WATER CONSERVATION STANDARDS

The Commonwealth of Massachusetts
EXECUTIVE OFFICE of ENERGY AND ENVIRONMENTAL AFFAIRS
and
WATER RESOURCES COMMISSION
July 2006
Updated June 2012

Note on the 2012 Update of the Massachusetts Water Conservation Standards
June 2012

The Massachusetts Water Resources Commission completed a major revision and update of the Massachusetts Water Conservation Standards in July 2006. It is the intent of the commission to review the standards every five years and update them as needed.

A substantive review of the 2006 standards is in progress. Until this review is completed, nonsubstantive revisions and updates to the information in the 2006 standards have been incorporated into this edition.

This document is available on the web site of the Massachusetts Water Resources Commission.

June 2012

DEAR WATER USER,

It is with great pleasure that I present to you the Massachusetts Water Conservation Standards.

Massachusetts is rich with many water bodies and plentiful rainfall. But as our demand for water increases with growth, and our infrastructure ages, some of our streams and lakes have become stressed and we are facing water supply shortages. Today, the need to use our water efficiently with minimal amount of waste is critical to the long-term health and viability of these important resources.

Massachusetts first published water conservation guidelines in 1987. Since then, technological advancements have greatly helped improve the efficiency of water use. Additionally, our understanding of the impacts of human water use on the natural environment has increased. The current Water Conservation Standards continue to establish updated statewide goals for water conservation and water-use efficiency and provide guidance on the most current conservation measures. They will help bring greater awareness among users about water use and water waste, help tighten our infrastructure, ensure sustained water supply, and move us forward toward more pragmatic water use.

The Water Conservation Standards will be an invaluable resource for all citizens, businesses, and governmental bodies in the Commonwealth.

Sincerely,

Richard K. Sullivan, Jr.
Secretary

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ABBREVIATIONS

ASR	Annual Statistical Report
AWWA	American Water Works Association
CMR	Code of Massachusetts Regulations
DAR	Department of Agricultural Resources (Massachusetts)
DCR	Department of Conservation and Recreation (Massachusetts)
DFG	Department of Fish and Game (Massachusetts)
DHCD	Department of Housing and Community Development (Massachusetts)
EEA	Energy and Environmental Affairs, Executive Office of (Massachusetts)
EPA	Environmental Protection Agency (U.S.)
gpcd	Gallons per capita per day
gpd	Gallons per day
gpf	Gallons per flush
gpm	Gallons per minute
HET	High-efficiency toilet
ICI	Industrial, commercial, institutional
I/I	Infiltration and Inflow
IWRMP	Integrated Water Resource Management Plan
LID	Low-impact development
MaP	Maximum performance testing
MAPC	Metropolitan Area Planning Council
MassDEP	Massachusetts Department of Environmental Protection
MEPA	Massachusetts Environmental Policy Act
MGL	Massachusetts General Laws
MWRA	Massachusetts Water Resources Authority
NEWWA	New England Water Works Association
NPDES	National Pollutant Discharge Elimination System
OTA	Office of Technical Assistance (Massachusetts)
psi	pounds per square inch
REUWS	Residential End Uses of Water Study
RGPCD	Residential gallons per capita per day
SDI	Subsurface drip irrigation
UAW	Unaccounted-for water
UMass	University of Massachusetts
WRC	Water Resources Commission (Massachusetts)

Acknowledgements

The Executive Office of Energy and Environmental Affairs (EEA) and the Water Resources Commission were assisted by a working group of representatives of various interests and expertise that provided technical, policy, and regulatory advice during development of the 2006 update of the Water Conservation Standards. While the Standards do not reflect the opinions of every participant, EEA would like to acknowledge the members, as well as their respective organizations, for their time and invaluable input.

For the 2006 update of this document, the Water Conservation Standards Work Group comprised the following membership:

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In addition, we would also like to express our appreciation to the public for providing detailed comments in writing and at the public meetings. Finally, we would like to especially acknowledge the following entities for their expert input – Amy Vickers (Amy Vickers and Associates, Inc.), Pat Rogers (MassDEP), Paul Lauenstein (Neponset River Watershed Association Board), Irrigation Association of New England, Massachusetts Instream Flow Task Force, Mary Owen (UMass Extension), Massachusetts Municipal Association, Gus Ogunbameru (Office of Technical Assistance), Russ McIntosh (Sebesta Blomberg & Associates, Inc), and the Water Supply Citizens Advisory Committee.

Intent and Purpose of the Water Conservation Standards

The *Water Conservation Standards* (the Standards) set statewide goals for water conservation and water-use efficiency, and provide guidance on effective conservation measures to meet the statewide goals identified in the 2004 Massachusetts Water Policy[1] (Water Policy). The Standards also provide a vehicle to educate Massachusetts' citizens about the importance of water conservation, its crucial link to our natural resources, and how all consumers can use water more efficiently. Water conservation is defined as any beneficial reduction in water loss, waste, or use, and water efficiency is defined as the accomplishment of a function, task, process, or result with the minimal amount of water feasible (Vickers 2001). In this document, the terms water conservation and water efficiency are used interchangeably.

This document includes both *Standards* and *Recommendations*. *Standards* are achievable, implementable, and practical measures adopted by water suppliers, small and large water users, and state agencies in carrying out their water resources planning and management programs and in issuing permits or approvals that involve water use. The Massachusetts Executive Office of Energy and Environmental Affairs (EEA) strongly encourages and supports the adoption of *Recommendations* wherever possible. Although they may not be as widely achievable, implementable, and practical at the present time due to economic or technical reasons, they indicate the trend in responsible water use and may serve as a starting point for examining standards in future revisions of this document.

Background

These Water Conservation Standards are a revision of the Water Conservation Standards adopted by the Water Resources Commission (WRC) on July 13, 2006, and October 13, 1992. The goal of the 1992 Standards was to develop policies and specific recommendations to assist Massachusetts water suppliers in achieving the maximum possible water efficiency in their public water supply systems and to educate end users, homes, factories, and other places of business on conservation measures.

The 1992 Standards emphasized educating water suppliers and consumers on the importance of system efficiencies and conservation. The 1992 Standards focused on the development of local water conservation and resource management plans led by local conservation officials. A key approach was to charge the full cost of water to consumers and develop enterprise accounts. Subsequently, the Water Management Act program at the Massachusetts Department of Environmental Protection (MassDEP) used the Standards to condition water withdrawal permits, and the WRC used the Standards in reviewing interbasin transfer applications. The 1992 Standards were also fundamental to the 2001 Interbasin Transfer Act Performance Standards and have served as a benchmark for reviewing conservation efforts statewide.

The statewide Water Policy developed by EEA in 2004 identified the revision of the Standards as a crucial step in moving forward with water resources planning to sustain the economic and environmental value of our water resources. Water conservation is an essential component of a comprehensive effort to ensure that there will be sufficient water available now and in the future to meet the needs of humans as well as natural communities.

The 2006 update entailed a comprehensive review and substantive revision of the 1992 Standards. The 2006 Standards emphasized that "there is a role for everyone" in using water efficiently. New sections addressed comprehensive planning, water audits, and agricultural water use, and key features of the Lawn and Landscape Addendum to the 1992 Standards were incorporated. Standards for residential water consumption (65 gallons per capita per day) and unaccounted-for water (10 percent) were also added. The Water

[1] Massachusetts Water Policy (2004)

Resources Commission adopted the revised Standards in July 2006, with the intent that the Standards be reviewed every five years and updated as needed.

Introduction

Massachusetts has been a leader in the field of water resources protection, including water conservation and efficiency. On an average annual basis, Massachusetts has one of the lowest per capita residential demands in the country. The state is home to the Massachusetts Water Resources Authority (MWRA), which in the 1980s developed a highly successful water conservation program that resulted in dramatic reductions in its water supply system demand. Those gains have been sustained to this day. Many communities outside the MWRA distribution system have also made investments in water conservation and efficiency that have resulted in reductions in per capita demand and water supply system efficiency.

Despite these improvements, significant opportunity exists for greater water-use efficiency that will generate economic, public health, and environmental benefits. Many water suppliers are finding it increasingly difficult to meet essential public water supply needs for drinking, bathing, cooking, and fire protection. Although water use on a per capita basis varies widely from community to community and also from season to season, data show that great opportunity remains for improved efficiency in water systems and water use by consumers.

Massachusetts' economy is inextricably linked to its natural resources, water being a critical one. The Commonwealth receives an average of 45 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.

Furthermore, the Commonwealth's native flora and fauna rely upon the relative abundance of water in our natural environment. Our native aquatic and riverine organisms show a considerable degree of resiliency, surviving naturally occurring low-flow periods that result from extended periods without precipitation. However, human activities (such as streamflow-depleting water withdrawals, especially during natural low-flow periods, and increases in impervious surfaces) can increase the duration, frequency, and/or severity of low-flow conditions beyond natural levels. Placing streams under chronic unnatural low-flow conditions can cause substantial harm to aquatic and other water-dependent organisms and habitats, and ultimately to our economy and quality of life through loss of scenic, recreation, and property values. It can also result in a loss of other less obvious but vital ecosystem services such as purification of our water and reproduction of economically valuable marine species.

Massachusetts, therefore, continues to have an obligation to emphasize water-use efficiency in order to:

1. Preserve the Commonwealth's water resources, as part of the public trust;
2. Sustain water supplies to meet current and future needs;
3. Protect aquatic ecosystems and minimize water supply impacts; and,
4. Provide financial savings in the cost of water.

1. Preserve the Commonwealth's Water Resources as Part of the Public Trust

The WRC has outlined the State's interest in protecting water resources as public resources to be held in trust for current and future generations, as follows:

> "Water is a valuable resource of the Commonwealth, and as such, the state needs to establish laws and policies to provide for its multiple uses, protect its quality and ensure that it is available to meet the legitimate needs of its citizens. The state's overall goal is to ensure that water is available in sufficient quantity and quality to meet Massachusetts' current and future needs and to accommodate both consumptive and non-consumptive needs." (WRC 1984)

Water resources science and policy have evolved considerably since 1984 and today there is an increased emphasis on demand management as an essential component of the effort to ensure the sustainability of our water resources.

2. Sustain Water Supplies to Meet Current and Future Needs

Although Massachusetts receives relatively abundant rainfall and has numerous rivers, lakes and ponds, many cities and towns have found themselves facing water shortages. Water suppliers increasingly find new source development difficult due to a variety of constraints including cost, time, environmental impacts, regulatory requirements, and an increasing scarcity of suitable sites. Finding new water by investing in efficiency and demand management is almost always more cost-effective than developing a new source.[2] Demand or system management through programs such as leak detection, metering, conservation pricing, and reductions in indoor and outdoor use, has the additional benefit of causing no environmental impacts, unlike developing new water sources. Water savings that result from increased efficiency can, in effect, serve as a new water source. Efficiency should be given priority over new source development, with the understanding that in some cases new water supply sources will be needed to accommodate new growth and/or to offset localized environmental stress or other factors.

3. Protect Aquatic Ecosystems and Minimize Water Supply Impacts

In addition to meeting the growing demand for water for human use and consumption, instream water-dependent uses must also be protected. Instream uses include aquatic habitat for wildlife, flow, temperature-dependent fisheries such as brook trout, and water-dependent recreation such as paddling, fishing, and swimming. Some areas of Massachusetts are experiencing environmental impacts, related in part to drinking water withdrawals and movement of wastewater to another basin, including deterioration of water quality, loss of stream flow, loss of habitat, and disruption of connection between habitats.[3] Water taken from aquatic systems for public water supply is only one component of the water balance. However, it can be a substantial component, especially if the greatest water demands are occurring during the summer season, or during extended droughts, when water is least available in the natural environment. Dams, diversions, and export of wastewater from our river basins can also place significant stress on aquatic ecosystems and alter the streamflow and hydrology in our watersheds. Water savings that result from increased efficiency can help protect aquatic habitat, mitigate the impact of withdrawals, and restore balance to the stressed natural systems.

[2] That said, it is possible for a new water supply source to have a net environmental benefit if it replaces or mitigates an existing source that causes adverse ecological impacts (such as eliminating or reducing pumping from an existing shallow streamside well that desiccates an adjacent stream).

[3] For examples of observations of streams with unnaturally low- or no-flow conditions please see the Riverways' Low Flow Inventory at: http://www.mass.gov/dfwele/der/riverways/programs/ri fls/lowflow_inventory.htm

4. Provide Financial Savings in the Cost of Water

Increasing water-use efficiency can provide an economically competitive advantage for public water suppliers and businesses by reducing operating and maintenance costs (lower electrical power costs and reduced chemical costs for water treatment), reducing wastewater treatment costs, freeing up plant capacity for pumping and treatment of water and wastewater, and avoiding the considerable cost of investing in new sources of water. Individual residents, businesses, and the public sector save significantly by decreasing their water use. Water conservation can significantly improve the performance and longevity of septic systems, benefiting the users of such systems as well as the integrity of adjacent surface and ground waters. Greater water efficiency can also delay, avoid, and restrain capital costs to develop, treat, and convey additional water, and reduce needed wastewater treatment capacity.

Summary

Water-use efficiency is critical to ensuring the long-term sustainability of water supplies and in balancing consumptive and instream uses. Water-use efficiency is becoming increasingly important as water demand rises. It is a crucial factor in sustaining the economic health of the State and continued vitality of the region. Its great promise resides in the idea that increasing knowledge, sophistication, technology and care can save substantial volumes of water and increase the productivity of each unit of water that is used.

Implementation of the Water Conservation Standards

The standards and recommendations should be used in all programs affecting the planning and management of the Commonwealth's water resources, including the Water Management Act, the Interbasin Transfer Act, and the Massachusetts Environmental Policy Act (MEPA). Water conservation standards should also be included in all construction, rehabilitation, and facility development activities statewide.

The standards and recommendations outlined in this document reflect the most current technical and operational knowledge about water-use efficiency.

Overview of the Standards and Recommendations

There is a role for everyone in water conservation and efficiency efforts. Each segment of the water-using community must do its part to understand and support the need for water conservation and encourage water-saving practices on an individual and community level. The following standards and recommendations are intended for adoption statewide by all water suppliers and users, including individual consumers, businesses, industries, and public agencies.

The standards and recommendations cover key areas of water supply planning and management, and indoor and outdoor water use, including the following ten topics:

1. Comprehensive Planning and Drought Management Planning
2. Water Audits and Leak Detection
3. Metering
4. Pricing
5. Residential Use
6. Public Sector Use
7. Industrial, Commercial, and Institutional Use
8. Agricultural Use
9. Lawn and Landscape
10. Public Education and Outreach

The goals of the standards and recommendations are to:

1. Integrate water conservation and efficiency measures into all aspects of water supply planning and management;
2. Maximize the efficiency of public water supply system operations by conducting regular water audits, performing regular leak detection as recommended through audits, promptly repairing leaks, metering all users of water supply systems, and practicing full-cost pricing;
3. Reduce indoor/outdoor water use by setting efficiency standards that are specific and measurable, and recommending options to meet or exceed those standards;
4. Emphasize and implement water conservation in government buildings and facilities to accurately account for water use and to demonstrate water-saving techniques and concepts to the public;
5. Maximize efficient outdoor water use so that outdoor use of potable water comprises only a small portion of total water use, with a long-term goal of further reducing demand through reliance on alternative irrigation sources (e.g., rainwater harvesting and reclaimed wastewater) and water-wise landscaping techniques; and
6. Promote public awareness of the long-term economic and environmental benefits of conserving water to build public support for all aspects of water conservation and efficiency, and to influence behavior to maximize conservation by individuals and institutions.

Note: In this document the term "water supplier" refers to public water suppliers, private water suppliers, and water districts; and the term "communities" refers to cities and towns.

1.0 Comprehensive Planning and Drought Management Planning

This chapter applies primarily to:

- *Water suppliers*
- *Water distributors*
- *Municipal governing bodies, boards, and departments*
- *State policy and regulatory entities*

Several anthropogenic components impact a watershed's hydrological cycle – water withdrawals, wastewater discharges, and land-use decisions, including their impact on stormwater flows. Together, these components can have a significant influence on the quantity and quality of water. An integrated approach is needed to keep water local and to begin to address and mitigate any hydrological imbalances that result. Water conservation is a major component of this approach and, as with energy conservation, is often the least costly and least damaging additional source of water. Planning for future upgrades, development, or expansion of water infrastructure within a community must take into consideration the interdependence of these three components.

Several guidance documents are available to assist communities with an integrated approach to water resources planning. These include guidance for developing the Local Water Resources Management Plan (Appendix B of the Interbasin Transfer Act Performance Standards,[4] WRC 2001), and the Integrated Water Resources Management Plan[5] (MassDEP 2007).

The Local Water Resources Management Plan, required by the WRC for all communities that have gone through the Interbasin Transfer Act approval process, can provide a framework for implementing these Standards and establishing long-term priorities and plans for system maintenance, source protection, and, as necessary, new source development. The goal of the plan is to integrate water supply, wastewater, and stormwater planning at the community, water, sewer, or stormwater district, or water or sewer authority level.

Communities with severe water resource management problems may benefit from an Integrated Water Resources Management Plan (IWRMP). Components of an IWRMP may be triggered by the Massachusetts Environmental Policy Act (MEPA) or the Interbasin Transfer Act. The Wastewater State Revolving Fund also encourages integrated water resources planning. The IWRMP may encompass an assessment of a community's existing water supply, wastewater, and stormwater practices and the impacts of these on the water balance in the watershed. It also identifies future needs and evaluates alternative approaches to meet those needs.

Drought/emergency management plans are another important component of water supply and demand management programs. Each public water supplier should have a written plan to respond to both naturally induced and human-made emergencies. A demand management plan that incorporates seasonal water use strategies is important to assisting water suppliers in reducing high seasonal demands and avoiding excessive strain on the water supply and distribution system or on the environment (as described in Section 9.0, Lawn and Landscape).

Standards

1. **Develop a drought management plan** that follows American Water Works Association drought management planning guidance (AWWA 2002). Develop strategies appropriate to the system to reduce

[4] http://www.mass.gov/dcr/waterSupply/intbasin/docs/finalps.doc

[5] http://www.mass.gov/dep/water/laws/iwrmp.pdf

daily and seasonal peak demands and develop contingency plans to ameliorate the impacts of drought, seasonal shortages and other non-emergency water supply shortfalls.

