Healthy Emory, Healthy Planet

The WaterHub at Emory University
Moving from Feasibility to Project Execution

Presented by Brent Zern and Bob Salvatelli
Learning Objectives

Why should we understand our water footprint?
• Universities are Bulk Water Consumers
• Review Typical University Water Footprint
• Appropriate Water Management Solutions

What are the benefits of water reclamation and reuse?
• Descriptive Case Study of Green Infrastructure Benefits
• On-Site Adaptive Solution
• Enhancing Sustainability on Campus

How can water reuse be integrated into a building or campus fabric?
• Innovative and Site-Adaptive Technologies
• Collaborative Approach to Innovative Solutions
• Unique Methodological Approach
Water Stewardship to Address Global & Local Water Challenges
Extensive Societal Water Demands

- Power
- Sanitation
- Manufacturing
- Food Production
- Climate Control
Growing Water Demand

In 2009, Metro Atlanta required 512 Million gallons of water per day (or about 91 gallons per person per day).
"And because we’re not using that drinking water, the county can use it other places, which is important for a region prone to water crises."

Brent Zern, Asst. Director of Operational Compliance and Maintenance Programs

Local Water-Related Stresses

Aging Infrastructure

Scarcity

Rate Pressure

Environmental Constraints
Water Scarcity and Drought

Lake Lanier hit all-time lowest water levels in 2007

Fairly consistent drought conditions felt across GA since 1998

Lake Lanier, 2007

USGS Drought Monitor
Clean water is required for the production of energy…

The treatment, distribution and disposal of water represents as much as 13% of the total energy use in the U.S.
Decentralized System Approach

Cherokee Water Reuse

RM Clayton WWTP

Google Data Center

Fowler Water Reuse

Cauley Water Reuse

Johns Creek Environmental

Scott Candler Drinking Plant

Emory University

Snapfinger WWTP

Polebridge WWTP
Aging Infrastructure

Estimated $4 billion in infrastructure needs

Atlanta’s water needs rely on a system designed in 1875, and build piecemeal ever since.
Rising Water Rates

DeKalb DWM Water & Sewer Rates

- $6.75 (2008)
- $7.84 (2009)
- $9.69 (2010)
- $10.54 (2011)
- $11.71 (2012)
- $12.99 (2013)
- $14.42 (2014)

11.5% CAGR

$/1,000 gallons

2008 2009 2010 2011 2012 2013 2014

Sewer Water Combined
Emory’s Water Saving Initiatives

- Stormwater Reuse Saves 800 KGPY
- Graywater Reuse Saves 750 KGPY
- Signage & Advertising
- Low-flow Fixtures

Consumes >340 MGPY
The Evolution of Water Conservation

Level of Sophistication and Impact

Simple Solutions
- Stickers
- Low Flow Fixtures
- Rain Barrels

Building-Based Solutions
- Stormwater Reuse

Campus-Wide Solutions
- Reclamation and Reuse

Low Flow Fixtures
Rain Barrels
Stormwater Reuse
Reclamation and Reuse
“We looked at where we currently use the most potable water in our facilities — applications where we don’t really need drinking-water quality water — and it came down to our toilets, our steam plants and our chiller plants.”

Brent Zern, Asst Director of Operational Compliance & Maintenance Programs, Emory University

Water Use at Emory, FY 13-14

- Domestic/Sanitary: 198,711,516 (60%)
- HVAC: 122,973,384 (37%)
- Irrigation: 11,141,100 (3%)
- Utilities: 333 M GPY
"The WaterHub is projected to help Emory reclaim some 300,000 gallons of campus wastewater daily, cutting potable water consumption as much as 35 percent and saving the university millions in water utility costs over a 20-year period." Matthew Early, Vice President for Campus Services, Emory University.

### Emory University Chiller Systems

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Startup Year</strong></td>
<td>1960s</td>
</tr>
<tr>
<td><strong>Number of Buildings Served</strong></td>
<td>50</td>
</tr>
<tr>
<td><strong>Total Square Footage Served</strong></td>
<td>4,390,000 sq ft</td>
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<tr>
<td><strong>Central Plant Capacity</strong></td>
<td>20,300 tons (3 plants)</td>
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<tr>
<td><strong>Number of Chillers</strong></td>
<td>20 chillers</td>
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<tr>
<td><strong>Fuel Types</strong></td>
<td>Electric</td>
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<tr>
<td><strong>Distribution Network Length</strong></td>
<td>2.5 trench miles</td>
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<tr>
<td><strong>Piping Type</strong></td>
<td>Direct-buried insulated steel</td>
</tr>
<tr>
<td><strong>Piping Diameter Range</strong></td>
<td>4 to 18 inches</td>
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<tr>
<td><strong>System Pressure</strong></td>
<td>90 psig</td>
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<tr>
<td><strong>System Temperatures</strong></td>
<td>44 F supply/54 F return</td>
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<tr>
<td><strong>System Water Volume</strong></td>
<td>295,000 gal</td>
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</table>
# Emory University Steam Systems

