THE FUTURE OF WATER REUSE IN NYC

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Overview

New York City is facing a number of challenges related to water and wastewater management. In order to improve general water quality and help meet the Mayor's sustainability goals, New York City is seeking ways to:

- Achieve net zero growth in water demand
- Reduce water demand and improve ability to make repairs to the NYC water supply system
- Reduce waste load to sewers and solids discharge, especially during Combined Sewer Overflow (CSO) events.
- Reduce load on wastewater facilities as City continues to grow.
- Reduce discharge of nutrients into receiving water bodies.

Over the last three years, the system wide advantages and public acceptance of water reuse[2] have been demonstrated at several new high value properties in the City. Currently, there are three operating systems, The Solaire, The Helena, Tribeca Green; three systems under construction, Millennium Towers, The River House and The Visionaire; and one system in the planning phase, Milstein Site 23/24.

The Solaire was completed in 2003 and being the first, it has been studied the most. The systems built after The Solaire all incorporated various technology upgrades so as to achieve even higher performance levels but the benefits documented at the Solaire, and realized by New York City, are substantial:

- 48% less water consumption
- 56% less hydraulic load and a 41% less waste load to the sewers
- Reduced contaminant discharge during Combined Sewer Overflow events in wet weather
- Reduced nutrient loads to city sewers and to receiving water bodies such as the Long Island Sound
- Significantly reduced overall demand on both NYC water and wastewater systems and the prospect of lower future capital spending requirements as growth continues
- A more sustainable long term approach to water resource management in general
- No cost to the City. These systems are constructed and operated entirely with private funds.

These benefits are important long term components of an overall strategy to help New York City maintain strong economic vitality while reducing environmental impact. Recognizing these advantages, in the spring of 2004, the New York City Department of Environmental Protection and Water Board passed a

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[2] Water reuse is defined for the purpose of this report to mean nonpotable water that is produced through a biological treatment system from a variety of sources, but primarily from wastewater. Nonpotable water reuse can include varying contributions of stormwater and grey water and thereby have varying environmental benefits, depending on system design.

rate designed to incentivize private developers to include these systems in their buildings. Entitled the Comprehensive Water Reuse Program, it provides a 25% reduction in water and wastewater fees (the Green Rate) for buildings that utilize a water reuse system that achieves a minimum reduction of water consumption of at least 25%. The incentive is presently administered as a fixed percentage of the remaining NYC water and sewer bill, so a developer that significantly increases their capital costs to achieve a 50% reduction, ends up decreasing the incentive because it becomes 25% of a much smaller bill.

Because of this, the incentive program does not encourage reuse of water and is not having a significant impact on new development trends. The cost of these systems (treatment and a second set of piping for non-potable water use) especially in high-rise buildings far exceeds the benefit to the owners and residents, even with the current New York City Comprehensive Water Reuse Program in place. There will be little if any significant new activity in this area without an improved incentive program.

The problem stems from the combination of several factors:

1. Decentralized treatment and reuse systems are not currently a rational choice for private developers. They do not provide a reasonable payback for the substantial investment required.
    a. The cost of public water and sewer in NYC is very low due to a long history of government subsidies
    b. Reuse water must be treated to a much higher level then public sewer effluent discharges and is therefore more costly to produce.
2. Most single building projects are at a disadvantage because they are all relatively small (<50,000 GPD) and cannot achieve an economy of scale.
3. The NYC incentives for water reuse:
    a. Are too low to equilibrate the customer cost differential with public services
    b. Do not provide the developer with any offset of additional capital expenses associated with constructing the system
    c. Offer no recognition for waste load reduction to the sewer system
    d. Actually become a disincentive for projects to exceed a 25% reduction in water consumption since the incentive is a reduction based on the remaining water bill.

The seven buildings that have water reuse systems are the result of the Battery Park City Guidelines and/or very high environmental goals on the part of the owner. Unfortunately, developers motivated by these goals represent a tiny fraction of those currently building in New York City. If the NYC DEP wants to have a significant impact on the future of water resource management, it will be necessary to modify the incentive. In fact, there are two large projects, The World Trade Center and Atlantic Yards, that are considering water reuse as a component of their building programs and the poor economics are weighing heavily on their decision.

There are many ways to design such an improved incentive, but one simple approach is to utilize the same program that is currently in place but to adopt three enhancements:

1. Allow the incentive to be commensurate with the reduction in average water consumption, i.e. provide a 45% incentive for a system that achieves a 45% reduction in water consumption.
2. Provide a further incentive to reflect the additional benefit to the City of waste load reduction to the City sewers, e.g., a building that achieves a 45% reduction in water consumption and a 50% reduction in wastewater discharge would receive an additional 50% bonus for a total incentive of 67.5% (45% incentive for reduced water consumption + 50% x 45% incentive for wastewater discharge reduction).

