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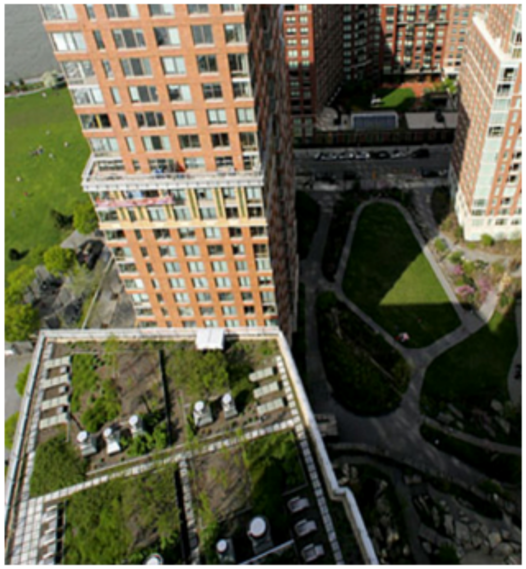
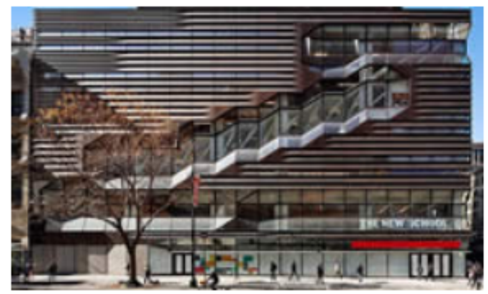
…A Better Way





Disruptive Tech: Beyond Net Zero Energy Onsite Water Reuse

Presented by: Zach Gallagher, PE & Bruce Douglas, PE

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"…A Better Way"

NSU consistently develops ***A Better Way*** to create value where others see waste.

1. NSU Introduction
2. Emerging Drivers for Water Reuse & The Water-Energy Nexus
3. In Building Water Reuse & Thermal Energy Recovery: Battery Park City Case Study & Video Tour
4. Macdonald Island Water Reuse & Thermal Energy Recovery Case Study
5. Conclusion: Onsite Water Reuse Economics

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NSU

30+ Year History Of Onsite Water Treatment & Reuse Solutions

1980s

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

Bristol-Meyers Squibb, NJ
1st Pharmaceutical Onsite Water Reuse system in the US.

1990s

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

Sonoma Raceway, CA
NSU Operates both the Onsite water supply and wastewater treatment facilities for the raceway.

2000s

250,000 GPD on-site water reuse system for New England Patriots, Foxboro, MA

The Solaire, Battery Park, NYC
1st residential water reuse project in the U.S.; LEED-Platinum

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

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.

The New School University, NYC
40,000 GPD in-building onsite water treatment & reuse for flushwater, cooling, irrigation & laundry.

Durst Halletts Point, Queens NYC
District scale redevelopment with in-building water reuse and thermal energy recovery systems

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Onsite Water Treatment & Reuse

New Drivers Are Emerging

- 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 & Lack of Centralized Sewer Services
  - Large percentage of the worlds cities still dump raw sewage into their waters
- **Aging Infrastructure**
- **Growing Demand for Increased Resiliency**
- **Green Building Initiatives & Resource Recovery**
- **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.

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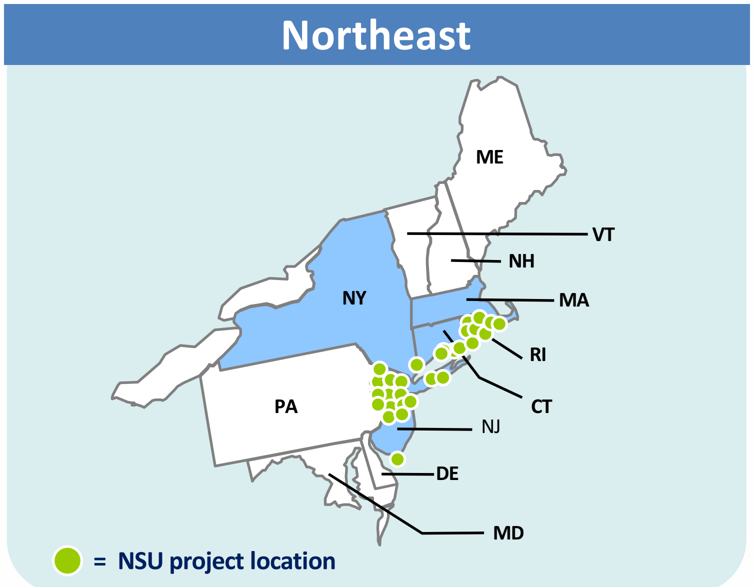
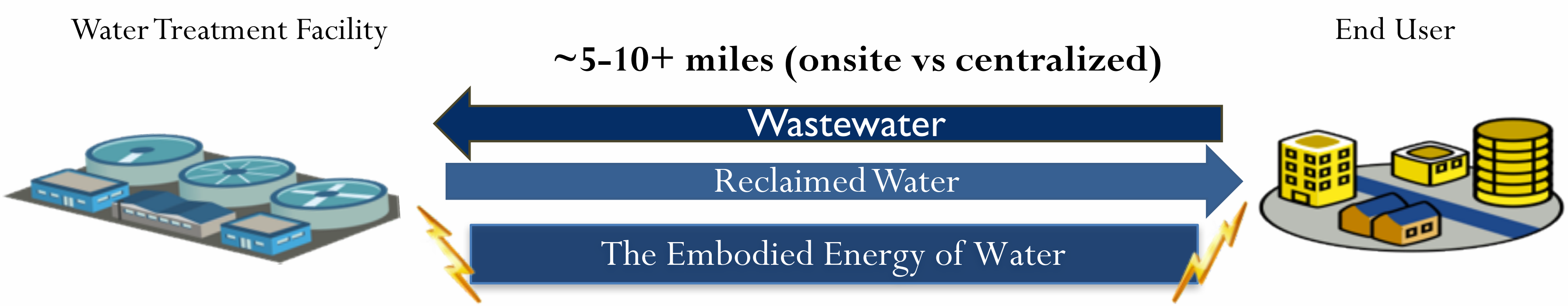
Onsite/Decentralized Vs Centralized