## Campus Utility Overview

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
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<tbody>
<tr>
<td>Startup Year</td>
<td>1922</td>
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<tr>
<td>Number of Buildings Served</td>
<td>70</td>
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<tr>
<td>Total Square Footage Served</td>
<td>7,500,000 sq ft</td>
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<tr>
<td>Central Plant Capacity</td>
<td>500,000 lb/hr steam</td>
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<td>Satellite Plant Capacity</td>
<td>N/A</td>
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<tr>
<td>Number of Boilers</td>
<td>5 boilers</td>
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<tr>
<td>Fuel Types</td>
<td>Natural gas, No. 2 fuel oil</td>
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<tr>
<td>Distribution Network Length</td>
<td>3.5 trench miles</td>
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<tr>
<td>Piping Type</td>
<td>Majority Class A direct-buried &amp; some walk-through tunnels</td>
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<tr>
<td>Piping Diameter Range</td>
<td>1-1/2 to 12 inches</td>
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<tr>
<td>System Pressure</td>
<td>125 psig</td>
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<tr>
<td>System Temperatures</td>
<td>353 F/180 F condensate return</td>
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<tr>
<td>System Water Volume</td>
<td>N/A</td>
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Reclaimed Water Distribution

Gallons/Day

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

- 50,000 100,000 150,000 200,000 250,000 300,000 350,000

Quad Energy Plant
WMB Chiller
MS Chiller Plant
Steam Plant
Future Expansion

Phase II Reclaimed Water Distribution Expansion

Gallons/Day

- Phase 1
- Phase 2

30% Increase

EU Hospital
Woodruff Library
CDC
Decentralized Reclamation and Reuse

Before

After
Benefits to Emory University:

- Redundant Water Supply
  - Drought
  - Municipal infrastructure failures
- Additional On-Site Storage
- Reduced Environmental Impact
- Flexibility, Independence & Resilience
- Reduced Community Reliance
- Minimum recovery time
- Insulation from rising water costs
"This (facility) offers an interesting case study for how an institution can move a community toward a bold step in water conservation. It’s also exactly the kind of reduction we need to see in order to support a more sustainable future."

Ciannat Howett, Director of the Office of Sustainability Initiatives at Emory

Emory’s WaterHub uses natural processes to reclaim wastewater.
Water Displacement:
- 35% Total Campus Water Reduction
- 90% Total Utility Water Reduction
- 40% Total Wastewater Reduction
“Emory is a leader in sustainability, with this facility, we’re taking a major step forward in becoming one of the first in the nation with this technology for cleaning our own wastewater.”
Matthew Early, Vice President Campus Services, Emory University
The WaterHub at Emory University
## Ecological Treatment Technologies

### Comparison Table

<table>
<thead>
<tr>
<th></th>
<th>ReCip® Tidal Wetlands</th>
<th>Hydroponic and Fixed Media</th>
<th>Moving Bed Bioreactor (MBBR)</th>
<th>Membrane Bioreactor (MBR)</th>
<th>Conventional Activated Sludge</th>
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Moving & Fixed Media Solutions

Hydroponic Reactor

- Root Zone
- BioWeb™
- Submerged Fixed Film Media

Moving Bed Bio-Reactor

- Moving Media Zone
- Aeration Bed
- BioPortz™
How the WaterHub Works

1. Extraction and Rotary Screen. Wastewater is extracted from the south site and pumped to the rotary screen at the north site (on roof) which removes non-bio-degradables.

2. Anaerobic Moving Bed Reactors (MBBR). In an oxygen depleted environment, carbon containing material is removed by colonizing microorganisms that colonize on freely-moving “BioPortz” (honeycombed plastic pellets which maximize habitat). Wastewater circulates between MBBRs to optimize nitrogen removal and minimize creation of odorous gases.

3. Aerobic Moving Bed Reactors. Wastewater is aerated with coarse bubble diffusers. This removes much of the carbonaceous material and further removes odorous gases from the water.

4. Hydroponic Reactors. Within the greenhouse, dense tropical plant root systems and BioWeb provide a healthy habitat for large microbial populations. This results in stable biofilm growth and efficient, stable wastewater treatment. Outdoor Hydroponic Reactors utilize native and naturalized plant species and allow greater volumes of wastewater to be treated. Fine bubble aeration diffusers add oxygen to enhance reduction of carbonaceous material and nitrification. Beneficial organisms graze on microbial biomass and reduce solids/slug.