3. Provide a capital offset incentive in the form of a grant to the developer to compensate for the additional construction costs

A more aggressive incentive program in the short term could spur on-site water treatment and reuse on a much larger scale. In the long term, the NYC rates for sewer and water are projected to increase so that water reuse actually becomes more cost effective within the next ten years. There is a tremendous amount of building planned during this time frame and New York City will have missed the opportunity to benefit from a substantial investment of private money and the advantages of water reuse if action is not taken presently to increase the incentives.

Economy of Scale

Thirty five water reuse systems exist in the Northeast, spanning various applications, ages, technology changes and non-potable water uses. Data from these various facilities indicates that the cost to treat wastewater and produce reuse water varies depending mostly on system size, but also on age of the system, method of sludge management and specific treatment details associated with final water quality requirements. For example, systems that include cooling tower reuse may require a higher level of phosphorous removal and are more costly to operate then are systems that provide only flush water for toilets. Table 1 provides the cost ranges based on typical size variations and illustrates the dramatic impact made by economy of scale. Anything that makes the systems smaller drives up the cost of construction and operation on a gallon per gallon basis.

Table 1 – Water Reuse System Costs Ranges

	Small System (<50,000 GPD)	Large System (>500,000 GPD)
Capital Costs	$45/GPD	$16/GPD
Operating Costs	$0.013/Gallon	$0.009/Gallon

The NYC projects built to date all fall into the small size category because they were planned for single or duplex buildings only. Systems that would accommodate larger projects such as The World Trade Center or Atlantic Yards would move into the large system category, or somewhere in between depending on the nature of the reuse desired. Economics will play a large part in determining system size, and how water will be reused or if it will be reused at all.

Supporting Data from the Solaire

Because the water reuse system at The Solaire has been in operation the longest, it provides the best resource for performance data. Water quality performance has never been an issue and a side-by-side analysis commissioned by the Battery Park City Authority indicates that the reuse water is completely suitable for nonpotable uses and in fact is very similar to New York City potable water. A complete water chemistry analysis is attached in Appendix A.

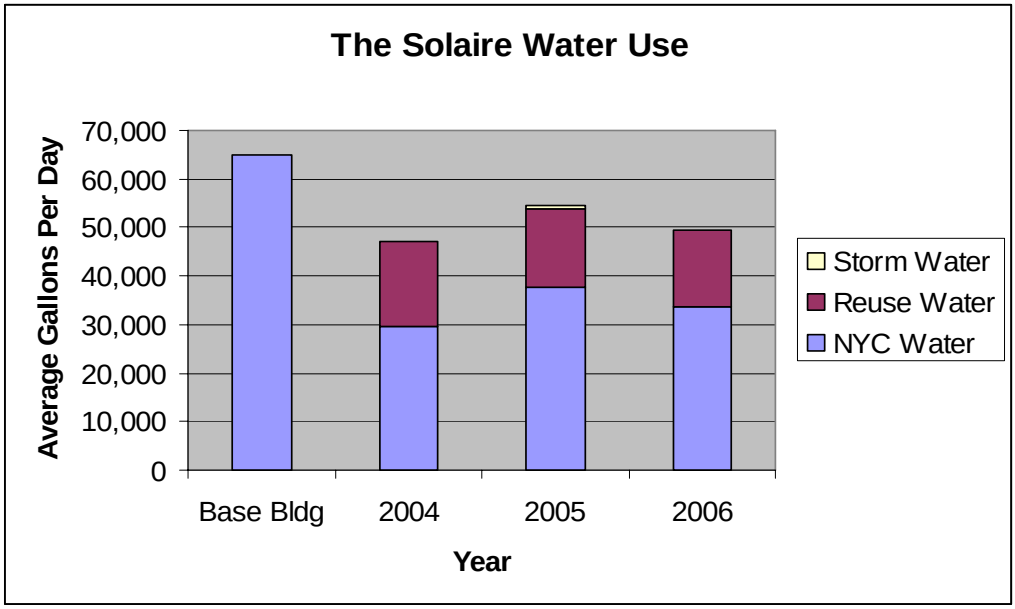
From a water conservation and waste reduction standpoint, the performance of the water reuse system at The Solaire has exceeded initial expectations. Over the first 31 months (939 days) of operation, the building water reuse performance is reflected in Table 2 below.

