In May 2008, Governor Doyle signed into law 2007 Wisconsin Act 227, confirming Wisconsin’s commitment to the Great Lakes-St. Lawrence River Basin Water Resources Compact (Great Lakes Compact). Following similar legislation in other Great Lakes States, the Compact was introduced to Congress in July 2008, approved by Congress in September 2008, and on October 3, 2008, signed into law by President Bush. The compact extends to Canada through the Great Lakes-St. Lawrence River Basin Sustainable Water Resources Agreement. The Compact took effect in Wisconsin on December 8, 2008.

The compact and related agreement are landmark legislation that treat the Great Lakes Basin as an ecosystem, requiring that any withdrawals of water from the Basin be returned to the Basin. The agreements further require that all states and provinces within the Basin establish and enact conservation and efficiency measures for all water users.

This report is intended to serve two purposes: 1) provide interested stakeholders an overview of conservation and efficiency issues for Wisconsin, and 2) assist the Wisconsin Department of Natural Resources (DNR), Public Service Commission (PSC), and Department of Commerce (Commerce) as they develop statewide and Great Lakes Basin-specific programs for water conservation and efficiency. The report is the result of a project conducted by graduate students in my Fall 2008 Water Resources Institutions and Policies class at the University of Wisconsin-Madison (URPL/ENVIR ST 865).

The project explored potential policy directions for water conservation and efficiency measures in Wisconsin. DNR and PSC staff members were gracious with their time and support for this project, and the students and I appreciate their insights and assistance. The class members demonstrated substantial resourcefulness, initiative, and leadership throughout this work. All of the students contributed to the report. Special recognition is due to Melissa Whited, Master’s degree student at the Nelson Institute for Environmental Studies, who invested additional time and effort beyond the fall semester to expand and help me to finalize the report.

We hope those agencies along with other interested stakeholders and policy makers find this report to be helpful in furthering discussions of how we manage Wisconsin’s—and the region’s—precious water resources.

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I. INTRODUCTION

The focus of this report is on water conservation and efficiency, particularly related to water quantity issues rather than water quality issues. Wisconsin is overhauling water quantity management, exemplified by the passage of 2003 Wisconsin Act 310, the state’s groundwater protection law, and 2007 Wisconsin Act 227, Wisconsin’s implementation of the Great Lakes-St. Lawrence River Basin Water Resources Compact (Compact).

This introduction provides background on the development of the Great Lakes-St. Lawrence River Basin Water Resources Compact, and it outlines how other states have approached developing water conservation and efficiency programs. Subsequent chapters explore water conservation and efficiency measures across sectors: publicly supplied residential, commercial, and industrial uses; privately supplied industrial, agricultural, and residential uses; and energy production including hydroelectric and thermoelectric power production. A land conservation chapter contextualizes the previous chapters, examines the importance of the watershed-based approach of the Compact, and explores watershed-scale land use measures significant to water quantity and quality. We conclude the report with a summary of recommendations for moving forward with conservation and efficiency measures in the Great Lakes Basin and the State of Wisconsin.

A. BACKGROUND

Wisconsin is a water-rich state with 15,000 inland lakes, 32,000 miles of perennial rivers and streams, 5.3 million acres of wetlands, and 1.2 quadrillion gallons of groundwater (Wisconsin Academy of Sciences, Arts and Letters [WASAL], 2003). The state is bound to the north and east by Lake Superior and Lake Michigan and to the west by the Mississippi River. Located between two of largest and most valued basins in the United States, Wisconsin’s social, environmental, political, and cultural values are inextricably tied to water and natural resources. Beginning in the Progressive Era, Wisconsin established itself as a national leader in conservation in part due to its exceptional water resources. Major industries in the state—agriculture, timber production, and tourism—are all heavily dependent on water resources (WASAL, 2003).

The citizens of Wisconsin value the state’s resources; however, there is little appreciation for the vulnerability of the state’s water resource supply (WASAL, 2003). Despite its apparent water wealth, Wisconsin faces both water quality and quantity challenges. Non-point source pollution, particularly agricultural runoff, is one of the preeminent issues throughout much of the state. Additionally, point source infrastructure requires attention, and out-of-date wastewater treatment facilities need improvement. In terms of water quantity, over-pumping of groundwater in some areas has caused aquifer levels to decline precipitously. Declining groundwater levels have contributed to the disappearance of springs, streams, and rivers, while residents in areas from
Abbotsford in central Wisconsin to Waukesha in the southeast are facing health concerns due to insufficient or contaminated water supplies.

1. **2003 Wisconsin Act 310**

2003 Wisconsin Act 310 expanded the state's ability to consider the environmental impacts of new high capacity wells. The act designated two groundwater management areas (GMAs) in the Lower Fox River Valley and southeastern Wisconsin. Under Act 310, the Wisconsin Department of Natural Resources (DNR) is required to review new high capacity wells for environmental impacts on Exceptional Resource Waters, Outstanding Resource Waters, springs, and trout streams. A common misunderstanding is that surface water can be treated separately from groundwater, but nearly all surface waters interact with groundwater components (Hunt, 2003). Act 310 includes legal recognition of the interconnection between surface waters and groundwater. The Groundwater Advisory Council (GAC), convened through the implementation of Act 310, reported that Act 310 is a positive contribution towards integrated water resources management (Wisconsin Groundwater Advisory Council [GAC], 2007). In 2007, the GAC advised that Wisconsin further develop a comprehensive statewide water management policy that should:

- Balance competing water uses
- Rely on sound science and adaptive management
- Encourage efficient water use and discourage waste
- Provide state and local agency coordination
- Seek to ensure adequate water supplies for future generations

To accomplish these objectives, the GAC advised that the Wisconsin legislature authorize the development of a comprehensive state water conservation program.

2. **2007 Wisconsin Act 227 - The Great Lakes Compact**

The Great Lakes – St. Lawrence River Basin Water Resources Compact, ratified by Wisconsin through 2007 Wisconsin Act 227, requires the Great Lakes states and provinces to “…act together to protect, conserve, restore, improve, and effectively manage the waters and water dependent natural resources of the Basin ecosystem...” The states committed to a collaborative strategy of adaptive management, bound together by an interstate compact. Key components of the agreement include:

- Sustainable use and responsible water management,
- A ban on new diversions from the basin,
- Consistent standards for the assessment of water uses throughout the states and provinces,
- Development of regional goals for water conservation and efficiency, and
- Collection and sharing of technical data and continued public involvement.
As part of the Compact, the Great Lakes-St. Lawrence River Water Resources Regional Body established the following goals:

1. Ensure improvement of the waters and water dependent natural resources.
2. Protect and restore the hydrologic and ecosystem integrity of the Basin.
3. Retain the quantity of surface water and groundwater in the Basin.
4. Ensure sustainable use of waters of the Basin.
5. Promote the efficiency of use and reducing losses and waste of water.