2. **Develop emergency management plans** as per MassDEP requirements (MassDEP Feb. 1997: Declaration of a State of Water Supply Emergency - or the latest available version).
3. **Develop a written program to comply with these Conservation Standards** and, where possible, with the recommendations outlined in this document, in the operation and management of the water supply systems.
4. **Make the above documents readily available** to personnel from all municipal departments to facilitate compliance and, if necessary, enforcement.

Recommendations

1. Integrated Planning – Infrastructure planning evaluations within communities should include water supply, wastewater, and stormwater with greater emphasis on the issue that is most problematic. Planning should follow either: a) the MassDEP guidance for Integrated Plans (MassDEP 2007); or b) the Water Resources Commission guidance for a Local Water Resources Management Plan (WRC 2001). The plans should be updated periodically. Specific principles that should be considered include the following:

    - Stormwater. Stormwater is often a significant component of the water budget and can influence the amount of water transported away from a subbasin. The Water Policy includes a recommendation to "Promote stormwater recharge close to its site of origin." Standard No. 3 of the Massachusetts Stormwater Management Standards requires that "Loss of annual recharge to groundwater shall be eliminated or minimized through the use of infiltration measures including environmentally sensitive site design, low impact development techniques, stormwater best management practices, and good operation and maintenance." (MassDEP 2008) Integrated planning efforts should recognize stormwater as a resource, especially with regards to its potential for providing recharge to the hydrologic system through infiltration or controlled surface water replenishment designs. As recommended in the Water Policy and Massachusetts Stormwater Management Standards (MassDEP 2008), communities should reduce the amount of impervious surface in new development and use Low Impact Development (LID) techniques to control stormwater runoff and increase recharge.[6]

    - Wastewater. Infrastructure often transports wastewater out of its basin of origin, thus disturbing the water balance and depleting local streamflow and groundwater. To mitigate this, options such as decentralized treatment plants and recharge and reuse should be strongly considered. The Water Policy includes a recommendation to "increase treated wastewater recharge and reuse" and states that "Infiltration and recharge of water and treated wastewater into the ground will help replenish aquifers, enhance riverine base flows, and maintain healthy flow levels even in high demand summer months." As recommended in the Water Policy, communities should consider use of reclaimed water for ballparks, golf courses, driving range fields, and other recreational irrigation, as well as for large-scale development projects.[7]

[6] Low Impact Development (LID) is an approach to stormwater management that encourages groundwater infiltration, runoff detention and filtration. LID techniques infiltrate and filter stormwater at the lot level, instead of conveying the water away from the project. The primary tools of LID are site design to minimize land disturbance and the use of landscaping features and naturally vegetated areas, which encourage detention, infiltration and filtration of stormwater on site. Other tools include water conservation, use of pervious surfaces, and maintaining existing vegetated areas. The national LID manual (Low Impact Development Design Strategies: An Integrated Design Approach) can be found on the EPA website at: http://www.epa.gov/owow/nps/lid/. Also see the low-impact development section of the Water Resources Commission website.

[7] Regulations on reclaimed water (promulgated by MassDEP in March 2009) are available at 314 CMR 20.00: Reclaimed Water Permit Program and Standards.

- Infiltration and Inflow (I/I). Infiltration is defined as groundwater that enters the wastewater collection system through physical defects such as cracked pipes/manholes or deteriorated joints. Typically, many sewer pipes are below the surrounding groundwater table; therefore leakage of clean groundwater into the sewer (infiltration) is a broad problem. Where sewer pipes run through Zone II areas or other land areas contributing flow to water supply withdrawal points, I/I to those pipes can significantly reduce the yield of that water supply. Inflow is extraneous flow entering the collection system through point sources. Inflow may be directly related to stormwater runoff from sources such as roof leaders, yard and area drains, sump pumps, manhole covers, and cross-connections from storm drains or catch basins. Inflow may also be contributed from non-storm-related point sources, such as leaking tide gates, cooling-water discharges, or drains from springs and swampy areas (Infiltration/Inflow Task Force March 2001).

- I/I removal plays an important role in balancing the water budget by minimizing the amount of groundwater and stormwater lost into wastewater systems. As applicable, communities should strive to implement the seven overall goals approved by the I/I Task Force:
  - Eliminate all sewer system backups;
  - Minimize, with a long-term goal of eliminating, health and environmental impacts of sewer system overflows related to I/I;
  - Remove all (and prevent new) inflow sources from separate sanitary systems;
  - Minimize system-wide infiltration;
  - Educate and involve the public;
  - Develop an operation and maintenance program; and
  - Improve funding mechanisms for identifying and removing I/I.

- Water Supply. Water supply development, whether for residential use, industrial use, development, irrigation or fire protection, needs to be within the water budget of the local basin. In many cases, water is moved via infrastructure from one basin to another, thus dewatering one basin in order to support another. This can lead to low streamflows, habitat impairment and other ecological problems in the donor basin. Ideally, the water should be used and discharged locally so as to create the least amount of disturbance to the water balance and the local ecology, and recharged whenever possible. In cases where transport of water across basin lines is required, alternatives must be considered, as required by the Interbasin Transfer Act. The preferred alternative would be one that is most protective of the environment while providing the most time- and cost-sensitive option.

2. Communicate with other local officials – To aid in community planning and decision making, water suppliers should keep local officials (Conservation Commissions, Zoning and Planning Boards, Selectmen, and other agencies concerned with development) regularly informed of water consumption and supply availability. These local officials should, in turn, ensure that their actions affecting land or water use do not impair the integrity of the public water supply by enabling source water to be diminished in quality or quantity, or by permitting development that exceeds the capacity of the system or impair the quantity or quality of future potential sources.

3. Water Banks – Communities and water suppliers, especially those prone to capacity problems or experiencing significant growth, should consider establishing a Water Bank. The purpose of a Water Bank is to provide a water supplier, developer, or municipality with required resources to maintain or reduce existing demand on water resources, while accommodating the water needs of existing and future development. For example, a water bank could require that anyone seeking to connect to the municipal water supply must reduce from the existing water supply system or end users at least two gallons for every new gallon that is required. Alternatively, a developer seeking connection to a wastewater collection system may reduce infiltration and inflow or recharge stormwater. For further information on water banks, see Appendix A.

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2.0 System Water Audits and Leak Detection

This chapter applies primarily to:

- *Water suppliers*
- *Water distributors*
- *Municipal governing bodies, boards, and departments*

Water audits provide water suppliers with an effective means of identifying and reducing water and revenue losses and making better use of water resources. The overall goal of the water audit is to help the public water supplier select and implement programs to reduce distribution system losses. In addition to water audits, regular leak detection survey programs provide critical information on system water losses and are an essential component of system management. Detecting and fixing leaks can provide one of the largest returns on investment, especially in older systems.

An important measure of system efficiency is the volume of unaccounted-for-water (UAW). UAW is defined as the residual resulting from the total amount of water supplied to a distribution system as measured by master meters, minus the sum of all amounts of water measured by consumption meters in the distribution system, and minus confidently estimated and documented amounts used for certain necessary purposes as specified by the MassDEP.

Examples of UAW include, but are not limited to unavoidable leakage, recoverable leakage, meter inaccuracies (unless they fall under the category of source-meter calibration, which allows for adjustment per results of source-meter calibration required in the MassDEP's Annual Statistical Report (ASR) audit), errors in estimation of stopped meters, unauthorized hydrant openings, illegal connections, data processing errors, and undocumented fire fighting uses.

Certain volumes specified by MassDEP that can be confidently estimated and documented in writing can be excluded from the calculation of UAW. As of the 2010 ASR, these include fire protection, hydrant and water main flushing; water main flow testing; water main construction; storage tank overflow and drainage; bleeding or blow-offs; sewer and stormwater system flushing; street cleaning; source meter calibration; and major main breaks, within parameters provided by MassDEP. Any adjustments made as a result of the properly documented source-meter calibration should be provided as required by the ASR. Generally, leakage is classified as UAW; however, individual water main breaks can be discounted on a case-by-case basis.

All public water suppliers are required to calculate UAW as part of the ASR submittal to MassDEP. The industry standard for UAW ranges from 10% to 15%, depending on the reference consulted. It is important to note that for many public water systems, a significant portion of UAW is not water that is wasted, misused or lost, but water that may be used for legitimate purposes but is not accurately measured, or measured at all.

Standards

1. **Conduct the ASR water audit on an annual basis** using the MassDEP Water Audit Guidance Document (http://www.mass.gov/dep/water/approvals/wmgforms.htm#audit).
2. **Conduct complete system-wide leak detection every two (2) years** unless:
   - The results of the ASR water audit indicate that leakage constitutes a small portion of the system's unaccounted-for water; or
   - The volume of leaks detected through the most current leak detection survey (conducted within the previous two years) indicates insignificant leakage.

Note: In these cases, the water supply system should work with the regulatory agency (ies) to develop a more efficient schedule for leak detection.

3. **Meet or demonstrate steady progress towards meeting[8] 10% UAW as soon as practicable**, especially in those communities in a basin with a higher level of stress[9]. The WRC will periodically monitor the state-wide progress of communities using information provided in the ASR water audit.
4. **Conduct field surveys for leaks and repair programs** in accordance with the most recent edition of AWWA Manual 36 and any MassDEP guidance documents.
5. **Repair all leaks found as expeditiously as possible**. Each community establish a priority system to implement leak repairs. Leaks causing property damage or affecting public safety should be fixed immediately. Further guidance is referenced in recommendation 3 below.

Recommendations

1. Comprehensive Water Audits – Conduct a comprehensive audit every 5 to 10 years depending on the findings of the ASR audit. A comprehensive audit is strongly recommended for communities/systems showing significant and unexplainable increases in UAW from one year to the next, and for communities/systems that are consistently unable to meet regulatory standards for UAW.

2. System Assessment – To help eliminate and prevent leaks and water loss, water suppliers should perform assessments of their systems on a regular basis to determine where capital improvements are appropriate and incorporate the recommendations into a long-term capital improvement program. Specifically, aged and undersized or structurally deteriorated pipe should be replaced, and structurally sound pipe should be cleaned and lined to ensure long-term structural integrity.

3. Guidance for Leak Repair – Communities and water suppliers looking for more specific guidance on timelines for repairing leaks should refer to documentation recommended by MassDEP:
   - AWWA Manual M36 and the ANSI/AWWA Standard G200-09 for Distribution System Operation and Maintenance
   - MWRA regulations, 360 CMR 12.09: Leak Repairs

4. Leak Detection Services – Communities and water suppliers should consider pooling resources to procure leak detection services, similar to the MWRA program that procures a leak detection consultant for a three-year period and makes the consultant services available to customer communities on a task order basis. The three-year procurement includes pricing for a larger volume of service (about 5000 miles of water main) than would be procured by any one community (typically individual community systems are 100 to 200 miles of water main).

5. Establish penalties and/or fines for stealing water –Those with authority to set and enforce penalties for theft of public water (including but not limited to municipal Water Commissioners, Town Selectmen, and public water suppliers; not including private water suppliers) develop a new bylaw/ordinance or amend existing bylaws/ordinances to establish a penalty, by providing authority to levy a significant fine and/or penalty, that may be enforced criminally or noncriminally. Massachusetts General Law (MGL Ch. 165, Sec. 11), establishes penalties for water theft consisting of triple the amount of damages or

[8] Communities already meeting the 10% UAW standard should continue activities to further reduce UAW, taking advantage of advancing technology. The Commonwealth recognizes the existence of circumstances that could affect a community's efforts to fully meet this standard. These circumstances could include aging infrastructure. In such cases, the community should document, as part of its regulatory requirements, all efforts that have been undertaken in order to comply with this standard.

[9] Basin stress as defined by the Water Resources Commission. See WRC publication 'Stressed Basins in Massachusetts, December, 2001' or most recent version.

$1,000, whichever is greater, or imprisonment, or both. The language of MGL Ch. 165, Sec. 11 is included in Appendix B. Example language from a recent bylaw passed in East Bridgewater, Massachusetts, on unauthorized use of a fire hydrant is also included in Appendix B.

6. Remote Reading – Communities/water suppliers should consider investing in an automated remote leak detection system.

7. Pressure Reduction – The Massachusetts plumbing code (248 CMR 10.14(g) Excessive Water Pressure) requires that a pressure-reducing valve be installed on the water service connection to a building when the pressure is eighty (80) pounds per square inch (psi) or greater. Community water suppliers should evaluate existing water system regulations in order to ensure compliance with this regulatory requirement. This evaluation could include the establishment of maximum pressures for users as a conservation measure. Maintaining water pressure within the regulatory limit conserves water. Water suppliers should map their jurisdictions to show areas in which water pressure may exceed the limit in the absence of pressure-reducing valves. They should recommend to and assist the plumbing inspector in conducting periodic surveys to determine whether the pressure-reducing valves are functioning properly, and take remedial action as needed.

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3.0 Metering

This chapter applies primarily to:

- *Water suppliers*
- *Water distributors*
- *Municipal facilities and public works personnel*
- *State facilities personnel*
- *Industrial facilities, commercial facilities, and other consumers who own large meters (such as residential institutions and multifamily complexes)*

Complete system metering informs both the supplier and the customers of how much water they are using, provides the supplier with valuable knowledge of customer use patterns, assists in demand management programs such as water audits, and enables the supplier to bill the customer more accurately based on actual use. Complete system metering also provides essential data for managing water resources state-wide. With accurate knowledge about current water use, the supplier can more effectively identify potential water savings and assist specific users to implement water-saving measures, thereby providing the opportunity to reduce overall system demand. This would also free up water that may be needed by new customers, and enable the retention of more water in the natural environment. In addition, full and accurate metering means that water suppliers can be paid for all the water they provide, without lost revenue from unmetered or inaccurately metered water.

Standards

1. **Ensure 100% metering of all water uses**, including all indoor and outdoor water use at all municipal and state facilities (schools, school athletic fields, etc.). Properly size the service lines and meters for all water distribution system users to meet AWWA performance standards. See AWWA Manual M6, Water Meters – Selection, Installation, Testing, and Maintenance.
2. **Increase billing frequency**. For domestic accounts, bill customers on actual, not estimated, meter readings. If billing frequency is less than quarterly (i.e. annual or biannual), implement quarterly or more frequent billing as soon as possible. This helps customers keep better track of their water use, take note of seasonal variations or potential leaks, and make adjustments in their water use accordingly. Frequent billing also reduces the risk of unexpectedly high water bills and unhappy customers resulting from undetected new leaks.
3. **Implement a water meter repair/replacement policy and program**. The program should replace meters by size and time based on AWWA standards (AWWA Manual M6). Establish an annual budget line item for the calibration, replacement, and repair of all sources of supply and distribution network water metering systems.
4. **Seal all water account metering systems against tampering** and periodically inspect to ensure water works system integrity.
5. **Calibrate** any meter used to record quantity, according to its type and specification. The AWWA Standards (AWWA Manual M6) can be consulted for calibration requirements and accuracy standards. Time periods for calibration are generally based on meter size. Meter wear is a function of the amount of water metered rather than the passage of time.
6. **Properly size water service lines and meters** to handle required water volumes and ensure a high level of metering accuracy.

7. Water suppliers **establish the necessary regulations and controls** to ensure that owners of large meters (1.5 inches or greater) calibrate the meters annually and provide the results as part of an annual reporting requirement.

Recommendations

1. Funding for Meter Replacement – The Commonwealth should make financial assistance (e.g. matching grants) available for meter replacement and automatic meter reading equipment.

2. For billing,
   - Indicate the rate structure on the water bill.
   - For large users read meters and generate bills monthly.
   - Where applicable, share the cost of reading and billing between the water and sewer operations.
   - Utilities move toward adopting billing software that allows customers to compare their individual water use for the previous 12 months, and compare their water use with average water use for their customer class.
   - Report water use in gallons and provide a table or brochure on residential water use that includes residential gallons per capita per day (rgpcd), a comparison of the average cost of bottled water to the cost of tap water, a comparison to water-use standards, and promotion of efficient water-use behavior (see Appendix C).
   - Printed material encouraging residents to save money by conserving water, providing advice on how to conserve, announcing rebates, etc. should accompany the water bill (see Appendix C).
   - Water bills could include an automated "thanks for conserving water" message where use drops over the comparable period the previous year, and a "please do what you can to conserve water" message for users whose water use increased over the same time period.
   - In communities with Automatic Meter Reading systems, a web site could be set up to provide secure access to water use-data by customers and water auditors.

3. Remote Reading – Communities/water suppliers should consider investing in an automated meter reading system that allows remote reading of meters and facilitates more frequent billing to improve cash flow, eliminates estimated meter readings, utilizes employees efficiently, supports water audits, detects leaks, monitors UAW, enables users to track their water use, and provides water suppliers with more detailed information on water-use patterns in the community that can be useful in enforcing water-use regulations.

4. Minimize Use of Estimated Data – Meter reading should be done in a manner that allows for actual data instead of estimated data for ASR reporting.

4.0 Pricing

This chapter applies primarily to:

- *Water suppliers*
- *Water distributors*
- *Municipal governing bodies, boards, and departments*
- *State policy and regulatory entities*

Consumers should be charged the full cost of water. Full-cost pricing refers to price levels that recover all the direct and indirect costs associated with providing water, as outlined below in Pricing Standard 1. Full-cost pricing can take the form of any rate structure, so long as all costs are recovered through prices. Pricing should be reviewed and updated often enough to avoid budget shortfalls due to erosion of revenues and increases in costs (such as energy) from inflation.

The price of water can be an important demand management tool if set properly. Studies have shown that, to some degree, demand for water can be manipulated by price. Water for necessities (sanitation, cleaning, and cooking) is far less responsive to price than water for more discretionary uses (lawn watering, car washing, and swimming pools).

Rate structures can be categorized as being conservation-oriented (likely to promote conservation), conservation-neutral (neither promoting nor discouraging conservation), or discouraging conservation. Some conservation pricing options include:

- Increasing block rates
- Seasonal rates

Increasing block rates charge a higher unit price as consumption rises.

Seasonal rates, where prices rise and fall according to water supplies and weather conditions (with higher prices usually occurring between April and October), target discretionary uses of water (such as lawn watering, sidewalk cleaning, and pool filling). Adopting higher water rates in the summer is strongly recommended as this directly addresses peak water use, one of the biggest challenges for water utilities (MAPC 2006). Water consumption typically peaks in the summer when outdoor water use increases and, in some areas, there may be an increase in population due to an influx of vacationers. This is also the time of year when water-dependent organisms and ecosystems are already under considerable stress and can least afford to have water levels further reduced.

