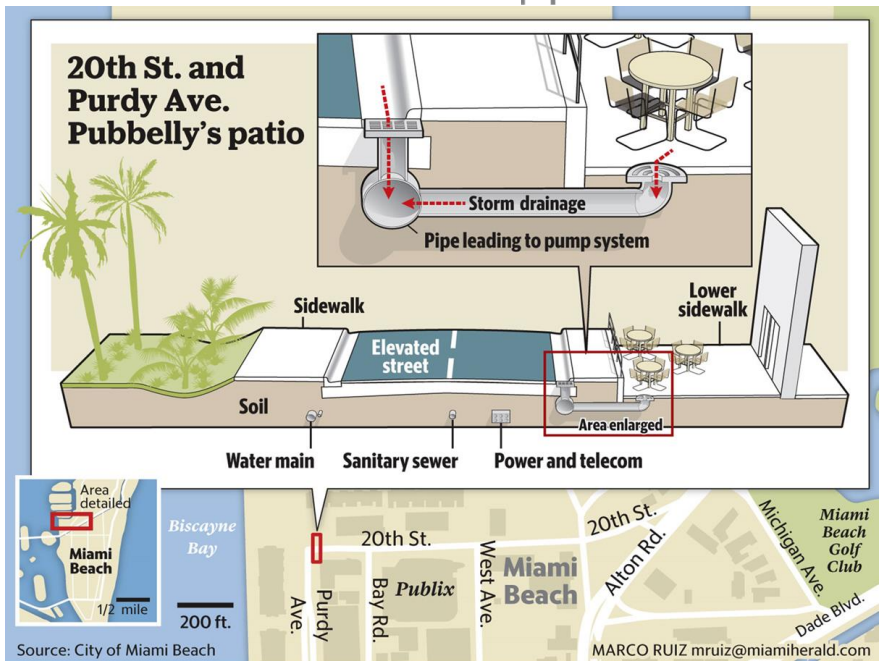
Existing Stormwater Drainage System



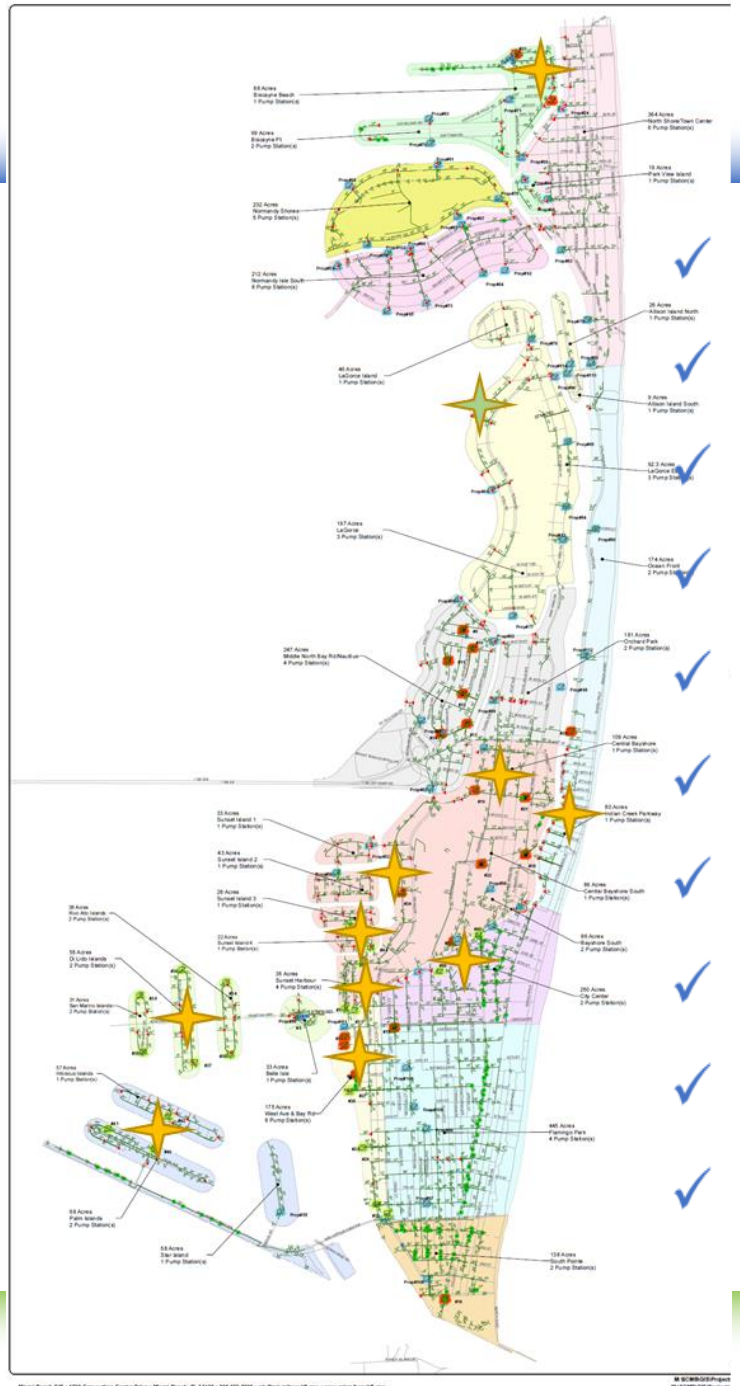
- 48 stormwater pump stations
- 110 miles of stormwater pipes
- 367 stormwater outfalls,
- 7,800 stormwater structures (including manholes, drains, and basins)
- 400 gravity wells

Basics of our Flood Mitigation Strategy

- **Elevate roads and seawalls** to mitigate tidal flooding
- **Install large pipes and pumps with WQ treatment systems** to manage storm water



Completed Drainage Projects since last MP



- ✓ Indian Creek
- ✓ Palm and Hibiscus
- ✓ Sunset Harbour
- ✓ Sunset Islands
- ✓ Venetian Islands
- ✓ Lower North Bay Rd
- ✓ City Center
- ✓ Biscayne Point
- ✓ Bayshore
- ✓ Bioswale Pilot

Palm & Hibiscus

Indian Creek

BEFORE AFTER

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Stormwater Master Plan Approach

2

Project Initiation

- ✓ **Notice to Proceed (NTP):** October 2022

Data Collection

- ✓ Stormwater geodatabase
- ✓ Miami Beach LiDAR survey
- ✓ Resident Complaints and PW Work Orders (Cityworks)
- ✓ Recent studies

Analysis

- ✓ Prioritization criteria for Critical Needs Projects
- ✓ Geospatial analysis of flooding complaints
- ✓ Public and stakeholder engagement strategy
- ✓ "Drainage toolbox" for Critical Needs Projects

Stormwater Modeling

- ✓ Updated the City's Master Drainage Model
- ✓ Stormwater infrastructure planning for the City's Neighborhood Improvement Projects

Stormwater Master Plan Approach (cont.)

Stormwater Modeling Technical Memorandum

- ✓ Detailed description of the methods used to develop the City's Master Drainage Model

Prioritized Capital Improvement Plan (CIP) Report

- ✓ Updated Construction Cost Estimates for the City's Neighborhood Improvement Projects
- ✓ Identified Critical Needs Projects to be implemented for the next 10 years (supplemental to Neighborhood Improvement Projects)

Public Outreach

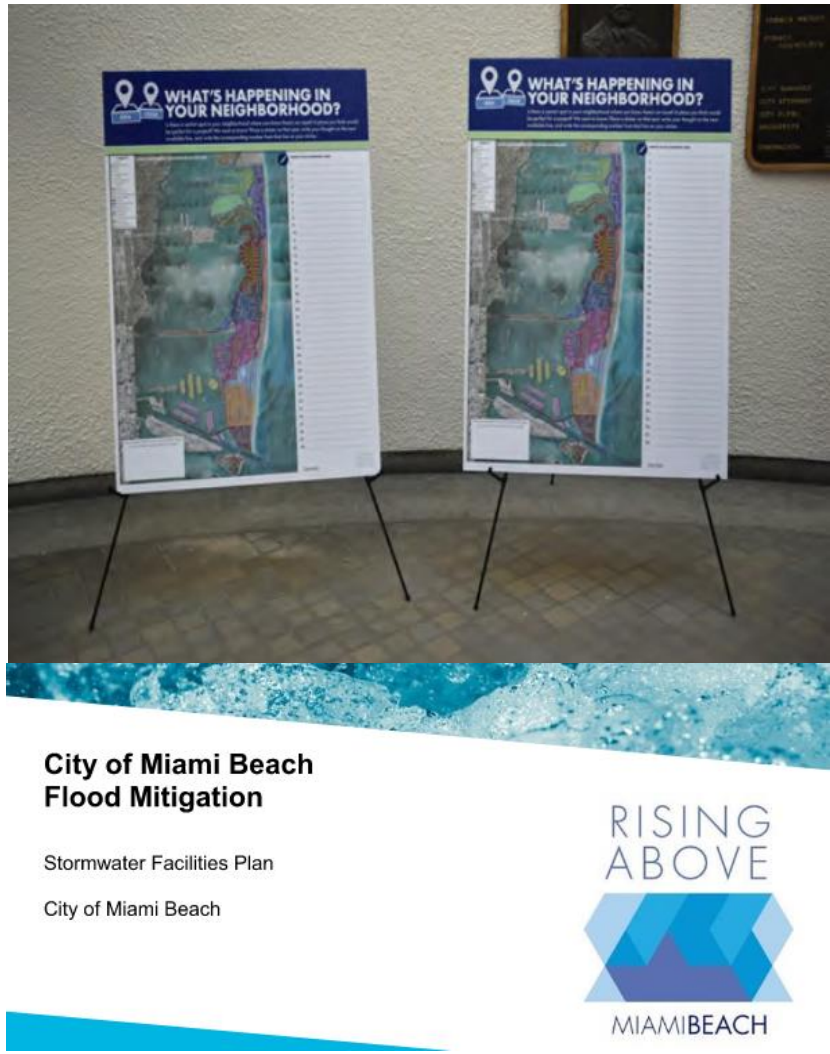
- ✓ Informed residents about Study results and obtained feedback (September 2023)
- ✓ Oct 2023 to FERC
- ✓ Incorporated feedback into **Final Master Plan**

Approved by Commission

- ✓ March 2024 Final Master Plan adopted by Commission

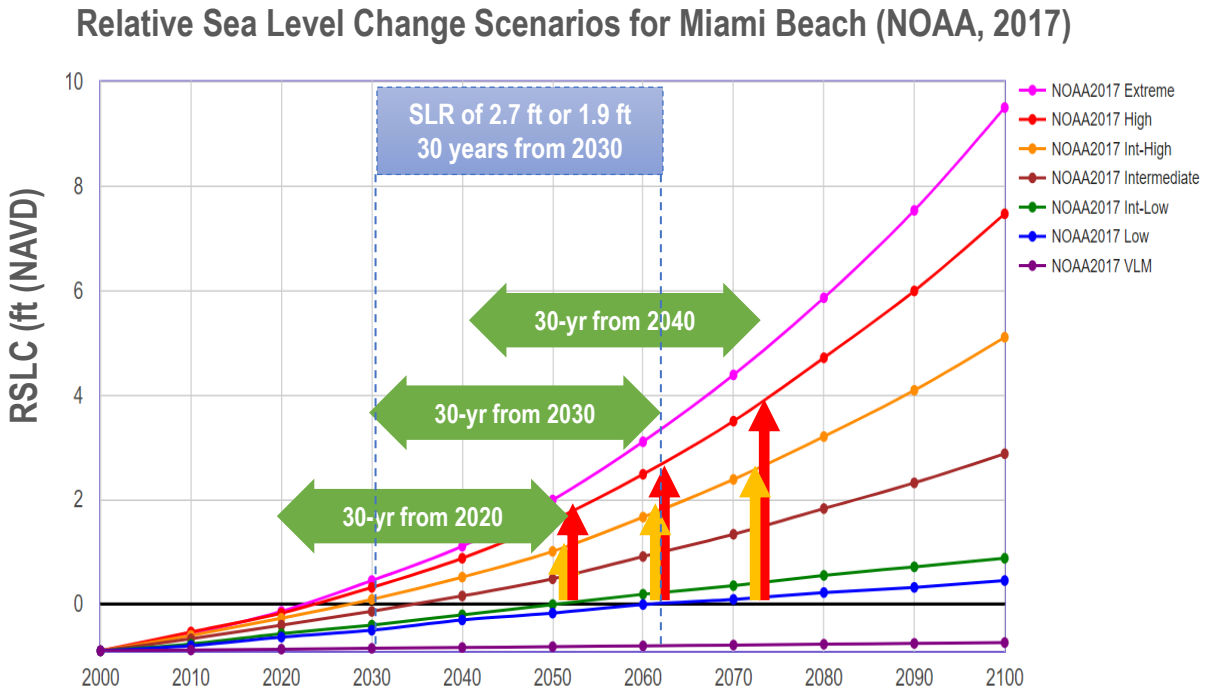
Incorporated Recent and Ongoing Studies

- Road Elevation Strategy
- Neighborhood Project Prioritization
- Blue-Green Stormwater Infrastructure Concept Plan
- Stormwater Facilities Plan
- Seawall Prioritization Plan
- Basin Drainage Reports for Flood Mitigation Study
- Stormwater 20-Year Needs Analysis (HB 53)
- Sea Level Rise Vulnerability Assessment and Adaptation Plan (ongoing)



Master Plan Approach - Level of Service

DESIGN STORM	• 10-year, 24-hour Storm
ROADWAY DESIGN LIFE/RESILIENCE	• 30 years
SEA LEVEL RISE PROJECTION	• NOAA Intermediate High



	Proposed Edge of Pavement Elevation		
Road Type / Construction Start	2025	2030	2035
Arterial and Local Roads*	4.2’	4.5’	4.9’
Emergency (FDOT) Roads	5.2’	5.7’	6.2’

* 1 ft road thickness above bottom of road base.

