Overview of Water Reuse Technology:

Pricing Considerations Related

To Reclaimed Water

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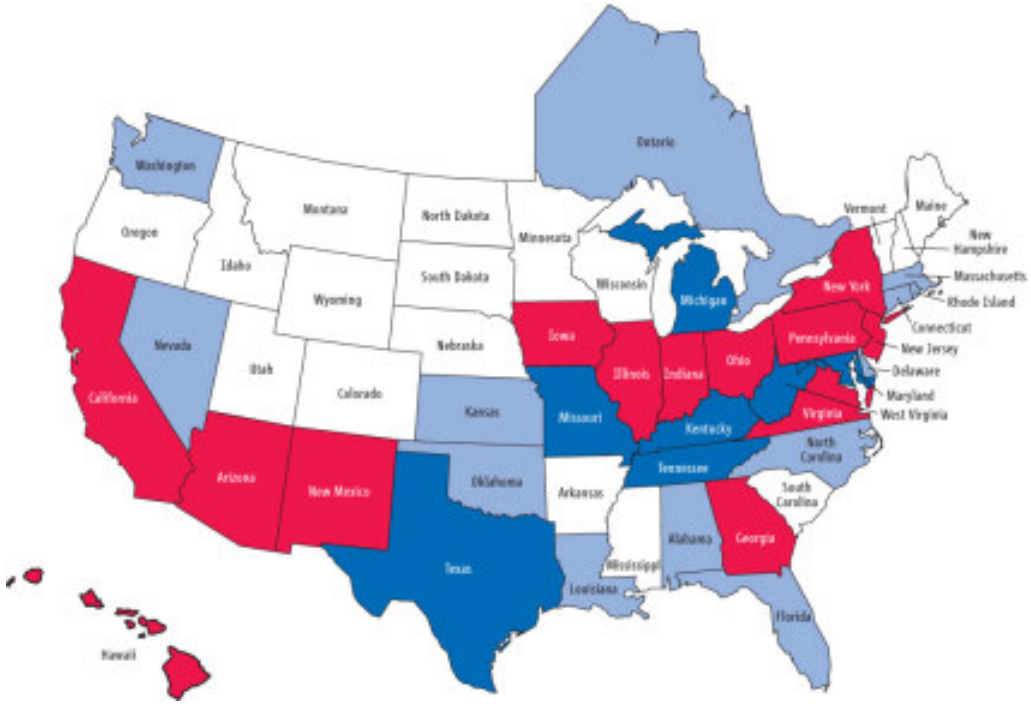

American Water is the largest water and wastewater services provider in North America, headquartered in Voorhees, NJ.

American Water serves over 16.2 million people in 32 states and Canada, and employs nearly 7,000 water professionals.

American Water owns or operates over 870 water treatment plants & wells and 270 wastewater facilities.

The company conducts over one million water quality tests each year for over 100 regulated parameters, and up to 50 types of water-related tests each day.

www.amwater.com

American Water reuses nearly 2 billion gallons per year

RWE Group

Reuse of Treated Wastewater

- Water reuse in the U.S. is a large and growing practice
- Nationally, an estimated 1.7 billion gallons per day is reused.
- Reclaimed water use on a volume basis is growing an estimated 15% per year.
- In 2002, Florida reclaimed 584 mgd. California ranked a close second with 525 mgd used every day.
- Florida has an official goal of reclaiming 1 billion gallon per day by the year 2010.
- Texas, Arizona, Nevada, Colorado, Georgia, Washington

Types of Reuse

- **Urban Reuse**
  - Irrigation of parks, highway medians, golf courses, etc.
  - Commercial uses such as vehicle washing, window washing, etc.
  - Fire protection
  - Dust control and concrete production
  - Toilet and urinal flushing
- **Groundwater recharge**
- **Augmentation of potable supplies**
- **Industrial Reuse**
  - Cooling water
  - Boiler make-up water
  - Industrial process water
- **Agricultural reuse**
- **Environmental and recreational**
  - To create, restore, and/or enhance wetlands
  - Recreational and aesthetic impoundments

