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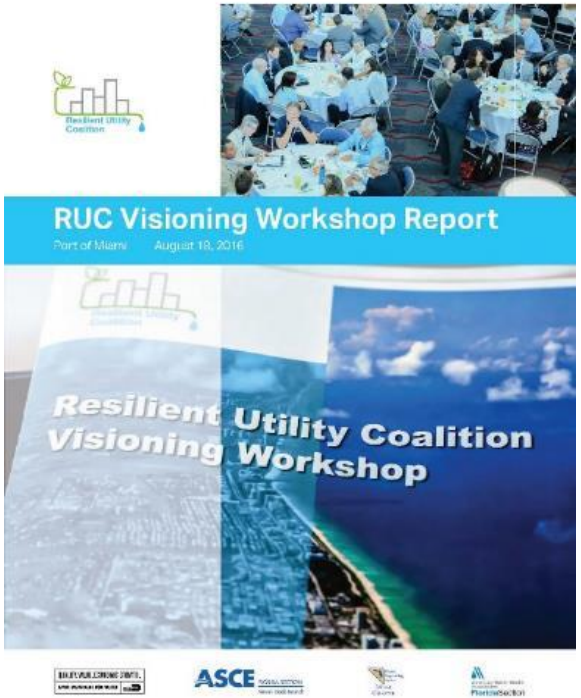
Enhancing Utility Resilience

A New Way of Doing Business by Embracing Resilience through O&M, CIP, and Utility Policy

Agenda

- Building on 2016 RUC Visioning Workshop
- Key elements of a Resilient Water Utility
- Enhancing Utility Resilience through:
  - Enhanced Policy
  - Capital Improvements (CIP)
  - Operations and Maintenance

Building on RUC Visioning Workshop, Aug. 18, 2016



Summary and Outcomes

- RUC Mission and Objectives
- Key themes and discussion items
- Path forward

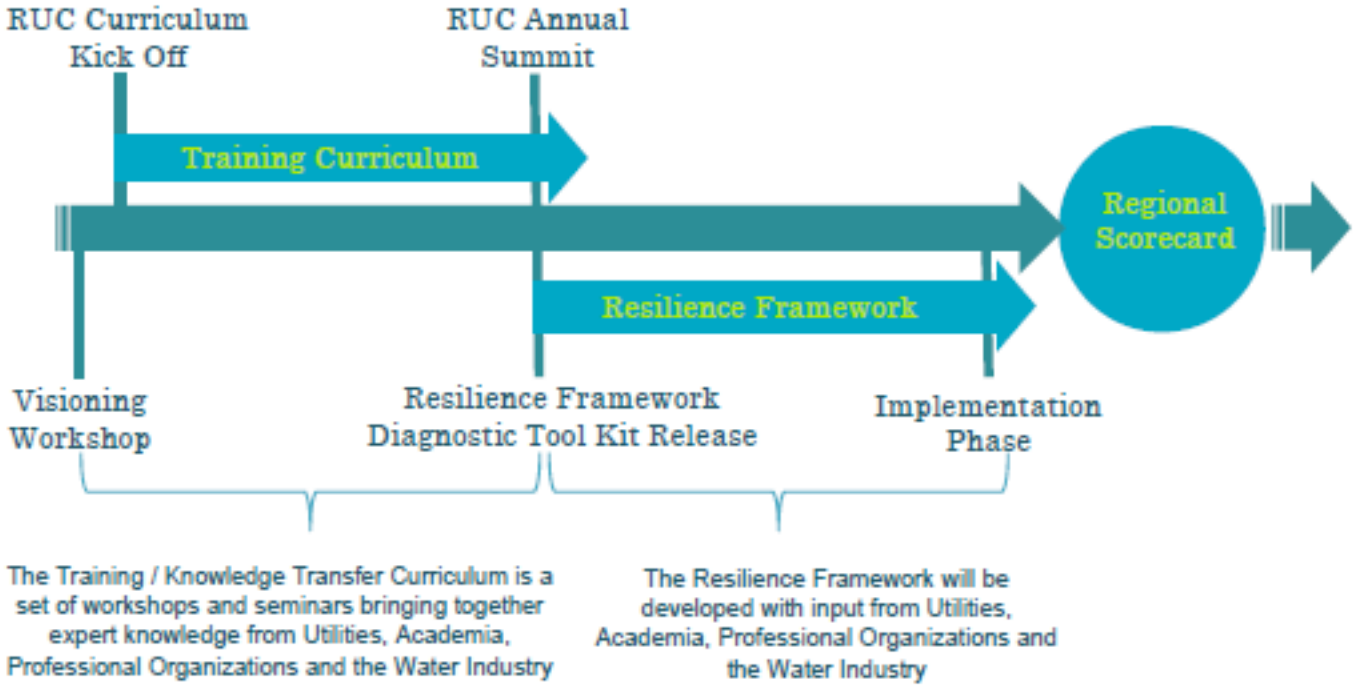
Resilient Utility Coalition Mission and Objectives

- Advance utility infrastructure resilience efforts and provide essential value to its members and partners.
- Provide leadership in assessing and adapting utility operations to address the potential effects of climate change.
- Develop adaptation strategies and improving water management decision-making in the face of climate uncertainty.

Key Breakout Group Themes at Kickoff Workshop

- Resilience Planning
- Innovation in Utilities and Emerging Technologies
- Operational Reliability
- Asset Management
- Design Standards

RUC Path Forward



RUC Key Milestones Diagram

Key Elements of a Resilient Water Utility

Key Elements of a Resilient Water Utility

- Leadership support and staff training
- Comprehensive understanding of asset strengths and weaknesses (vulnerability/risk)
- Clear understanding of climate hazards/scenarios & implementation guidance
- Resilience informed planning, policy, design guides, LOS and operations manuals – resilience is mainstreamed into decision making
- Defined process for CIP decision support and prioritization

Purpose of Enhancing Utility Resilience

By “Mainstreaming” resiliency into all aspects of planning, design, construction, operations, and policy, utilities can :

- Incentivize and evaluate technical innovations
- Change the culture of utilities, industry, and community (adopt and adapt)
- Empower the workforce to engage in resiliency
- Cross-train personnel (engineers in operator spot, operator in engineer spot)
- Obtain operator input as it relates to current vulnerability to extreme weather and future resiliency design
- Achieve multiple benefits: cost savings of integrating climate adaptation into asset management


Leadership

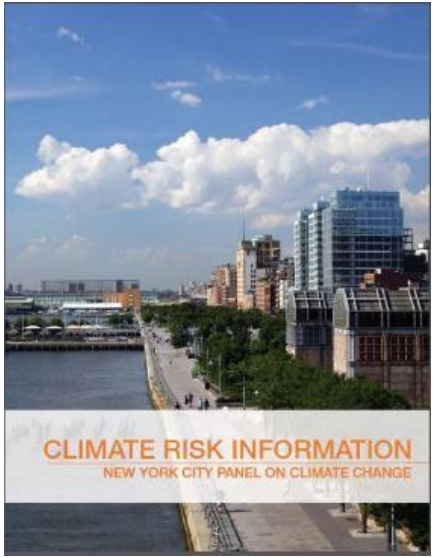
Resilience Leadership

- Top down support and alignment with other initiatives
- Inter-department collaboration and staff training
- Regional stakeholder & regional effort collaboration
  - SE FL Climate Compact
  - Resilient Utility Coalition
  - 100 RC (MDC, City of Miami, City of Miami Beach)
- Consistent public messaging and continued engagement
- Forward looking policy to maximize funding opportunities

Climate Change Impacts on New York City Sewer and Drainage Systems

=> Leadership from Mayor's Office and NYC DEP

- Study of potential climate and population change impacts on New York City drainage infrastructure performance.
- Analysing potential conditions in the 2050's, under two climate scenarios
- Sea level rise, rainfall and temperature
- Conduct vulnerability analysis (street flooding and sewer spills):
  - Hunts Point WWTP
  - Flushing Bay Watershed
- Screening and analysis of adaptation options
- Developing framework for Citywide adaptation planning

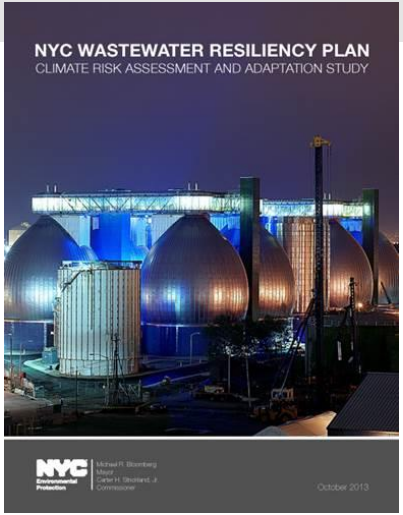


New York City Panel on Climate Change: Climate Risk Information. Feb. 2009.

