The MTA Blue Ribbon Commission on Sustainability

Water Report

October 29, 2008

Prepared for:

Metropolitan Transportation Authority (MTA)

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I. Executive Summary

Water is a critical element of the MTA's overall sustainability program. Booz Allen presents in this report a strategy for how the MTA may integrate sustainability into its future water management activities. The report evaluates available 2006 water consumption baseline data and provides a basis for establishing a water consumption reduction goal. An approach for achieving the reduction goal is outlined and sustainability measures are provided for consideration.

While there is insufficient data available across MTA's operations to determine the best suite of actions to reduce water use, an estimate can be made based on available data and interviews of MTA staff and the evaluation of the performance of water conservation projects at the MTA and other transportation agencies. Booz Allen believes that a potable water consumption reduction of 25 percent by year 2020 is achievable and likely to provide payback on investment. This reduction would amount to nearly 900 million gallons conserved annually. Investment costs to perform modifications necessary to achieve a 25 percent reduction target would be offset by an average annual cost savings of as much as $2 million (2009 dollars). Potable water reductions of far greater than 25-percent are possible; however, investment costs and certainty of payback would become increasingly more restrictive for each increment of reduction.

Due to insufficient data and information available at the MTA, Booz Allen was unable to identify the specific plan for best achieving the target goal; however, measures are suggested for consideration. The selection of specific measures to implement would require accurate and detailed information not centrally maintained currently at the MTA, and in many cases, not yet collected by the MTA agencies. As such, a multi-year phasing plan was determined to be an appropriate means for proceeding forward and consists of the following: Data Collection Phase; Data Analyses and Selection Phase; and Implementation Phase. This phasing plan is outlined in detail within this report.

II. Introduction

Water is a key component of any sustainability program that the MTA initiates. Access to water is crucial for allowing the MTA to maintain its operations and continue serving its customers. In addition, the MTA impacts the environment through its discharge of stormwater, sanitary and industrial sewer discharges, and groundwater pumping.

The MTA operations and its 47,000 employees use an average of over nine million gallons per day of potable water for drinking, washing, cooling, sanitary and other purposes. Water is crucial for maintaining many aspects of bus and rail operation including cooling transformers for subway power, heating and cooling for buildings, washing vehicles and equipment, supplying building plumbing fixtures, and supporting a variety of other industrial activities. The MTA realizes that many of its uses of water do not require drinking water quality. Moving away from using potable water for these other water-related activities can result in significant cost savings and increased water conservation. The MTA already has begun to take steps to conserve water. For example, all but one of the New York City Transit's (NYCT) bus depots use some form of recycling for their bus-washing activities.

This report discusses an overall approach for the MTA to use in developing and implementing its water sustainability program. Available data and information from the MTA and peer agencies are reviewed, and considerations for setting an overall reduction target are discussed. An approach for planning and implementing measures required to meet the reduction target also are discussed. In addition, specific conservation measures for consideration are provided.

III. Water Consumption Data

Water consumption data were reviewed from the MTA to evaluate usage patterns and potential areas for water conservation. These data include information on water reclamation and reuse, groundwater usage, and implementation of water-saving measures.

The MTA provided water consumption data, including baseline data from 2006, and on costs by organization for 2007. The consumption data indicates that the MTA uses a significant amount of potable water, nearly 3.5 billion gallons per year. The cost data suggests that the MTA spends in excess of $6 million/year on potable water. The following tables and figures estimate aggregate volumes of water consumption by each MTA agency, based on 2006 and other available data and estimates.

