Today's webinar will begin in a few moments.

Find information about upcoming

Water Infrastructure Investments: Strategies to Improve Your County’s Resilience

National Association of Counties
December 19, 2016

Stronger Counties. Stronger America.
Tips for viewing this webinar

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Water Infrastructure Investments: Strategies to Improve Your County’s Resilience

National Association of Counties
December 19, 2016
Today’s Speakers

Adam Ortiz
Director
Department of the Environmental for Prince George’s County

Hardeep Anand, P.E.
Deputy Director
Miami Dade Water & Sewer Department

Laurens Vander Tak
VP and Technology Fellow
CH2M, Water Resources and Ecosystems Management
Today’s Moderator

Terry Martin
Senior Water Accounts Manager
Esri
Green Infrastructure and Green Stormwater Infrastructure

GIS Tools:
Context, Analysis, Connectivity, Understanding, Site Suitability, Planning, Implementation, Management, and Evaluation

Terry Martin (tmartin@esri.com) & Ryan Perkl (rperkl@esri.com)
Green Infrastructure Definitions:

Florida: Corridors of Green Infrastructure as ecosystem services for water quantity and quality

EPA: Green Infrastructure as constructed features that mimic the ecosystem services with regard to water, stormwater, and waste water infrastructure

Mind The Gap:
- Connectivity
- Context
- Localization
- Prioritization
- Site Suitability
- Management
- Evaluation
- Standardization

Planning and Engineering Brought Together
When rain falls in natural, undeveloped areas, the water is absorbed and filtered by soil and plants. Stormwater runoff is cleaner and less of a problem than in cities.

Green infrastructure uses vegetation, soils, and other elements and practices to manage water quality naturally. At the large scale, green infrastructure is a patchwork of natural areas that provide habitat, flood protection, cleaner air, and cleaner water.

At the neighborhood or site scale, Green Stormwater Infrastructure systems mimic natural processes.

Two Scales
Green Infrastructure

Natural Systems
Regional Scale

Green Infrastructure for the U.S.
Connecting Landscapes, People, and Communities across the Country

Built systems that mimic natural systems
Local Scale
GIS for Green Infrastructure

Water Stress, Water Quality, Water Security…” The Arrows are all going in the wrong direction”…

“Be inspired, grasp the methodologies and tools and alter the course of what’s going on.”

Jack Dangermond
GeoDesign Conference 2016

It’s a geographic problem
It needs a geographic approach
It needs a GIS Platform to solve it
Green Infrastructure

- Green Infrastructure: intact tracts of natural ecosystems providing ecosystem services that benefit us all.
- Preserve and protect
- Enhance
- Restore
- Connect
Green Stormwater Infrastructure

- Green Infrastructure is an approach to water management that protects, restores, or mimics the natural water cycle.
- Context
- Connectivity
- Site Suitability
- Sustainability
Why Green Infrastructure?

Reduce Runoff
Conserve water resources
Improve water quality
Reduce CO2
Urban Agriculture
Energy Savings
CSO Requirements
Increase green space
Better than Gray Infrastructure
Less Expensive
Habitat improvement
Wildlife corridor
Aesthetics
It’s the right thing to do
Siting a green infrastructure project is a geographic problem, GIS software, helps solve this problem by identifying optimal green infrastructure sites. It allows us to demonstrate how organizations can integrate green initiatives into their business. It has also helps to bring attention to the problems and solutions.

Most of the tools already exist. GeoPlanner, Model Builder, GeoDesign, City Engine, Green Infrastructure, StoryMaps, even 22 of the Water Utility Solutions fit with no changes (except the name).
Benefits

Every place can benefit from the cost effective application of green infrastructure because it saves money, reduces energy consumption, is more aesthetically pleasing and provides additional benefits such as carbon reduction and wildlife habitat.

Every water organization can benefit.