NYC Environmental Protection

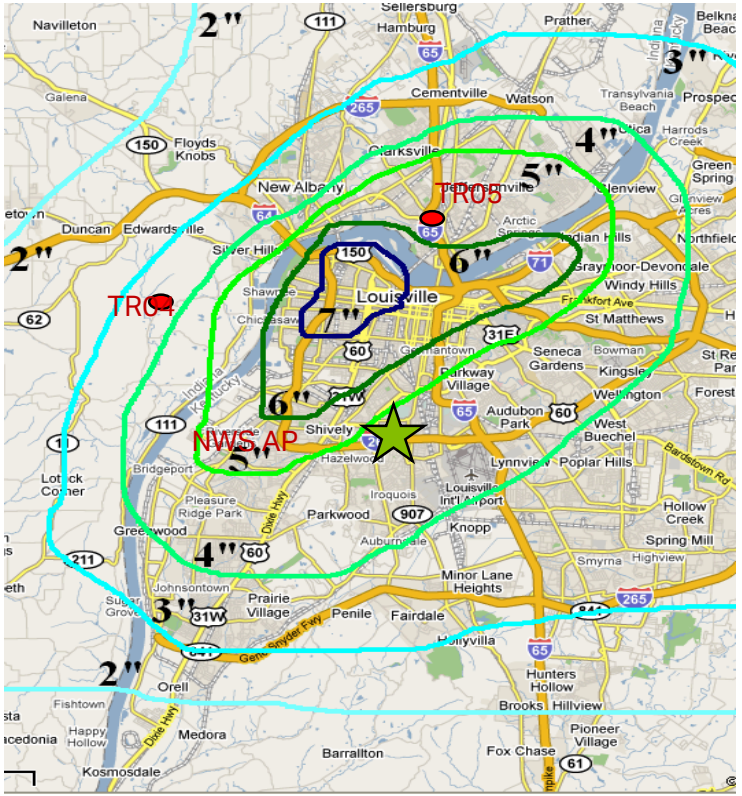
Lessons Learned from New York City Resilience Planning

- Political leadership is key (Mayor's commitment prior to Sandy)
- Adopted SLR and freeboard guidance legislatively
- NYPCC (Science Panel) formally established and mandated to make periodic revisions
- Design guidelines established based on scenario planning with changes in rainfall, and SLR for 2050 (asset life cycle)
- Maintain flexibility in approach to resilience (green and grey solutions, use cost/benefit analysis)



Louisville, KY August 2009 Rainfall Event
=> Timing is everything, and the words you use!

- Five inches of rain fell in 90 minutes
- Rainfall rates up to 8.80”/hour
- NOAA Atlas 14: 1,000-yr return interval is 3.83”/hour
- MSD TR04 = 6.97”
- MSD TR05 = 6.04”
- NWS Airport = 5.53”

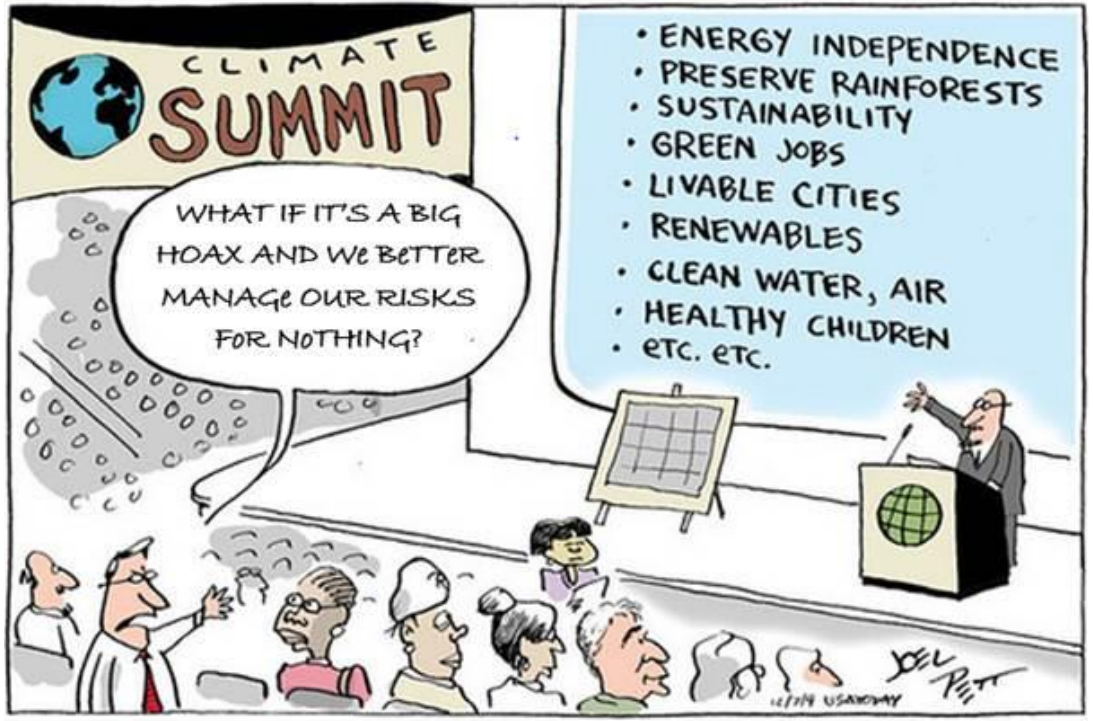


Source: NWS, Louisville, KY

Louisville Metropolitan Sewerage District
Lessons Learned

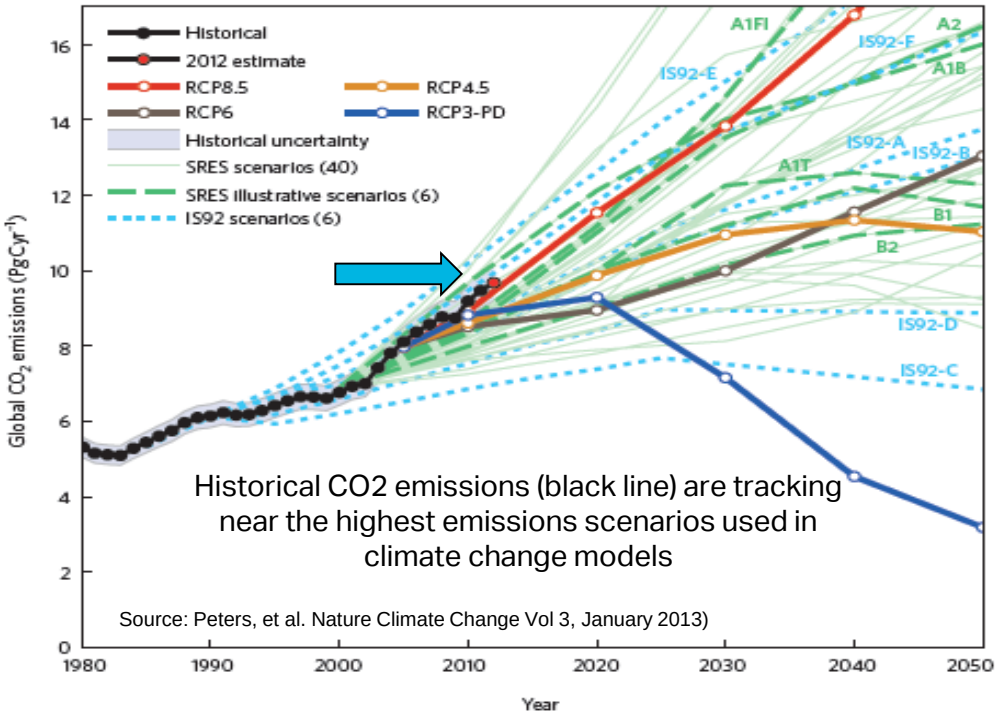
- Initially focused on resilience to current extreme events
- Prepared projections in rainfall based on best available science and made those available to staff
- Updated design guidelines based on asset management and scenario planning approach, with rainfall projections out 20 years.
- Updated CIP based on design guidelines drove rate revisions, so messaging was carefully controlled

Resilience is about Risk Management – with many Co-Benefits



Climate Science Scenarios

Making the science accessible requires tools and working with outreach specialists