Table 1: Estimated MTA Potable Water Usage for 2006

Operation	Total Water Usage (gallons/year)
NYC Transit	2,744,221,545
Metro-North Rail Road	584,512,074
Long Island Rail Road	103,613,024
MTA Bus Facilities	20,460,730
Bridges & Tunnels	20,077,687
Long Island Bus Facilities	5,927,343
TOTAL	**~3.5 Billion**

Table 2: Estimated MTA Wash Water Volumes for 2006

Wash Operation	Total Water Usage (gallons/year)
New York City Transit (NYCT) Bus	211,000,000
NYCT Subways	45,192,475
Long Island Railroad	18,533,717
MTA Bus	4,000,000
Metro-North Railroad	3,516,820
Long Island Bus	1,186,215
TOTAL	**~283 Million**

Figure 1: Estimated MTA Potable Water Usage for 2006

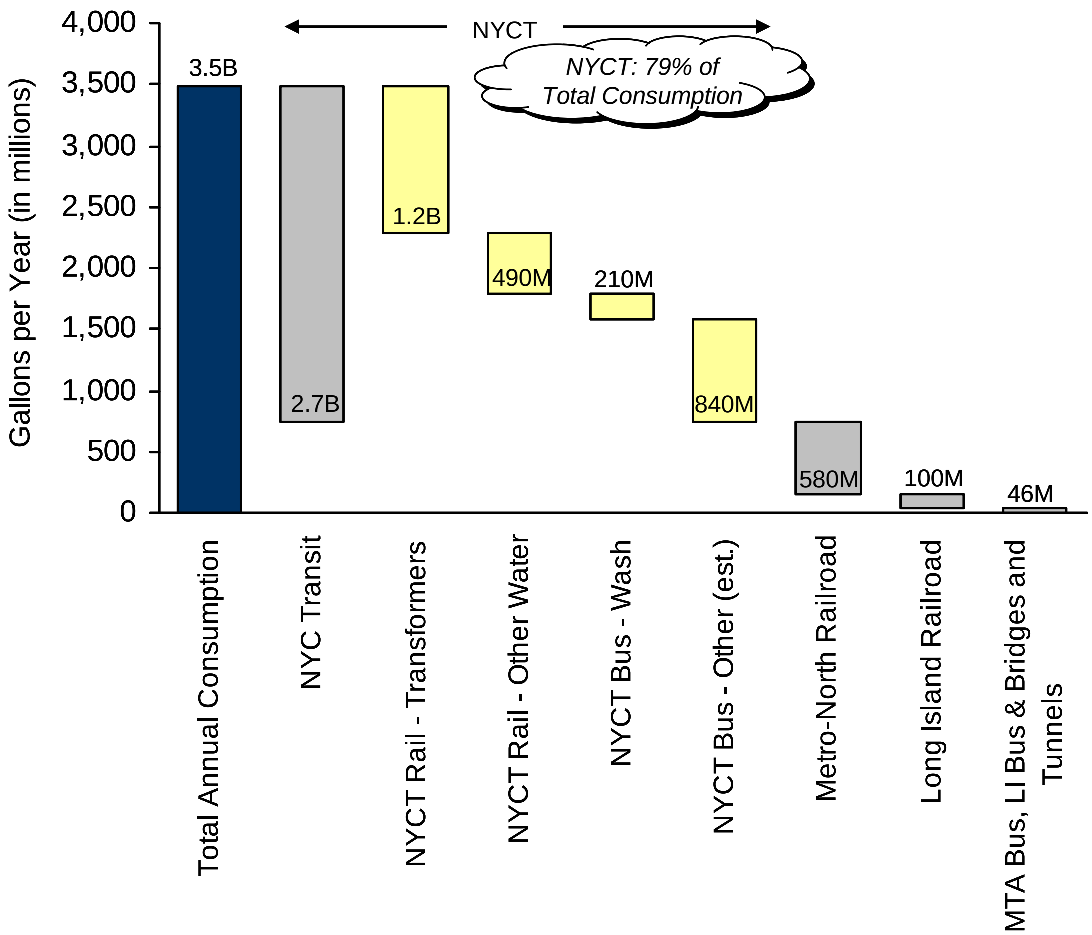
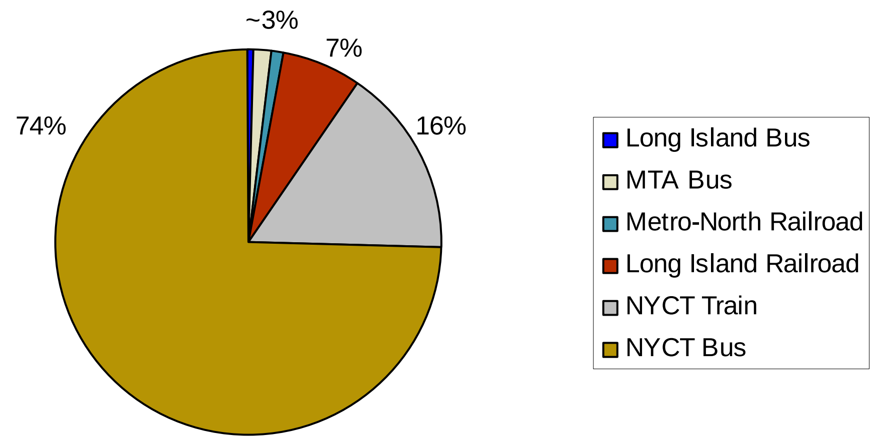


