The Marlboro Water Conservation Project
Final Report

Prepared for:

Massachusetts Department of Environmental Protection
United States Environmental Protection Agency

Prepared by:
Massachusetts Office of Technical Assistance and Technology
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Water Meter Installed By Massachusetts Container Corporation

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Executive Summary
In 2008, at the request of the New England Region of the U.S. Environmental Protection Agency, the Massachusetts Office of Technical Assistance and Technology entered into an agreement with the Massachusetts Department of Environmental Protection to evaluate the feasibility of water conservation at sample facilities in the city of Marlborough, Massachusetts, which was experiencing restraints on development due to limited capacity to process wastewater discharges. OTA hired consultants to perform eight audits, accompanied by OTA staff, and performed two audits on its own. DEP transferred $52,000 to OTA to pay for the consultants, so that OTA could offer subsidized water audits to companies. Participation was voluntary, and the audits were conducted under OTA's offer of confidentiality. The audits looked for opportunities for:

- Overall system optimization, including improved measurement or user awareness
- Modification of water using equipment or processes
- Reuse or recycling of water, and use of rainwater

Potential savings were found in all facility types examined, and implementable options were found in all of the opportunity categories, although no facility has yet planned implementing options to use rainwater. For eight facilities, estimates were produced of the expected costs of implementation and expected cost savings and reduced water consumption. At these eight facilities, *thirty-six viable options were identified, about four per facility.*

- The 36 actions would save 15,119,617 gallons per year, at a total cost of $752,481, and an average payback under 3 years. *Nineteen, or slightly more than half, had paybacks of less than two years*, and would save 10,154,088 gallons per year, at a total cost of $253,399.
- Of the ten facilities, eight responded to follow-up. All eight found the audits to be of high value. Three have already implemented significant projects: a water efficient laundry at a hotel, a container rinsewater reuse system at a chemical company, and a full water conservation program at a paper-box manufacturer encompassing flowmeters at workstations, use of treated water for equipment cleaning, and other actions. Two other facilities have plans for water conservation efforts, and others are actively researching options and are including proposed projects in capital budgeting requests.
- *Projects are being implemented that are expected to save about 6,066,000 gallons per year, at a total cost of about $96,000, with expected annual savings of about $55,900. Projects have already been implemented at a cost of about $36,000, which are expected to save over 2.5 million gallons per year and about $25,900 per year.*

Providing free audits can be a useful tool for accelerating the implementation of water conservation initiatives. Only some facilities are equipped or motivated to recognize and implement such options on their own. Only three facilities had already embarked on water conservation initiatives before the auditing occurred. All facilities visited expressed appreciation for the assistance provided. Due to stresses induced by

the recent economic downturn, many viable options (such as use of rainwater) have not received serious attention, and may still present significant opportunities, such as for irrigation or pressure washing.
The audits identified investments with paybacks of two years or less that on an average of about $25,000 per facility could result in an average of about a million gallons per year reduction in water consumption. These estimates pertain to the average member of the top fifty water users in a mix of commercial and industrial facilities.

The follow-up showed that five of the ten visited facilities took action as a result of the audits. Three provided data showing they had already reduced an average of 855,000 gallons per year with average investments of $12,000 each, and annual savings of about $8,600.

Half of all visited facilities have planned water conservation activities, with an average expected savings of more than a million gallons per year and more than $11,000 in annual return, with an average annual initial cost of investment of less than $20,000.

These predicted and actual results show that water conservation investments can be very reasonable business investments, and can be stimulated by the increased attention prompted by auditing. (The project also shows the actual results as having lower investment costs and quicker payback (on average) than predicted by the audits). These results were obtained in the absence of financial incentives such as are typically supplied to promote energy efficiency, quantitative use information communicated to users, and innovative pricing to incentivize conservation.

Regarding the project as a demonstration of what subsidized water conservation auditing can accomplish, *the expected savings from a similar water conservation effort may be estimated as about one-eighth (12%) to one-fifth (20%) of industrial and commercial facility discharges.*

How the Water Audits Were Provided

OTA hired consultants to perform eight audits, accompanied by OTA staff, and performed two audits on its own. DEP transferred $52,000 to OTA to pay for the consultants, so that OTA could offer subsidized water audits to companies. Participation was voluntary, and the audits were conducted under OTA's offer of confidentiality.

