OPERATIONALIZING FLOOD DESIGN GUIDELINES

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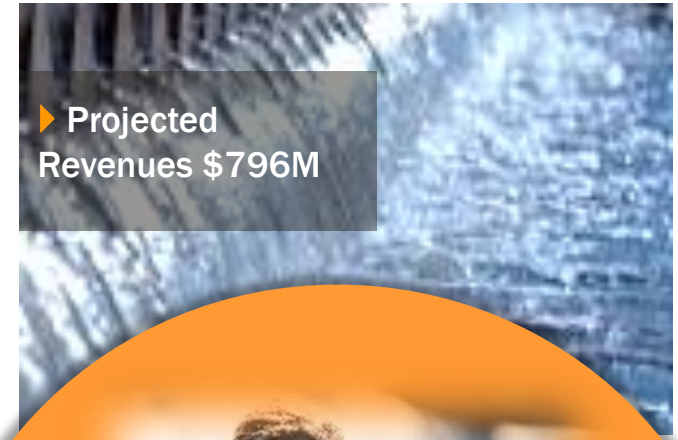
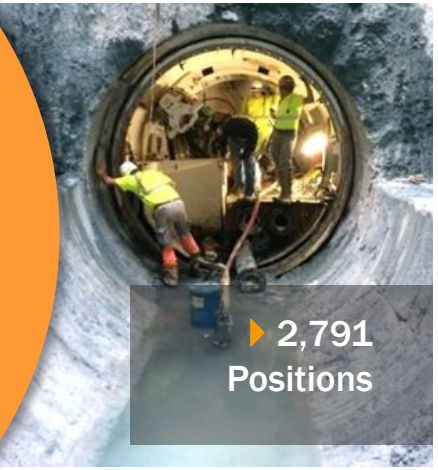
Flood Resilience Training,
Boca Raton, FL May 7, 2019

AGENDA

1. Miami-Dade County Flooding Risks
2. Policy and Other Drivers
3. Modeling and Assessments
4. Design Guidelines and Tools
5. Examples and Lessons Learned



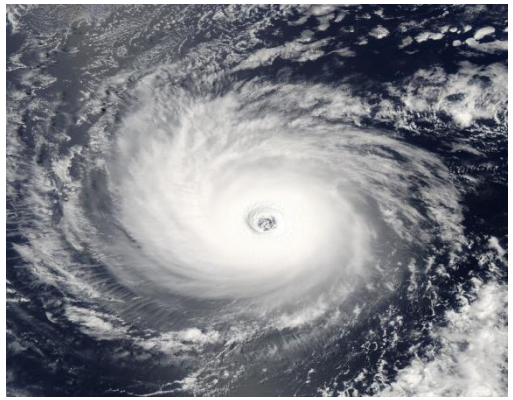
Serving
Over 2.3 Million
Residents



The Miami-Dade Water & Sewer Department

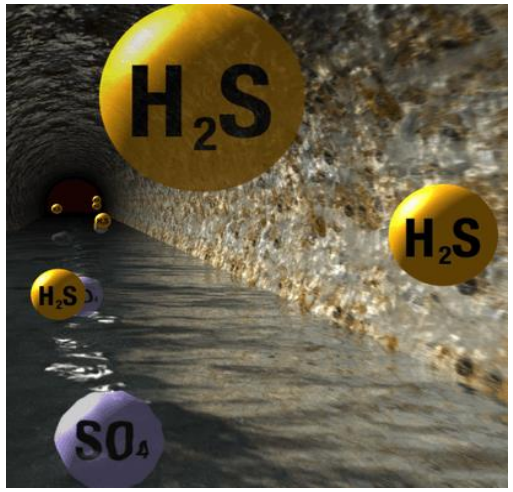
Largest water utility in the Southeastern United States, providing high-quality, affordable water & wastewater services to the residents and visitors of Miami-Dade County

Utility Challenges



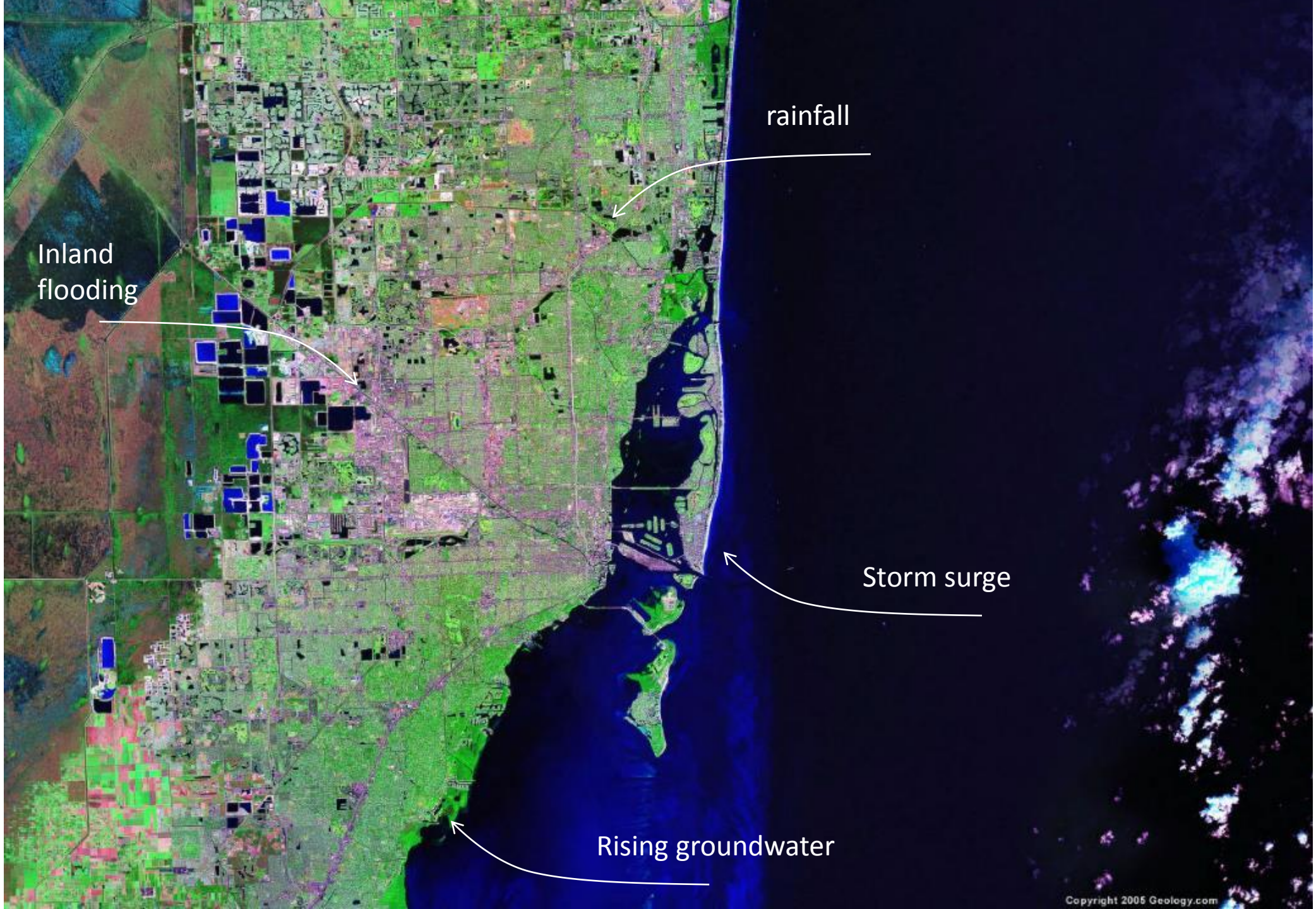
Shocks - sudden events

- Hurricanes & natural disasters
- Infrastructure failure/service disruptions
- Flooding events (King Tides/Storms)
- Malevolent Acts – Attacks, Cybersecurity



Stresses - weaken the fabric of a system on a longer term basis

- Aging infrastructure
- Rising sea and groundwater levels – flooding, salt water intrusion
- Limited financial resources
- Changes in precipitation - increase in Inflow & Infiltration, flooding
- Increasing levels of nutrient and other pathogens in natural systems
- Population and development pressures
- Regulatory requirements


rainfall
Inland flooding
Storm surge
Rising groundwater
Copyright 2005 Geology.com

Sectors Requiring Adaptation

Building Blocks of Utility Resilience

1989 Biogas from wastewater treatment used to generate energy

1992 4 weeks w/out power after Hurr. Andrew – shift in supply and design practices