Figure 2: Estimated MTA Wash Water Volumes for 2006



During this study, potential inaccuracies in 2006 baseline data were identified, particularly with respect to substation cooling. Baseline data indicated less than 200 million gallons per year were used for this purpose while NYCT staff estimate 1.2 billion gallons per year. The higher value was used in the above tables and charts and constitutes the single largest component of usage within the MTA. As evident by the discrepancies in estimates, a complete picture of the water consumption pattern at the MTA based on 2006 baseline data is questionable. Individuals familiar with the operations were interviewed, however, and provided valuable insight, specifically on substation transformer cooling, rail and bus wash facilities, well systems, facility heating and cooling systems, parts washing, and other consumption.

Based on the above pattern of water usage at the MTA, if accurate, it is clear that substation cooling in itself can potentially provide the MTA with a major opportunity for reducing water consumption. Due to the questionable baseline data however, measures should be considered throughout the MTA at this time in multiple water use categories that can potentially contribute to potable water reduction and meeting sustainability needs.

IV. Development of Conservation Goals

A water conservation goal for the MTA in terms of a percentage reduction in potable water consumption was initially sought to be established during this study. Due to insufficient data on the MTA facilities and their site-specific water consumption patterns, it was determined that a bottom-up determination of a reduction target could not be ascertained with great accuracy and certainty of achievability. However, an understanding of the general condition of the MTA facilities and operations allows reasonable estimations to be made when considering conservation goals of similar organizations.

Based on the above understanding, several peer transit agencies were contacted to inquire about their own water programs. Information was compiled from these interviews as well as from a review of published information. Agencies were selected based on similarities to the MTA, however agencies were also sought from locales having progressive environmental programs or regions known for water supply challenges, such as the southwestern United States. Information that was able to be collected from these agencies is summarized in Table 3 below.

Table 3. Survey of Transportation Agencies and Water Conservation Goals

Transit Agency	Goals for Water Conservation	Notes
Transport for London	Focused on reducing staff water usage.	The 2007 annual report indicates a decrease of 7.6 cubic meters per person (42 percent) in a number of headquarters offices after installing low-flow fixtures and faucets.
Phoenix (Valley-Metro Regional Public Transit Authority)	The agency has no current water conservation goals	The Valley Metro RPTA has no specific conservation goals, but incorporates conservation technologies into new buildings and renovations. All vehicle wash facilities use recycled water.
San Francisco (Municipal Transportation Agency)	No current water conservation goals were identified	MUNI water consumption/conservation goals controlled by Public Utilities Commission. The Commission has not set specific water conservation goals.

Transit Agency	Goals for Water Conservation	Notes
Toronto	All agencies to meet 15 percent water consumption reduction over 17-year period.	Province has set minimal water conservation requirements
Colorado	All state agencies required to meet a 10-percent water consumption reduction over a 5-year period.	Part of Greening of the State Government initiative created in 2007.

As evident from the above table and in additional communications performed with other organizations, including the American Public Transportation Association (APTA), it was generally observed that overall, a relatively low level of focus on applying water reduction targets was placed by transportation agencies.

