

## Current Status of Water Reuse

Edward A. Clerico, P.E.

January 10, 2008 <sup>1</sup>

It has been reported that it takes 1,200 gallons of water per capita per day to operate the U.S. economy but the human population only consumes less than 1 gallon of water per capita per day. It is clear from this fact that water reuse offers tremendous opportunity to reduce our impacts on water resources because theoretically all but the 1 gallon per capita per day can be readily reused. Water reuse is not new, but it is not well recognized for the potential benefits that it offers because the entire delivery mechanism for water and wastewater services in America; regulatory, financial, legal, business and physical assets, are not structured to embrace the water reuse approach. Recent experience with water reuse projects in urban, suburban and rural settings suggests that these hurdles can be readily overcome with new technology and business delivery mechanisms that deserve widespread consideration because they have proven significant environmental benefit.

Throughout the world, we are faced with a situation wherein our water resources are being depleted and destroyed as a result of:

1. Growing population and pursuit of better living conditions that include abundant use of water for many lifestyle demands
2. Increasing discharge of new products that include more complex chemical constituents that are not readily removed by traditional wastewater treatment
3. Growing anthropogenic pressures on water resources from many activities that have indirect impacts

There are a number of well known large scale reuse projects in America that are mostly in the arid regions and they almost exclusively use treated wastewater effluent for irrigation purposes. Arguably, if this causes the irrigation of additional arid land, it does not offer any real environmental benefit but if it replaces existing irrigation supply, it does reduce the demand on water supply. Such water reuse projects are accepted by the public and they are beneficial, but the benefits are mostly seasonal and only of significant value where irrigation is in high demand.

Direct water reuse is a more beneficial and innovative approach whereby wastewater is treated and reused for multiple nonpotable purposes inside and outside of buildings. This has been accomplished mostly on a distributed system basis where small to medium size facilities are built on-site to provide service to a specific customer or customer group. Typical uses are for toilet flushing, cooling tower make up and laundry uses in addition to landscape irrigation. There are 30 such direct water reuse projects in the Northeast and they span a period of 20 years. Most recently, such projects have been built in urban areas where an abundant supply of wastewater can be readily minded for treatment and reuse. The benefits of this approach are numerous:

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<sup>1</sup> Includes some excerpts from Testimony to Congress, Energy and Environment Subcommittee, Edward A. Clerico, Oct 30, 2007

- 48% to 95% reduction in water consumption by comparison to typical modern buildings
- 60% to 95% reduction in wastewater discharge and waste loads
- Reduced environmental impact from Combined Sewer Overflows (CSO)
- Reduced nutrient and chemical loads to water bodies
- Consistent performance year round that is not dependant on geographical location or season
- Economical operations that use the waste as a resource, provide treatment at the source and yield a favorable Life Cycle Cost and Life Cycle Assessment
- Economical asset management that avoids the need for large capital projects associated with conventional centralized water and wastewater systems
- The opportunity for improved energy efficiency relative to water and wastewater treatment systems and water movement in general
- The opportunity for improved nutrient management for further environmental benefits

By way of example, for a mixed use (residential – commercial – office) development it is very possible that the nonpotable water reuse demands would nearly match the wastewater generation such that wastewater discharge can be almost entirely eliminated. Such dramatic results are not widely recognized and embraced within the water and wastewater industries for many reasons, but one of the most prevalent issues is the fact that our water and wastewater infrastructure has mostly not been configured to be conducive to water reuse. America tends to adhere to a centralized systems approach that requires large capital investment and would require massive retooling of the industry to achieve widespread water reuse. However, small scale decentralized systems offer an alternative approach that yield high performance water reuse systems tailored to the specific user and built at the user's site. Many examples of this decentralized approach exist with long operating experience and this decentralized water reuse approach is now gaining popularity.

Droughts are always catalysts for new initiatives in water conservation and reuse and 2007 was one of the worst years on record for drought conditions in the Southeast US. It is therefore no surprise that the Comprehensive Statewide Water Management Plan prepared by the Water Rights Working Group of the Georgia Joint Comprehensive Water Plan Study Committee supports water reuse and thereby states:

*The State should conserve the waters of the State through suitable policies promoting water conservation, efficiency, and reuse and by encouraging private efforts to conserve and to avoid waste.*

By December 2007, more the half of Georgia was experiencing drought conditions considered “exceptional” which is consistent with a one in 100 year occurrence.<sup>2</sup> These same conditions were prevalent through the Carolinas and Florida and highlight how even in humid high rainfall areas, drought conditions can wreak havoc on water supply resources if development is insensitive to consumption and depletion issues.