Proposed Stormwater Infrastructure Summary

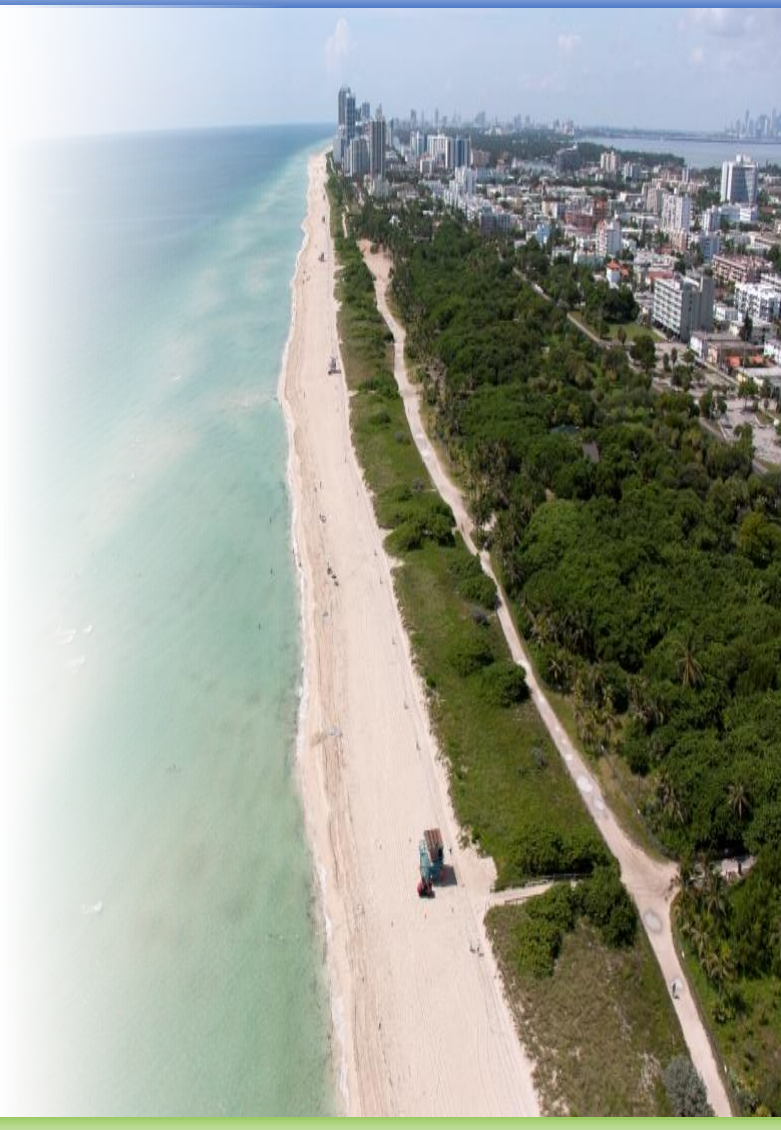
48 existing, with 33 stormwater pump stations proposed to remain

Proposed 83 stormwater pump stations

-Including Best Management Practices (BMP) water quality treatment

Approx. 104 miles of proposed large stormwater pipes

2024 budgetary estimate for the proposed NIPs: **$3.7 Billion** *(City ROW)*



Proposed Stormwater Infrastructure Summary

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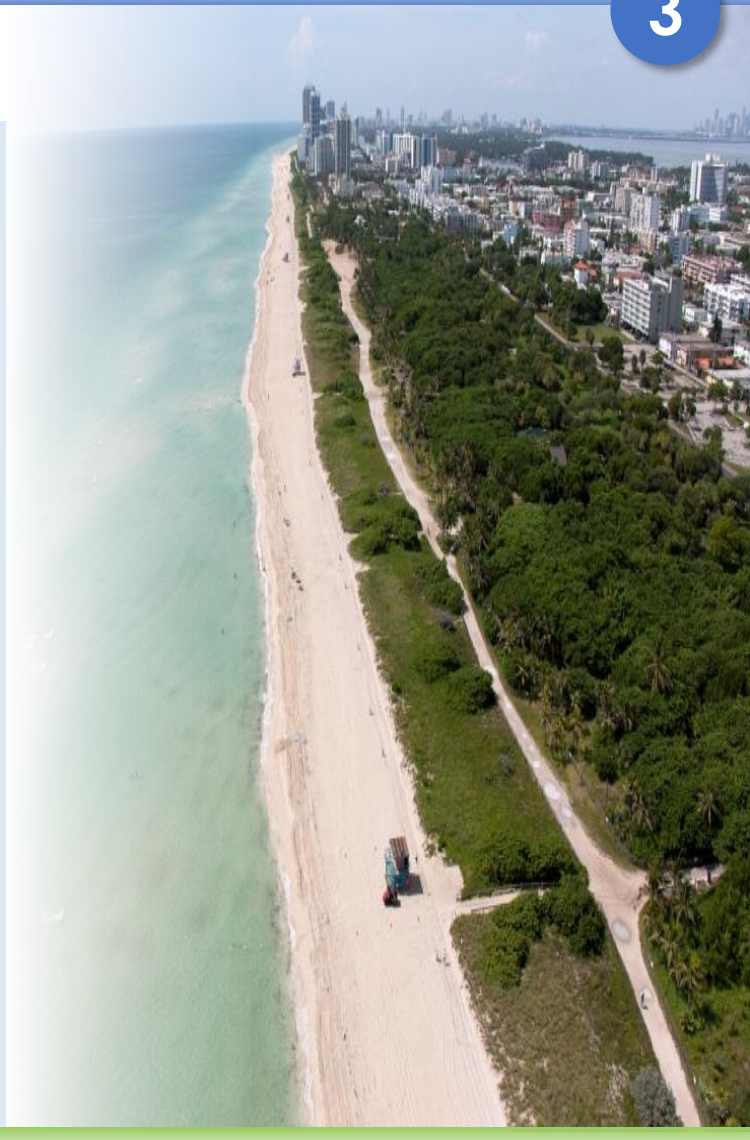
WHAT IS KNOWN

- Existing stormwater master plan
- Stormwater models and reports prepared by AECOM and other consultants
- GIS data (drainage wells, backflow prevention devices, water quality treatment, pumping stations, exfiltration trenches, pipes)
- As-built drawings
- Updated lidar survey data

WHAT IS UNKNOWN

- Finished Floor Elevation (FFE)
- The difference in SLR condition of the project implementation to the completion stage
- Capacity of 1,700 gravity drainage wells
- Ultimate Sea Level Rise (SLR)



Hydraulic Model Overview

Hydraulically **Distinct** Areas

- Flexibility in development
- Improved Collaboration and Communication
- Reducing Risk/Margins for Error
- Future development accessibility

Model-Building Assumptions

Existing seawalls at a minimum elevation of **2.70 feet, NAVD**

10-Year, 24-Hour Design Storm **multiplied by a factor of 1.25**

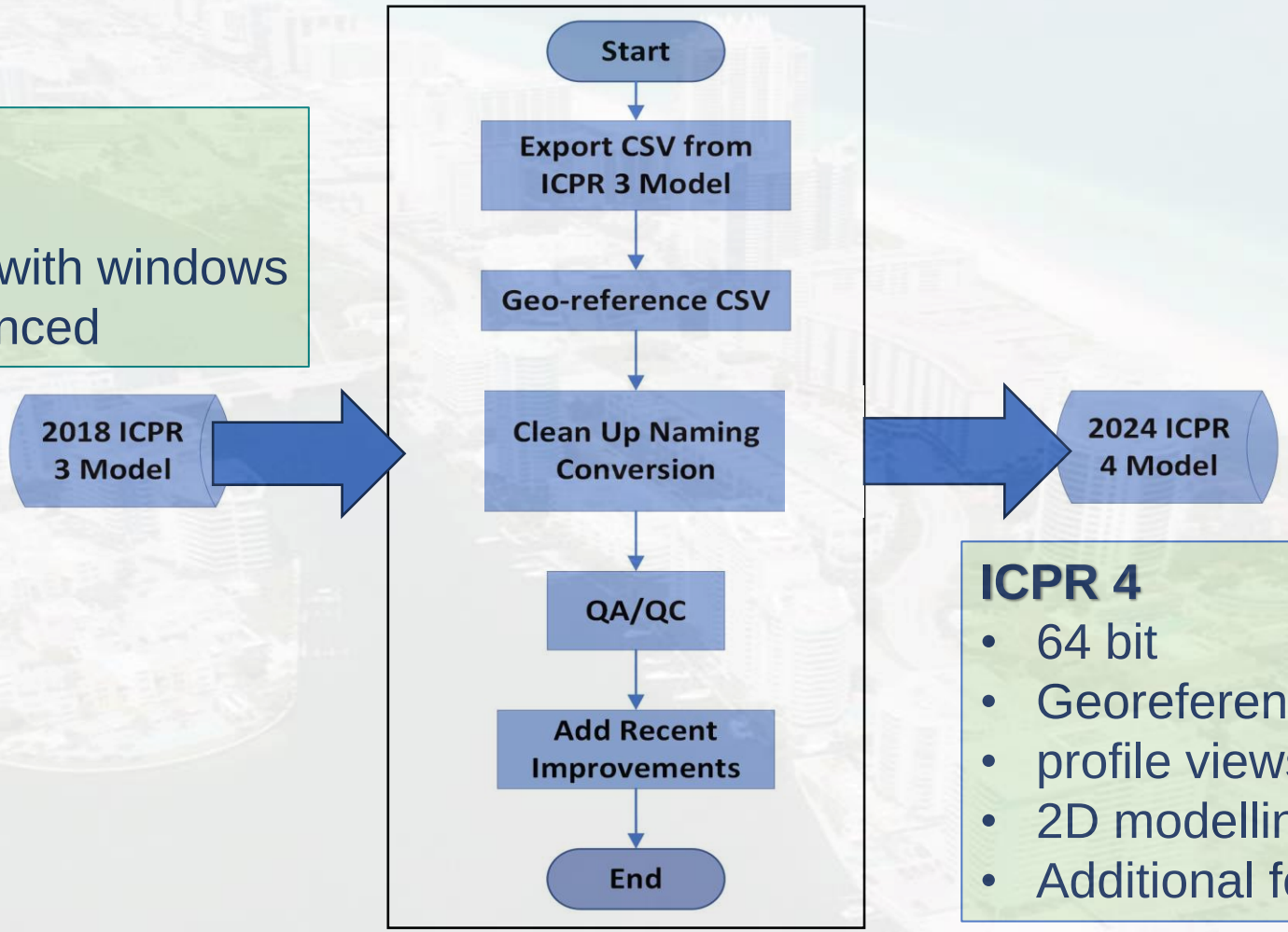
Curve Numbers (CN)= **ninety-five (95)**