2006 High Level Disinfection Project – critical assets raised and flood resistant gens

2008 Began reporting Green House Gas (GHG) Emissions

2010 Sustainability Strategies in County GreenPrint and Electricity Plans

2010 Unified Southeast Florida Sea Level Rise Projection – WASD was contributor

2012 Landfill methane sequestration and pipeline to plant to generate energy

2014 WASD/USGS - integrated surface water/groundwater numerical flow model

Unified Sea Level Rise Projections
Southeast Florida Regional Climate Change Compact

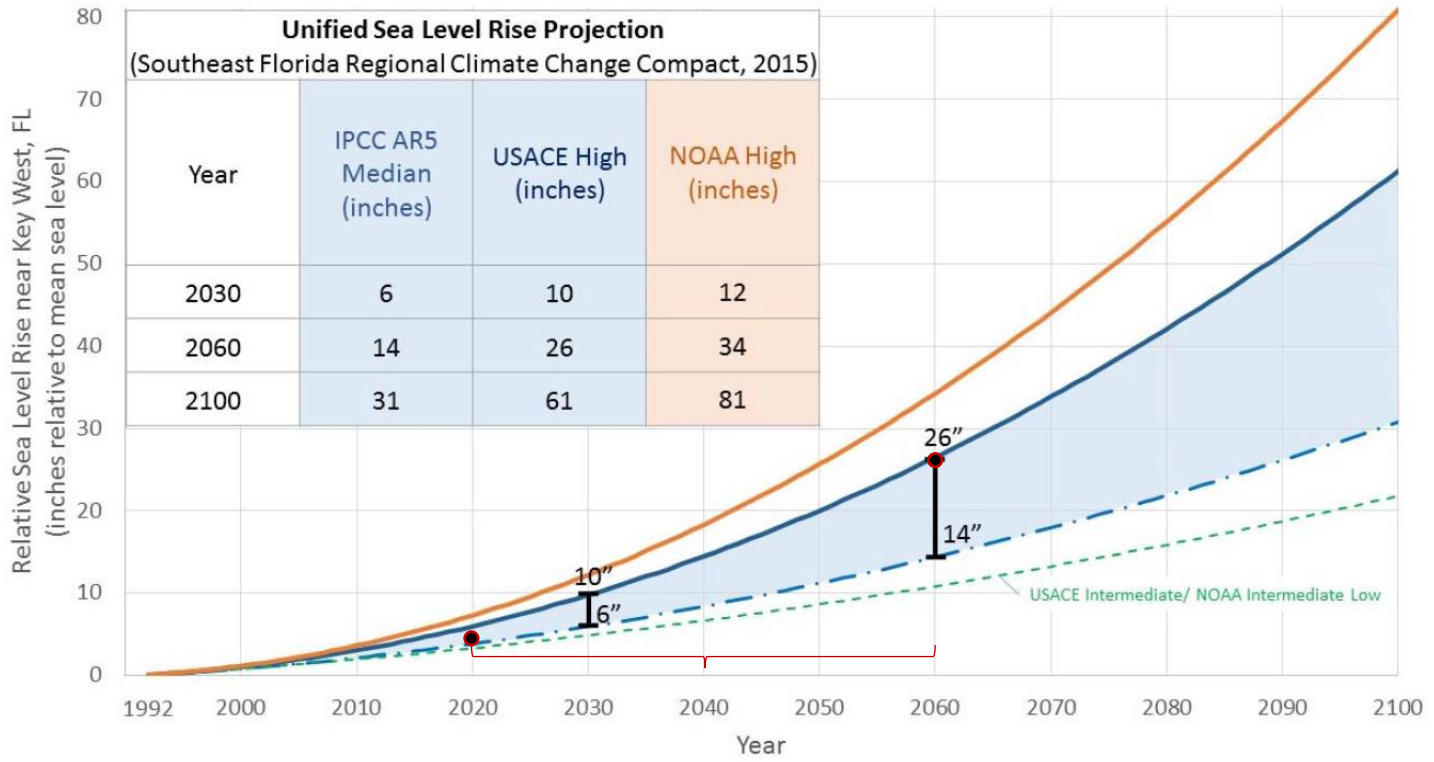
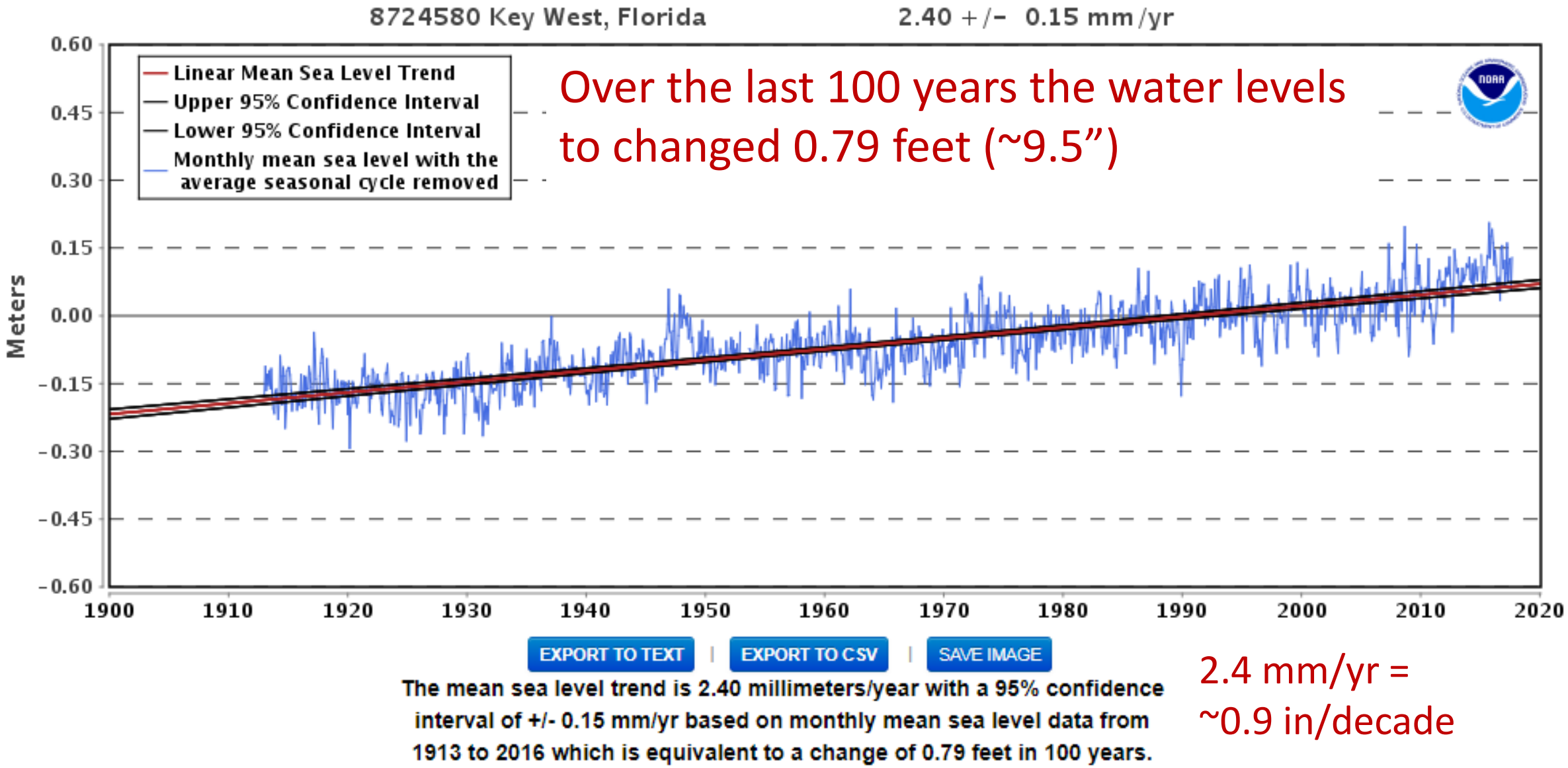


Figure 1: Unified Sea Level Rise Projection. These projections are referenced to mean sea level at the Key West tide gauge. The projection includes three global curves adapted for regional application: the median of the IPCC AR5 RCP8.5 scenario as the lowest boundary (blue dashed curve), the USACE High curve as the upper boundary for the short term for use until 2060 (solid blue line), and the NOAA High curve as the uppermost boundary for medium and long term use (orange solid curve). The incorporated table lists the projection values at years 2030, 2060 and 2100. The USACE Intermediate or NOAA Intermediate Low curve is displayed on the figure for reference (green dashed curve). This scenario would require significant reductions in greenhouse gas emissions in order to be plausible and does not reflect current emissions trends.