The capability and specific means for the MTA to meet consumption reduction targets depend on site-specific physical conditions and current consumption. Since this information and data are generally not collected and maintained centrally, qualitative estimations were developed for a number of reduction targets ranging from 5 percent reduction to 75 percent reduction. Each target was evaluated against several factors including: ability of the MTA to implement, conservation impact, and return on investment (ROI). The analysis was qualitative because of the lack of data to make a quantitative analysis. Table 4 below summarizes these estimations for each consumption reduction target.

Table 4. Percentage Reduction Goals and their Estimated Implementation Potential, Conservation Impact, Return on Investment, and Implementation Probability

Percent Reduction Goal	Ability to Implement[1]	Conservation Impact[2]	Return on Investment[3]	Comments *(Note each set of comments is additive in order to reach the goals.)*
5	●	○	●	Primarily focused on upgrading maintenance, minimizing drips, instituting new process performance standards.
15	●	◔	●	Evaluate all water-using process operations and identify opportunities to minimize water use. Areas of focus could include parts washing operations, staff showers, similar sorts of activities. Design new construction to use low-flow fixtures.
25	◕	◑	◕	Replacement program for fixtures that focuses on replacing damaged fixtures with low-flow fixtures. Initiate a capital program that replaces old wash components with advanced technologies as they are scheduled for replacement.
50	◑	◕	◑	Accelerate the fixture and vehicle wash replacement programs so that all fixtures and wash systems are low flow by 2020. Initiate an aggressive maintenance program to monitor water flow and react to water loss with rapid maintenance.

Percent Reduction Goal	Ability to Implement[1]	Conservation Impact[2]	Return on Investment[3]	Comments *(Note each set of comments is additive in order to reach the goals.)*
75	◑	●	◔	Aggressively move away from NYC DEP service, replacement of NYC DEP water with groundwater, stormwater, or recycled water, in all facets of Agency operations. Replacement of all fixtures with low flow units. Major modifications to all vehicle washes with newest technologies focused on enhanced recycling and use of alternative water sources.

<u>Notes</u>:
1. Ability to Implement – measure of how achievable the goal is with respect to the number of available technologies or potential modification of operational practices that may achieve the goal.
2. Conservation Impact – measure of the degree of potable water conservation.
3. Return on Investment – measure of the likelihood that investment costs to implement change would be fully recovered through savings in potable water charges.

<u>Legend</u>:

Minimal Potential, Impact, or Return	○
Low Potential, Impact, or Return	◔
Medium Potential, Impact, or Return	◑
Medium-high Potential, Impact, or Return	◕
High Potential, Impact, or Return	●

The reduction goals evaluated above range from what can be done with relatively low levels of intervention to significant impacts associated with large changes in infrastructure and operations. These goals are discussed further below.

- Five Percent Reduction—This low goal may be reached through a number of relatively straightforward activities that can be carried out with changes in policy and (in some cases) some small amount of training and retrofitting of equipment. Because of this, the likelihood of these being implementable is estimated at greater than 95-percent. ROI is high since measures would only be selected that offer a clear payback in terms of upfront investment costs.

- Fifteen Percent Reduction—This relatively low goal may be reached through a broad effort on potable water conservation across all of the MTA. A greater than 90 percent likelihood of being able to successfully implement the activities is estimated. ROI is high since measures would only be selected that offer a clear payback in terms of upfront investment costs.

- Twenty-five Percent Reduction—This goal represents a major attempt to reduce potable water usage. A 75 percent probability that such a program could be implemented successfully is estimated. Measures to be implemented would undergo a rigorous evaluation for feasibility and cost payback. At this level of reduction, ROI would begin to see potential investment costs that do not result in a clear offset from savings in potable water costs, although a full return on investment is possible.

- Fifty Percent Reduction—This reduction in potable water conservation is possible through aggressive measures performed throughout the MTA including major transformations toward alternative water sources for many water systems. A major fixture replacement program would likely be implemented, and significant investment would be required for many measures. Because of the aggressiveness and required upfront costs for such a program, only a 50 percent likelihood of achievability is estimated. ROI would be less clear, and payback periods for some measures would be extended to less foreseeable time horizons. Some measures implemented may not result in a foreseeable cost payback.

