Agenda

• Introduction to West Palm Beach
• Regional Perspective in South Florida – One Water
• West Palm Beach Challenges
  • Resilient West Palm Beach
  • Drought Management
  • Water Quality Protections
  • Sustainable Biosolids
  • Leveraging Technology in Asset Management
• Driving Quality and Innovation in the Utility

Grassy Waters Preserve
<table>
<thead>
<tr>
<th><strong>West Palm Beach</strong></th>
<th><strong>Combined Water, Wastewater &amp; Storm Water Enterprise Fund</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>35,890</td>
<td>110,222 Water Accounts 2018 Population</td>
</tr>
<tr>
<td>27,518</td>
<td>58 Sewer Accounts sq. miles</td>
</tr>
<tr>
<td></td>
<td>Combined Water, Wastewater and Storm Water Enterprise Fund</td>
</tr>
<tr>
<td>61</td>
<td>61 sq. miles Water Service Area*</td>
</tr>
</tbody>
</table>

*Supplies water service to Palm Beach and South Palm Beach

**Legend**
- Municipal Boundary
- Operational Service Area 61 square miles of service territory
FLORIDA: Water Resource Challenges

- Drainage upgraded in Jacksonville neighborhood flooded by Irma
- Sea Level Rise Will Rapidly Worsen Coastal Flooding in Coming Decades, NOAA Warns
- Mayors Talk Aging Infrastructure Using Flint As Example
- Polk Regional Water Cooperative proposes new water supply projects
- There’s a solution to the Southeast’s water crisis. But will Georgia and Florida agree to it?

Sea-level rise is a regional threat. It will need a regional game plan to fight it.
South Florida Regional Challenges Drive New Thinking about Water

- Drought
- Growth
- Mandates
- Water Value
- Resource Availability
- Sea Level Rise
- Technology
- Cost
- Stewardship
- Sustainability
- Risks
South Florida Water Supply: Recent History

2005 to 2015 Trends

- 15% (per capita)
- 6% (Population*)
- 463% (Floridan Aq.)
- 20% (Reuse)

Trends from SFWMD LEC planning data

*Composite from actual and forecast

- Water Availability Rule: 20-yr Water Use Permits Expire
- Up to 178 mgd of RW available (OOL)
- Drought & Economic Downturn
- Ocean Outfall Legislation (OOL)

Estimates from SFWMD LEC planning data
South Florida Water Supply: Future Outlook
Aggressive Demands Did Not Materialize

Conservation Impacts
- Reduced per capita demand

Deferred Need for Expansion
- Timing
- Water quality
- Supply diversity
- Technology

8.5 mgd
Long-Term Planning Begins Now

Estimates from SFWMD LEC planning data

- Water Demand Growth
- Permitted Water Supply
- WS Deficits Emerge Beyond 2030
- Drought & Economic Downturn
- Ocean Outfall Legislation (OOL)
  Water Availability Rule
- Up to 178 mgd of RW available (OOL)

2005 2010 2020 2030 2040

20-yr Water Use Permits Expire
Leveraging a Wide Variety of Solutions

Regional Wellfields
Stormwater Capture
Reclaimed Water
Biscayne
C-51
IWRP
Wetland Rehydration
Floridan
Demand Management
System Integration
Cost Management
Adaptation Strategies
ASR
Conservation
Offsets
Example: One Water Approach in Action

- Allows recovery of stranded capacity
- Multi-County & multi-jurisdictional
- Private/Public stakeholders
- Optimize water-production costs
- Provide offset water supply to Broward County
- Increase water supply resiliency
Hollywood’s OOL Compliance Strategy Leverages One Water Approach

Reuse Required by OOL: 20.4 mgd

**Achievements**

1. Reduced new reuse required by 14.4 mgd (70% reduction)

2. Estimated savings - $200M

**Remaining Requirements**

1. Expand actual reuse by 1.5 mgd

2. Pursue 4.5 mgd of Contracted Reuse

3. Implement effluent disposal via deep well injection
Resilient West Palm Beach

Goals/ Commitments

- GHG Net Zero 2050
- 100% Renewable Energy,
- Energy Secure Cities 2025
- Better Buildings Challenge 2025
- Global Covenant of Mayors

Major Initiatives

- STAR Communities
- Stormwater Master Plan
- WaterSmart
- Resilience Assessment
Drought Resiliency Background

- In **2011**, WPB experienced a significant, localized drought forcing water restrictions on its customers.

- Since 2011, WPB invested millions of dollars in drought-proofing its water supplies.