Table 2 – Water Reuse Performance (GPD)

	Base Building	Solaire	% Reduction
Water Consumption	65,078 GPD	34,031 GPD	48%
Sewer Discharge	53,578 GPD	23,491GPD	56%
Waste Load Discharge	112 LB/Day	67 LB/Day	41%

Figure 1 is a bar graph representation illustrating the water consumption aspect over the 31 month period. The stormwater component is included simply to show the contributions of the various sources of supply. Approximately, one third of the water was nonpotable reuse water and two thirds was potable New York City water. The variation in performance over the 31 month period was mostly attributed to varying demand of the cooling towers and the correction of leaking toilet flapper valves problem that occurred in the second year.

Figure 1



Stormwater did not make a significant contribution at the Solaire to the overall average water consumption because it is kept separately from the water reuse system and is strictly dedicated to irrigating the rooftop gardens and green roof. Future buildings more directly incorporate storm water flow into the water reuse system to improve stormwater performance. However, it must always be recognized that stormwater is available on an intermittent and highly variable basis, therefore it will not provide as significant a benefit in water consumption reduction as will wastewater treatment, unless very large stormwater storage tanks are provided at significant upfront cost to the a developer. Conversely, wastewater is always available to fulfill reuse water demands and results in significant waste load reduction to City sewers.

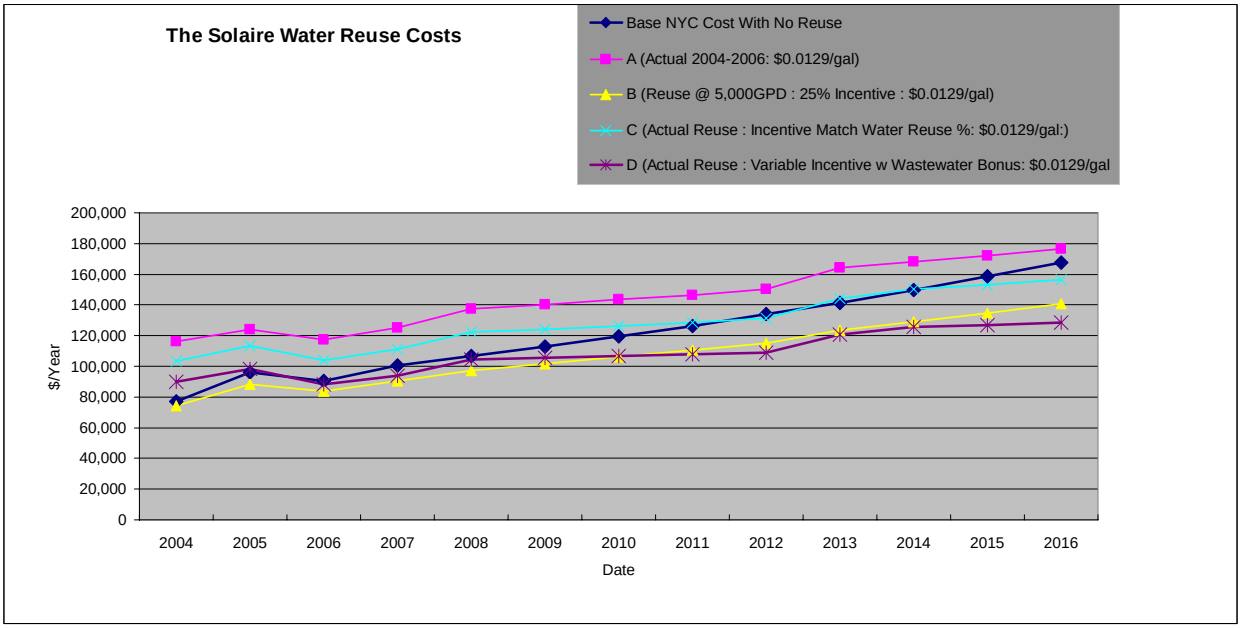
The water reuse system at The Solaire is sized for 25,000 GPD capacity and it now serves the neighboring sister building, The Verdesian which was not yet constructed when this data was gathered. During the first 31 months therefore, the water reuse system had adequate capacity to meet almost all of the reuse water demands except peak cooling tower demands during the hottest days of summer.

Given that the New York City Comprehensive Water Reuse Program only provides an incentive for a 25% reduction in water consumption, water balance calculations indicate that a 5,000 GPD reuse system

would have met this objective and provided a reasonable payback for the developer. It would have been considerably less costly in capital construction and would have yielded a larger incentive bonus, thereby improving the overall cost benefit to the developer. There would also have been a decreased level of environmental benefit if the smaller system were implemented.

