NATURAL SYSTEMS UTILITIES

A Sustainable Water Company

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

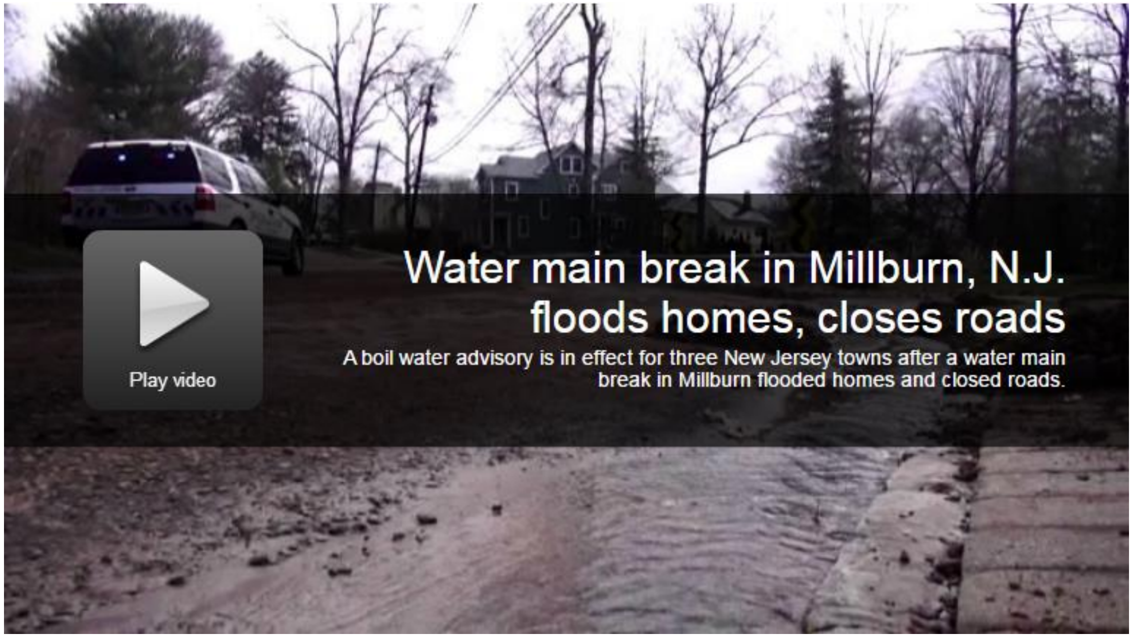
- Demand & Supply: Increasing Population & Inefficient Use
  - >7 billion today, estimated 9 billion by 2050
  - Water use has been increasing at more then twice the rate of population growth over the last century
  - Agriculture accounts for 70% of the total use
- Pollution
  - Large percentage of the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

Aging Infrastructure & Resiliency

A few January reports…..

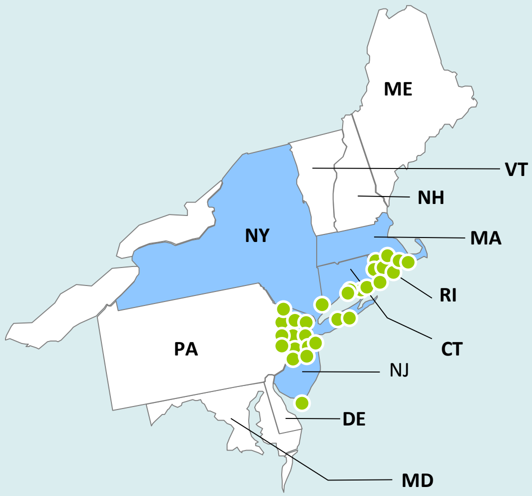
- Atlanta, GA: WXIA11 reports on January 9th that multiple water main breaks turn streets into sheets of ice – forcing traffic closures.
- Indianapolis, IN: Fox59 reports on January 9th that eight water main breaks occurred over the course of just a few days.
- Louisville, KY: WLKY32 reports on January 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



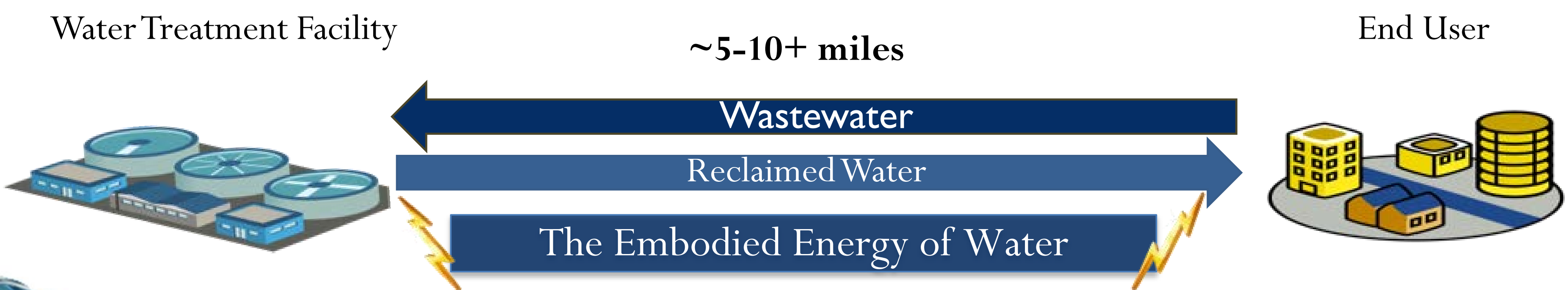
Centralized & Decentralized, Resiliency:
Lessons learned from Super-Storm Sandy