Every community, city, and county can benefit.
Types of Built Green Infrastructure

By Location:
- Inverts
- Drainage
- Outfalls
- Constructed Wetlands
- Right of way
- Green Street (permeable paving)
- Zoos
- Botanical Gardens
- Parks
- Schools
- Public Land
- Private Land
- New Development
- Retrofit

By Type
- Inverts
- Drainage
- Outfalls
- Constructed Wetlands
- Right of way
- Green Street (permeable paving)
- Zoos
- Botanical Gardens
- Parks
- Schools
- Public Land
- Private Land
- New Development
- Retrofit
How it’s done

Consent agreement
Master Plan
Grant Proposal
Site Selection (public, private, agency)
Planning
Design
Construction
Operations and Maintenance
Public Awareness and outreach
It is a geographic problem.
It is only sometimes a geographic workflow

1. Geographic Approach offers:
2. Data Management (Portal/AGOL, versioning, QA/QC Data Reviewer)
3. Site Suitability Tools (Green Infrastructure web tools, Model Builder, ArcPy)
4. Site Selection (decision support tools, LiDAR, 3D, ArcGIS Earth, City Engine, GeoPlanner)
5. Data Export for Design (ArcGIS for AutoCAD, Portal (group), Import (data reviewer)
6. Construction (GeoEvent, Drone2Map)
7. Operations and Maintenance (Workforce Manager, Navigator, Collector, Survey 123)
8. Public Engagement (Story Maps, Crowdsourcing apps, public facing AGOL, Publisher)
The Esri Green Infrastructure Initiative provides Data and Tools that give you a regional Context for natural and constructed green infrastructure projects.

The tools provide a method to localize the regional data and develop local data and plans to support green infrastructure projects and green stormwater infrastructure projects.

This allows you to connect your local projects to the bigger picture.
Green Infrastructure Initiative provides context and connectivity for planning and managing GI projects.

Can be applied to GI restoration, stormwater management, and resilient adaptation to the effects of climate change.

Improving chances for sustainability

http://www.esri.com/about-esri/greeninfrastructure
Understanding our world.
Prince George’s County, Maryland

Adam Ortiz
Director
Department of the Environmental for Prince George’s County
Mandate for Prince George’s County

• Build filters to treat 15,000 impervious acres by 2025
  – Approximately 46,000 stormwater filtration devices
  – Will cost approximately $1.2 billion

• Pay for this with a dedicated funding source (Clean Water Act Fee)

The Prince George’s Model: Make work for us

• Clean our waters
• Revitalize older communities
• Lead with innovation
• Grow local economy
• Partner as much as possible
CLean WATER MANDATE

Mandate for Prince George’s County
  • Build filters to treat 15,000 impervious acres by 2025
    – Approximately 46,000 stormwater filtration devices
    – Will cost approximately $1.2 billion
  • Pay for this with a dedicated funding source (Clean Water Act Fee)

The Prince George’s Model: *Make work for us*
  • Clean our waters
  • Revitalize older communities
  • Lead with innovation
  • Grow local economy
  • Partner as much as possible
OUR PERSPECTIVE

1. Have a lot of catching up to do
2. Need to be humble, we don’t have all the answers
3. Embrace culture of innovation
4. Transcend stereotypes with a can-do mindset
5. “Lets things happen to us” vs. “Make things happen for us”
6. Leverage opportunity for interconnected issues (County Executive Baker)
7. Role of Government?
   To align outside forces for the public good
WE ARE NOT ENOUGH

Public Sector
WE MUST PARTNER

Public Sector

- Private Property Owners
- Local business
- Universities & Colleges
- Towns and Cities
- Workforce pipelines
- HOA’s and apartments
- Nonprofits and Churches
- Residents

Private Property Owners

Local business

Universities & Colleges

Towns and Cities

Workforce pipelines

HOA’s and apartments

Nonprofits and Churches

Residents
PARTNERSHIP: PRIVATE PROPERTY OWNERS

Our Rain Check Program provides up to $3 Million for private property owners to address polluted runoff.
PARTNERSHIP: SCHOOLS

Our 200 school properties can help us meet our retrofit acreage goals while we help them meet their environmental literacy goals, turning raingardens into outdoor classrooms.
PARTNERSHIP:
CHURCHES AND NONPROFITS

Alternative Compliance Program

1. Easements: Up to 50% reduction in fee
2. Green Teams and Green Ministries: Up to 25% reduction
3. Green Housekeeping: Up to 25% reduction
PARTNERSHIP:
WORKFORCE TRAINERS
PARTNERSHIP: PRIVATE SECTOR

Public Private Partnership (P3)