Mean Sea Level Trend
8724580 Key West, Florida

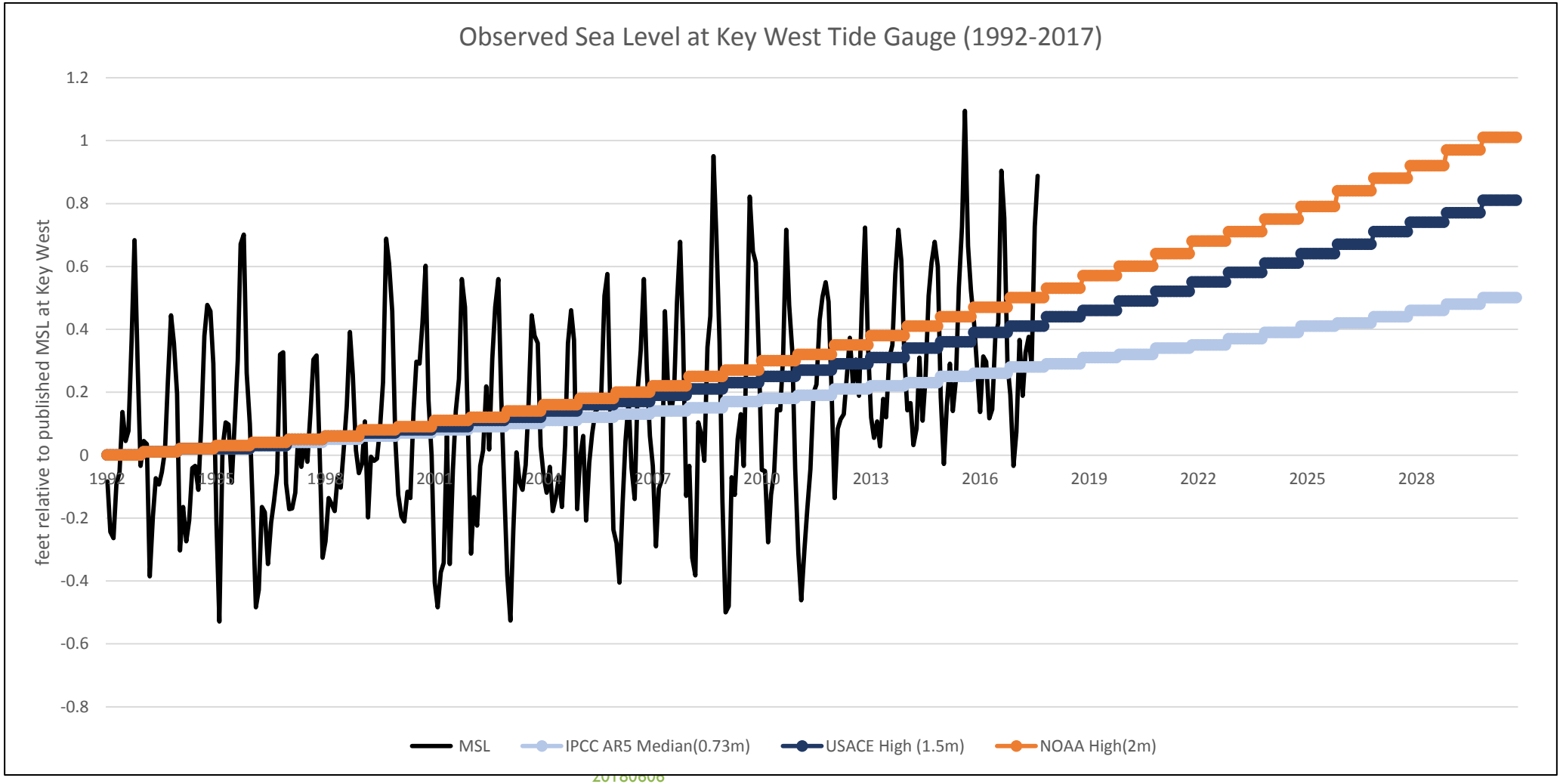


Over the last 100 years the water levels to changed 0.79 feet (~9.5”)

The mean sea level trend is 2.40 millimeters/year with a 95% confidence interval of +/- 0.15 mm/yr based on monthly mean sea level data from 1913 to 2016 which is equivalent to a change of 0.79 feet in 100 years.

2.4 mm/yr =
~0.9 in/decade

Observed sea levels agree with the SLR projections



Sea level rise expected by 2030:

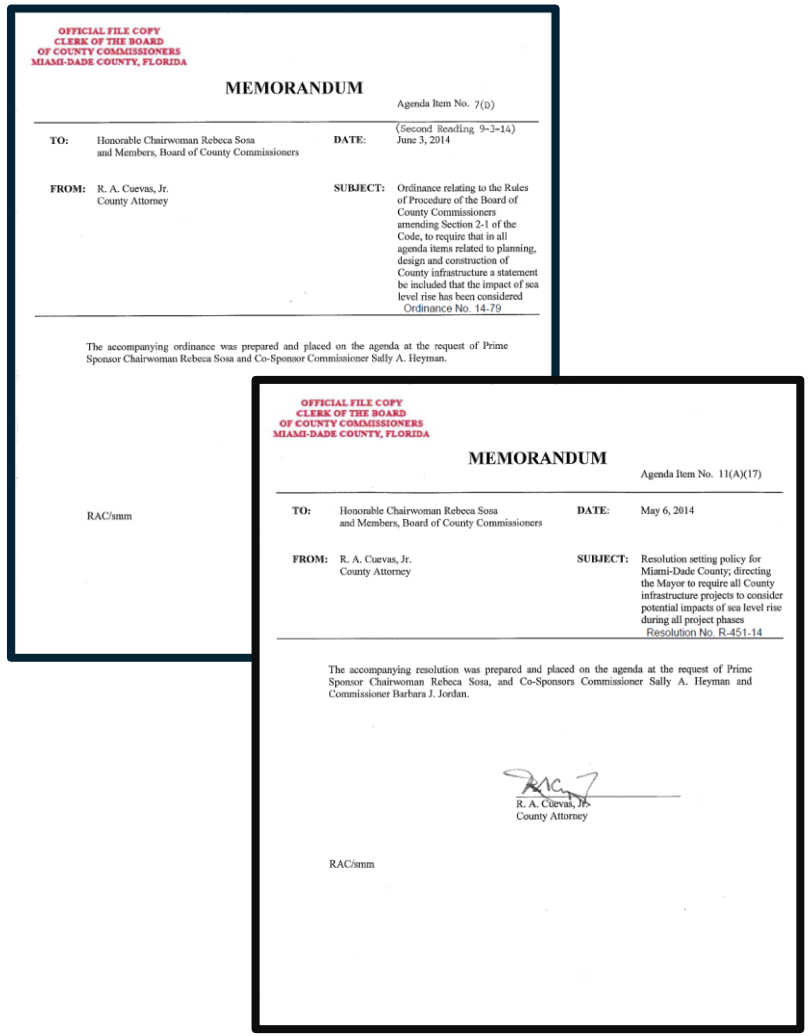
12inches

10inches

6 inches

Completed Project Examples – project by project basis

Driver for Standardized Approach - Miami-Dade County requires sea level rise be considered in county infrastructure projects



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CLERK OF THE BOARD
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MIAMI-DADE COUNTY, FLORIDA

MEMORANDUM

Agenda Item No. 7(D)
(Second Reading 9-3-14)

TO: Honorable Chairwoman Rebeca Sosa and Members, Board of County Commissioners

DATE: June 3, 2014

FROM: R. A. Cuevas, Jr. County Attorney

SUBJECT: Ordinance relating to the Rules of Procedure of the Board of County Commissioners amending Section 2-1 of the Code, to require that in all agenda items related to planning, design and construction of County infrastructure a statement be included that the impact of sea level rise has been considered
Ordinance No. 14-79

The accompanying ordinance was prepared and placed on the agenda at the request of Prime Sponsor Chairwoman Rebeca Sosa and Co-Sponsor Commissioner Sally A. Heyman.