Northeast



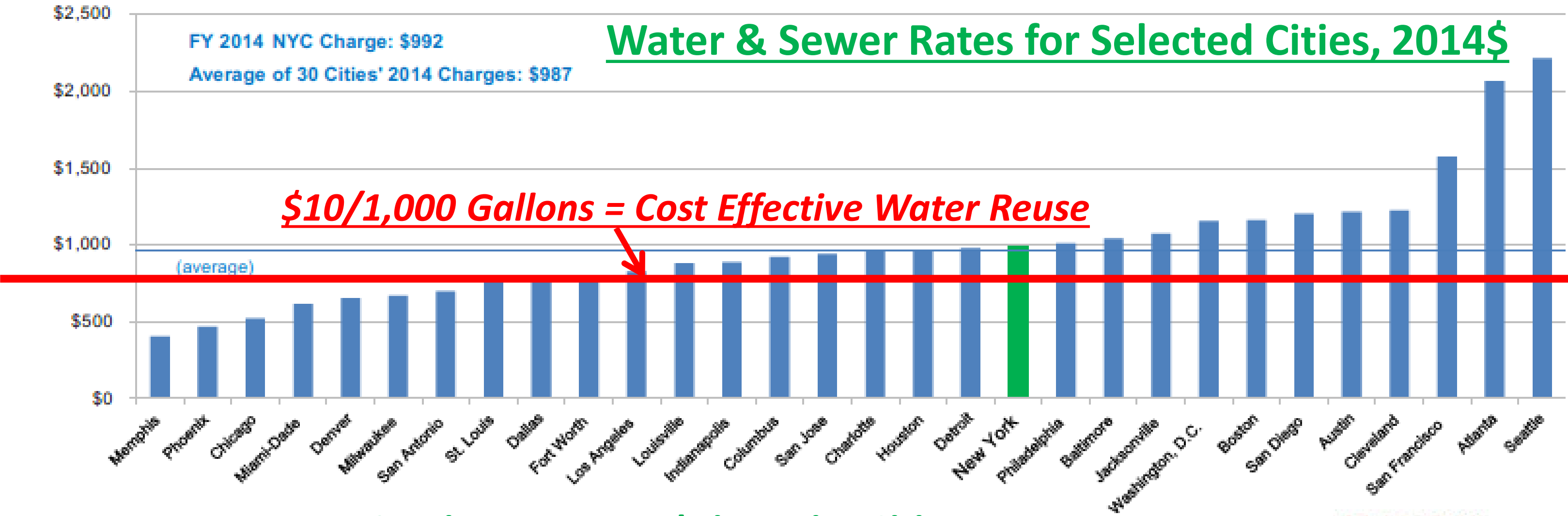
= **NSU project location**

- >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)



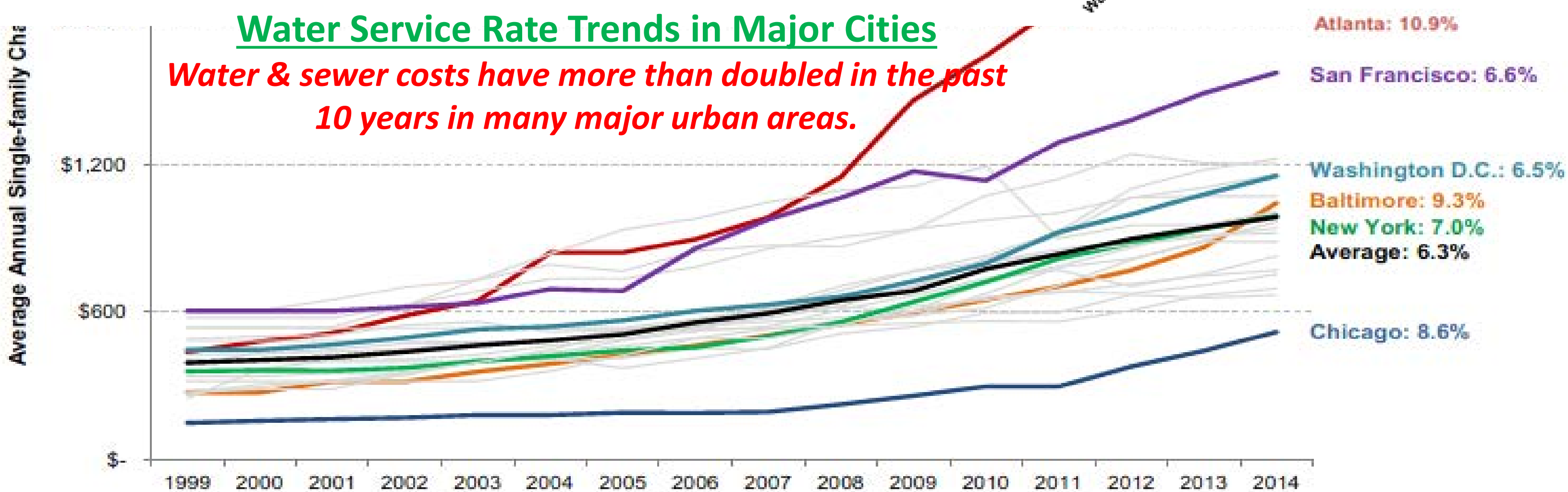
The Emerging Water Reuse Business Case

Annual Residential Water/Wastewater FY2014 Charges



Other Notable Cities Not Listed which are Above The Line

- Portland
- Kansas City
- Virginia Beach
- Oakland
- Colorado Springs
- Raleigh

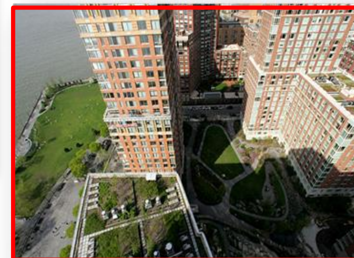


History of Distributed Water Reuse

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

Bristol-Meyers Squibb, NJ
1st Pharmaceutical WWT/Reuse system in the US

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

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.