• Enhance strengths and mitigate weaknesses of the other

• Use market forces to achieve goals, bring down pricing, and nurture a ‘Stormwater Silicon Valley’
CLEAN WATER PARTNERSHIP
THE AGREEMENT

• Construction: 3 years to retrofit 2,000 acres
• Maintenance: 30 years
• Manage $100M in contracting
  • Pay for performance:
    • Time & budget
    • Socio Economic –
      • 40% County business
        - Small and minority business targets
        - Local hiring (51%)
      • Local business mentor-protoge development
THE CLEAN WATER PARTNERSHIP

STUCTURE

Community Partnerships
- Universities
- Faith & Nonprofit
- Environmental
- Job Training
- Schools
- Mentoring
- Towns & Cities

Construction
- Subcontractors
- Suppliers
- Materials
- Workers
- Inspectors
- Drivers

Maintenance
- Subcontractors
- Suppliers
- Services
- Inspectors
- Construction
- Labors
- Equipment

Master Program Agreement
County - Oversight
Corvias - Management

Clean Water Utility Fee

Corvias
THE CLEAN WATER PARTNERSHIP
TIMELINE

- Master Program Agreement Signed
- Implementation Phase Begins
- First Contractor Prequalification Outreach Event
- Additional Scope Added to Include Schools
- Forestville New Redeemer Baptist Church - AOP
- Mentor Protégé Program Begins
- Three New General Contractors Added
- Construction Season Begins
PERFORMANCE METRICS & TRANSPARENCY

CWP Dashboard
Cleanwaterpartnership.com

DoE Clean Water Map
Princegeorges.maps.arlcgis.com
PERFORMANCE METRICS & TRANSPARENCY

PUBLIC SCHOOLS
39 ACRES
ESTIMATED 18 PROJECTS

MUNICIPAL SITES
372.54 ACRES
ESTIMATED 180 PROJECTS

PONDS
460.19 ACRES
ESTIMATED 4 PROJECTS

PRIVATE PROPERTY
24.27 ACRES
ESTIMATED 50 PROJECTS

OUTFALLS
50 ACRES
ESTIMATED 50 PROJECTS

WORKFORCE DEVELOPMENT
11,285.55 TOTAL HOURS WORKED BY COUNTY RESIDENTS (15.32%)
55,988.05 TOTAL HOURS WORKED
Year 1 15%  Year 2 30%  Year 3 51%

COMMUNITY IMPACT
125,000 INVESTMENT IN STUDENT INTERNSHIPS
MORE THAN 50 OUTREACH EVENTS IN THE BUSINESS COMMUNITY
SMALL CHURCHES CONNECTING WITH CONGREGATIONS AS PART OF OUR CWP PARTNERSHIP WITH FAITH-BASED AND 501(c) NON-PROFIT GROUPS
PERFORMANCE METRICS & TRANSPARENCY
PERFORMANCE METRICS & TRANSPARENCY
# PROCESS TRANSFORMATION

<table>
<thead>
<tr>
<th>Before</th>
<th>Now</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silo’d design, build, and maintenance</td>
<td>Integrated project development</td>
</tr>
<tr>
<td>James Brown: “Hit it and quit it”</td>
<td>Long term investment in product</td>
</tr>
<tr>
<td>Focus on individual projects</td>
<td>Focus on effective system</td>
</tr>
<tr>
<td>Narrow Control</td>
<td>Broad Empowerment</td>
</tr>
<tr>
<td>Costly duplication</td>
<td>Aggregation and standardization</td>
</tr>
<tr>
<td>Input preoccupation</td>
<td>Outcome preoccupation</td>
</tr>
<tr>
<td>Start over from scratch</td>
<td>Scalable resources</td>
</tr>
<tr>
<td>Change orders</td>
<td>No change orders</td>
</tr>
<tr>
<td>Missed deadlines, extensions</td>
<td>Timeliness</td>
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</tbody>
</table>