- Seventy-five Percent Reduction—This reduction goal would be viewed as very aggressive within the mass transit industry. Achievability would be much less certain than lower goals although it is possible. Conservation measures would be required across most of the MTA and in most aspects of potable water consumption. An aggressive use of alternative water sources would be required throughout the MTA for both large and small systems, and ROI would be less certain. Although there are many measures that can result in significant potable water savings and can collectively achieve the target reduction, many measures would not result in a cost payback nor would the program as a whole be certain of a payback.

V. Approach for Meeting Water Consumption Goal

Due to insufficient data on the MTA's current pattern of water consumption, it is difficult at this time to select the specific measures that the MTA should implement to achieve its targeted goal. The collection of data and information is a recommended first step in any program prior to implementation. A phased approach is suggested that consists of the following: 1) Data Collection, 2) Data Analyses and Selection, and 3) Implementation.

In the Data Collection Phase, complete information would be sought on all the significant water demands at the MTA. A complete water budget would be developed which would illustrate the proportion of water used by various categories. Categories would include items such as bus vehicle washing, railcar washing, parts washing, personnel usage, and transformer cooling. Additionally, this information would be available for each significant facility at the MTA. Data may be obtained through the installation of sub-meters or detailed estimates based on numbers of personnel and vehicles, pump capacities, wash water recycle rates, wash durations and cycles, hydrologic/stormwater calculations, and other quantitative data pertinent to the specific operation. This phase would also include an audit and leak detection program to provide an inventory of installed fixtures and equipment that impacts water demand and also an estimate of the condition of the delivery system (leaks).

In the Data Analyses and Selection Phase, the complete set of water consumption data would be evaluated which would allow the MTA to identify and target the greatest opportunities for reducing water consumption at the lowest cost. In consideration of costs, additional site-specific information would be required and obtained during this phase including, but not limited to, proximity of systems and facilities to alternative water sources, water quality of alternative sources, operational considerations, system maintenance and replacement plans, and planned capital projects. Based on the analyses performed during this phase, a combination of measures would be selected that when implemented, can achieve the MTA's selected target goal.

For potential opportunities that may involve or require public acceptance or private partnerships (e.g., supplying groundwater to DEP, or private/public partnership to use groundwater for central heating plant), a public relations or marketing strategy can be developed during this phase and begin to be implemented. Such a strategy would be developed after it was determined that the opportunity can be cost effective and beneficial for the MTA. Measures may include advance notification of plans, public meetings, solicitation of partners, an education campaign, localized focus sessions, and other activities. Water sustainability practices, including water conservation and the use of recycled water, have increased significantly over the past two decades, particularly in the southwestern U.S., and such attention resulted in a generally favorable public opinion of such practices. A fair amount of literature and guidance is available within the water industry for achieving approval of such initiatives.

In the Implementation Phase, the measures that are selected during the prior phase would be planned and implemented. Measures that can be performed with relatively low impact in terms of costs and disruption would be implemented immediately. These may include simple procedural changes or minor adjustments to mechanical systems. Measures that require more significant funding resources would be planned and designed as necessary, prior to implementation.

The above approach represents a reasonable process by which the MTA may achieve its water reduction consumption goal. It is estimated that the Data Collection Phase can take as much as two years to complete. The Data Analyses Phase can take as much as one year to perform. The duration of the Implementation Phase is dependant on the remaining time horizon to meet the target goal.

VI. Water Conservation Practices

As discussed previously, it is difficult at this time to determine exactly which measures to perform to achieve the MTA's water conservation goal most cost-effectively. During the Data Analyses Phase, these determinations would be made. An inventory of best practices was developed and is provided in the appendix.

VII. Conclusions

Based on a review of the MTA's practices and in consideration of industry best practices, it is estimated that a water conservation reduction of 25 percent by 2020 represents a reasonable and achievable goal for the MTA. Higher reductions are possible given the number of opportunities available, however upfront investment cost factors would become increasingly more restrictive. It is estimated that a 25 percent reduction in water consumption would result in an annual potable water cost savings of as much as $2 million (2009 dollars) using current NYC NYC DEP rates and adjusted for inflation and estimated rate increases.