Reclaimed wastewater is an increasingly important source of supply

Current Regulations & Guidelines

- Currently there are no federal regulations directly governing water reuse practices.
- 25 states have regulations regarding the use of reclaimed water
- 16 states have guidelines or design standards
- 9 states have no regulations

Example: Membrane Bioreactors

- American Water operates nearly 30 membrane bioreactors (MBRs), to treat wastewater and provide the potential for water reuse.

- MBR Advantages:
  - Increased Reliability
  - High Quality Effluent
    - Free of Suspended Solids
    - Increased Pathogen Removal
  - Easily Automated
  - Reduced sludge
  - Reduced Footprint

- American Water has experience with different membrane configurations (flat sheet and immersed membranes) and cost models.

Solaire, Battery Park

Wrentham Mall

New Jersey

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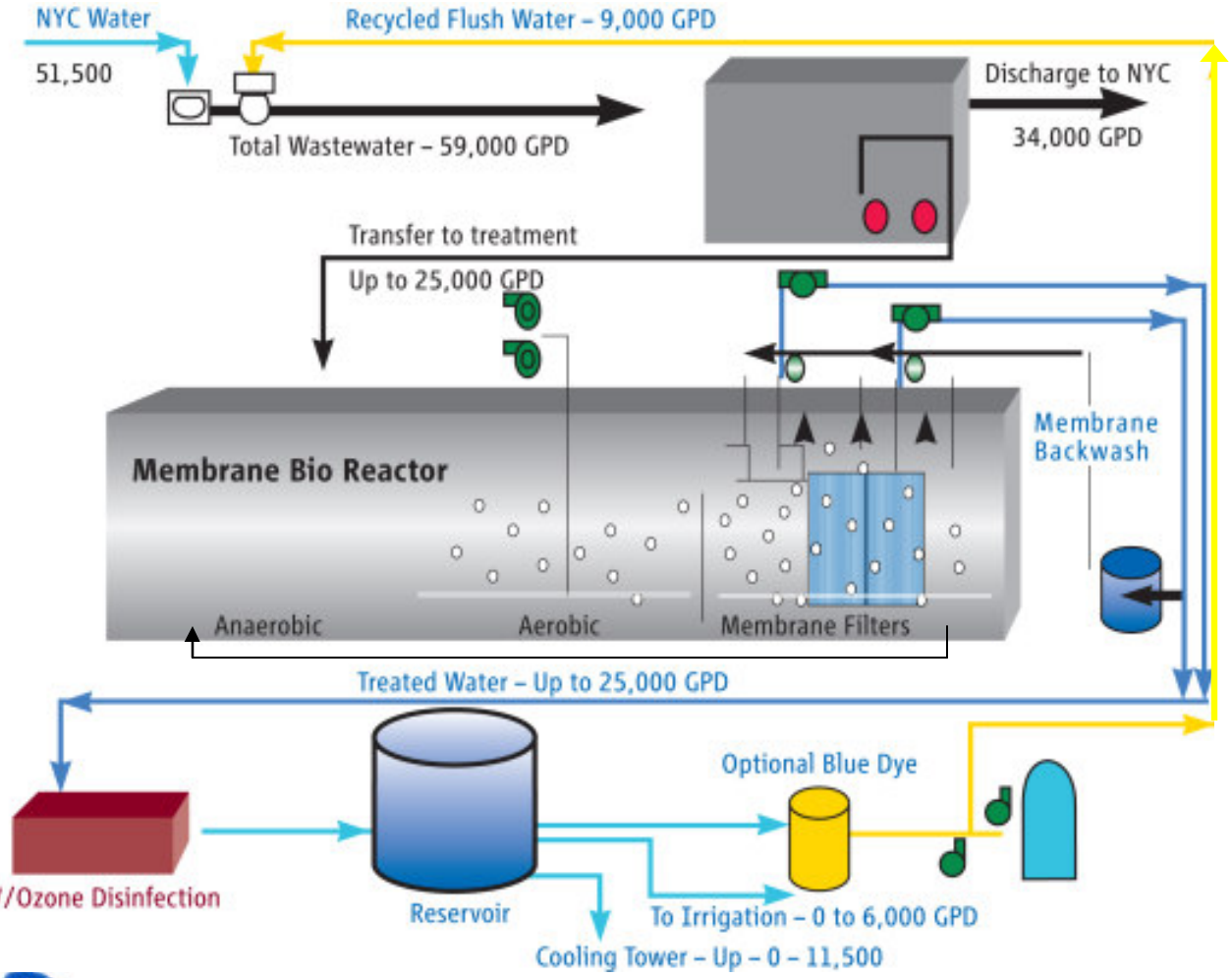
Solaire in Building Recycling
Battery Park City, NY