To fully understand the impact of the incentive program and the costs for operating the reuse system, data was collected from The Solaire over the first three years of operation. These figures were then projected 10 years into the future using published information about future rate expectations. This evaluation was then performed for five scenarios to demonstrate the impact of various changes to the incentive program or the reuse system configuration.

Figure 2



Scenario A - Solaire actual performance as currently configured

- No customer cost benefit until sometime after 2016
- Developer experiences $1 million of additional capital expense with no economic benefit and a payback period of over 20 years[3]

Scenario B – If Solaire system were designed with less capacity to achieve only 25% reuse

- Immediate customer cost benefit
- Reduced capital expenditure from approximately $1 million to $300,000
- Payback period is still approximately 10 years

Scenario C – Solaire with incentive of 48% to match water consumption reduction

- No customer cost benefit until 2014
- Developer experiences $1 million of capital expense with a payback period of over 20 years

[3] Payback period is defined as the point where the total economic benefit exceeds the total expenses. Capital outlay is amortized over 40 years at 5% interest rate in this analysis.

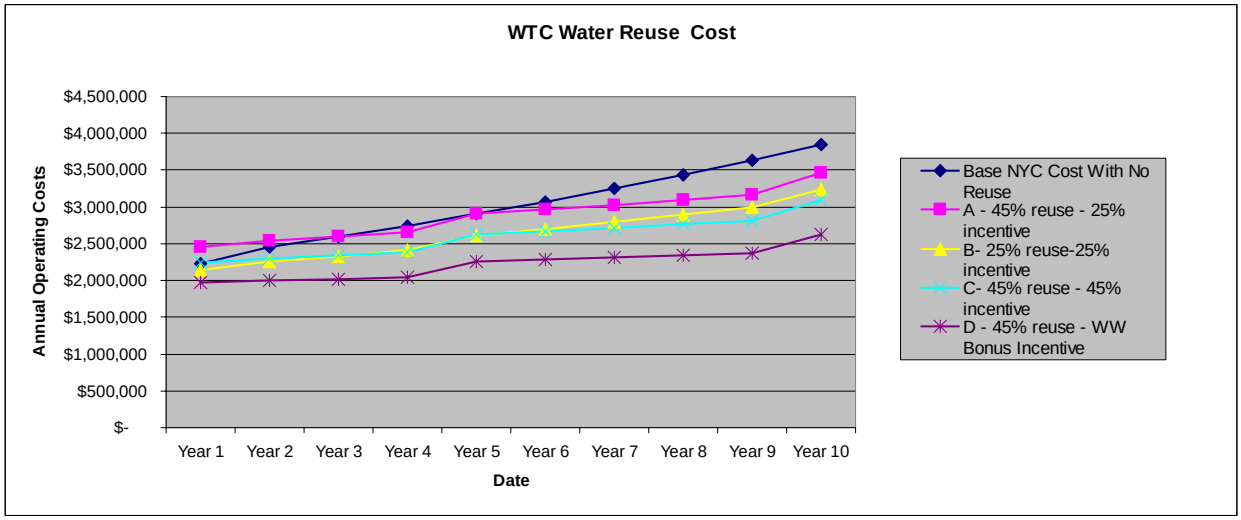
Scenario D – Solaire with incentive of 75% (48% to match water consumption reduction plus 27% bonus for wastewater reduction)

- Customer cost benefit after 2009
- Developer experiences $1 million of additional capital expense with a payback period still longer then 20 years

For small systems such as The Solaire, even with an enhanced incentive program, the developer does not have economic reason to utilize water reuse unless there is something to offset the capital expense. Even under the enhanced incentive program where there would be an operating benefit, the timeframe to achieve the payback for the invested capital is unreasonably long.

This picture changes significantly if the size of the system is increased such that the operating and capital costs are reduced to the lower "large system" figures indicated in Table 1 above. A feasibility analysis recently completed for the World Trade Center indicates a much different economic analysis as depicted in Figure 3 below. This analysis is based on a private utility model wherein the water reuse asset is built, owned and operated as a regulated nonpotable water supplier wherein the utility makes an equity investment in the asset based on a regulated rate of "Return on Equity" (ROE). An operating cost model of this alternative indicates that $0.009/gallon is a reasonable rate for water reuse at this larger scale. Discussions with the New York State Public Service Commission corroborate this approach, but of course any such rate would be subject to possible PSC rate regulation and scrutiny before it would be deemed acceptable. This model has a positive effect on the initial capital expense of the developer because as the system size increases, the utility would make a larger equity investment, thereby lowering the capital cost to the developer.

