NJWEA: May 11th, 2015
Integrated Water Resource Management: Past, Present & Future
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Water Reuse Drivers: New Drivers are Emerging

“Water will likely replace oil as a future cause of war between nations.”
—Arizona Water Resource

- **Demand & Supply: Increasing Population & Inefficient Use**
  - >7 billion today, estimated 9 billion by 2050
  - Water use has been increasing at more than twice the rate of population growth over the last century
  - Agriculture accounts for 70% of the total use

- **Pollution**
  - Large percentage of the world's cities still dump raw sewage into their waters

- **Aging Infrastructure & Resiliency**

- **Increasing Water & Sewer Costs**

- **Water/Energy Nexus**
  - Biofuels, electric cars, natural gas, and wind power use less oil, however, these alternatives dramatically increase water use

- **Onsite/Distributed Systems**
  - To combat these issues, many communities have opted to provide onsite water resource management systems to help reduce the amount of potable water being used and the amount of wastewater entering the receiving environment.
A few January reports…..

- Atlanta, GA: WXIA11 reports on January 9th that multiple water main breaks turn streets into sheets of ice – forcing traffic closures.
- Indianapolis, IN: Fox59 reports on January 9th that eight water main breaks occurred over the course of just a few days.
- Louisville, KY: WLKY32 reports on January 9th that an 8” water main break forces the closure of a major intersection.
- Washington, DC: ABC7 reports on January 14th that a 6” water main burst disrupted water service to 40 homes.

“In light of today’s infrastructure challenges, on-site water reclamation may be the most viable way to combat municipal water supply risks, as well as manage drought and ever-increasing water costs.” ~ Sustainable Water
Centralized & Decentralized, Resiliency: Lessons learned from Super-Storm Sandy

>160 systems in US across 9 states
- Manage one of the largest bases of distributed wetland & water reuse treatment systems in the U.S.

>90 systems currently in the Northeast

Annually treat over 2.6 billion gallons of water in the Northeast region

~10-15% Direct Water Reuse
~80% Indirect Reuse (Groundwater Dispersal)

Northeast

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- >90 systems currently in the Northeast
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The Emerging Water Reuse Business Case

Water & Sewer Rates for Selected Cities, 2014$

$10/1,000 Gallons = Cost Effective Water Reuse

Water Service Rate Trends in Major Cities
Water & sewer costs have more than doubled in the past 10 years in many major urban areas.

Other Notable Cities Not Listed which are Above The Line
- Portland
- Kansas City
- Virginia Beach
- Oakland
- Colorado Springs
- Raleigh
History of Distributed Water Reuse

1980s
- Small Community On-site Wastewater Treatment
  40 homes; Agriculture/Open Space Preservation

1990s
- Bristol-Meyers Squibb, NJ
  1st Pharmaceutical WWT/Reuse system in the US
- Copper Hill Elementary School, East Amwell, NJ
  1st public school water reuse system

2000s
- Gillette Stadium, Foxboro, MA
  Spurred economic development along Route 1 corridor including shops, restaurants and offices
- The Solaire, Battery Park, NYC
  1st residential water reuse project in the U.S.; LEED-Platinum

2010s
- MacDonald Island, AB, Canada
  Integrated Water Reuse and Heat Recovery system utilizing treated wastewater effluent for irrigation and flush water while also recovering the effluent heat for pool heating within the rec center.
- Village of Ridgewood WWTP, NJ
  DBOF municipal retrofit producing renewable energy with a 20 yr. PPA.
- Sub-surface Treatment Wetland Systems
  Operates the most natural treatment systems in the U.S.
Indirect Reuse: Groundwater Dispersal / Aquifer Recharge

- Harts Landing, Sussex County, DE (Drip Irrigation)
- Patriot Stadium, Foxboro, MA (Subsurface Dispersal Field)
- Hawk Pointe, Washington Twp, NJ (I/P Pond)
The Reality of Direct Water Reuse

- Actual age of reuse water is often days instead of hundreds of years – this is a time frame that we can fully appreciate. Ohio River during low flow period is 50% wastewater effluent near Louisville.

- Surface water flow is flashy during rainfall events and quick to diminish during dry periods due to reduced recharge.

- Landscape irrigation
- Agricultural irrigation
- Toilet & urinal flushing
- Industrial applications
- Fire protection
- Aesthetic fountains & lagoons
- Construction applications
- Environmental & recreational applications
- Groundwater recharge
- Vehicle washing
# Direct Water Reuse Requirements/Guidelines

## NJDEP Category 1 RWBR Public Access Systems

<table>
<thead>
<tr>
<th>Parameter</th>
<th>RWBR Requirement</th>
<th>Sample Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Rate</td>
<td>Continuous</td>
<td></td>
</tr>
<tr>
<td>Total Nitrogen</td>
<td>&lt;10 mg/L*</td>
<td>Grab</td>
</tr>
<tr>
<td>Total Suspended Solids (TSS)</td>
<td>5 mg/L</td>
<td>Grab</td>
</tr>
<tr>
<td>Fecal Coliform</td>
<td>14 col/100 mL (2.2 weekly avg.)</td>
<td>Grab</td>
</tr>
<tr>
<td>Turbidity</td>
<td>2 NTU**</td>
<td>Continuous</td>
</tr>
<tr>
<td>Disinfection</td>
<td>100 mJ/cm² (UV) / 1 mg/L (CPO)</td>
<td>Continuous</td>
</tr>
</tbody>
</table>

**Notes:**

* The NJDEP may impose a total nitrogen concentration limitation greater than 10 mg/L if the permittee can demonstrate that a concentration greater than 10 mg/L is protective of the environment.