- 293 Unit Building
- 25,000 GPD Reclaimed Water
- Treatment Plant Located in the Basement of a Luxury Apartment Building
- Gold LEED Certified

MBR Technology



Beneficial Reuse: Solaire

Recycles up to 25,000 GPD:

9,000 GPD toilet flush water
11,500 GPD cooling tower make-up
6,000 GPD landscape irrigation

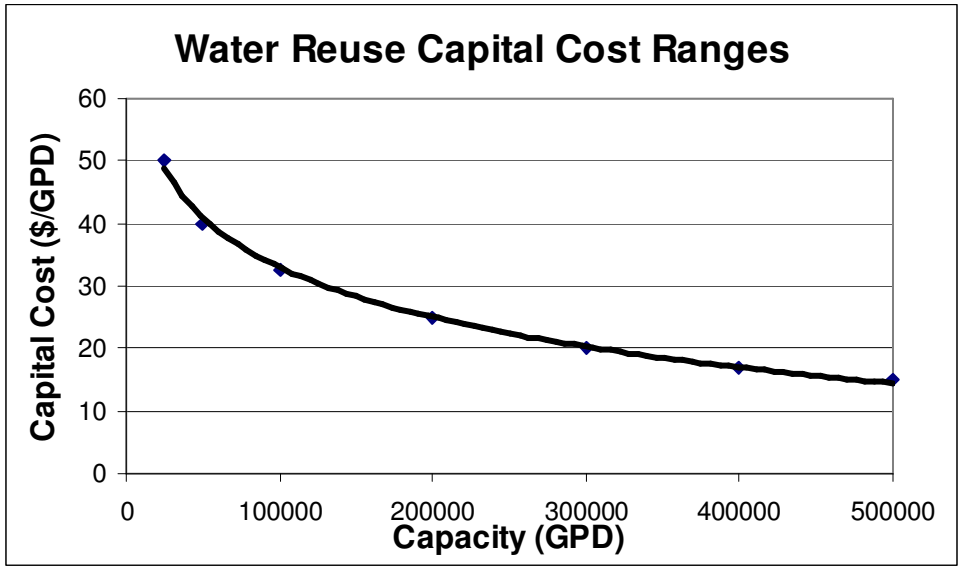
Advanced membrane bioreactor system:

35% less overall energy consumption
65% less energy at peak demand
50% less potable water used than other high-rise buildings of same size