Lessons Learned From Super-Storm Sandy



- ~100 onsite systems currently managed in the Northeast, 80 within those areas directly impacted by Super-Storm Sandy.
- <u>**ZERO**</u> NSU onsite facilities exceeded effluent permit requirements while many centralized facilities were down for weeks or longer discharging untreated sanitary wastewater into the local water bodies.



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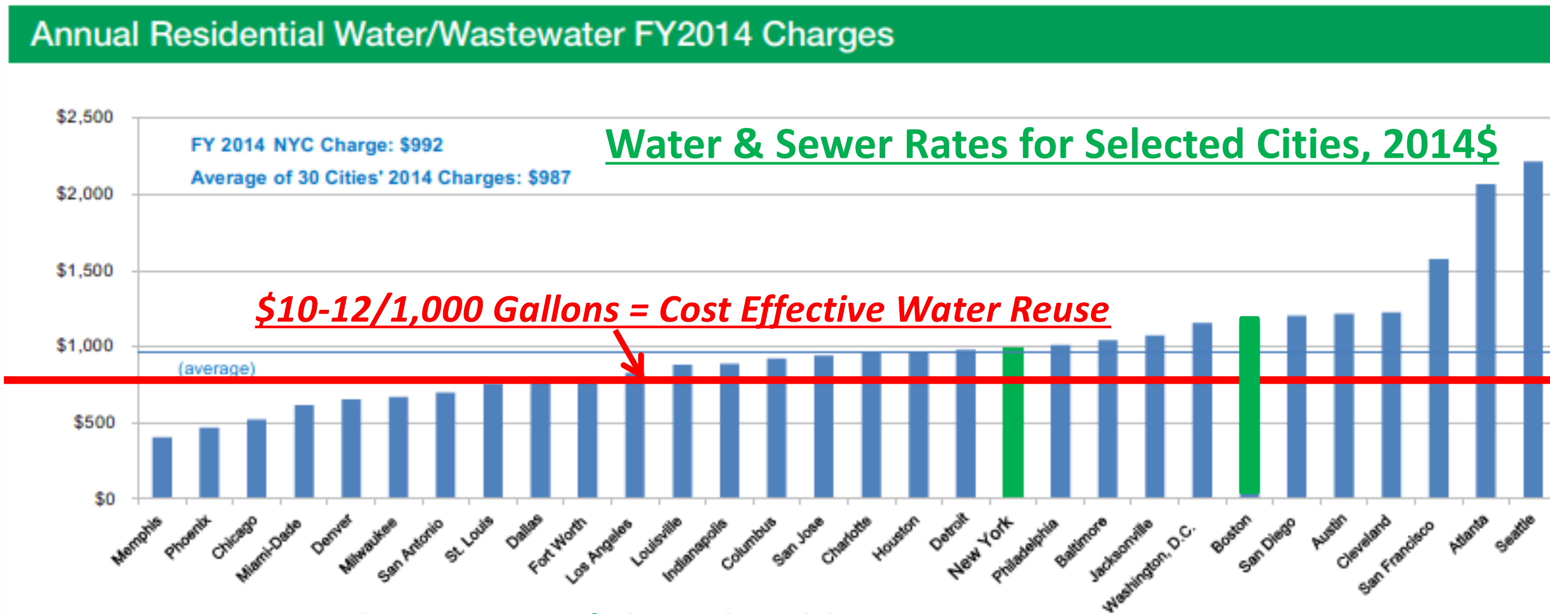
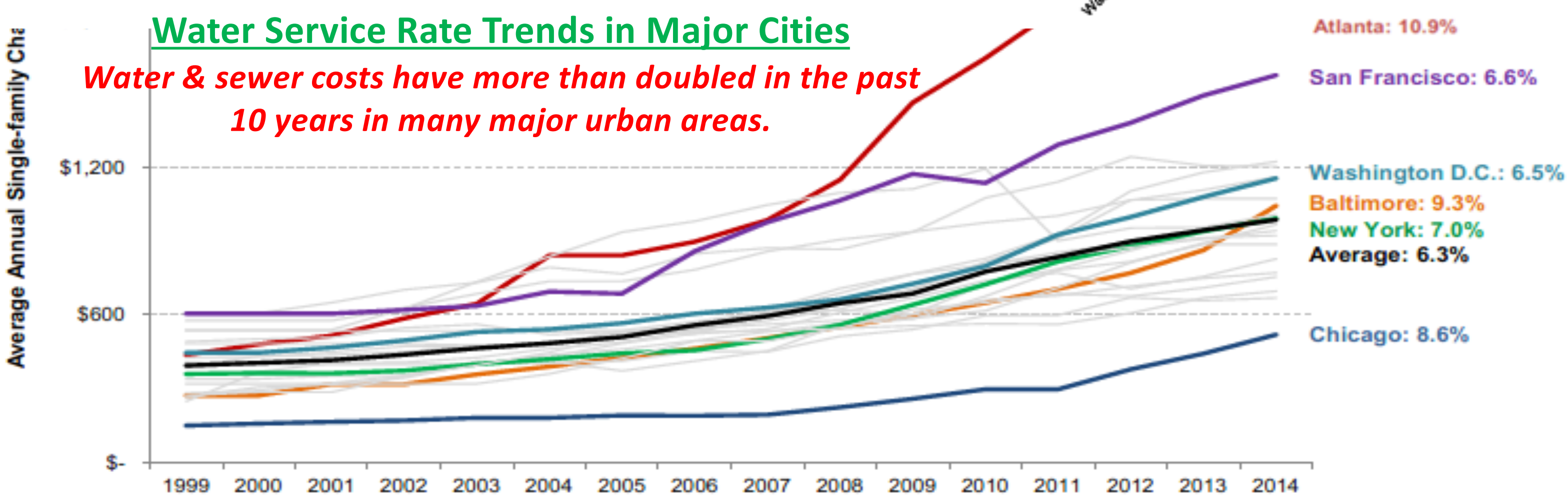
The Emerging Water Reuse Business Case