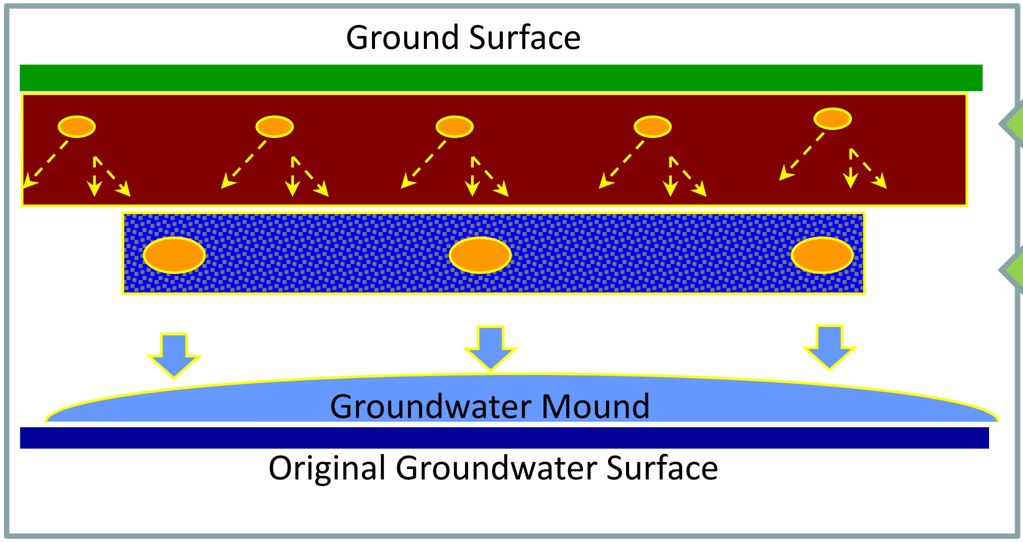
Westbrook Outlets, CT
Economic Development in environmentally-sensitive area

Copper Hill Elementary School, East Amwell, NJ
1st public school water reuse system

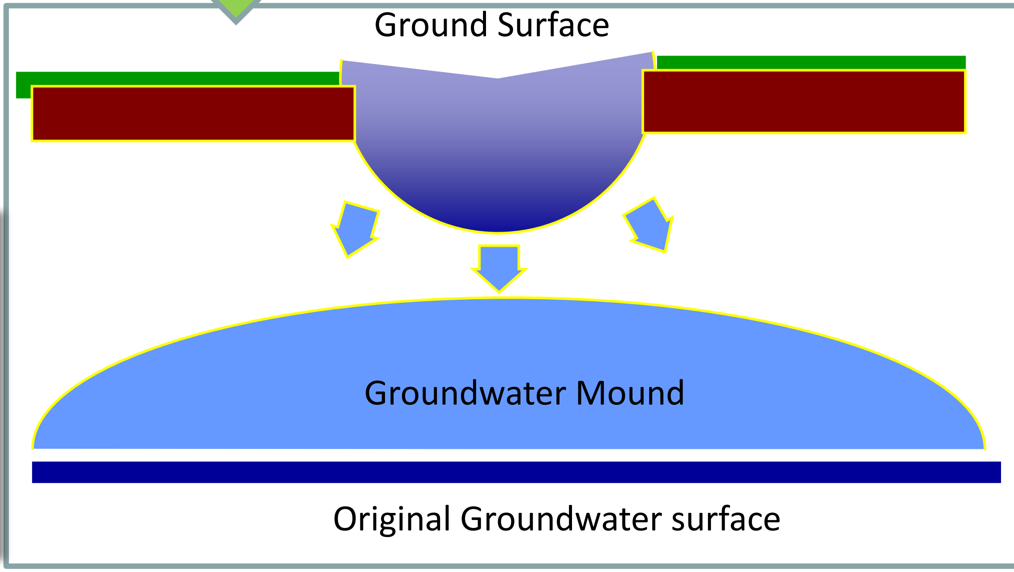
Sub-surface Treatment Wetland Systems
Operates the most natural treatment systems in the U.S.

Village of Ridgewood WWTP, NJ
DBOF municipal retrofit producing renewable energy with a 20 yr. PPA.

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

Parameter	RWBR Requirement	Sample Type
Flow Rate		Continuous
Total Nitrogen	<10 mg/L*	Grab
Total Suspended Solids (TSS)	5 mg/L	Grab
Fecal Coliform	14 col/100 mL (2.2 weekly avg.)	Grab
Turbidity	2 NTU**	Continuous
Disinfection	100 mJ/cm^2 (UV) / 1 mg/L (CPO)	Continuous

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.

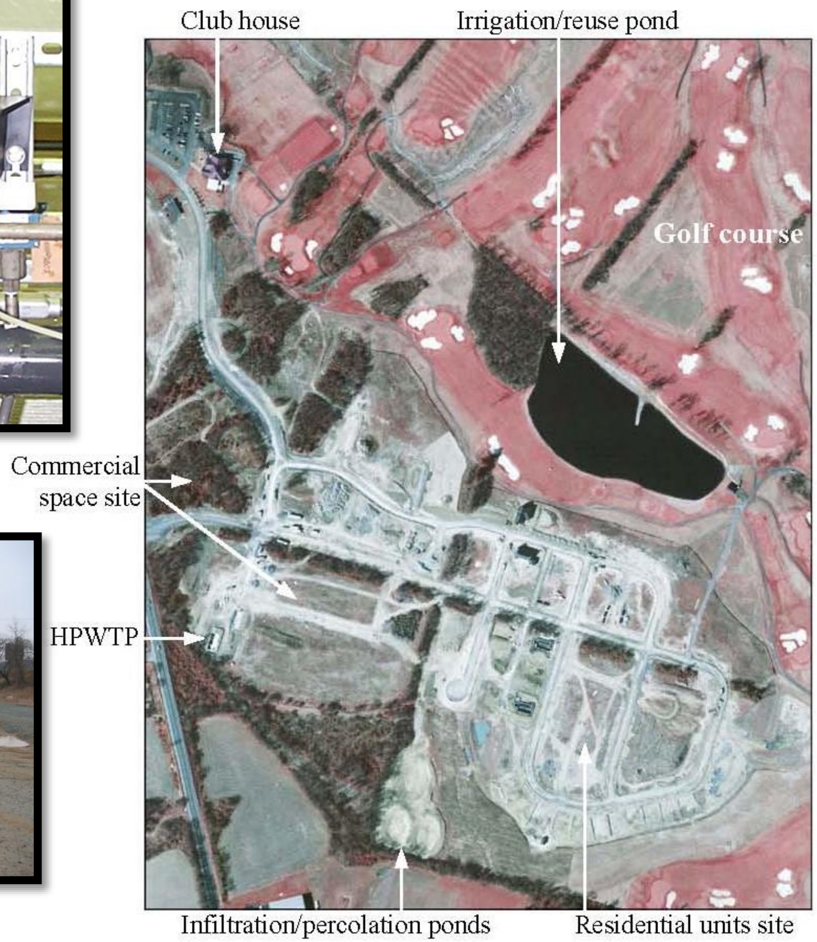
** A statistically significant correlation between turbidity and TSS shall be established prior to commencement of the RWBR program. For UV disinfection, in no case shall the level of turbidity exceed 2 NTU while still maintaining the 5 mg/L maximum level for TSS.