Rainwater collection system irrigates 10,000 square feet of rooftop gardens

Treated Effluent Storage Tanks in Basement Equipment Room

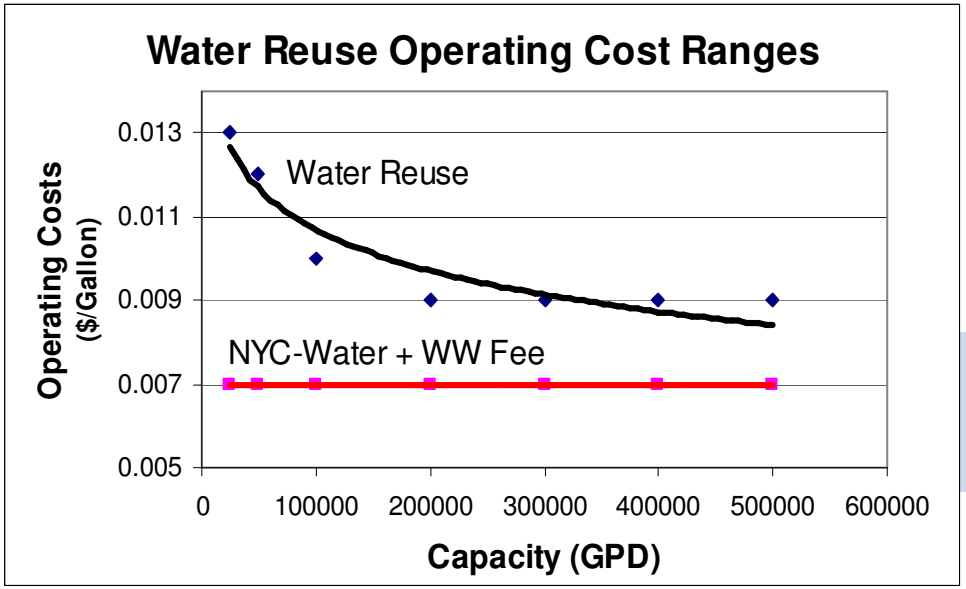
Cost Estimates From Solaire



Capital Cost Range

- $50/GPD at 10,000 GPD
- $15/GPD at 500,000 GPD

(Based on current experience - specific site conditions would dictate actual costs)



Operating Cost Range

- $0.013/Gallon at 25,000 GPD
- $0.009/Gallon at 400,000 GPD
- NYC = $0.007/Gallon W + WW

Wrentham Village Outlet Mall

- Municipal sewer was unavailable.
- On-site facility required to treat to same levels as municipal plant would.
- Construction schedule was critical to project success.
- Toilet flushing and groundwater recharge
- Original system designed for 375,000 sq. ft. of retail outlet stores.
- Two subsequent reuse plant upgrades of $500,000 and $1.3 MM; serving nearly 700,000 sq ft of commercial space.

Wrentham Village Outlet Mall

- Direct reuse advantages at Wrentham, MA:
  - Capital cost savings: smaller effluent disposal fields needed
  - Operating cost savings by reducing potable water consumption
  - Public relations improved
  - Conserved water resources

The Challenge :

- Where could the Town of Foxboro, MA find a reliable source of 250,000 gallons per day of water to meet the game-day demands of a modern National Football League stadium?
- If water was available, how could the Town treat and dispose of the 250,000 gallons per day of wastewater that was generated?
- What would be the potential environmental impacts of instantaneously withdrawing 250,000 gallons per game-day?

Gillette Stadium Project Profile

- 250,000 GPD, membrane bio-reactor wastewater treatment plant – expandable to 1.1 MGD.
- 680,000 gallon equalization tank.
- 3,500 GPM submersible lift station.
- 2.4 acre leach field – on site wastewater discharge and recharges local aquifer.
- Reclaimed water is utilized for stadium toilet flushing.
- $5.2 million capital project; AWM has 20 year operating contract.
- Added commercial development made possible via expandability of recycling capabilities

Anthem Arizona

- Initial Service Date: 1999
- Design Capacity: 7 million GPD (water)
  3 million GPD (wastewater)
- Population Served: 13,000
- Treatment:
  - Prescreening
  - MBR
    - Anoxic
    - Aerobic
    - ZenoGem membranes
  - UV disinfection
  - Chlorine residual