STORMWATER MANAGEMENT DIVISION
# INDUSTRY TRANSFORMATION

<table>
<thead>
<tr>
<th>Before</th>
<th>Now</th>
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</thead>
<tbody>
<tr>
<td>Uncertain price and schedule</td>
<td>Fixed price, fixed payment process</td>
</tr>
<tr>
<td>Unpredictable payments to subs</td>
<td>Timely payment</td>
</tr>
<tr>
<td>Cost per acre +-$130k</td>
<td>Cost per acre +-$50k</td>
</tr>
<tr>
<td>Community disengagement</td>
<td>Broad socio-economic engagement</td>
</tr>
<tr>
<td>Same ol’ contractors</td>
<td>New contracting participants</td>
</tr>
<tr>
<td>Limited financing options</td>
<td>Additional financing options</td>
</tr>
<tr>
<td>Subordination to market</td>
<td>Driving the market</td>
</tr>
</tbody>
</table>
LESSONS LEARNED

1. Negotiation Process
   - Hold negotiations early and anticipate adequate time
   - Establish clear and defined roles for oversight of different disciplines

2. Duration of Agreement
   - It must correspond with the scope and scale of deliverables
   - Consider increases in production or product demand

3. Project Inventories and Distribution
   - Discuss and develop clear planning guidelines for the partnership
   - Create and maintain a transparent, alternate system to handle viable projects that may be more conducive to an enhanced CIP program
LESSONS LEARNED

4. Quality Assurance/Quality Control
   • Create specific and detailed performance measures

5. Completion Certifier Agreement
   • Respond to inquiries from outside entities that may be watching
   • Have an independent third party entity certifying the execution and completion of the program’s work

6. Permitting
   • Anticipate and adjust local permitting processes to address pace of individual project loads
   • Develop and implement expedited permitting relationships with local agencies (i.e. the County Permitting Agency, MNCPPC, SCD, etc).
   • Make permitting processes geared toward restoration oriented projects vs. a typical development track.
LESSONS LEARNED

7. Procurement

- Resources and capacity
- Evaluate and adjust the procurement process to help facilitate prompt payments for partnership workforce and vendors

8. Maintenance

- Have a long term maintenance plan in place

9. Private Property Access

- Ensure that the Agreement allows for project participation on private property
- Ensure that local governing laws/regulations authorize local stormwater fund revenue expenditures on private property
- Anticipate the need for project implementation on private property
LESSONS LEARNED

10. Diversification
   • Evaluate and look for opportunities that will diversify the program (i.e. developing a programmatic approach with the school system or faith based communities)

11. Partnerships
   • Engage stakeholders up front
     • Executive and Legislative Branches
     • Other Public Agencies (local, State, and Federal)
     • Schools and Universities
     • NPOs/NGOs
     • Communities
     • Municipalities
     • Environmental Groups

12. Be Adaptive
   • Anticipate and plan for change
   • Be flexible with the program
THANK YOU.
Miami-Dade County, Florida

Hardeep Anand, P.E.
Deputy Director
Miami Dade Water & Sewer Department

Laurens Vander Tak
VP and Technology Fellow
CH2M, Water Resources and Ecosystems Management
M-D WASD

Water Infrastructure Investments: Becoming a Resilient Utility
Introduction

01 System Overview

02 A Resilience Framework for Action

03 Implementation

04 Resilient Utility Coalition
01. SYSTEM OVERVIEW

Water System

- 3 large regional and 5 small water treatment plants (WTP), plus new Hialeah Reverse Osmosis WTP
- Supplying an average of 314 million gallons per day (MGD)
- Per capita water use 137 GPCD

- 15 wholesale customers
- 432,000 retail customers
- 100 water supply wells
- 8,206 miles of pipes
- 38,381 fire hydrants
- 126,306 valves
Wastewater System

- 3 wastewater treatment plants
- 2 ocean outfalls and 21 deep injection wells
- Collecting, treating, and disposing 308 MGD
- 350,000 retail customers
- 13 wholesale customers
- 6,309 miles of mains and laterals
- 1,047 sewer pumps stations
- Reusing 13 MGD
### Programs

**PSIP:** Design/construct 119 pump station & forcemain projects totaling approximately $200M over a 3-year period

**Consent Decree:** Design/construct 82 capital improvement projects totaling approximately $2.2B over a 15-year period

**OOL:** Complete system-wide wastewater infrastructure improvements over 60 projects totaling approximately $5.4B

### Planning and Compliance

**Integrated Master Plan:** Comprehensive plan encompassing water, wastewater, climate adaptation, integration of technologies