5. Demonstration Reciprocating Wetlands (DRW). Created to demonstrate alternate waste treatment systems, the DRW receives screened influent from the MBBR. The fill-and-drain wetland cells use various sizes of gravel which provide microorganism habitat. Fill-and-drain cycling occurs 8 to 16 times a day and provides alternating anaerobic and aerobic treatment. Requiring little mechanical energy, yet large land mass, a Reciprocating Wetland is a treatment system appropriate to rural areas and developing countries.

6. Clarifier Tank. Removal of dissolved phosphorus by use of coagulating agents and gravity. A portion of the solids are sent to the greenhouse to provide ample bacterial communities to begin the treatment process.

7. Disk Filter. Very clean water is sent to the greenhouse and through a disc filter which removes solids using a felt filter membrane. At this point, the water contains very small amounts of microorganisms.

8. Ultraviolet Disinfection. Water is subjected to high-quality ultraviolet (UV) light, an energy-efficient, chemical-free method of removing remaining microorganisms.

9. 50,000 Gallon Storage Tank. Fully treated water is stored underground. This reserve allows for variability in demand or planned outage work at the WaterHub.

10. Campus Distribution. Water is distributed to the steam and chiller plants for use as process make-up water and to residence halls for toilet flushing.
Ecological Treatment Design
WaterHub in GlassHouse

- **MBBR**
- **Plant Racks**
- **Root Zone**
- **Aeration Bed**
- **Textile Media**

Footprint Compact and Efficient
Outdoor System (Lower Site)

Convergence of Multiple Ecological Treatment Technologies
Reciprocating Wetlands

Pioneered by the Tennessee Valley Authority (TVA), Reciprocating Wetlands are made up of pairs of adjacent cells, which contain plants and rocks. Treatment is brought about by coupling anaerobic, anoxic and aerobic environments within and between the cells via reciprocation—adjacent cells are alternately drained and filled on a defined and recurrent basis.
The WaterHub at Emory University
"I think it also shows an important role the university can play in advancing sustainability and engaging in this idea of the campus as a living laboratory, a place of experimentation and engagement and learning. This (facility) offers an interesting case study for how an institution can move a community toward a bold step in water conservation. It’s also exactly the kind of reduction we need to see in order to support a more sustainable future."

Ciannat Howett, Director of the Office of Sustainability Initiatives at Emory
EPA Administrator Gina McCarthy Tours Emory University’s WaterHub

@EmoryUniversity cut water use by ~35% w/new WaterHub, saving the school big on utility costs. A model for us all!

@EmoryUniversity WaterHub isn't a typical treatment facility. It filters wastewater thru plant roots & microbes clean out organic material.
“The WaterHub will make it possible for Emory to save tens of millions of gallons of potable water every year. That is a real achievement.” – Gina McCarthy
Unique Development Approach

Water Purchase Agreement

~ Shared Savings Agreement ~ Operating Lease ~ DBO Agreement ~ Performance Contract

Benefits

- No up-front capital
- Innovative Technologies
- Leverages superior credit rating
- Immediate, Guaranteed Savings
- Long Term Pricing Stability
- No O&M Responsibilities
- SW bears majority of risk

Lifecycle Savings at Various Water Rate CAGRs

Cumulative Savings

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<tr>
<th>Year</th>
<th>9%</th>
<th>7%</th>
<th>5%</th>
<th>3%</th>
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<tr>
<td>Year 1</td>
<td>$100</td>
<td>$200</td>
<td>$300</td>
<td>$400</td>
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<tr>
<td>Year 2</td>
<td>$200</td>
<td>$400</td>
<td>$600</td>
<td>$800</td>
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<td>Year 3</td>
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<td>$1200</td>
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<tr>
<td>Year 4</td>
<td>$400</td>
<td>$800</td>
<td>$1200</td>
<td>$1600</td>
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<tr>
<td>Year 5</td>
<td>$500</td>
<td>$1000</td>
<td>$1500</td>
<td>$2000</td>
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sustainability initiatives

EMORY UNIVERSITY
O & M under WPA

- Highly Automated Operations with Remote Monitoring Capabilities
- State Certified Operator On-Site
- Daily Compliance Testing
- Preventative & Predictive Maintenance & Repairs
- Includes All Operating Expenses

- Labor
- Energy
- Permit Fees
- Compliance Testing
- Taxes

- Insurance
- Chemicals
- Discharge Fees
- All Maintenance & Repair
“It provided the experience of collecting real data, interpreting results and writing reports. For some students, it may have been the first hands-on lab experience that they’ve had.”

“One of the things we talk about in class is the growing problem of water scarcity around the world — globally, we’re running out of water. Water scarcity will be one of the defining issues during the lifetime of these students.”

Christine Moe, Eugene J. Gangarosa Professor of Safe Water and Sanitation in the Rollins School of Public Health (RSPH) and Director of the Center for Global Safe Water at Emory
EXTENDING THE LIFECYCLE OF WATER.


QUESTIONS?

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