NYC Department of Buildings
Performance Standards for Reuse

Parameter	Standard
pH	6.5-8
BOD	<10 mg/L
Total Suspended Solids (TSS)	<10 mg/L
Fecal Coliform	<100 / 100 mL
E. Coli	<2.2 / 100mL
Turbidity	<2 NTU (95%) / <5 NTU (Max)

- 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



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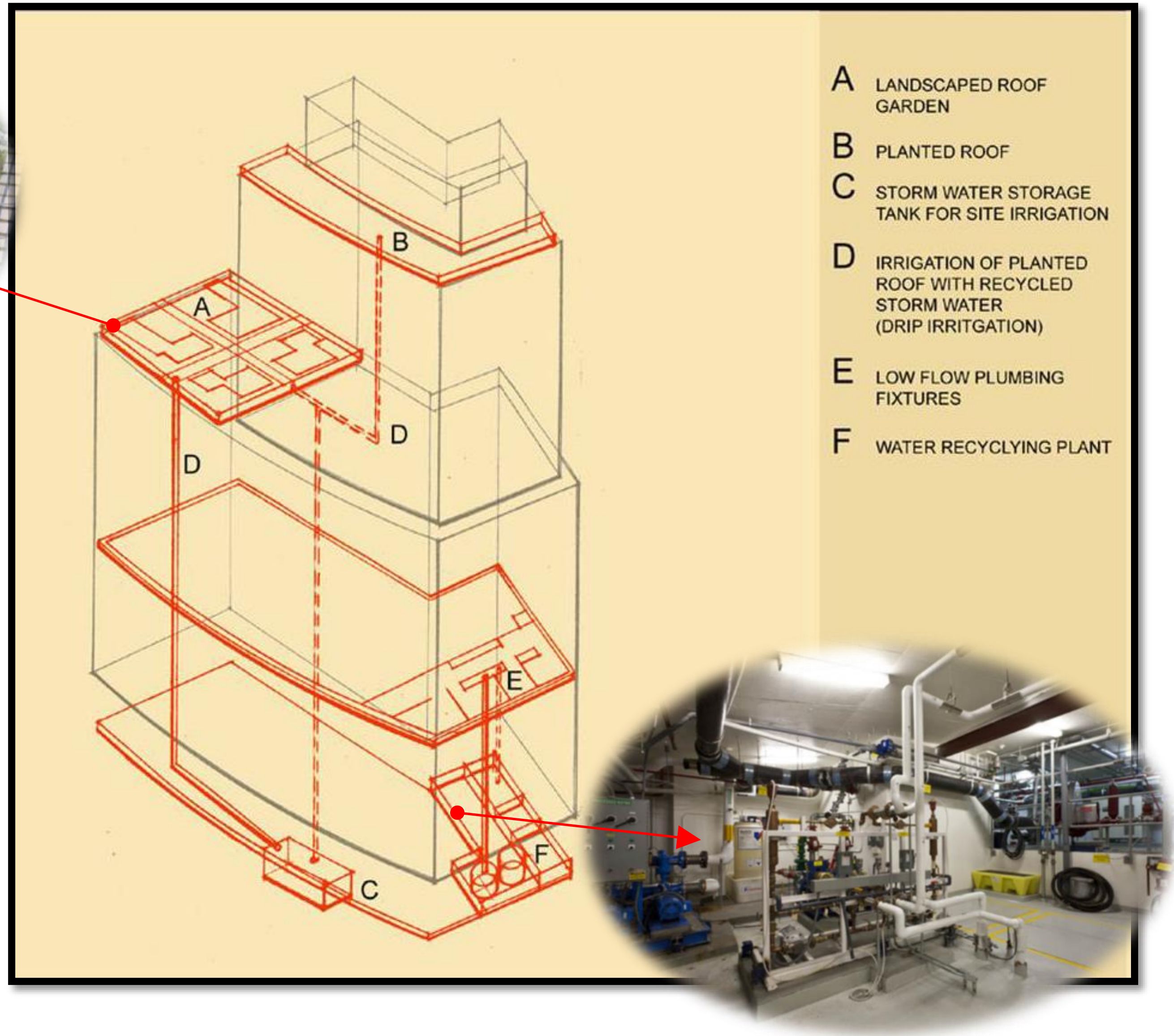
Water Reuse System Performance Data

Parameter	DOB Limit	Membrane Specs
BOD (mg/L)	<10	<2
TSS (mg/L)	<10	<2
Fecal Colliform (CFU/100mL)	<100	<10
Turbidity (NTU)	<2	<0.2
E. Coli Colony Count (#/100mL)	<2.2	N/A
pH	6.5-8.0	N/A

Over 10 years of in-building urban reuse system performance data consistently exceeding permit requirements