** A statistically significant correlation between turbidity and TSS shall be established prior to commencement of the RWBR program. For UV disinfection, in no case shall the level of turbidity exceed 2 NTU while still maintaining the 5 mg/L maximum level for TSS.

## NYC Department of Buildings Performance Standards for Reuse

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.5-8</td>
</tr>
<tr>
<td>BOD</td>
<td>&lt;10 mg/L</td>
</tr>
<tr>
<td>Total Suspended Solids (TSS)</td>
<td>&lt;10 mg/L</td>
</tr>
<tr>
<td>Fecal Coliform</td>
<td>&lt;100 / 100 mL</td>
</tr>
<tr>
<td>E. Coli</td>
<td>&lt;2.2 / 100mL</td>
</tr>
<tr>
<td>Turbidity</td>
<td>&lt;2 NTU(95%) / &lt;5 NTU(Max)</td>
</tr>
</tbody>
</table>

- No federal regulations governing water reclamation & reuse, regulated at the state level.
- 26 states with adopted regulations
- 16 states have guidelines
- 9 states without regulations or guidelines
- No states with regulations that cover all potential uses of reclaimed water.
Direct Reuse: Hawk Pointe & Homestead, NJ – Spray Irrigation
# Water Reuse System Performance Data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>DOB Limit</th>
<th>Membrane Specs</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOD (mg/L)</td>
<td>&lt;10</td>
<td>&lt;2</td>
</tr>
<tr>
<td>TSS (mg/L)</td>
<td>&lt;10</td>
<td>&lt;2</td>
</tr>
<tr>
<td>Fecal Colliform (CFU/100mL)</td>
<td>&lt;100</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Turbidity (NTU)</td>
<td>&lt;2</td>
<td>&lt;0.2</td>
</tr>
<tr>
<td>E. Coli Colony Count (#/100mL)</td>
<td>&lt;2.2</td>
<td>N/A</td>
</tr>
<tr>
<td>pH</td>
<td>6.5-8.0</td>
<td>N/A</td>
</tr>
</tbody>
</table>

## System Location Performance Data

<table>
<thead>
<tr>
<th>System Location</th>
<th>BOD, mg/l</th>
<th>TSS, mg/l</th>
<th>Turbidity NTU</th>
<th>Fecal Coliform #/100 ml</th>
<th>E. Coli #/100 ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Solaire (2003)</td>
<td>&lt; 6</td>
<td>&lt; 1</td>
<td>0.05 – 0.25</td>
<td>&lt; 1</td>
<td>___</td>
</tr>
<tr>
<td>Millennium Tower Residences</td>
<td>&lt; 6</td>
<td>&lt; 1</td>
<td>0.15 – 0.45</td>
<td>&lt; 1</td>
<td>___</td>
</tr>
<tr>
<td>The Visionaire</td>
<td>&lt; 6</td>
<td>&lt; 1</td>
<td>0.15 – 0.45</td>
<td>&lt; 1 (Total coliform)</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>The Helena</td>
<td>&lt; 6</td>
<td>&lt; 1</td>
<td>0.05 – 0.20</td>
<td>&lt; 1</td>
<td>___</td>
</tr>
</tbody>
</table>

**Over 10 years of in-building urban reuse system performance data consistently exceeding permit requirements**
Integrated Water Resource Management

Reuse Applications:

- Toilet Flushing
- Cooling Tower Make-Up Water
- Landscape Irrigation
- Laundry
Maximize Water Reuse Demand Opportunities: Cooling Water

<table>
<thead>
<tr>
<th>Metric</th>
<th>Cooling Tower Limits</th>
<th>Conc. in Reuse Water</th>
<th>Conc. in City Water</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>8.5</td>
<td>7.3</td>
<td>6.9</td>
<td>N/A</td>
</tr>
<tr>
<td>Conductivity</td>
<td>5,000</td>
<td>500-650</td>
<td>100</td>
<td>umhos</td>
</tr>
<tr>
<td>Ca Hardness</td>
<td>500</td>
<td>40-60</td>
<td>16</td>
<td>ppm</td>
</tr>
<tr>
<td>Orthophosphates</td>
<td>10</td>
<td>0.7-1.5</td>
<td>1.7</td>
<td>ppm</td>
</tr>
<tr>
<td>Chlorides</td>
<td>200&lt;sup&gt;(2)&lt;/sup&gt;</td>
<td>50-100</td>
<td>12</td>
<td>ppm</td>
</tr>
<tr>
<td>Iron</td>
<td>0.2</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>ppm</td>
</tr>
<tr>
<td>Copper</td>
<td>0.1</td>
<td>0.05-1.0</td>
<td>&lt;0.05</td>
<td>ppm</td>
</tr>
<tr>
<td>Ammonia</td>
<td>1</td>
<td>&lt;0.10</td>
<td>-</td>
<td>ppm</td>
</tr>
</tbody>
</table>