Due to insufficient data on water consumption across the MTA, specific measures for meeting the MTA's target goal cannot be determined at this time. A multi-year three-phase plan is recommended for meeting the goal, consisting of data collection, data analyses and selection, and implementation. This approach would ensure that conservation measures are justified and implemented in a manner that is most cost-effective.

Appendix: Water Sustainability Practices

Many measures exist that can potentially reduce potable water consumption at the MTA, and a sampling of these measures is provided herein. Due to insufficient site-specific data on water systems and their associated consumption volumes available for this report, these measures are only provided as suggestions, and they should not be construed as recommendations. It is recommended that a focused campaign to collect data be performed initially by the MTA, which would allow a complete picture to be developed and appropriate measures to be selected.

The following table lists innovative water sustainability practices, the MTA operations where the practice may be applicable, and the extent of their use.

Table A: Water Sustainability Practices and Their Applicability to The MTA

Practice	Description	Primary Focus Area	Types of MTA Facilities Where Applicable	Examples of Use
Stormwater collection	Practice is currently in use at the MTA Grand Avenue facility and Corona Rail Yard. Stormwater may be used as makeup water for cooling systems to replace evaporative, blow down, and drift losses.	Non-potable water substitution	All facilities	Widespread use throughout country
Use of groundwater for potable purposes	Consists of providing raw or treated groundwater to a local public water utility.	Potable water substitution	Facilities in proximity to well systems	Widespread use among water utility purveyors
Beneficial use of groundwater for non-potable purposes	Consists of providing raw or treated groundwater for washing, cooling, or other non-potable purposes	Potable and non-potable water substitution	Facilities in proximity to subway well systems	Widespread use among water utility purveyors
Cooling towers	Consists of mechanical systems that re-cool spent cooling water allowing the water to be recirculated and reused	Potable water conservation	Substation transformers	Widespread use throughout country
Low flow or ultra-low flow fixtures	All new fixtures in U.S. manufactured since 1993 have had to meet low-flow standards	Potable water conservation	All facilities	Widespread use throughout country

Practice	Description	Primary Focus Area	Types of MTA Facilities Where Applicable	Examples of Use
No flow urinals	Urinals contain an oil-based liquid that is not flushed	Potable water conservation	All facilities	Limited use nationally but rapidly growing
Advanced wash water treatment	Practices include automated backwashing, water quality sensors and automation, multimedia filters, chemical coagulants	Vehicle wash water	Vehicle wash facilities	Widespread use of onsite advanced treatment systems
Constructed wetlands	Consists of treating water through an artificial wetlands	Sanitary discharge reduction	Outlying areas	Limited use in southeast U.S.
Onsite reclamation of sanitary wastewater	Consists of small treatment systems that recycle sanitary water within a facility for non-potable purposes. Wastewater may be used as makeup water for cooling systems to replace evaporative, blow down, and drift losses.	Potable water conservation; sanitary discharge reduction	All facilities	Limited use throughout country; used in Manhattan
Vehicle wash facility modifications	Practices include minimizing wash cycle/arches, minimizing detergent, reducing final rinse volumes, faster wash durations/drive times, increased pressures/lower volumes, lower pump capacities, and use of alternative water sources.	Potable and non-potable water conservation; sanitary discharge reduction	Vehicle wash facilities	Widespread use throughout country
Advanced water meter monitoring	Improved consumption monitoring such as a centralized energy management system (CEMS) can identify opportunities for conservation.	Potable water conservation	All facilities	Limited facility use
Leak detection and water audit	Leakages from piping can result in losses of as much as 20 percent from a water utility, particularly in older systems.	Potable water conservation	All facilities	Widespread use throughout country

