Because Wastewater Matters

Evolutions in Wastewater Treatment and Examples of Distributed Treatment

April 4, 2016
3:00-4:00 PM ET
<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
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<tbody>
<tr>
<td>Bruce Lung</td>
<td>DOE</td>
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<td>Eric Lohan</td>
<td>Sustainable Water</td>
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<td>Stephen Pierett</td>
<td>Volvo Trucks</td>
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<td>Erin English</td>
<td>Biohabitats</td>
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Eric Lohan

Sustainable Water
FOUNDATIONS OF DECENTRALIZED REUSE

Water Source
- Rainwater/Stormwater
- Foundation Drainage
- Cooling Tower Blowdown
- Graywater
- Blackwater

Reuse Application
- Irrigation
- Toilet Flushing
- Cooling Tower Make-up
- Boiler Make-up

Project Scale
- Building Based
- Multi-Building
- District-Scale

Flexibility in Source, Application, and Scale Delivers Impactful Conservation Results
## Decentralized Reuse

### Water Source

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<thead>
<tr>
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<th>Secondary</th>
<th>Tertiary</th>
<th>Reuse</th>
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<td>Bio Treat. or Chem Oxidation</td>
<td>Filter</td>
<td>RO</td>
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<td>EQ</td>
<td>SUBSURFACE IRRIGATION</td>
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### Treatment

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Different Sources Require Application Specific Treatment Steps
### Decentralized Reuse

#### Potable Water Displacement in Utilities Offer Large-Scale Conservation Returns

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<th>Treatment</th>
<th>Water Reuse</th>
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Regulatory + End-Use Drivers Dictate Treatment and Allowed Uses

Black designation - Reg 1014

- Public Health Regulations
- Environmental Regulations
- Disinfection
- BOD Removal, TSS Removal, Nitrification
- TOILET FLUSHING
- VEHICLE WASHING
- SURFACE IRRIGATION
- SUBSURFACE IRRIGATION
- COOLING TOWERS
- BOILERS

Nitrogen Removal
- Required for coastal environments or for areas with groundwater contamination concerns

Deionization
- Required for sensitive soil and plant communities or for HVAC reuse
Rainwater Systems are Simple to Implement and Permit.
GRAYWATER REUSE

Graywater Treatment and Reuse Process

1. Screening
Lint and hair are removed through a self-cleaning screen and flushed to sewer.

2. Biological Treatment
Pollutants are biologically degraded by microorganisms living on the patented surface-active treatment media in an aerated tank.

3. Filtration + UVs
A self-back flushing filtration system removes suspended solids and UV disinfection eliminates any pathogens.

4. Chlorine + Dye
Dosing pumps, chemical storage, and spill containment are provided in the integral chemical cabinet to accommodate optional chlorine and dye injection.

Modular Building-Based System can be Accommodated into Nearly All Buildings
San Francisco Public Utilities Commission (SFPUC)

An onsite reclamation system reclaims and treats all of the building’s wastewater to satisfy 100% of the water demand for the building’s low-flow toilets and urinals.

Location
San Francisco, California

Project Timeline
2012

Footprint
1,100 sq ft

Hydraulic Capacity
5,000 gallons per day

Community Service
900 people

“We built [SFPUC HQ] to save ratepayers hundreds of millions of dollars, create jobs, and demonstrate to the world best practices for energy efficiency and water conservation.”

- Ed Lee, Mayor of San Francisco
THE WATERHUB AT EMMORY UNIVERSITY

CLIENT TYPE:
College / University

LOCATION:
Atlanta, GA

PROJECT DESCRIPTION:
Campus-Scale Wastewater Reclamation & Reuse System

YEAR BUILT:
2015

GOALS / OUTCOMES:
- Up to 40% reduction in potable water footprint
- Up to 66% decrease in wastewater discharge
“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, Assistant Director of Operational Compliance & Maintenance Programs, Emory University
EMORY WATERHUB: SYSTEM OVERVIEW