There are several key drivers that are increasing the demand for direct water reuse:

- Population density continues to increase thereby stressing local water resources and increasing the likelihood for severe problems caused by short term shortages such as occurred in Georgia
- Pollutants are becoming more difficult to treat as new products are introduced into the market place and the tolerance for discharge of new “emerging” contaminants becomes more critical.
- Awakening to the “green building” movement which strives to counteract behaviors that are not sustainable and thus encourages a wide array of more sensitive building and land management practices.
- The lack of federal subsidies for water resource infrastructure and the resultant full cost pricing which will advance water reuse alternatives as more efficient and cost effective in many instances.

In fact, the option of direct water reuse already has a long successful history. Table 1 below is a partial listing of water reuse systems in the northeast spanning a 20 year period. These systems were all developed by Applied Water Management, a subsidiary of American Water.

**Table 1**

<i>Building Type</i>	<i>Date of 1<sup>st</sup> System</i>	<i>Water Reuse</i>	<i>Water Uses</i>
<i>Research</i>	1987	95%	Toilet flushing
<i>Office</i>	1989	95%	Toilet flushing
<i>School</i>	1990	75%	Toilet flushing
<i>Commercial Centers</i>	1993	70%	Toilet flushing
<i>Stadiums</i>	1996	75%	Toilet flushing
<i>Urban Residential High Rise</i>	2000	50%	Toilet flushing, cooling, irrigation and laundry
<b>30 Systems</b>	<b>20 Years</b>	<b>80% Reuse Nonresidential</b>	
		<b>50% Reuse Residential</b>	

<sup>2</sup> David Emory Stooksbury, PhD, State Climatologists and Associate Professor, University of Georgia, presentation entitled, “ Current Drought Conditions winter & Spring 2008 Outlooks, 21 December 2007”

Addressing the myriad of water resource constraints in the future will become a growing problem that will lead to more water conservation and reuse applications. Attached to this report as Appendix 1 are site specific project data sheets that illustrate the nature and history of several of the water reuse projects included in table 1. These are included for illustration purposes only because each project stands on its own merits and requires specific analysis to properly marry the resource options with the water demand requirements.

Water reuse is becoming an important alternative for minimizing water balance impacts from new development and in mitigating existing water balance problems in urban areas. As the applications and uses continue to expand, the technology will become more widespread and new alternatives will evolve. Typical water demand considerations for water reuse now include:

- Toilet flushing supply
- Cooling tower supply
- Irrigation
- Laundry supply

Typical water resource supply options for water reuse now include:

- Wastewater from all sources or from separate grey water and black water systems
- Condensate water from air conditioning and steam
- Storm Water
  - Green roof – from rooftop filtration and storage
  - Blue roof – from rooftop storage
  - Site drainage from parking lots, sidewalks and lawn areas

Both the water demand considerations and the water resource supply options have specific characteristics that are site and user specific and as such each system must be designed accordingly. Experience with commercial centers such as the Wrentham Mall (Wrentham MA.), Westbrook Factory Outlets (Westbrook, CT.) and Clinton Crossing Outlet Stores (Clinton, CT) illustrate the specific nuances of retail applications with food service provisions. Gillette Stadium (Foxboro, MA) and Skylands Park (Newton, NJ) represent the challenging applications of water reuse within stadiums which have a wide variation in wastewater strength and quantity demands. A number of schools have utilized water reuse for many years including Princeton Montessori School (Princeton, NJ), Copper Hill School (Flemington, NJ) and the Freehold High School (Freehold, NJ), each with variations in child age, activities and water uses. Residential applications are some of the most current with a number of applications in New York City including The Solaire (293 units), Tribeca Green (275 units) and Millennium Towers (350 units). Office and research park applications are one of the oldest with the Convatec headquarters (Division of Squibb Pharmaceutical in Princeton, NJ) which has operated continuously since 1987.

These are listed simply to illustrate the wide variety of applications currently in operation and to call attention to the need for site specific design. The regulatory aspect of water reuse is also evolving across the country with a number of states adopting specific standards. California Title 22 was the earliest of the water reuse standards and it has provided a benchmark for many other states which are currently preparing standards. In addition, the American Society of Heating, Refrigeration, Air Conditioning Engineers (ASHRAE) in conjunction with the United States Green Buildings Council (USGBC) and the American Society of Testing Materials (ASTM) are developing specific in-building quality standards relative to water reuse.