In addition, Wisconsin adapted the Great Lakes Objectives to be specific to Wisconsin’s situation and needs.

Wisconsin agreed to be the first of the Great Lakes States to pilot its own adaptation of the Regional Water Use Efficiency and Conservation objectives. The Compact requires that the states individually assess programs annually and report to the Great Lakes Council and public on their progress. Act 227 specifically requires the DNR, in collaboration with the Public Service Commission (PSC) and Department of Commerce (Commerce) to implement a statewide water conservation and efficiency program. The program is mandatory for the Great Lakes Basin and voluntary outside the basin, and it must be implemented no later than 24 months after the approval of the Compact.

3. **Water Law in Wisconsin – Defending the Public Trust**

Outlining a new water conservation and efficiency program begins with an overview of existing water rights and institutions. Water rights in Wisconsin and in all Great Lakes Basin states generally follow the riparian doctrine. Under the doctrine, water rights are granted to the owners of riparian lands subject to reasonable use. In Wisconsin, public trust doctrine also guides Wisconsin water management: water is regarded as a public resource to be held in trust by the state. The public trust in Wisconsin includes the right to transportation on navigable waterways and has expanded to include rights to water quality, water quantity, recreational activities, and scenic beauty (Quick, 1994).

Wisconsin case law indicates that on issues in which riparian rights interfere with the public trust, the public trust supersedes riparian doctrine. The prominence of the public trust doctrine in Wisconsin has resulted in some of the most progressive water management policies in the United States. The impetus for statewide water conservation and efficiency programs coincides with the idea that the waters of the state should be protected for the good of the public. The Wisconsin Supreme Court has held that the public trust doctrine is an active trust and, therefore, it is subject to supervision and modification by the state legislature (Patronsky, 1994). The expansion of statewide water quantity protection is consistent with a strong and broad Wisconsin public trust doctrine for waters.
4. **Existing Institutions**  
Various institutions and programs already exist in Wisconsin to support a new water conservation and efficiency program. Mechanisms in planning, water use regulation, metering, water use reporting, efficiency/water loss, pricing/water rules, reuse and recycling, education/outreach and other programs already guide conservation and efficiency (Public Service Commission of Wisconsin [PSC], unpublished report, 2007). In 2007, the DNR created a new Water Use Section charged with the task of promulgating new rules and implementing a statewide water conservation and efficiency program. Although many programs exist, the new section will create and coordinate a unified program.

5. **Water Use Stakeholders**  
The coordination and implementation of the Great Lakes Compact and a statewide water conservation and efficiency program includes many stakeholders. Wisconsin water users include public and private water supply systems, industrial and agricultural producers, and power generators. Wisconsin has approximately 750,000 private wells (Masarik, 2000). Although limited comprehensive water use data are available, the United States Geological Survey (USGS) compiles data on withdrawals by sectors. Table 1 depicts USGS data on water withdrawals in Wisconsin by use.

<table>
<thead>
<tr>
<th>Use</th>
<th>Including Thermoelectric</th>
<th>Excluding Thermoelectric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermoelectric</td>
<td>79% 6,094</td>
<td></td>
</tr>
<tr>
<td>Industrial</td>
<td>8% 603</td>
<td>40% 603</td>
</tr>
<tr>
<td>Domestic</td>
<td>4% 289</td>
<td>19% 289</td>
</tr>
<tr>
<td>Agricultural Irrigation</td>
<td>3% 195</td>
<td>13% 195</td>
</tr>
<tr>
<td>Public Use</td>
<td>2% 160</td>
<td>11% 160</td>
</tr>
<tr>
<td>Non-Irrigation Agriculture</td>
<td>2% 137</td>
<td>9% 137</td>
</tr>
<tr>
<td>Commercial</td>
<td>2% 118</td>
<td>8% 118</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7,597</strong></td>
<td><strong>1,503</strong></td>
</tr>
</tbody>
</table>

Source: based on USGS, 2000a.

At 79 percent of total withdrawals, power generation is the most intensive water use activity in the state. However, power generation is generally non-consumptive, with the majority of water withdrawn returned to the source (Shaffer, 2008). (Consumptive use is defined as the portion of water withdrawn not returned to the hydrologic basin due to evapo-transpiration, incorporation into products, or other processes (Pebbles, 2003).) Industrial water use is the second most intensive use of water within the state, but is also not highly consumptive. Domestic use constitutes approximately 19 percent of withdrawals (excluding thermoelectric), but is generally
regarded as non-consumptive. Agricultural uses constitute 22 percent of withdrawals (excluding thermoelectric), and are highly consumptive (USGS, 2000a).

Diminished water quantity affects recreation, industry, public supply, agriculture and power generation, all of which depend upon plentiful water resources. Consequently, stakeholders in conservation and efficiency program development include the public as users of drinking water and for recreational uses; industry for production and manufacturing; agriculture for crop irrigation, fisheries, and livestock; and the electric industry for hydroelectric and thermoelectric power production.

Additional stakeholders include Native American tribes, water advocacy groups, local and state government, and the citizens of Wisconsin. Balancing the multitude of values and needs within the state adds significant complexity to the development of a statewide water conservation and efficiency program. An analysis of the various water use sectors and synergistic rule and program recommendations are important components in the development of a statewide water conservation and efficiency program.

B. STATEWIDE WATER CONSERVATION PROGRAM FRAMEWORK

1. CONSERVATION PROGRAM APPROACHES

Traditionally, statewide water conservation programs have been informed by two general approaches: “performance-based” and “measure-based.” Performance-based programs focus on the achievement of specific reduction targets, with few stipulations regarding the means to achieve those ends. One of the main issues with this approach is that uniform reduction targets can unfairly penalize sectors and regions of a state whose unique characteristics make it more difficult to achieve water savings. Thus, some states have instead required the implementation of particular measures (i.e., Best Management Practices – “BMPs”) with well-defined coverage, schedule, and documentation requirements.