City of Fillmore, California

- 2006 DBO for new 1.8 MGD, $40 million, wastewater treatment plant
- Stringent Performance Criteria
- Wastewater reuse for irrigation and groundwater recharge
- Energy
  - Conservation Issues
  - Self Generation Incentives

Constituent	Enhanced Requirements (5)
Biochemical Oxygen Demand (BOD_5 20°C)	<5 mg/L
Total Suspended Solids (TSS)	<5 mg/L
Nitrate + Nitrite (NO_3-N + NO_2-N)	<5 mg/L
Nitrite – Nitrogen (NO_2-N)	<0.5 mg/L
Turbidity	0.2 NTU
Title 22 ReuseWater MCLs	
Total Nitrogen	<8 mg/L

Lifecycle Cost Comparison

Manufacturer		Zenon	USF-Memcor	Kubota
Chemical Costs				
Annual Cost of Cleaning Chemicals	**$**	**5,376**	**8,988**	**835**
NPV of Chemical costs	$	78,279	130,879	12,159
Power Costs				
Permeate pump power consumption	kWh/yr	32,614	42,340	86,140
Membrane air scour blowers power consumption	kWh/annur	235,578	287,255	775,990
RAS pump power consumption	kWh/yr	75,258	188,705	26,280
Total Power Consumption	kWh/yr	343,451	518,300	888,410
Cost of power	$/kWh	0.12	0.12	0.12
Total Annual Cost of Power	**$**	**41,214**	**62,196**	**106,609**
NPV of Power Costs	$	600,141	905,669	1,552,393
Lifecycle Opex Costs (ex. Labor & biol. processes)	$	678,420	1,036,548	1,564,552
Capital Cost of System	**$**	**2,610,000**	**2,610,587**	**2,450,000**
TOTAL MBR LIFECYCLE COST	**$**	**3,288,420**	**3,647,135**	**4,014,552**
Cost Differential (Zenon as base case)	**$**		**(358,715)**	**(726,132)**

NB. NPV calculations assume an annual inflation rate of 3% and an interest rate of 6%