HYDRAULIC CAPACITY:
400,000 Gallons Per Day (146 MGY)

TECHNOLOGIES APPLIED:
Primary Screen: Rotary Screen
Pretreatment: MBBR
Secondary: Hydroponic (SFFR)
Demo: Recip® Wetland System (5 KGPD)
Filtration: Disk Filter
Disinfection: UV & Chlorine

EFFLUENT QUALITY:
State of GA Reuse Regulations
BOD: <5
Turbidity: <3
TSS: <5
TKN: <5

BACKUP STORAGE:
50,000 Gallons
EMORY WATERHUB: DISTRICT-SCALE REUSE

FOOTPRINT:
- 3,200 ft² GlassHouse
- 1,600 ft² Outdoor Landscaping

NON-POTABLE DISTRIBUTION:
- 4,400 linear feet (Purple Pipe)

REUSE DEMAND TYPES
- Boiler Makeup
- Cooling Tower Makeup
- Toilet Flushing

SYSTEM END USERS:
- Michael Street Chiller Plant
- Steam Plant
- WMB Chiller Plant
- Quad Energy Plant
- Raoul Hall (Dormitory)

FUTURE EXPANSION:
- Emory Hospital Chiller Plant
- Woodruff Library Chiller Plant
EMORY WATERHUB: PROJECT EXECUTION

CLIENT SERVICES OFFERED:
- Water Reuse Feasibility Study
- WaterHub Design-Build
- Owner-Operator (Current)

PROJECT DELIVERY METHOD:
Water Purchase Agreement: Design-Build-Own-Operate (DBOO)

DESIGN-BUILD TEAM:
Developer: Sustainable Water
Engineer: McKim & Creed
Contractor: Reeves Young

TIMELINE:
Feasibility: 3 Months (2013)
Engineering: 6 Months (2014)
Commissioning: 3 Months (2015)

LESSONS LEARNED:
- Dedicate a Project Manager
- Know Your Waste Stream
- Prepare for Academic Engagement
- Prepare a Tour Strategy
- Communicate across all Campus Silos
EMORY WATERHUB: OPERATIONS

START-UP
May, 2015

HIGHLIGHTS:
- 1 full-time operator
- Highly automated & controlled treatment / distribution system
- Zero compliance Issues

RESULTS:
- 150 million gallons treated to-date
- Offset 92% of potable water use at 3 largest chiller operations
- Net energy reductions in campus water management

"THIS IS A FIRST OF ITS KIND FACILITY IN NORTH AMERICA. IT EXEMPLIFIES HOW WE AS A SOCIETY CAN TAKE A MORE INTELLIGENT AND RESPONSIBLE PATH TO STEWARDSHIP OF NATURAL RESOURCES, FOR THE GOOD OF EACH OTHER."

- JIM WAGNER, FORMER PRESIDENT OF EMORY UNIVERSITY
Benefits

- No up-front capital
- Innovative technologies
- Leverages superior credit rating
- Lifecycle savings
- Long-term pricing stability
- No O&M responsibilities
- SW bears majority of risk

Flexible, Innovative Vehicle that Yields Guaranteed Savings
EMORY WATERHUB: RECOGNITION

PUBLICATIONS:
Nearly 50 Articles Published
- District Energy
- Industrial WaterWorld,
- Civil Engineering News and more

AWARDS & ACCOLADES:
7 National Organizations
- Water Reuse Association, 2015
- US Water Alliance, 2016
- Society of College & University Planning, 2016
- American Society of Safety Engineers, 2016
- APPA, 2016
- National Association of College and University Business Officers, 2016
- Water Environment Federation, 2016

7 State & Regional Organizations
- Construction Management Association (South Region), 2015
- Metro Atlanta Chamber, 2015
- American Society of Safety Engineers of North Carolina, 2015
- Health and Environmental Conference and the Georgia Chapter of the American Society of Safety Engineers, 2015
- Urban Land Institute VA, 2015
- Southface, 2016
- Atlanta Better Buildings Challenge, 2016
Stephen Pierett