System Location	BOD, mg/l	TSS, mg/l	Turbidity NTU	Fecal Coliform #/100 ml	E. Coli #/ 100 ml
The Solaire (2003)	< 6	< 1	0.05 – 0.25	< 1	___
Millennium Tower Residences	< 6	< 1	0.15 – 0.45	< 1	___
The Visionaire	< 6	< 1	0.15 – 0.45	< 1 (Total coliform)	< 1
The Helena	< 6	< 1	0.05 -0.20	< 1	___

Integrated Water Resource Management



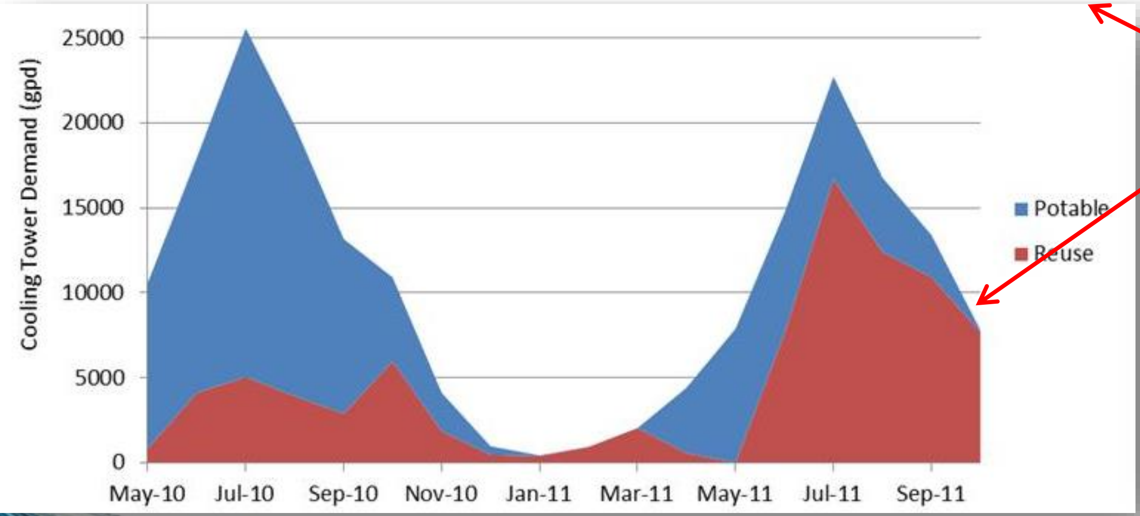
Reuse Applications:

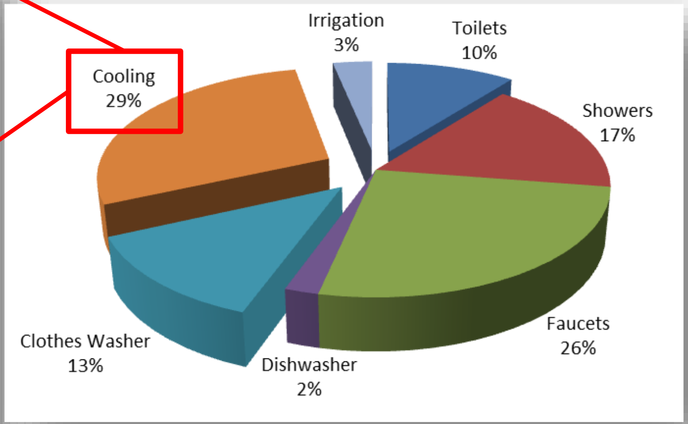
- Toilet Flushing
- Cooling Tower Make-Up Water