Water & Sewer Costs Are Increasing



Other Notable Cities Not Listed which are Above The Line

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



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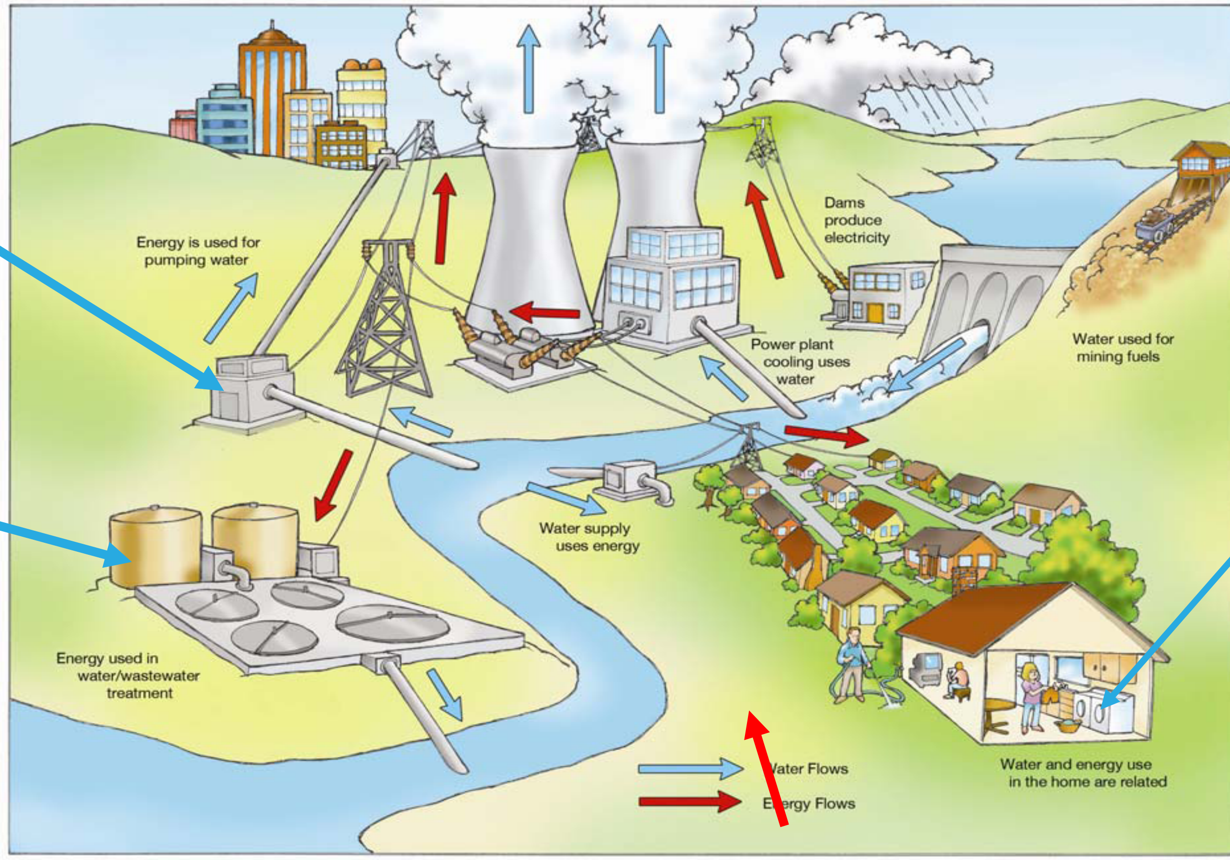
Water-Energy Nexus

Most of the Energy in WW is in the form of sensible heat

2,200 kWh/MG

2,200 kWh/MG



40,000 kWh/MG

25,000 kWh/MG Lost Heat

Energy Use In The Water Cycle

Item	range	typical	Comments
	kWh/MG		
Drinking Water Treatment	200 -13,000	200	Lost energy
Drinking Water Supply	250 - 3000	2,000	Lost energy
In House Energy Gains			
. Sensible Heat	30,000 - 60,000	40,000	Remains as Sensible Heat
. Oraganic Matter Energy	5,000 - 10,000	6,000	Remains as Chemical Energy
Wastewater Collection			
. Pumping	50 - 500	150	Lost energy
. Lost Heat	15,000-30,000	(25,000)	Sensible Heat lost to Environment
Wastewater Treatment	500 - 6,000	2,000	Lost energy

Energy in Wastewater

Wastewater contains ten times (10x) the energy currently used for treatment. Can we harvest it?