Reclaimed water provided for over 55% of residential demands (commercial and academic >75%).
Optimize Water Reuse Energy Performance

Typical Energy Performance

- Trash Pump
- Odor Control
- Inline Grinder
- Permeate Pump
- Feed Pump
- Back pulse pump
- Recirculation Pump
- Booster Pump
- Disinfection
- Fine Air
- Coarse Air

Optimized Energy Performance

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- Coarse Air

Energy Use (avg kWh/day)

Flow Treated (avg gpd)

- Process Aeration: 56.9%
- Feed and Maceration: 1.1%
- Booster Pump: 14.5%
- Odor Control: 5.5%
- UV Disinfection: 5.0%
- Ozone Disinfection: 9.4%
- Permeate Pump: 2.8%
- Recirculation: 4.2%
- Backpulse Pump: 0.1%
The Building/Block Scale

- Achieve 55% Water Use Reduction
- Achieve 64% Sewer Discharge Reduction
- 100% Reuse For Cooling Tower Make-up
- Energy Profile Optimization
- 25% Credit on Water & Sewer Bill – CWRP Established 2004
- Simple implementation for single building/owner
- **More cost effective than NYC water & sewer at the block scale**
- Lower energy use than NYC utility infrastructure at the block scale (prior to energy recovery)

![Bar chart comparing energy, potable water, sewer discharge, and total costs for Baseline Building, Conserving Building, and The Visionaire](chart.png)
Electric Energy for Treatment = 5% of building demands (**350 kWh/day**: single high-rise building scale, prior to optimization)

Recovered Heat = 65,500 Btu/hr (≈**400 kWh/day**)

- Embedded energy in wastewater is greater than 4x the amount of energy used for treatment (43 kWh/kgal).
- Water reuse systems can now become net energy neutral and net energy positive at the high-rise building scale or larger with this technology (after accounting for conversion losses).
MacDonald Island, AB, Canada

- Located in the Regional Municipality of Wood Buffalo at the junction of the Clearwater, Athabasca and Snye Rivers.
- Previous facilities on MacDonald Island (MI) included a Recreation Center and Golf Course.
- A recent expansion to the recreational has been completed with a sports complex and a stadium known as Shell Place which will generate water & wastewater demands exceeding current infrastructure capacity.
- A decentralized/distributed water reclamation and energy recovery system has been installed on MI to treat all wastewater from MI, recover the heat energy for pool heating and reuse the treated effluent for irrigation and flushwater.
Scenario 2: Annualized Water Balance (Golf Course Reuse Only)

- **Potable Water Supply**: 284 m³d, 75,133 gpd
- **Reuse Supply (Indoor)**: - m³d, - gpd
- **Reuse Supply for Golf Course Irrigation**: 217 m³d, 57,245 gpd
- **Reuse Supply (Golf Course Irrigation)**: - m³d, - gpd
- **Reuse Supply (Non-Golf Irrigation & Washdown)**: - m³d, - gpd
- **Direct Precipitation to Irrigation Ponds**: 32 m³d, 8,550 gpd
- **Discharge to Central WWTP**: 8 m³d, 2,038 gpd
- **Discharge to WRFC (Reuse)**: 217 m³d, 57,245 gpd
- **Surface Water to Golf Course Irrigation**: - m³d, - gpd
- **Reuse to Golf Course for Irrigation**: 207 m³d, 54,795 gpd
- **Non-Golf Irrigation & Washdown (Potable)**: 32 m³d, 8,351 gpd
- **Evaporation from Golf Course Ponds**: 42 m³d, 11,000 gpd
- **Pool/ice Rink Consumptive Use**: 28 m³d, 7,500 gpd

Water Reclamation Facility (Indoor/Outdoor non-potable reuse)
1. Influent WW to PS/Valve Chamber
2. Treatment System Location
3. Heat Recovery Loop
4. To Golf Pond
5. To Hotel
6. To Stadium
7. Emergency By Pass FM
MacDonald Island Heat Recovery & TBL Impacts

**Triple Bottom Line Impacts**
- Reduce indoor potable water use by 30%
- Reduce wastewater flow to grid by nearly 100%
- Utilize 100% reclaimed water for golf course irrigation
- Reduce surface water diversions by 20 Mgal per year
- Recover 240kW of wastewater heat energy
- Reduce 605 tCO2e greenhouse gas emissions
- Reduce capital expense by $3M
NSU Tour:  https://www.youtube.com/watch?v=iDJ1tvtO0W8
The Visionaire, Battery Park, NYC