For effective pricing, water suppliers, communities, and water planners need to consider, at a minimum, the following three issues: i) the service population's ability to afford higher rates; ii) the effects of conservation rates on a utility's revenues; and iii) the actual effectiveness of rates in reducing water demand (EPA 2003). Further guidance on these three concepts is provided in pricing guidance documents referenced in footnote 12.

A variety of rate structures are used throughout Massachusetts. Some are conservation-oriented while others are not. Based on results of a survey of Massachusetts communities (Tighe & Bond 2010):

- 63% use an ascending rate structure;
- 6% use seasonal rates;
- 35% use a flat rate structure; and
- 2% use a flat fee.

Billing is another important component of operations that provides an opportunity to enhance conservation if implemented effectively. Billing at a frequency that provides customers the opportunity to regularly evaluate and adjust their use is preferable. Of the Tighe & Bond (2010) survey respondents:

- 56% use quarterly billing;
- 34% use a biannual billing cycle;
- 6% use a monthly billing cycle; and
- 4% use either an annual, bimonthly, or tri-annual frequency.

In addition to billing frequency, the ease of understanding a bill and the educational value of the bill are also important methods of promoting conservation, as outlined in Section 3.0, recommendation 2.

Standards

1. **Use Full-Cost Pricing**. Establish a water pricing structure that includes the full cost of operating, maintaining, and protecting the water supply system. Perform a rate evaluation every three to five years to adjust costs as needed. Full-cost pricing factors all costs including operations, maintenance, capital, and indirect costs (such as environmental impacts, watershed protection, and revenue stabilization) into prices. Full-cost pricing can take the form of any rate structure so long as all costs are recovered through prices. A full-cost water pricing structure includes, but is not limited to, the following:
   - A water conservation program that could include the following:
     - Purchase and installation of water conservation/retrofit devices and rebate programs to promote their adoption in the service community;
     - Water audits;
     - All aspects of a public education program including purchase and distribution of educational materials and related staff time;
     - Leak detection equipment, services, and repair;
     - Metering and billing, including a meter replacement/repair program; and
     - Automated meter reading equipment, including installation and maintenance.
   - Hiring staff to run all aspects of the water supply system, staff benefits package, and staff training and professional development;
   - Pumping, maintenance, electricity/fuel;
   - Treatment and associated treatment plant costs;
   - Distribution system operation, repair, and maintenance;
   - Watershed land purchase/protection, well site purchase/protection, aquifer land purchase/protection, stormwater recharge plan;
   - A capital replacement fund, capital depreciation account, and debt service; and
   - A rate stabilization fund to moderate potential fluctuations in revenue associated with fluctuations in consumer demand.
2. **Prohibit decreasing block rates**. Decreasing block rates that charge lower prices as water use increases during the billing period, are **not allowed** by M.G.L. Chapter 40, Section 39L. Although this law does not cover private companies that are regulated by the Department of Public Utilities, private water companies are governed by a memorandum of understanding (dated December 29, 1998) between the DPU and MassDEP. MassDEP will include a provision requiring the filing of a rate adjustment application with DPU in any permit issued to a private company. This rate adjustment application shall

propose either a flat or increasing block rate structure. DPU must then consider the application and issue a determination directing the company to implement either a flat or increasing rate structure unless the company has adequately supported reasons why this should not occur. Although flat fee systems and uniform rates are allowed, increasing block or seasonal rate structures are preferred (see recommendation 1 below).

Recommendations

1. Rate Structuring – To promote water conservation, communities and water suppliers should consider rate structures that encourage efficiency in essential water use and reduction of nonessential water use. Generally nonessential uses are defined as those activities not required: (a) for health or safety reasons; (b) by regulation; (c) for agricultural production; (d) for the maintenance of livestock; or (e) to meet the core functions of a business. Communities and water suppliers should avoid flat fee rates,[10] and uniform rate structures[11] that are set too low to encourage conservation. These rate structures do not discriminate between essential and non-essential water use, and do little to encourage conservation. Those with responsibility for setting rates must consider the impact of adopting seasonal and increasing block rates on those uses that may fall into one of the above categories. It may be more appropriate to develop a separate rate category for other classes of uses (i.e., "essential"), which takes into account the legitimate essential water uses, but still provides for water conservation.

   The following rate structures may be appropriate to reduce nonessential water use:

   - Increasing block rates. Increasing block rates or tiered pricing encourages reduced water use by increasing the per-unit charges for water as the amount used increases. For residential rates, the first block should be based on a volume of water that represents efficient indoor water use by an average household, the next block is charged at a higher rate, and so forth. The price difference between blocks and the number of gallons included in each block are very important in influencing the customer's use behavior. If the difference in cost between blocks is too small, or the number of gallons included in each block is too large, it will not provide the incentive to conserve at the higher block rate.

   - Seasonal rates. Seasonal rates are set according to water demands and climate conditions. There are a variety of approaches to develop conservation-oriented rates including increasing block rates only during the summer months (May 1 to September 30 when demand is often higher) or a year-round inclining block rate structure with higher block rates during the summer months.[12]

2. Enterprise Accounts – It is recommended that the water supplier establish an enterprise account for water in accordance with Massachusetts General Law, Chapter 44, Section 53F 1/2 Enterprise Funds.

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[10] Flat fee rates do not vary by customer characteristics or water use.

[11] A uniform rate charges the same price per unit for water use beyond the fixed customer charge, which covers some fixed costs. If uniform rates are high enough, they can encourage conservation although not as effectively as an increasing block rate.

[12] For more information on developing conservation-oriented rates, see:

- "Water Conservation-Oriented Rates: Strategies to Extend Supply, Promote Equity, and Meet Minimum Flow Levels" (Wang et al., American Water Works Association, 2005)
- New England Water Works Association.2009. Best Management Practice – Conservation Pricing: Rate Setting, Metering, and Billing Considerations to Encourage Water Conservation. May 29, 2009. Available at http://www.newwa.org/Media/waterUtilityNews.htm
- The US EPA homepage on Water and Wastewater Pricing: http://water.epa.gov/infrastructure/sustain/financing_priceofwater.cfm
- "Water and Wastewater Pricing, An Informational Overview" (US EPA Office of Water and Wastewater Management EPA 832-F-03-027) http://www.epa.gov/owm/waterinfrastructure/pricing/pdfs/waterpricing_final2.pdf
- American Water Works Association,: M1 Principles of Water Rates, Fees and Charges 5th, edition (2000).

3. Develop a Methodology to Assess Environmental Costs – EEA should commit to developing a methodology for assessing the environmental costs of water withdrawals for water suppliers to use in setting true "full cost" water prices.

5.0 Residential

This chapter applies primarily to:

- *Residential consumers*
- *Institutional and commercial facilities*
- *Water suppliers*
- *Water distributors*
- *Municipal governing bodies, boards, and departments*
- *State facilities personnel*
- *State policy and regulatory entities*

Over fifty-five percent of the metered public water supply in Massachusetts is used for residential purposes.[13] So, any improvements in residential water efficiency will result in significant water savings. Residential water use consists of indoor and outdoor water use. Indoor use typically includes toilets, clothes washers, showers, faucets, dishwashers, and other domestic uses including cleaning and cooking. National average indoor water use for a nonconserving and a fully conserving single-family home in North America are presented in Appendix D, Table 1, and residential water-use data and benchmarks are provided in Appendix E. Outdoor water use can include irrigation of lawns and gardens, filling and refilling swimming pools, car washing, and other cleaning. Leakage within the consumer-owned portion of the water system can be an additional and sometimes substantial component of indoor and outdoor water use.

Standards

Additional standards for outdoor residential water use related to lawns and landscapes are presented in Section 9.0 Lawn and Landscape.

1. **Install Water-Efficient Plumbing Fixtures**. For plumbing fixtures installed prior to 1989, meet the standards set forth in the Federal Energy Policy Act, 1992 (or most recent version) and the Massachusetts Plumbing Code (Appendix D, Table 2). Include low-flow showerheads, faucet aerators, low-flow toilets (1.6 gpf), or high efficiency toilets (HETs) (1.28 gpf or less).[14] Provide and promote toilet leak detection kits, and educational literature about installation of water-saving devices and water conservation savings (in gallons and dollars) in retrofit programs.
2. **Use Residential Water Efficiently**. Meet or demonstrate steady progress toward meeting[15] residential water use of 65 gallons per capita per day (gpcd), including both indoor and outdoor use, as soon as practicable, especially in those communities in a basin with a higher level of stress.[16] The WRC will periodically monitor the state-wide progress of communities using information provided in the ASR water audit.
3. **Implement a comprehensive residential water conservation program** that seeks to reduce residential water use by implementing some or all of the applicable recommendations listed in this section and by meeting the standards in Section 9.0 on Lawn and Landscape. The scope of the program will be specific

[13] Based on MassDEP analysis of ASR data for 2009 and 2010, fifty-five percent of water that entered distribution systems was metered as residential.

[14] Manufacturers continue to improve fixture efficiency. As of 2012, 68 manufacturers offer 550 models of single-flush high-efficiency toilets (1.28 gallons per flush or less). See EPA's WaterSense program for product evaluations and guidelines on selecting the most efficient fixtures.

[15] The Commonwealth recognizes the existence of circumstances that could affect a community's efforts to fully meet this standard. These circumstances could include aging residential infrastructure and large seasonal population fluctuations. In such cases, the community should document, as part of its regulatory requirements, all efforts that have been undertaken in order to comply with this standard.

[16] Basin stress as defined by the Water Resources Commission. See WRC publication 'Stressed Basins in Massachusetts, December, 2001' or most recent version.

to circumstances in each community and the recommendations listed below are provided as a menu of options. If a community's water consumption is at or below 65 gpcd, that community should continue with efforts to remain at that level or improve residential per capita water use.

Recommendations

The following recommendations apply to indoor water use and outdoor water use that is not related to lawn and landscape maintenance. Recommendations for outdoor residential water use related to lawns and landscapes are presented in Section 9.0 Lawn and Landscape.

1. Promote Water-Efficient Household Appliances – Water Efficient Household Appliances (especially clothes washers) provide an opportunity for significant water (and energy) savings (Appendix D, Table 1). In most communities, indoor water use constitutes the majority of water used, even in summer. State and municipal officials should take the lead with professional organizations in implementing the following six strategies to achieve this recommendation.
   - Update the State Plumbing Code. The State should include efficiency standards for household appliances in the plumbing code and should update existing plumbing fixture standards to reflect current designs that allow for greater water-use efficiency.
   - Create tax incentives for installation of water-efficient appliances. The State should investigate opportunities to provide a sales tax exemption on the purchase of qualified water-efficient toilets and washing machines.
   - Offer rebates for replacing inefficient fixtures and appliances. Communities with older housing stock should consider the costs/benefits of implementing a wide-ranging program to replace older, high-water-use toilets through retrofit/rebate programs as described above. Water suppliers should consider providing customer rebates for water-efficient fixtures and appliances. The state should investigate opportunities to offer rebates on water-efficient appliances through the energy industry.
   - Install water-efficient fixtures and appliances in new construction. Water suppliers, water commissioners, mayors, selectmen, building and/or plumbing inspectors, and appropriate local boards or officials should work together, strongly recommending that contractors and owners install water-efficient household appliances, including clothes washers, "point of use" water heaters and dishwashers, in new developments and redevelopments whenever feasible.
   - Incorporate water conservation into MEPA review for large new developments. EEA should work with MEPA to develop a standard set of water conservation recommendations as part of the MEPA review for large new developments and redevelopments. The recommendations should include but not be limited to the installation of water-efficient household appliances and meeting all appropriate standards and recommendations for lawn and landscape water conservation as included in Section 9-Lawn and Landscape.
   - Promote use of high-efficiency toilets (HETs).[17] Programs that include low-flow toilets should consider High Efficiency Toilets that use less than 1.28 gallons per flush, including "dual-flush" toilets widely used in Europe and Australia, as well as power-flush models that use as little as 0.8 gpf and offer significant water savings over the now standard 1.6-gallon models. Performance testing indicates that many HETs provide equal or greater flushing power than conventional toilets (http://www.map-testing.com/).

2. Provide Residential Water Audits – Communities and water suppliers should consider providing free or low-cost residential water audits to customers, targeting the largest users first. A residential water audit should include the following components at a minimum:
   - Inspection of toilets, showers, faucets, clothes washers, dishwashers, water filters, water softeners, evaporative coolers, spa/hot tub, etc. for leaks, flow rate, presence of water-saving retrofit devices, and efficient use of fixtures and appliances by residents. Audits should include a payback analysis

[17] http://www.cuwcc.org/resource-center/products/toilet-fixtures-main.aspx http://www.map-testing.com/

showing homeowners how reductions in water costs justify the investment in the recommended upgrades. A sample worksheet for residential water audits is included in the Handbook of Water Use and Conservation (Vickers 2001).

3. Promote Efficient Non-Landscape Outdoor Water Use – The State, communities, water suppliers, and other applicable public/private/nonprofit organizations should promote efficient outdoor residential water use by educating consumers to adopt simple but effective practices such as the following:
   - Covering swimming pools when not in use to prevent evaporative losses;
   - Sweeping driveways, walks and decks with a broom rather than hosing them off; and
   - Washing vehicles using a bucket and sponge, employing a hose for rinse only.
4. Promote Efficient Lawn and Landscape Water Use – See Section 9.0 for lawn and landscape standards and recommendations.
5. Promote Waterless Plumbing Fixtures – Communities, water suppliers, developers and individuals wishing to go beyond current standards and do more to conserve water should consider installing waterless plumbing fixtures such as a composting toilet or 3-ounce foam flush toilet, which can be flushed with only 6 ounces of a soapy solution (3 ounce pre-flush and 3-ounce post flush). State and municipal buildings should be used as demonstration sites for these technologies.
6. Minimize/Discourage Use of Garbage Disposals – Encourage consumers to reduce the use of sink garbage disposals to improve septic system function (where applicable) and save water. Divert compostable waste to a compost pile instead. Finished compost then can be added to the soil around the home or even spread thinly on the lawn to help boost its soil moisture retention capacity and reduce the need for watering.
7. Educate Homeowners about how Water Conservation benefits Water Quality – Water conservation helps septic systems work better and last longer, and in sewered communities reduces the burden on wastewater treatment facilities, augmenting the return on investment in water-conserving fixtures and appliances.
8. Facilitate Leak Repair – Communities should create a list of plumbers that would be willing to fix a leak at a reasonable rate, and provide this list to the public, to provide an incentive for people to fix leaks that they might otherwise allow to run continuously.
9. During site design, incorporate Low Impact Development (LID) techniques that preserve or restore a site's natural hydrology, and use low water-use/drought-resistant landscaping techniques, to the maximum extent practicable.

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6.0 Public Sector

This chapter applies primarily to:

- *Municipal governing bodies, boards, and departments*
- *Municipal facilities and public works personnel*
- *State facilities personnel*
- *Private and nonprofit organizations*
- *State policy and regulatory entities*

Municipal and state buildings, facilities, and landscapes should be at the forefront on indoor and outdoor water use efficiency. They should set an example and lead the way in water conservation, water-saving techniques, and concepts. These sites should serve as demonstration sites with signage to make the public aware that the state and municipalities are leaders in water conservation. The following standards and recommendations will help emphasize and implement water conservation and efficiency in government buildings, facilities, and landscapes. They will also help to accurately account for water use and serve as demonstrations of water saving techniques and concepts to the public. Appendix L highlights features of municipal water conservation programs in Massachusetts.

Standards

1. Municipal and state buildings
   - **Conduct indoor and outdoor audits** and account for full use of water, based on full metering of public buildings, parks, irrigated playing fields, and other facilities.
   - **Analyze existing water-use data** to spot trends, patterns, and unexplained increases that could indicate leaks or inefficient use of water.
   - **Identify** measures where the **greatest efficiencies** and potential savings can be realized.
   - Build new public buildings with **equipment that reduces water use**, such as faucet aerators, low-flow showerheads, composting or high-efficiency toilets (HETs) (or "dual-flush" models),[18] and self-closing faucets. Water-saving devices and measures should be well identified to users of public buildings and facilities.
   - **Focus on replacing/retrofitting** water-consuming equipment in buildings (e.g. bathrooms, boilers, chillers).
   - **Practice good, efficient lawn and landscape water-use** techniques and meet the standards as described in Section 9.0.
2. **Meter or estimate contractor use of water** from fire hydrants for pipe flushing and construction.
3. **Strictly apply plumbing codes** and incorporate other conservation measures in new and renovated buildings.

Recommendations

1. Outdoor Water Use – Adopt outdoor water-use strategies as per recommendations in Section 9.0 on Lawn and Landscape.
2. Create Demonstration Sites – Use public buildings as demonstration sites for innovative water conservation techniques such as composting, foam-flush and dual-flush toilets, cisterns for rain collection, and water-wise landscaping.

[18] High-efficiency toilets (HETs) have an effective flush volume of 1.28 gallons per flush or less.

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7.0 Industrial, Commercial, and Institutional (ICI)

This chapter applies primarily to:

- *Commercial facilities*
- *Industrial facilities*
- *Institutional facilities*
- *Municipal facilities*
- *State facilities*

Water is crucial for the functioning of industrial, commercial, and institutional (ICI) facilities (including hospitals, schools, prisons, universities, and colleges). It may be used for heating, cooling, and processing, and includes an appreciable sanitary and landscaping component. In many communities, ICI facilities can use more gallons per day than any other individual water user. Instituting water conservation measures will help reduce the overall community water use significantly and result in appreciable monetary savings. The measures must be tailored to reflect the type of water use and characteristics of individual facilities (see Appendix F for BMPs). They can be built into an industry's strategy to comply with sewer and National Pollutant Discharge Elimination System (NPDES) discharge requirements. The following standards and recommendations increase the efficiency of water use through use of best available technologies.

Standards

1. **Carry out a water audit** to determine the location and amount of water used for heating, cooling, processing, sanitary use, and outdoor use (see Appendix H for sample ICI water audit). Use the findings from the audit as the basis for actions to conserve water such as:
   - Recycling and reusing cooling waters to achieve greatest water-use efficiency/closed-loop cooling.
   - Using non-potable water (in conformance with the plumbing code and MassDEP regulations[19] to assure safe drinking water and to avoid cross-connections).
   - Using heat-sensitive valves to control cooling equipment.
   - Replacing water cooling with air cooling (where possible within air quality standards).
   - Installing or retrofitting efficient sanitary water devices, performing scheduled meter maintenance and calibration, and xeriscaping.
2. Significant users (i.e. those using greater than 50,000 gpd) **install separate meters for process water** so that water can be accounted for and appreciated as a raw material in production and for sanitary use.
3. **Develop and implement a water savings strategy**, addressing among other items: demand management, leak detection and repair, a program of preventive maintenance, and a program of employee education.
4. In new and renovated buildings, comply with plumbing codes, **use the best available technologies for water conservation, and reuse treated wastewater** within the facility to the extent possible.
5. **Practice good lawn and landscape water-use techniques** and meet the standards described in Section 9.0.