Practice	Description	Primary Focus Area	Types of MTA Facilities Where Applicable	Examples of Use
Groundwater for thermal heat exchange	Practice has been used however site-specific constraints are common	Potable water substitution	Facilities in proximity to subway well systems	Limited use to date but new uses frequently developed, for internal as well as external facilities
Heat island mitigation	Daytime sprinkling decreased road surface temperature during both day and night, helping to mitigate the heat island effect of urban areas.	Sanitary discharge reduction	MTA-jurisdiction roadways	Japan
Air handler condensate capture	This approach includes condensate used for cooling tower makeup water.	Potable water conservation	MTA Facilities	Atlanta
Blue Roof	This approach utilizes rainwater capture for green roof watering, allowing for natural cooling and reduction in HVAC stress.	Potable water conservation	MTA Facilities	Toronto

As evident in the table above, many options exist for the MTA to implement water sustainability measures. The following details some specific considerations for potential alternatives which offer particularly significant reductions in water consumption if implemented on a wide scale.

- As with any large organization, the MTA discharges to the sanitary sewer from every sink, shower, and toilet fixture owned by the Authority. High potential exists for installing low-flow systems and using grey-water or stormwater for flushing and similar sorts of operation. It is likely that the MTA has as much as ten thousand or more of these various fixtures to support its 47,000 employees. Interviews with the MTA indicate that a vast majority of existing fixtures are currently not of a low-flow design.

- Vehicle washing represents a significant part of the MTA's overall water consumption. A strong potential exists to increase the use of stormwater in such operations, as is already done at the Grand Avenue Bus Depot. Implementing newer more advanced technologies or using modified processes and tighter process control can also result in significant benefits.

- Groundwater is a potential source to substitute potable water currently used for non-potable purposes, such as vehicle washing. The MTA currently operates four well fields that extract seven million gallons of water per day in order to keep the subway tunnels and stations dry. As such, there is a strong potential for the MTA or others to use this water in beneficial ways. The volume of water generated from the wells greatly exceeds MTA needs however other non-MTA entities could also potentially benefit from the supply.

  - Groundwater can potentially be supplied to NYC DEP as a water supply source, depending on results of water quality testing. The MTA could potentially provide raw groundwater to NYC DEP, who can treat the water and use it in a potable or non-potable water distribution system. The benefits for the MTA would be a reduction in stormwater discharges and a major source of revenue or cost savings from the purchase of water (potentially several million gallons per day). Some benefits for NYC DEP would be a supplemental water supply source reducing the required flow from its aging aqueducts without incurring the full energy and maintenance costs associated with the MTA's well operation (MTA can continue to operate the well fields). Additionally, discharges to NYC DEP sanitary sewers would also be reduced, thus reducing the potential for combined sewer overflows. The MTA should work closely with NYC DEP to investigate such opportunities.

  - Use of groundwater for non-potable purposes may also represent a strong potential sustainability measure for the MTA. Non-potable uses may include vehicle washing, facilities cooling, construction water, and cooling of transformers and other equipment. Water may also be provided to neighboring customers (e.g., power plants, manufacturers) for a fee. Alternative uses such as heating and/or cooling purposes for both MTA and non-MTA owned properties may also be investigated.

  The use of pumped groundwater can result in substantial opportunities for the MTA to reuse a currently wasted resource. Due to the high volumes associated with groundwater pumping, the MTA should consider proceeding with an accelerated effort to evaluate this practice. A focused study can identify potential MTA and non-MTA entities in close proximity to the groundwater sources who can potentially benefit from receiving this water. If the practice is deemed feasible in terms of costs, distances to beneficiaries, water quality, and regulatory issues, it should then be promoted further. Further discussion of a marketing strategy to promote the beneficial use of groundwater is provided in Section 5 of this report.

- A high volume of potable water has been estimated by the MTA for cooling subway transformers (1.2 billion gallons per year). This water is used for once-through cooling and then discharges to either the storm or sanitary sewer, depending on location.

  - Spent cooling water is relatively clean and may be recovered by the MTA, NYC DEP, or a private entity, potentially through a public/private partnership. As spent cooling water, its temperature is elevated and the heat from such may be captured by a central heating plant or other heat-generating system. The water may also potentially be provided to NYC DEP, a manufacturer, power plant, or other private venture who would reuse or transfer and resell the water for other non-potable purposes. It is unlikely that the water can be reused for potable purposes due to stringent regulation on source water supplies.