RAC/smm

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CLERK OF THE BOARD
OF COUNTY COMMISSIONERS
MIAMI-DADE COUNTY, FLORIDA

MEMORANDUM

Agenda Item No. 11(A)(17)

TO: Honorable Chairwoman Rebeca Sosa and Members, Board of County Commissioners

DATE: May 6, 2014

FROM: R. A. Cuevas, Jr. County Attorney

SUBJECT: Resolution setting policy for Miami-Dade County; directing the Mayor to require all County infrastructure projects to consider potential impacts of sea level rise during all project phases
Resolution No. R-451-14

The accompanying resolution was prepared and placed on the agenda at the request of Prime Sponsor Chairwoman Rebeca Sosa, and Co-Sponsors Commissioner Sally A. Heyman and Commissioner Barbara J. Jordan.

R. A. Cuevas, Jr.
County Attorney

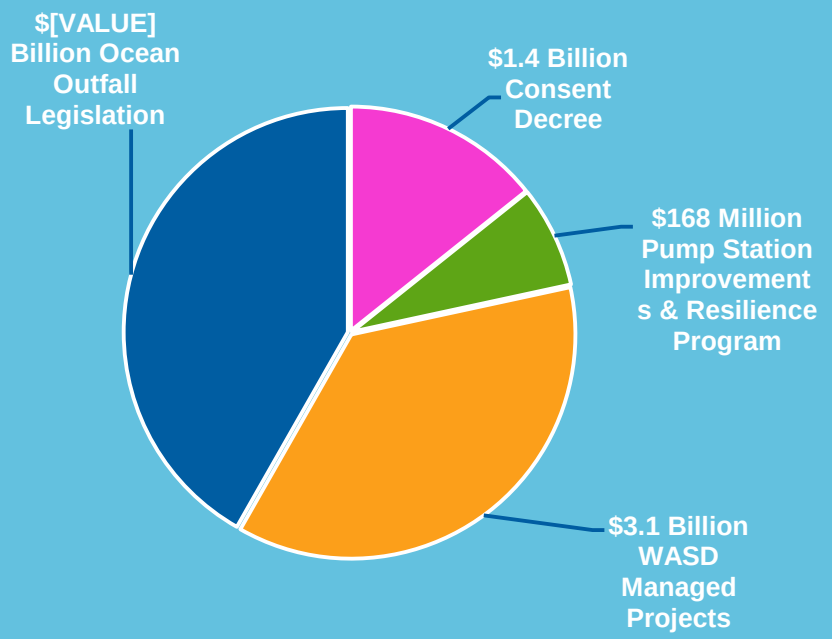
RAC/smm

"It is the policy of Miami-Dade County that **all County infrastructure projects**, including but not limited to County building elevation projects, County installation of mechanical and electrical systems, County infrastructure modifications, and County infrastructure renovations, initiated from the effective date of this resolution **shall consider sea level rise projections and potential impacts** as best estimated at the time of the project, **using the regionally consistent unified sea level rise projections**, **during all project phases** including but not limited to planning, design, and construction, **in order to ensure that infrastructure projects will function properly for fifty (50) years** or the design life of the project, whichever is greater."

Driver for Standardized Approach - Capital Improvement Program

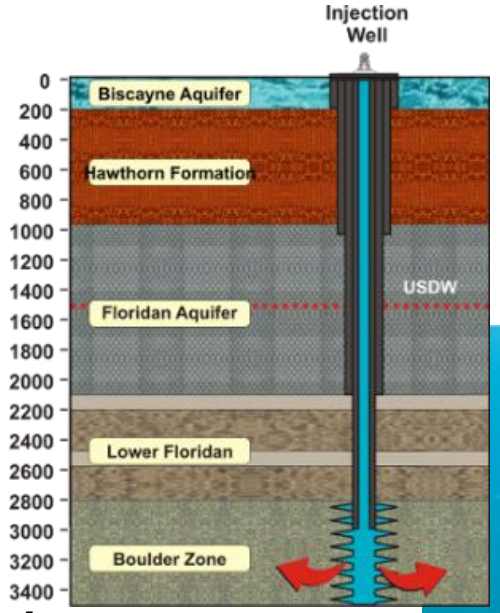
- Significant redesign of plants and system to meet legislative regulatory requirements
- Objectives
  - Ensure regulatory compliance & eliminate moratoriums
  - Address aging infrastructure
  - Build system-wide capacity for development & growth
  - Foster and encourage economic growth & community investments
  - Build system resiliency

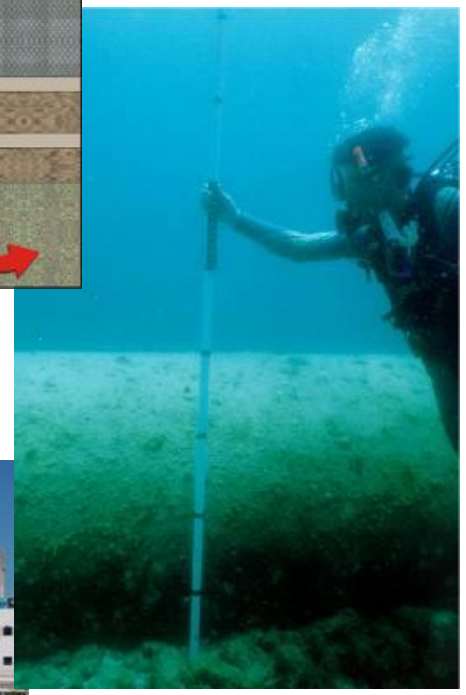
Multi-year Budget Breakdown



Ocean Outfall Legislation (OOL) Program

- Florida Statutes Title CS/SB 444 Section 403.086 Requirements:
  - Wastewater utilities in southeast Florida must move away from using ocean outfalls to dispose of treated wastewater
  - Reduce the use of outfalls by 2025





1 Nutrient Reduction
Reduce cumulative nutrient discharges by 2025

2 60 Percent Reuse
Reuse 60% of the wastewater flows by 2025

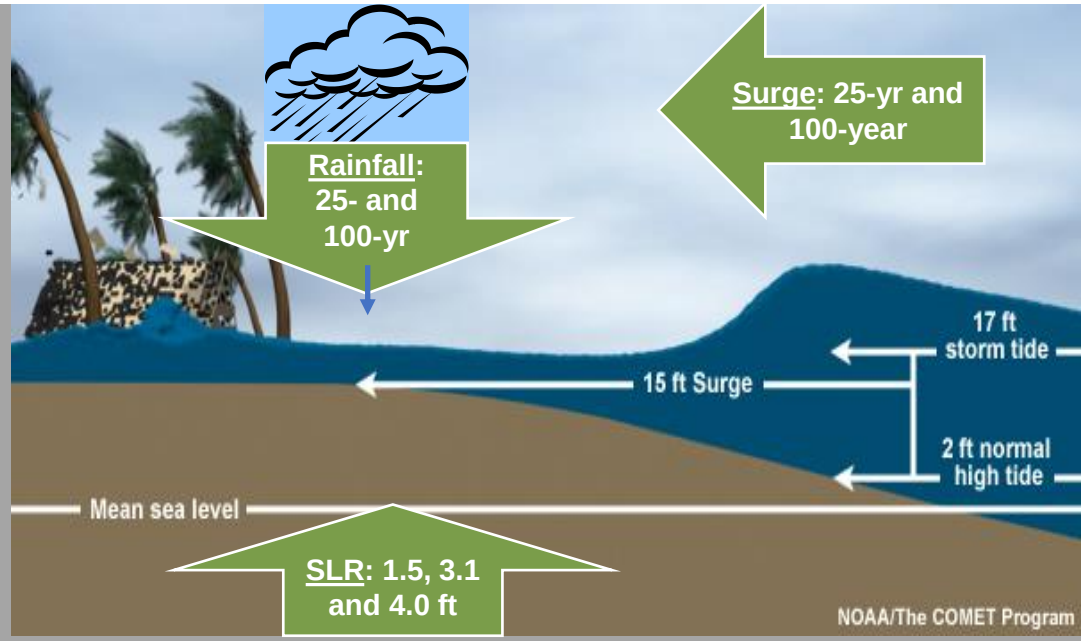
3 Outfall Discharge
Peak flow disposal backup

FPL

Relationship of Modeling Tasks: Storm Surge with Future SLR and Rainfall, Wave Effects

Key Variables:

- Wind driven storm surge:
  - 100-yr and 25-yr storms
- Sea Level Rise (SLR):
  - 1.5 ft (2040), 3.1 and 4.0 ft (2075)
- Coastal Storm Surge Modeling with SLR:
  - MIKE 21 used for scenarios of storm surge and SLR
  - Impacts of coastal bathymetry on storm surge and SLR