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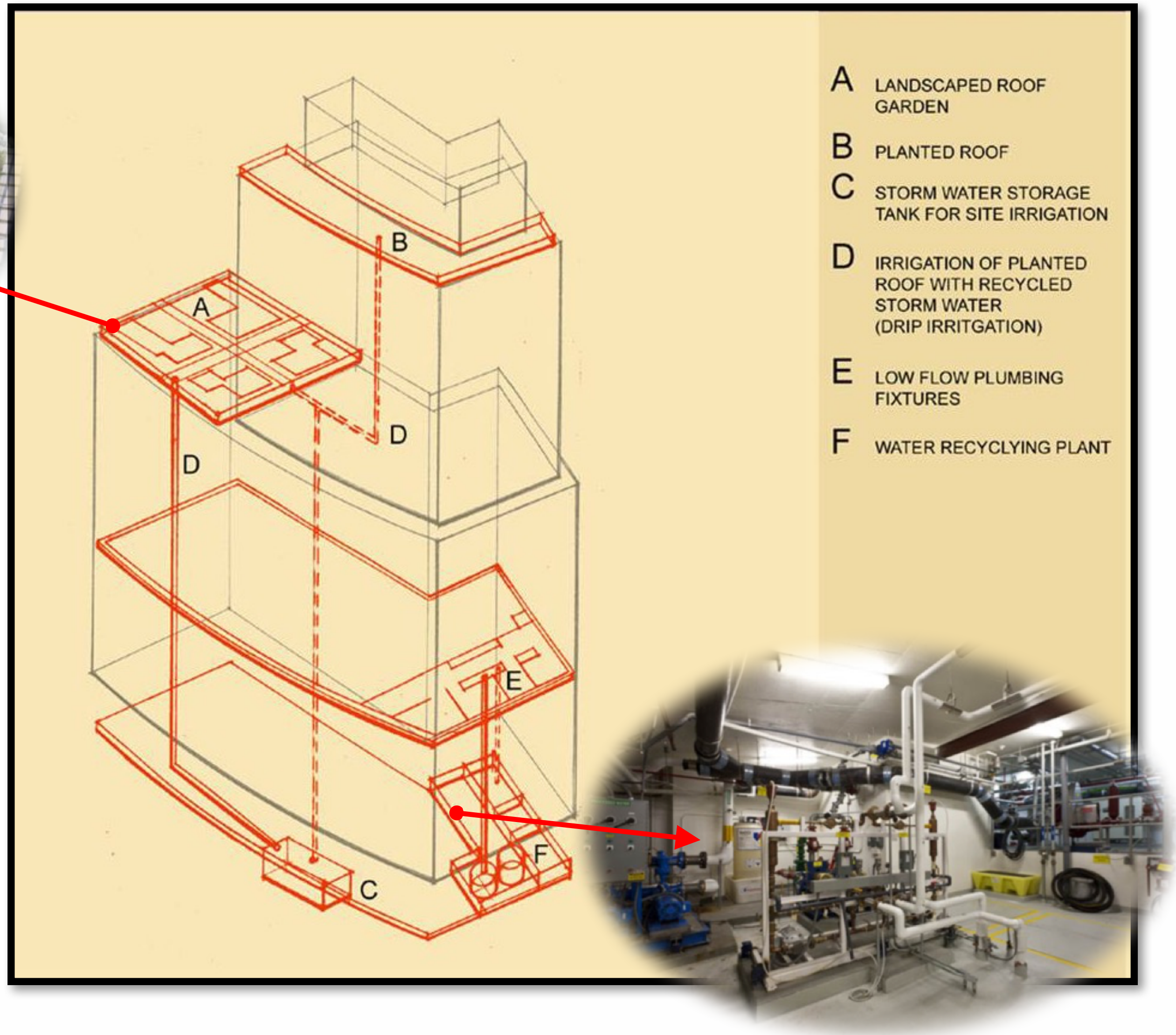
WWTP Energy Market in US

Existing flow range (mgd)	Number of facilities	Total Existing Flow (mgd)	Average Energy Intensity kwh/MG	Power Demand MW
0.000 to 0.100	5,703	257	5,440	58
0.101 to 1.0	5,863	2,150	5,440	487
1.001 to 10	2,690	8,538	2,503	890
10.001 to 100	480	12,847	2,288	1,225
100.001 and greater	38	8553	2,200	784
Other	6			
Total	14,780	32,345	2,556	3,445

Wastewater Treatment Plants in the US have an estimated electric power demand of 3,500 MW

Case Study: Battery Park, NYC

In Building Water Reuse & Thermal Energy Recovery



Reuse Applications:

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

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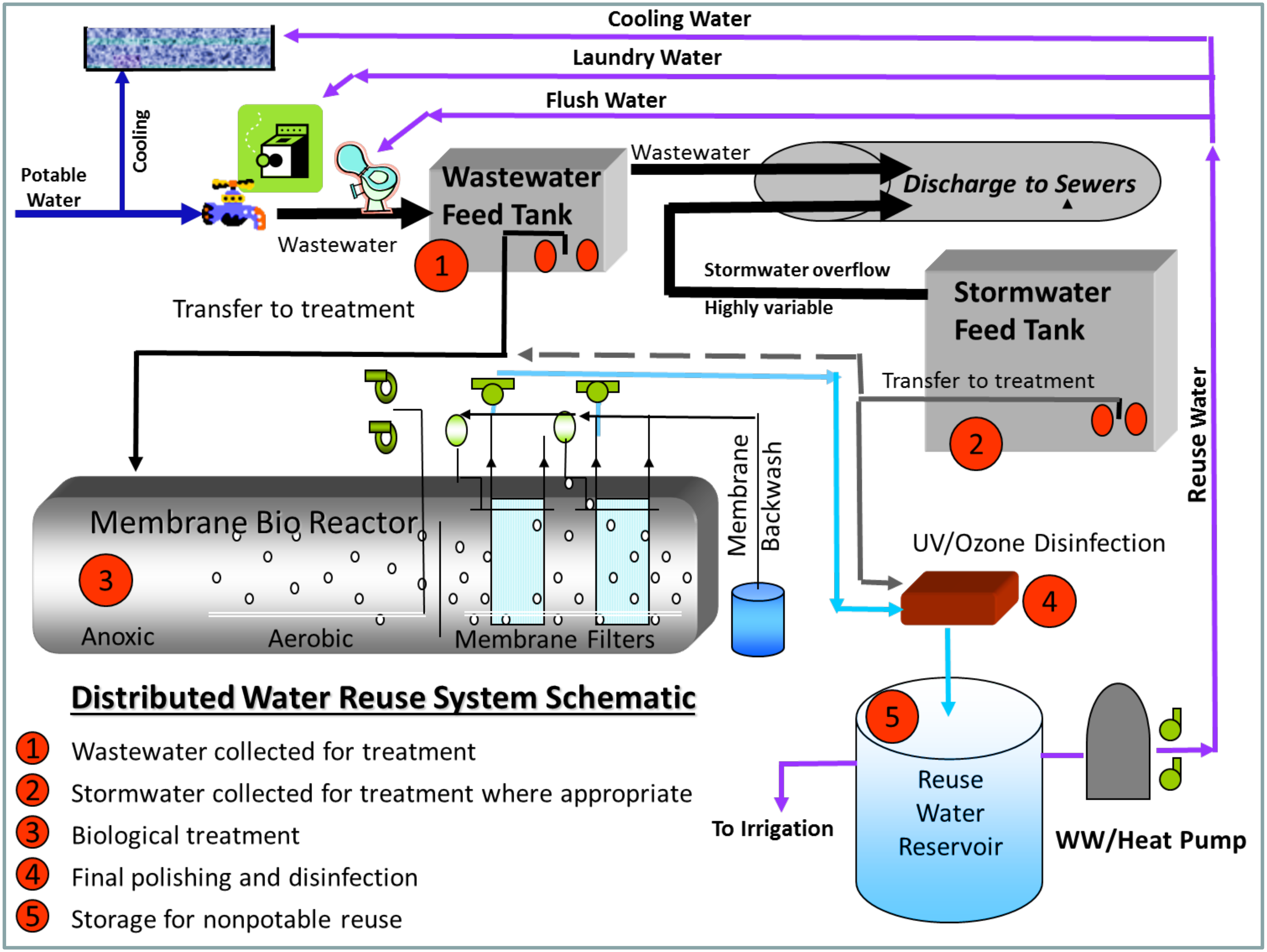


Distributed Water Reuse System Schematic

1. Wastewater collected for treatment
2. Stormwater collected for treatment where appropriate
3. Biological treatment
4. Final polishing and disinfection
5. Storage for nonpotable reuse