- WPB officials wanted a long-term water supply plan to ensure resiliency through 2065 under localized and regional droughts, and climate change.
Long Term Water Supply Planning

Lake Okeechobee

L-8

L-8 Basin

Control Structure #2

L-8 Tieback

M-Canal

Water Catchment Area

Grssty Waters

Lake Mangonia

Clear Lake

Apoxee Park

WTP
New Supply Options Evaluated

**Permit Changes**
- Permit Changes (5 to 45 MGD, with varying levels of difficulty in achieving)
- Demand-Side Management (up to 9.5 MGD by 2065)

**Other Options**
- Expanded Tidal Capture (up to 45 MGD)
- Brackish Groundwater Desalination (10 MGD)
- C-51 Surface Reservoir (10 MGD)
- Seawater Desalination (10 MGD)
- Expanded Aquifer Storage & Recovery (2 MGD)
- Expanded Eastern Wellfield (7.2 MGD)
WEAP Model Used to Estimate Gap

Natural Resources
- Rainfall-Driven Water Supply/Demand
- Water Quality
- Ecosystem
- Needs/Constraints

Human Infrastructure
- Water Demand & Demographics
- Transport: Canals, Pipelines
- Supply: Reservoirs, Groundwater, ASR

Capital Investment
- Revenue & Reserves
- Capital Financing – Net Present Value
- Dynamic Cost-Benefit Analysis
Planning Process for Long-term Plan

Define Planning Objectives, Metrics & Scenarios

Determine Need (Gap Analysis)

Analyze Supply Options and Combine into Alternatives

Test Under Scenarios

Rank Alternatives

Recommended Strategy

Water Demands and Existing Water Supply System

WEAP Model
Creating Alternatives from Options

1) **Low Cost** – Lowest cost options only

2) **High Redundancy** – Most reliable options, but leads to redundancy for non-drought years

3) **High Diversity** – Mix between Low Cost & High Redundancy

4) **No Action** – No new supply options implemented

<table>
<thead>
<tr>
<th></th>
<th>Max Yield</th>
<th>Year 2065</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(mgd)</td>
<td>Low Cost</td>
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<tr>
<td>Demand-Side Manag.</td>
<td>9.5</td>
<td>9.5</td>
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<tr>
<td>Eastern WF Expansion</td>
<td>7.2</td>
<td>7.2</td>
</tr>
<tr>
<td>ASR Expansion</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Tidal Capture Expansion</td>
<td>45</td>
<td>15</td>
</tr>
<tr>
<td>Brackish GW Desal</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>C-51 Reservoir</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Seawater Desal</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>93.7</strong></td>
<td><strong>33.7</strong></td>
</tr>
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</table>

Example of options included to meet 2065 needs
<table>
<thead>
<tr>
<th>Objectives</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SUPPLY RELIABILITY.</strong></td>
<td>Provide supply reliability during average weather and drought conditions.</td>
</tr>
<tr>
<td><strong>COST-EFFECTIVENESS.</strong></td>
<td>Develop cost effective solutions with rate payers in mind.</td>
</tr>
<tr>
<td><strong>IMPLEMENTATION EASE.</strong></td>
<td>Provide solutions that are acceptable by public, easy to operate, and scalable.</td>
</tr>
<tr>
<td><strong>WATER QUALITY IMPACTS.</strong></td>
<td>Improve taste, odor and other secondary water quality attributes.</td>
</tr>
<tr>
<td><strong>ENVIRONMENTAL IMPACTS.</strong></td>
<td>Minimize impacts on ecosystems and natural environment.</td>
</tr>
<tr>
<td><strong>STEWARDSHIP.</strong></td>
<td>Provide leadership in sustainable water management.</td>
</tr>
</tbody>
</table>
## Cost of New Supply Options

<table>
<thead>
<tr>
<th>Water Supply Option</th>
<th>Supply (MGD)</th>
<th>Capital Cost ($ Millions)</th>
<th>O&amp;M Cost/Yr ($ Millions)</th>
<th>Unit Cost * ($/1000 gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand-side Management</td>
<td>up to 9.4</td>
<td>$0.2</td>
<td>$1.1</td>
<td>$0.32</td>
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<tr>
<td>Expanded Tidal Capture</td>
<td>45</td>
<td>$34.5</td>
<td>$0.3</td>
<td>$0.16</td>
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<tr>
<td>Expanded Eastern Wellfield</td>
<td>7.2</td>
<td>$4.0</td>
<td>$0.2</td>
<td>$0.19</td>
</tr>
<tr>
<td>Expanded ASR</td>
<td>2</td>
<td>$7.2</td>
<td>$0.2</td>
<td>$0.89</td>
</tr>
<tr>
<td>Brackish GW Desalination</td>
<td>10</td>
<td>$70.0</td>
<td>$3.3</td>
<td>$2.14</td>
</tr>
<tr>
<td>C-51 Reservoir</td>
<td>10</td>
<td>$45.5</td>
<td>$2.4</td>
<td>$1.48</td>
</tr>
<tr>
<td>Seawater Desalination</td>
<td>10</td>
<td>$165.0</td>
<td>$6.1</td>
<td>$4.61</td>
</tr>
</tbody>
</table>