Anticipates SLR over **the next 40 years**

Hydraulic Model : Workflow Overview

Technical Approach

ICPR 3
- 32 bit
- Not compliant with windows
- Not Georeferenced



ICPR 4
- 64 bit
- Georeferenced
- profile views of the hydraulics
- 2D modelling
- Additional features

Hydraulic Model Overview

Leveraging Automation

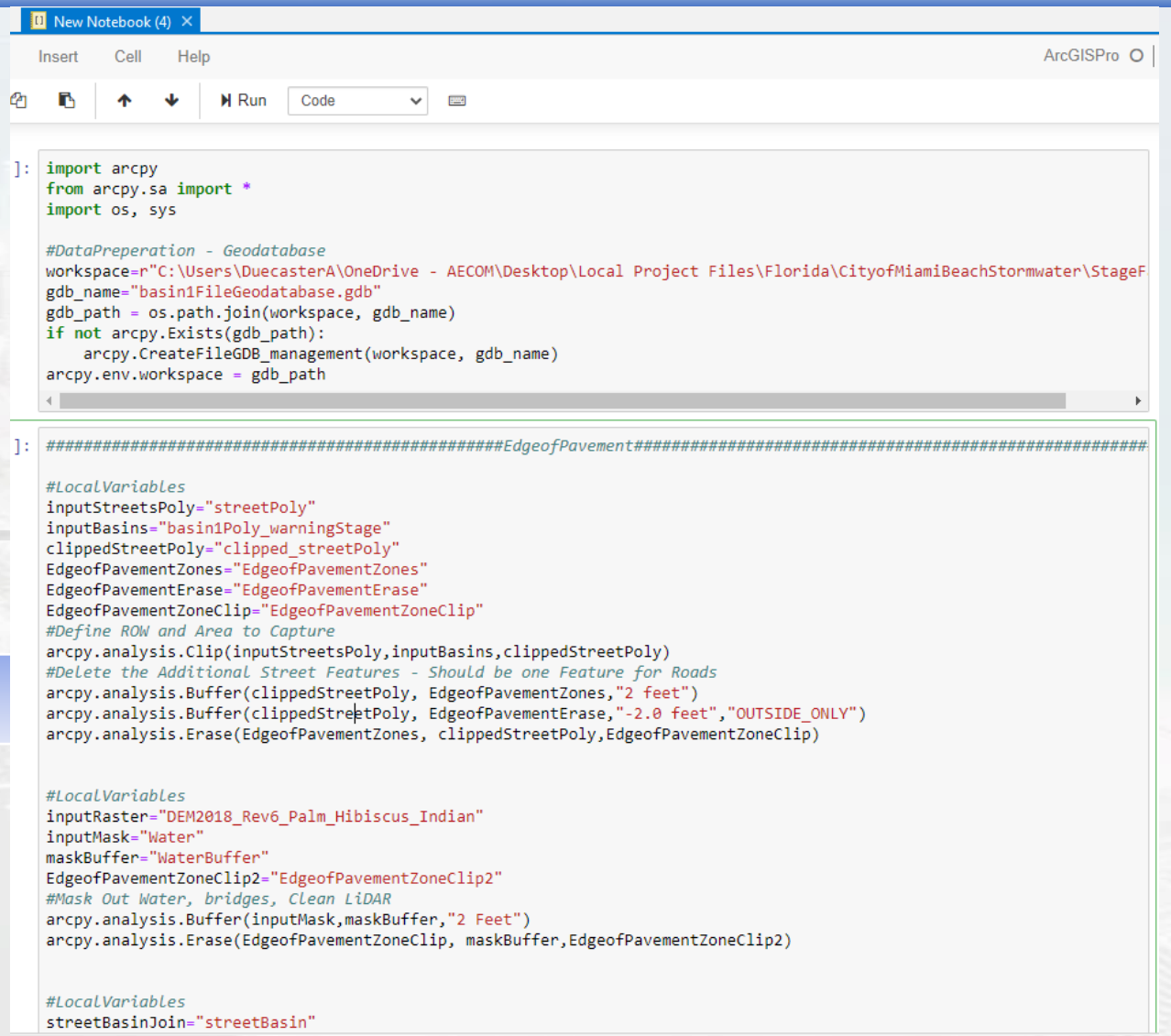
Developed a program within Microsoft Access

Developed script in GIS to pull new model warning stages

Worked with Streamline Technologies, Inc. for stage area calculations (Stormwise 4.08.00)

Leveraging Automation Benefits

- **Improved accuracy**
- **Improved speed**
- **Repeatability**



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Conclusions

Updated **higher resolution LiDAR data**

Successful models for each of the **six (6) Master Plan Basins**

Tool for future development

(NIP & CIP)

Stormwater Master Plan Projects

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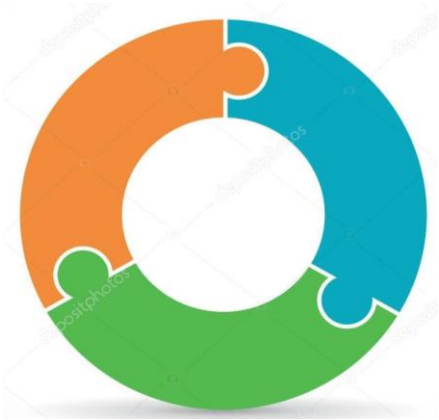
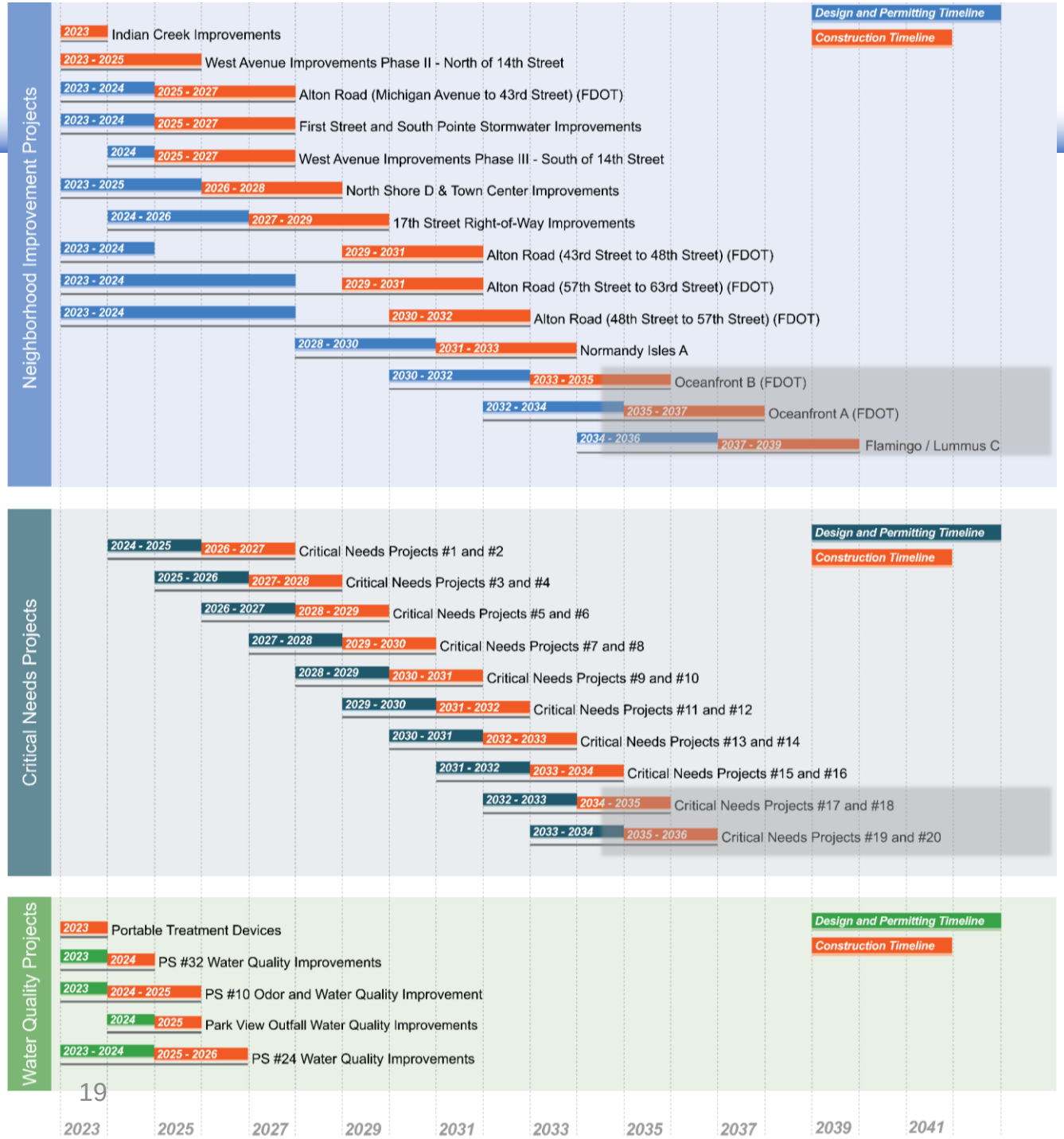


A combination of…

- ✓ Neighborhood Improvement Projects
- ✓ Critical Needs Projects
- ✓ Water Quality Projects

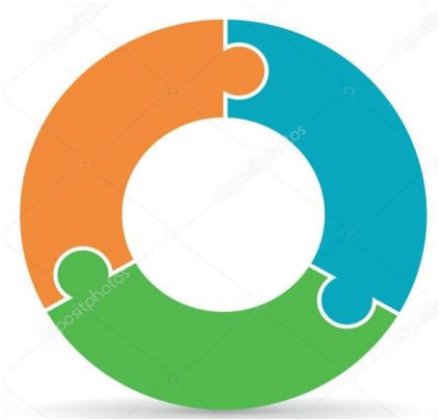
Proposed 10-Year Plan

- ✓ NIPs ~$800 M
- ✓ Critical Needs ~$95 M
- ✓ Water Quality ~$6 M



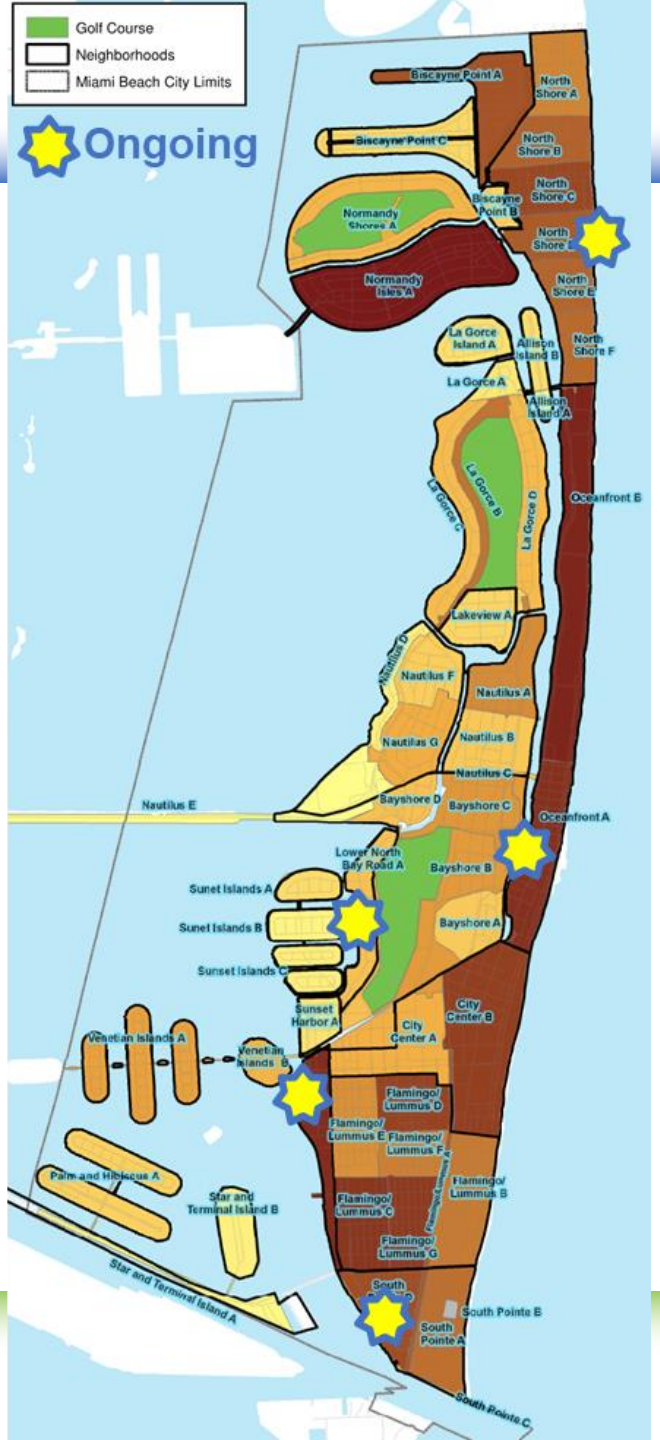
Stormwater Master Plan Projects

A combination of…



- ✓ **Neighborhood Improvement Projects**
- ✓ Critical Needs Projects
- ✓ Water Quality Projects

Neighborhood Improvement Projects (NIPs)



Holistic projects that involve multiple City services to enhance the quality of life in a neighborhood:

- Stormwater (large pipes and pump station/treatment)
- Potable water and wastewater collection
- Roadway elevation and aboveground components (sidewalks, street lighting, landscaping, etc.)