A letter from the Mayor invited large water-using and water-discharging companies to take advantage of the offer of a free water audit. OTA called companies from the city's list of water users and dischargers and told those on the list:

- The facility was being called because it was a significant water user and/or wastewater discharger, and not because of any problem with the facility
- The city of Marlborough had recently experienced waste water treatment capacity problems, was facing limits on what it could discharge, and needed to investigate the possibilities of conserving water and reducing wastewater discharges. MA DEP and US EPA were interested in having the city do this, and had asked OTA to help
- OTA would provide confidentiality and it would be up to the facility if they wanted OTA to use their name in the final report. Without that permission OTA would not tell EPA or DEP which facilities they visited, nor the city[1]
- If OTA did find something worth talking about, it would be a chance for positive publicity

[1] Except in two cases where the City of Marlborough's Water Department assisted OTA in securing some of the visits, and the visited facility knew the City was aware that OTA was auditing them.

- The OTA staff accompanying the consultant would also look out for energy, toxics use reduction, or compliance relating to environment, safety or health, which could also be of significant value
- A half-day plus some follow-up was the minimum commitment. If the facility wanted to do more work and pursue the identified options, OTA would be available to assist with that
- The purpose of the audit was to learn what options might be feasible. Neither OTA, MA DEP, US EPA, or the city of Marlborough were going to force the company to do anything the company didn't want to do

The companies agreeing to receive audits were all significant water users, and also represented a variety of facilities. Some of the visited facilities have waived confidentiality because they have implemented water conservation, are already water efficient, or are planning to implement water conservation. Some that have maintained confidentiality also fit that description. Full, formal audits resulting in quantification of potential savings were performed at a school, a technology company, a medical facility, a chemical company, a paper box manufacturer, two hotels, and a biological research facility. Two other facilities (a car wash, and the town's public works facility) received informal audits that produced recommendations (and results), but no quantification of expected savings.

OTA had published a public offer to compete for contracts to perform the subsidized audits, and received three proposals. All were acceptable and OTA entered into contracts with:

- Filters, Water and Instrumentation of Londonderry, NH (auditor: Mike Tomaselli)
- Fuss & O'Neill of Providence, RI (auditor: Laura Marcolini)
- Ambient Engineering of Concord, MA (auditor: Ken Pyzocha)

In each facility, OTA and the consultants first met with the facility personnel to discuss water use and potential conservation or reuse opportunities, and then performed a walk-through to view areas of water use. The audits all looked for opportunities for:

- Overall system optimization, including improved measurement or user awareness
- Modification of water using equipment or processes
- Reuse or recycling of water, and use of rainwater

Either before or after the walkthrough OTA and the auditors reviewed water bills received by the facility, usually over a year's time, and in most cases blueprints or other charts of the physical plant, to identify the flow of water through the facility and each point of use. At each significant point OTA and the auditors asked questions about how the water was used and attempted to determine if consideration had already been given to potential conservation options. Auditors collected whatever information they could to quantify or estimate the flows. In some cases, because the facility managers realized that obtainable information was not immediately at hand, the auditors arranged for return visits or to receive the information at a later date.

The auditors then supplied a report to OTA with best estimates of flows and the potential savings in water and water charges that conservation options could provide. OTA reviewed and edited the reports before authorizing that they be sent to the visited facilities. OTA then followed up with the facilities to determine if the reports had any impact on operations. OTA used the opportunity to assess the potential for savings in toxic chemical use and energy conservation as well, and in some cases noted compliance issues that needed to be addressed.

Summary of Results

Each of the audits resulted in the identification of opportunities to save water at each facility. Potential savings were found in all facility types examined. Implementable actions found during the audits included all of the opportunity categories listed above. For eight facilities, estimates were produced of the expected costs of implementation and expected cost savings and reduced water consumption. At these eight facilities, *thirty-six viable options were identified, about four per facility.*

- The 36 actions would save 15,839,617 gallons per year, at a total cost of $752,481, and an average payback under 3 years.
- *Nineteen, or slightly more than half, had paybacks of two years or less*, and would save 10,149,691 gallons per year, at a total cost of $125,793.
- Eleven actions had paybacks of less than one year.
- Information from existing meters was found to be a generally unused resource for targeting high-use activities or locations.

Of the ten facilities, eight responded to follow-up. Three have already implemented significant projects. *These projects are saving an average of about 855,000 gallons per year, at an average cost of $12,000, with an average payback of less than a year and a half.*

Two others have projects in the works. *Options are being implemented that are projected to save 6,066,000 gallons per year, with expected annual savings of about $56,000 and a total investment of about $96,000.* Other facilities are actively researching options, and one is including proposed projects in capital budgeting requests. All eight facilities responding to follow-up found the audits to be of high value.

The Potential Effectiveness of Providing Audits

The project demonstrates that providing free audits can be a useful tool for accelerating the implementation of water conservation initiatives. Only some facilities are equipped or motivated to recognize and implement such options on their own. Only three facilities, the specialty chemical company; the pharmaceutical research company, and the biological research facility, had already embarked on significant water conservation initiatives before the auditing occurred. All these facilities had a high level of technical capacity, and were part of large, well-capitalized organizations.