Recently, states have been moving toward a hybrid of the two in order to achieve even greater flexibility, yet promote specific goals that are measurable and enforceable. California began with mandatory BMPs, but has moved to an approach that allows flexibility in the BMPs or even selection of targets instead of BMPs. Arizona began with a per-capita target approach, but later introduced a more flexible BMP option that has proven increasingly popular. Examples of such approaches are given below; Table 2 summarizes state approaches for the public supply sector.

- Performance Based
  a. Per capita water use target
  b. Per account target for non-residential use
  c. Percentage cutback
  d. Percentage reduction of forecast demand
• **Measure Based**
  
  a. Requirement to implement a set of mandatory BMPs
  
  b. Requirement to implement a certain number of pre-approved BMPs
  
  c. Cost effectiveness standard (requirement to implement all conservation programs that are cost effective up to a designated point)

• **Hybrid Approaches**
  
  a. Flexibility regarding whether water users implement a set of BMPs or meet certain demand reduction targets (e.g., California)
  
  b. Flexibility regarding the nature of BMPs implemented, as long as water users implement the required number, they add up to a certain number of “points,” or they achieve a specified reduction target
  
  c. Some basic BMPs are required. Additionally, reduction targets are set at the local level and approved by a regulatory agency, but water users have flexibility in how to meet them (e.g., Texas)

Due to the flexibility inherent in the hybrid approach to statewide water conservation programs, this report focuses on identifying BMPs that have been successful in other regions and that could be adapted to Wisconsin, as well as opportunities for specifying local level performance targets where appropriate.

2. **Key Characteristics of Effective Programs**

Lessons learned from other states suggest that effective programs exhibit several key characteristics:

• Stakeholder buy-in through a participatory process
• Quantifiable goals/standards (i.e., well-defined coverage, schedule, and documentation requirements for BMPs or specific reduction targets)
• Flexibility (e.g., multiple tracks to choose from, and exceptions to requirements if utilities can demonstrate that the measure would not be cost effective or achieve meaningful water savings)
• Sufficient monitoring
• Rigorous and accessible public reporting (i.e., reports made available on-line)
• Adequate incentives to ensure compliance (enforcement and consequences)

Conservation programs also benefit from the principle of adaptive management, in which the success of each component is assessed regularly, and the program is amended as appropriate.
Table 2: Summary of Current Statewide Conservation Programs for Public Water Utilities

<table>
<thead>
<tr>
<th>Program Name</th>
<th>States Implementing</th>
<th>Mandatory Measures</th>
<th>Flexible Measures</th>
<th>Mandatory Reduction Targets</th>
<th>Uniform, Tiered, or Custom Requirements</th>
<th>Specific Requirements</th>
<th>Issues Associated with Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per Capita / Account Reduction</td>
<td>Arizona (GPCD Program) Massachusetts California &quot;20x2020&quot; Plan</td>
<td>X</td>
<td>X</td>
<td>Depends; can be any.</td>
<td>Arizona: Utilities assigned per capita target based on 1990 water use, future demand projections, and potential savings from water conservation. Targets ranged from 6 to 11 % reduction over 10 years, with higher targets for higher users. Massachusetts: Target of 65 gallons per capita for residential.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance Based (&quot;Outcome&quot;)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>California: 20% per capita reduction by 2020. Details not yet finalized.</td>
<td>Difficult to define baseline. If not sector specific, can penalize areas with developing industries &amp; commercial sectors. Also penalizes areas growing faster than projected, and those having already implemented conservation programs.</td>
<td></td>
</tr>
<tr>
<td>Percentage Reduction of Forecast Demand</td>
<td>X</td>
<td></td>
<td></td>
<td>Depends; can be any.</td>
<td>Reduce forecast demand by certain percentage</td>
<td>Difficult to define baseline. Can penalize high growth areas, and utilities that have already implemented conservation programs. Does not generally account for changes in income, climate, etc.</td>
<td></td>
</tr>
<tr>
<td>Total System Percentage Cutback</td>
<td>X</td>
<td></td>
<td></td>
<td>Depends; can be any.</td>
<td>Reduce demand by certain percentage</td>
<td>Difficult to define baseline. Can penalize high growth areas, and utilities that have already implemented conservation programs. Generally not implemented on a state-wide basis, but often implemented on a short-term basis for cities (especially for drought), and sometimes specific sectors (e.g. government).</td>
<td></td>
</tr>
<tr>
<td>All Mandatory BMPs</td>
<td>California MOU (original) Rhode Island Arizona Non Per Capita (original)</td>
<td>X</td>
<td></td>
<td>Uniform</td>
<td>California: Utilities required to implement all 14 BMPs unless they can prove that it would not be cost effective. Rhode Island: All utilities required to implement specific practices. Arizona: 12 specific BMPs required, with option to substitute 4 BMPs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tiered Mandatory BMPs</td>
<td>Arizona Non Per Capita Program (new)</td>
<td>X</td>
<td></td>
<td>Tiered</td>
<td>Requires that all utilities implement education and metering BMPs; medium-sized utilities must select 5 additional BMPs from approved list; large utilities must select 10 additional BMPs from approved list. Utilities may develop their own BMPs, subject to agency approval.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost Effectiveness Standard</td>
<td>X</td>
<td>Uniform Implementation Standard</td>
<td></td>
<td>Utilities required to implement all conservation programs that are cost effective up to a certain point, for example up to $400 per acre foot.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMPs OR Targets</td>
<td>California MOU (new) (only for one &quot;track&quot;)</td>
<td>X</td>
<td>X</td>
<td>Uniform within tracks, but flexibility in choosing which track. Utilities may choose between 3 &quot;tracks&quot;: 1) following the standard 14 BMPs, 2) choosing substitute BMPs from an approved list, or 3) meeting a per capita reduction target.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tiered Mandatory BMPs, and Utility-set Targets</td>
<td>Kansas Texas</td>
<td>X</td>
<td></td>
<td>Tiered BMPs, Utility-Customized Targets Texas: Requires all utilities to meet a few basic BMPs, and all medium and large utilities to meet several additional BMPs and submit conservation plans with customized targets that are approved by the TX Water Development Board. Kansas: Requires utilities with sensitive sources or receiving state funding, submit conservation plans. Depending on size and avg per capita usage (as compared to a regional baseline), utilities are encouraged or obligated to implement specific BMPs. Exceptions are made for unusual local conditions.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hybrid</td>
<td>X</td>
<td>Can be Uniform or Tiered</td>
<td></td>
<td>A list of BMPs with corresponding points for implementation. Flexibility in choosing BMPs, as long as a certain number of points are met.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- 7 -
C. ORGANIZATION OF THE REPORT

The remainder of this report consists of four main chapters: II) publicly supplied water for commercial, industrial, and residential; III) privately supplied water for residential, commercial, industrial, agricultural, and irrigation uses; IV) water for power production; and V) land use as it impacts water resources.