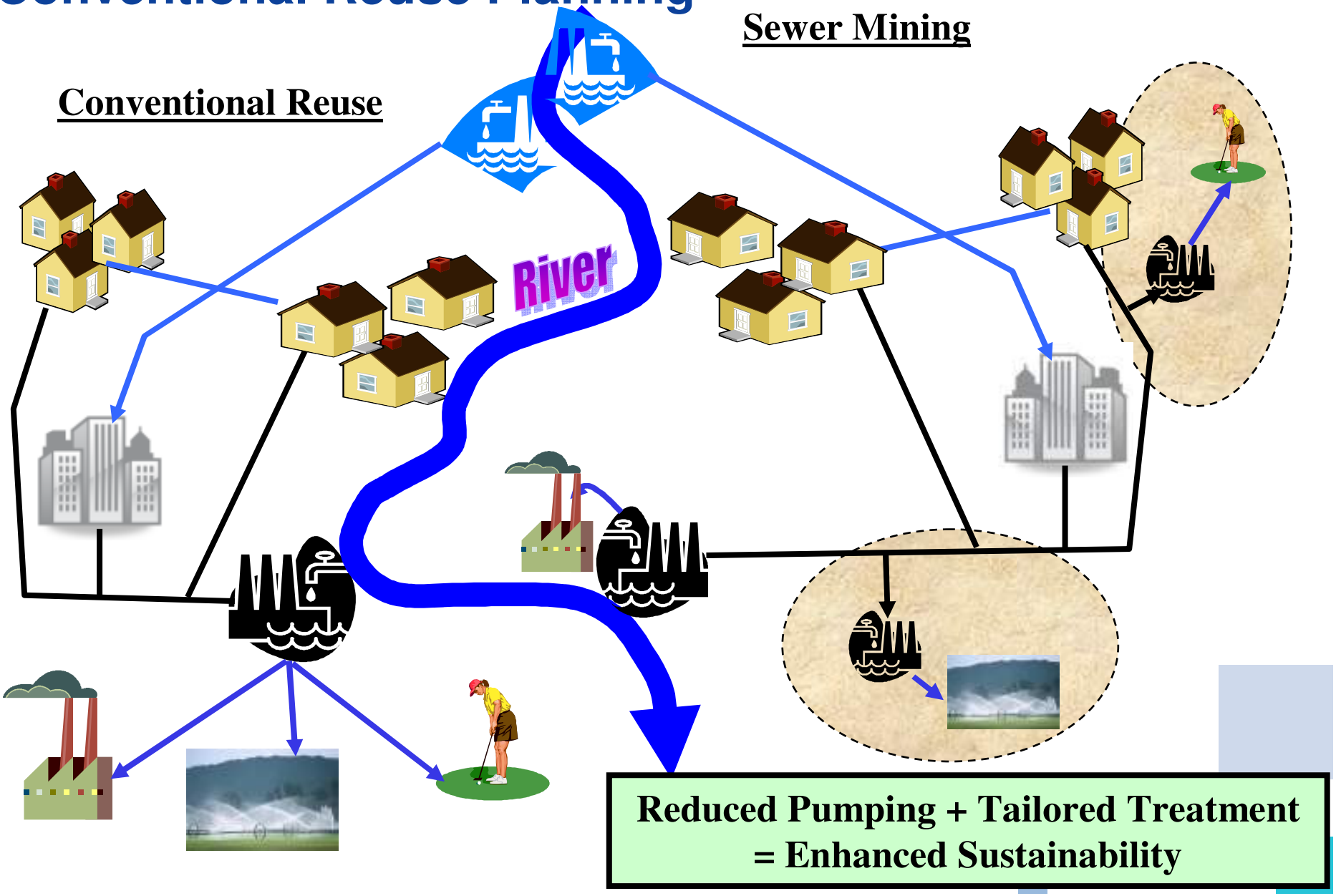
Other cost drivers include sludge handling and reactor sizing

Orange County Groundwater Replenishment System

- Treats 70 MGD wastewater to a vey high level using microfiltration, reverse osmosis membranes and ultraviolet and hydrogen peroxide oxidation
- Replenish the groundwater basin, to protect from seawater intrusion, and for industrial uses
- Reduces the amount of wastewater released into the ocean and delays the need for another ocean outfall
- Decreases reliance on imported water from northern California and the Colorado River
- Helps drought-proof the county
- Helps reduce mineral build up in the groundwater.
- Total program cost of $480.8 million

http://www.gwrsystem.com

Sewer Mining vs. Conventional Reuse Planning



Sewer Mining: Immediate Benefits

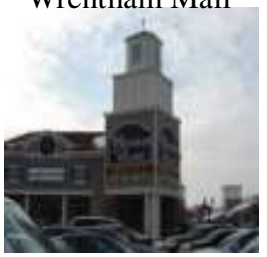
- Enhances collection system capacity
- Increases water supply reliability
- Minimizes infrastructure requirements
  - Reclaimed water distribution requirements kept at a minimum
  - Saves on pumping costs of reuse water
  - Extends capacity of the collection system
- Waste Activated Sludge to collection system
  - Improves odor control
  - In-pipe treatment
- Provides planning, operating and capital investment flexibility

Conclusions

- Wastewater reuse is an increasingly important element of the water cycle.
- Drivers for reuse include lack of alternative water supplies, groundwater replenishment, barrier to saltwater intrusion, pollution management
- Lack of federal regulations and varied applications makes defining reuse difficult
- MBR technology perfect for reuse: compact, effective, automated
- Pricing of reuse water is difficult – need to account for all the environmental benefits and the cost of the alternative supplies.

Solaire, Battery Park

Wrentham Mall



New Jersey

Antham

Foxboro

Thank you for your attention!

Acknowledgements

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