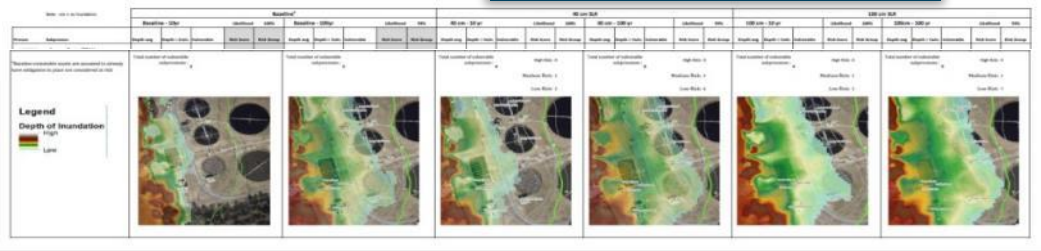


Historical CO2 emissions (black line) are tracking near the highest emissions scenarios used in climate change models

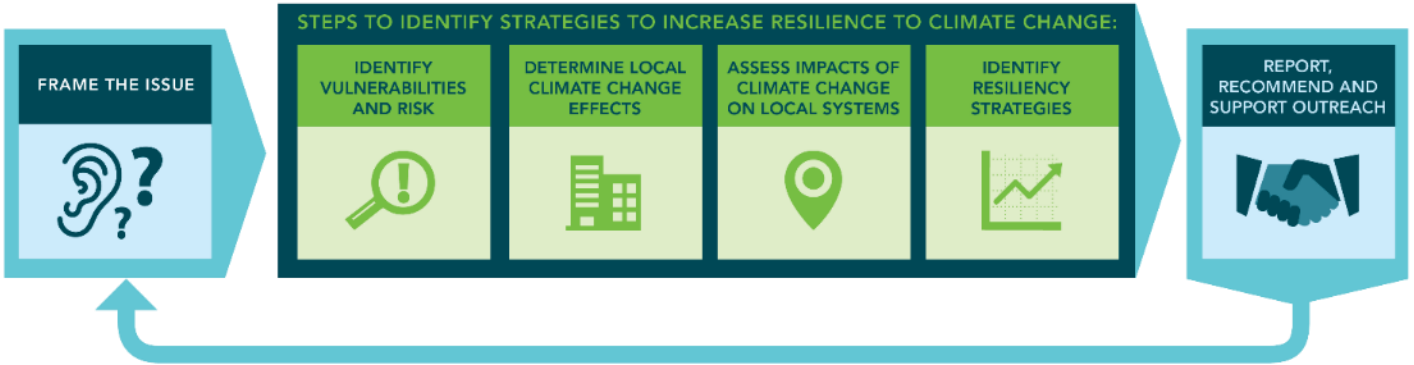
Source: Peters, et al. Nature Climate Change Vol 3, January 2013)

USEPA Climate Adaptation Guidance

- Climate Adaptation Strategies Guide (2011)
- EPA Climate Resilience Pilot Project - Wilmington, NC Vulnerability Assessment
- EPA Flood Resilience Guide (2014)



Adaptation Framework: Adaptive planning process provides flexibility to address future uncertainty.



- <u>Two key elements:</u>
- Vulnerability is function of exposure, sensitivity and adaptive capacity
- Climate risk is a function of consequence of failure and probability of climate event

A problem well-defined, is a problem half solved.

~Charles Kettering

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Frame the Issue

"What are the overarching questions to answer and climate scenarios to plan for, with the goal of increasing resilience to extreme weather and climate change?"

- Are facilities near tidal waters, subject to sea level rise and storm surge?
- Are my operations at risk of riverine flooding or greater I/I?
- Are my operations at risk from extreme heat? From extreme wind? From drought? From wildfire?
- What is the planning horizon for evaluating climate change:
  - Service life of assets
  - CIP planning cycle, based on growth, land use change, finances
- Select climate scenarios based on your risk tolerance:
  - Consider low, medium and/or high future scenarios

Framing the Issue: Rainfall and Extreme Storms –
Climate Change Impacts Vary Based on System Function and Source (Drainage, Riverine, and Coastal)

Precipitation

Sea level rise

Storm surge

2- to 10-year storms

100-year storms

Tidal flooding

Tropical storms

Stormwater/Drainage Management

- Localized flooding
- Increased CSOs

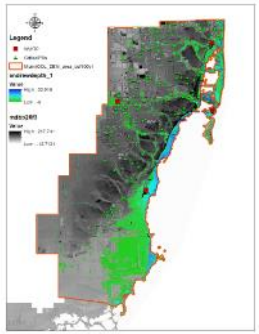
Riverine Floodplain Management

- Regional flooding

Miami Herald Miami Beach

Select your community

Rain or no rain, beachfront streets flood due to 'spring tide'



Resilient Scenario Planning

- Build upon SE FL Regional Climate Compact
- Multi-hazard scenario development
- Short, mid and long term scenario planning
- Clear and regionally consistent implementation guidance

Policy

Resilient Policy

- Consistency between guiding documents and regulations.
- Incentivize building resilience.
- Includes both private and public infrastructure.
- Requires cross-dept. collaboration and input.
- Identify and mitigate unintended consequences of policy changes.

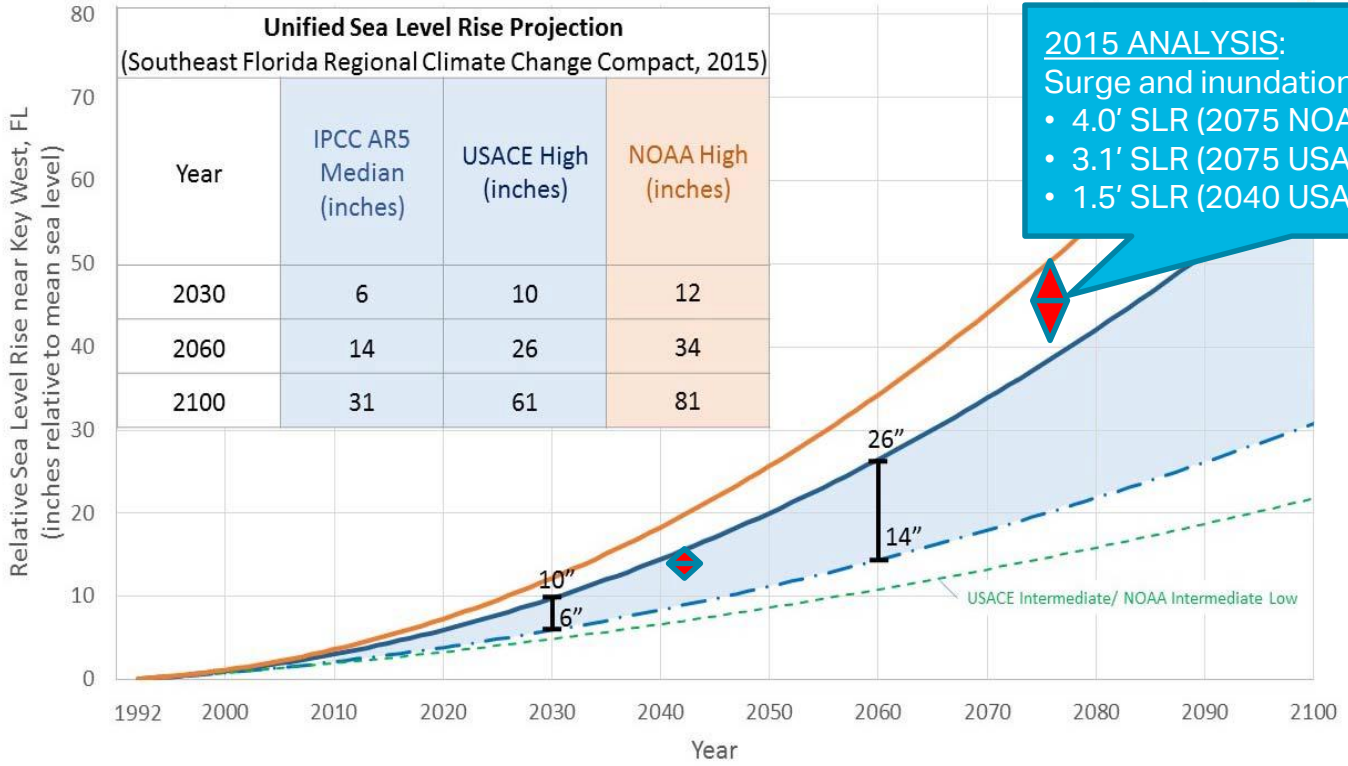
Resilient Policy

Policy / Design Guide /	
Land Development Regulations	Private infrastructure projects
Public Works/ Engineering Manuals	Public capital projects
Stormwater/Utilities Masterplan	Public stormwater/utility projects
Comprehensive Plan	Municipal requirements / LOS
Design Guides	Historic, area plans, public works
Coastal Management Plans	Dunes, seawalls, beaches, CCCL
Local Mitigation Strategy (LMS)	Disaster management
NFIP Community Rating System (CRS)	Align for maximum benefit