Each chapter begins by identifying the character of the use in Wisconsin, followed by a discussion of the policy context in terms of applicable state and federal regulations and programs. Each chapter also includes conservation and efficiency program components and analyzes them in terms of effectiveness and applicability to Wisconsin. Fifty case studies throughout the document provide examples of programs and approaches in use today.

D. KEY TERMS

Water Conservation – The preservation of quantities of water sufficient for economic and agricultural uses, drinking water supplies, and to sustain water-dependent ecosystems. In water management, conservation is associated with managing demand by reducing human consumption and improving water use efficiency (Sinykin et al., 2005).

Water Efficiency – Water efficiency describes the relationship between the amount of water required for use and the amount actually used. The focus of efficiency is on the reduction of water waste, as opposed to reduction of water demand (Vickers, 2002).

Consumptive Use – Consumptive use is the portion of water withdrawn not returned to the hydrologic basin due to evapo-transpiration, incorporation into products, or other processes (Pebbles, 2003)

Non-Consumptive Use – Non-consumptive use is the portion of water withdrawn and then returned to a hydrological system for other uses.

Public Water Supply – Public water supply refers to systems that provide water to the public for human consumption through pipes or other constructed conveyances. For USEPA regulation, service must include at least 25 people or 15 service connections for at least 60 days per year (USEPA 2007)

Private Water Supply – Supplies that are not public. These include agricultural, industrial, and domestic wells.

High-Capacity Well – one or more wells, drill holes or mine shafts on a property that have a combined pumping capacity of greater than 70 gallons per minute (100,000 gpd) (Wisc. Admin. Code ch. NR 812). In Wisconsin, water wells used for irrigation are considered high-capacity wells and are managed under NR820.
II. PUBLIC WATER SUPPLY

A. PUBLIC WATER SUPPLY IN WISCONSIN

Public water supply systems are a vital component of water resource provision in the state of Wisconsin and throughout the country. Approximately two-thirds of Wisconsin’s population is served by nearly 11,500 public water systems, 582 of which are designated as “public utilities.” (Wisconsin Department of Health Services, 2008; PSC, 2009a) (Public utilities provide service to the general public, rather than to a special class of customer such as that defined by the relationship of landlord and tenant (Sun Prairie v. Public Service Comm.,1967).) In addition to residential customers, public systems also provide water to many industrial, commercial, and institutional customers.

Public suppliers have a responsibility under the Safe Drinking Water Act of 1974 to ensure the protection of public health and safety by carefully monitoring drinking water quality, and all public supply systems are regulated by the DNR. Wisconsin’s water utilities are additionally regulated financially by the PSC, which works to ensure that utilities provide adequate and reasonably priced service to their customers. The PSC divides Wisconsin water utilities into three classes: AB (serving more than 4,000 customers), C (1,000 – 4,000 customers), and D (less than 1,000 customers). This chapter focuses primarily on these public water utilities that are jointly regulated by the DNR and PSC.

In recent years, water conservation and efficiency has gained momentum across the state. Several utilities have implemented conservation rate structures since 2007, and many others are implementing educational outreach initiatives, toilet rebate programs, water sprinkling ordinances, and other strategies to reduce water consumption.

Despite these encouraging developments, few communities have yet engaged in comprehensive conservation and efficiency efforts. According to the PSC’s 2008 “Survey of Water Conservation and Efficiency Efforts,” 75 percent of responding utilities had implemented fewer than four of the suggested conservation measures, and 31 percent had not implemented any of the measures. In addition, there is potential to improve distribution system efficiency at many utilities. In 2008, more than 200 billion gallons was pumped by public utilities for public use, of which 86 percent was sold, two percent was used for system maintenance or fire protection, and twelve percent was lost to infrastructure failure, theft, or was otherwise unaccounted for (PSC, 2009b).

According to the US Census Bureau, Wisconsin’s population is projected to increase by more than one million by 2030, which is a 20 percent increase over the state’s 2000 population (Wisconsin Department of Administration, 2004). As population growth places higher demands on Wisconsin’s water resources, conservation and efficiency measures for water use will become increasingly important for public systems.
B. STATE-LEVEL APPROACHES TO PUBLIC SUPPLY CONSERVATION PROGRAMS

Many states have implemented conservation program requirements for some or all of their public suppliers, particularly public utilities. Although many of these programs originated in the southwestern United States, they have spread across the country and include states historically considered relatively water-rich, such as Massachusetts, New Hampshire, and Rhode Island.

As described in this report’s introduction, statewide conservation programs for public suppliers have been undergoing transformations. Traditionally many programs focused on achieving specific reduction targets or implementing a set of mandatory BMPs. An approach that is gaining in popularity is a hybridized approach that offers a menu of BMPs and/or locally-established reduction targets.

1. A PUBLIC UTILITY CONSERVATION FRAMEWORK FOR WISCONSIN

A formal statewide public utility conservation framework does not yet exist for Wisconsin. In keeping with a trend toward hybrid approaches, a framework could be designed to require that all utilities develop an individualized conservation plan and engage in a specified number of conservation best management practices, such as a public education campaigns or developing a water loss management program. However, Wisconsin’s water resources and utilities are diverse, and a statewide conservation framework would need to reflect this diversity through a flexible approach. Program requirements would take into consideration:

- Whether the water supplier and customers lie within the Great Lakes Basin or a Groundwater Management Area
- The size of the water utility
- Whether the utility’s customers exhibit abnormally high per capita water consumption

For example, the Table 3 illustrates how varying numbers of BMPs could be required based on utility size and location (within or outside the basin). Additionally, requirements could be added for other conservation priorities, such as location in a GMA or other water-constrained area.