Figure 3



Scenario A – WTC with 45% reuse and current 25% incentive program

- Customer cost benefit begins after year 6
- Developer experiences $2.8 million of additional capital expense and payback period that is greater then 10 years

Scenario B – WTC with 25% reuse and 25% incentive

- Operating cost benefit begins immediately

- Developer experiences $3.6 million of additional capital expense and payback period is 5 years (Note- The capital expense is greater because the utility buy-back value is lower but this higher capital cost is offset by a much greater rate benefit that begins immediately)

Scenario C – WTC with 45% reuse and 45% incentive for reduction in water consumption

- Operating cost benefit begins immediately
- Developer experiences $2.8 million of additional capital expense and payback period is 4 years (Note – The capital expense is lower because the utility buy-back value of the larger system is higher, thus reducing the payback period)

Scenario D – WTC with 45% reuse and 70% incentive (45% to match water consumption reduction plus 25% bonus for wastewater reduction – this scenario provides the best utility investment and the best incentive and thus yields the greatest economic advantage)

- Operating cost benefit begins immediately
- Developer experiences $2.8 million of additional capital expense and payback period is one year

At the larger scale, the economics of water reuse are much more favorable and are particularly attractive to the customer if the incentives are commensurate with the reuse achieved plus a bonus for the wastewater load reduction achieved. If this strategy were combined with a capital cost off-set program, the economic advantage of water reuse would become immediate and would be applicable to the developer as well as the customer.

Conclusions

Recent experience in New York City indicates that water reuse facilities:

- Reduce water consumption significantly (48%)
- Reduce wastewater discharge significantly (56%) if the system treats wastewater as opposed to stormwater only
- Reduce waste load discharge (41%) if the system treats wastewater as opposed to stormwater only
- Are readily accepted by customers and the general public with no resistance or complaints about water reuse in existing buildings that have been operating for years
- Are built and operated at no cost to the general public
- Will not be routinely incorporated into new development because the current rate incentive falls short of providing adequate economic benefit to the developers and residents
- An enhanced incentive program that would include a combination of enhanced rate incentives and capital offset incentives would likely result in large projects integrating these systems into their developments at significant benefit to the City.
- Such incentives become even more important to encourage water reuse on smaller projects for any but the most environmentally concerned and motivated developers.

The Battery Park City Authority's Environmental Guidelines and the United State Green Building Council's LEED® program have created a wonderful push to implement innovative water resource systems in New York City. Unfortunately, Battery Park City is now nearly complete and even developers that are aggressively greening their buildings are more likely to invest in sustainable strategies that have a better payback or that offer fewer operational challenges.

It is in New York City's interest to take action on this matter immediately because large developments such as the World Trade Center and Atlantic Yards have expressed a desire to incorporate water reuse

into their projects, but will not unless the economics are improved. Thus, the City is unlikely to obtain the benefits of

- Reduced CSO impacts
- Reduced demand on water and wastewater infrastructure
- Less discharge of nutrients to water bodies
- Avoided capital spending to upgrade existing infrastructure

Recommendations

New York City should act immediately to improve the incentive program to encourage more water reuse projects. This can be achieved via several simple steps:

1. Amend the incentive formula to allow the incentive percentage to be equal to the percentage reduction in water consumption plus provide a bonus for reduction in wastewater load. The suggested formula would be:

   Incentive = A + (A)(B) where:
   A= the percent reduction in water consumption by comparison to base building
   B= the percent reduction in wastewater discharge

   In this manner, the water reuse system can utilize any desired blend of wastewater, stormwater, greywater, etc and the incentives are adjusted to account for the benefit gained by the City and the rate incentive remains as a permanent means of assuring the customers are rewarded economically and thus the systems kept in operation thereby offering long term permanent benefits

   Implementation of this incentive would best be accomplished by requiring an annual professional engineer's certification of the percentages achieved based on the monthly water and wastewater readings that are now collected for the Department of Health reports.

2. Provide a capital offset incentive of $10/GPD of water reduction and $15/GPD of wastewater reduction such that the water reuse systems are no longer an economic disadvantage to the developers.
3. Encourage infrastructure planning that allows developers to join together to form larger shared water reuse systems

This water reuse incentive program would likely be reviewed and adjusted on a 5 year basis as the economics of water and wastewater costs shift over time. In this manner the City can assure maximum long term benefit while moderating the incentives to match current economics.