Even at these facilities, where water conservation had already received attention, and each had implemented some initiatives before we arrived, performing water audits still made a significant difference. At the specialty chemical company, staff had identified water-saving initiatives but had not received approval to move forward. The attention of the state and the provision of an independent confirming perspective provided the needed impetus to launch the projects. In addition, the audit expanded the recognition of opportunities for application of water reuse practices, roughly doubling the facility's water conservation goals. At the biological research facility, equipment was designed for efficient water use, but water conservation had not been a particular focus before the audits were performed, and as a result of the audits, a program of employee training was launched. And although the pharmaceutical research company had already installed water-efficient sanitary devices and had already optimized process water use, the visits spurred even greater attention to possibilities for reducing water use, including sanitary devices with even lower water use, and examining the potential for using stormwater in cooling towers.

One other facility, the carwash, had pursued water conservation in the past, and had instituted careful measurement of water use, including monitoring of how much water was used to wash each car. The facility

had installed washwater reuse equipment several years earlier, and then removed it when its use impeded the effective cleaning of cars (it caused visible "spotting" on car surfaces). OTA recommended revisiting the option as new, advanced water reuse technologies have been developed in recent years, and provided information on a nearby car dealership that had installed a wash water reuse system and had used it successfully for several years. Because the carwash did not respond to attempts to follow up on the audits, it cannot be determined whether the audits have prompted a renewed attention to the option of reusing water.
No other visited facilities were attending to water use in any significant respect before the audits were performed. As a result of the audits, eight have reported taking action. Five facilities have already implemented or planned implementation of options projected to save over 6 million gallons per year, and three more are actively investigating options or seeking funding for them. All eight facilities that responded to follow-up have significantly elevated attention to water conservation, articulating to OTA an awareness of the importance and potential value of reducing intake and discharges.

Ensuring Audits Are Effective

It is important to note that considerable persistence was required to ensure the success of this project. Companies did not initially leap forward to take part. Frequent calling and carefully articulated offers were necessary to gain acceptance of the offer of the audit, even though it was free and confidential. It is likely that a major factor was the combination of water options with the examination of opportunities for energy and toxics use reduction, as well as compliance assistance. This enhanced the value that companies expected from the time they devoted to the audits. The confidentiality of OTA was also important, as was the strategic participation of the city, state and federal governments. A balance was necessary, to ensure that companies viewed the government role as legitimate and authoritative and not coercive or intrusive.

Persistence was also required in follow-up, because providing the free audits alone may only establish a foundation for awareness and may not lead to action. At least two of the facilities clearly had taken no action until they were repeatedly recontacted during the follow-up period. Follow-up caused them to review the audits more carefully than before.

The fact that OTA also noted opportunities for saving energy and reducing toxics use, and compliance issues, seemed to be of considerable importance. One facility was under OSHA enforcement and valued OTA's assistance in developing an efficient method of complying. Another responded to OTA's recommendations concerning hazardous waste management by reinvigorating a facility plan that had fallen into disuse and retraining all employees. A third seemed to pay closer attention to OTA's toxics use reduction recommendations than to its water conservation recommendations. Nearly all showed a high degree of interest in energy conservation options and OTA's information about rebates and tax incentives. These and other facilities may have agreed to accept the audits partly because these options were combined with the water audit.

Although this project provides strong indications that a water audit program can be an effective tool for promoting action and awareness, it may be necessary to structure such programs with additional incentives and continuous interaction to enhance the likelihood of impact.

Detailed Summary of Water-Conservation Opportunities Found

All ten facilities received suggestions to consider opportunities in all categories. The following tables set forth the recommendations provided by auditors to each facility about those opportunities that represented

significant potential savings, and their estimates of that value. The text narrative that follows each table describes what was learned after following up with the facilities[2].

Overall System Optimization, Including Improved Measurement or User Awareness

System

The audits found:

Facility	Water Conservation Opportunity	Estimated Savings (GPY)	Estimated Cost $	Estimated Savings $	Payback Period (Yrs)
School	Check flowmeter regularly, record and report				
Public Works	Reduce pressure at intake				
Technology Company	Wastewater discharge flowmeter		$17,300.00		
Paper Box Manufacturer	Flowmeter installation		$6,200.00	$1,709.00	3.6

(*Please note: payback denotes time in years for accumulated savings to equal investment).* One facility received a suggestion to install a pressure reducer at the point of water intake, and has stated this will be implemented. Three facilities received recommendations to install or monitor flowmeters. The more precise measurement of use and discharge that such meters would provide could result in the detection and reduction of losses or excessive use, or possibly rebates on discharge fees (for water not actually discharged). These could all provide a payback on the investment, but sufficient information existed in only case to develop estimates of what the savings might be. The paper box manufacturer has already installed flowmeters at each production unit that uses significant amounts of water for cleanup, and has measured savings from this investment. The estimated payback for that option, drawn from the consultant's report, turned out to be too conservative (3.6 years). The company calculates the investment will pay for itself in less than two years.