Recommendations

1. The EEA Office of Technical Assistance (OTA) should be reinforced in its efforts to provide technical assistance to companies and large water users and work with industry groups and suppliers.

[19] See 314 CMR 20.00. Reclaimed Water Permit Program and Standards.

2. Significant users should aim, wherever possible, to decrease their average water use by at least 10%. The investment will pay back in the form of lower water, wastewater, and energy bills.
3. All ICI users should install/retrofit water-saving sanitary devices, including but not limited to low-flow showerheads, faucet aerators, toilet displacement devices, and low-flow or high-efficiency toilets and urinals. Guidelines on efficient products can be found on the WaterSense program website at www.epa.gov/watersense/.
4. Industrial and commercial users should work with code officials, standards committees, state programs, manufacturers, and legislators to promote water conservation and efficient use.
5. Increase the amount of pervious areas on property. ICI facilities often include large areas of impervious surfaces (building rooftops, parking lots, etc.) which offer excellent opportunities for replacement with pervious materials, installation of green roofs and bioretention areas in parking lots, and rainwater harvesting. Rainwater harvesting can serve as a supplemental water supply source and can infiltrate clean runoff into the ground where it can replenish aquifers and streamflow.
6. See Section 9.0 for lawn and landscape recommendations.

8.0 Agricultural

This chapter applies primarily to:

- *Agricultural and horticultural entities*
- *State policy and regulatory entities*

Commercial agriculture is highly water dependent and economically sensitive to water availability and quality. It cannot exist without access to water. In Massachusetts, agricultural water users tend to be self-suppliers with wide-ranging needs for water. Water is used i) for irrigation of crops and nursery stock; ii) for harvesting of crops (cranberries); iii) as the medium for aquaculture; iv) for washing and processing of commodities; v) as a drinking source for livestock; and vi) for cleaning and cooling animals.

Agricultural needs for water vary by type of enterprise and on a seasonal basis. Water demands are also site specific and, depending on the type of enterprise, are affected by multiple factors, including climate and weather, number and types of animals, the water-holding capacity and infiltration rate of the soil, and differing crop needs.

Any conservation approach to agriculture should strike an appropriate balance between both agricultural needs for water and the need to conserve water. Examples of conservation approaches in agriculture include proper irrigation scheduling, in both timing (daily and seasonal) and volume; control of runoff; the uniform application of water; irrigation technologies, such as drip irrigation (where appropriate) and automated irrigation systems for cranberry operations; and the use of tail-water recovery systems.

The standards encourage the adoption by agricultural entities of a conservation approach to water use that is appropriate for their operation and site conditions.

Standards

1. As part of the management of an agricultural operation, adopt a water conservation approach through which **water is used** in a planned and efficient manner with appropriate amounts and frequency **to meet needs without excessive water loss**. Over-irrigating can damage crops and increase runoff, washing nutrients and minerals out of the soil and damaging soil in the long run. Establish an irrigation schedule based on the needs of the crop.

Recommendations

1. A Water Conservation Working Group comprised of agricultural stakeholders should be coordinated and facilitated by the Department of Agricultural Resources (DAR). The role of the working group is to identify ways to improve water efficiency in all categories of agricultural water use and facilitate water-use planning and drought contingency planning by growers.
2. Industry member associations and commodity groups are encouraged to develop and promote industry-specific best management practices that are dynamic, adaptable to new technology, and selected based upon both economic and environmental concerns.
3. The Agro-Environmental Technology Grant[20] program should be funded and should include funding dedicated to the development of innovative technologies for water conservation.

[20] Other Agricultural Grants for water conservation:

- Agricultural Environmental Enhancement Program (AEEP), 251 Causeway Street, Boston, MA 02114. Contact: 617-626-1700. http://www.mass.gov/agr/programs/aeep/index.htm
- Environmental Quality Incentives Program (EQIP), USDA Natural Resources Conservation Service, 451 West Street, Amherst, MA 01002. Contact: 413-253-4350

4. Micro-irrigation systems, such as subsurface drip irrigation (SDI) should be adopted where suitable. According to the United States Department of Agriculture's Natural Resources Conservation Service, micro-irrigation systems are suited to orchard and row crops, windbreaks, greenhouse crops, residential and commercial landscape systems, on steep slopes where other methods would cause excessive erosion, or on areas where application devices interfere with cultural operations.
5. Growers should maintain adequate soil moisture for optimum plant growth without causing excessive water loss, erosion, or reduced water quality. Adding organic matter, such as manure or compost, to the soil can enhance its moisture retention capacity, reducing the need for irrigation.
6. Where sprinkler systems are used for irrigation, the systems should be capable of uniform application of water with minimal evaporative loss and minimal surface run-off. The amount of water applied should only be sufficient to fill the effective crop root zone. Irrigation during hot or windy conditions should be avoided in order to minimize evaporation.
7. Irrigation system efficiency should be evaluated on a regular basis. See Appendices I and J.

9.0 Lawn and Landscape

This chapter applies to all water users.

The WRC formally added the Lawn and Landscape Water Conservation Standards and Guide[21] as an addendum to the Water Conservation Standards in October 2002. At that time, the Commission also adopted the following policy on outdoor water use:

> *Water used for maintaining landscapes and lawns should not be used at the expense of public health and safety or the environment. Water that is used for maintaining landscapes and lawns should be used in a manner that minimizes such use through the implementation of sound water conservation and water efficiency practices.*

The above policy statement and the standards and recommendations are incorporated and defined herein along with revisions to bring them up to date.

Standards

1. **Minimize watering lawns or landscapes**, especially in water-short communities and where the water source is in a stressed basin or sub-basin.
2. **Develop and implement seasonal demand management plans** as part of the drought management plan. These plans must identify water supply and environmental indicators (such as streamflow triggers) to serve as water-use restriction triggers and outline a set of increasingly stringent and effective water-use restrictions that are designed to protect public health and the environment.
3. **Adopt and implement (as appropriate) a water-use restriction bylaw**, ordinance, or regulation, which applies to both municipal and private wells. This bylaw, ordinance, or regulation should provide the community government or designee (i.e. water supplier, police department, etc.) with the ability to implement mandatory water-use restrictions. These restrictions should be tied to water supply and environmental indicators (such as streamflow triggers) as outlined in a seasonal demand management plan. See Appendix B for model water-use restriction bylaws.
4. **Abide by water restrictions** and other conservation measures implemented by the municipality or water supplier.
5. **Fully enforce water-use restrictions**. This will ensure effectiveness of the restrictions so that they will be taken seriously by the public. Also, empower authorities to issue warnings to first-time offenders and citations to repeat offenders.

Recommendations

Unless otherwise noted, the following apply to: i) owners and managers of residential, industrial, commercial and institutional lawns and landscapes; ii) recreational fields and golf courses; iii) owners and managers using private wells or water sources; iv) municipal and school land managers; and v) state agencies.

[21] For further reference, see the following publications in the References section:

- WRC. May 2002. Guide to lawn and landscape water conservation. Available at http://www.mass.gov/eea/docs/eea/wrc/lawnguide.pdf.
- EEA. 2004. More than just a yard: Ecological landscaping tools for Massachusetts homeowners. Available at http://www.mass.gov/eea/docs/eea/wrc/morethanjustyard.pdf

In addition to these recommendations, Appendix I provides a summary of recommendations for lawns and landscapes; Appendix J includes a checklist for lawn and landscaping irrigation water efficiency; and Appendix K includes Massachusetts Turf and Landscape Irrigation Best Management Practices.

1. Establish policies, regulations, or bylaws/ordinances that ensure that land use and development practices preserve natural vegetation, preserve or restore a site's natural hydrology (by using techniques such as LID), and use low water-use/drought-resistant landscaping techniques, to the maximum extent practicable.[22]

2. Minimize Use of Potable Water and Groundwater for Lawn Irrigation –Use collected rainwater or treated wastewater to help meet outdoor water demand, whenever possible. Communities should strive to avoid application of potable drinking water for lawn irrigation purposes. Additionally, use of other groundwater sources for lawn irrigation, such as private irrigation wells, should be minimized or avoided.

3. Control Outdoor Water Use – Limit the number of watering days per week or per month (in most years Massachusetts generally has enough rainfall to naturally supply the water needs of a healthy mature lawn, designed to be drought-resistant, *without the need for watering*). Clients and other users of lawns, recreational fields, etc. should be informed that some turf grasses naturally go brown and dormant during hot dry weather and will usually revive when cooler, wetter weather returns. See Appendices H, I, and J for more information on watering.

4. Infiltrate Rainwater – Redirect gutter downspouts or rainwater collection overflow spouts away from pavement and into places where water can infiltrate into the ground, like a rain garden.

5. Irrigate Efficiently – Water only when necessary. The amount of water applied should be sufficient to only fill the effective root zone and minimize evaporative loss. Do not water during precipitation events, and avoid watering in windy conditions, and during the hottest part of the day (8am to 6pm).

6. Maximize Water Conservation of Automatic Irrigation Systems – Use the best available technology to ensure maximum water efficiency and conduct regular irrigation audits to evaluate and adjust water efficiency.
   - Install water conservation equipment including moisture sensors, rain shut-off devices, and climate-based controllers. Basic recommended features of a good irrigation system controller are outlined in Appendix I and associated references.
   - Properly operate and maintain automatic irrigation systems. Sprinkler irrigation systems should be capable of uniform application of water with minimal runoff and evaporative loss. Evaluate irrigation system efficiency on a regular basis. A do-it-yourself checklist for evaluating lawn and landscape irrigation efficiency is included in Appendix J. Appendix K provides additional Best Management Practices for lawn and landscape irrigation.
   - Avoid installing automatic lawn irrigation systems in water-short communities. Where local bylaws do not restrict or prohibit the installation and operation of irrigation systems, they should nevertheless prohibit the operation of those systems that are wasteful (e.g. municipalities should issue fines for irrigation systems that spray and/or run off significant amounts of water onto unplanted surfaces such as sidewalks, driveways, etc.; or systems that water during rainfall events).

7. Enhance Soil Health – Ensure adequate depth and type of soil. At least 6 inches of topsoil is recommended. Generally, a sandy loam with 5% organic content is recommended for turf grass and landscapes. Some tips for soil improvement include using peat moss, manure or compost to improve

[22] For more information see: "Create a Framework: By-laws and other Regulations" in "Summer Smart Water Use, A Guide to Peak Season Water Demand Management for Massachusetts Communities" (MAPC and Arc of Innovation, 2006), and Refer to the EEA LID webpage (and the Massachusetts Smart Growth/Smart Energy Toolkit (http://www.mass.gov/envir/smart_growth_toolkit/) for details on LID.

moisture retention, and using organic fertilizer for strong root growth.[23] Avoid pesticides that also kill beneficial organisms such as earthworms that aerate and fertilize the soil naturally. Choose proven biological pest management materials to control grubs. See Appendix I for more information.

8. Mow High, Often, and Sharp – Mow lawns at the highest recommended height (at least 2.5 inches), and do not allow grass to grow higher than about 4 to 5 inches. Sharpen the mower blades to cut the grass blades cleanly rather than shred them; this will minimize water loss and help to reduce the chances of disease infestation. Allow grass clippings to decompose where they fall, and contribute to the organic content of the topsoil. If clippings tend to be very clumpy, simply mow over them again to cut them into smaller pieces. This will help them to filter down into the lawn, decompose more quickly, and prevent smothering of grass plants.

9. Plant According to Micro-Climates – Be aware of the various micro-climates in your yard (hot/sunny, cool/shady, moist, dry, etc.) and plan your gardens and plantings accordingly. Do not plant water-loving plants unless you have the natural conditions to support them without supplemental irrigation. There are many varieties of low water-use plants that can minimize the need for supplemental watering and provide additional wildlife value.[24]

Additional Recommendations

Owners and Managers of Recreational Fields and Golf Courses

- Design and maintain facilities to minimize water use, ideally relying on rainwater to meet all irrigation needs.
- If studies indicate that irrigation is required to maintain proper turf health and safe athletic fields, follow best management practices outlined above and in Appendix I and associated references, to minimize water use.

Owners and Managers using Private Wells or Water Sources

- Abide by local water restrictions.
- Unless properly permitted, do not withdraw water directly from any ponds, lakes, streams or rivers, except for any ponds constructed specifically for irrigation purposes.

Municipalities and other Public Water Suppliers

- Establish policies, regulations, or bylaws/ordinances that ensure that land use and development practices preserve natural vegetation, preserve or restore a site's natural hydrology, and use low water-use/drought-resistant landscaping techniques, to the maximum extent practicable.[25]
- Consider developing a water conservation bylaw that includes some or all of the following provisions:
  - requires water conservation equipment and audits for automatic irrigation systems;
  - requires registration of automatic irrigation systems;
  - minimizes installation of high water-use landscape areas;
  - restricts land clearing and lawn size in new developments and requires a minimum 6-inch depth of topsoil on all cleared areas to help retain moisture; and,
  - prohibits topsoil stripping.

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[23] The following websites provide additional information on proper care and maintenance of turf and landscape plants, and describe the importance of amending soils with organic matter for improving the soil's water retention characteristics for reducing water consumption.

a. www.umassgreeninfo.org b. www.umassturf.org
c. American Horticultural Society http://www.ahs.org/publications/the_american_gardener/0005/smartgarden.htm
d. Greenscapes Massachusetts (http://www.greenscapes.org/)

[24] For a list of Northeastern US Native Plants that are drought tolerant and/or have wildlife benefits see Appendix 1 in "More Than Just A Yard, Ecological Landscaping Tools for Massachusetts Homeowners" (EEA, 2004)

[25] For more information see: "Create a Framework: By-laws and other Regulations" in "Summer Smart Water Use, A Guide to Peak Season Water Demand Management for Massachusetts Communities" (MAPC and Arc of Innovation, 2006)

- Raise public awareness through an education and outreach program on outdoor water use, featuring alternatives to traditional lawn watering, demonstrations of water-wise landscaping and efficient irrigation practices on municipal properties (which also include school departments and recreation and athletic fields).
- Provide landscape water audits for residential, industrial, commercial, and public properties that are large water users.
- Provide rebates for the installation of climate-based controllers and/or moisture sensors for automatic irrigation systems.
- Control direct water withdrawal from water bodies. Communities should consider adopting an ordinance that prohibits the taking of water from any surface water source without advance written permission from the Conservation Commission and paying the same (or more) for the water as it would have cost the proponent to obtain it directly from the public water supplier. Passing such a bylaw would help control the documented problem of hydro-seeding or other water tanker trucks withdrawing directly from local waterways, taking water without permission or paying for it, and sometimes contaminating the body of water from which the water was withdrawn.

  Note: The water used for agricultural operations (as defined in M.G.L. c.128 section 1A) is necessary for these commercial activities to continue. Therefore, the conditions of this section should not cover water used by agricultural operations.

State Agencies and Property Managers

State agencies and property managers should use their property to demonstrate the development and management of low-water-use landscapes. Appropriate public education and outreach should publicize these efforts. In addition, state property managers should practice the following:

- Implement water-wise landscaping and use of native vegetation to reduce outdoor watering. Emphasize the advantages of efficient irrigation practices (e.g. drip irrigation) over broadcast watering. Promote these measures in educational campaigns.
- Where feasible, use non-potable water supplies (like rainwater harvesting, stormwater infiltration, and treated wastewater) for landscaping, street cleaning and building washing, recognizing public health considerations and plumbing board decisions. State and municipal facilities often include large areas of impervious surfaces (building rooftops, parking lots, etc.), which offer excellent opportunities for rainwater harvesting that can serve as a supplemental water supply source and can provide opportunities to infiltrate clean runoff into the ground where it can replenish aquifers and streamflow.

State Regulatory Programs

- The MassDEP is responsible for issuing permits under the WMA for those withdrawing more than 100,000 gpd from new water supply sources, or those increasing withdrawal from existing sources. The MassDEP should continue to condition the permits of water supply sources to avoid significant environmental impacts. MassDEP should also work to assist water suppliers in developing seasonal drought/demand management plans and in providing technical assistance to those adopting and implementing water-use restrictions as appropriate.
- The Commonwealth, in conjunction with potentially regulated communities and other interested parties, should evaluate the benefits of establishing a licensing or certification program for irrigation professionals incorporating an ecological component. This program should cover potential environmental impacts to aquatic ecosystems that can result (directly or indirectly) from irrigation conducted in an environmentally responsible manner.

State Procurement Activities

- State agencies responsible for the renovation and maintenance of state facilities, and state agencies that procure services for lawn and landscape maintenance should ensure that the appropriate lawn and landscape design, irrigation design, and maintenance and construction guidelines for minimizing outdoor water use are included in the procurement bid documents and in the bid evaluation criteria.

10.0 Public Education and Outreach

This chapter applies primarily to:

- *Water suppliers*
- *Water distributors*
- *Municipal governing bodies, boards, and departments*
- *Municipal facilities and public works personnel*
- *State policy and regulatory entities*

The responsibility for ensuring a sustainable water future lies with the community as a whole; everyone has a role to play to make sure that all water (rainwater, stormwater, public water supply, etc.) is handled responsibly and planned for properly.

Education of the public at large, municipal officials, and the water suppliers is crucial to generating an understanding of the issues and implementing and creating acceptance of water conservation activities. It is important to provide to the public the basic understanding of sound water resources management and planning and explain the associated economic and environmental benefits.

Public education and outreach can facilitate the successful adoption and implementation of conservation measures. For example, public acceptance of and compliance with outdoor watering restrictions can be enhanced if they are preceded by an outreach effort that clearly establishes the need for such restrictions in terms of maintaining system reliability, safeguarding hydric habitats, etc.