**I/I Program:** Implementation of an overall program and scorecard

**Resiliency Program:** Climate change and sea level rise adaptation

**Utility Development:** Utility coordination, roadway projects and system betterment for new service areas

### CIP

**UPEC:** Program and construction management for CIP pipeline projects (water and sewer)

**Pumps:** Program and construction management for CIP pipeline projects (water and sewer)

**Plants:** Design/construct new 50 MGD Northwest Wellfield WTP; new 20 MGD South Miami Heights WTP; and CIP/R&R Plant projects

---

**01. SYSTEM OVERVIEW**

---

**CIP & REGULATORY COMPLAINCE**
A Resilience Framework
Resilience Vision

- Operations Optimization
- Integrated Planning
- Quality, Value, Economic Growth
- Engaged & Skilled Workforce
- Integrated Technologies
- Best Practices, Industry Recognitions
02. A RESILIENCE FRAMEWORK

Guiding Framework

Effective Utility Management (EUM)
- 10 attributes of effectively managed utilities
- 5 keys to management success
- Lean six sigma

EPA Climate Ready Utilities
- Adaptive response framework
02. A RESILIENCE FRAMEWORK

Envision Sustainable Infrastructure Rating System
Department of Energy Partnership

- Better Plants Program
- CHP Accelerator
- Wastewater Plants Accelerator

To date, Better Plants Partners have saved 457 trillion British thermal units and $2.4 billion cumulatively in energy costs.
Utility of the Future Today

2016 Recognition at WEFTEC
02. A RESILIENCE FRAMEWORK

Changing the Culture

- Comprehensive and Integrated Planning
- Leveraging Technology and Data
- Customer Engagement
- Alternative Project Delivery and Funding Approaches
- Proactive Approach / Regulatory Compliance
- Workforce Training and Development
Embracing Technology

Integrated Technology Solutions
- CCTV
- GIS
- HYDRAULIC MODEL
- SCADA
- EAMS
- CIIS
- RISK-BASED MODEL

Decision Support System

- DATA
- DECISIONS

RISK-BASED PLANS WITH SUPPORT-RESILIENT FRAMEWORK

Resilient Community Investment Plans
Resilience Vision

Effective utility management

Plan to meet SLR challenges

Blueprint for action

Participation in professional associations

Partnership with DOE

ISO certifications

Technology integration and reliability

Professional internal training
Implementation
03. IMPLEMENTATION

CMOM

New CMOM Program Requirements

- Defined purpose
- Defined goal
- Documented with specific detail
- Implemented by trained personnel
- Established performance measures
- Written procedures for periodic review

INFORMATION MANAGEMENT SYSTEM (IMS) PROGRAM

- Sewer System Asset Management Program
- Pump Station Operations & Preventative Maintenance
- Force Main Operations, Preventative Maintenance and Rehab
- Gravity Sewer System Operations and Maintenance
- WWTP Operations and Maintenance Program
- Sewer Overflow Response Plan (SORP)
Hydraulic Modeling

- System data
- Operation data
- Stakeholder
- Community

- Decision-making support system
- Gap analysis
- Triple bottom line evaluation (social, environment, economic)

- GIS
- InfoWater
- SCADAWatch / IWLived
- InfoMaster
- Cafe / KANEW
- SCADA
- EAMS
- PCTS

- Analyses + Programs
  - Level of service
  - Hydraulic modeling
  - Facility assessment and score card
  - Energy management & operational efficiency
  - Water conservation
  - Risk assessment
  - Asset management program
  - Optimization of existing infrastructure
  - CIP prioritization
  - CIP schedule
  - Cost estimates

- Benefits
  - Sustainable economic development
  - Reliable infrastructure, fewer breaks / overflows
  - Cost assurance rate justification
  - Regulatory compliance
  - Community benefits and reinvestment
  - Proactive decision-making
Pipeline Improvements

Norris Cut Force Main Replacement

- 5,300 LF of 10' Dia. Tunnel under Norris Cut from Fisher Island to Virginia Key
- 2,700 LF of 60" Dia. Open Cut Pipeline Installation in WWTP
- 1,000 LF of 10" Dia. Horizontal Directional Drill

Results

- Increased reliability/redundancy
- Renewal of aging infrastructure
- Customer satisfaction
- Enhanced infrastructure stability
- Staff training on alternative technologies
Pipeline Improvements