Employee Training and Housekeeping

The audits found:

Facility	Water Conservation Opportunity	Estimated Savings (GPY)	Estimated Cost $	Estimated Savings $	Payback Period (Yrs)
Biological Science	Employee training	135,000	$375.00	$1,530.00	0.25
Paper Box Manufacturer	Employee training	25,000	$50.00	$283.00	0.2
Biological Science	Housekeeping, maintenance	67,500	$625.00	$765.00	0.8
Paper Box Manufacturer	Housekeeping, maintenance	37,500	$625.00	$425.00	1.5
Public Works	Employee training, housekeeping, maintenance				
	Average	66,250	$418.75	$750.75	1
	Total	265,000	$1,675.00		

[2] The time between audit and follow-up varied from facility to facility, but was on average about six months after the delivery of the audit recommendations.

Three facilities received recommendations for employee training and all have begun implementing them. Three received recommendations to change housekeeping and maintenance practices, and have begun implementing them. These very low cost options were only recommended by the consultants at a few sites, but are applicable to all the sites visited. The hotel that responded to follow-up has implemented efforts to educate employees and improve housekeeping, as has the school. The consultants estimated savings at three sites, totaling a quarter of a million gallons.

Modification of Water Using Equipment or Processes

Washing

The audits found:

Facility	Water Conservation Opportunity	Estimated Savings (GPY)	Estimated Cost $	Estimated Savings $	Payback Period (Yrs)
Biological Science	Washer Cycle Reductions	242,250	$3,000.00	$2,746.00	1.1
Paper Box Manufacturer	Operations Cycle Reductions	20,775	$1,000.00	$235.00	4.2
Biological Science	Washer Retrofit	484,500	$11,500.00	$5,493.00	2.1
Hotel 1	Ozone Laundry	8,609	$40,000.00	$5,000.00	8
Public Works	Reduce Water in Washup				
	Average	189,034	13,875	3,369	4
	Total	756,134	55,500		

The hotel that received the recommendation to switch to ozone laundry (because it is more water efficient, and also uses reduced chemicals and energy) did not switch to ozone laundry, but did switch to a more water-efficient process, and credits the audit for this. The hotel manager estimates cost-savings that would produce a payback in about two years, significantly better than estimated in the consultant's report. The paper box manufacturer has implemented reductions in water-using operations but has not calculated its value. The biological science facility has reported generally that it has implemented recommendations, without providing further detail, and the public works facility has reported it will examine washup operations.

Cooling Towers and Boilers

The audits found:

Facility	Water Conservation Opportunity	Estimated Savings (GPY)	Estimated Cost $	Estimated Savings $	Payback Period (Yrs)
Technology Company	Modify TDS setpoint on cooling tower	1,604	$500.00	$602.00	0.83
Chemical Company	Cooling tower optimization	500,000	$5,000.00	$5,000.00	1
Medical Facility	Cooling tower blowdown reduction	1,182,000	$1,000.00	$1,341.00	0.74
Paper Box Manufacturer	Boiler Operations	250,000	$10,000.00	$2,834.00	3.5
	Average	483,401	4,125	2,444	2
	Total	1,933,604	16,500		

The technology company well-understood the possibility of optimizing cooling tower operations, but because the system is operated by contractors this is not an option they can directly implement. They are also

mindful, as were the consultants, that modifying cooling tower inputs is a complicated matter and that a failed system would have a serious negative impact on production capacity. The chemical company and the medical facility, whose staff maintained the system, had a similar perspective. Although there are potential water savings in cooling tower optimization, facilities seem generally reluctant to tinker with a system that is delivering acceptable performance. The paper box manufacturer was very receptive to suggestions to optimize boiler operations to minimize blowdown, even though the quantity was not substantial, because the audit included suggestions for boiler optimization for the purpose of increasing energy efficiency, such as installing an economizer, which recovers heat from air (the liquid discharge "blowdown" carries away heat as well).