✓ NIPs provide comprehensive long-term tidal and rainfall flood mitigation.

✓ Prioritized NIPs List Adopted by Commission in 2020 and incorporated into this Master Plan.

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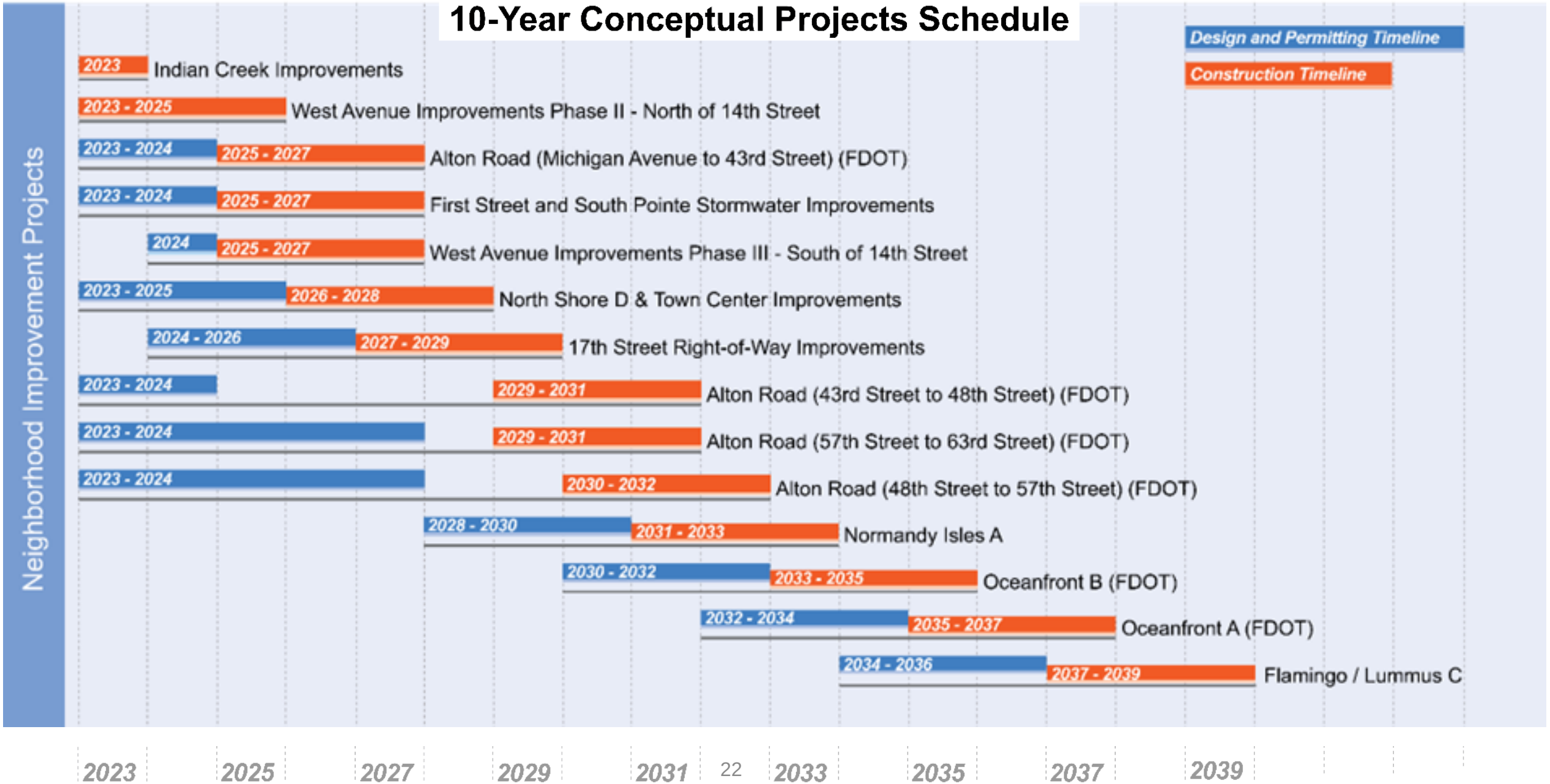
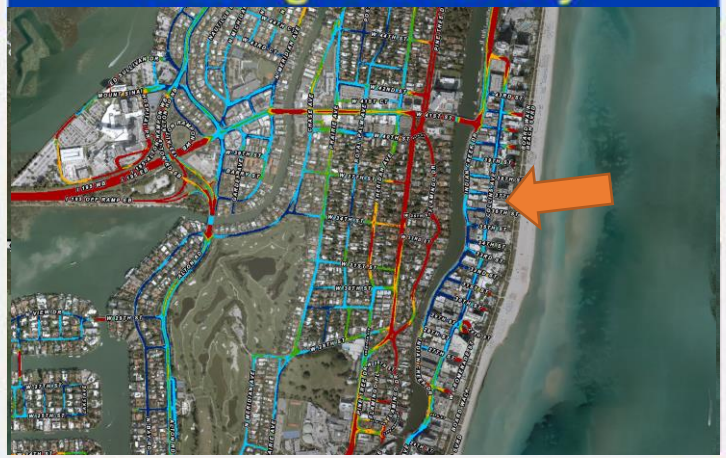
10-Year Conceptual Projects Schedule