Four main areas of emphasis for an educational program should be:

- Highlighting the environmental benefits of keeping water local and reducing water demands. This should include education regarding the connection between ground water and surface water; the potential impacts of withdrawals on streamflow and instream uses such as habitats for fisheries and other wildlife, water-based recreation, pollution dilution; and the relationship between pumping and salt water intrusion for coastal areas.
- Explaining that water conservation helps water quality as well. Conservation helps septic systems work better and last longer, and helps wastewater treatment plants function better. Water conservation also enables more water to be retained in the natural environment where it helps dilute pathogens and other pollutant concentrations, and buffers waterways from excessive heating or freezing that can harm aquatic life.
- Showing that investments in efficiency and conservation will provide water users with long-term savings compared to the cost of developing and treating new water supply sources and expanding wastewater treatment facilities. For example, through a domestic device retrofit program, including publicity, follow-up visits or mailings, water suppliers can make customers aware that making a few simple changes can provide tangible savings.
- Explaining to water users all the costs involved in providing water, including planning, engineering, construction, operation, maintenance, treatment, wastewater facilities costs, piping, metering, leak detection, compliance costs, salaries, protection costs, pensions, health care, staff training, and public education.
- Making the connection between water use and energy costs. For water utilities, the energy required to pump, treat, and distribute water and collect wastewater is significant – representing about twenty-five

percent of total operation and maintenance costs.[26] Implementing improvements in both energy and water efficiency can reduce operating costs, providing an opportunity to redirect funds to other needed water system improvements. Reducing water use at the household level can also reduce energy use and the costs associated with heating water and operating water-using appliances.

Standards

1. Each community and water supplier or distributor: **develop and implement an education plan**, which includes most, if not all, items in the following list:
   - Target the largest users early on to realize the greatest potential savings and to demonstrate the benefits of a conservation program.
   - Include in bill stuffers or bills a work sheet on the reverse to enable customers to track water use and conservation efforts and estimate the dollar savings. Also, provide a table enabling the recipient to estimate the household gpcd to see how it compares with the 65 rgpcd standard (see Appendix C).
   - Use public space advertising/media to highlight stories on successes (and failures).
   - Take advantage of social networking tools to communicate water conservation messages and alerts.
   - Establish conservation information centers perhaps run jointly with electric or gas company.
   - Encourage speakers for community organizations.
   - Partner with garden clubs, farmers' markets, environmental organizations, and others on campaigns promoting wise water use.
   - Sponsor public service announcements and radio/T.V./audio-visual presentations on supply sources and current status.
   - Conduct joint advertising with hardware stores to promote conservation devices.
   - Use civic and professional organization resources.
   - Sponsor special events such as Conservation Fairs.
   - Make available multilingual materials as needed.
   - Incorporate contests and recognition for innovation into the public education program.
   - Organize water conservation workshops for the general public and include them in the school curriculum.
   - Provide information on water-wise landscaping, gardening, efficient irrigation, and lawn care practices.
   - Include education information in retrofit and rebate programs.

   Water users and agencies should choose from these and other resources to create and implement programs best suited for their particular situation. The education plan should especially target school children with age-appropriate media that appeals to children, including getting them involved in water resource projects and field trips.

2. As part of a public education program, **address the issue of why it is equally important for self-supplied water users** (e.g., homes or businesses on their own private wells) **to conserve water**, especially when their water source might dry up an aquatic habitat or deplete the water available for public use (e.g., their withdrawal point taps the same aquifer as a nearby public wellfield).

[26] See EPA, 2008: Ensuring a Sustainable Future: An Energy Management Guidebook for Wastewater and Water Utilities. Available at http://www.epa.gov/owm/waterinfrastructure/pdfs/guidebook_si_energymanagement.pdf

Recommendations

1. Communities/water suppliers should hire a part- or full-time water conservation coordinator or circuit rider shared among several water systems. A draft job description for a water conservation coordinator is included in Appendix G.
2. To facilitate implementation of these standards a position of State Water Conservation Coordinator should be established in the Executive Office of Energy and Environmental Affairs to work with water suppliers, industries, watershed associations, and other local entities as well as with existing state programs.
3. Water suppliers and the state should consider using social marketing to help build public support for water conservation. Social marketing is a valuable technique that focuses on the most effective ways to change behavior, leading people to adopt and implement sustainable practices. .[27]
4. Other town boards should get involved in water conservation, especially those regulating land use (Planning and Zoning Boards), managing Town property (park and recreation departments, cemetery departments, and schools), looking after water resources and aquatic habitats (Conservation Commissions, Boards of Health), and Open Space/Community Preservation committees. These entities can help promote water conservation as well as restore the hydrological balance by enhancing infiltration of clean water into the ground thus replenishing aquifers and streamflow.

[27] Fostering Sustainable Behavior through Community-Based Social Marketing http://www.cbsm.com**.** "Community-based social marketing draws heavily on research in social psychology, which indicates that initiatives to promote behavior change are often most effective when they are carried out at the community level and involve direct contact with people."

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APPENDICES

A) Water Bank Guidance

B) Model Bylaws

C) Education and Outreach Materials

D) Plumbing Fixtures and Appliances: Water-Use Data and Water-Use Standards

E) Residential Water-Use Data and Benchmarks

F) BMPs for Selected Industries

G) Water Conservation Coordinator Job Description

H) Sample Worksheet for Industrial / Commercial / Institutional Water Audit

I) Summary of Water Conservation Recommendations for Lawns and Landscapes

J) Checklist for lawn and landscaping irrigation water efficiency

K) Turf and Landscape Irrigation Best Management Practices

L) Local Water Conservation Efforts

A) Water Bank Guidance

Demand management facilitates the generation of physical savings of water as well as economic savings (Rosegrant 1997) – i.e. it brings about conservation in order to help sustain current and future supplies and induces an effective cost recovery system (National Research Council 1995). Economic instruments that can be used could be tradable water permits, water pricing, or water banking. These instruments are based on the premise that a value can be associated with each water-use activity and it is this differential that makes transfers or purchases possible and attractive.

What is a 'Water Bank'?

Over the years, a "water bank" has come to mean different things to different people. In the western states, water banks are typically systems of valuing, trading, buying or selling water rights. Permanent water banks have been established in Idaho and Texas. The state of California, in 1991, 1992 and 1994, set up emergency drought water banks to reallocate water. Water was purchased from those farmers who were willing to leave their lands idle or were willing to use groundwater instead of surface water. This was then sold to either cities or farms or used for instream uses or to dilute pollutants (Frederick 1998).

In Massachusetts, the term water bank is evolving to mean a system of accounting and paying for measures that offset or mitigate water losses due to water withdrawals, sewering, and/or increased impervious areas that prevent aquifer recharge. The primary goals of a water bank are to balance the water budget, reduce water losses, increase water efficiency, and keep water local.[28] There is no "one size fits all" approach, and municipalities should have the flexibility to adopt a program that best fits their particular circumstances.

The Benefits of a Water Bank

Water banking can be an effective management tool for "water-short" communities where development pressure is exceeding the carrying capacity of water resources. It is also a good option for communities concerned about their ability to meet projected water demand and to protect the environment. A water-banking program can free up water and ensure that there is an adequate supply of water for competing uses – i.e., instream flow and habitat, recreation, wetlands, water supply, and economic development. It can mitigate, or offset, the impacts of water withdrawals, balance the water budget, assist in restoring and protecting instream flow, promote water conservation, and ensure an adequate supply of potable water. Massachusetts' communities are beginning to use this tool to accommodate future growth while ensuring the sustainability of their water resources.

Key Principles

There are some key organizing principles that communities should follow when developing an effective water-banking program. They are:

1. A dedicated fund, or banking mechanism is necessary
2. At least a 2:1 ratio for mitigation should be the goal in medium- and high-stressed basins
3. If fee-based, the fee charge must bear a reasonable relation to the cost of implementing the offset and the program's administrative costs, and
4. If the work is performed by the developer, documentation must be provided, and there must be verification by the local department or board administering the program

Because a 1:1 ratio only preserves the status quo in already degraded watersheds, and because measuring the gains from individual water offset measures is often imprecise, to protect or restore water resources especially in medium- or high-stressed basins, a ratio of at least 2:1 is recommended. In other words, for every gallon of

[28] Interbasin transfers, for example, are not subject to inclusion in a water bank as they by definition do not keep water local. However, reductions in the amount of water transferred out-of-basin, via sewers for example, would qualify as mitigation. See the Water Resources Commission's Offsets Policy Regarding Proposed Interbasin Transfers (October 11, 2007).

new water demand projected for development, redevelopment or expansion projects, the goal should be saving or retaining at least two gallons in the basin where the water is being withdrawn.

While water conservation measures, i.e., retrofits of public buildings and older residences with low-flow toilets, showerheads and faucet aerators, have been the primary currency of Massachusetts' water banking programs to date, there are a variety of other techniques that can be used. These can return water or prevent water loss in the basin, such as reduced infiltration and inflow, recharge of stormwater, and retrofit of existing development using LID principles. Additional capacity can also be gained through groundwater recharge of locally treated wastewater formerly exported out of the basin, and through reuse of grey water. There are also a host of water conservation measures such as rebate programs for high-efficiency plumbing fixtures and appliances, xeriscaping, and installation of rainwater collection systems that can be utilized in a water-banking program. The bank can be structured I/I mitigation that many communities are now requiring for new and redevelopment projects. Ratios ranging from 4:1 to 10:1 are typical. This can help to create capacity, or to fulfill regulatory requirements for regional wastewater systems. The work can be performed either by the developer, or a fee can be charged and the I/I removed by the municipality's DPW. A water bank can also be structured to include market mechanisms in which those seeking new or increased water use could buy credits previously banked in excess of the 2:1 ratio in lieu of performing the work themselves. A water bank could also involve multiple towns or be organized on a regional or watershed basis.

If a municipality opts to charge a per gallon fee, either to perform the work itself, or to contract it out, the fees should be deposited in a dedicated enterprise fund and used solely to accomplish the offset measures, and to fund the program's administrative expenses. However, adequate documentation is critical for tracking and reporting on the measures to ensure that the savings are in fact being achieved. Documentation, review and verification by the municipal department or the public water supplier administering the program assures that the work has been performed.

CASE STUDY - Town of Weymouth's Water Banking Program

The Town of Weymouth developed a successful water banking program that has enabled it to stay within its authorized withdrawal volume. The bank saved the town 1.2 mgd (million gallons a day) and has helped the town to accommodate new growth and water demand, and to implement an aggressive water conservation program.

Weymouth's Water Use Permit Program, administered by its DPW, applies to new customers and existing ones seeking to increase water use, for example through the addition of a bedroom or a commercial process. It requires that for every gallon of new demand, two gallons of water, i.e. a 2:1 water savings be achieved. Projected water use is based on Title 5 flows.

The DPW developed guidelines on water saved by various low-flow household devices and a list of older businesses and residences suitable for installation, or retrofitting. Originally, permit applicants were responsible for doing the residential retrofits, or in the case of businesses, modifying water use practices and processes to create the required savings. However, in 2000, the program was expanded to give applicants the option of paying a $10.00 per gallon mitigation fee to compensate the town for performing the work.

The mitigation fee, based on cost per gallon to perform the work, including administration costs, is held in a dedicated enterprise Water Conservation Fund, which the Water Department uses to achieve the requisite mitigation. Water savings in excess of 2:1 savings are "deposited" in the water bank for the Town's use.

While affordable housing developments under M.G.L. c. 40B are subject to the fee, there is a hardship exemption available for individual homeowners. The Fund has also been used to install rain sensors on automatic irrigation systems. The program has not had a negative impact on development, which remains robust in Weymouth.

B) Model Bylaws

1. Private Wells

   Falmouth, Article 17, section 223-4 pertains to the Board of Selectmen's authority to declare a state of water supply conservation and provides in pertinent part as follows: *However, if the Board of Selectmen makes a specific finding that the shortage of water exists because of a clear and imminent threat to the sole source aquifer underlying Falmouth, such threats to include severe drought, environmental pollution or salt water intrusion, the restrictions adopted pursuant to Section 223-5 shall apply to all citizens, water users, and consumers regardless of the source of water supply.*

2. MassDEP Outdoor Water Use Model Bylaw/Ordinance:

   Web page: http://www.mass.gov/dep/water/laws/policies.htm#wmgt
   Direct link to document: http://www.mass.gov/dep/water/laws/modowubl.pdf

3. Cape Cod Commission Model Land Clearing, Grading and Protection of Specimen Trees Bylaw

   http://www.capecodcommission.org/index.php?id=154&maincatid=21

4. Massachusetts General Law establishing fines and penalties for water theft:

   MGL Chapter 165, Section 11: Intentional injury to or interference with meter; penalty

   Whoever unlawfully and intentionally injures, or suffers to be injured, a water meter belonging to a city, town, district, or company engaged in supplying water, or prevents such meter from duly registering the quantity of water supplied through it, or hinders or interferes with its proper action or just registration, or attaches a pipe to a main or pipe belonging to a city, town, district or water company, or otherwise uses or causes to be used the water supplied by a city, town, district or company without the consent of the same, unless it passes through a meter set by such city, town, district or company, shall be punished by a fine of triple the amount of damages sustained thereby or $1,000, whichever is greater or by imprisonment for not more than one year, or both. Damages shall include the value of the water used and the cost of labor and equipment repair and replacement.

5. Bylaw to establish a fine for unauthorized use of a fire hydrant (East Bridgewater)
   - Article 25, Part Three- Offenses and Penalties of the Town By-Laws and Unauthorized Use of Fire Hydrant (http://www.lawlib.state.ma.us/docs/EastBridgewaterBylaws.pdf)
     - Any person, other than an employee of the town performing municipal services, taking or using water from a Town fire hydrant without the prior written consent of the Board of Water Commissioners shall pay to the town a fine in the amount of three hundred dollars ($300.00) for each such offense. The fine may be enforced criminally or non-criminally in the manner set forth in Article XVI.
     - Any person taking or using municipal water from a Town fire hydrant shall be liable for any damage caused by such action including, but not limited to, damage to any fire hydrant, water main or connection.

6. Water-wise/Water efficient/Native landscaping bylaws from Massachusetts and other states:
   - Massachusetts
     http://www.greenscapes.org/
   - Arizona
     http://www.ci.gilbert.az.us/ordinances/waterconservation.cfm
   - California
     http://www.co.marin.ca.us/depts/CD/Forms/00000067.pdf
   - Colorado
     Water-Efficient Landscape Design: A model landscape ordinance
   - Florida
     http://sarasota.ifas.ufl.edu/Hort/WEL/ord/docs/ord.htm
   - Nevada
     http://www.snwa.com/land/landscapes.html

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C) Education and Outreach Materials

Water Bill Inserts: Courtesy, Sharon Water Department

OUR REBATE PROGRAM

Get a $100 credit on your water bill for installing a high-efficiency toilet!

Get a $200 credit on your water bill for installing a front load washing machine!

These advanced devices deliver many benefits. They reduce your water bill and may extend the life of your septic system.

Gallons Per Capita Daily (GPCD) Lookup Table*

GALLONS USED IN 6 MONTHS (for annual GPCD, average your last two water bills)	NO. OF HOUSEHOLD OCCUPANTS 1	2	3	4	5	6	7	8
4,000	22	11	7	5	4	4	3	3
6,000	33	16	11	8	7	5	5	4
8,000	44	22	15	11	9	7	6	5
10,000	55	27	18	14	11	9	8	7
12,000	66	33	22	16	13	11	9	8
14,000	77	38	26	19	15	13	11	10
16,000	88	44	29	22	18	15	13	11
18,000	99	49	33	25	20	16	14	12
20,000	110	55	37	27	22	18	16	14
22,000	121	60	40	30	24	20	17	15
24,000	132	66	44	33	26	22	19	16
26,000	142	71	47	36	28	24	20	18
28,000	153	77	51	38	31	26	22	19
30,000	164	82	55	41	33	27	23	21
32,000	175	88	58	44	35	29	25	22
34,000	186	93	62	47	37	31	27	23
36,000	197	99	66	49	39	33	28	25
38,000	208	104	69	52	42	35	30	26
40,000	219	110	73	55	44	37	31	27
42,000	230	115	77	58	46	38	33	29
44,000	241	121	80	60	48	40	34	30
46,000	252	126	84	63	50	42	36	32
48,000	263	132	88	66	53	44	38	33
50,000	274	137	91	68	55	46	39	34
52,000	285	142	95	71	57	47	41	36
54,000	296	148	99	74	59	49	42	37
56,000	307	153	102	77	61	51	44	38
58,000	318	159	106	79	64	53	45	40
60,000	329	164	110	82	66	55	47	41
62,000	340	170	113	85	68	57	49	42
64,000	351	175	117	88	70	58	50	44
66,000	362	181	121	90	72	60	52	45
68,000	373	186	124	93	75	62	53	47
70,000	384	192	128	96	77	64	55	48
72,000	395	197	132	99	79	66	56	49
75,000	411	205	137	103	82	68	59	51
80,000	438	219	146	110	88	73	63	55
85,000	466	233	155	116	93	78	67	58
90,000	493	247	164	123	99	82	70	62
95,000	521	260	174	130	104	87	74	65
100,000	548	274	183	137	110	91	78	68

**The state water use planning goal for Massachusetts is 65 GPCD.*

Save Water! Save Money!

Get Valuable Rebates

for installing

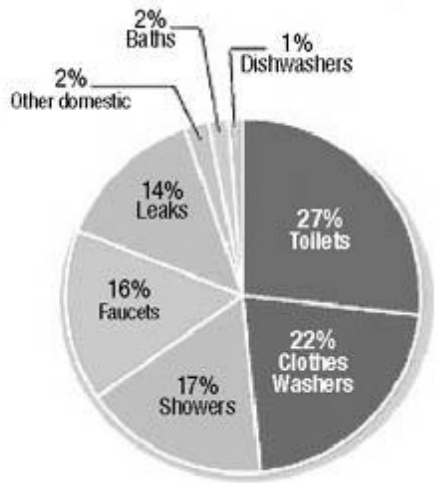
High-Efficiency Toilets

and

Washing Machines

Sharon Water Department
and
Water Management Advisory Committee

Toilets and clothes washers are the top two indoor water guzzlers in a typical home*:



High-efficiency toilets and front load clothes washers help keep your water use under **65 GPCD** (see the handy GPCD lookup table on the reverse to find out your water use). Thanks to innovative engineering, they also function better than older models.

*Sources: American Water Works Association and AWWA Research Foundation

TOILET TIPS

- Install advanced High Efficiency Toilets (HETs) that average less than 1.3 gallons per flush. HETs are powerful and less prone to overflow. HETs may save 15,000 gallons per year compared to old 3.5 gallon models.
- Avoid flushing the toilet when not absolutely necessary, and don't use your toilet as a wastebasket.
- Toilet leaks cause high water bills. Check for toilet leaks by putting food coloring in your toilet tank. Do not flush. If dye appears in the bowl within 10-15 minutes, check the flapper in your toilet tank to see if it has deteriorated and needs to be replaced.
- Don't put strong cleaning chemicals in your toilet tank. They may corrode the rubber and plastic parts in your toilet tank and cause leaks.