Table 3: Sample Conservation Program Requirements

<table>
<thead>
<tr>
<th>Size</th>
<th>Category</th>
<th>Number of BMPs (In Addition to Existing Requirements)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMALL UTILITIES</td>
<td>Out of Basin</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>In Basin or In GMA</td>
<td>4</td>
</tr>
<tr>
<td>MEDIUM UTILITIES</td>
<td>Out of Basin</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>In Basin or In GMA</td>
<td>7</td>
</tr>
<tr>
<td>LARGE UTILITIES</td>
<td>Out of Basin</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>In Basin or In GMA</td>
<td>10</td>
</tr>
</tbody>
</table>
Utilities could be given an extensive list of approved BMPs from which to choose, with certain BMPs mandatory for utilities falling in specific categories (See Table 4). Although not all BMPs will result in quantifiable demand reduction, successful implementation could be judged on other factors such as percentage of customers receiving retrofits, number of customers exposed to public information campaigns, or other “coverage” standards. The establishment of specific, meaningful implementation standards will be a crucial part of this process. (See the California case study for an example of coverage standards.)

One of the BMPs listed in Table 4 requires utilities to set a demand reduction goal (in terms of percentage reduction). Including this component would incorporate a reduction target into the program, but allow utilities to set a target that is tailored to their own unique situation. The setting of this goal would serve to heighten utilities’ awareness of their system’s usage profile, while also providing baseline data for establishing reasonable reduction target ranges. The

### Table 4: Sample BMP Requirement Schedule for Public Water Supply Utilities

<table>
<thead>
<tr>
<th>Category</th>
<th>SMALL UTILITIES</th>
<th>MEDIUM UTILITIES</th>
<th>LARGE UTILITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BMP</td>
<td>Out of Basin</td>
<td>In Basin or GMA</td>
</tr>
<tr>
<td>Universal Metering</td>
<td>Required</td>
<td>Required</td>
<td>Required</td>
</tr>
<tr>
<td>Annual Reports Submitted to the PSC</td>
<td>Required</td>
<td>Required</td>
<td>Required</td>
</tr>
<tr>
<td>Compliance with Plumbing Standards</td>
<td>Required</td>
<td>Required</td>
<td>Required</td>
</tr>
<tr>
<td>Compliance with Unaccounted For Water Standards (standards specific to utility class)</td>
<td>Required</td>
<td>Required</td>
<td>Required</td>
</tr>
<tr>
<td>Outreach programs conducted in local schools.</td>
<td>Optional</td>
<td>Highly Recommended</td>
<td>Recommended</td>
</tr>
<tr>
<td>Plumbing Fixture Retrofit Rebate Program</td>
<td>Optional</td>
<td>Optional</td>
<td>Recommended</td>
</tr>
<tr>
<td>Conservation website established.</td>
<td>Optional</td>
<td>Recommended</td>
<td>Recommended</td>
</tr>
<tr>
<td>Water bills show the amount of water used in gallons and the cost of the water</td>
<td>Highly Recommended</td>
<td>Required</td>
<td>Required</td>
</tr>
<tr>
<td>Water bills compare the amount of water used in this billing period with same period last year.</td>
<td>Recommended</td>
<td>Highly Recommended</td>
<td>Recommended</td>
</tr>
<tr>
<td>Water conservation tips provided in water bills during summer</td>
<td>Optional</td>
<td>Recommended</td>
<td>Recommended</td>
</tr>
<tr>
<td>Billing performed on a monthly basis.</td>
<td>Optional</td>
<td>Recommended</td>
<td>Recommended</td>
</tr>
<tr>
<td>Inclining Block Rate Structure for Residential Customers</td>
<td>Optional</td>
<td>Recommended</td>
<td>Required</td>
</tr>
<tr>
<td>Leak Detection Plan</td>
<td>Recommended</td>
<td>Required</td>
<td>Highly Recommended</td>
</tr>
<tr>
<td>Demand Reduction Goal (% per sector)</td>
<td>Required</td>
<td>Required</td>
<td>Required</td>
</tr>
<tr>
<td>Perform long term planning, including supply and demand projections and analyses for 5 yr and 20 yr horizons.</td>
<td>Recommended</td>
<td>Recommended</td>
<td>Highly Recommended</td>
</tr>
</tbody>
</table>
public reporting component of the conservation program would be intended to encourage utilities to reduce their per capita water usage to a level comparable with other utilities in their region. The PSC currently publishes state-wide median usage statistics, and could also make regional median usage data available.

2. **State-Level Conservation Program Examples**

The five case studies below illustrate state-level conservation programs for public utilities. These examples highlight a variety of elements relevant for a statewide program framework for Wisconsin. The cases include Arizona, California, Texas, Kansas, and Minnesota.

**CASE STUDY: ARIZONA**

In 1980, Arizona state law created a new agency, the Arizona Department of Water Resources (ADWR), which produces 10-year plans to reduce groundwater extraction. The plans offer three different programs, although these are currently being consolidated: 1) total gallons per capita per day percentage reductions, 2) non-per capita program, and 3) alternative program (Arizona Department of Water Resources, 2006; American Water Works Association, 2006).

1) **Total gallons per capita per day program:** For the first 10 year plan, all water providers were assigned a total system gallons per capita per day (GPCD) target based on 1980 water use, future demand projections, and the potential savings from water conservation measures commonly used in the western United States. Targets ranged from 6 to 11 percent reduction over 10 years, with higher targets for higher users. For the second 10 year plan, each provider was assigned a target per capita usage based on an analysis of the water use in each provider’s area and the conservation potential. Providers who do not meet their targets are subject to fines and sanctions. The program has proven to be difficult for some service providers to meet their targets due to fluctuations in population and other factors. The program is currently under review, with the possibility of converting it to a BMP approach.

2) **Non-per capita conservation program:** Factors such as rapid commercial and industrial development and changing population characteristics impacted the ability of some providers to meet their GPCD targets. The program originally required that providers eliminate groundwater pumping not replaced by recharge, and to implement “reasonable conservation measures” (RCMs). ADWR specifies 12 RCMs, with four substitute RCMs that can be used in lieu of the original RCMs. Several cities switched to this program because compliance is generally easier. In 2008, the mandatory BMPs were reduced to comprehensive metering and educational programs, with additional BMPs required based on number of service connections.
3) **Alternative conservation program:** Establishes a limit on groundwater use, a per capita target for residential water use only, and requirements addressing specific nonresidential uses; the program was not popular and will be discontinued.

For all programs, a substantial reporting requirement is in place.