- Landscape Irrigation
- Laundry

Maximize Water Reuse Demand Opportunities: Cooling Water

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

Reclaimed water provided for over 55% of residential demands (commercial and academic >75%).





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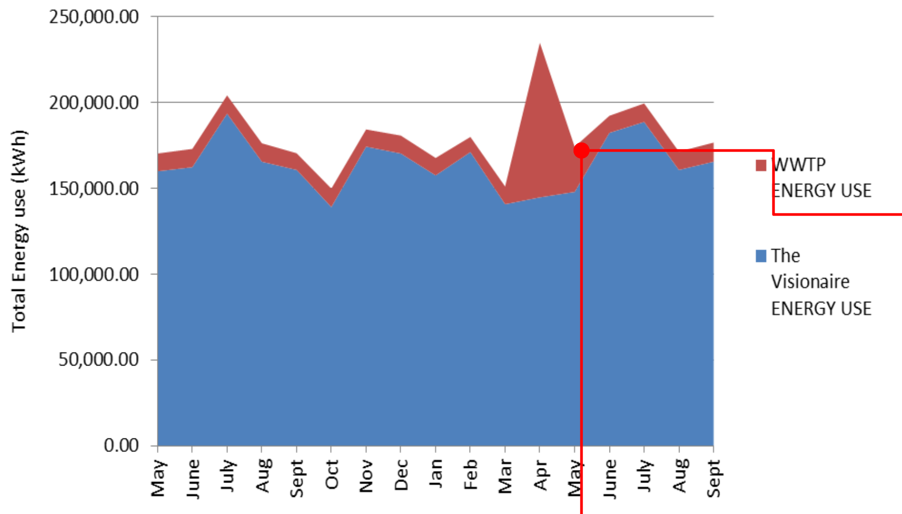
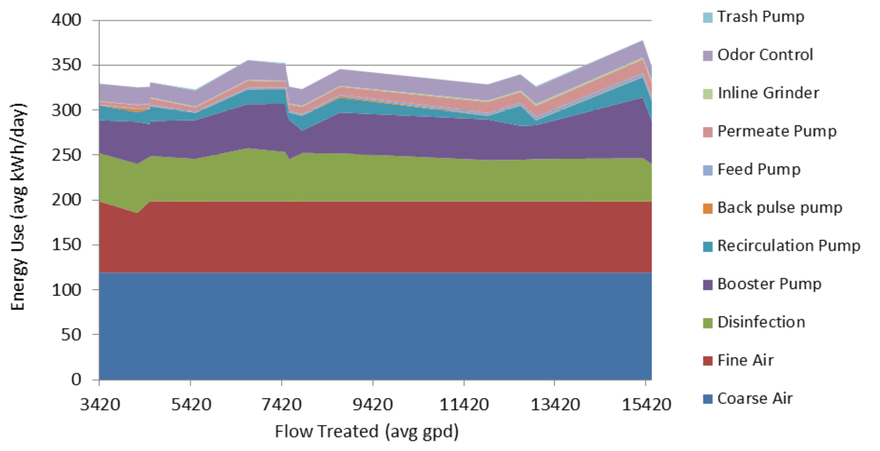
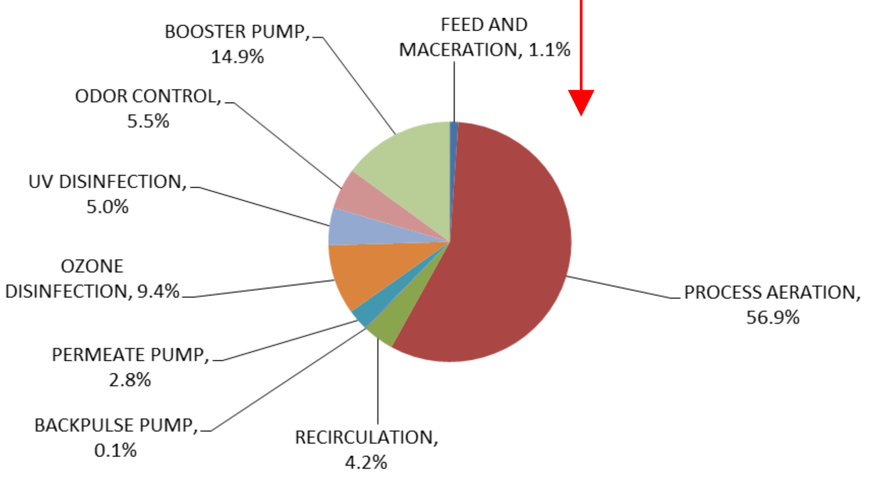
Optimize Water Reuse Energy Performance