- Inland Inundation modeling:
  - Flood Modeler Pro for scenarios of propagation of SLR, Surge, and Rainfall inland
- Wave effects modeling:
  - WHAFIS for wave crest analysis at shoreline and propagation inland

Plant Locations and Inundated Area

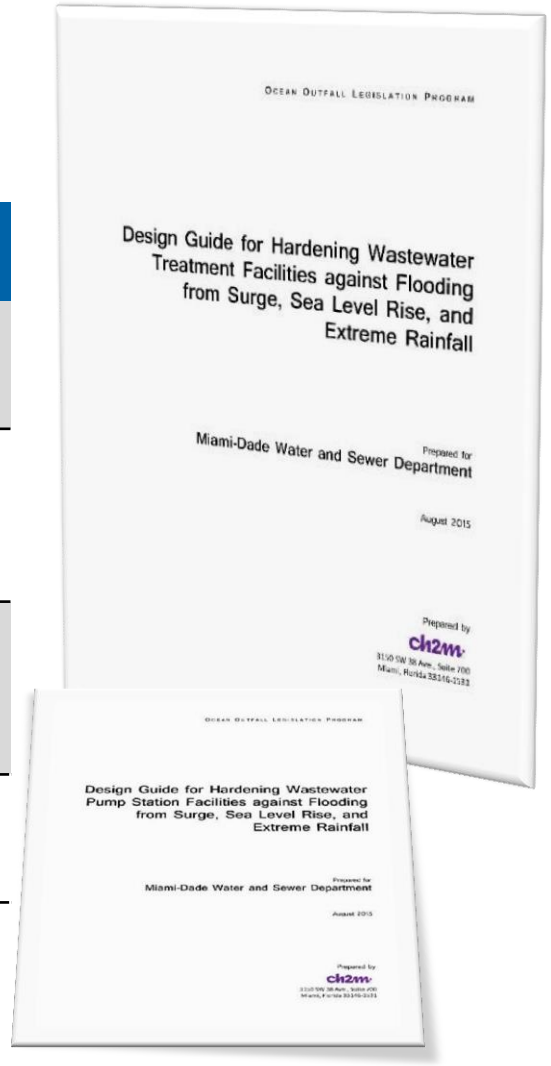
Facility hardening elevation design guidelines for existing and new WWTP assets

	EXISTING WWTP Facility Assets		NEW WWTP Facility Assets	
	ft NGVD29	**Basis**	**ft NGVD29**	**Basis**
CDWWTP	**16.0**	FEMA BFE + 3ft SLR from SEFLCC(2011) +FB +SF	**20.9**	2075 Surge + 4.0 ft SLR + FB +21”(100-yr, 72-hr rainfall)
SDWWTP	**16.0**	FEMA BFE + 3ft SLR from SEFLCC(2011) +FB +SF	**18.8**	2075 Surge + 4.0 ft SLR + FB +21”(100-yr, 72-hr rainfall)
NDWWTP	**16.0**	Same as CDWWTP and SDWWTP	**18.2**	2075 Surge + 4.0 ft SLR + FB +21”(100-yr, 72-hr rainfall)

FB= Freeboard = 2.0 ft per ASCE Standard 24-05/2010 FBC Category IV

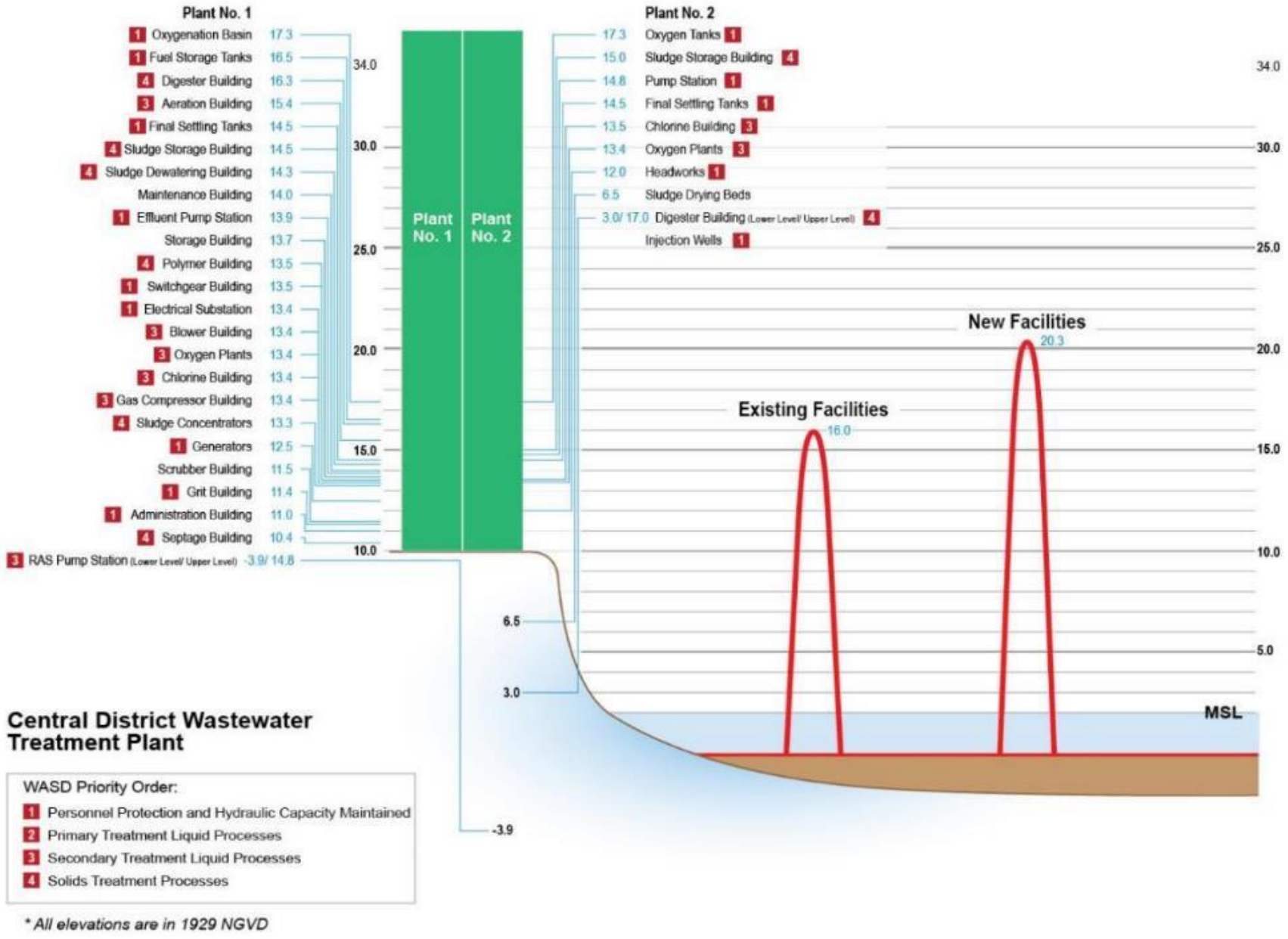
SF= Safety Factor = 1.0 ft per 2014 MWH study at CDWWTP

SLR = 4.0 ft per NOAA High projection for 2075 (USACE High projection is 0.93m)



Percent of Assets Below Flood Design Elevation

57% at NDWWTP
87% at CDWWTP
72% at SDWWTP



Adaptation Strategies and Protective Measures

- site-specific protective measures
- minimize prolonged service interruption and flood risk
- balancing feasibility, resiliency, and cost
- Elevating equipment is not the only option

Source:
NYCDEP

OOL Program Key Challenges

CONSENT DECREE Program
52 Project Elements
$1.6 Billion

OCEAN OUTFALL Legislation Program
$3 Billion

1 **Coordination Between Programs**

2 **Site Space**

3 **Coordination Between Design Consultants and Contractors**

4 **MOPO**

South District Wastewater Treatment Plant

Project	
ST-1B	Stepfeed and Rehab
ST-1C	Filter Backwash
ST-2A	Headworks, O2 trains and SCs
ST-2B	HLD
ST-2C	CCTs and IW PS
ST-2D	Electrical Distribution Bldg
SE-2	Injection Wells