**Enforcement/Sanctions:** the ADWR performs a number of audits each year. If water providers are found to be out of compliance, a settlement is negotiated for the over-usage of water (penalties can be up to $10,000 a day) (Arizona Department of Water Resources, 2006; American Water Works Association, 2006).

**CASE STUDY: CALIFORNIA MOU**

More than 120 urban water agencies, environmental groups, and civic, business, and industrial interests signed an MOU in 1991 regarding water efficiency and agreeing to implement a list of BMPs. During the first ten years of the agreement, the list of BMPs was amended seven times, with changes to both the substance and number of BMPs. Thus the MOU is a living document and not a rigid, inflexible agreement that locks a water agency into a program that may turn out to be ineffective (California Urban Water Conservation Commission, 2008; American Water Works Association, 2006).

**Features of the MOU:**

- Currently the MOU has 14 BMPs, each with its own “coverage requirement” used to evaluate whether the BMP has been successfully implemented. (see Table 5)
- An agency is not obligated to implement a program that is not cost-effective if it can prove to its peers that a particular BMP would either be too costly or not save enough water to justify.
- As of December 2008, water suppliers have two alternative options for meeting the BMP compliance requirements of the MOU:
  - Flex Track Menus of additional BMPs that can be implemented to show water savings equal to or greater than that which would have been achieved by following the original BMP list; and
  - Gallons Per Capita Daily approach evaluates the overall reduction in per capita demand over time, with a current requirement to reduce demand 18% from baseline levels by 2018.
- Credit is given for past accomplishments.
- Savings estimates are revised as more information becomes available.
- A BMP online reporting process has been established, and is done every two to four years (depending on size of water provider). The report includes details on the implementation schedule, expenditure, and in some limited cases, estimated water savings. The reports are publicly available (California Urban Water Conservation Commission, 2008).
Table 5: California MOU Current BMPs

<table>
<thead>
<tr>
<th>BMP</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMP 1</td>
<td>Water survey programs for residential customers</td>
</tr>
<tr>
<td>BMP 2</td>
<td>Residential plumbing retrofit</td>
</tr>
<tr>
<td>BMP 3</td>
<td>System water audits, leak detection and repair</td>
</tr>
<tr>
<td>BMP 4</td>
<td>Metering with commodity rates for all new connections and retrofit of existing unmetered connections</td>
</tr>
<tr>
<td>BMP 5</td>
<td>Large landscape conservation programs and incentives</td>
</tr>
<tr>
<td>BMP 6</td>
<td>High efficiency clothes-washing machine financial incentive program</td>
</tr>
<tr>
<td>BMP 7</td>
<td>Public information programs</td>
</tr>
<tr>
<td>BMP 8</td>
<td>School education programs</td>
</tr>
<tr>
<td>BMP 9</td>
<td>Conservation programs for institutional, commercial, and industrial accounts</td>
</tr>
<tr>
<td>BMP 10</td>
<td>Wholesale agency assistance programs</td>
</tr>
<tr>
<td>BMP 11</td>
<td>Retail conservation pricing</td>
</tr>
<tr>
<td>BMP 12</td>
<td>Conservation coordinator</td>
</tr>
<tr>
<td>BMP 13</td>
<td>Water waste prohibition</td>
</tr>
<tr>
<td>BMP 14</td>
<td>Residential ultra-low-flush (ULFT) replacement programs</td>
</tr>
</tbody>
</table>


**Coverage Requirements:** It is not always easy to track the impact of a particular conservation measure, such as public education and outreach. To ensure compliance, the MOU requires that water providers meet other quantifiable standards. An example of the coverage requirement for public outreach found in the 2008 version of the MOU (California Urban Water Conservation Commission, 2008) is given here:

- Agencies shall maintain an active public information program to promote and educate customers about water conservation. At minimum a public information program shall consist of the following components:
  1) Contacts with the public (minimum = 4 times per year, i.e., at least quarterly).
  2) Water supplier contacts with media (minimum = 4 times per year, i.e., at least quarterly).
  3) An actively maintained website that is updated regularly (minimum = 4 times per year, i.e., at least quarterly).
  4) Description of materials used to meet minimum requirement.
  5) Annual budget for public outreach program.
  6) Description of all other outreach programs
Enforcement/Sanctions: Sanctions include adverse publicity, no water use efficiency grants, lack of support for water supply projects from environmental groups, and civil penalties (California Urban Water Conservation Commission, 2008).

While becoming a signatory to the MOU is voluntary, a new state-wide conservation plan was recently proposed by Governor Schwarzenegger. The Governor’s plan, “20x2020” would result in per capita usage reductions of 20% by 2020. Establishment of a baseline has been somewhat controversial and the proposal is still in draft form (California State Water Resources Control Board, 2009).

CASE STUDY: TEXAS

The Texas Water Development Board (TWDB) requires conservation plans from water suppliers using more than 1,000 acre feet per year. Utilities serving fewer than 5,000 people are required to submit a minimum plan. As summarized on the Texas Water Development Board website, minimum plans include:

- Annual water use by customer class for the current year and last five years
- Monthly total system water use and per capita use data
- Water projections over the planning horizon for the utility
- Conservation measures including:
  - Universal metering
  - Measures to determine and control unaccounted-for water
  - A public education program
  - A water rate structure that is not promotional

Plans for utilities serving 5,000 or more users must include the minimum requirements, plus:

- A leak detection program
- Conservation plans that include specific, quantified 5-year and 10-year targets for water savings. The entity preparing the plan establishes the targets. Targets must include goals for water loss programs and goals for municipal use in gallons per capita per day. TWDB recommends a minimum one percent reduction per year of current per capita usage with a statewide average goal of 140 gallons per capita per day (GPCD) (Texas Water Development Board [TWDB], n.d; Texas Administrative Code §363.15).

In 2004, Texas developed a document describing Best Management Practices (21 for municipal utilities) that may be implemented as additional strategies for meeting the agency’s water conservation plan. All are voluntary (TWDB, 2004b).
CASE STUDY: KANSAS

Kansas encourages all utilities to submit water conservation plans, although plans are only required for utilities meeting certain criteria, such as sourcing water from a key reservoir or receiving state funding. Approximately 50 percent of Kansas utilities currently submit water conservation plans. Kansas provides a schedule of BMPs that are categorized as “optional,” “recommended,” or “highly recommended” based on utility size and GPCD (Kansas Water Office, 2007). This approach informed the sample table for Wisconsin presented as Table 4 in this report.