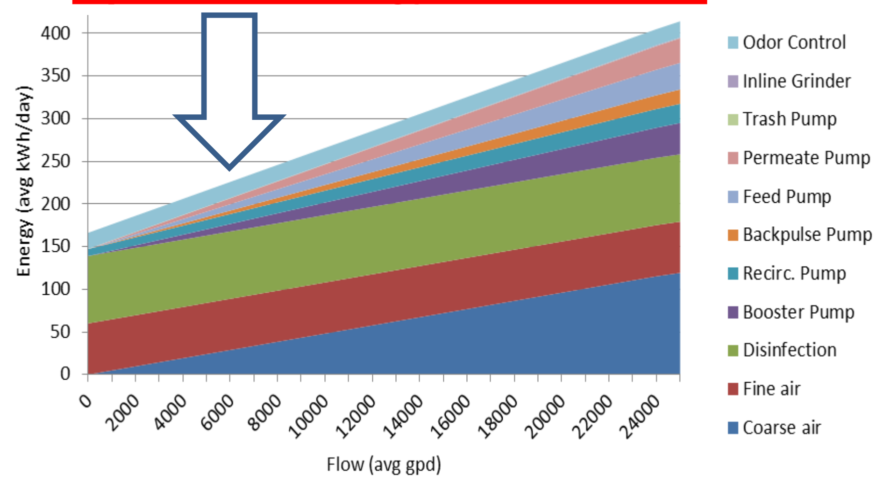


Typical Energy Performance



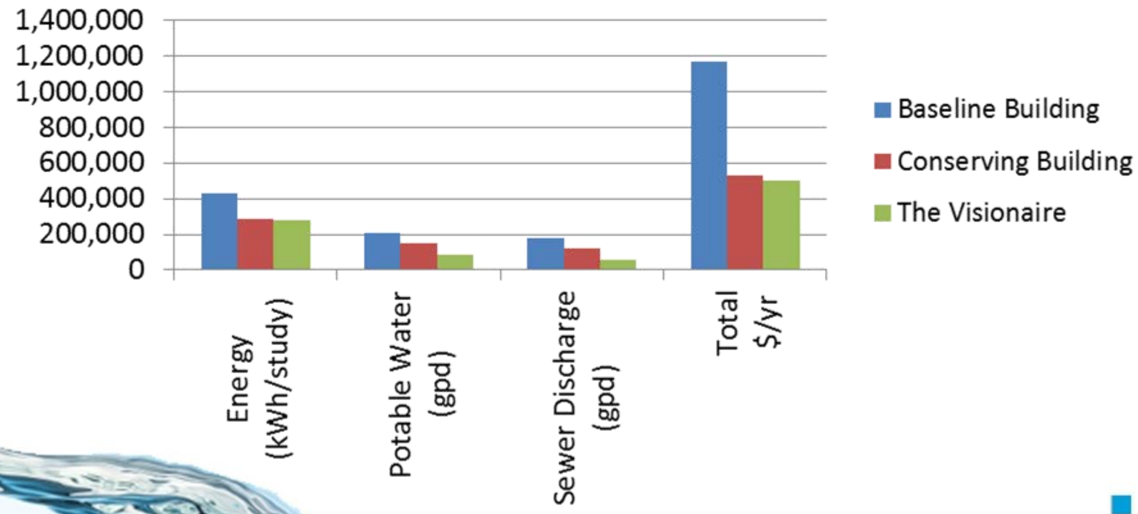


Optimized Energy Performance



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)**



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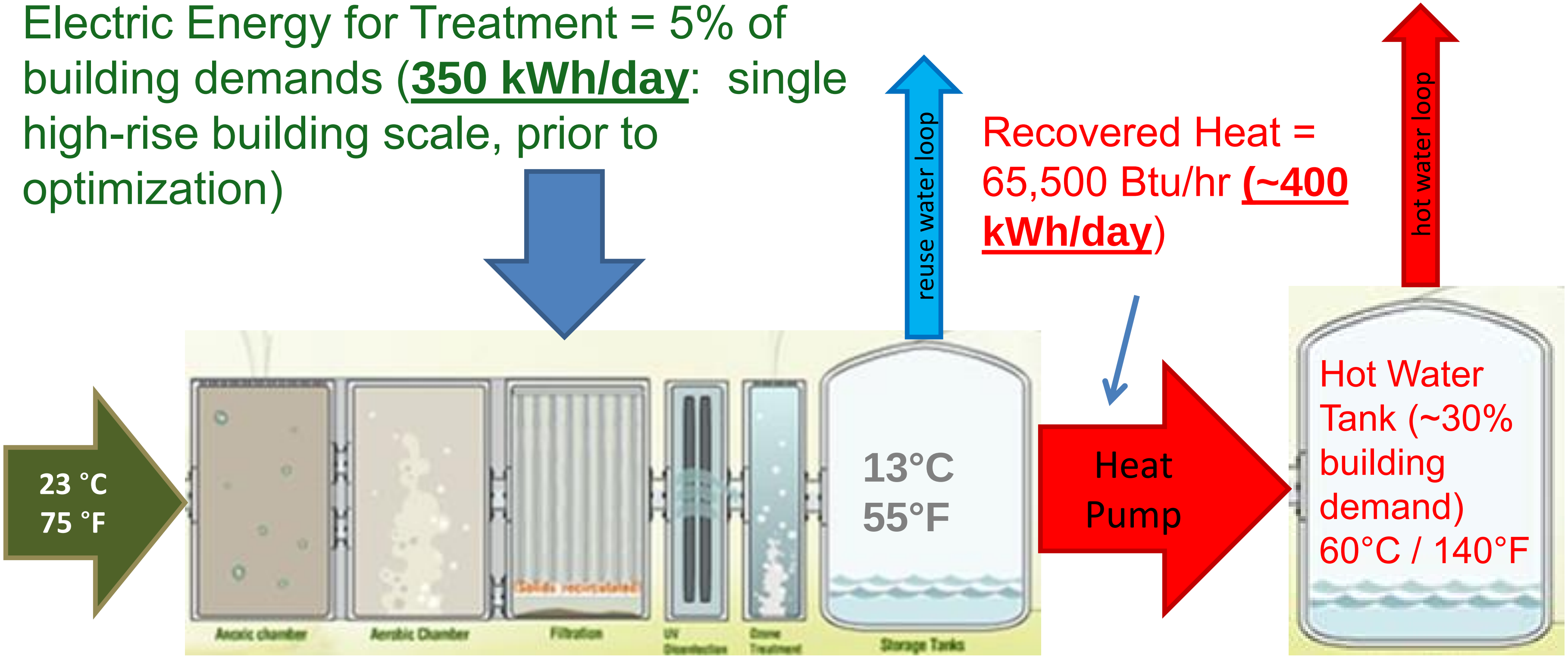
Water / Energy Nexus: Thermal Energy Recovery

Electric Energy for Treatment = 5% of building demands (**<u>350 kWh/day</u>**: single high-rise building scale, prior to optimization)

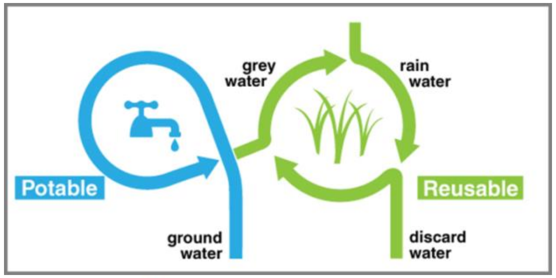


- Embedded energy in wastewater is greater than 4x the amount of energy used for treatment (43 kwh/kgal).
- Water reuse systems can now become <u>net energy neutral</u> and net energy positive at the high-rise building scale or larger with this technology (after accounting for conversion losses)