Reuse or Recycling Of Water, and Use of Rainwater

Water Reuse

The audits found:

Facility	Water Conservation Opportunity	Estimated Savings (GPY)	Estimated Cost $	Estimated Savings $	Payback Period (Yrs)
Chemical Company	Reusing Reject Water	750,000	10,000	7,500	1.3
Chemical Company	Rinsewater Reclamation	800,000	60,000		Not Est
Car Wash	Install Reuse System				
Paper Box Manufacturer	Water Reuse				
	Average	775,000	35,000	7,500	1.3
	Total	1,550,000	70,000		

The return on the water reuse option was by far the highest, amounting to several hundred thousand gallons per year. The chemical company had already identified an option for cleaning water that had been used for rinsing containers, but it had not been implemented. As a result of the audit, with confirmation from the consultant of the value of this idea, and the attention of the state, the project was approved. In addition, the consultant noted a similar opportunity with other rinsewater. The first project has already been implemented and the second is in the process of implementation. Projected savings are very substantial. The audit predicted savings of more than 800,000 gallons, but the company told OTA the reuse system it has already implemented is projected to save about 2 million gallons per year, at a savings of $20,000 in reduced water charges. The project cost of about $25,000 is less than what the audit estimated and is on track to save that amount within 15 months. The additional reuse system and the reject water reuse idea, not yet implemented, are expected to save an additional 3 million gallons per year, with an expected cost of investment of about $60,000 and a payback of about two years.

The paper box manufacturer has already implemented water reuse, using treated wastewater for cleanup. Due to a shortage of resources it did not have the ability to estimate quantities saved, but management was sufficiently impressed with results that the company is moving forward with enhancements to water treatment so that more uses can be made of the treated water, not just for cleaning equipment but also for use in making up starch solution that goes into the product.

The car wash had a washwater reuse system in place that it had deactivated, because it did not keep the water clean enough to use. The facility manager initially expressed interest in considering new technology which has been used successfully by a nearby dealer, but did not maintain this interest. Car washes may be able to

reuse washwater at some stage of their operations. If used in an initial wash the water does not have to be as clean as the final rinse, which must use very clean water or there will be residues left on the car. But the first wash removes the most road soil and oils, and thus is harder to clean. In addition, a dealer has a cleaner stock to manage than what comes into a car wash.

Rainwater

The audits found:

Facility	Water Conservation Opportunity	Estimated Savings (GPY)	Estimated Cost $	Estimated Savings $	Payback Period (Yrs)
Hotel 1	Rainwater in Swimpool & Irrigation w/o Treat	16,230	$47,710.00	$5,963.00	8
Hotel 2	Rainwater in Swimpool & Irrigation	6,377	$25,000.00	$3,571.00	7
Technology Company	Rainwater for Irrigation	9,304	$21,461.00	$3,577.00	6
Technology Company	Rainwater for Cooling Tower Makeup Too	25,347	$21,461.00	$9,538.00	2.25
Biological Science	Stormwater Collection	675,000	$25,000.00	$4,584.00	5.5
Paper Box Manufacturer	Stormwater Collection	1,257,000	$35,000.00	$8,536.00	4.1
School	Stormwater Irrigation	5,000,000	$25,000.00	$16,750.00	1.5
	Average	998,465	$28,661.71	$7,502.71	4.91
	Total	6,989,258	$200,632.00		

(*Note the rainwater system for the technology company is counted twice, because it is suggested for two separate purposes. This is an overestimate of the likely cost of the system).* The suggestion to consider the use of rainwater was well received at nearly every facility visited, and the option had not been considered at any of them (at least not by the facility staff and managers participating in the audit). It was a new and welcome idea that sparked interest and enthusiasm. With OTA, these facilities began investigating using rainwater for various purposes, but in no case did any of the ideas result in a plan for implementation. The economic stresses most visited facilities are facing has limited the amount of time that facility operators have to research innovative options such as rainwater use, and the ability to invest in needed capacity. The fact that rainwater may have to be filtered, that it may have to be pumped, and that storage space is needed all make considering its use more complicated than initially expected. However, upon follow-up, all facilities that showed initial interest stated that they are still interested – and would like to explore its potential further at some point in the future. Providing assistance on prefiltering rainwater to ensure cleanliness when it is stored, easy means of assessing quality, inexpensive pumping and storage systems, as well as demonstrating successful applications, may be needed to increase adoption of these promising systems.

The use of rainwater for cooling tower make-up presented special issues. Some facility managers told OTA that they depend on third-party service suppliers to essentially take full charge of cooling tower water treatment, and would not make changes to the system on their own. Several stated that reducing blowdown in cooling towers is risky, since cleaning out cooling towers and heat exchanger surfaces when they don't work is very undesirable. Facility operators must have the expertise to understand the nuances of cooling tower chemistry. The treatment of the makeup water is highly dependent on the chemical characteristics of

the water source. Often, water quality can change during the cooling season due to the change in source from the municipal supply. However, because the cooling towers use thousands of cubic feet of water each month, they are important areas to continue examine.

Totals

Options Identified In Audits and Estimated Value

The predicted savings and costs from the eight facilities visited by auditors, as calculated by the consultants, was for nearly two million gallons per facility, at a cost of less than $100,000 per facility, with an average payback of about three years.