Utilities must identify a GPCD target. A water utility whose current GPCD is below the regional average may use its current GPCD as its goal. A water utility whose current GPCD is above the regional average should choose a GPCD goal that is lower than its current GPCD. No water utility may choose a GPCD goal that is more than 25 percent above the regional average, regardless of its current usage, unless very unusual local conditions can be substantiated that preclude its use. Fewer water use efficiency practices are recommended for small water utilities with a low or medium GPCD usage rate than for large water utilities with high GPCD usage rates (Kansas Water Office, 2007).

Table 6: Kansas Sample Requirement Schedule for Water Conservation BMPs

<table>
<thead>
<tr>
<th>Water Use Efficiency Practices</th>
<th>Small Water Utilities&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Medium Water Utilities&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Large Water Utilities&lt;sup&gt;c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Water bills will show the amount of water used in gallons and the cost of the water.</td>
<td>Highly Recommended</td>
<td>Highly Recommended</td>
<td>Highly Recommended</td>
</tr>
<tr>
<td>2. Water bills will show the amount of water used in gallons during this billing period and the number of gallons used last year during the same billing period.</td>
<td>Optional</td>
<td>Optional</td>
<td>Recommended</td>
</tr>
<tr>
<td>3. Water conservation tips will be provided with the monthly water bills during the summer months.</td>
<td>Optional</td>
<td>Recommended</td>
<td>Optional</td>
</tr>
<tr>
<td>4. Water conservation articles or issues will be provided or discussed each month during the summer by the local news media.</td>
<td>Optional</td>
<td>Optional</td>
<td>Recommended</td>
</tr>
<tr>
<td>5. The Board of Education and teachers will be encouraged to become involved in water conservation through classroom lectures and incentives for children to conduct home checks.</td>
<td>Optional</td>
<td>Optional</td>
<td>Recommended</td>
</tr>
<tr>
<td>6. Make available information on water conserving landscape practices through publications, local news media, seminars or other appropriate means.</td>
<td>Optional</td>
<td>Recommended</td>
<td>Highly Recommended</td>
</tr>
</tbody>
</table>

CASE STUDY: MINNESOTA

Minnesota’s conservation program, established by Minnesota Statute § 473.1565, combines certain BMPs with performance targets (see Table 7). The program is less flexible than the other programs profiled in this section, but its benchmarks could be appropriate for Wisconsin.

Table 7: Minnesota Conservation and Efficiency Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unaccounted Water Target = Less than 10%</strong></td>
<td>If unaccounted for water is more than 10%, a plan is required to address reductions of unaccounted water through meter testing and repair and distribution system leak detection and repair.</td>
</tr>
<tr>
<td><strong>Residential Gallons Per Capita per Day Target = 75 (GPCD)</strong></td>
<td>If per capita residential consumption is greater than 75 GPCD, a plan is required to evaluate and implement measures targeted at reducing residential per capita such as: • Analyze and determine reasons for consumer high per capita use • Customer education to reduce indoor and outdoor use • Contact large volume customers and offer home audits and conservation tips • Incentive programs to reduce per capita use</td>
</tr>
<tr>
<td><strong>Peak Demands Maximum Day to Average Day Ratio Target = Less than 2.6</strong></td>
<td>If ratio is greater than 2.6, a plan is required to reduce peak demands. A plan could include: • Lawn watering ordinances, with enforcement &amp; penalties • Customer education/conservation tips in peak demand</td>
</tr>
<tr>
<td><strong>Conservation Rate Structures</strong></td>
<td>Conservation rate structure is required such as an increasing block or summer surcharge with 25-cent minimum increments between blocks or normal rates.</td>
</tr>
<tr>
<td><strong>Water Supply Planning</strong></td>
<td>Water supply planning activities should include: • Development and maintenance of a base of technical information needed for sound water supply decisions, including surface and groundwater availability analyses • Water demand projections • Water withdrawal and use impact analyses • Water resource modeling</td>
</tr>
</tbody>
</table>

Source: Adapted from Water Resource Availability Data Collection and Analysis, Metro Area Water Supply Advisory Committee (2006)
C. INTEGRATED WATER RESOURCE PLANNING AND CONSERVATION PLANNING PRACTICES

1. INTEGRATED RESOURCE PLANNING OVERVIEW

Historically the response to increasing water demand has been to develop additional sources of supply, usually additional reservoirs or wells. Over the past few decades, there has been a shift toward greater consideration of demand-side management measures in the water supply planning process, following the emphasis in the electricity and natural gas sectors on the comprehensive planning approach referred to as integrated resource planning (Baumann, et al., 1998).

A primary concept of integrated resource planning is to emphasize the concurrent consideration of supply-side and demand-side resources, and the quantification of externalities, such as environmental impacts, of various supply options. Thus, analyses of conservation alternatives and development of plans to implement them are necessary components of integrated water resource planning. Integrated resource planning is also conducted using an open and participatory planning process that emphasizes the cooperation of the many institutions involved in water resource policy and planning (Baumann, et al., 1998).

2. CURRENT WATER SUPPLY PLANNING IN WISCONSIN

Currently, water supply expansion and approval is subject to PSC construction approval, and future supply plans will also be regulated by DNR’s supply planning procedures and comprehensive planning requirements. Despite these disparate agency regulations, procedures for evaluating and selecting water supply options, including conservation alternatives, remain unspecific. A summary of Wisconsin water supply planning regulations is presented below, followed by a discussion of opportunities for further developing integrated water resource planning practices at Wisconsin water utilities.

a) CONSTRUCTION APPROVAL PROCESS

Under Wisconsin Administrative Code ch. PSC 184, each public water utility or combined water and wastewater utility must receive approval by the PSC before constructing capacity expansion projects, including new wells or other sources of supply. Applications for construction approval must include “the purpose and necessity of the project with supporting data,” as well as a “brief description and analysis of the alternatives to the project” (Wisconsin Administrative Code ch. PSC 184.04). However, the code is not specific with regard to what an alternatives analysis should entail, nor does it specify that cost-effective conservation measures must be evaluated as an alternative to the project.

b) WATER SUPPLY PLANNING

Under section 281.348 of the Great Lakes Compact, DNR will establish and administer a water supply planning process for public water supply systems that has the potential to incorporate
integrated water resource planning. However, the requirements only apply to utilities serving populations greater than 10,000, a total of approximately 75 utilities, or 13 percent of Wisconsin’s 582 public water utilities. The Compact’s planning requirements will take effect December 31, 2025 (Wisconsin 2007 Act 227, §281.348(3)(a)2.).