Sea Level Rise Impacts: Coastal Flooding and Increased Wastewater Flow (due to higher groundwater and rainfall)

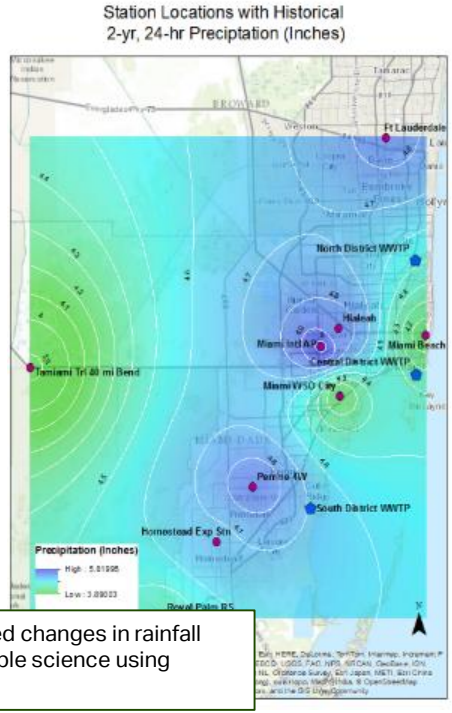
Unified Sea Level Rise Projection
(Southeast Florida Regional Climate Change Compact, 2015)

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



2015 ANALYSIS:
Surge and inundation modeling run with
- 4.0′ SLR (2075 NOAA High)
- 3.1′ SLR (2075 USACE High)
- 1.5′ SLR (2040 USACE High)

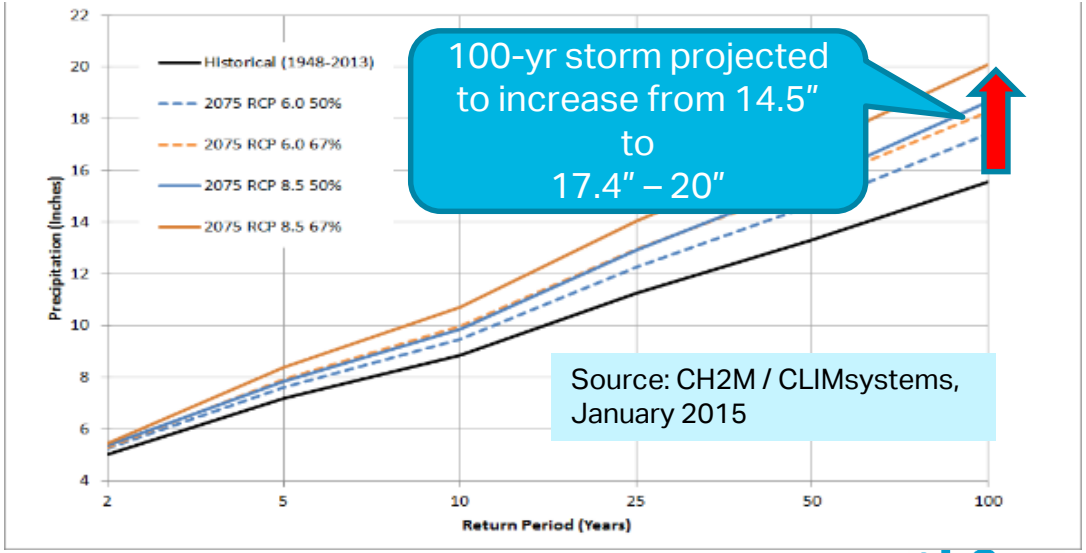
Miami-Dade Precipitation Intensity-Duration-Frequency (IDF) Projections: Peak Flow and Flood Impacts



Miami-Dade FL: Projected changes in rainfall derived from best available science using SimCLIM

Pump Station Peak Flows based on 2-yr Storm:

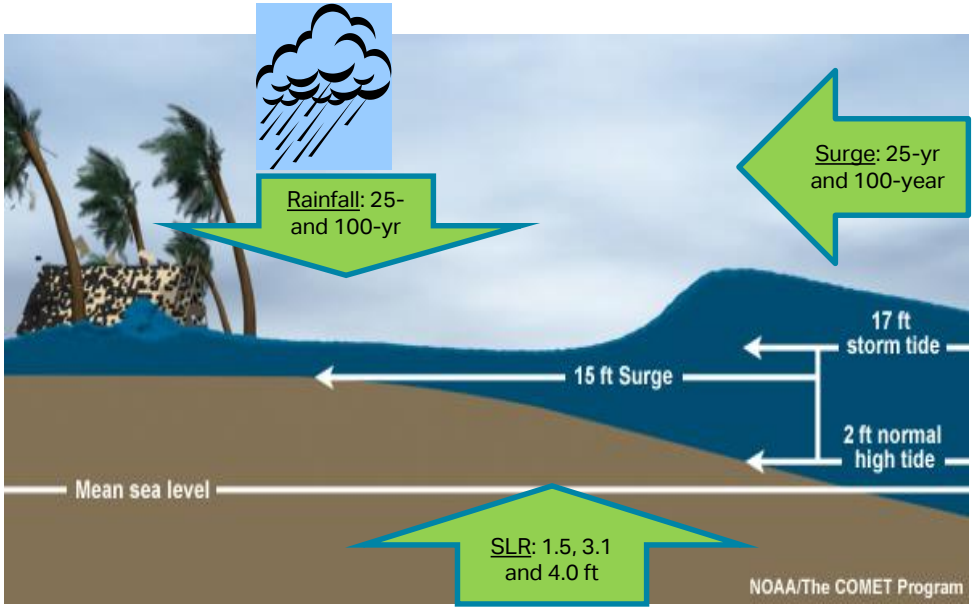
- Historically: 4.5″ (SFWMD, 2001)
- Updated: 4.9″ (2014)
- Projected: 5.4″ to 6″ (2040 to 2100)



Modeling Tools Reflect Flooding Source: SLR, Storm Surge with Future SLR and Rainfall, Wave Effects

Key Variables:

- Wind and pressure driven storm surge: 100-yr and 25-yr storms
- SLR:
  - 1.5 ft (2040)
  - 3.1 ft and 4.0 ft (2075)
- Impacts of storm tracks and coastal bathymetry at shoreline and inland
- Flood Propagation inland
- Wave effects at shoreline and propagation inland

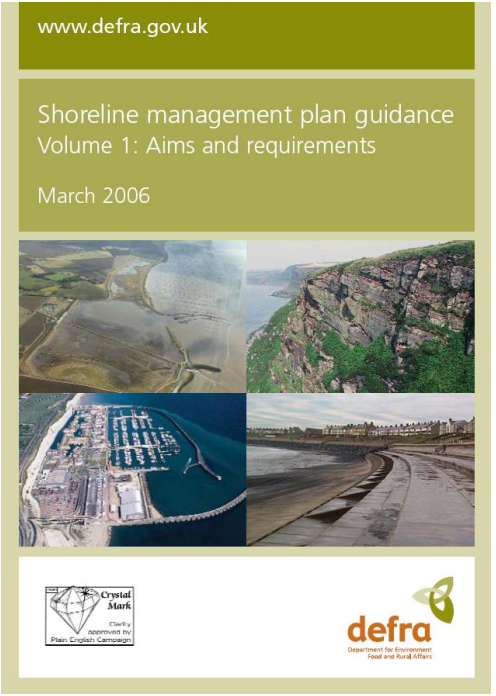


WASD Facility Hardening Design Guidelines for Existing and New WWTP Assets: Draft issued Aug.2015, revision planned in 2017

	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	20.3	2075 Surge+1.23m(48")SLR + FB +SF+21"(100-yr, 72-hr rainfall)
SDWWTP	16.0	FEMA BFE + 3ft SLR from SEFLCC(2011) +FB +SF	19.0	2075 Surge+1.23m(48")SLR + FB +SF+21"(100-yr, 72-hr rainfall)
NDWWTP	16.0	Same as CDWWTP and SDWWTP	17.1	2075 Surge+1.23m(48")SLR + FB +SF+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 = 1.23m = 48" per NOAA High projection for 2075 (USACE High projection is 0.93m)				

Legislation: Sustainable Risk Management Plans are Required by Law in the UK

- Program to develop long-term adaptation plans for all river basins and coastal cells in England & Wales
- Aim to identify sustainable, adaptive policies to manage risks
- Stakeholders involved throughout
- Consider 20, 50 and 100-year time steps
- Integration of approaches to flood risk management, including:
  - habitat conservation & restoration
  - land use
  - development planning
  - flood protection works
  - flood warning and emergency response
- Reviewed every 5-10 years



http://www.defra.gov.uk/environ/fcd/guidance/smp.htm


O&M

Resilience in Operations and Maintenance

- Internal staff cross-dept. coordination to align goals and objectives and integrate programs
- O&M staff inclusion for transfer of system knowledge
- Capture multiple benefits from each action
  - Economic, Environmental & Social
- Inclusion of climate hazards in action prioritization
- Multi-criteria decision support