Indian Creek Drive -- 25th St. to 41st St

Raising of Roadway



New 72" SRPE Trunkline

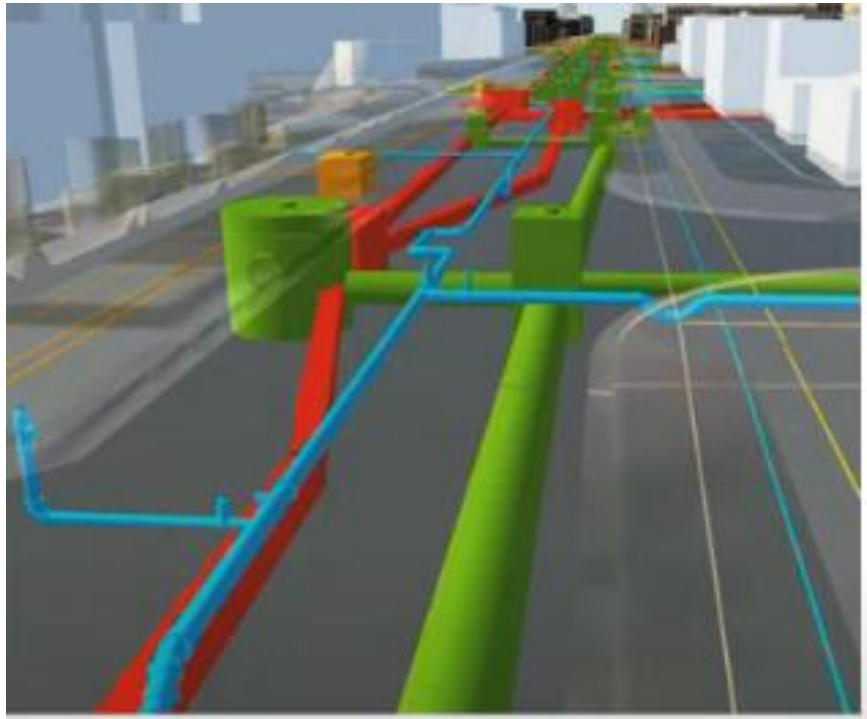
New Roadway Drainage

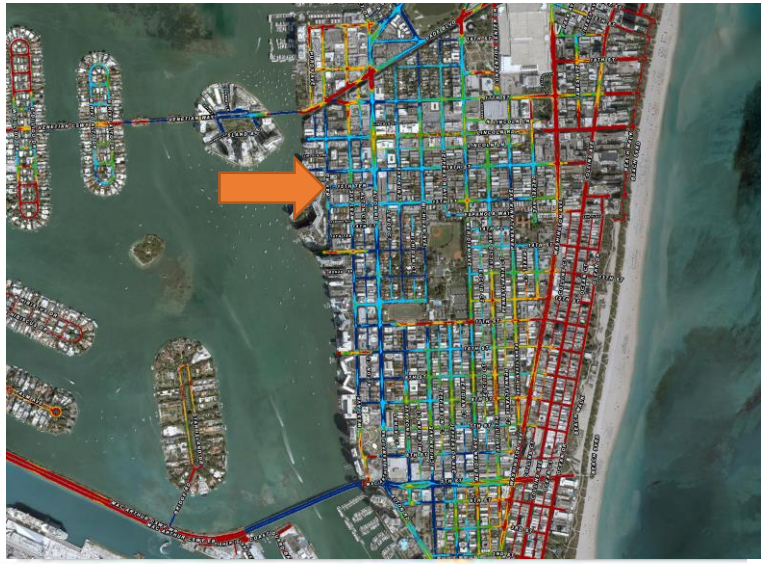
New Pump Station

Seawall Replacement

Harmonization

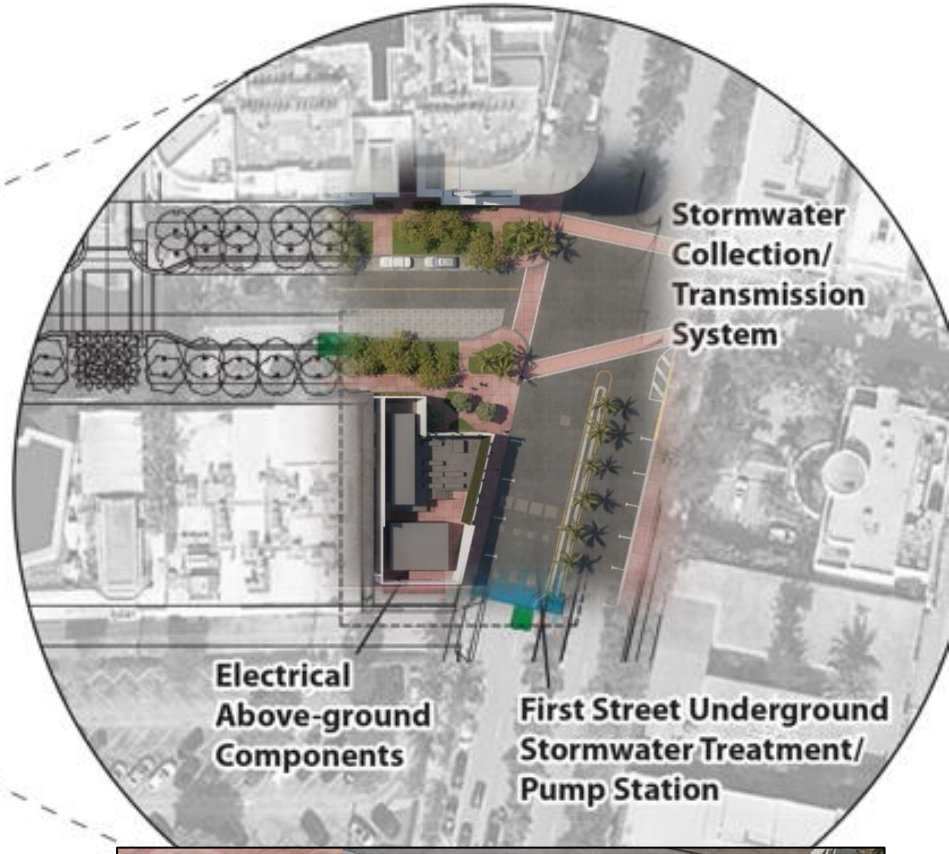
West Avenue Phase II Improvements



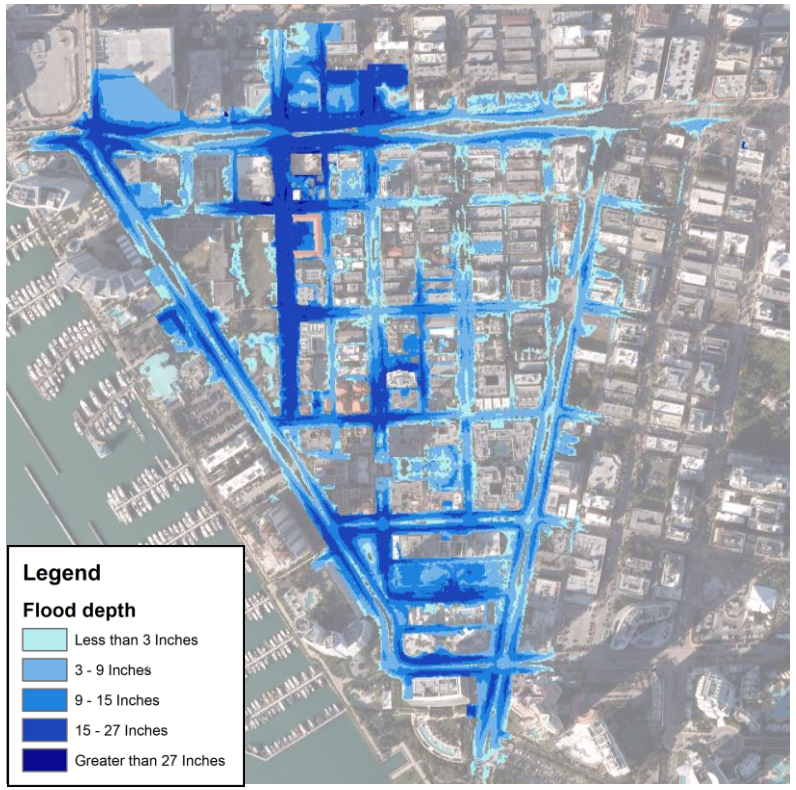


First Street and South Pointe Stormwater Improvements

- Stormwater Collection, Treatment and Discharge
- Water and Sewer Upgrades
- First St. Reconstruction

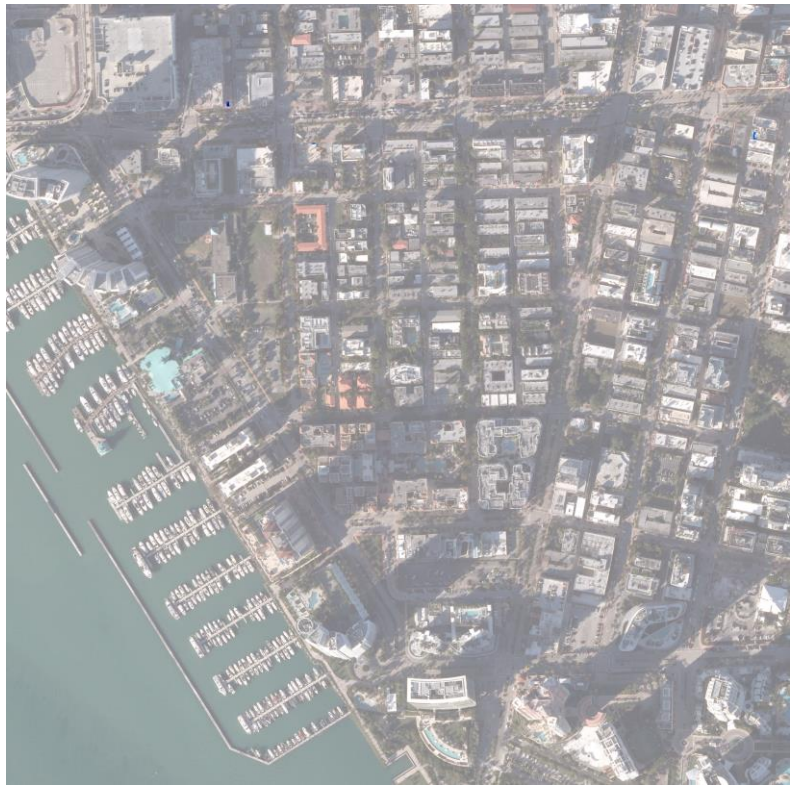


First Street and South Pointe Stormwater Improvements



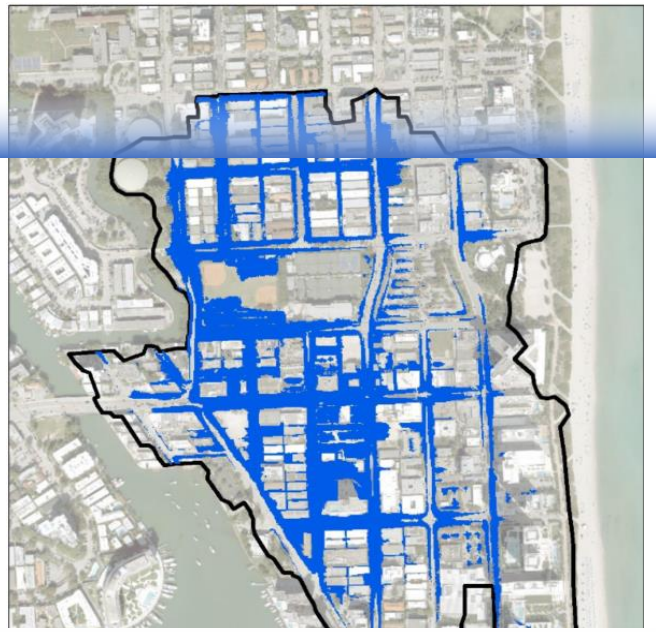
Existing Conditions
(Rainfall Event 8/1/17)

Flooding post Completion of this project excluding South Pointe Drive in the scope
(Rainfall Event 8/1/17)



Flooding post Completion of all planned South of Fifth Neighborhood Upgrades by future project
(Rainfall Event 8/1/17)

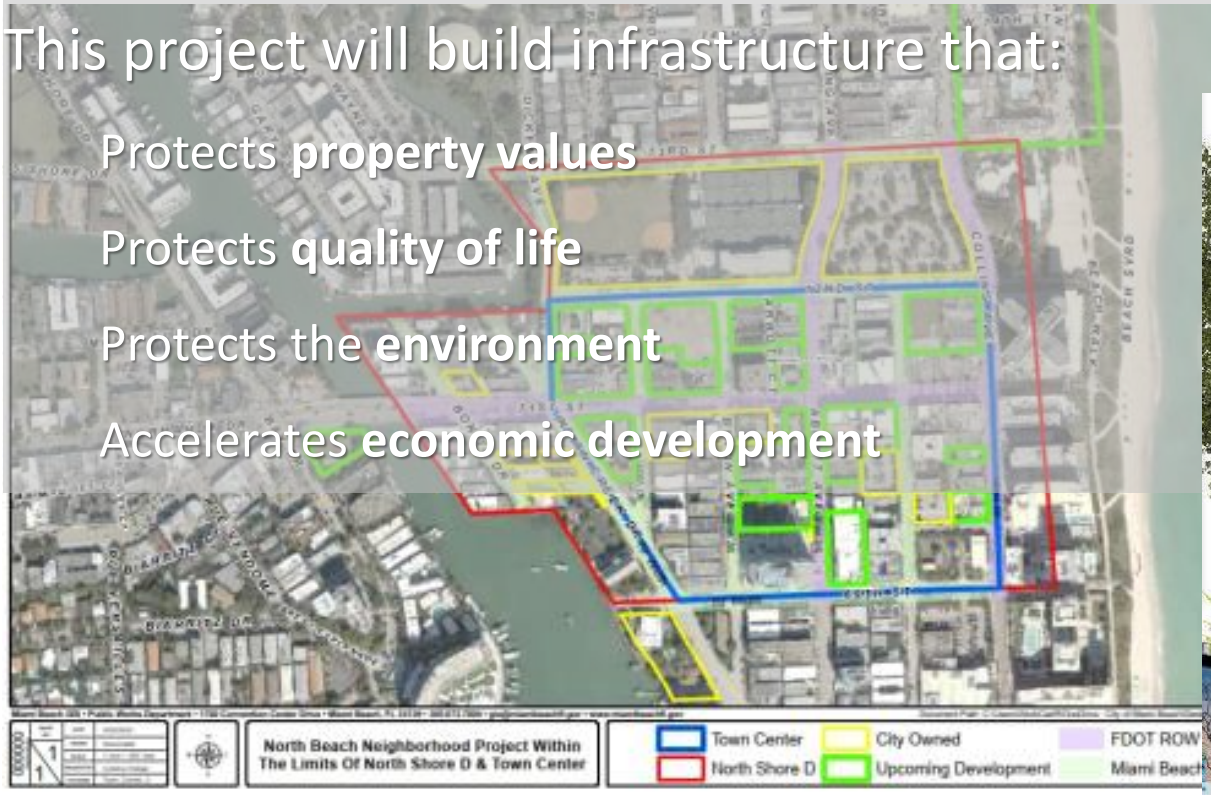
North Shore D – North Beach Town Center



Priority flood mitigation project in an area targeted by the City for new development

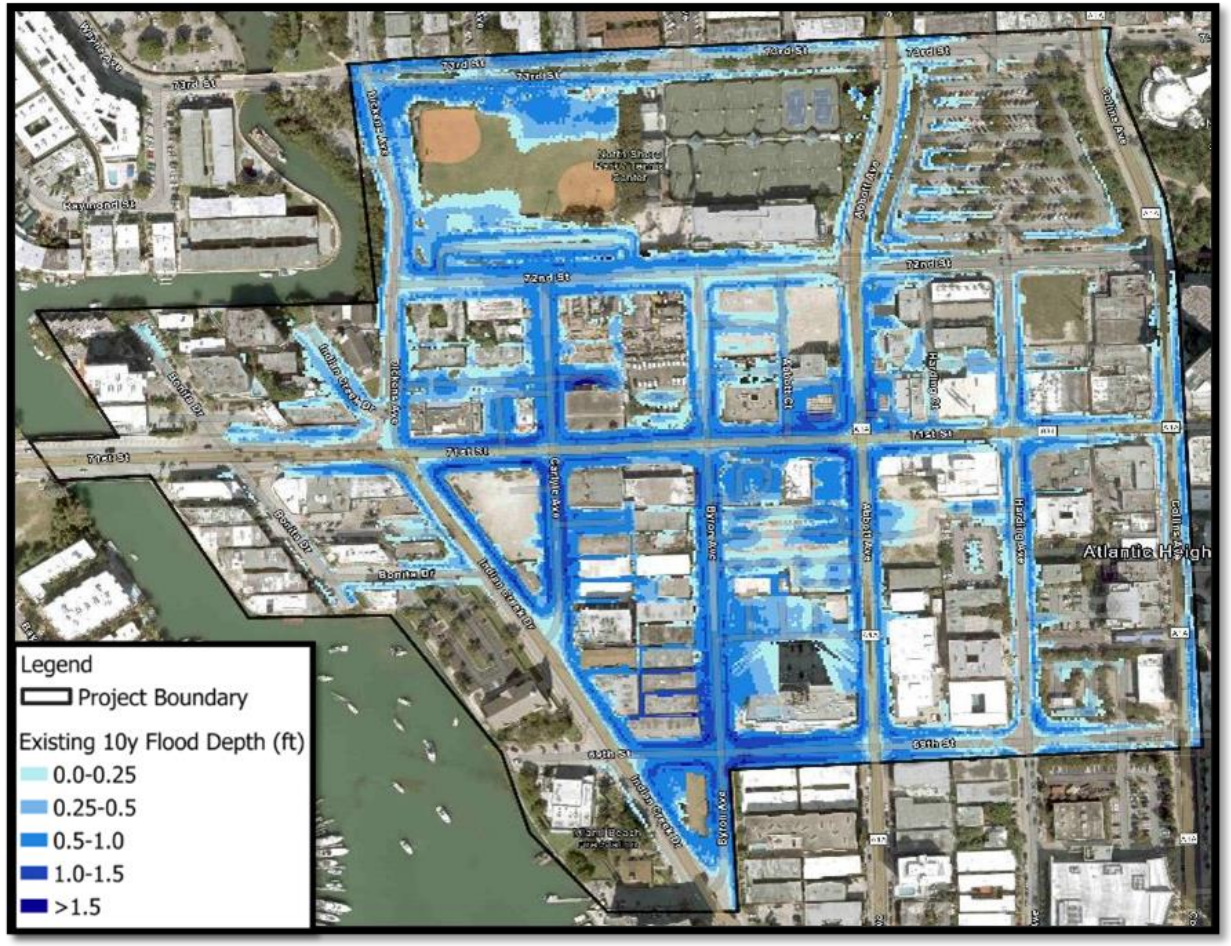
This project will build infrastructure that:

- Protects **property values**
- Protects **quality of life**
- Protects the **environment**
- Accelerates **economic development**

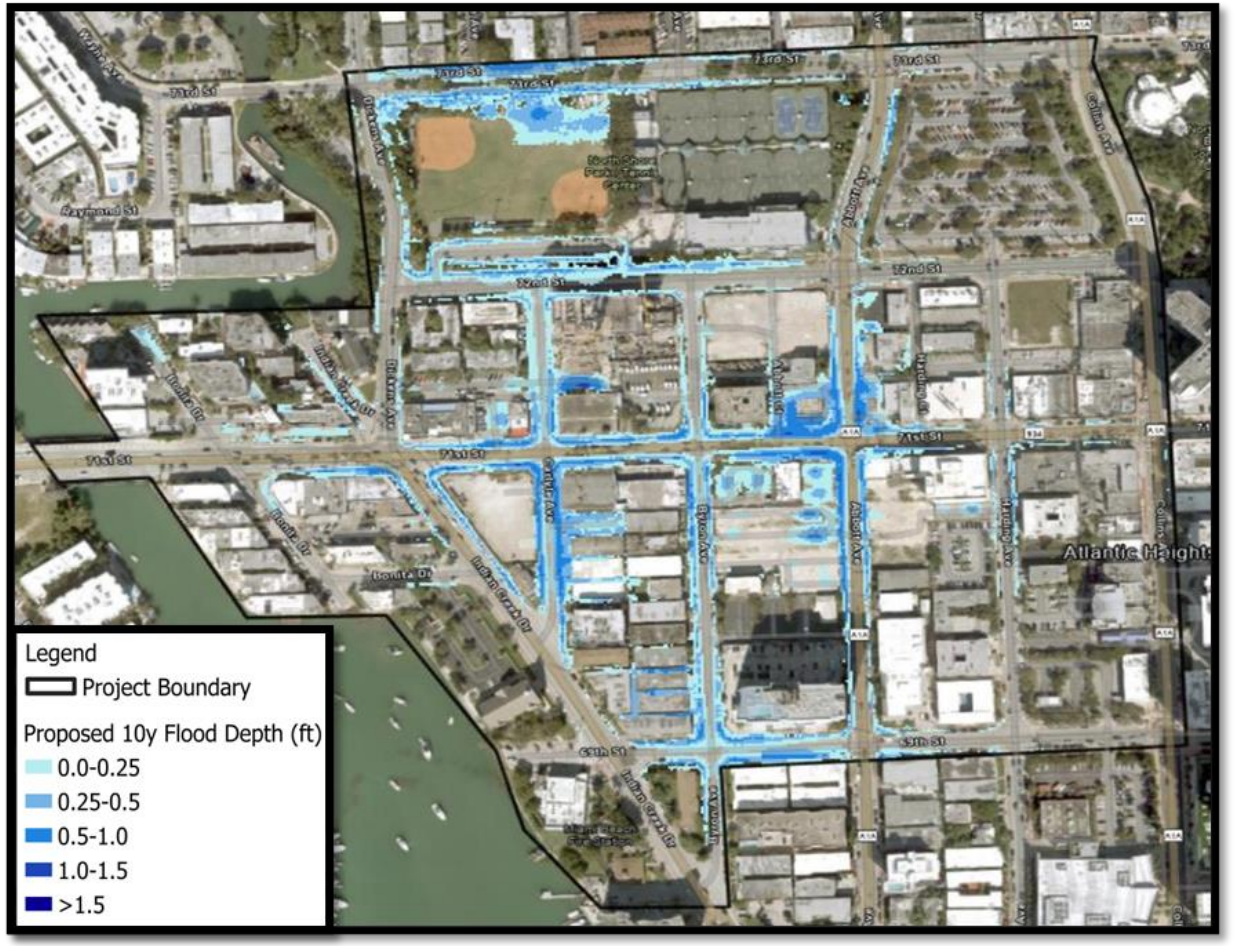


North Shore D – North Beach Town Center Flood Mitigation

Existing Conditions



Proposed Conditions*



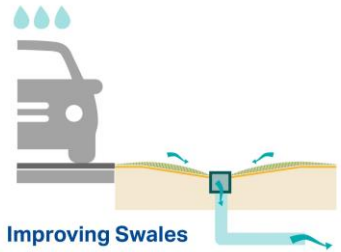
Stormwater Master Plan Projects

A combination of…

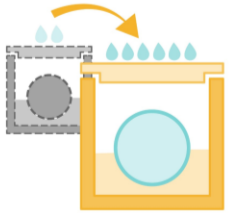
- ✓ Neighborhood Improvement Projects
- ✓ **Critical Needs Projects**
- ✓ Water Quality Projects

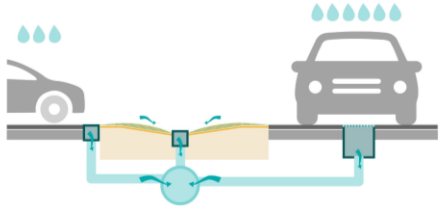
Critical Needs Stormwater Projects

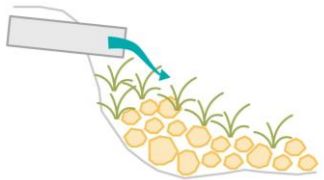
- Smaller project aimed at addressing nuisance flooding to provide both **beneficial** and **cost-effective** solutions within targeted areas.
- **Complimentary** and **adaptable** to the future NIPs (not throw-away…)
- Includes a variety of solutions available in the “Drainage Toolbox”.

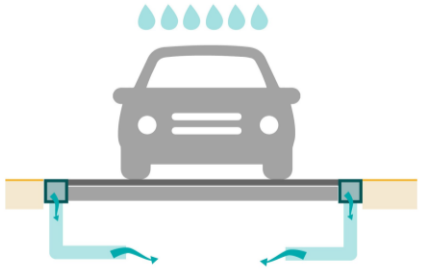

Improving Swales


Regrading, Repaving, and Minor Road Raising

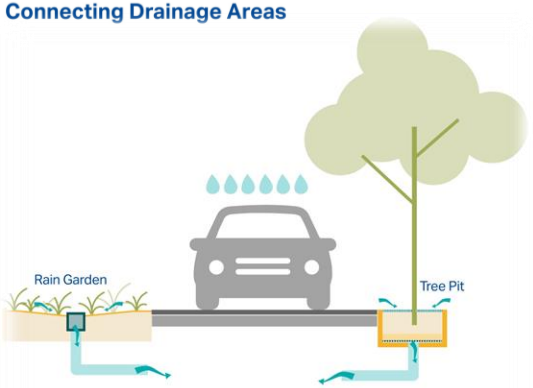

Upsizing Infrastructure


Connecting Drainage Areas

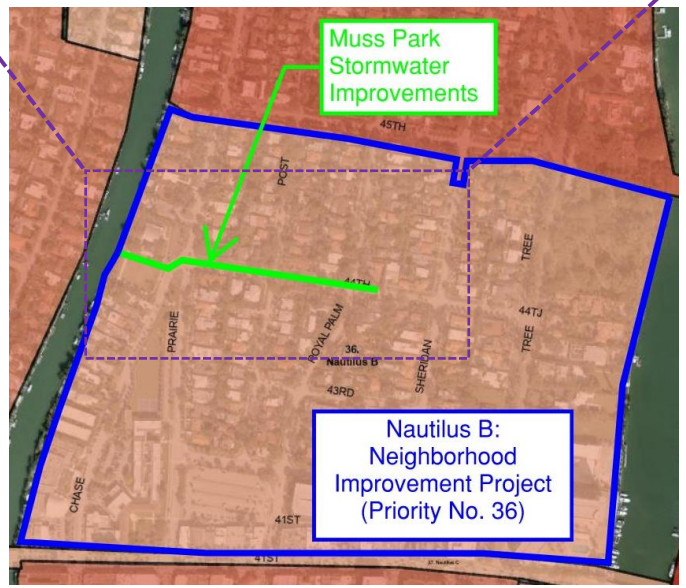

Enhance Existing Outfalls


Adding Catch Basins


Water Quality Improvements



Implementing Blue-Green Infrastructure



Prioritization of Critical Needs Projects

Criteria	Criteria Weighting
• Temporary Pumps Historically Deployed	7
• Low Topography / Tidal Inundation	7
• Flooding Complaints	7
• Constructability/ Ease of Implementation	7
• Neighborhood Improvement Project Ranking	6
• No Improvements in the Last 10 Years	6
• Insufficient Drainage	4
• Exfiltration Trenches	4
• Drainage Wells	4
• Historic District	3
• Community and Emergency Facilities	3
• No Permitting Complexity	3
• No Connection to Outfalls	1
• 10-Year Design Storm Flooding	1

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Recommended Critical Needs Projects

Critical Needs Rank	NIP Rank	Critical Needs Project Name	FY 2023 Budgetary Estimate	Anticipated Construction Commencement	Escalated Budgetary Estimate	Critical Needs Score
1	39	Nautilus F (North)	$ 4,000,000	FY 2026	$ 4,900,000	Ongoing
2	36	Nautilus B - Muss Park	$ 4,300,000	FY 2026	$ 5,300,000	Ongoing
3	33	La Gorce C - N Bay Rd 1	$ 4,300,000	FY 2027	$ 5,400,000	247
4	48	La Gorce A	$ 3,000,000	FY 2027	$ 3,800,000	243
5	33	La Gorce C - N Bay Rd 2	$ 4,000,000	FY 2028	$ 5,200,000	239
6	29	City Center A - Palm View	$ 4,800,000	FY 2028	$ 6,200,000	236
7	23	Flamingo/Lummus E - Lenox Ave	$ 1,300,000	FY 2029	$ 1,800,000	216
8	39	Nautilus F - Nautilus Dr	$ 800,000	FY 2029	$ 1,000,000	216
9	9	N Shore B & C - Dickens Ave	$ 2,600,000	FY 2030	$ 3,700,000	202
10	6	mingo/Lummus A - Jefferson Aven	$ 1,900,000	FY 2030	$ 2,600,000	200
11	21	North Shore A - Byron Ave	$ 5,900,000	FY 2031	$ 8,600,000	194
12	49	Nautilus D - N Bay Rd	$ 3,500,000	FY 2031	$ 5,100,000	192
13	5	Flamingo/Lummus C - Lenox Ave	$ 3,100,000	FY 2032	$ 4,600,000	187
14	22	Nautilus A - Royal Palm Ave	$ 2,400,000	FY 2032	$ 3,600,000	187
15	42	Lakeview A (North)	$ 3,200,000	FY 2033	$ 5,000,000	185
16	28	Nautilus G - N Bay Rd	$ 3,400,000	FY 2033	$ 5,300,000	175
17	25	Bayshore B (North)	$ 4,200,000	FY 2034	$ 6,700,000	170
18	31	Normandy Shores A - Shore Lane	$ 1,200,000	FY 2034	$ 1,900,000	170
19	34	Lower North Bay Rd A	$ 1,800,000	FY 2035	$ 3,000,000	167
20	36	La Gorce Island A	$ 6,800,000	FY 2035	$ 11,300,000	164
		TOTAL	**$ 66,500,000**		**$ 95,000,000**	

Stormwater Master Plan Projects

A combination of…

- ✓ Neighborhood Improvement Projects
- ✓ Critical Needs Projects
- ✓ **Water Quality Projects**