In summary, local demands and drivers with regards to water resource management will make the transition towards water reuse occur at different paces in different places, but the trend will be inevitable and ultimately universal. As a footnote, the International Space Station provides an excellent research and development tool because in outer space water reuse is not an option, it is an absolute necessity.

## Appendix 1 Examples of Water Reuse

(from Applied Water Management, Subsidiary of American Water)

### **1. Anthem Facility, Anthem, AZ**

This project utilizes advanced membrane filtration technology to provide potable water and treat wastewater for beneficial reuse. Membrane filtration technology offers many advantages over conventional treatment, including greater automation, smaller facility requirements, greater odor control, and high-quality results.

Anthem Water Treatment Plant:

- Treats surface water from the Central Arizona Project Canal and Lake Pleasant
- 7 MGD capacity, serving 13,000 residents
- Small footprint facility – approximately 10 acres
- Utilizes immersed membrane filtration technology, with ultraviolet and chlorine contact tanks for disinfection

Anthem Wastewater Treatment Plant:

- Treats 3 MGD of wastewater generated by 3,000 residents
- Produces Class A+ effluent – the highest standard designated by the Arizona Department of Environmental Quality
- Effluent is used for irrigation at a community park, two golf courses, and highway medians, and for spray application to control dust
- Approximately 17% of effluent recharges the aquifer



Figure 1 – Anthem, AZ

## 2. Gillette Stadium – Foxboro, MA

The stadium that serves as the home of the New England Patriots has a distinction like no other NFL Stadium in the United States. This stadium reuses water to flush toilets on game day. Lack of water supply and wastewater treatment capacity in Foxboro required an innovative approach for this facility. The system is designed as a nonpotable water supply utility and it collects wastewater from the stadium and surrounding commercial facilities and distributes treated reuse water accordingly.

The system is a closed loop wastewater treatment and recycling facility. Through the use of membrane bio-reactor (MBR) technology and ultra violet treatment the wastewater is treated and disinfected for reuse. In addition the facility is a level 5 treatment facility with nitrogen removal to meet Massachusetts direct reuse standards.



Figure 2 – Gillette Stadium Water Reclamation Facility and Flow Equalization Tank

Working closely with the town, a project was developed to support the stadium that resulted in the construction of the following facilities:

- 250,000 gal/day Membrane Bioreactor facility capable of being expanded to treat around 1 MGD
- 680,000 gallon glass-lined equalization tank to capture the wastewater surge at half-time
- 2.4 acre leach field for the excess permeate
- 500,000 gallon elevated water tank for reclaimed water

The plant has operated successfully since being commissioned by American Water in 2002.

### 3. Solaire, Battery Park, New York City, NY

The Solaire was rated as one of the top ten “Green Buildings” for 2004 by the American Institute of Architects (AIA). It has also received a Gold LEED (Leadership in Energy & Environmental Development) rating. The Solaire was an innovative building which is located in lower Manhattan in close proximity to the site of the former World Trade Center. It is a 34-story 293 unit high rise, mixed-use building with commercial spaces and a restaurant on the ground floor.