Rehab of 72" Sanitary Sewer Force Main
- 15,300 LF of 63" HDPE Slip-lined Pipe
- Fittings, Connections and Thrust Restraints
- 180 Days (Dry-Season)

Results
- **Preventative replacement** successfully mitigated potential for failures and property damage
- Maximization of existing infrastructure
- **Enhancement in operational resilience**
- Financially viable solution
Energy Initiatives

South District WWTP Cogeneration Facility Improvements

- Upgrade of existing cogeneration facility constructed in early 1990’s
- Capacity expanded to process methane gas from adjacent municipal landfill
- Four 2,000 kw cogeneration units
- Upgrades to digester and landfill gas conditioning systems

Results

- Increased energy output and system efficiency
- Reduction in carbon emissions
- Improved redundancy and WWTP resilience
03. IMPLEMENTATION

Water System Initiatives

Enhanced Leak Detection System

- Deployment of fixed network in densely populated area with aging infrastructure
- Piloted over 109 miles of transmission and distribution system piping
  - 50 Leaks identified in first four months
  - 459 Millions of Gallons of Water Saved
  - Significant savings in non-revenue water

2016 NACO Achievement Award in Water Loss Management and Accountability
Water System Initiatives

Acoustic Fiber Optic Emergency Response System

- Real time monitoring of wire strands in vulnerable PCCP pipe
- Installed on high criticality/high risk assets
- Automatic alerts upon wire breaks
- AFO allows for preventative action prior to critical failures
Water System Initiatives

Advanced Metering Infrastructure (AMI)

- MDWASD preparing to deploy AMI throughout service area (450,000 accounts)
- Improvements in customer service and engagement
- Water conservation and improved efficiencies
- Leveraging of data for planning
  - Real-time consumption
  - Pressure monitoring
  - Leak detection
  - Other network applications
Resilient Utility Coalition
RUC Vision

How do we operationalize?

How do we reduce & mitigate risks & enhance resilience?
# Members and Roles

<table>
<thead>
<tr>
<th>Academia</th>
<th>Professional Organizations</th>
<th>Water Industry</th>
<th>Utilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Innovation, research and development</td>
<td>- Best management practices and industry standards</td>
<td>- Innovative &amp; comprehensive solutions</td>
<td>- Regional scorecard</td>
</tr>
<tr>
<td>- Opportunity to collaboratively engage in labscale studies, pilots, pursue research grants</td>
<td>- Training and education of workforce</td>
<td>- Holistic approach to incorporate resiliency from planning to operations</td>
<td>- Quarterly roundtable meetings</td>
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<tr>
<td></td>
<td>- Advocacy and policy development</td>
<td>- Tech talks</td>
<td>- Exchange of resources and materials</td>
</tr>
<tr>
<td></td>
<td>- Networking and engagement</td>
<td></td>
<td>- Preparedness Drills</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>- Share best practices and lessons learnt</td>
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<td></td>
<td></td>
<td></td>
<td>- Interlocal Agreements</td>
</tr>
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</table>
Continuous Process

**Rapid Recovery**
Ability to adapt and learn from an event. Better preparedness.

**Robust & Flexible**
Able to rebound back from small, daily disruptors. This is part of the operational stability. Ability to keep absorbing shocks and keep responding.

**Resourceful & Actionable**
Ability to manage an event as it unfolds. Sound action plans / alternatives to put in action.
CARDS Aligned

Comprehensive and Collaborative
Actionable and Adaptive
Robust and Resiliency
Dynamic and Diligent
Sustainable and Strategic

Changing the organizational
culture
Overarching planning
that aligns the CARDS
The Resilience Path

1. CARDS aligned. A recognized leader; continuous improvement

2. Evaluate and implement low hanging fruit

3. CARDS aligned. A recognized leader; continuous improvement

4. Evaluate and implement low hanging fruit

5. Compliance

Non-compliance with jurisdictions within which you operate

Integrate all benefits in the operation of the system
For more information, please contact:

Hardeep Anand, P.E., Deputy Director
Capital Improvement Program
hardeep.anand@miamidade.gov
786-552-8571

www.miamidade.gov/water
Acknowledgements

- Bertha M. Goldenberg, Miami-Dade Water and Sewer Department, FL
- Dr. Doug Yoder, Miami Dade Water & Sewer Department, FL
- Hardeep Anand, Miami Dade Water & Sewer Department, FL
- Dr. Virginia Walsh, Miami Dade Water & Sewer Department, FL
- Evelio Agustin, CH2M, FL
- Matt Alvarez, CH2M, FL
- Dr. Jennifer Baldwin, CH2M, TN
- Dr. Say-Chong Lee, CH2M, FL
- Paul Robinson, CH2M, CA
- Dr. Swamy Pati, CH2M, FL
- Dr. Peter B. Urich, CLIMsystems Ltd, NZ
Agenda

• Background
• Climate Projections
• Flood Inundation Modeling with Climate Change
• Draft Design Guidelines for Facility Hardening with Climate Change
• Next Steps
Climate Resilience/Facility Hardening-Objectives and General Approach

• Assess projected climate change for key climate variables (sea level rise, precipitation, wind, inundation due to surge)
• Define critical wastewater assets and risk due to climate change
• Define design criteria to minimize risk
• Develop facility hardening plans and design guidelines for OOL and PMCM design teams
Background

• In 2015, CH2M completed
  – Storm surge modeling
  – Determined 2075 flood elevations at 142 pump stations accounting for 3.1 and 4.0 feet of Sea Level Rise
  – Developed draft design guidelines for facility hardening at WWTPs and at pump stations

• Design guidelines for pump station facility hardening updates ongoing:
  – Update modeling scenarios
  – Develop criticality levels for pump station design
  – Develop decision flow chart for levels of protection and hardening alternatives based on risk and criticality
Climate Projections
Precipitation Intensity-Duration-Frequency (IDF) Projections: Peak Flow and Flood Impacts

Pump Station Peak Flows Are Based on 2-yr Storm:

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

100-yr storm projected to increase from 14.5” to 17.4” – 20”
Sea Level Rise Impacts: Coastal Flooding and Increased Wastewater Infiltration/Inflow (due to higher groundwater and rainfall)

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

<table>
<thead>
<tr>
<th>Year</th>
<th>IPCC AR5 Median (inches)</th>
<th>USACE High (inches)</th>
<th>NOAA High (inches)</th>
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<tr>
<td>2030</td>
<td>6</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>2060</td>
<td>14</td>
<td>26</td>
<td>34</td>
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<tr>
<td>2100</td>
<td>31</td>
<td>61</td>
<td>81</td>
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**2015 ANALYSIS**: Surge and inundation modeling run with  
- 4.0’ SLR (2075 NOAA High)  
- 3.1’ SLR (2075 USACE High)
Flood Modeling with Climate Change
Relationship of Modeling Tasks Reflects Flooding Source: SLR, Storm Surge with Future SLR and Rainfall, Wave Effects

Key Variables:

- Wind 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 on storm surge and SLR
- Flood Propagation of SLR, Surge, and Rainfall inland
- Wave effects at shoreline and propagation inland
Surge Modeling: Comparison of Peak Surge Elevation: modeled with MIKE21 vs observations for Hurricane Andrew
Additional Storm Surge Modeling Scenarios (MIKE21): 25-year storm surge with 1.5, 3.1 and 4.0 ft SLR

Spatial variation of the 25-year SWEs and each SLR scenario along transects, Ocean points

Spatial variation of the 25-year SWEs and each SLR scenario along transects, Bay points

Location of model transects
Inland Flooding: 100-year Depth

Current (no SLR)

With 4 ft SLR
Refined Inland Flooding: 100-year Depth (zoomed in at PS #1)
Refined Inland Flooding: 25-year Depth (zoomed in at PS #1)

Current (no SLR)

With 4 ft SLR
Miami-Dade Design Guidance on Facility Hardening with Climate Change
Factors in Setting Risk-based Design Criteria Used to Evaluate Cost/Benefit of Facility Hardening

• Planning Horizon to establish the service life:
  − 2075 for Critical Long-Term Facilities (e.g. WWTPs)
  − 2040 selected for pump station flows (e.g. PS-1)

• Criticality, based on wastewater or pumping facility function, such as:
  − Maintenance of facility hydraulics
  − Maintenance of equivalent primary treatment, liquid train
  − Maintenance of secondary treatment, liquid train
  − Maintenance of solids treatment
Facility Hardening Costs were Developed for Critical Facilities above Design Flood Elevation

Central District Wastewater Treatment Plant

WASD Priority Order:
1. Personnel Protection and Hydraulic Capacity Maintained
2. Primary Treatment Liquid Processes
3. Secondary Treatment Liquid Processes
4. Solids Treatment Processes

*All elevations are in 1929 NGVD
Adaptation Strategies / Protective Measures

- Identified 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.