Ongoing Water Quality Projects

Design and Permitting Timeline

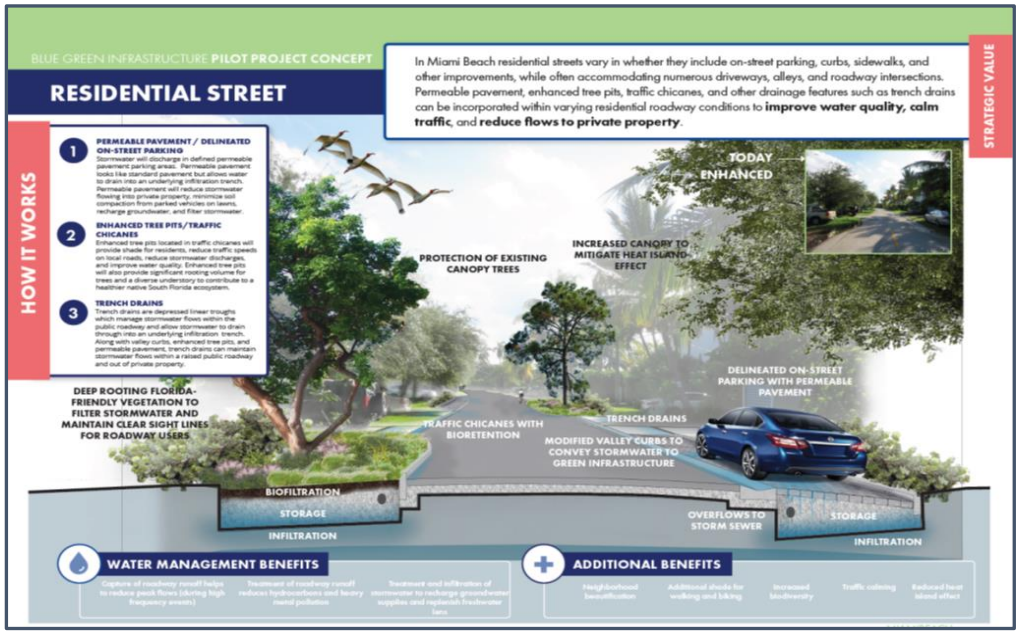
Construction Timeline

Water Quality Improvement Efforts & Approach

5

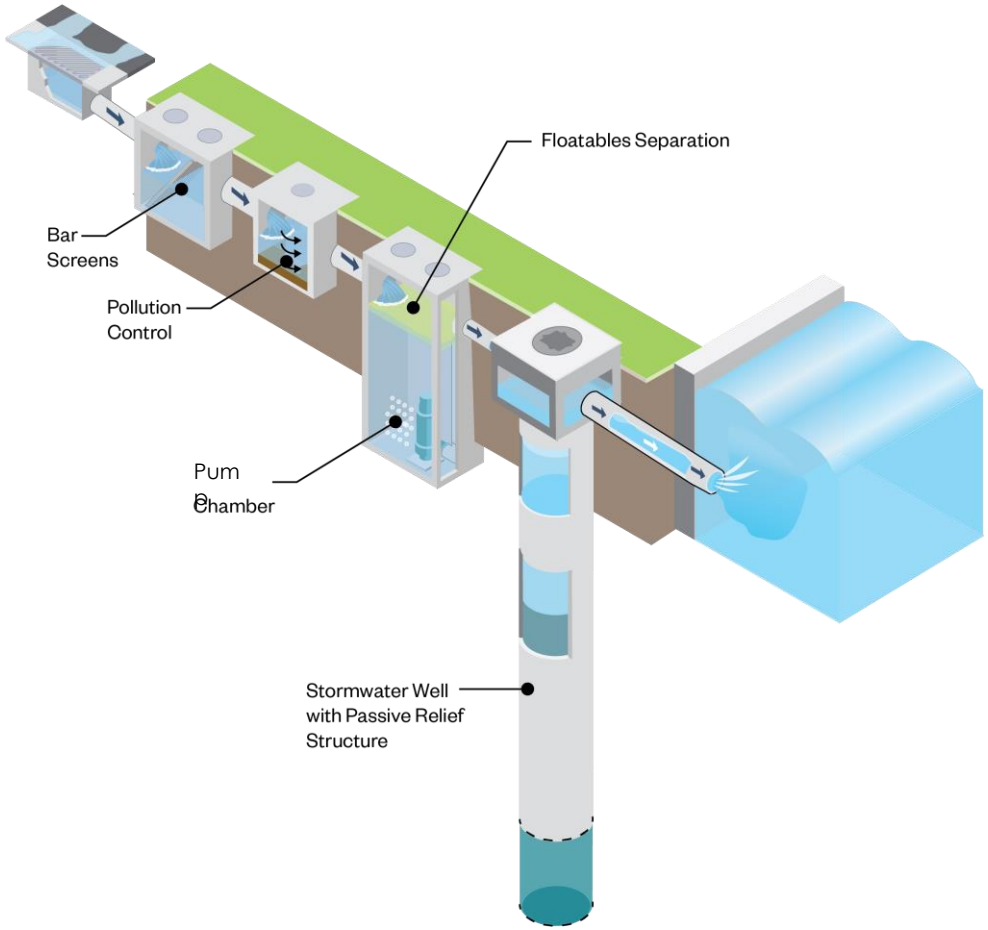
Blue Green Stormwater Infrastructure Integrated Into All Relevant Planning

- **Recommended practices:**
  - Bioretention (ponds/swales)/Rain Gardens
  - Blue-green roofs
  - Constructed/floating wetlands
  - Detention basins
  - Enhanced tree planters
  - Pumped injection
  - Permeable pavement
  - Rainwater Harvesting
  - Stormwater planters
  - Subsurface infiltration/storage
  - Wet ponds
  - Tree canopy
- **Implementation scenarios:** residential, commercial, transportation & public spaces



New-Generation Stormwater Treatment Systems

Examples of planned improvements: PS 32, First Street, West Ave, PS 24



Water Quality Treatment Systems:

- ✓ 5 stage treatment - <u>incorporates best of available technologies</u>
- ✓ Includes injection well to sequester "first flush"
- ✓ Outfall for Large Storms

Injection Wells: Annual Average Pollutant Load Removal

City of Miami Beach

Example Basin Calculation

Annual Average Pollutant Load Removal

Annual Average Water Quality Treatment from Injection Wells*

1-Hour Intensity Range	Annual Runoff by Range	Average Depth of Runoff	@ 1-inch/hr % Runoff Treated	% Annual Runoff by Range	% Annual Runoff Treated (TSS/TN/TP)	Weighted Ave Annual Runoff
	(inches)	(inches)	(%)	(%)	(%)	$(inches)^2$
1	2.45	0.08	100.00%	4.11%	4.11%	0.20
2	11.31	0.23	100.00%	18.98%	18.98%	2.60
3	1.68	0.45	100.00%	2.82%	2.82%	0.76
4	7.75	0.57	100.00%	13.01%	13.01%	4.42
5	5.87	0.80	100.00%	9.85%	9.85%	4.70
6	1.05	0.92	100.00%	1.76%	1.76%	0.97
7	4.30	**1.02**	100.00%	7.22%	7.22%	4.39
8	0.78	1.12	89.29%	1.31%	1.17%	0.87
9	3.68	1.23	81.30%	6.18%	5.02%	4.53
10	3.37	1.42	70.42%	5.66%	3.98%	4.79
11	2.99	1.63	61.35%	5.02%	3.08%	4.87
12	3.47	1.90	52.63%	5.82%	3.07%	6.59
13	3.92	2.30	43.48%	6.58%	2.86%	9.02
14	2.79	2.98	33.56%	4.68%	1.57%	8.31
15	1.17	3.60	27.78%	1.96%	0.55%	4.21
16	1.25	4.17	23.98%	2.10%	0.50%	5.21
17	0.46	4.61	21.69%	0.77%	0.17%	2.12
18	0.43	4.98	20.08%	0.72%	0.14%	2.14
19	0.50	5.72	17.48%	0.84%	0.15%	2.86
20	0.36	7.24	13.81%	0.60%	0.08%	2.61
Totals	**59.58**			**100%**	**80.10%**	**76.15**

1.28	Weighted Annual Average Runoff Depth
78.24%	Percent Treatment Based on weighted annual runoff depth
1.02	Maximum Treatment Capacity of Injection Well

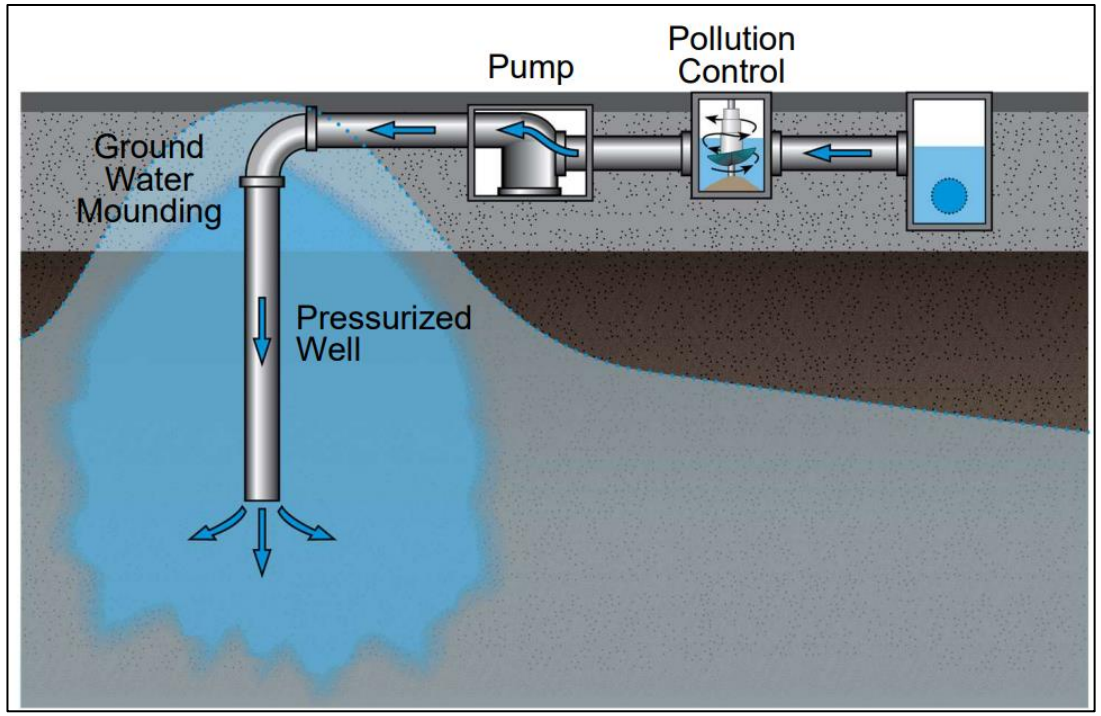
* Assumes WQ Injection Wells sized to treat 1-inch WQ treatment volume over 1-hour

Projected capture of 80% of total annual runoff to address Total Suspended Solids (TSS), Total Phosphorus (TP), and Total Nitrogen (TN).