    Modifications to the transformer cooling systems should be considered in light of energy sustainability requirements as well. For instance, pumping of cooling water to a new location would consume a certain amount of electric, gas, or other fuel. Reuse of spent cooling water, however could supplement the heating required by a central heating plant or other heat-generating system.

- NYCT has a long-term plan over forty years to eventually replace all their water-cooled transformers with air-cooled transformers. The MTA may wish to consider accelerating this replacement program over a 10 to 20 year period. By replacing the water-cooled transformers, the MTA would dramatically reduce its overall water consumption. This measure, however should be considered in light of several tradeoffs, including capital costs, energy costs and energy conservation goals.

- One alternative for the transformer cooling systems is to re-cool spent cooling water and recirculate it back to the transformers. Spent water can be captured, passed through cooling towers, and reused. The MTA would essentially modify its once-through cooling systems with closed-loop systems that recirculate the water.

  Cooling towers are mechanical systems that remove heat from water by interfacing water with air. There are several types of cooling towers available, some relying on evaporation in order to achieve cooling while others use airflow. Towers can vary in size, ranging from large hyperboloid structures to roof top units to small compact portable units. Smaller towers can be supplied to the MTA factory-built and installation is relatively straightforward. Actual locations for installing towers were not detailed in this study, however given the range and types of the cooling towers that are available, a number of options exist. A mechanical draft tower uses power driven fans to induce air through the tower. The cooled water is collected in holding tanks after its interaction with the airflow and would be pumped back to the transformer substations. During winter months, simply circulating the water through the holding tank can be sufficient for reducing the water temperature for reuse. Occasionally, particularly during hotter weather, a portion of the water would be drained and replaced with make-up water to maintain appropriate water quality and temperature.

  Similar to other alternatives for the transformer cooling systems, this measure should be considered in light of many factors, including capital costs, water savings, energy costs and energy conservation goals. Since the MTA is currently already in the process of replacing its water-cooled transformers with air-cooled transformers, the installation of cooling towers may be most cost-beneficial if applied only toward transformers planned to be replaced during latter years (e.g., greater than 15-20 years away). In this manner, the installed towers would be used for a longer period of time and would result in a greater water cost savings relative to the capital investment required.

- Wetlands can offer significant benefits for removing pollutants from stormwater runoff as they can serve as natural biological filters. The industry understanding of wetlands has reached a level now in the U.S. where they are even used for treating sanitary wastewater. There are a number of MTA facilities that could benefit from the directing of stormwater to an existing or new artificial wetlands. By directing storm flows into a wetlands, issues associated with existing overburdened storm sewers and combined sewer overflows can be reduced. A habitat for wildlife would also be created and/or maintained by the influx of a new water source. Wetlands can potentially be constructed using soil materials excavated from construction and dredging operations. In such instances, costs incurred by the MTA associated with the transport and disposal of such soils could potentially be reduced. The use of wetlands would require careful consideration with respect to the source water quality and viability of the wetland plants to survive.

- Many opportunities exist for combining water conservation initiatives with other sustainability programs, specifically energy and facilities. By itself, water sustainability measures may not provide sufficient cost-benefit in order to be implemented. In some cases, however the costs for implementing the water initiative can drop significantly if coupled with a measure that may already be planned. For instance, implementation of a centralized energy management system (CEMS), which monitors operational performance by networking with meters and compiling usage data, can also be used for monitoring water meters. Having real-time and centralized data can help identify opportunities for reducing water demand as well as identify potential leakages. Facility sustainability initiatives can also include water conservation measures as well. For example, during the design of new or modified facilities, low flow or no flow fixtures can be specified.

- Recycling of sanitary wastewater discharges on-site has gained increased use throughout the country. Many advances have been spurred on in the southeastern U.S. and California due to significantly higher regional water supply issues. More recent applications are being implemented in the New York area, particularly with the rapid advancement of treatment technologies, specifically membrane treatment.