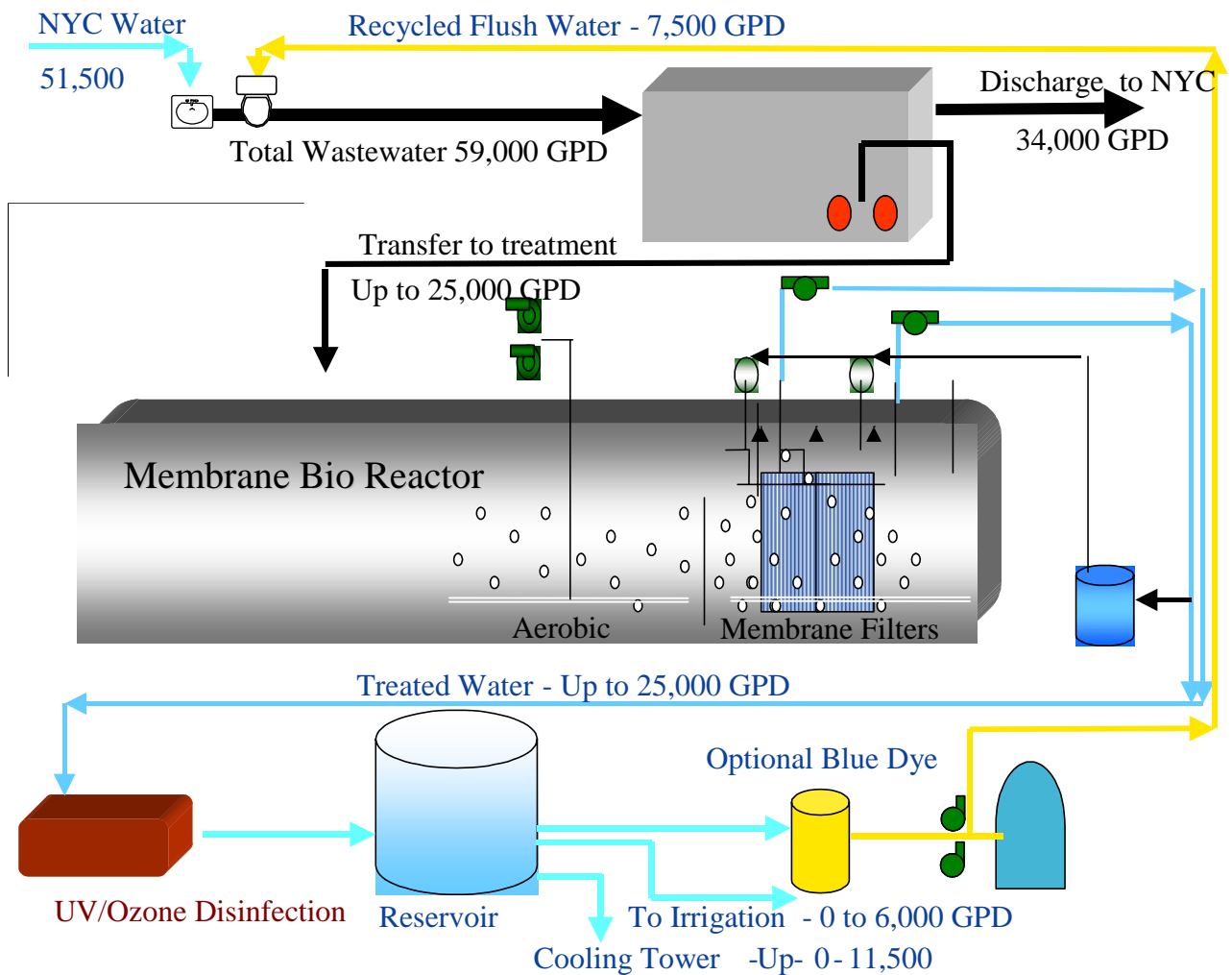


Figure 4 – Solaire Building Flow Diagram

Among the unique features that have set the Solaire apart from other environmental responsible buildings is the fact that there is a wastewater treatment system constructed on the basement level. This system, mines the wastewater by capturing it, treating it and using the reclaimed water to flush toilets (Figure 4), to matriculate through the cooling towers, and to irrigate rooftop gardens. The recycling plant process comprises aerobic and anaerobic treatment process to:

- Remove nitrogen to New York direct reuse standards
- Remove suspended solids through submerged hollow fiber micro filtration membranes
- Kill pathogenic bacteria through the use of ultra violet light

The bio-solids and sediment from the trash trap are discharged to the NYC sewer system during dry weather to help alleviate combined sewer overflow problems. Three other similar systems are currently built and operating in NYC with three additional systems in design and/or construction.

Historically, the City of New York has been able to meet the increasing demand for potable water from its upstate watershed. However, reduction in water supply demand is a key aspect of future water planning to allow repairs to the aging aquaduct system. Adding capacity to the aquaduct system is an extremely expensive and slow process. Growth within the city over the next 20 years anticipates 1 million additional residents and 750,000 new workers while at the same time demanding a reduction in water supply and wastewater discharge of 60 MGD. Water conservation, reuse and alternative sources of supply will play an important role in achieving this goal.

#### **4. Village at Hawk Pointe, Washington Township, NJ**

The Village at Hawk Pointe consists of 120 age restricted housing units plus 100 assisted living units; proposed 340,000 square-feet of commercial space; an existing golf course with clubhouse/banquet hall; and a proposed hotel/restaurant.

The wastewater treatment process consists of a conventional biological treatment followed by an innovative ultra-filtration membrane system. The membrane system removes suspended solids down to a very small size and consistently produces a very high quality effluent. The facility is permitted to discharge 82,000 gpd to groundwater through three (3) infiltration / percolation ponds.