Estimated Savings (GPY)	Estimated Cost $	Estimated Savings per Year $	Estimated Payback Period (Yrs)
15,839,617	$752,481	$228,778	2.97

Removing the rainwater collection ideas and one recommendation to spend more than $17,000 on a flowmeter[3], the average facility could realize about one million gallon per year savings with an investment of about $66,000, (between six and seven cents per gallon per year) with a 2.5-year payback.

Estimated Savings (GPY)	Estimated Cost $	Estimated Savings per Year $	Estimated Payback Period (Yrs)
8,850,359	$534,549	$176,259	2.5

[3] This particular flowmeter was not intended for conservation, but for seeking a rebate on water discharge fees for water that is evaporated and not discharged, and the company is not currently pursuing this option.

Options Implemented By Facilities, or For Which Planning Has Begun

Although the results of following up with each facility showed that what actually happened varied significantly at each facility, in total the results are very close to what was recommended and predicted (leaving out rainwater options). Five facilities are already implementing activities, and three have already implemented projects with significant positive impacts. Actions that have already been taken are projected to save more than 2.5 million gallons per year, and projects in the planning stage are expected to save over 6 million gallons per year. Not counted here as projects in the planning stage are the projects that facilities reported considering, even those under active investigation. Only those projects on which some form of work had actually begun at the time of writing this report, or for which work had been scheduled, are counted.

Implemented Projects				
Facility	Water Conservation Opportunity	Estimated Savings (GPY)	Estimated Cost $	Estimated Savings $
Biological Science	Employee training, housekeeping			
Hotel 1	Ozone laundry	200,000	$4,000.00	$2,300.00
Chemical Company	Rinsewater reclamation	2,000,000	$25,000.00	$20,000.00
Paper Box Manufacturer	Employee training, housekeeping, Operations Cycle Reductions, flowmeters, water reuse, toilets, all together:	366,000	$7,000.00	$3,600.00
Public Works	Employee training, housekeeping			
	Implemented Projects Total	**2,566,000**	**$36,000.00**	**$25,900.00**
	Implemented Projects Average	**855,333**	**$12,000.00**	**$8,633.33**
Planned Projects				
Biological Science	Showers			
Chemical Company	Reusing Reject Water	1,000,000	$20,000.00	$10,000.00
	Rinsewater Reclamation	2,000,000	$40,000.00	$20,000.00
	Pressure Reducer	500,000		
	Planned Projects Total	**3,500,000**	**60,000**	**30,000**
	Planned Projects Average	**1,166,667**	**30,000**	**15,000**
	Total for all Projects	**6,066,000**	**96,000**	**55,900**
	Implemented and Planned Project Average	**1,011,000**	**21,000**	**11,817**

Discussion of Results

Common Opportunities and Site Variability

A number of water conservation opportunities were found to be common at visited sites. Low-flow bathrooms, stormwater for irrigation and perhaps for cooling towers, and reading meters on a daily basis, were standard recommendations to consider everywhere. Thus, to some extent one can scale up the results

from the sample facilities examined here to estimate the potential for water savings on a city-wide basis. But there is also a great deal of site variability, which includes not just physical conditions such as whether there is space for storing storm water, or the specific ratio of automatic flush to manual flush that is appropriate for a facility, but also the specific culture at a facility, and its capacity to make investments.

For example, at the technology company, low-flow fixtures had already been installed, but the manager was interested in considering installing even more efficient equipment. In another, there was willingness to consider waterless urinals, but in many, the potential maintenance issues this might involve ruled out consideration, even though the equipment is rapidly improving. Fresh capitalization from corporate buy-out made a big difference at the chemical company, while in most other facilities there was no such available funding, and marginal improvements would not likely be considered. At the chemical company the institutional support for water conservation was strong if a reasonable payback could be shown. At one of the hotels, upgrades could be considered when existing equipment was in need of repair. At the school, projects with reasonable paybacks could be included in requests to the Massachusetts School Building Authority. At the paper box manufacturer, water conservation was seen as an area where cost savings could be found and as part of a general ethic of efficiency. Water reuse opportunities varied greatly depending on uses and quality requirements. Any estimation of what can be achieved on a city-wide basis derived by scaling up from specific examples should take this high site-specific variability into account.

Water Conservation as a Priority

At none of the eight facilities that responded to followup does water conservation seem lodged on a back burner, even though all the managers are distracted by pressing issues stemming from the economic downturn. In most places, the projects that have been pursued are those easiest to implement, consistent with upgrading, and with short paybacks. Many opportunities for water conservation still remain, but will likely require more (incentives, education, technical assistance, time) to stimulate adoption.