* Assumes capital costs are amortized at 5% for 30 years.
Ranking of Alternatives

- **High Diversity**: Rank #1
- **Low Cost**: Rank #2
- **High Redundancy**: Rank #3
- **No Action**: Rank #4

The ranking is based on the following criteria:

- **Supply Reliability**
- **Cost-Effectiveness**
- **Implementation Ease**
- **Water Quality Impacts**
- **Stewardship**
- **Environmental Impacts**
Water Projects Implemented

- Clear Lake Divide Structure and Pump Station
- Eastern Wellfield
- C-51 Canal Tidal Discharge Capture
- C-17 Canal Tidal Discharge Capture
- Aquifer Storage and Recovery Well
- Western Wellfield (Last Option)
Drought Measures Operating Protocols

Yearly Rainfall:
- Average: 57"  
- 1-In-10 Drought: 45"  
- 1-In-25 Drought: 43"  
- 1-In-50 Drought: 40"  
- 2011 Drought: 38"  
- 1-In-100 Drought: 37"

Control Structure No. 2
67 MGD
- ON

C-17, C-51 Tidal Capture
up to 126 MGD
- ON
- Intermittently Available

ASR Well
up to 8 MGD
- Available

Eastern Wellfield
14.4 MGD
- Available

Clear Lake Divide/Pump Station
up to 60 MGD
- Available

Western Wellfield
24.5 MGD
- Available
Water Quality Protection

In 2007, a series of bacteriological hits in the distribution system led to two system wide boil water notifications.

The regulator (Palm Beach County Department of Health) and the City entered into a consent order to upgrade the City’s WTP by 2018.

In 2008, the City made major improvements coupled with operational changes to resolve the immediate issue as well as initiated a robust watershed protection program.
Water Treatment Alternatives

ALT 1
- PAC-UV

ALT 2
- IX-UF-GAC

ALT 3
- IX-UF-GAC (ECR Site)

ALT 4
- ENH.COAG-ACT-UF (Riviera Beach Site)
Condition Assessment and Criticality Analysis of Existing Assets

- Existing asset data was collected and organized including:
  - Asset names/codes
  - Age/service life
  - Photographs
  - Performance data
  - Condition assessment rating
  - Repair and replacement cost
### Summary of Financing Options and Parameters for Alternatives

<table>
<thead>
<tr>
<th></th>
<th>Alternative 1</th>
<th>Alternative 2</th>
<th>Alternative 3</th>
<th>Alternative 4</th>
</tr>
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<tbody>
<tr>
<td>CAPEX</td>
<td>$33.6m</td>
<td>$107.7m</td>
<td>$362.7m</td>
<td>$289.3m</td>
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<tr>
<td>R&amp;R 2015-2019</td>
<td>$2.8m/yr</td>
<td>$2.3m/yr</td>
<td>$0.9m/yr</td>
<td>$0.9m/yr</td>
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<td>Fin. opt. for CAPEX</td>
<td>City’s Util.</td>
<td>Utility bonds</td>
<td>Utility bonds</td>
<td>Private fund.</td>
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<td>reserve &amp;</td>
<td>from market</td>
<td>from market</td>
<td>through ext.</td>
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<td></td>
<td>book balance</td>
<td></td>
<td></td>
<td>contract ops</td>
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<tr>
<td>R&amp;R 2020-2024</td>
<td>$6.4m/yr</td>
<td>$1.7m/yr</td>
<td>$0.0m/yr</td>
<td>$0.0m/yr</td>
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<tr>
<td>Fin. opt. for R&amp;R</td>
<td>Pay as you go</td>
<td>Pay as you go</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td></td>
<td>(from yearly</td>
<td>(from yearly</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>budget surplus)</td>
<td>budget surplus)</td>
<td></td>
<td></td>
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<tr>
<td>Expected immediate</td>
<td>No increase</td>
<td>3%</td>
<td>35%</td>
<td>23%</td>
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<tr>
<td>increase of util.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>rate</td>
<td></td>
<td></td>
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<tr>
<td>Expected annual inc.</td>
<td>2.0%</td>
<td>1.5%</td>
<td>1.0%</td>
<td>1.5%</td>
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<tr>
<td>of util. rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>(4-year avg.) due</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>R&amp;R needs</td>
<td></td>
<td></td>
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</table>
Selected Alternative UV Disinfection Facility
UV Reactors
Selected Alternative
Powdered Activated
Carbon Chamber
Improved East Central Regional Wastewater Facility Drives Sustainability Goals
Biosolids Improvements Facilities