Flows	Existing	Proposed
Avg (mgd)	112.5	131
Peak (mgd)	285	329

Flows	Existing	New
Elevation	16.0	18.8

Ocean Outfall Legislation Projects

Construction Cost Estimate of $350M

Process-Specific Approach to Implement Hardening Criteria

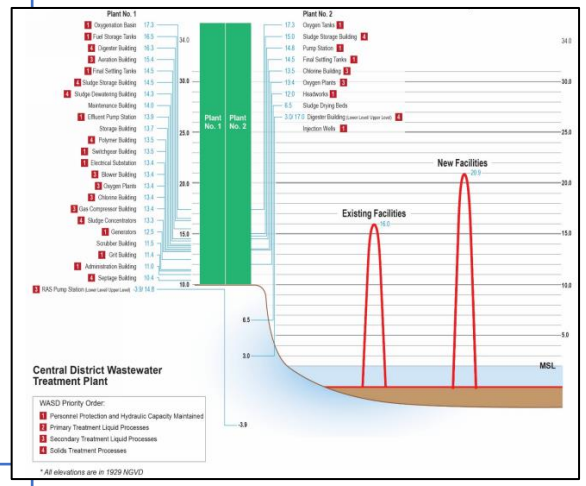
Define Level of Service Priority

Risk-based framework

1. Personnel protection
2. Recovery after storm event
3. Hydraulic capacity maintained
4. Primary treatment liquid processes
5. Secondary treatment liquid processes
6. Tertiary treatment liquid processes
7. Solids treatment processes

Define Actual and design Elevations and Define Complexity

Group by Tier Level



Define Hardening Approach and Alternatives

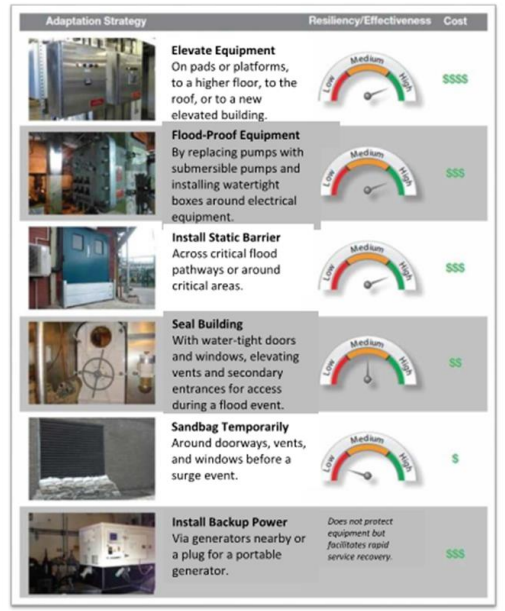


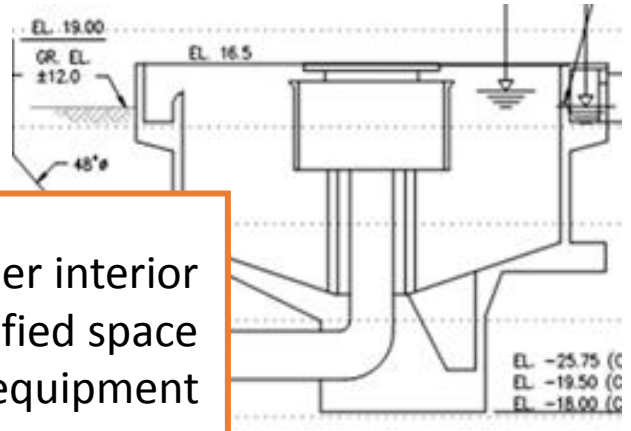
Figure 4. Facility Hardening Approaches. (Source: NYCDEP, 2013)

INTERPRETING HARDENING DESIGN GUIDELINES – Secondary Clarifiers 11 & 12

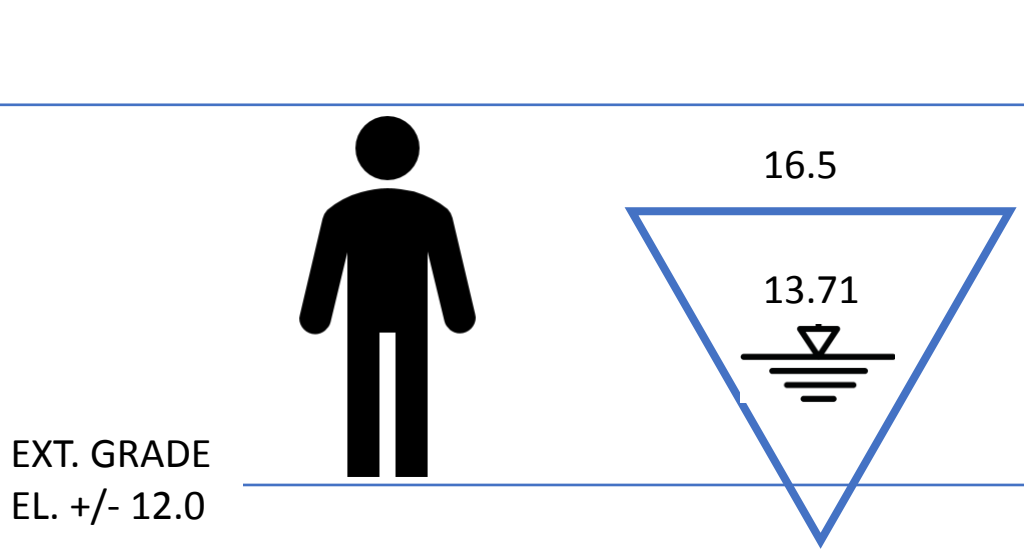
Alternative 1: "Do Nothing" Match to existing clarifiers

Alternative 2: Match structural wall elevations, but raise center platform for electrical components driving clarifier mechanisms **~ $26k**

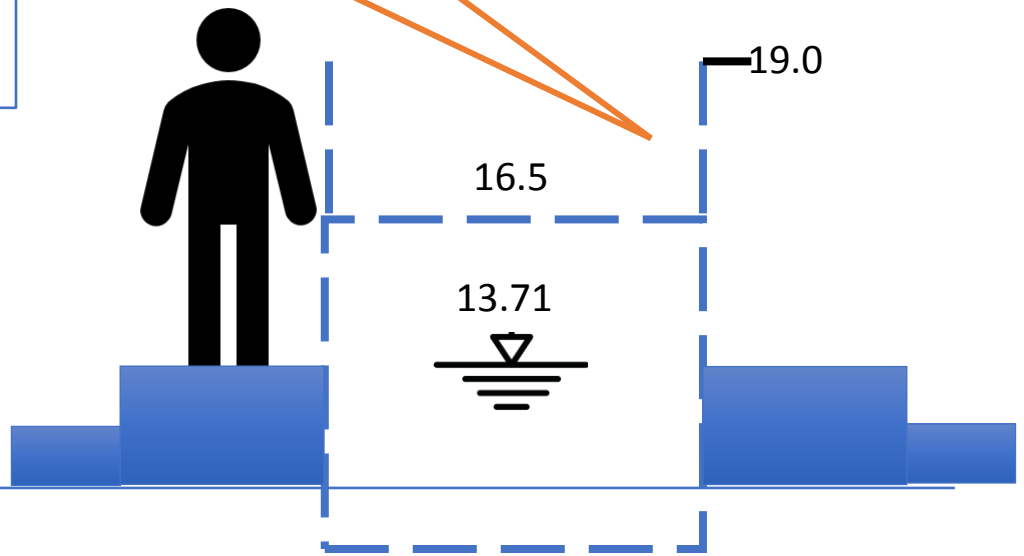
Alternative 3: Raise top of wall elevation to 19' to protect interior from flooding



Turns clarifier interior into a classified space increasing equipment cost **~ $1M**