In November of 2004 American Water received a NJDEP Category 1 – Reclaimed Water for Beneficial Reuse (RWBR) permit modification to the existing NJPDES-DGW permit, to supplement the existing golf course irrigation system with treated wastewater effluent. NJDEP Category 1 RWBR is for Public Access Systems where the highest degree of treatment is required.

The population served by this system includes 220 residential units, 340,000 square feet of commercial space, and a club house / banquet hall. American Water has operated and maintained this system successfully from its inception in 2004. Please refer to the flow diagram in Figure 6 for more detail of the designed flow and technical makeup of this system.



Figure 5 – Golf Course Irrigation

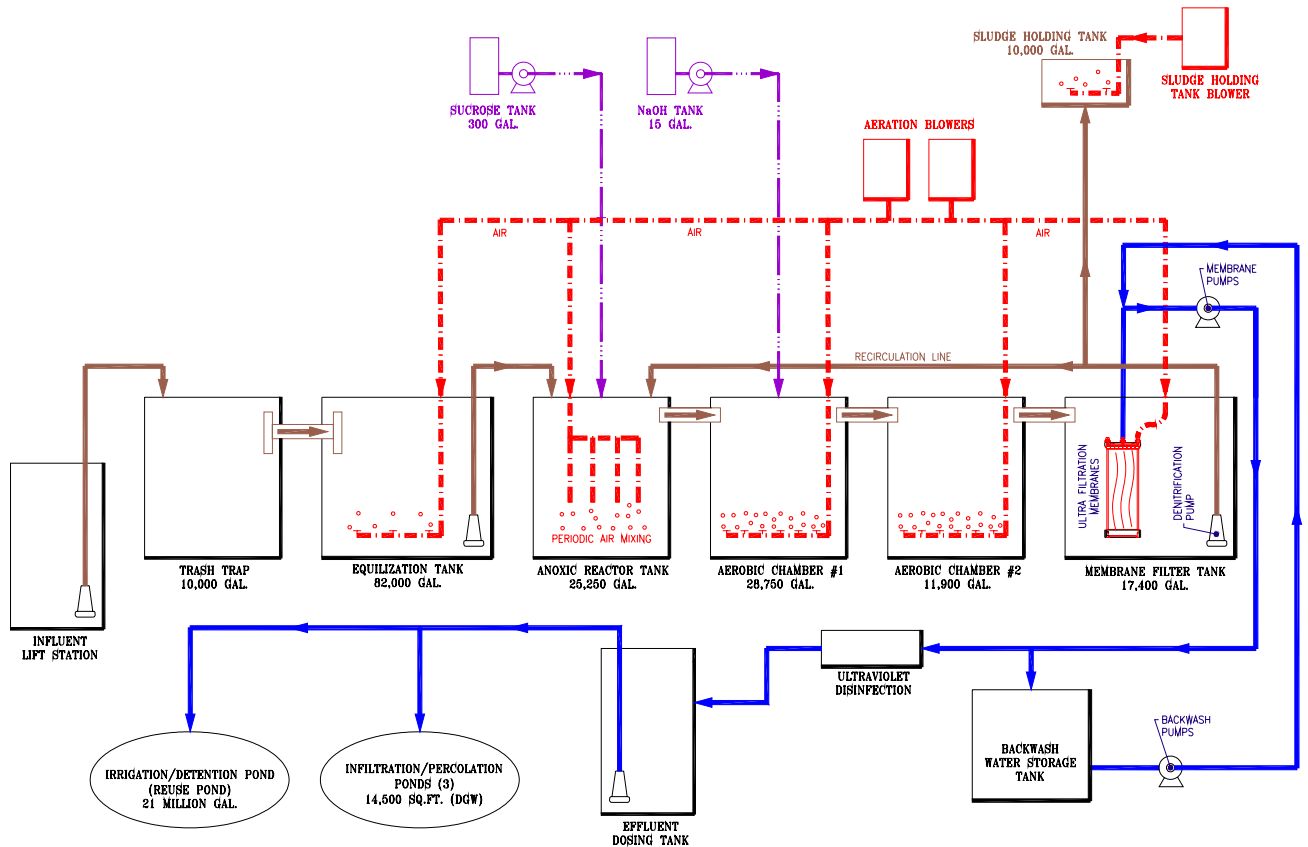


Figure 6 – Hawk Pointe Flow Diagram