### Adaptation Strategy

<table>
<thead>
<tr>
<th>Adaptation Strategy</th>
<th>Resiliency/Effectiveness</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevate Equipment</td>
<td>Low</td>
<td>$$$$</td>
</tr>
<tr>
<td>Flood-Proof Equipment</td>
<td>Medium</td>
<td>$$</td>
</tr>
<tr>
<td>Install Static Barrier</td>
<td>Low</td>
<td>$$</td>
</tr>
<tr>
<td>Seal Building</td>
<td>Low</td>
<td>$</td>
</tr>
<tr>
<td>Sandbag Temporarily</td>
<td>Low</td>
<td>$</td>
</tr>
<tr>
<td>Install Backup Power</td>
<td>Low</td>
<td>$$</td>
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</tbody>
</table>

Source: NYCDEP
## Facility Hardening Costs - WWTPs

**Scenario 1 (Design Elevation 16.0 ft)**

<table>
<thead>
<tr>
<th>Facility</th>
<th>CD (Existing)</th>
<th>OOL (Existing)</th>
<th>Total</th>
<th>CD</th>
<th>OOL (Existing Facilities)</th>
<th>Total</th>
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<tbody>
<tr>
<td>CDWWTP</td>
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<td>$4,576,200</td>
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<tr>
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<td>$5,513,000</td>
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<td>NDWWTP</td>
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</table>

**Scenario 2 (2075 SLR + FB + SF)**

<table>
<thead>
<tr>
<th>Facility</th>
<th>CD (Existing)</th>
<th>OOL (Existing)</th>
<th>Total</th>
<th>CD</th>
<th>OOL (Existing Facilities)</th>
<th>Total</th>
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<tr>
<td>CDWWTP</td>
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<td>NDWWTP</td>
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<td></td>
<td></td>
<td>$14,578,000</td>
<td></td>
<td>$14,578,000</td>
</tr>
</tbody>
</table>

**Note:**

OOL Facility hardening was only estimated for retrofitting existing facilities.

New OOL facilities would be hardened to same design criteria.
Facility Hardening Design Guidelines for Existing and New WWTP Assets:
Draft issued Aug. 2015, revision planned early 2017

<table>
<thead>
<tr>
<th>Existing WWTP Facility Assets</th>
<th>New WWTP Facility Assets</th>
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</thead>
<tbody>
<tr>
<td><strong>ft NGVD29</strong></td>
<td><strong>Basis</strong></td>
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<tr>
<td>CDWWTP</td>
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<tr>
<td>SDWWTP</td>
<td>16.0</td>
</tr>
<tr>
<td>NDWWTP</td>
<td>16.0</td>
</tr>
</tbody>
</table>

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)

- Criticality Factors
  - Flow
    - Based on population served
  - Priority 1 critical facilities served
    - Hospitals, shelters, first responders, emergency centers, city hall, homeland security, potable water facilities, prisons
    - Booster stations
    - Re-pump stations
  - Priority 2 critical facilities served
    - Other government buildings, schools, care service centers, fleet vehicle stations
Next Steps

• Prioritize Critical Pump Stations based on Flooding Risk
• Refine facility hardening approaches of priority pump stations based on feasibility, cost/benefit
• Cost estimates for categories of pump stations based on selected facility hardening approaches
• Update design guidelines for both pump stations and WWTPS
  - Flood protection elevations
  - Decision flow chart based on:
    • Criticality and Risk
    • Cost benefit (feasibility)
    • Service life
  - Case studies
• Develop GIS mapping tool for current and projected flood elevations
Question & Answer session

- Type your question into the “Questions” box and the moderator will read the question on your behalf.
Learn more and register at:

www.naco.org/webinars
THANK YOU!

Additional questions or feedback?
Contact Jenna Moran at jmoran@naco.org