Onsite Water Treatment & Reuse Tour

http://www.naturalsystemsutilities.com/offerings/water-reclamation/water-reuse/

System Performance

Proven Technologies/System Operations With Proven Results

NYC Required 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

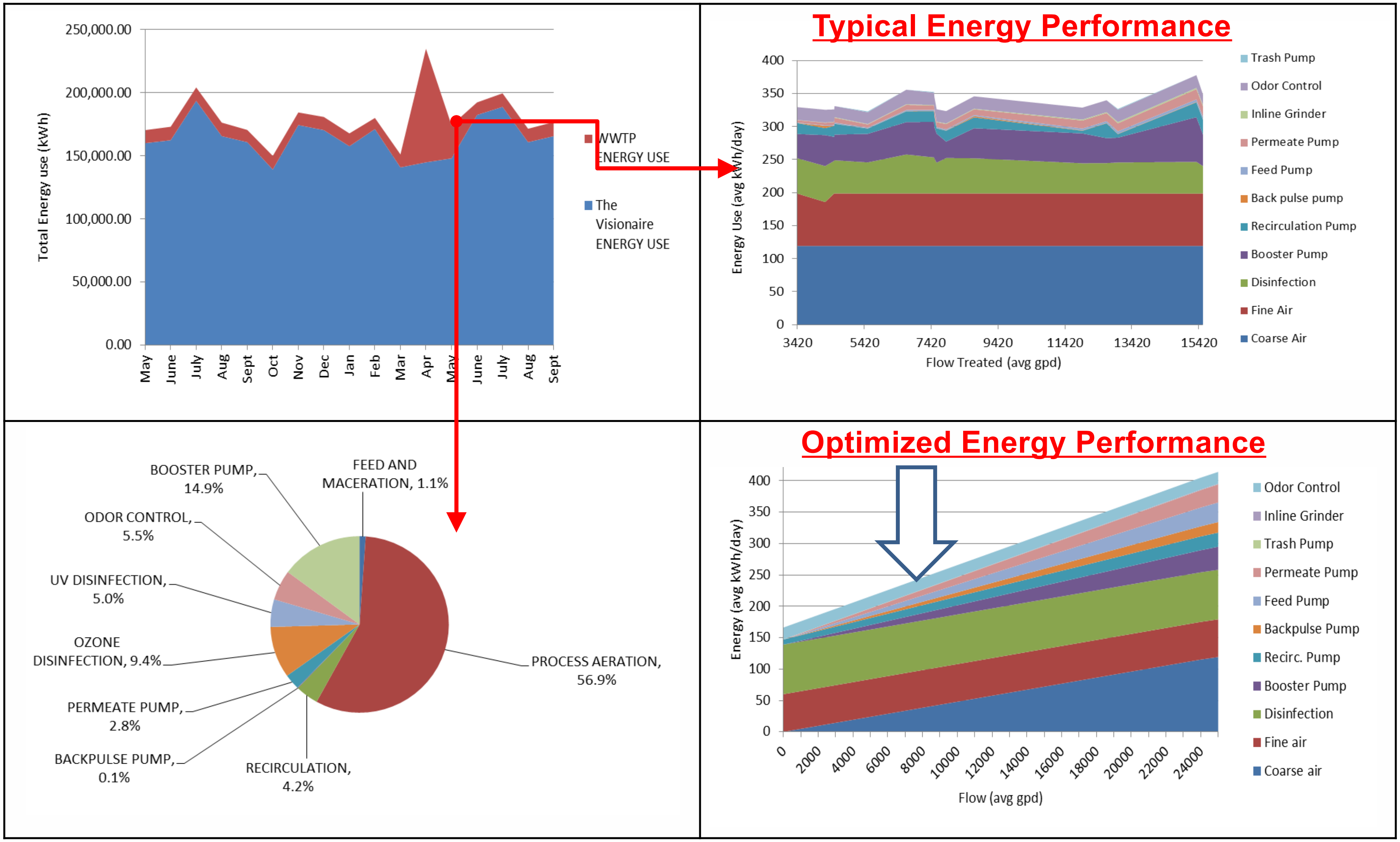
System Requirements

Actual Performance

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	___

Over 10 years of onsite in-building urban reuse system performance data consistently exceeding permit requirements with zero violations!

Optimizing System Energy Performance



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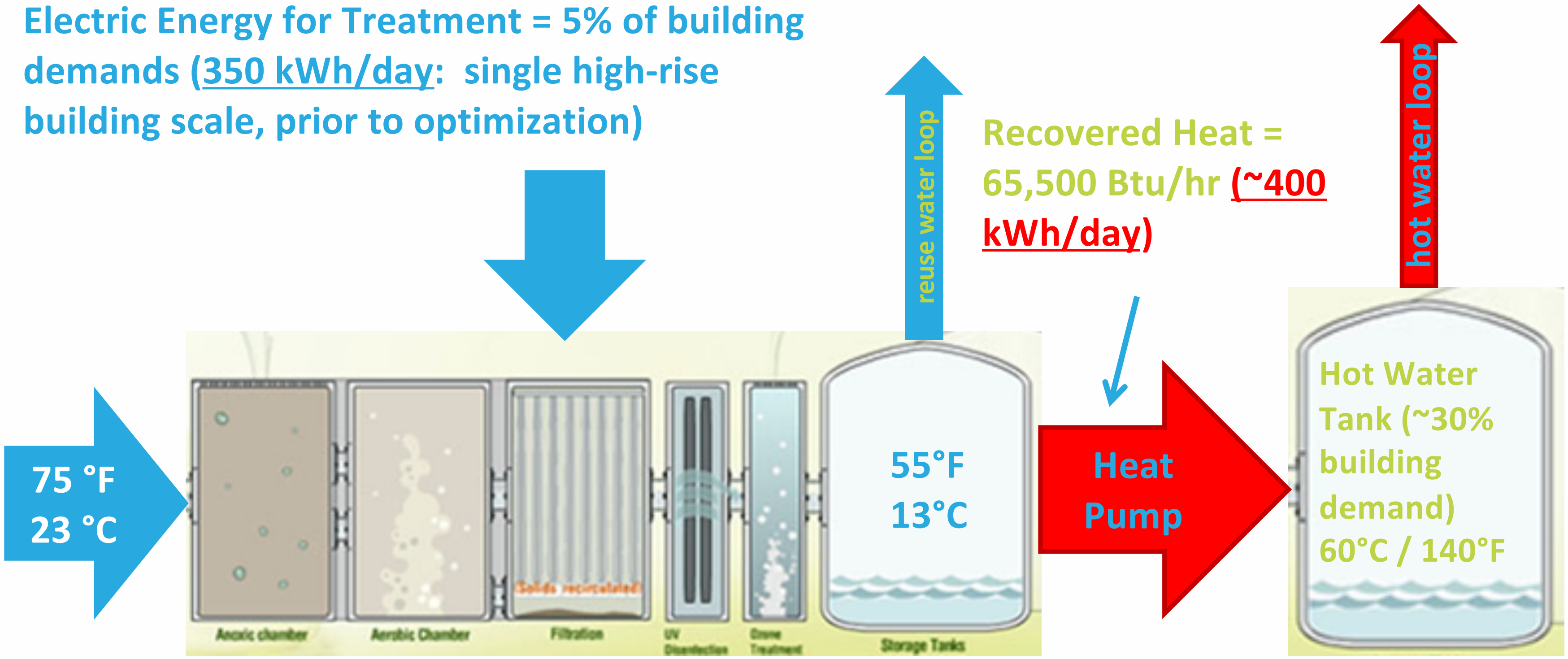
Thermal Energy Recovery