Staff Training:
Making Climate Science Accessible

Multiple Training Opportunities through Professional Societies:

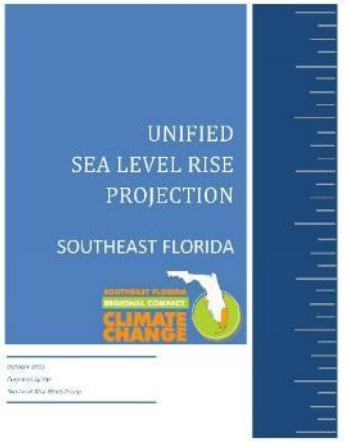
- ACCO
- AWWA
- ASCE
- ISC: Climate Leadership Academy

Multiple Resources from Federal Agencies:

- USEPA: Climate Ready Water Utilities
- NOAA: US Climate Resilience Toolkit

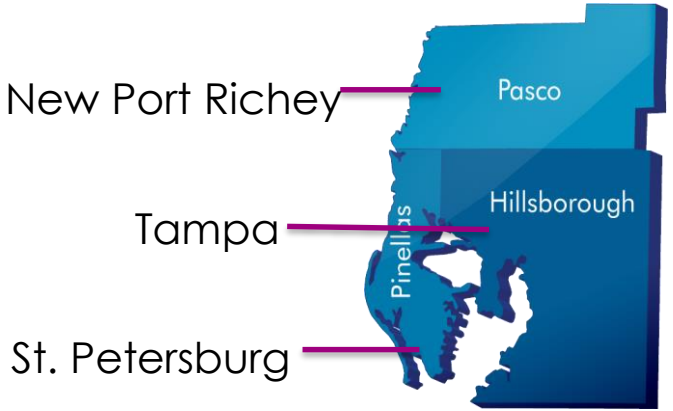
Universities and regional planning agencies

- Southeast FL Climate Compact
- FAU CES
- FIU SLSC
- UM Rosenstiel School
- UF Climate Institute



Tampa Bay Water

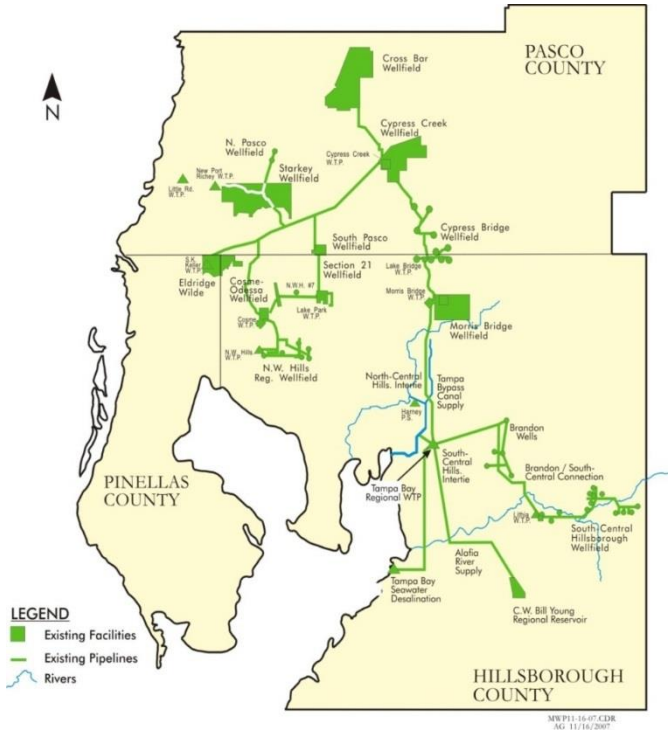
- Exclusive wholesale water provider for all six Member Governments – Serving 2.4 million people
- Diverse water supply system, groundwater, surface water and desalinated seawater - ~ 240 mgd regional demand
- The Long-Term Master Water Plan - meets demands through the 2040 planning horizon ~ 25 mgd of new supplies



Source: Alison Adams, TBW

Tampa Bay Water

- 13 groundwater wellfields (permitted 121 mgd annual average)
- 120 mgd capacity surface water treatment plant (two river intakes)
- 15.5 BG off-stream reservoir
- 25 mgd capacity desalination plant



Source: Alison Adams, TBW

Tampa Bay Water

- Risk Based Asset Management
- Maximizing system efficiency
- Evaluating capabilities of existing infrastructure before building new
- Multi-discipline approach for O&M, and Engineering staff
- Collaborate with local, regional and national working groups.