FRONT LOAD WASHERS

Front load washing machines use less than 15 gallons per load, far less than the 35 to 50 gallons per load used by older top load models, and may save 10,000 gallons per year.

Front-load washing machines:

- Conserve heated water and lower your energy bills.
- Wring out more moisture in the spin cycle, reducing drying time and energy costs.
- Decrease wear on clothes so they last longer.
- Require less detergent.
- Help extend the life of your septic system.

D) Plumbing Fixtures and Appliances: Water-Use Data and Water-Use Standards

Table 1. Average indoor water use in nonconserving and conserving North American single-family homes

Water Use Type	Nonconserving Home*	Conserving Home 2001*	Conserving Home 2005**	Nonconserving Home	Conserving Home 2001	Conserving Home 2005
Units	*Average gpcd*	*Average gpcd*	*Average gpcd*	*Percent of total*	*Percent of total*	*Percent of total*
Dishwasher	1	0.7	0.7	1.4%	1.5%	1.9%
Baths	1.2	1.2	1.2	1.7%	2.7%	3.3%
Leaks	9.5	4	4.0	13.7%	8.8%	11.0%
Faucets	10.9	10.8	10.8	15.7%	23.9%	29.8%
Showers	11.6	8.8	7.0	16.8%	19.5%	19.4%
Clothes Washer	15	10	5.2	21.7%	22.1%	14.3%
Toilets	18.5	8.2	5.6	26.7%	18.0%	15.6%
Other Domestic	1.6	1.6	1.6	2.2%	3.4%	4.4%
TOTAL	**69.3 gpcd**	**45.2 gpcd**	**36.2 gpcd**	**100%**	**100%**	**100%**

**Source: Vickers, 2001 (Adapted from Mayer et al, 1999)*

***Substituting 1.1 gpf High Efficiency Toilets, a 14 gpl front-load washing machine, and 2.0 gpm showerheads for Vickers' 1.6 gpf toilets, 27 gpl washing machine and 2.5 gpm showerheads*

gpcd = gallons per capita daily, gpf=gallons per flush, gpl=gallons per load, and gpm=gallons per minute

To find out how much water you use, try the Home Water Works Calculator at http://www.home-water-works.org/calculator.

Table 2. Federal and Massachusetts water-use standards for plumbing fixtures and selected appliances

Fixture or Appliance	Standard (Federal and MA)
Toilets	1.6 gpf
Urinals, Residential and Commercial	1.0 gpf
Showerheads, Residential	2.5 gpm (at 80 psi)
Lavatory faucets and replacement aerators, Residential	2.2 gpm (at 60 psi)
Kitchen faucets and replacement aerators, Residential	
Faucets, Commercial	Private* faucets: 2.2gpm at 60 psi Public restroom faucets: 0.5 gpm at 60 psi Metering (auto shut-off) faucets: 0.25 gpc
Dishwashers, Residential	Standard models: Water Factor of 6.5 gpc or less Compact size: WF of 4.5 gpc or less
Clothes Washers, Residential and Commercial (Family-sized)	Water Factor of 9.5 gpc/ft^3 or less

gpc = gallons per cycle
gpf = gallons per flush
gpl = gallons per load
gpm = gallons per minute
psi = pounds per square inch

WF = Water Factor, a measure of the gallons of water used per cycle per cubic foot

* "Private" defined as residential, hotel guest rooms, and health care patient rooms.

Sources: Adapted from Vickers, 2001; Alliance for Water Efficiency, August 2011

References: Energy Policy Act of 1992, Energy Policy Act of 2005, Energy Independence and Security Act of 2007, National Appliance Energy Conservation Act, MA Plumbing Code

E) Residential Water-Use Data and Benchmarks

The following discussion presents residential water-use numbers, including state, national, and international data, to provide the reader with some context and background for how the residential water-use-efficiency benchmarks were developed.

The amount of water consumed by a residential population is commonly used as a benchmark to evaluate the success of water conservation efforts. Water use is typically measured in gallons, and reported as gallons per capita per day (gpcd) that includes indoor and outdoor water use for a single residence. Measured and estimated numbers for residential gpcd vary throughout the state, the country, and the world. In a survey of average combined indoor and outdoor residential water use for 13 cities and the United Kingdom, Vickers reports a low of below 50 gpcd for Cairo, Egypt, and the United Kingdom, and a high of over 200 gpcd for Phoenix, Arizona, and Las Virgenes, California.

Data considered in developing and evaluating benchmarks for efficient residential water use are presented below, along with several theoretical water budget scenarios.
Note: all numbers are residential gallons per capita per day (rgpcd) unless otherwise noted.

INDOOR WATER USE

- Vickers[1]: US avg. = 69
- REUWS[2]: 12 cities, 1,188 homes, predominantly west and southwest
  Avg. = 60
- Maddaus[3]: US Avg. = 60
- MA Title 5 wastewater modeling assumptions[4]: Avg. wastewater flow = 55
- Seattle Home Water Conservation Study[5]: Avg. = 45
- *Range: 45 to 69*

Comments: Base indoor water use does not vary significantly over the year or across the country and continues to go down on average. Base indoor water use typically constitutes the majority of total water use even in summer months. Improvements in base indoor water use efficiency help reduce water use in summer when it matters the most.

OUTDOOR WATER USE

- Vickers: US avg. = 32
- REUWS: Avg. = 101
- Full Conservation: close to zero
- *Range: zero to 101*

Comments: Outdoor water use varies significantly over the year and across the country and has been going up on average. In New England, outdoor water use during the months of May through September typically increases by approximately 25-50% over base indoor use from November through March.[29]

[29] The peak irrigation season is typically between June and August

THEORETICAL WATER BUDGET SCENARIOS

Following are some residential water-use scenarios that were considered in developing annual water consumption benchmarks:

Scenario 1: Full Conservation 2005
Assumes fully conserving fixtures and appliances available in 2005 for indoor use, and 25% increase over base for outdoor use

Assume 36 for indoor (months of October through April)
Assume 45 during the months of May through September (36 indoor + 25% increase over base)
Annual avg. = 40 gpcd

Scenario 2: Full Conservation 2001
Vickers' conserving household numbers published in 2001 for indoor use, and 25% increase over base for outdoor use

Assume 45 for indoor (months of October through April)
Assume 56 during the months of May through September (45 indoor + 25% increase over base)
Annual avg. = 50 gpcd

Scenario 3: Massachusetts Average
MA Title 5 numbers for indoor use and 50% increase over base for outdoor use

Assume 55 for indoor (months of October through April)
Assume 82.5 during the months of May through September (55 indoor + 50% increase over base)
Annual avg. = 66 gpcd

Scenario 4: US Average
Vickers numbers for average indoor use and 50% increase over base for outdoor use

Assume 69 for indoor (months of October through April)
Assume 104 during the months of May through September (69 indoor + 50% increase over base)
Annual avg. = 84 gpcd

STATUS of MA COMMUNITIES IN RELATION to MassDEP BENCHMARKS of 65 RGPCD

MassDEP, 2008 – 2010 ASRs[6], 280 communities reporting at least one year:

- Average = 64 rgpcd
- 74 communities or 26% were 66 rgpcd or higher
- 206 communities or 74% were 65 rgpcd or lower

Massachusetts Water Resources Authority (MWRA), 2008 – 2010, 29 communities entirely served by the MWRA:

- Average = 64 rgpcd

SOURCES (see References for full citations)

1. Amy Vickers. 2001. Handbook of Water Use and Conservation.
2. Mayer et al. 1999. Residential End Uses of Water Study (REUWS)
3. Maddaus, W.O. 1987. Water Conservation. American Water Works Association. Denver, CO.
4. MassDEP and DeFeo, Wait & Associates, Inc. 1991. Technical Evaluation – Title 5.
5. Mayer et al. 2000. Seattle Home Water Conservation Study.
6. MassDEP Public Water Supply Annual Statistical Report Data, 2008, 2009, 2010

F) BMPs for Selected Industries[30]

Water consumption in the Semiconductor, Metal Plating, Printed Circuit Boards, Paper and Rubbers and Plastics industries is quite high. Knowledge of water balance for the entire facility and specifications for each stream are useful for a program on water conservation. Simple engineering systems such as countercurrent flows, high-pressure, low-volume atomized or fog spray rinsing systems, tying dumping of baths to measurement of critical bath parameters, installing essential instrumentation (e.g. flow restrictors, conductivity controllers, pH meters, etc.) and installing filtration/screening and cooling systems are all options to reclaim, refine, and reuse water continuously.

WATER CONSERVATION PLANS (general)

Water is an important resource or raw material in the manufacturing of various products; however, for many facilities water is usually considered an overhead cost. In most municipalities in the Commonwealth of Massachusetts, facilities pay a contracted rate for the volume of water supplied and a sewer cost, typically at a higher and different rate. To appreciate the contribution of water to the operation of any plant, there should be a cost value assigned to its input, whether it is a reactant, a solvent, a cleaning agent, a convenient means to transport other resources, or a way to store intermediate or final products.

Controlling the use and cost of water is the responsibility of everybody in the company. A policy statement with clear objectives that is supported by top management will define the company's position on water use. The objectives serve as guidelines to develop goals that all employees can work towards. Included in this policy, a management team should be established and a continuous program for educating employees should be implemented.

The management team monitors the use of water in the facility and to formulate an equitable means of allocating cost to the use of water and its disposal. For a small facility, these responsibilities maybe assigned to an individual with the additional authority to enforce viable and cost-effective changes.

Basic Program

Outlined below are some simple, practical and general measures and procedures that may promote water conservation and optimal uses in some industry sectors. The list is by no means exhaustive. The peculiarities of an individual facility may make some of the suggestions impractical - ideally, such peculiarities should be viewed as opportunities to develop viable alternatives.

Water Budget

Measurements should be taken to establish a water budget for all operations. Inputs and effluents from all processes should be assessed. The flow of water at all points of input and effluent for all process steps should be measured, documented and continuously monitored. Water meters may be installed for major consumers. Simple methods to estimate flow rates, e.g. using a bucket and a timer, can be adequate to get reasonable flow rates.

Cost Centers

A realistic cost value based on volumes used should be assessed to all process steps. Major consumers may be considered cost centers and the cost to supply water and to dispose of wastewater should be documented regularly.

[30] Best Management Practices for Selected Industries and Additional Resources. Gus Ogunbameru, PhD. Ch. E. - Massachusetts Office of Technical Assistance. For more information, see the Water Conservation Publications on the OTA web site.
See also the Alliance for Water Efficiency, "Water Saving Tips: Commercial, Industrial, and Institutional Water Use," at http://www.allianceforwaterefficiency.org/CII-tips.aspx

Monitor and Audit

At established periodic intervals, flow rates should be measured and compared with those established through the water balance.

Maintenance

All fresh water and wastewater leaks should be logged on a daily basis. Maintenance should be carried out to fix leaks within 24 hours of their discovery.

Energy Savings

In many operations, water conservation will reduce energy costs as well as water costs.

More Information

For further information on BMPs in each of the following industrial sectors, please visit the OTA website at: : http://www.mass.gov/envir/ota/resources/water_conserv.htm

- Semiconductors
- Metal Plating
- Printed Circuit Boards
- Paper Mills
- Rubber and Plastics

G) Water Conservation Coordinator Job Description

Water conservation coordinators are commonly found in the West and other places frequently plagued with drought conditions. Here in the New England, however, one would be hard pressed to find a water conservation coordinator – even in a large utility.

Some public water suppliers may not see the need to employ a water conservation coordinator. Water is plentiful most times of the year; if demand gets too high in the summer, mandatory restrictions on outdoor water use is usually an effective way to deal with the problem.

However, reacting to emergency situations is not in the long-term best interests of the utility and could lead to poor relations with customers. Responsible water suppliers manage water demand to reduce waste and ensure adequate supplies for essential domestic use and fire safety, without restricting customers' use. One way to achieve this goal is to create and implement a comprehensive water conservation program that addresses residential, institutional, and commercial users. To be effective, water conservation must be continuously promoted by all levels of local government over a period of years or even decades to raise the consciousness of the community regarding the importance of responsible, efficient water use.

Public Water Suppliers seriously interested in implementing a comprehensive water conservation effort should hire an individual to create and carry out the conservation program. While some water conservation activities can be added to existing staffs' duties, a program is more likely to succeed when staff is hired specifically to implement conservation programs because:

- A coordinator's sole focus is reducing water use in the community. He or she is able to methodically plan and carry out a water conservation program without the distractions and/or demands of other duties.
- Existing staff may not have the desired skill set of a coordinator

In regards to funding the position, there are several models water suppliers could consider. A large utility may find it necessary to hire at least one full-time person. In other parts of the country, water suppliers have a staff of water conservation specialists. Smaller utilities can hire a water conservation specialist on a part time basis or share one among several towns.

Typical job duties of a water conservation coordinator include the following:

- Establish water conservation goals
- Develop a water conservation program
- Identify and assess conservation incentives appropriate for implementation
- Analyze the costs and benefits of the water conservation program
- Encourage installation of water monitoring infrastructure such as remote meter reading and leak detection systems
- Study various rate structures to encourage water conservation
- Answer public inquiries
- Coordinate with state and federal government
- Design and write water conservation outreach material, including letters to the editor, bill inserts, brochures and web site content
- Create and implement promotional and marketing campaign aimed at achieving water conservation program goals
- Assist residential, commercial and institutional customers in conserving water
- Administer and enforce local water regulations and restrictions
- Conduct presentations at various forums including stakeholder groups, schools, clubs and business associations

H) Sample Worksheet for Industrial / Commercial / Institutional Water Audit[31]

AUDIT COMPLETED BY (NAME): **DATE:**

GENERAL INFORMATION

Customer/Account Name:
Address:
Facility contact person:
Product(s) or services(s):

SIC category(ies)

Facility dimensions (for each building) in sq ft:		No. floors	Width	Height	Age of facility(years)
Avg. no. of occupants (employees and nonemployees):		Female:	Male	Total	
Avg. no. of days facility occupied/year	Avg. no. hours occupied/day:		Weekdays	Weekends	Holidays
Is recycled water currently used on site?		Yes No	If yes, describe and give amount used (e.g. gallons per year):		
Building wastewater is:	Treated on site	Connected to municipal/off-site system	Other (describe)		

METER INFORMATION

	Meter No. 1 ID No.	**Meter No. 2 ID No.**	**Meter No. 3 ID No.**	**Meter No. 4 ID No.**	**Meter No. 5 ID No.**
Meter location					
Meter type					
Reading frequency					
Units of register					
Multiplier (if any)					
Meter size					
Connection size					
Meter installation date					
Testing frequency					
Last service (date)					
Last test/calibration (dates)					

Note: The complete ICI water audit worksheet is five pages and covers an ICI building/facility water-use inventory, recommended efficiency measures, potential water savings from ICI efficiency measures, and potential benefit and costs from ICI efficiency measures. For details, see Vickers 2001, Appendix G.

[31] Source: Vickers, Amy. 2001. *Handbook of water use and conservation.* Amherst, MA: WaterPlow Press.

I) Summary of Water Conservation Recommendations for Lawns and Landscapes

GRASS

Care and Maintenance Components	Water Conservation Recommendations
Size of Grass Area	Minimize lawn size and maintain/enhance existing native vegetation.
Grass Species	Use drought-resistant/low-water-use grass species. Fine fescues, including creeping red fescue, chewings fescue, and hard fescue, are drought tolerant and low maintenance in their needs, and are recommended low-water-use species.
Grass Height	Mow lawns at the highest recommended height (at least 2.5 to 3 inches).
Pest Control	Practice Integrated Pest Management.[1, 2] Choose proven biological pest management materials to control grubs.
Fertilizing Grass	Fertilizing for phosphorus and potassium should be done based on a soil test (and may not actually be necessary, based on the soil). Don't fertilize unless recommended by a soil test. Adjusting pH (usually by liming) should also be done base on a soil test. If fertilizer is needed, applications are best made in late summer-early fall and in mid-spring. Check weather forecasts before application and do not apply if rain is forecasted. Organic fertilizer is recommended.[1, 2, 5]

SOILS

Care and Maintenance Components	Water Conservation Recommendations
Soil Health	• Ensure adequate depth and type of soil (at least 6 inches of good topsoil). Generally, a sandy loam with 5% organic content is recommended for turf grass and landscapes. The texture, organic content, pH level, drainage, salinity and fertility are important characteristics of soil that should be considered before planting anything. • Some tips for soil improvement include using peat moss, manure or compost to improve moisture retention, and using organic fertilizer for strong root growth. Peat moss must be thoroughly mixed with the soil in order to be effective at improving drainage characteristics. If used as a topdressing or over aeration holes, it can actually wick water away from the soil and roots. Choose manure and composts that are well decomposed. Manure and compost can be a source of weed seeds if not well decomposed. • Apply agricultural lime to neutralize acidic soils (if recommended by soil test results). • Avoid pesticides that also kill beneficial organisms such as earthworms that aerate and fertilize the soil naturally. Choose proven biological pest management materials to control grubs.
Soil Moisture	Test soil for dryness. Water should soak down deeply enough to recharge the root zone, about 4-6 inches. This encourages deep root growth.

PLANTS

Care and Maintenance Components	Water Conservation Recommendations
Plant Species	Choose plant species according to micro-climates in the yard.[2, 4]
Mulch	Use mulch to retain soil moisture and reduce the need for watering. Be careful not to apply too much, because the soil does require some heat.[3]

LAWN WATERING

Care and Maintenance Components	Water Conservation Recommendations
How much water?	• Massachusetts generally has enough rainfall to naturally supply the water needs of most healthy mature lawns with good soil, without the need for watering. • In years of drought and/or high heat, lawns may enter drought dormancy, turning brown and stopping growth. When drought is severe and heat is extended for a long period of time, lawn managers should plan to overseed their lawns with desirable, drought tolerant grasses when cool, moist weather returns in late summer – early fall. Watering at overseeding and renovation is critical to successful establishment of healthy, weed, pest and drought-resistant lawns and fields. • Athletic fields and recreational areas that are used during drought dormancy will experience severe loss of turf, as the crowns of the grass plants will be unprotected by living foliage. It is best to keep traffic and play off drought dormant grass in order to avoid the development of unsafe playing surfaces and recreational areas. If it is necessary to use such areas, especially if heat and drought are prolonged, the managers of those properties should plan to overseed or renovate the fields as necessary. Watering at overseeding and renovation is critical to successful establishment of healthy, weed, pest and drought-resistant lawns and fields. • During non-drought conditions, watering (if necessary at all) should be done to re-moisten the root zone (4-6 inches). The amount will depend on the soil and many other site factors. A general rule of thumb is one inch per week including rain, but some sites will need less and some may need more. See Appendix J for additional guidance.
When to water?	Water between sunset and early morning. Avoid watering at night during hot humid weather to avoid disease outbreak, and avoid watering on windy days.
How to water?	Water slowly and deeply. Avoid pooling (runoff).
Rainwater	Collect rainwater for landscaping needs. Use rain barrels or larger containment systems and/or build a rain garden.