Net Neutral/Positive Energy Onsite Water Reuse

Electric Energy for Treatment = 5% of building demands (350 kWh/day: 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 net energy neutral and net energy positive at the high-rise building scale or larger with this technology (after accounting for conversion losses)

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Energy Positive & Cash Positive

Item	Units	Natural Gas	Heating Oil	Propane	Electricity
Cost of Electric Energy	$/ kWh	0.12	0.12	0.12	0.12
Cost of Fuel	$/dTherm	11	30	37	35
Electric Energy Intensity WWTP	kWh/kgal	10	10	10	10
Electric Energy Cost for WWTP	$/kgal	1.2	1.2	1.2	1.2
Value of Energy Recovered	$/kgal	1.6	4.4	5.4	5.2
Net Income to WWTP Operator	$/kgal	**0.4**	**3.2**	**4.2**	**4.0**

- **Payback of 1.5 to 5 years depending on the fuel displaced and environmental incentives**
- **New System vs Retrofit makes a difference**

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Case Study: MacDonald Island

Water Reuse & Thermal Energy Recovery

MacDonald Island, AB, Canada

- Located in the Regional Municipality of Wood Buffalo at the junction of the Clearwater, Athabasca and Snye Rivers.
- Existing facilities on MacDonald Island (MI) include a Recreation Center and Golf Course.
- Plans to expand the recreational activities with a sports complex and stadium known as Shell Place will generate water & wastewater demands which exceed current infrastructure capacity.
- A decentralized/distributed water reclamation and energy recovery system will be 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.

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Case Study: MacDonald Island

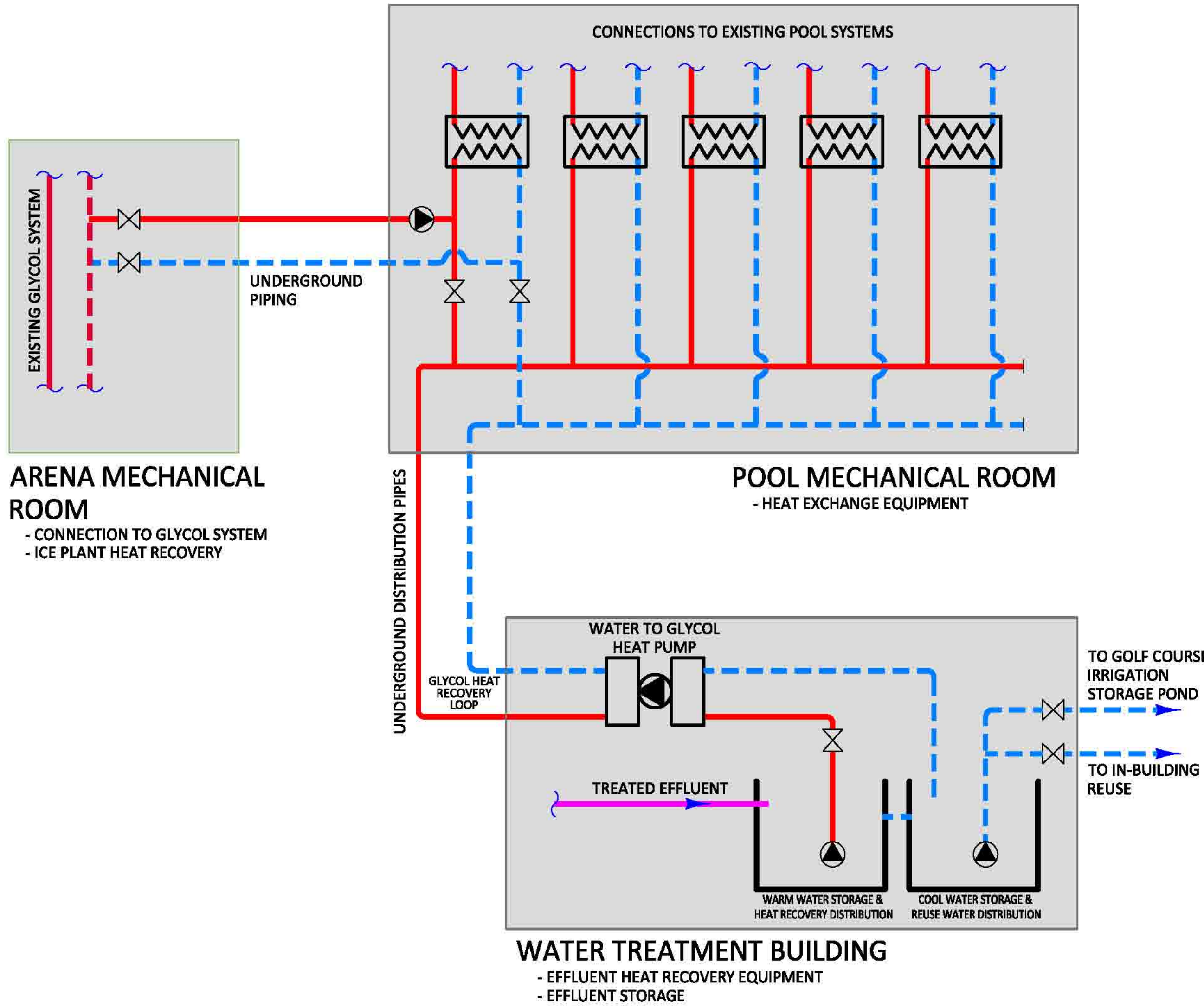
Water Reuse & Thermal Energy Recovery

Case Study: MacDonald Island

Water Reuse & Thermal Energy Recovery

<u>Triple Bottom Line Impacts</u>

- 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
- <u>Recover 240kW of wastewater heat energy</u>
- Reduce 605 tCO_2e greenhouse gas emissions
- Reduce capital expense by $3M
- <u>Operations Data:</u>
  - 342 MWh of heat recovered from the wastewater effluent.
  - 66 MWh of heat recovered from the ice rink refrigeration system.
  - Competition pool is operating on 100% recovered heat.