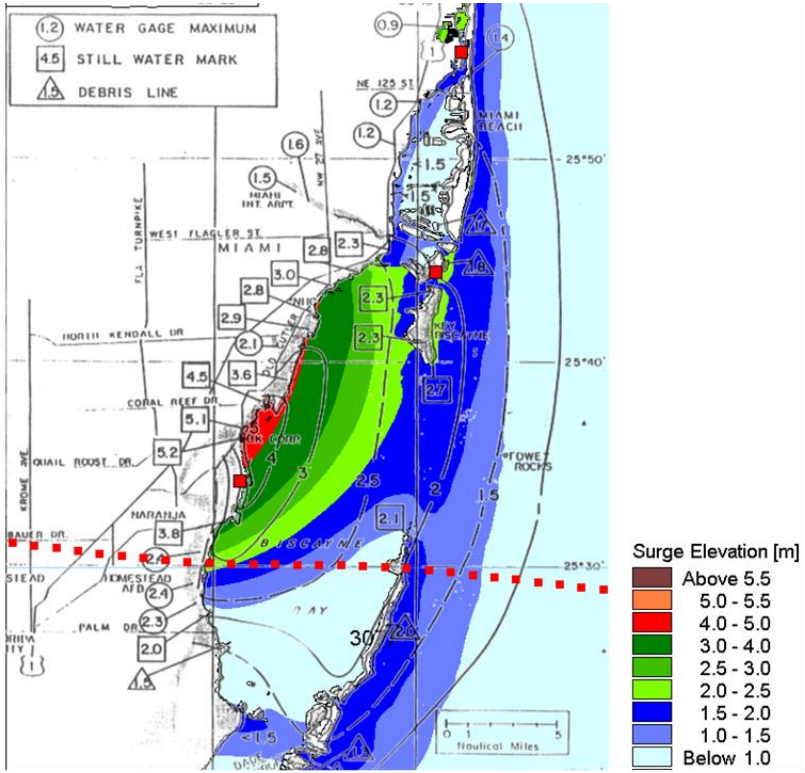
Source: Alison Adams, TBW

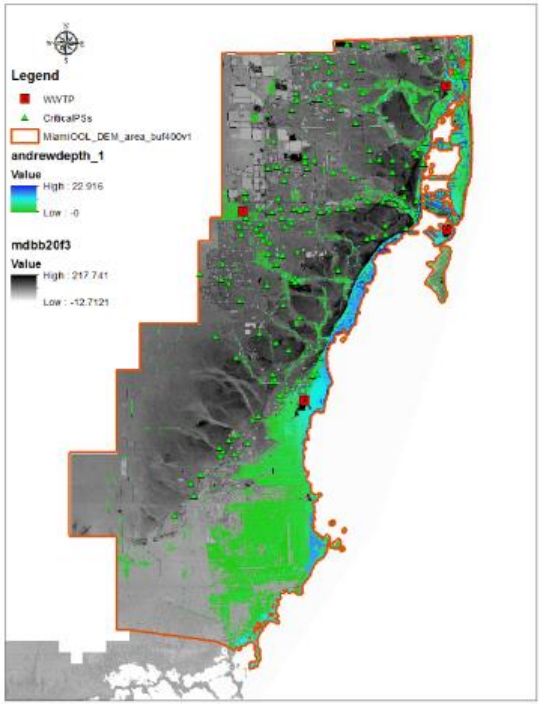

CIP

Resilience in Capital Improvement Programs

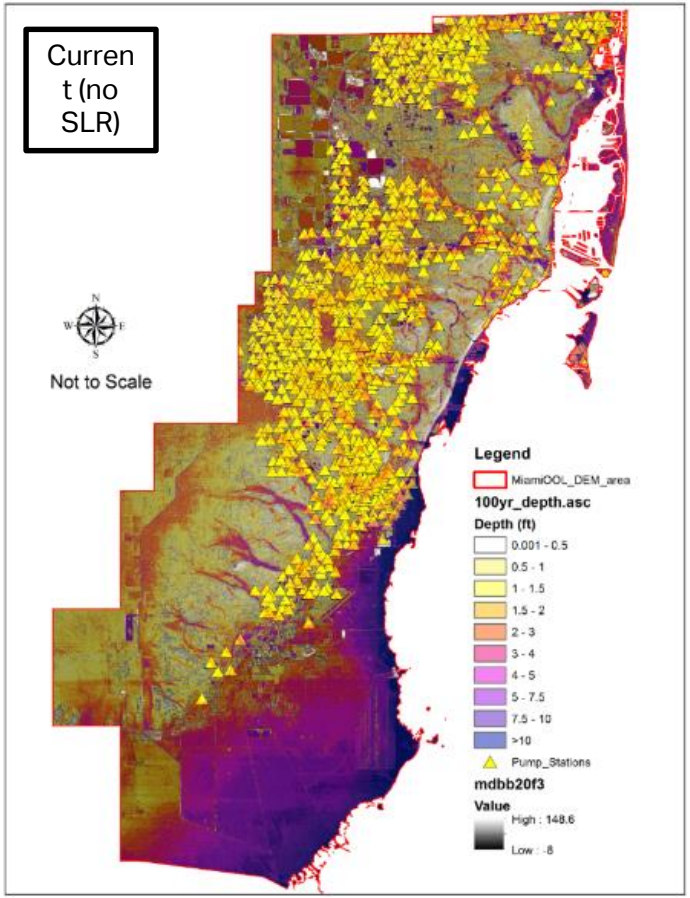
- Establish climate based goals and objectives aligned with other County wide initiatives including:
    - LMS/emergency management, LOS, CRS, security and level of community protection
- Develop and adopt clear guidance for implementation
- Create inter-dept. coordination task force and procedures
- Utilize multi-decision/ TBL based support framework including climate based scenario triggers and prioritization

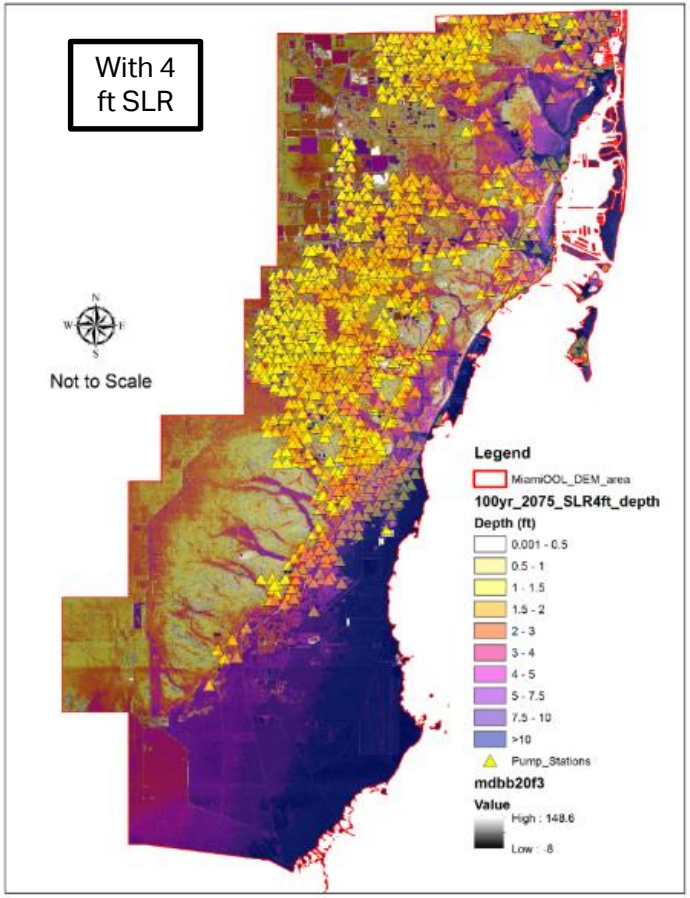
Surge Modeling: Comparison of Peak Surge Elevation: modeled with MIKE21 vs observations for Hurricane Andrew



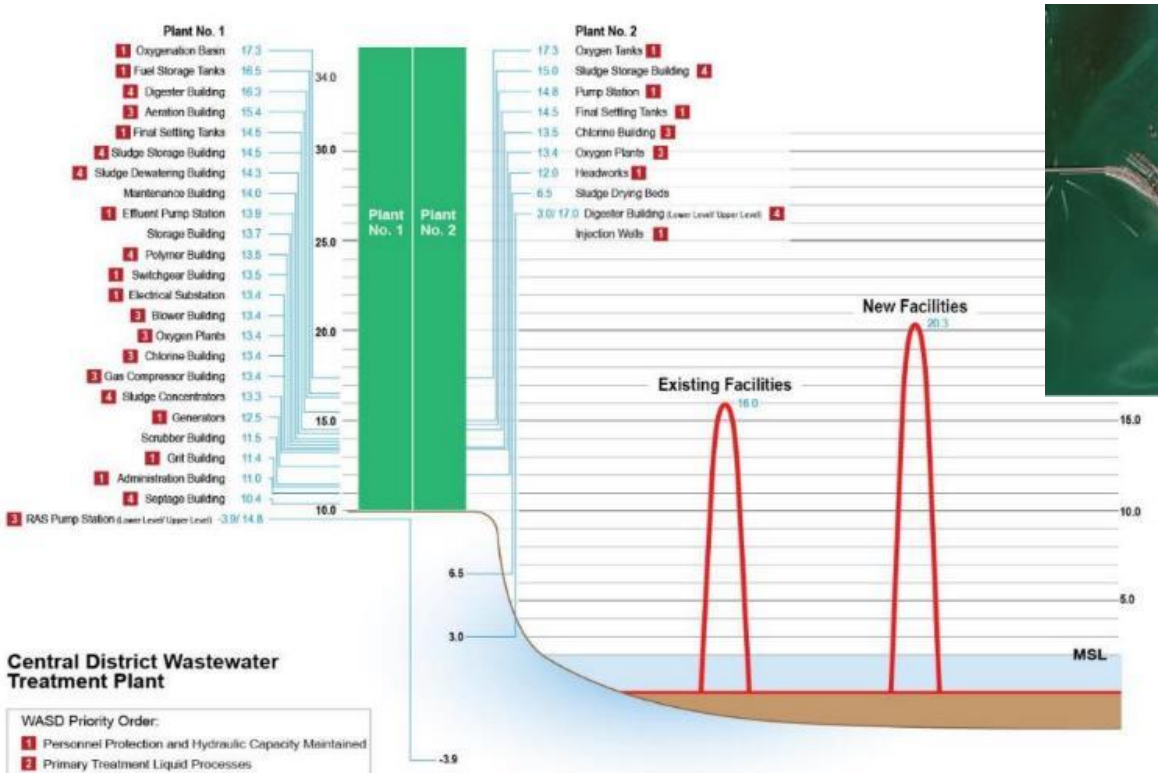


Inland Flooding with Flood Modeler Pro: 100-year Storm Depth from Rainfall, Surge, with/without Sea Level Rise





Facility “Hardening” (Flood Control) Costs were Developed for Critical Facilities above Design Flood Elevation



Adaptation Strategies for Improving Flood Resilience

- **Adaptation Strategies for Stormwater Management and Flood Protection Systems**
  - Grey Solutions:
    - Raising electrical and mechanical equipment
    - Sealing wall penetrations
    - Water tight doors
    - Adding tide gates to outfalls
    - Backup generators
    - Barriers or local surge walls
    - Adding capacity to the drainage network
    - Moving flows from one part of the system to another
    - Emergency response planning
  - Green Solutions:
    - Green infrastructure
    - Coastal wetlands
    - Renewable energy and Co-generation
    - Zoning and Land Use Planning
- **Phasing adaptations to account for uncertainty in projections and risk tolerance**