Existing Clarifiers



Alternative 3

INTERPRETING HARDENING DESIGN GUIDELINES – Effluent PS

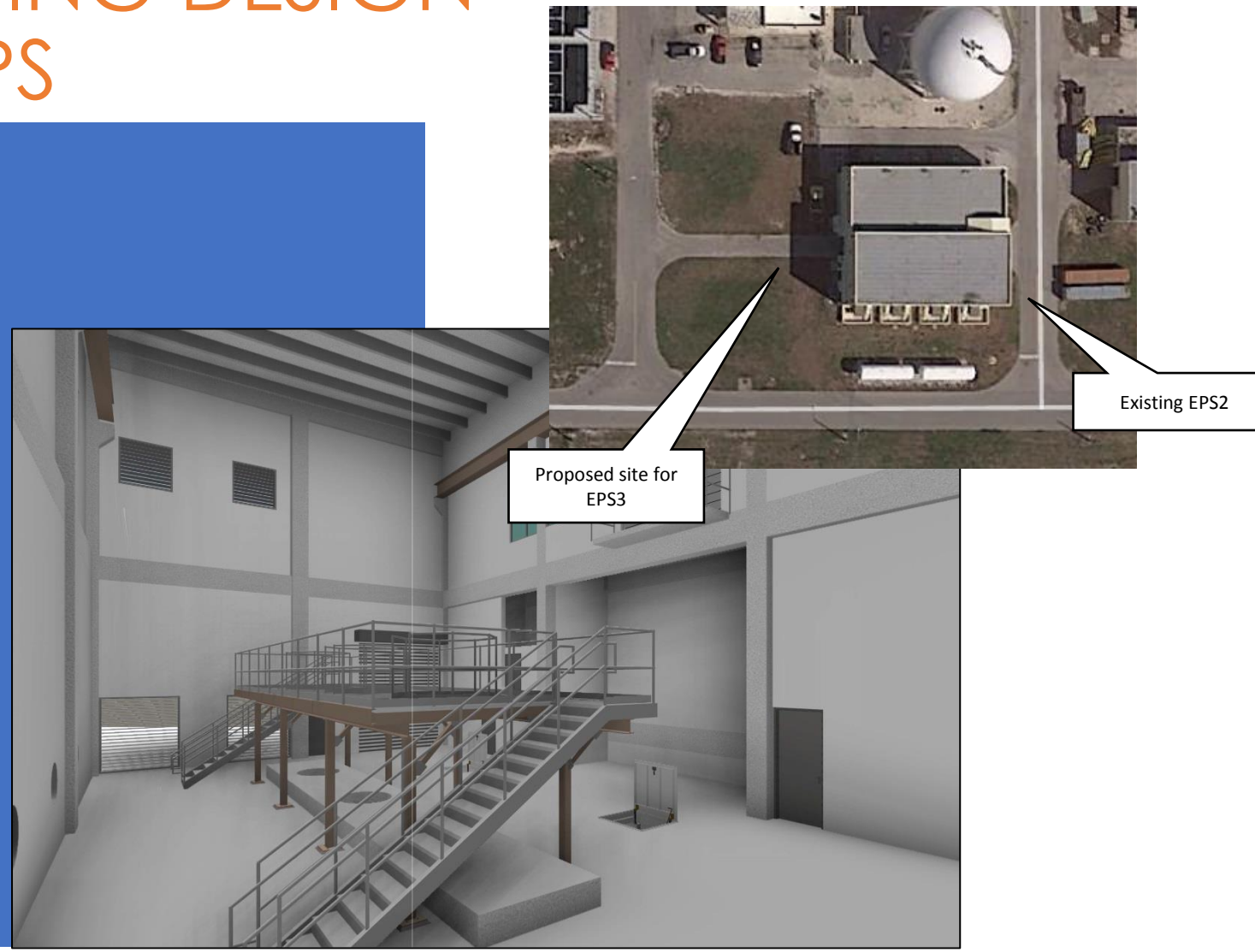
Alternative 1: "Do Nothing" match existing PS

Alternative 2: Hardening Design – 19 ft-NGVD finished floor elevation (FFE)

- This is 5 ft higher than existing Effluent Pump Station FFE **– $$$**

Alternative 3: Prioritized keeping all electrical equipment above the 19'

- Adding stairs and platforms to access equipment rather than FFE at 19' - **~ $1.5M**



Conceptual design of effluent pump station

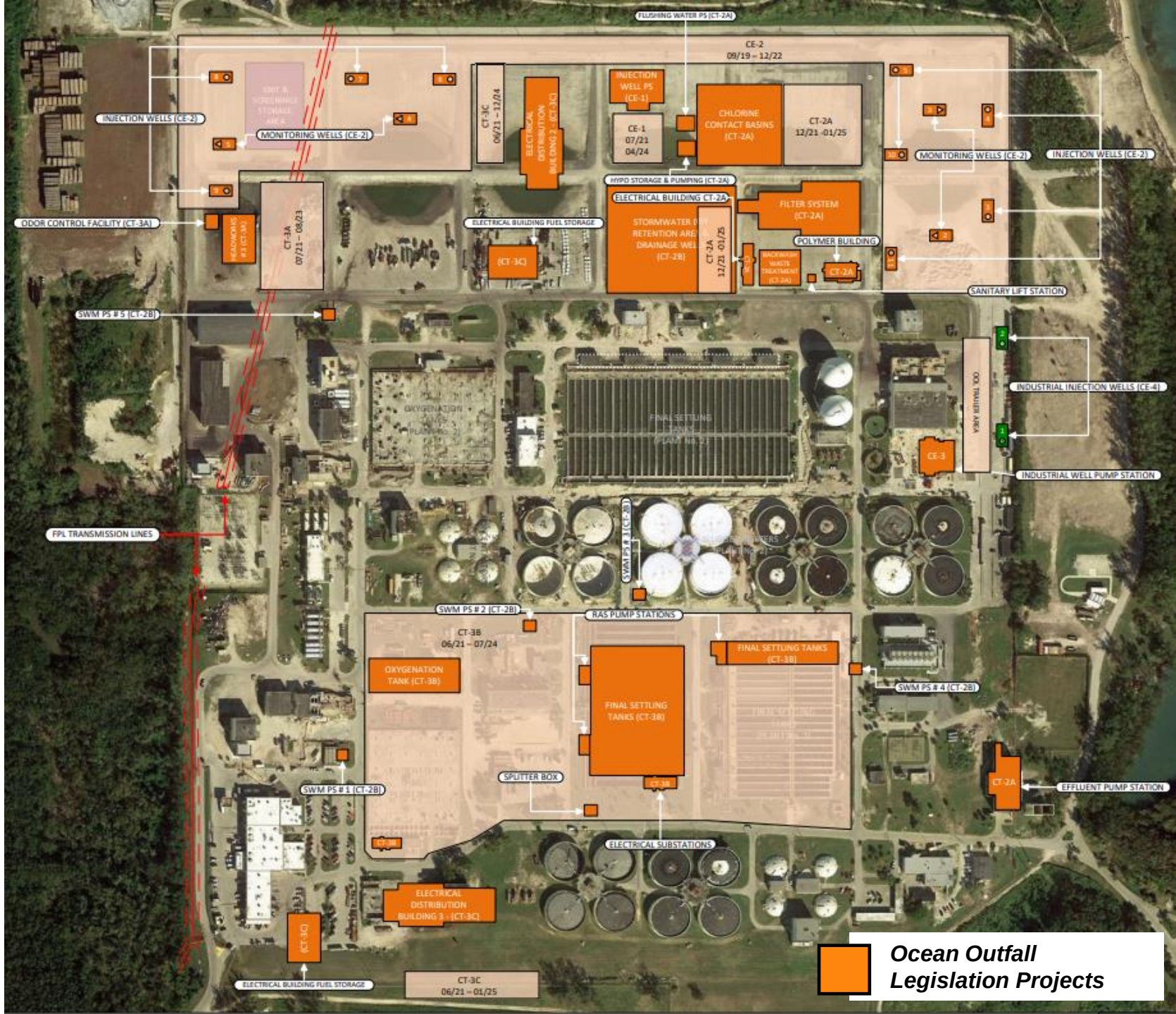
CDWWTP OOL Projects

Project	
CE-1	IW Pump Station
CE-2	Injection Wells
CT-3A	Headworks
CT-3B	O2 Train and SC
CT-3C	Electrical Distribution Bldg
CT-3D	Oxygen Production
CT-2	HLD System

Flows	Existing	Proposed
Avg (mgd)	143	143
Peak (mgd)	≈286	368

Flows	Existing	New
Elevation	16.0	20.9

Construction Cost Estimate of $630M



Process-Specific Approach to Implement Hardening Criteria

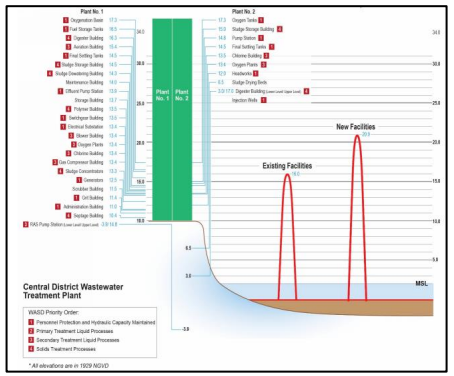
Define Level of Service Priority

Risk-based framework

1. Personnel protection
2. Recovery after storm event
3. Hydraulic capacity maintained
4. Primary treatment liquid processes
5. Secondary treatment liquid processes
6. Tertiary treatment liquid processes
7. Solids treatment processes

Define Actual and design Elevations and Define Complexity

Group by Tier Level



Define Hardening Approach and Alternatives

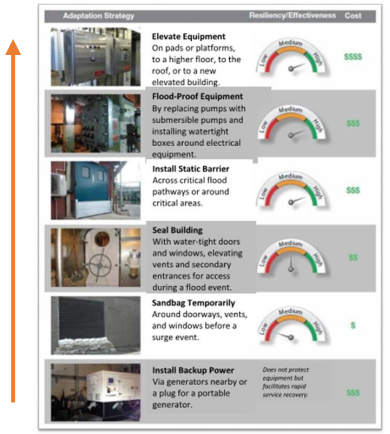


Figure 4. Facility Hardening Approaches. (Source: NYCDEP, 2013)

Validation and Documentation

Conceptual Functional Analysis

Impact to Operations & Maintenance

Cost Impact

Meet with WASD and OOL PM for alignment

Document Approach to Continue Design

ASSET DESCRIPTION AND PRIORITY OF MITIGATION

Asset Description	SDWWTP Clarifier 11 and 12 out of a total of 12 clarifiers.