Many facilities expressed strong appreciation for the assistance, indicating that the subsidized assistance project did make a difference. The facility manager of the biological research facility wrote, (referring to auditor Ken Pyzocha, Marlborough Assistant Commissioner of Public Works Doran Crouse, and OTA): "I believe that any organization could benefit and save some water and money with Ken's work. I'm glad Doran pointed you and Ken in my direction." The EHS manager at the chemical company wrote: "The OTA's expertise and support have been a critical success factor for these vital water conservation projects". The paper box manufacturer manager told OTA that the water conservation actions they undertook were caused by the audits. The school facility manager wrote: "We need to do these things. This has been very thought-provoking and will help make a case with MSBA" (the Massachusetts School Building Authority). Our contact at medical facility commented, (referring to auditor Mike Tomaselli): "Although we will be unable to implement the water recovery initiatives outlined by Mike, his analysis demonstrated green technologies that could be incorporated into any larger scale new construction we will be doing in the future." The manager of Hotel #1 told OTA: "We learned a lot from everything you sent us. Conserving water now comes up every day at morning staff meetings. The water meter is read every day and water use is now tracked. The audits opened up eyes to a lot of issues, now people are aware that this is what you do."

By revealing the potential for cost savings, free water audits can cause water conservation to be a higher priority for facility managers. The question remains as to whether companies would find it worthwhile to conduct water audits if they had to pay for them. Considering that the average cost for implemented projects was $12,000 and the average annual savings was $8,633, a company willing to consider investments with a

payback of up to two years should still find it worthwhile to spend up to $5,266 on an audit. Many companies will also find it possible to engage in water auditing on their own, by following these steps:

1. Use water bills and the water meter to see patterns of water use
2. Identify points of use and review purposes of water use and actual practice
3. Research and brainstorm options for reducing use, reuse, and using rainwater
4. Compare identified alternatives to current practices, considering savings over time
5. Take steps to inculcate a facility-wide ethic of continuously reducing water waste
6. Improve water measurement as needed and repeat these steps periodically.

Some companies will find it useful to build the inhouse capacity to do self-auditing. But even those companies motivated to do so may wish to consider the benefits of enlisting the assistance of a competent outside auditor, to learn quickly how to perform such audits. External reviewers frequently spot opportunities that internal staff miss, and experienced water auditors can bring a great deal of knowledge about opportunities and how to implement them.

Use of Audits to Estimate City-Wide Conservation Potential

Together, Marlborough's two sewage treatment plants are designed to handle average flows of 8.39 million gallons per day. The Westerly plant, where most industrial discharges flow, is designed to handle 2.89 million gallons per day.

Although only ten facilities were visited, some of them were among the largest dischargers in the city. Six of the visited facilities were among the top fifty dischargers to the Westerly plant, and these were the visited facilities with the majority of use and potential savings. Six visited facilities discharged to this plant, and were the 2nd, the 5th, the 15th, the 16th, the 20th and the 29th largest dischargers. The top fifty dischargers to the Westerly plant discharged approximately 220 million gallons per year, (about 600,000 per day), of which these six facilities represented about one-fifth (twenty percent). The visited facilities were not only distributed across the spectrum of size, but represented a mix of activities. What they accomplished provides an approximate sampling of what may be possible for a population of wastewater dischargers.

The visited facilities were industrial and commercial operations. Except for some applications, such as washing containers for shipping chemicals, many of the options for reducing water use were in operations that are common to many industrial and commercial facilities, such as cooling towers, washing, or landscaping. Lawn irrigation (not implemented or planned by any participating facility, but considered a potential application for eventual rainwater collection), laundry and kitchen operations have their smaller counterparts in residences. Every facility had low-flow options for sinks, lavatories, and showers.

The water conservation planned and implemented by the six facilities is projected to save about 6 million gallons per year, one-eighth (12.5 percent) of their total discharge (about 47 million gallons). The potential for reductions with two-year payback or less identified by consultants was about 10 million gallons per year. *The expected savings from a similar water conservation effort may therefore be estimated as about one-eighth to one-fifth of discharges (12.5 – 20%), from 75,000 gallons per day to 120,000 gallons per day.*

The audit subsidies cost about $50,000, and realized reductions in water use equaling about $56,000 in savings. Although these savings go to the companies, there are also savings to the municipality. In the case of Marlborough, a lack of capacity for managing wastewater discharges has limited development, so the value of water conservation has great value in eliminating a barrier to economic development, far beyond the reduction in fee revenue that a successful water conservation effort will produce.