Tacoma Central Plant Flood Wall

Water Street Green Infrastructure, Onondaga NY

Example Adaptation Measures for Water Reclamation Plants

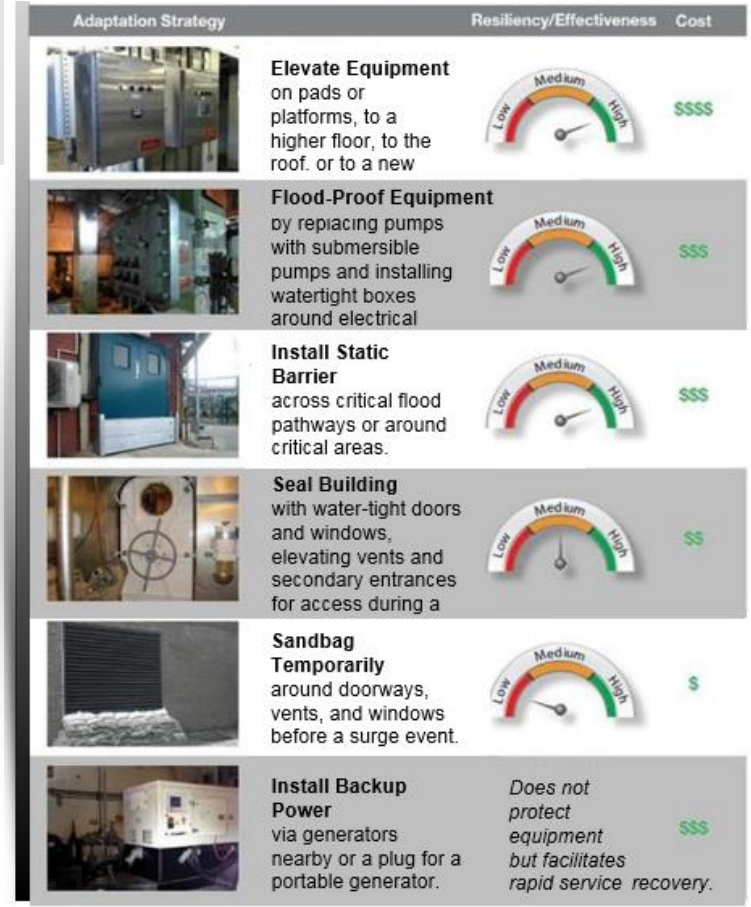
Threats	Adaptations
Flooding by storm surge with sea level rise	Waterproof individual structures
	or
	Build perimeter wall around facility

Climate change impacts require modifications to planning, design, and construction approaches

Source: LA Bureau of Sanitation

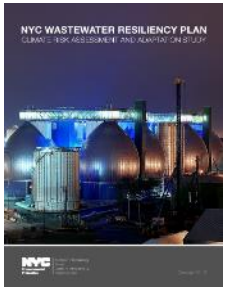
Adaptation strategies and protective measures

- Identify site-specific protective measures to minimize prolonged service interruption and flood risk while balancing feasibility, resiliency, and cost
- Establish robust design guidelines for future wastewater infrastructure upgrades/designs that assist in mitigating flood risk
- No action, which includes emergency response planning to provide replacement parts to repair damaged items



Source: NYCDEP

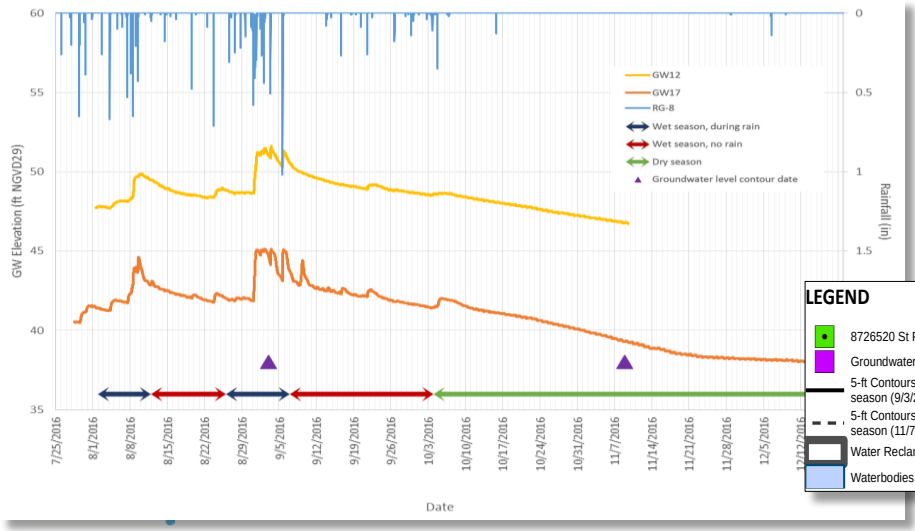
NYCDEP Wastewater Resiliency Plan Comparison of Mitigation Costs and Cost of No Action (ie Benefits of Mitigation)

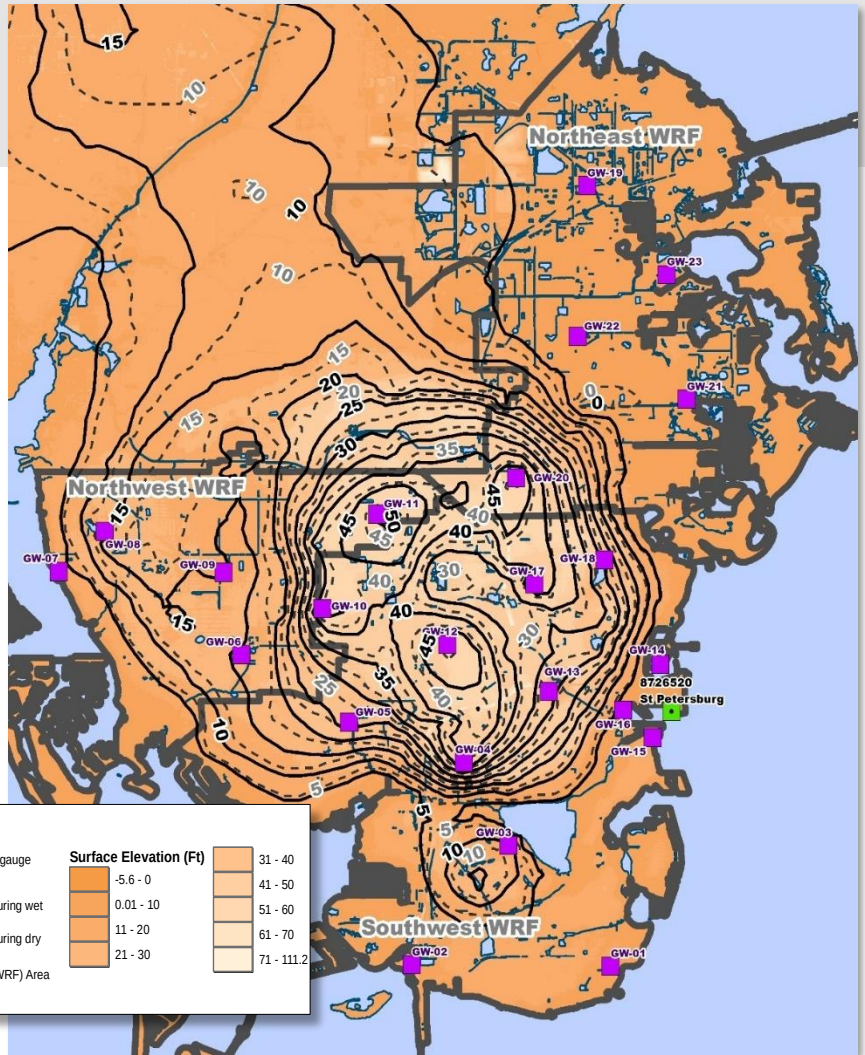


Investing **$315 Million** in strategic fortification can safeguard **$1.1 Billion** of vital infrastructure and save the city **$2.5 Billion** in emergency response costs over the next 50 years.

St. Petersburg Wastewater Overflow Mitigation Program

- I&I assessment
- Groundwater response
- Rainfall projections
- Collection system capacity evaluation





Adaptation Strategies for Improving Drought Resiliency

- Water banking and increased conjunctive use of surface water and groundwater
- New or increased water storage
- Municipal and industrial water conservation
- Temporary water transfers from agriculture to urban areas
- Development of local “drought-proof” supplies
  - Wastewater reuse
  - Desalination of ocean or brackish supply

Loudoun County VA Quarry/ Future Reservoir

Yuma AZ Desalting Plant

Reuse in CA

Lake Mead Intake February 2012
Source: Kay Brothers, SNWA

Wetland Enhancement/Creation

- Wetland Enhancement Project, Freedom Park, Naples
  - 50 acre natural stormwater treatment wetland and recreational amenity
- Wetland Creation and Aquifer Recharge Project, Pasco County, FL
  - Nutrient reduction, habitat enhancement, reclaimed water disposal, groundwater recharge
  - 385 acre project to restore hydrology using 5 MGD of available reclaimed water