Volvo Trucks
Water Management For Truck Manufacturing

Steve Pierett, C.E.M., CP EnMS
Environmental Manager

Volvo Group North America, LLC
New River Valley Plant, Dublin, VA

Area’s Largest Manufacturing Facility
Largest Manufacturing Facility in Volvo Family
Wastewater Recycling and Reuse – An Overview

- Additional energy cost to operate reuse systems is outweighed ~ 4:1 by the savings from reduced water use at county rates
- Improved feed water quality and water balance for production processes
- Reduced chemical usage for non-process requirements
- Partial Fulfillment of the Volvo Environmental Goal
- Reduced environmental liability and risk with fewer discharges to local POTW
- Use as process monitoring tool prompting considerable savings
Overall, water use efficiency improved 41% since the baseline year of 2003.
#1 - Cab Leak Test Water Recycling

- Baseline water use for cab leak testing - 1100 gallons per truck
- System installed to clean and recycle the water used for cab leak testing.
- Upgrade investment of $520,000
- The benefit of recycling this water for reuse
  - Water use savings of 700 gallons per truck
- This represented a plant-wide reduction for water use of 22%.
Process Wastewater Treatment Method

The reuse system consists of the following components:

- **Untreated Wastewater**
- **Waste Water Storage**
- **Cartridge Filter**
- **UV Light**
- **Ultra-Filtration**
- **Reuse Water Storage**
- **High Pressure Reverse Osmosis**
- **HPRO Feed Storage**
- **To Plant Processes**
Process Wastewater Reuse Drivers

Environmental Issues

- Surfactant issues at the regional authority / foaming
- Molybdenum contamination of land-applied sludge
- Volvo was proactive to identify its contribution to a potential issue

Volvo Environmental Requirements

- Wanted Position: To install water recycling processes with low water usage and preferably with chemical recycling in closed loop processes
Process Wastewater Reuse Incentives

Environmental Sustainability

- Average incoming water from processes = 12M gal
- Average reuse water to processes = 7.4M gal
- Average annual reuse rate is ~70% for process water

Environmental Liability / Risk Mgmt.

- Capital funds invested for recycling water instead of meeting increasingly stringent environmental regulations. $1.5 MUSD vs 1.1 MUSD
Process WWTP Specifications

1. Average daily flow from WWTP
   - 36,307 gallons per day
2. Maximum treated flow (WWT) = 500 gpm
3. Storage capacity of untreated wastewater
   - 274,000 Gallons
4. Conventional precipitation system.
   Treats Nickel and Zinc (0.099 mg/L limit for Ni and 0.6 mg/l limit for Zn)
Usage Points

- PROCESS
  - E-coat System: 15,000 to 20,000 gpd

- NON-PROCESS
  - Humidification: 500 to 1,000 gpd
  - Parts Wash: 12,000 gpd
  - Cooling Tower: 4,000 to 6,000 gpd
Process Wastewater Treatment Method

The reuse system consists of the following components:

- Untreated Wastewater
- Waste Water Storage
- Cartridge Filter
- UF Feed Storage
- UV Light
- Reuse Water Storage
- High Pressure Reverse Osmosis
- HPRO Feed Storage
- To Plant Processes
- Ultra-Filtration
- UV Light

Volvo NRV Plant – Dublin, Virginia
System Upgrade in 2015

- UltraFilter and High Pressure Reverse Osmosis replaced NF/RO
  - When NF permeate conductivity $> 2000 \mu\text{ohms/cm}$, the RO permeate conductivity will exceed 30 $\mu\text{ohms}$ for processes.
  - Resulting in a discharge event
    - Install UF and HPRO operating at 800 – 1000 psi allowing treatment of conductivities of 45,000 $\mu\text{ohms/cm}$

- Upstream of WWTP, reduce solids content of wastewater to minimize impact and loading on UF and HPRO
  - Install filter system to remove E-coat solids and other solids