AUTOMATIC IRRIGATION SYSTEMS

Care and Maintenance Components	Water Conservation Recommendations
Climate-based Controllers	Adjust your watering schedule to track weather conditions at least once or twice a month. Consider a SWAT ("Smart Water Application Technology") compliant climate controller. [32]
Rain Shut-off	Install a rain shut-off device to prevent watering if it rains.
Maintenance	Inspect your system a few times during the watering season while it is running. Look for and repair leaking or broken sprinklers, and reposition those that spray unintended areas. See Appendices J and K for additional information.
Testing	Hire an irrigation professional to test and adjust your system annually.
System settings	The best setting for irrigation systems is "off." Keep your system on manual and turn it on only when needed.[5]

[32] See EPA WaterSense specification for landscape irrigation controllers at www.epa.gov/watersense/products/controltech.html.

REFERENCES

1) *A Homeowners Guide to Environmentally Sound Lawncare*, MA Department of Agricultural Resources, 1997
2) *More Than Just A Yard, Ecological Landscaping Tools for Massachusetts Homeowners*, Executive Office of Environmental Affairs, 2004
3) *Handbook of Water Use and Conservation*, Amy Vickers, 2001
4) *Garden and Landscaping Water Conservation Tips*, Massachusetts Water Resources Authority, 2005
5) *Greenscapes Guide*, Greenscapes Massachusetts, 2005

J) Checklist for lawn and landscaping irrigation water efficiency

Consider the following to increase the beauty, health and efficiency of your landscape.

Look into Automatic Irrigation System Programming:

Normally, lawns need no more than one inch of water per week throughout the summer, and this includes precipitation, ***so often there is no need to water at all***. Make sure your irrigation system does not deliver more water than one inch per week, including precipitation. If there are problems with the lawn turning brown or looking dry, it is likely that there are other problems or issues, and solutions other than increasing irrigation.

Evaluate the programming of the sprinkler system:

1. Make sure the system delivers no more than one inch of water per week (test the system if necessary – see some options below for testing automatic irrigation systems).
2. Make sure that the irrigation system delivers a reasonable amount of water to each zone, delivering water as each zone needs: less to shaded areas, while trees and well-established shrubs will probably not need any irrigation.
3. Adjust the system seasonally: if you must water in the spring and fall, reduce the system run time during these more moderate seasons.
4. Adjust the system according to weather: if it has been more cool and cloudy than usual, over-ride the system temporarily to save water.
5. Make sure the system operates at night (except on very hot humid nights) or in the early morning (before 8:00 am), not during the day.
6. Watering longer twice per week instead of short times every day can help plants and turf grow longer roots and stay healthy with less irrigation. Adjust your sprinkler system for less frequent watering.
7. Know the watering restrictions of your community and follow them. Make sure your irrigation system is programmed to water only during times allowed, and make sure it is compliant in other respects (some communities require an irrigation system be registered, have a working rain sensor (as mentioned below), and / or other requirements).

Tests for the sprinkler system:

Test for the amount of water - I

- Place measuring cups down on the lawn in each sprinkler zone (these will need to be calibrated like rain gauges, to show the inches of precipitation the ground has received)
- Run the sprinkler system through a test cycle.
- Note the run time of each sprinkler zone during the test cycle.
- Using the amount of water delivered to the lawn during the test cycle and the schedule of the sprinkler system, determine the amount of water that goes on to the lawn each week.
- The amount of water should be no more than one inch per week.

Test for the amount of water - II

Not only can the following procedure be used to get an idea if the irrigation system is using more water than needed, it can also be used to determine whether more water is being used because of worn sprinkler heads, which is a common problem as sprinkler systems age.

- Plan the test for a time when no water will be used or needed anywhere else in the house or on the premises
- Read the water meter
- Be ready to time the sprinkler system test cycle
- Run the sprinklers through a test cycle while no other water is being used, timing the cycle
- Read the water meter

- Calculate the water used during the test cycle from the readings before and after, and the meter constant
- Calculate the average water use per minute (flow rate) by the sprinkler system in gallons per minute (GPM)
- Compare the water flow rate with what should normally be used by the sprinkler heads in each zone (this would be the sum of the rated flows for each sprinkler head). If the flow rate is significantly greater than what manufacturer's data might indicate, sprinkler heads may be worn.
- Using the amount of water delivered to the lawn during the test cycle, the schedule of the sprinkler system, and the area of the lawn, determine the amount of water that goes on to the lawn each week.
- The amount of water should be no more than one inch per week (remember that this one inch includes precipitation).

For sprinkler system uniformity
See Appendix K.

Automatic Irrigation System Performance:

Sprinkler system spray and distribution
Try to determine if the sprinkler heads are worn, and hence using more water than they were designed for. Other signs of problems include:

- broken heads
- areas being over-watered
- pavement or any non-lawn areas being watered
- the same schedule for a north-facing area as for a south-facing area
- signs of piping leaks
- water run-off (if so, soil aeration may be needed)
- uneven spray patterns

Use properly installed soaker hoses instead of sprinklers for beds of plants to reduce evaporative losses (if these beds must be watered, see notes on this below). Make sure your sprinkler system has a working rain sensor, set at ¼ of an inch of precipitation, and properly located (not under an overhang or any place where it is sheltered from the rain).

Water pressure
Check the system pressure. If the street water pressure is above the rated pressure for the irrigation system, that system will need a working pressure reducer valve to bring that pressure down to the correct level, or damage to the irrigation system can occur and water will be wasted.

Irrigation needs for plants and shrubs
Look to see if there are well-established shrubs or trees that are being watered by the irrigation system, and consider capping off sprinkler heads that water them. The plants might have needed watering at one time, but may not anymore. Many irrigation systems provide far more water to plants and shrubs than needed. Often, a new landscape in New England features plants that need plenty of water until established, and then they do not need any irrigation – the natural rainfall is quite enough.

Soil / Plant Health
Check for soil and plant condition by the following:

- Perform a few soil core samples (with a trowel if you do not have a core sampler), looking at depth and type of topsoil, root depth, etc. Lawns should have at least six inches of good topsoil.
- It is possible to perform a simple soil test to indicate proportions sand, silt, loam and clay.
- Examine the condition and types of plants and turf.

- Check for soil pH (degree of acidity): acidic soil can greatly decrease the health of a lawn, and can affect plants that do not like these conditions. Depending on a soil test, neutralize acid with limestone; this may need to be done every year or every few years. (Note: acid rain does not cause acidic soil.)
- Understand that some areas may not grow turf, and watering a lot might not help. Where there are large trees, the combination of shading and the tree roots may make grass sparse.
- Make sure smaller trees, shrubs and beds of plants are properly mulched; this saves water, keeps the weeds down and is good for the plants.
- Look for areas where soil may be compacted.

Consider the following actions:

- Aeration of soil
- Adding lime
- Top dressing the turf with compost to improve soil
- Using an organic fertilizer instead of chemical fertilizers
- The most important time to fertilize is in the late summer–early fall (late August – September)
- Improvements to sprinkler system operation and design
- Installation, relocation, and/or re-setting of a rain sensor
- Landscape creatively with larger plants, beds of mulched plants, and many other options
- Consider lettering an area "go wild" for a while, and allow whatever plants to grow naturally without any action on your part (in New England, this is likely to get you a wildflower garden during the summer). Be aware that this can potentially increase the dog and deer tick populations in a yard.

If you are looking for a home:

Check the amount of topsoil

Insist on checking the level and quality of the soil under the lawn, and let the person showing you the home know that this is important to you.

Unfortunately, much of the newest construction is also the most inefficient when it comes to irrigation system efficiency. New construction in recent years has often involved bulldozing nearly everything, removing topsoil and most of the subsoil, grading the landscape, adding just a few inches of loam. The homeowner is then left with trying to keep grass green using an automatic sprinkler system rather than natural conditions.

At least 6 inches of topsoil is recommended. Generally, a sandy loam with 5% organic content is recommended for turf grass and landscapes. Some tips for soil improvement include using peat moss, manure or compost to improve moisture retention, and using organic fertilizer for strong root growth.

This list was developed with assistance from Russ McIntosh of Sebesta Blomberg & Associates, Inc.
The above guidelines are intended to be a general set of good practices for conserving water used for irrigation in residential and commercial settings. They do not necessarily cover all situations.

These guidelines were prepared mostly with technical information from research and development of the landscaping water audit offered as a service by Energy New England, LLC. Help was provided from the Water Departments of the Towns of Acton and Concord, Massachusetts.

K) Turf and Landscape Irrigation Best Management Practices

Landscape irrigation is a process to supplement precipitation by artificial means, with the goal of maintaining soil moisture during the growing seasons of turf and ornamental plants. It is vital that a set of standards is formed that incorporate best management and conservation practices to protect Massachusetts' water resources from misuse. Conservation measures are any water management practices and water-efficiency measures resulting in beneficial reduction in water loss, waste, or use.

Introduction

This appendix presents Best Management Practices (BMPs) for irrigation of turf and landscapes. These BMPs support the design, installation, maintenance, and management of landscape irrigation systems in ways that save water and protect water quality.

1. Water Quantity – using water as efficiently as possible while providing for the needs of the plants. Many landscape plants require supplemental irrigation to meet their intended aesthetic or recreational function. Supplemental irrigation should equal the evapotranspiration rate of the plant being maintained minus any precipitation that occurred. Excessive irrigation is not only wasteful but can have a negative impact on plant health and water quality.
2. Water Quality - irrigation at a rate equal to or less than the infiltration rate of the soil. This prevents surface runoff and limits the off-site movement of sediment, pesticides, and nutrients. Irrigation that exceeds the water-holding capacity of the soil may lead to leaching of pesticides and nutrients. Maintaining a healthy plant cover increases soil infiltration rates and minimizes soil erosion and sedimentation of surface waters. This mitigates the effects of storm events and flooding.
3. Soil Conservation – improving the physical, biological, and chemical properties of the soil. A healthy plant cover provides for improved infiltration of rain or storm water and reduced erosion. A robust plant/soil system filters contaminants and ensures a healthy aquifer recharge.
4. Plant Management – employing sound agronomic/horticultural practices, including irrigation, to maximize plant health and performance.

The goal is to provide landscape irrigation owners and operators with tools to understand, implement, and manage efficient turf and landscape irrigation systems.

► BMP 1 Design the Irrigation System for the Efficient and Uniform Distribution of Water

The irrigation system shall be designed to be efficient and to uniformly distribute water. Specific criteria that shall be considered in the design include soil type, slope, root depth, plant materials, micro-climates, weather conditions and water source (e.g., quantity, quality and pressure). To conserve and protect water resources, the irrigation designer shall select appropriate equipment components that meet state and local code requirements and site requirements. Specific design considerations should include:

- The design should be based on a thorough evaluation of physical, environmental, and hydrogeologic site conditions.
- Placement and spacing of sprinklers should be based on performance data and site-specific considerations.
- The use of pressure-regulating devices in the system will maintain water distribution uniformity throughout the zone.
- All plants within a sprinkler zone should have similar water requirements and root depths. Plants with different water requirements (such as grass and shrubs) should be in separate zones.
- Watering cycles should be scheduled for times of low wind and low evaporation.
- Sprinkler heads must be spaced to provide head to head coverage, using guidelines suggested by the manufacturer, and wind factors must be considered.
- Sprays and rotor irrigation heads cannot be used within the same zone.
- Sprinklers located on a steep slope require check valves be installed on all heads on that irrigation zone.
- The irrigation design should consider the different micro-climates found in most landscapes.

- The controller should have multiple programs so these different irrigation schedules can be utilized.
- "Smart" controllers should be considered for operation of the system.[33]
- Guidelines on pressure at the head/emitter,
  - Spray Heads - 20 to 35 pounds per square inch (psi)
  - Gear Rotors - 60 psi or less
  - Impact Rotors - 60 psi or less
  - Drip emitters - 40 psi or less
- Do not allow water to spray onto non-landscaped areas.

► BMP 2 Install the Irrigation System to Meet the Design Criteria

Irrigation systems shall be installed according to design specifications, manufacturer's specifications, and state and local code requirements. The installation should result in an efficient and uniform distribution of water. The irrigation contractor or installer shall be licensed and/or certified where applicable.

- The installed irrigation system shall have a rain interruption device.
- The installer will ensure qualified supervision of the installation process.
- Final inspection and approval of the system shall be conducted by a qualified and authorized individual.
- Review as-built design, operation manual, and system orientation with owner/manager.
- A set of actual construction drawings, updated daily by the installing contractor and clearly annotated shall be kept during the construction process. The final as-built document should include the locations and sizes of the water meter, shutoff valves, backflow prevention device, mainline pipes, zone valves, lateral pipes, sprinklers, controller locations and sensors.
- A written manual of suggested maintenance of the system, including winterizing and start-up procedures, shall be submitted to the owner.

► BMP 3 Maintain the Irrigation System for Optimum Performance

The irrigation system shall be regularly serviced to maintain the performance of the system as designed. Maintenance shall result in sustaining an efficient and uniform distribution of water.

- Appropriate personnel shall educate and train the system manager on proper use, operation, and capacity of the system. This includes seasonal adjustments or system shut-down based on prevailing or impending weather conditions.
- The irrigation schedule should be routinely modified based on plant health and vigor and should account for current and anticipated weather, pest pressure, or other pertinent conditions.
- In order to prevent runoff, the irrigation schedule should not exceed the soil infiltration rate.
- Periodically perform a thorough inspection of the system to verify that all components meet the criteria for efficient operation and uniform distribution of water, and repair or replace components as needed. Perform periodic visual inspections while the system is operating to check for needed repairs and adjustments.
- Qualified persons should perform start-up of the system in spring and shut-down in winter.

[33] "Smart" controllers are controllers that use water more efficiently than traditional timers by monitoring specific site conditions – including plant and soil type, slope, soil moisture, and weather conditions – and by automatically adjusting the watering schedule on an ongoing basis to provide the right amount of water for each part of the landscape each day. They turn sprinklers on and off in response to actual environmental conditions such as, soil moisture, rain, wind, slope, soil, plant type, etc., and thus provide only the amount of water needed. Source: Irrigation Consulting, Inc.

► ***BMP 4 Incorporate Other Techniques that Result in Water Conservation***

Landscape irrigation will be most effective when implementing a variety of techniques that result in water conservation. These techniques may include:

- water audits
- alternative plant species (drought tolerant plants)
- reclaimed water and/or retained storm water
- deficit irrigation scheduling
- soil cultivation/aeration
- syringing[34]
- soil amendments and wetting agents
- soil and nutrient management
- mulches

These Best Management Practices were developed with assistance from the Irrigation Association of New England, P.O. Box 354 Concord, NH 03302
Tel: (603) 679-9991; www.irrigationassociationne.org

[34] Syringing is a quick spray technique, used only on occasion to provide instant cooling of the grass. It is used mainly in athletic fields and golf courses.

L) Local Water Conservation Efforts

This appendix includes successful water conservation efforts in many Massachusetts communities that could serve as examples in other cities and towns. Features of their water conservation programs are highlighted below. Please note that this is not an endorsement of the WRC.

Acton[35]

The Acton water district provides water to the town from eleven wells located within the town. The district's system consists of 106 miles of water main, four storage tanks, and a variety of treatment facilities that assist in the production of high quality finished water. The district is faced with demand during peak-use seasons as Acton's population increases. The town's water withdrawal permit allows for an average withdrawal of 1.92 mgd. On peak demand days (generally during the months of May-October) water use can reach and exceed 2.45 mgd. Although use is lower during the winter months, the annual average withdrawals come very close to the limit.

CONSERVATION EFFORTS

Conservation measures, such as limitations on outdoor water use and water efficient landscape designs and practices have been shown to result in average water savings of up to fifty percent. Such savings would allow Acton to sustain itself for the foreseeable future on existing supplies.

1. Pricing

The water rates are based upon consumption; inclining block rates have been set to encourage conservation.

Inclining Block Rates in cubic feet	January Bill Winter Rate	April Bill Winter Rate	July Bill Summer Rate	October Bill Summer Rate
Service Charge per Unit	$15.00	$15.00	$15.00	$15.00
Between 0 and 2000	0.03	0.03	0.036	0.036
Between 2001 and 4000	0.033	0.033	0.042	0.042
Between 4001 and 6,000	0.045	0.045	0.053	0.053
Greater than 6,000	0.054	0.054	0.063	0.063
Municipal Rate	0.032	0.032	0.032	0.032

Rates, other than per unit charge, are per cubic foot, as of July 1, 2010. cf = cubic feet; 100 cf = 748 gallons.

Online water bill calculator in the "Water Bill" section at http://www.actonwater.com/.

[35] Source: Acton Water District: http://www.actonwater.com/

2. Outdoor Watering

Every year from May 1st to October 1st, strict outdoor water restrictions are put into effect - no lawn can be watered from **7AM-7PM**. The town of Acton has also formulated a weekly rotation system in which certain people will be able to use water outdoors on specific days of the week. **Even** numbered houses may use water outdoors on **Tuesday, Thursday,** and **Saturday**. **Odd** numbered houses may use water outdoors on **Wednesday, Friday,** and **Sunday.** No household is allowed to use water outdoors on Monday.

3. Outreach and Education

The philosophy of Acton's water conservation program is that the school children of today will soon be tomorrow's water resource stewards. Teaching children to value and protect their drinking water is an important investment in the future, as well as an excellent way to send a message home to parents. The Acton Water District's education program is offered free of charge to all students and teachers in Acton's Public Schools.

The following are provided to schools:

- Classroom visits and field trips with Water District staff;
- A menu of drinking water-related lessons and activities that can be presented by Water District staff, or provided to teachers for their own implementation;
- Lesson plans that incorporate the Massachusetts Department of Education Science and Technology Curriculum Frameworks;
- Consultation on integrating drinking water topics into science curriculum;
- Lending library of educational videos, books, and other resources;
- Special activities each spring during Drinking Water Week; and
- Sponsorship of student summer internships and special drinking water-related projects.