Pasco County Recharge Basin

Pasco County Reclaimed supply pumps

Freedom Park Wetland

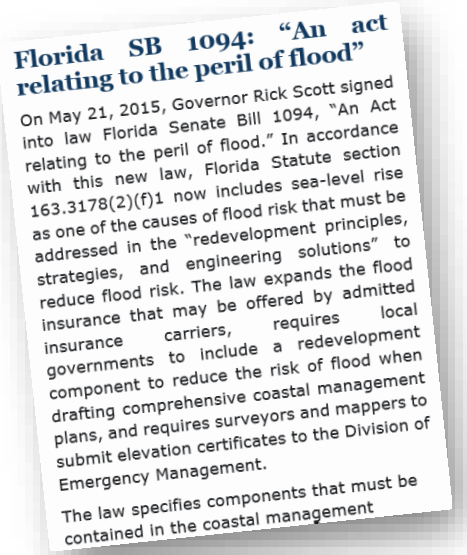
Long Range Planning

Long Range Planning for Utilities

- Future conditions vs asset lifespan
- Population projections & demand growth
- Short term events (surge) vs. long term events (SLR)
- Integration with future land use planning
- Managing for today & investing for tomorrow

Resilience in Long Range Planning

- Masterplan considerations out to 2100
  - Include short, mid and long term actions
- Comprehensive Plan
  - Senate Bill 1094 “Peril of Flood”
  - Adaptation Action Areas
  - Future Land Use & Zoning designations
- Post Disaster Planning, Pre Disaster
  - Planning to capture funding for quick recovery



Florida SB 1094: “An act relating to the peril of flood”

On May 21, 2015, Governor Rick Scott signed into law Florida Senate Bill 1094, “An Act relating to the peril of flood.” In accordance with this new law, Florida Statute section 163.3178(2)(f)1 now includes sea-level rise as one of the causes of flood risk that must be addressed in the “redevelopment principles, strategies, and engineering solutions” to reduce flood risk. The law expands the flood insurance that may be offered by admitted insurance carriers, requires local governments to include a redevelopment component to reduce the risk of flood when drafting comprehensive coastal management plans, and requires surveyors and mappers to submit elevation certificates to the Division of Emergency Management.

The law specifies components that must be contained in the coastal management

Tampa Bay Water - Planning for the future:

- Developed hydrology and system models to evaluate changes in precipitation, groundwater & temperature
- Decision Support System to optimize asset vulnerabilities vs. remaining lifespan
- Population (2040 with longer term projections)
- Diversified supply
- Emerging pollutants and water quality concerns
- Incorporate climate change effects into standards and review criteria

Source: Alison Adams, TBW

Seattle Public Utilities – Lessons Learned

- Created an internal Climate Resilience Group in late-2000s (2 full time staff)
- Focused on staff capacity building (internal education)
- Engaged with Water Utility Climate Alliance (WUCA)
- Commissioned and conducted research with academic partners
- Partnered with other utilities in region

Seattle Public Utilities – Lessons Learned

Integrate climate change into internal planning:

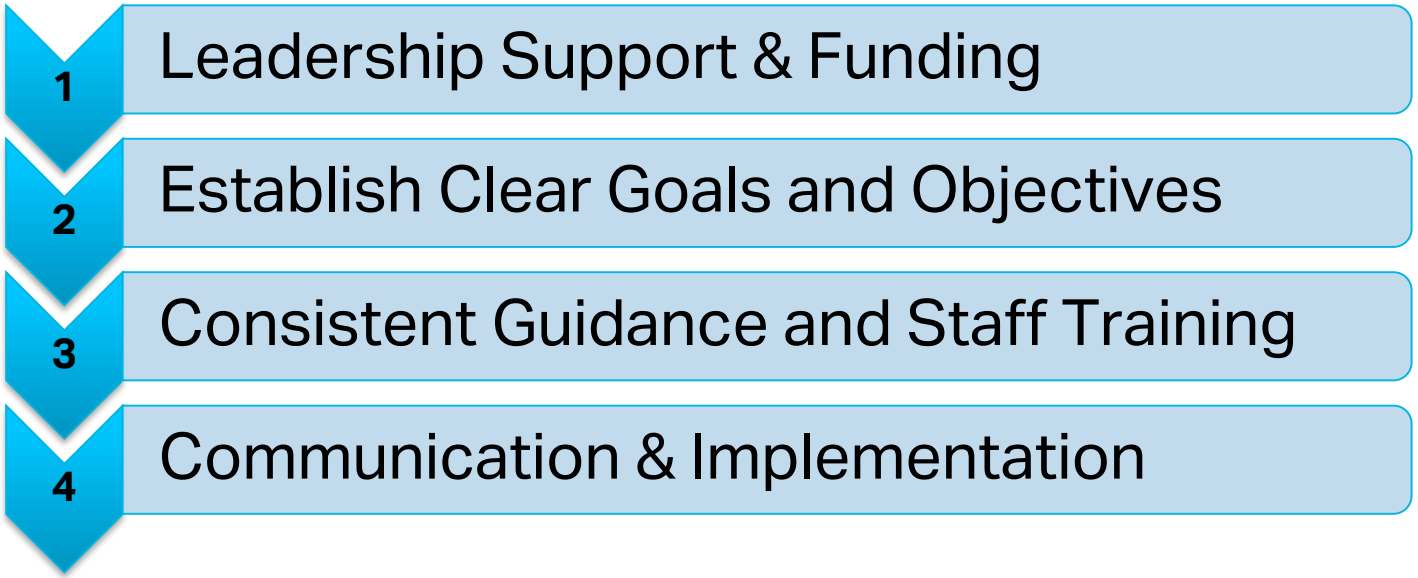
- Strategic Business Plan (tied to funding)
- Department-wide planning
- Capital improvements (Stage-Gate Process for infrastructure investments must consider climate impacts)
- Developed seasonal projection capability to drive operational decisions for water supply and flood control (e.g. understanding El Nino impacts)
- Forensic analysis of extreme events: operators inform CIP planners why a system failed after an event, and determine critical thresholds

Summary

Key Takeaways and Conclusion

- Leadership support and buy in at every level.
- Communication and staff training (one team, one approach).
- Factor Risk Management into all aspects of utility management and decision making.
- Maximize co-benefits through integrated policy, planning, design guides, LOS and O&M.
- Inter-dept. and regional collaboration.

Steps to a Resilient Utility



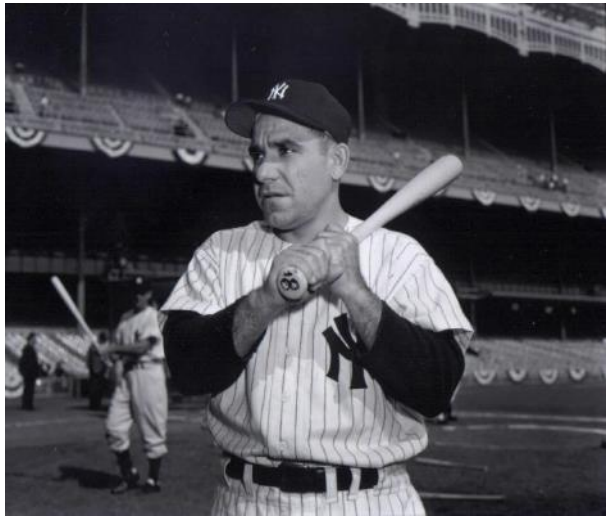
Yogi Berra On Climate

Climate Stationarity

"The future ain't what it used to be."

Future Climate

"I wish I had an answer to that because I'm tired of answering that question."



Yogi Berra

Future Tech Talks – RUC Training Curriculum

Planning and Capital Improvements

- Achieving Resiliency Goals through Comprehensive Vulnerability Assessment and Flexible Adaptation Planning
- Smart Decision Support - A Holistic Approach to Resiliency Planning
- Understanding your Utility Vulnerabilities: Prioritization of Capital Improvement and R&R Investments

Operations

- Risk Analysis and Management for Critical Asset Protection – J100 Standard for Risk and Resilience Management of Water and Wastewater Systems
- Infrastructure Risk Assessments – Helping Enhance Utility Resilience

Disaster Management

- Safeguarding Vital Wastewater Infrastructure: A Strategic Risk and Triple-Bottom Line Adaptation Framework
- Planning for Utilities Operational Resiliency through Implementation of Disaster Resiliency Scorecards Water Security and Preparedness - Lessons Learned on Utility Resiliency

Future Tech Talks – RUC Training Curriculum

Innovation/Emerging Technologies

- Sea Level Rise Tools and Utility Exposure Examples
- Emerging Technologies for Operationalization of Resilience in Water/Wastewater Utilities
- Business Continuity Plan for the Water Sector through Partnership with the Water Research Foundation

Utility Resilience Case Studies

- Rising Seas and Wastewater Infrastructure in the New York Metropolitan Area (Case Study)
- 100 Resilient Cities: Lessons Learned on Utility Resiliency – The cases of San Francisco PUC, New York City DEP, and Miami Beach

Questions

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