Injection Wells: Limitations & Challenges

$ cost & maintenance requirements

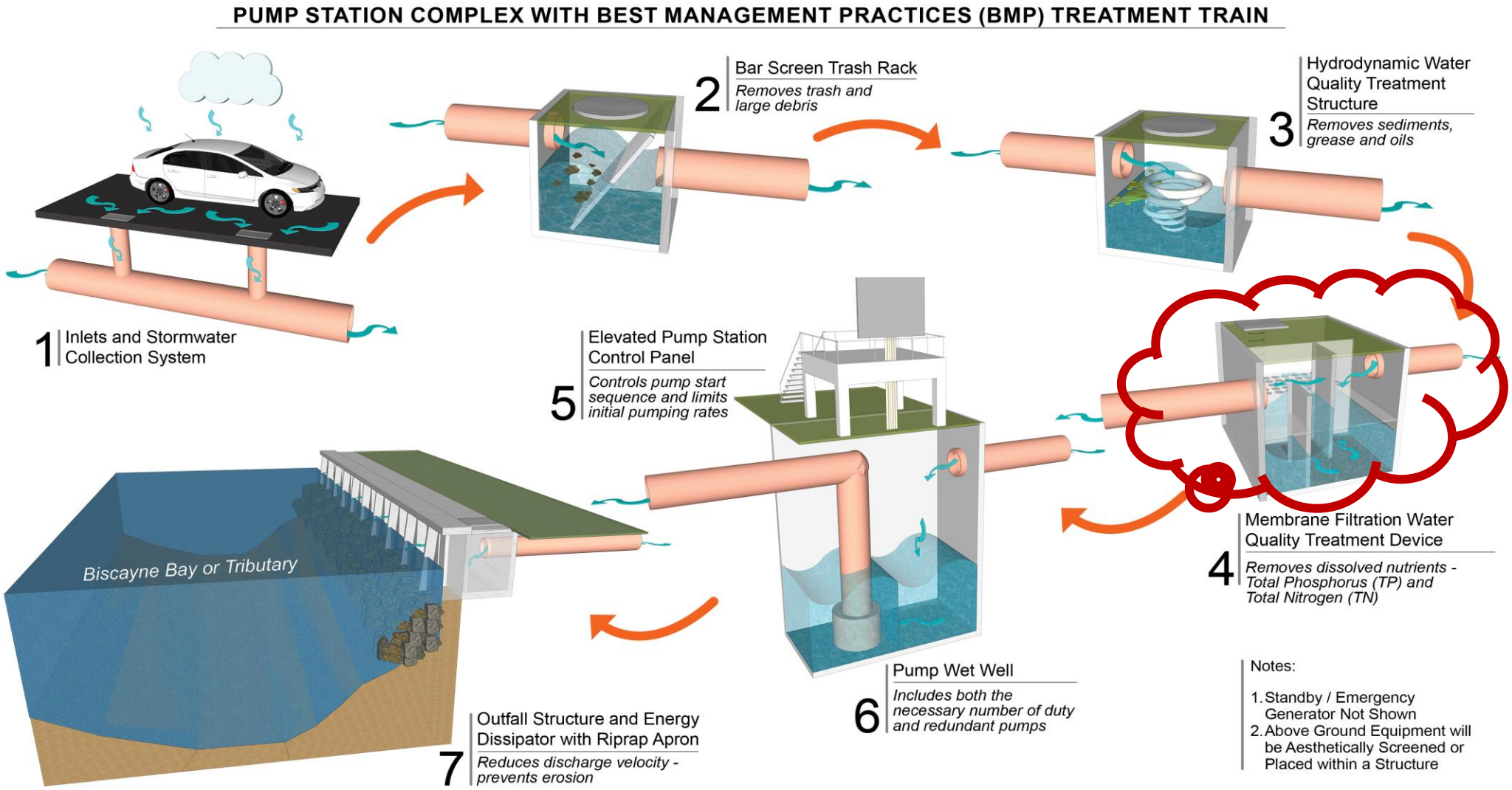
groundwater mounding



limited space within the ROW

Thus, evaluated other solutions that offer effective and cost-efficient alternatives.

Next-Generation Stormwater Treatment Systems



MIAMIBEACH

Filtration Water Quality Treatment Device

Stormwater Treatment Proposed Infrastructure

The filters provide a very large surface area to effectively remove fine sand and silt-sized particles, and a high percentage of particulate-bound pollutants such as nitrogen, phosphorus, metals, and hydrocarbons while ensuring long-lasting treatment.

MIAMIBEACH

Annual Average Pollutant Removal Calculation

City of Miami Beach

Example Basin Calculation

Annual Average Pollutant Load Removal

Basin Parameters		
Basin Area	50	acres
Time of Concentration, Tc	60	minutes
Runoff Coefficient	0.95	
Est. Pump Capacity	162	cfs
Est. Pump Capacity	72800	gpm
Annual Rainfall Runoff	59.58	inches

Required Water Quality		
150% of 1-Inch over Entire Basin	272,250	cubic feet
Water Quality Treatment Rate	75.6	cfs
(water quality volume to be treated over period of 1-hour)		
Proposed Water Quality Treatment		
Water Quality Treatment Rate	76.0	cfs
(to be provided in one or more treatment trains)		

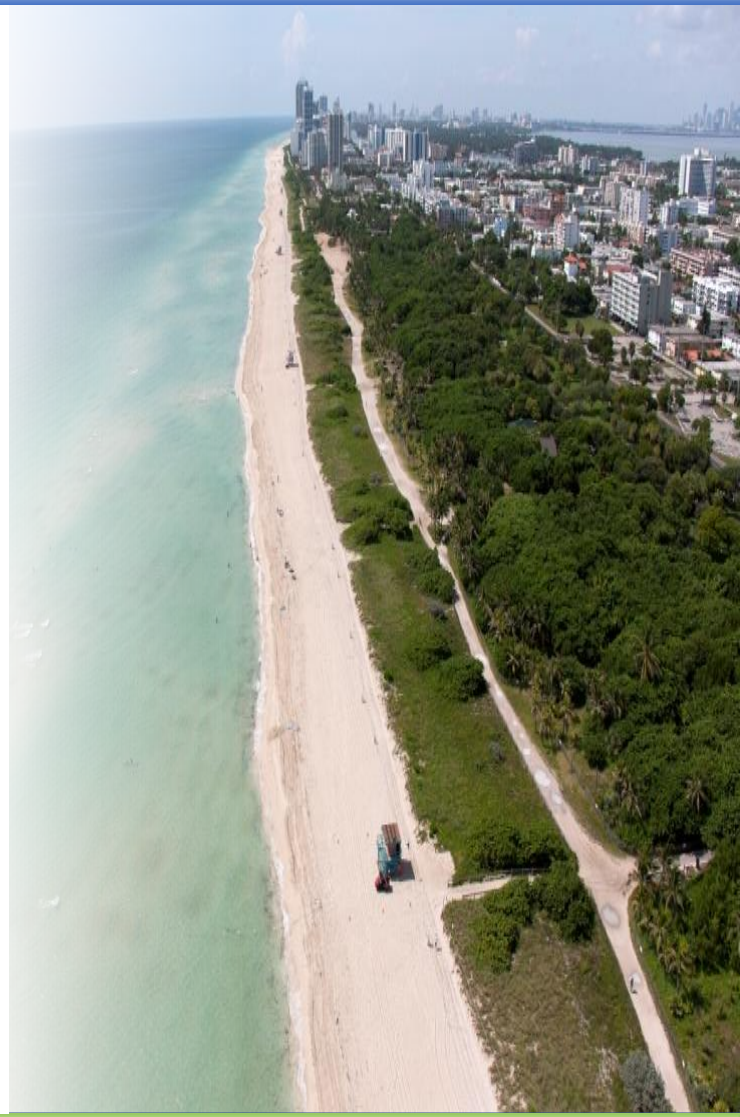
JellyFish Removal Efficiencies		
Total Suspended Solids	89	%
Total Phosphorus	59	%
Total Nitrogen	51	%
Hydrodynamic Separator Efficiencies		
Total Suspended Solids	80	%
Total Phosphorus	10	%
Total Nitrogen	0	%

Intensity Interval	Intensity Range (in/hr)	Average Intensity[1] (in/hr)	% Annual Rainfall by Intensity[1] (%)	Cumulative Rainfall Volume (%)	Runoff Flow Rate Generated (CFS)	Treatment Flow Rate (CFS)	Percent Flow Rate Treated (%)	Average Runoff Depth (inches)	Increment of Annual Runoff (inches)	Percent Annual Runoff (%)	Cumulative Annual Runoff (inches)	Cumulative % Annual Runoff (%)	% Annual TSS Removed (TSS)	% Annual Phosphorus Removed (TP)	% Annual Nitrogen Removed (TN)
1	0.0-0.06	0.025	25.67%	25.67%	1.18	1.2	100%	0.08	2.45	4.12	2.45	4.12	22.85	15.15	13.09
2	0.06-0.12	0.099	39.67%	65.34%	4.69	4.7	100%	0.23	11.31	18.99	13.76	23.11	35.31	23.41	20.23
3	0.12-0.18	0.153	2.99%	68.33%	7.25	7.3	100%	0.45	1.68	2.82	15.44	25.93	2.66	1.76	1.52
4	0.18-0.24	0.202	10.78%	79.11%	9.61	9.6	100%	0.57	7.75	12.95	23.19	38.88	9.60	6.36	5.50
5	0.24-0.30	0.294	5.92%	85.03%	13.95	14.0	100%	0.80	5.87	9.85	29.06	48.73	5.27	3.49	3.02
6	0.30-0.36	0.333	0.91%	85.94%	15.81	15.8	100%	0.92	1.05	1.76	30.11	50.49	0.81	0.54	0.46
7	0.36-0.42	0.399	3.39%	89.34%	18.95	18.9	100%	1.02	4.30	7.22	34.41	57.71	3.02	2.00	1.73
8	0.42-0.48	0.457	0.56%	89.90%	21.71	21.7	100%	1.12	0.78	1.32	35.19	59.03	0.50	0.33	0.29
9	0.48-0.54	0.503	2.40%	92.29%	23.91	23.9	100%	1.23	3.68	6.17	38.87	65.20	2.13	1.41	1.22
10	0.54-0.66	0.600	1.91%	94.21%	28.50	28.5	100%	1.42	3.37	5.66	42.24	70.86	1.70	1.13	0.97
11	0.66-0.78	0.707	1.47%	95.68%	33.60	33.6	100%	1.63	2.99	5.02	45.23	75.88	1.31	0.87	0.75
12	0.78-0.96	0.854	1.47%	97.14%	40.59	40.6	100%	1.90	3.47	5.83	48.70	81.71	1.30	0.86	0.75
13	0.96-1.20	1.079	1.37%	98.51%	51.27	76.0	100%	2.30	3.92	6.59	52.62	88.30	1.22	0.81	0.70
14	1.20-1.55	1.366	0.75%	99.26%	64.90	76.0	100%	2.98	2.79	4.68	55.41	92.98	0.67	0.44	0.38
15	1.55-1.76	1.657	0.26%	99.52%	78.72	76.0	97%	3.60	1.17	1.96	56.58	94.94	0.22	0.15	0.13
16	1.76-2.02	1.877	0.24%	99.75%	89.16	76.0	85%	4.17	1.25	2.09	57.83	97.03	0.18	0.12	0.10
17	2.02-2.28	2.151	0.08%	99.83%	102.18	76.0	74%	4.61	0.46	0.77	58.29	97.80	0.05	0.04	0.03
18	2.28-2.50	2.373	0.07%	99.90%	112.72	76.0	67%	4.98	0.43	0.73	58.72	98.53	0.04	0.03	0.02
19	2.50-3.10	2.704	0.07%	99.96%	128.43	76.0	59%	5.72	0.50	0.84	59.22	99.37	0.03	0.02	0.02
20	3.10-4.01	3.455	0.04%	100.00%	164.11	76.0	46%	7.24	0.36	0.61	59.58	99.98	0.01	0.01	0.01
								Totals	**59.58**	**99.98**	**Annual Percent Removal**		**87.68**	**58.12**	**50.24**

Notes: (1) Source: NOAA National Centers for Environmental Information (https://www.ncei.noaa.gov/cdo-web/datasets)

89.16 Represents runoff volumes in excess of maximum treatment capacity

1.63 Represents runoff rates in excess of 1-inch per hour



BMP Treatment Train Results

City of Miami Beach

Example Basin Calculation

WQ BMP Treatment Train

Annual Average Pollutant Load Removal

	BMP Treatment Train												
	Street Sweeping[1]	HydroDynamic Separator					Jellyfish[2]						Total Percentage Annual Removal
	Efficiency #1	Efficiency #2					Efficiency #3						
Parameter	Percent Removed	Percent Efficiency		Percent Remain		Percent Removed	Percent Efficiency[3]		Percent Remain		Percent Removed		
Total Phosphorus	6.8	10.0	*	93.2	=	9.3	58.1	*	83.9	=	48.8		64.9
Total Suspended Solids	0.0	80.0	*	100.0	=	80.0	87.7	*	20.0	=	17.5		97.5
Total Nitrogen	1.8	0.0	*	98.2	=	0.0	50.2	*	98.2	=	49.3		51.1

Notes: (1) Source: Stormwater Quality Study for the City of Miami Beach - Ardurra Group, Inc., August 4, 2022

(2) Nutrient Removal Efficiency at Flow Rates at (or below) rated capacity

(3) Efficiency Rates Based on Evaluation of Annual Average Nutrient Removal (see example calculation)

In Conclusion:

This approach complies with State requirements for reconstruction of existing stormwater management systems and meets the intent of the proposed Reasonable Assurance Plan forthcoming for Biscayne Bay.

Additionally, this approach approximately **doubles** the City's current stormwater management system removal rates of Total Nitrogen (from 27.3% to 51.1%) and Total Phosphorous (24.4% to 64.9%).

Thank you!

Questions?