Concord[36]

With a total population of 17,600 people, the town of Concord supplies 97% of its water. Average daily residential demand is 68 gallons per person and overall demand fluctuates between 2 mgd in the winter and 5 mgd in the summer. Satisfying demand during the peak summer months is particularly challenging. The town is supplied by a total of six groundwater wells and one surface water withdrawal (summer use only). The water is 100% metered and is distributed among: residential (65%); industrial, commercial and institutional (33%); municipal (1%); and second meter (1%) users.

CONSERVATION EFFORTS

1. Metering and Leak Detection

All customers in Concord are metered. The metering program also includes free maintenance. This ongoing maintenance helps the town quickly detect any leaks or problems with the system. Technologies such as radio meters, weather-based irrigation controllers, and waterless urinals have played a key role in the water conservation efforts. The town conducts free residential water audits for its large users. Concord has also given incentives to switch old toilets and washing machines for new, more efficient ones. It also provides free leak detection kits, flip aerators, low-flow showerheads, shower timers, and rain gages.

2. Pricing

Concord employs full-cost pricing and has an enterprise account for water. The town has seasonal conservation water rates (rates as of June 1, 2011).

Residential Water Users – Single Unit Residential

Base Rate: $4.10per 100 cf bimonthly and year round.
Step 2: $8.20 per cf for 2,500 – 4,800 cf bimonthly May 1 through October 31.
Step 3: $10.25 per cf over 4,800 cf bimonthly May 1 through October 31

Approximately 2/3 of the residential customers stay within the 1st step (block pricing). Besides residential users, small businesses also stay within this first step. Year-round, the following rates apply:

Industrial, Commercial and Institutional Water Users (General Service)

1st step < 5000 cf = $4.10/cf
2nd step > 5000 cf = $5.21/cf

Municipal Water Users

$4.04/ccf

3. Outdoor Watering

In the town of Concord, irrigation represents a significant problem. Households with irrigation systems are consuming 75% more water on average, due to the watering and over-watering of lawns. In 2005, 27% of the total water withdrawn was used by 10% of the residential users. All irrigation systems are required to be registered with the town. The irrigation systems also need to include specific components – rain sensors, programmable devices, and reduced-pressure backflow devices. While about 380 of these systems have been registered, approximately 400 are thought to be unregistered.

4. Outreach & Education

The town of Concord does extensive education and outreach. These include the *Water Connection* newsletter that is available to customers twice a year, a rain barrel program, lawn signs, inclusion of conservation in the 4th grade curriculum, demonstrations on how to maintain a garden without wasting water excessively, and templates on how to create water-smart landscapes. Through these programs, the town of Concord hopes to spread the efforts and benefits of Water Conservation.

[36] Source: www.concordma.gov/Pages/ConcordMA_water/water%20efficiency and MAPC, "Summer Smart Water Use- A Guide to Peak Season Water Demand Management." Metropolitan Area Planning Council and 495/MetroWest Corridor Partnership, May 2006. Available at http://www.mapc.org/resources/watersmart-toolkit.

Dedham-Westwood[37]

The Dedham-Westwood Water District is responsible for distributing water to approximately 38,000 people. On an average day, the District pumps about 4.25 million gallons of water from eleven artesian wells, six in Westwood and five in Dedham. In December of 2005, the District was granted membership into the Massachusetts Water Resources Authority, allowing it to purchase supplemental water, when needed, to ensure public health and safety during peak water-use periods.

CONSERVATION EFFORTS

The Dedham-Westwood Water District has established a very strong and organized water conservation program. This program is divided into four stages. The first stage covers voluntary conservation, i.e. people responding to simple public requests or suggestions. The second stage describes a list of penalties that a person will receive if caught breaking the rules. At the third stage, the whole town goes under a mandatory restriction, and is given a schedule of when outdoor watering is permitted. The fourth stage is a re-enforcement of the third. Municipal crews drive around the city, and if they see a violation, they issue a warning. If the person is seen violating for a second time, a second warning is issued with a fine.

1. Metering

Electronic Meter Program – Most commercial water accounts have been outfitted with new radio-read meters. All new residential meters, both new construction and meter change-outs at existing properties, also use this technology. Water bills will be issued monthly once the entire system is equipped with radio meters.

2. Pricing

Residential customers are billed quarterly while large commercial and industrial customers are billed monthly. The Water District has an inclining block rate. For residential water users,[38] the fixed fee is $11.84 for every 100 cubic feet or 748 gallons of water. Residential rates are per quarter. Each resident is allowed 300 cubic feet at his rate. There are three inclining blocks above the minimum charge; the rate for the largest water users is $8.77 per hundred cubic feet for consumption greater than 75 hundred cubic feet (56,000 gallons).

3. Residential Rebates

The District offers a $50 rebate for low-flow toilets, $75 for high-efficiency toilets, and $100 for front-loading washing machines (http://www.dwwd.org/conservation-rebate-program).

4. Outdoor Watering

The Dedham-Westwood Water District offers detailed guidelines for water-use restrictions at three increasingly severe stages of a water supply emergency.

Stage I-A: Voluntary odd / even outside water use policy

- Public requested to conserve water and refrain from watering lawns.
- Publicity that mentions the need for water conservation, and suggests possible methods to conserve.

Stage I-B: Mandatory odd / even outside water use policy

- Public is required to restrict lawn watering to every other day based on address and calendar date.
- The District Water Commissioners may invoke monetary or other penalties for customers who violate any mandatory restriction order such as:
  - First Violation: Warning
  - Second Violation: $100.00 fine
  - Third and Additional Violations: $250.00 and discontinuance of water service. A reactivation fee of $250.00 will be charged before water service is restored.

Stage I-C: Mandatory restrictions on lawn watering by Town to two days per week between the hours of 6 a.m. to 9 a.m. and 6 p.m. to 9 p.m.

[37] Source: http://www.dwwd.org/

[38] Rates effective as of January 25, 2011.

Lawn watering is permitted only on Monday and Thursday in Dedham, and on Tuesday and Friday in Westwood. No lawn watering is allowed on Wednesdays, Saturdays, and Sundays. Hand-held hoses may be used for flower and vegetable gardens without hour and day restrictions.

Stage 1-D: Mandatory restrictions on lawn watering to one day per week between the hours of 6 a.m. to 9 a.m. and 6 p.m. to 9 p.m.

- The public is required to restrict lawn watering as noted below and requested to conserve water in all other practicable ways.
- Hand-held hoses may be used for watering flower and vegetable gardens and shrubbery without day or hour restrictions.
- Pools less than 10,000 gallons may be filled until Memorial Day only.

Allowed Day	Town	Address
Monday	Dedham	Odd
Tuesday	Westwood	Odd
Thursday	Dedham	Even
Friday	Westwood	Even

Lawn watering is **not** permitted on **Wednesdays, Saturdays, or Sundays.**

Stage II-A: Purpose is to reduce water consumption with minimum hardship or economic loss to individuals and business concerns

Use of the affected public water supply for any of the following purposes is prohibited:

- Watering shrubbery, trees, lawns, grass, plants.
- Washing vehicles or other mobile equipment
- Washing streets, driveways, parking lots, etc.
- Operation of any ornamental fountain or something similar.
- Filling (from an empty or less than three-quarters full condition) of swimming pools
- Service of drinking water in restaurants, except on request.

Stage II-B: In addition to those measures included in Stage II-A, use of affected public water supply for any of the following purposes is prohibited

- Adding water to any kind of outdoor swimming and/or wading pools, or to fountains, reflecting ponds, or other ornamental structures.
- Any other use of water supply for outdoor recreation.
- Air conditioning, where interior temperature is less than 78 degrees Fahrenheit.

Stage II-C: In addition to those measures included in Stages II-A and B, the use of affected public water supply for any of the following purposes is prohibited

- Adding water to indoor swimming pools.
- School athletic programs and other indoor athletic/recreation activities, including health spas.
- Fire hydrants other than for health and safety purposes.
- Construction purposes, including hydro-seeding, dust control, and filling or flushing water mains for new development.
- Commercial vehicle and automotive equipment washing.
- Watering of golf course greens.

Stage II-D: In addition to those measures included in Stages II-A, B and C, use of affected public water supply for any of the following purposes is prohibited

- Make-up water for air conditioners.
- Watering of plants by commercial nurseries and agricultural water users.
- Use of automatic ice making machines in hotels and motels.
- Production of bottling of beverages.
- Operation of any commercial or industrial facility which is ordered closed by the local jurisdiction.

Stage III: In addition to those measures included in Stages II, the use of water for any purpose not essential to life, health and safety is prohibited.

Ipswich[39]

The town of Ipswich is 33 square miles in area and home to approximately 13,175 people. Seventy percent of Ipswich's area is served by a single public water supplier, the Water Division of the Utilities Department. The Ipswich Water Division obtains water from six groundwater sources and two surface water sources, in both the Parker and the Ipswich river watersheds. The population projected for the town under build-out conditions is 23,089. In 2000, Ipswich received a consent order for exceeding its registered withdrawal limits. A water conservation plan with features outlined below was developed to fulfill requirements associated with Ipswich's WMA permit application.

CONSERVATION EFFORTS

1. Metering and Leak Detection

The town of Ipswich has completed installation of automatic meters throughout the town. Over the last few years, the Ipswich Water Division has had a widespread program to prevent leaks. Leak detection takes place annually in all households and businesses of Ipswich. The Water Division offers residential water audits free-of-charge to customers who suspect they are wasting water. Commercial water use does not fluctuate seasonally like residential water use. If a commercial customer does show a significant unexplained increase in consumption, the Water Division works closely with the customer to determine the cause and possible solution.

2. Pricing

The town of Ipswich established a seasonal water rate structure in 2003. The goal of the season rate structure is to manage summer water demand while remaining revenue neutral. With this structure, residential customers have their water rate increase 1.5 times the base (nonresidential) rate between May and November of each year. During the winter months, the rate drops below the base rate by a factor that is determined at the end of each summer. This rate drop is key to the revenue neutral portion of the structure. Residential customers with consistent annual usage pay no more each year than they would with the year-round base rate.

3. Outreach and Education

The Utilities Department sends a quarterly newsletter to all its customers, with the spring issue focusing on water conservation tips, the status of the system, and an announcement for the Annual Open House at the Water Treatment Plant. In recognition of Drinking Water Week, the Water Division increases its public awareness campaign with articles in the local newspaper. Personnel also conduct information sessions at the local elementary schools and host a poster contest.

4. Other

The town of Ipswich has developed a Water Bank. If there is a new housing development in the town with more than three houses, the developer has to search for its own water through offsets. The developer must also seek the town's approval in order to get water from Ipswich's water supply.

[39] Source: http://www.ipswichutilities.org/default.aspx?Page=WATER

Reading[40]

Since 2003, the town of Reading has been implementing a comprehensive water conservation program, which includes rebates, residential water audits, retrofits of municipal buildings with water-saving devices, an audit of the town's water distribution system, leak detection and repair, and an extensive public education program. As of 2011, the town had issued $434,780 in rebates to more than 1,000 households. In addition, nearly 3,000 water-saving retrofit devices had been distributed as part of free home and irrigation system water audits conducted for residential customers.

All municipal buildings have been retrofitted with water-saving fixtures, including toilets, showerheads, and faucets; the town also conducted a system-wide audit to evaluate potential ways to conserve water in the town's treatment and water distribution systems.

CONSERVATION EFFORTS

1. Leak Detection

The town conducts system-wide leak detection annually. It also conducts free home water audits that include both indoor and outdoor water use. The audit covers showerheads, faucet aerators and other fixtures, installation of free water-saving fixtures (such as shower heads, aerators, garden hose nozzles, displacement bags for older model toilets), comparison of water-use patterns, evaluation of outdoor water use, leak checking, a report with recommendations, and free educational material.

2. Pricing

Reading obtains water from the Massachusetts Water Resources Authority. As of September 2011, quarterly water rates are $8.27 per hundred cubic foot, with a minimum bill of $16.54 per quarter.

3. Residential Rebates

The town, as part of its water conservation rebate program, offers cash incentives to residents for purchasing water-efficient appliances and fixtures. All rebate applications must include as proof of purchase: an original, unaltered and dated sales receipt with brand and model number on the receipt. Rebates are available for the following items:

- High-Efficiency Clothes Washers - $200 per washer.
- Low-Flush Toilet (1.6 gallons per flush maximum). Rebates are available for purchases, permits, and installation costs, up to $120 per toilet. Toilets must replace a non-water saving toilet (3.5 or more gallons per flush) to be eligible for a rebate. Toilets purchased and installed in new construction projects or room additions do not qualify for a rebate. Also, replacing an existing low-flush model with another does not qualify for the rebate.
- Moisture sensor for irrigation system – up to $25 per sensor.
- Rain Barrel - $25 per Great American Rain Barrel.

4. Outdoor Watering

The town has restrictions on outdoor water use. The town has an odd/even-day watering restriction and the hours for water use are Monday through Sunday from 4:00 a.m. to 9:00 a.m. and 5:00 p.m. to 8:00 p.m.

5. Outreach and Education

The town also conducted an outreach and public education campaign on the water conservation and the rebate program. The outreach program included a water conservation curriculum delivered to all third-grade classes in the town. Approximately 370 students learned about water conservation and brought home an information packet and sample devices.

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[40] Sources: http://www.ci.reading.ma.us/dpw/, http://www.mass.gov/dcr/watersupply/ipswichriver/demo7-retrofits.htm, and Interbasin Transfer Required Annual Report dated July 28, 2011, from the Town of Reading to the Department of Conservation and Recreation.

Sharon[41]

The town of Sharon consumes approximately 1.2-1.5 mgd during the winter. Over the summer, especially in July and August, this number goes up to 2.5 mgd. Over time, use has dropped in Town, but the Town has found that the consumption of water is proportionate to the level of income.

CONSERVATION EFFORTS

The town of Sharon received a Water Conservation Award from the commonwealth of Massachusetts in 2009 and 2010. The town has focused on imposing heavy restrictions on lawn watering, which accounts for a significant percentage of the water consumed. Through water conservation, the Town is striving to ensure that its reservoirs don't dry up during the summer months. The town of Sharon has numerous conservation initiatives.

1. Leaks

Residences consuming more than 100,000 gallons per month are offered free audits, conducted by Energy New England. The audits provide customers with customized analyses, highlighting the most cost-effective strategies for conserving water. These audits would be key to finding leaks in people's homes, significantly reducing people's bills. The town provides the following tips for preventing leaks,

- Write down the reading on your water meter before leaving home. Check it again when you return. If it advanced while no one was home, there must be a leak.
- Worn out toilet flappers are a common source of leaks. You can check your toilet for leaks by putting food coloring in the tank and waiting a few minutes to see if the color leaks down to the bowl. (Note: if you have to jiggle the handle of your toilet to prevent it from running, fix it promptly.)
- If you have an irrigation system, be sure to winterize it properly, and check for leaks as soon as the ground thaws in spring. Be sure the nozzles are not leaking and are aimed at the lawn, not the sidewalk.
- Check faucets in the kitchen, bathrooms and outdoors, as well as showerheads. If you know there's a leak but can't find it, call the Sharon Water Department for help.

2. Pricing

Sharon has an increasing-block and seasonal residential rate structure:

Water usage, quarterly (gallons)	Winter Rate (Oct. – Mar.) (per 1,000 gal.)	Summer Rate (Apr. – Sept.) (per 1,000 gal.)
Base Fee	$15.00	$15.00
0 – 7,500	$3.00	$4.00
7,500 – 15,000	$6.00	$7.00
15,000 – 22,500	$8.00	$9.00
Over 22,500	$12.00	$13.50

Rates effective January 1, 2012

3. Residential Rebates

The town offers rebates as cash incentives to residents to improve water efficiency:

- A rebate up to $200 with the purchase and installation of a high-efficiency toilet (toilets that use less than 1.28 gallons per flush or less).
- A rebate up to $200 for high-efficiency washing machines with an EnergyStar Water Factor of 6.0 or less. The Town of Sharon provides 50-60 rebates a year.
- A rebate of up to $200 for purchase and installation of climate based irrigation controllers tested under the Irrigation Association's Smart Water Application Technologies Program (SWAT).
- A $300 rebate to decommission existing underground automatic irrigation systems with the capacity to irrigate 5,000 square feet or more.

[41] Source: http://www.townofsharon.net/Public_Documents/SharonMA_DPW/water

- A rebate of up to $200 to perform an audit of in-ground, automated irrigation systems; audits must be done by a WaterSense-certified irrigation partner.
- Rain barrels available for purchase for $50.

4. Outdoor Watering

From May 1 to October 1, the residents of Sharon are allowed to water their lawns on the schedule outlined below. One hand-held hose is allowed per premise with no restrictions.

- **Odd numbered** houses can water lawns on Monday and Wednesday from 6:00 pm to 8:00 pm.
- **Even numbered** houses can water lawns on Tuesday and Thursday from 6:00 pm to 8:00 pm.
- Exemptions are granted for new lawns for a period of two weeks.
- **No watering** is allowed on Friday, Saturday, or Sunday.

The Sharon Water Department prefers that customers minimize or eliminate the need for lawn irrigation by cultivating drought tolerant grass varieties, establishing a deep layer of organic loam, and allowing lawns to go dormant during periods of drought. For customers who do irrigate, the town offers the rebates described above to help residents with automatic sprinkler systems to irrigate as efficiently as possible.

Wayland[42]

The Town of Wayland, through its Board of Public Works, may declare a state of water supply conservation upon a determination by a majority vote of the Board that a shortage of water exists and conservation measures are appropriate to ensure an adequate supply of water to all water consumers.

CONSERVATION EFFORTS

1. Pricing

The Town of Wayland operates with an increasing-block-rate pricing system with four tiers.

Residential Water Users

Water Usage, cubic feet	Residential Rate (per 100 cubic feet)
<1,500	$5.10
1,501 – 3,000	$6.60
3,001 – 8,000	$7.75
8,000+	$12.50

2. Outdoor Watering

The town of Wayland requests residents to limit outdoor watering to two days per week. In addition, a restriction on outdoor watering can include one or more of the following elements:

- Outdoor watering is permitted only during daily periods of low demand, to be specified in the declaration of a state of water supply conservation and public notice thereof. Currently the town has an odd/even day watering restriction between the hours of 7:00 pm and 7:00 am. Hand-held hose watering is not restricted.
- Hand-held watering only.
- Outdoor watering is prohibited.
- Filling of swimming pools is prohibited.

[42] Source: http://www.wayland.ma.us/pages/WaylandMA_Water/index

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