If the four-fifths of the remaining top fifty dischargers not visited could achieve similar results the city's Westerly plant could perhaps have reductions of from 24 to 44 million gallons per year. It is not reasonable to expect that simply continuing the effort conducted by OTA would have this result. OTA had to invest considerable energy in enlisting volunteers willing to accept the audit. Many of the top dischargers to both the Westerly and the Easterly plants were contacted and declined to accept. Those who did choose to participate in this program were willing to volunteer – and thus the sample is biased in this respect. The project does not provide confidence that the 44 other top fifty dischargers would respond to a continued voluntary program in the same way, absent changes in the approach.

However, the results concerning potential do serve as indicators of what similar facilities may achieve, if motivated, for they reflect technical possibilities. Considering only the opportunities that had paybacks of less than two years, the results from all ten visits found that more than 10 million gallons could be saved with an investment of only $253,399, an average of about $25,000 per facility, and about a million gallons per year reduction. This expectation may be regarded as relevant to the average member of the top fifty users in a mix of commercial and industrial facilities. The follow-up was not far from what the auditors found. Three of the ten visited facilities took action, reducing an average of 855,000 gallons per year with average investments of $12,000 each, and annual savings of about $8,600. Half of all visited facilities have planned water conservation activities, with an average expected savings of more than a million gallons per year and more than $11,000 in annual return, with an average annual initial cost of investment of less than $20,000.

Additional Actions to Promote Conservation

That options were found in every facility means that the possibility for reductions is likely universal. What tools should be used to make this potential manifest? This project demonstrates that a voluntary initiative can prompt significant progress. Expanding the voluntary effort would likely result in even greater progress. However, additional actions should also be considered, for reaching facilities that do not readily respond to offers of assistance.

The results of this project may underestimate the potential that exists for water conservation. Due to stresses induced by the recent economic downturn, it seems that some facilities did not have the time or resources to fully evaluate what may be technically and economically viable options for them, and may still present significant opportunities. In addition, there were several options still under consideration at the time of writing this report that may yet be implemented. Finally, all the options described were implemented without any subsidies, and without the benefit of day-to-day or real-time monitoring of water use. For the analogous context of energy use, rebates and other financial incentives and the communication of quantitative use information have motivated reductions. If these actions were applied in the water context there would likely be more progress than has been estimated above.

Another factor is that the project took place in an environment in which pricing signals do not provide substantial motivation for reduction. Although an increase in price would likely motivate even further water conservation, concerns about providing an adequate share as a human right, and for robust economic development, make pricing schemes complicated. This report does not include an examination of pricing options, but notes that some facility managers reported to OTA that the low cost of water inhibited efforts to generate interest in conservation.[4]

[4] For a discussion of pricing, see *Massachusetts Water Conservation Standards*, Commonwealth of Massachusetts, Executive Office of Environmental Affairs and Water Resources Commission, 2006, pp. 15-17, at: http://www.mass.gov/Eoeea/docs/eea/water/water_conservation_standards.pdf. The report also discusses metering at pp. 13-14.

A further complication relating to water conservation efforts is that they may reduce revenue to the city or cause an increase in the unit price of water. It is likely that these effects can be mitigated by a sophisticated pricing system, but more importantly, it must be viewed in the overall context of the value of conservation to the locality. In the case of Marlborough, successful water conservation results in greater capacity for economic development, which may bring in more revenue to the city in tax receipts than it may lose in water charges. Successful water conservation will also help to extend the life of existing water supplies and treatment operations. It is also useful to consider that more communities are finding "smart grid" systems to be worthwhile investments. These systems not only provide better quantitative information on water use to the user, but also reduce the work-hours needed to check meters. The investment in the smart grid can reduce the costs of a water department. In the short run, absent a new pricing structure, water conservation can initially reduce revenues to the city, or cause an increase in the unit price of water, for the user. In the long run, it can help preserve jobs and the financial viability of communities.

A truly holistic view of the value of water conservation recognizes the points made in the *2006 Water Conservation Standards* issued by the Massachusetts Executive Office of Energy and Environmental Affairs and the Massachusetts Water Resources Commission:

Massachusetts' economy is inextricably linked to its natural resources, water being a critical one. The Commonwealth receives an average of 44 inches of rainfall each year - an amount many consider to be plentiful compared to other areas of the country. However, rainfall varies significantly from year to year and can drop to below 30 inches during a severe drought year. Short-term droughts can severely deplete water supplies as well as source rivers, streams, and ponds. Also, weather patterns are seasonal, and in summer, when evapotranspiration goes up, there is typically less rainfall available to contribute to recharge. It is also important to recognize that Massachusetts is one of the most densely populated states in the nation with over six million people living on slightly more than six million acres of land. In fact, the per capita water availability is significantly less than some desert states, such as Nevada. Hence, Massachusetts' current water use and future growth and development need to work within these constraints."[5]

Conserving water resources is critical to our future well-being, even here in the comparatively "water-rich" Northeast.

[5] *Ibid*, p. 3.