- Mechanical sludge thickening to concentrate solids to 5%
- Temperature-phased Anaerobic Digestion to destroy more solids
- Co-digestion of hauled grease
- Centrifuge dewatering to remove more excess water
- New state-of-the art facilities replace aged infrastructure
Biogas recovery options evaluated by ECRWRF

- Conveyance to regional biosolids pelletizer facility for dryer fuel
- On-site cogeneration – electricity and heat recovery (1,200 kW)
- Renewable natural gas (biomethane) for vehicle fuel (393,000 GGE/year)
- Pipeline quality biomethane for export/sale
Sustainable Design Benefit Projections

Temperature-phased anaerobic digestion
• Electrical power demand < 50% of equivalent aerobic digestion

Advanced digestion and dewatering
• Will reduce biosolids hauling by 15,000+ wet tons per year

Aeration diffuser system upgrades
• Will reduce aeration energy demand by 30% to 50%

Projected reduction in overall electrical usage:
• 1,350,000 kw-hrs/month (equivalent to 1,350 single family homes)

Biogas recovery for renewable energy:
• Equivalent to 1,200 KW or 393,000 Gasoline Gallon Equivalents/year
Quality Improvement Programs at the City of West Palm Beach

Asset Management Program
ISO 14001 Environmental Management System (EMS)
City Leverages Lean Six Sigma Tools
Asset Management Programs Drive Quality Decisions

Water Main Collection System Criticality Matrix Example

Leak Detection

Compiling Asset Inventory Using Global Positioning System (GPS) Initiative and Condition Assessments

Enterprise Wide Primary Information Management Systems
Asset Management - Root Cause and Criticality Analysis

Sanitary Sewer Collection System Criticality Assessment
- Identified **sanitary sewer pipes** that pose most risk of failure
- Used to prioritize condition assessments and rehabilitation

Sanitary Sewer Collection System Criticality Matrix Example

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description</th>
<th>Breakdown</th>
<th>Score</th>
<th>Weight</th>
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</thead>
<tbody>
<tr>
<td><strong>Pipe Age</strong></td>
<td>Remaining Useful Life</td>
<td>10</td>
<td>3</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>20% Survival to 40% Survival</td>
<td>5</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>40% Survival to 60% Survival</td>
<td>4</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>60% Survival to 80% Survival</td>
<td>2</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Sanitary Sewer</td>
<td>Number of Recorded Overflows</td>
<td>10</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>High Risk</td>
<td>10</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Medium Risk</td>
<td>5</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Low Risk</td>
<td>2</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td># Work Orders</td>
<td>Number of Recorded Main Breaks</td>
<td>10</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Rare Breaks</td>
<td>10</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Frequent Breaks</td>
<td>5</td>
<td>20</td>
<td>100</td>
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<tr>
<td></td>
<td>Extreme Breaks</td>
<td>1</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>

CITY OF WEST PALM BEACH
Wastewater / Sanitary Sewer System Map Direction (2015)

Location of RO: _____________________________________________________________________________________________

City of West Palm Beach
Sanitary Sewer System Map Direction (2015)

Location of RO: _____________________________________________________________________________________________

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Sanitary Sewer System Map Direction (2015)

Location of RO: _____________________________________________________________________________________________

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Location of RO: _____________________________________________________________________________________________

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Sanitary Sewer System Map Direction (2015)

Location of RO: _____________________________________________________________________________________________

City of West Palm Beach
Sanitary Sewer System Map Direction (2015)
ISO 14001 Environmental Management System (EMS)

ISO 14001 is a continuous improvement management process a Plan Do Check Act system.
City Trains 20 Greenbelts in Lean Six Sigma Methodologies Using DMAIC Process

DMAIC Roadmap

Remove inefficiencies in process workflow

D Define
- Define the problem and the objectives.

M Measure
- Analyze the process. Define factors of influence.

A Analyze
- What do we need to improve? Can we measure this?

I Improve
- Identify and implement improvements.

C Control
- Assure that improvements will sustain.
Six Sigma Safety Team

- Kaizens – (“change for better”) – activities that continually improve all functions and involve all employees from top to bottom.
Quality Results

- Stabilized O&M Budget
- Debt outstanding to net plant ratio decreased from 72% in 2010 to 49.6% (target <50%)
- Debt per customer decreased from approximately $4,000 down to $2,579
- Eliminated scheduled rate increases for two straight years
- Factored in $75 million bond issuance
- Eliminated need for an additional $150 million dollars of debt
- Increased internally funded annual R&R capital from $8 million to $12 million