- Improve Water Balance between production and non-production periods
  - Added two 17,000 gallon tanks to store clean water for reuse
Design Specifications and Installation

Ultraviolet Light (254nm)  Cartridge Filtration
Design Specifications and Installation

Ultra-Filtration

High Pressure RO
Process Improvement

- Installed solids removal equipment for E-coat discharge to reduce impact of process on conductivity/TDS & TSS.
Process Improvement

- Expand the storage capacity for reuse water to address losses associated with shutdown periods by addition of two 17,000 gallon pure water storage tanks.
Process Improvement

- High pressure RO system will address lower conductivity requirement for E-coat, but allow improved system reuse (provide up to 93% recovery of process water)
  - Operating at membrane pressures from 800 to 1,000 psi will allow for treatment of waters with conductivities approaching 45,000 μohms/cm.
Beyond Sustainability with a new purpose - WW reuse as a process indicator tool

- Wastewater Reuse as an indicator of process performance
- Indicators:
  - 93% reuse vs. 70% reuse driven by continuing issues with WW quality:
  - Fouling of NF, then UF membranes
  - Informal reports of issues with chemical treatment of paint overspray – the process for removing paint solids from booth water
- Organized a risk management committee to address process and environmental priorities and issues
- Focused on high quality and a consistent quantity of reuse water for paint processes and consistent quality of paint sludge.
Volvo NRV Plant – Dublin, Virginia

Cost of Chemical Treatment


$5.00 $10.00 $15.00 $20.00 $25.00

BIW CPU
Chassis CPU
The Financials for a Reuse System

- Plant-wide Baseline Water Use is 62M gal
- Water Use Average from 2004 to Present is 39M gal
- Average Annual Reduction in Water Use is 23M gal
- Plant-wide Average Cost Savings is $216,230 per yr

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- WWTP reuse system savings in 2015 is ~$69,000
- Increased Energy Use for WWTP reuse system is 136,320 KWH on average or $18,135/year
- WWTP reuse system net cost savings is ~$51,000 in 2015
Nominal Benefit to the County

- County Energy Savings Based on plant water savings
  - 926 KWH per Year average
- At 7.5 cents/KWH, Average County Cost Avoidance
  - $69.46 per year
- Overall, nominal energy savings or cost benefit for the County
Benefits for the WW Reuse

- Additional energy cost to operate reuse systems is outweighed ~ 4:1 by the savings from reduced water use at county rates
- Improved feed water quality and water balance for production processes
- Reduced chemical usage for non-process and process requirements
- Partial Fulfillment of the Volvo Environmental Goal
- Reduced environmental liability with fewer discharges to POTW
- A process monitoring tool for identifying savings for production with a contractor change, significant reductions in chemical use and continuing financial benefits with the ongoing solids mass balance.
Thank You
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THE SIDWELL FRIENDS SCHOOL
10 years of onsite wastewater treatment + reuse
MIDDLE SCHOOL – WASHINGTON, DC
3,000 gpd design flow

TREATMENT & REUSE FOR TOILET FLUSHING

EDUCATION & IMMERSION

AWARDS & CERTIFICATIONS
PRIMARY TANK (UNDERGROUND)
SECTION NAME

CONSTRUCTED WETLANDS

TRICKLING FILTER

PRIMARY TANK (UNDER GROUND)

SAND FILTER

CONSTRUCTED WETLANDS
SECTION NAME

CONSTRUCTED WETLANDS

TRICKLING FILTER

PRIMARY TANK (UNDER GROUND)

SAND FILTER

CONSTRUCTED WETLANDS

Filtration & Disinfection (Basement)
EDUCATION & INTERPRETATION
OPERATION & MAINTENANCE
THANK YOU!
Additional Resources

- **Biohabitats: Sidwell Middle School Case Study**

- **U.S. Department of Energy: Sidewell Friends Middle School**
  - [https://buildingdata.energy.gov/project/sidwell-friends-middle-school](https://buildingdata.energy.gov/project/sidwell-friends-middle-school)
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