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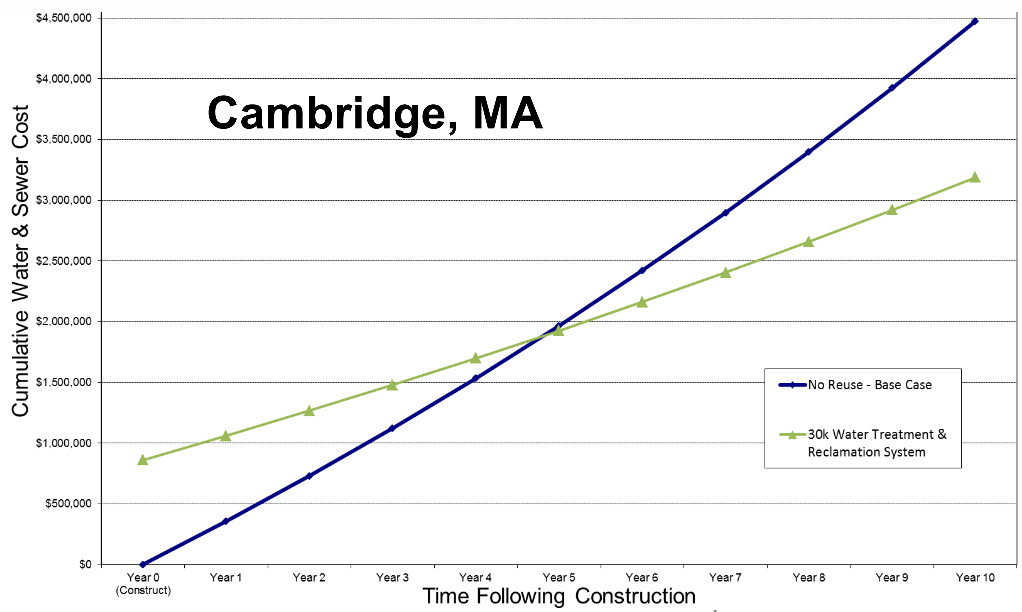
Onsite Water Treatment & Reuse

The Business Case: East Coast to West Coast

New York City

	A	B	C	D = B-C	E = (B/1,000) x A	F = (D/1,000) x A	G = F x -0.25	H = F + G	I = E - H	J	K = I - J
Yr	NYC Water & Sewer Fee (per 1,000 gal)	Total Building Water Use (NYC Supply & Reuse Supply - annual gallons)	Reuse Water Produced (annual gallons)	NYC Water Supply (annual gallons)	Annual Water & Sewer Fee (without reuse)	Annual Water & Sewer Fee (with reuse)	Annual Comprehensive Water Reuse Program (CWRP) Incentive	Annual Water & Sewer Fee (with reuse + CWRP)	Annual Water & Sewer Savings (with reuse)	Annual Reuse System Operating Cost	Annual Net Savings (with reuse)
2015	$12.81	78,475,000	23,725,000	54,750,000	$ 1,005,067.51	$ 701,209.89	$ (175,302.47)	$ 525,907.42	$ 479,160.09	$ 120,000.00	**$ 359,160.09**



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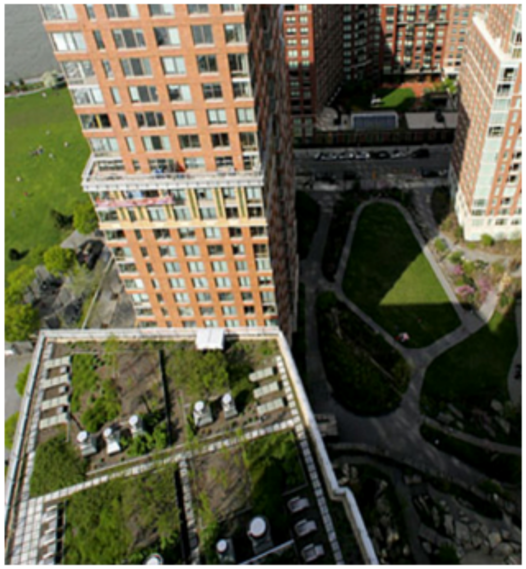

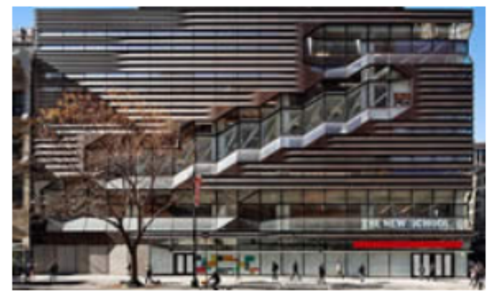

Thank You!

Questions?

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