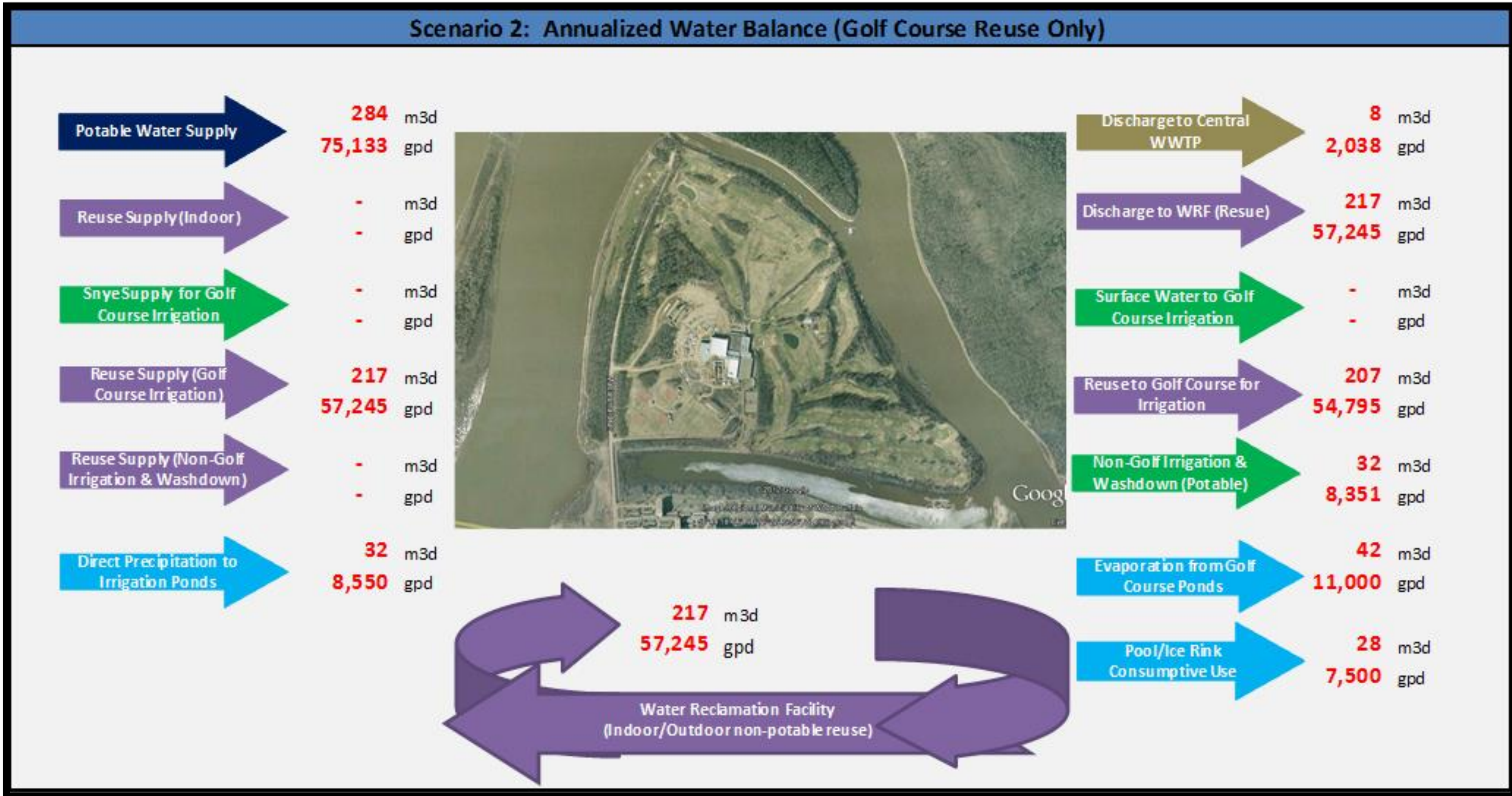
MacDonald Island Case Study

<u>MacDonald Island, AB, Canada</u>

- 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.



MacDonald Island Water Balance



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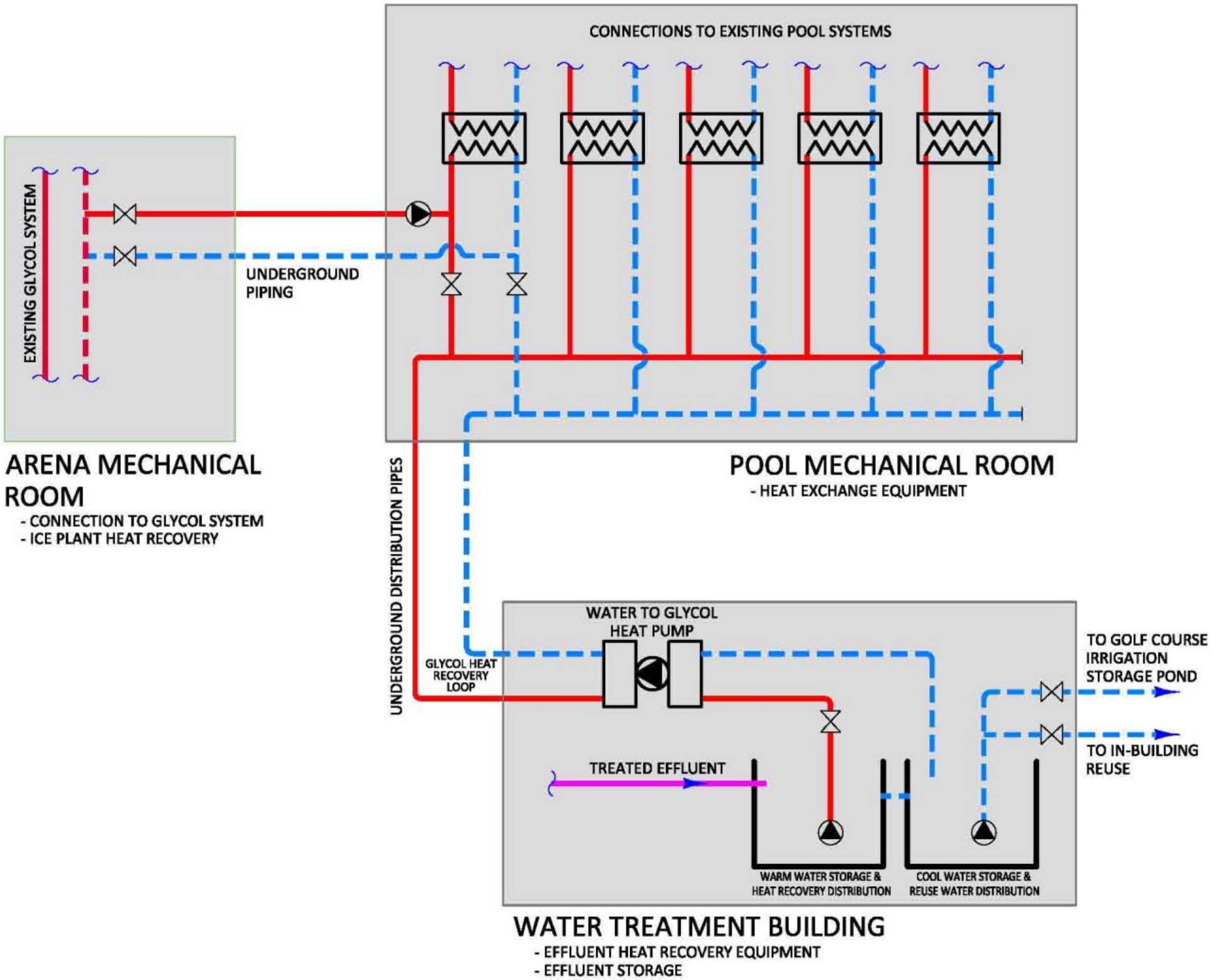
MacDonald Island Summary of Work / Site Plan / Photos

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