2. Vulnerability

Elevation of Existing Assets	16.5 ft
Flood Elevation	19.1 ft per SDWWTP Hardening Guidelines
Vulnerable of Flood (Y/N &	Yes
Vulnerable of Wind (Y/N &	Yes
Baseline (do nothing)	No special consideration for hardening. Do not raise walls or mechanism.
Existing Assets Hardening	Walls and mechanism existing at 16.5 ft.

3. Consequences

Replacement Cost & Note	$10,000,000	Only includes replacement of equipment.
Impact to Facility Operations from Asset Failure	If case of clarifiers failure, wastewater liquid process treatment will not occur. Likely consequence is damage to the clarifier mechanisms, which in a worst case event would require replacement and structural repairs. The clarifier concrete structure is unlikely to require replacement, but the connections to the mechanisms could be damaged.	

4. Priority of Mitigation

Priority	MEDIUM

Priority Definitions	Priorities	Level	Selected Priority
	Personnel Protection (e.g. asset/facility is staffed during storm event)	HIGH	
	Critical Element for Staff Onsite (e.g. emergency generators)	HIGH	
	Hydraulic capacity maintained	MEDIUM	
	Preliminary/Primary treatment liquid processes	MEDIUM	X
	Secondary treatment liquid processes	MEDIUM	
	Tertiary treatment liquid processes	LOW	
	Solids treatment processes	LOW	

Validation and Documentation

Step 1

Asset & Priorities

- Asset Description
- Vulnerability
- Consequences
- Priority of Mitigation

Step 2

ID Alternatives

- Increased Cost of Hardening

Step 3

Evaluate Measures

- Evaluation Criteria and Weight
- Total Score

Step 4

Decision Documentation

- Workshop with WASD
- Technical Memo

Electrical Substation 25 & 26 – Hardening Example

South East View

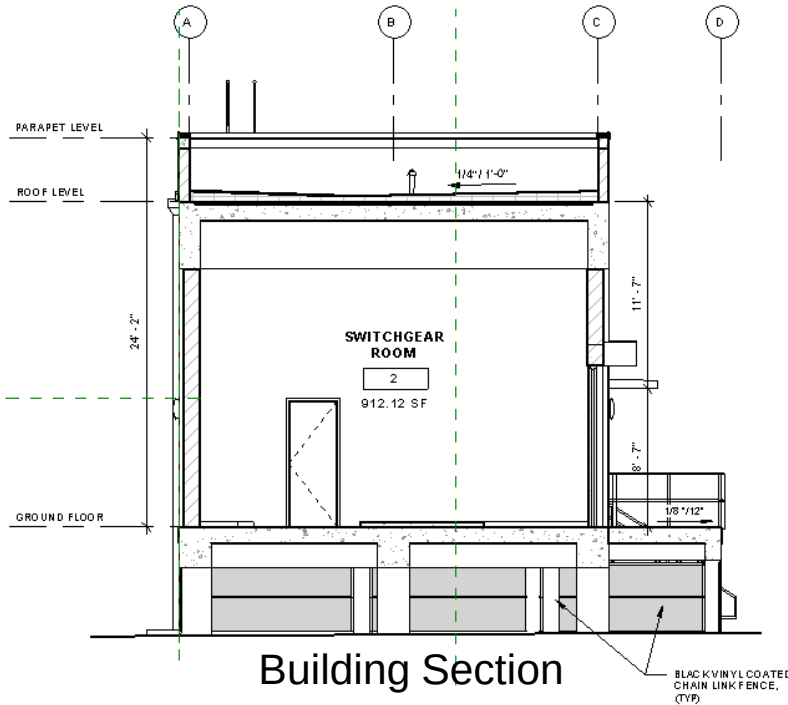
Alternative 1: "Do Nothing"

Alternative 2: Raise Building

- Building raised to provide equipment above 20.9'
- Fenced off area below building. Cannot be used for storage or parking because under electrical equipment.

Alternative 3: Harden Building

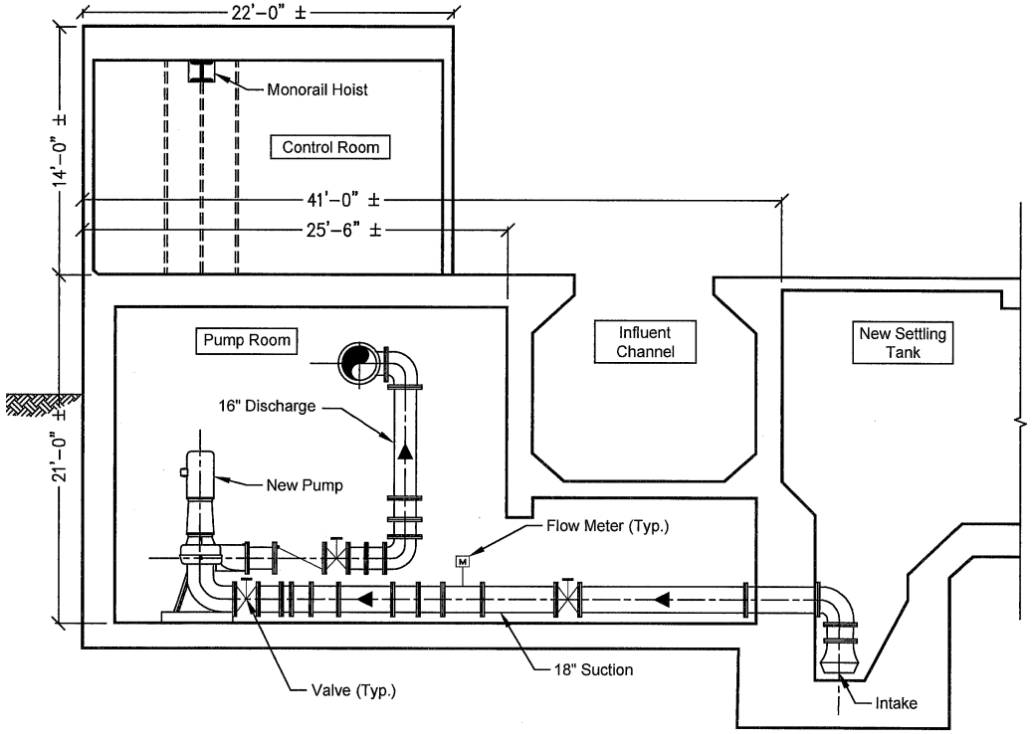
- Harden building with sealed doors and/or flood doors
- Keep electrical equipment at ground elevation



Building Section

RAS Pump Stations – Hardening Example

North East View



Alternative 1: "Do Nothing"

Alternative 2: Spare Motors

- Pumps must be at low elevation because pumping from bottom of clarifier
- Grit pumps at lower elevation. Will flood. Can provide spare motors in storage area designated in building.

Alternative 3: Raise Motors

- Add extended shaft to raise motor above 20.9'
- Would require 3 story building with higher monorail hoist to pull pumps and shaft out of building

Key Takeaways
- Operationalizing Flood Resilience

- Requires leadership and supporting policy
- Engage all stakeholders thru alternative selection
- Qualitative and quantitative metrics have value
- Consider phased adaptation and operational alternatives
- Consider O&M and labor impact
- Document decision-making process and cost/benefit component
- Include process in planning and design contracts

Employing tools that capture the knowledge and expertise of your utility allows for solid decision making and responsible investment in the face of uncertainty

Thank you!

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