The legislation mandates that each plan include 1) an inventory of current local water supplies, 2) a forecast of the demand for water in the area over the period covered by the plan, 3) options for supplying water that incorporate a cost-effective analysis of water supplies and water conservation alternatives, 4) an environmental and economic impact assessment, 5) identification of the procedures for implementing and enforcing the plan, and 6) analysis of how the plan supports or is consistent with any applicable and comprehensive plans (Wisconsin 2007 Act 227, §281.348(3)(c)).

c) COMPREHENSIVE PLANNING

Wisconsin’s comprehensive planning law requires that communities engaging in official mapping, subdivision regulation, or zoning, make those actions consistent with a community comprehensive plan. Pursuant to Wisconsin Statutes § 66.1001(2)(d), comprehensive plans must include a utilities and community facilities element. This element should include a “compilation of objectives, policies, goals, maps and programs to guide the future development of utilities and community facilities,” including water supply. The element shall “[forecast] the need…to expand or rehabilitate existing utilities and facilities or to create new utilities and facilities, and shall assess future needs for government services…that are related to such utilities and facilities.” Drawing connections between community growth and water supply needs should be part of any comprehensive planning process. Wisconsin’s eight Regional Planning Commissions (RPCs) are available to facilitate comprehensive planning through technical expertise and planning support (Assoc. of Wisconsin Regional Planning Commissions, 2005).

3. THE VALUE OF GROUNDWATER MODELING

Computer models can play an important role in providing water managers with valuable water quantity and quality information. Groundwater models are available that simulate the complex interactions between groundwater systems and surface streams and lakes. Models provide managers the ability to input data measured in the field in order to accurately estimate real-world conditions. The conditions measured in the field can then be used to calibrate the model before it is used to simulate the response of water levels and flow rates to environmental stresses, such as drought conditions or changes in well pumping rates.

CASE STUDY: WISCONSIN’S SAUK COUNTY

In 2005, Wisconsin’s Sauk County prepared a groundwater model using the computer software programs GFLOW and MODFLOW for a subdivision development to predict groundwater flow to wells. The model was used to analyze the anticipated impacts of several design alternatives on groundwater availability. The flexibility of the groundwater model that was used allowed the
County to simulate three different well configurations. The first design simulated each of the wells’ “capture zones,” or areas where snowmelt and rainfall seeps through the surface and into the aquifer. The second design simulated the effects of wells with casings that reach deeper into the bedrock aquifer. The third design simulated the use of a community well to supply water to all the homes within the subdivision (Gotkowitz, 2005).

The computer groundwater models used in Sauk County were able to be calibrated to match regional conditions. Model outputs available to resource managers provided a wealth of groundwater predictions. Approximations of groundwater conditions at specific locations provided sound technical assistance for proper and efficient land use planning. The model employed by Sauk County also was able to provide suggestions for minimum well casing depths and estimate the potential impacts of constructing a community water supply system. The impacts of groundwater pumping on adjacent bodies of water were also able to be analyzed using the model. In the Sauk County case, the impacts of pumping on water levels on nearby Lake Virginia were included in the model's analysis.

As with any predictive tool, groundwater models are subject to errors associated with the accuracy of available data and the uncertainty of real world conditions. They also cannot promise that new wells will provide clean, high quality water, but groundwater models do provide an innovative new approach for better understanding the potential impacts of proposed wells.


This section explores measures that could be taken to improve water supply planning in Wisconsin and presents case studies of programs in other states that illustrate how these actions can be implemented. The current programs that support public planning in Wisconsin provide a solid base and management structure for the implementation of expanded integrated resource planning practices. The gaps in these plans provide fresh opportunities for the implementation of policies that enhance and build on current procedures. A robust planning process for Wisconsin would focus on encouraging public involvement, establishing concrete benchmarks for measuring progress, and adaptive management at both local and regional levels. Several recommendations are presented:

a) integrate utility planning processes with other planning efforts
b) perform more comprehensive demand projections and data collection
c) require development of a detailed conservation plan
d) establish guidelines for evaluating potential conservation and efficiency measures
e) require frequent planning and public reporting
f) fund and support planning and implementation efforts.
g) define requirements for small suppliers
a) **Integrate Utility Planning Processes with Other Planning Efforts**

A primary goal of integrated resource planning is to improve collaboration and coordination among the many governmental institutions involved in water resource planning, including participation from the public. Opportunities exist to integrate with regional and local comprehensive planning processes, as well as stormwater and wastewater planning, public works development and maintenance programs, transportation, and other service areas. Utilities in Southeastern Wisconsin demonstrate potential regional linkages through their collaboration with the Southeastern Wisconsin Regional Planning Commission (SEWRPC). The recent SEWRPC regional water supply study and system plan include groundwater inventories and information about a groundwater simulation model. Those data are very helpful to local utilities in their planning efforts (see SEWRPC website). Massachusetts provides an example of integration at the local level.

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**CASE STUDY: MASSACHUSETTS REQUIREMENTS FOR INTEGRATED RESOURCE PLANNING**

Massachusetts' Integrated Water Resource Management Plan requirements have proven successful in enabling coordination and collaboration among many water-related agencies and the public at the local level, and have encouraged the adoption of innovative conservation programs. In order to qualify for financial assistance from the State Revolving Fund, Massachusetts requires municipalities to prepare an Integrated Water Resource Management Plan that “evaluates alternative means for addressing a community’s current and future wastewater, drinking water, and stormwater needs and identifies the most economical and environmentally appropriate means of meeting those needs” (Massachusetts Department of Environmental Protection, n.d.). Financial assistance from the State Revolving Fund can also be utilized to support the Integrated Water Resource Management planning process.

**Benefits Realized from Massachusetts' Integrated Water Resource Planning**

Massachusetts' experience has been that preparing one document in response to a number of different regulatory requirements saves time and money, as well as improves coordination among many diverse agencies. These agencies include the Water Department, Sewer Department, Board of Health, Department of Public Works, Conservation Commission and Planning Department. The Massachusetts *Water Resource Management Planning* guide provides compelling examples of the benefits of preparing an integrated plan:

> As roads are repaved, communities can inspect the water pipes, sewer pipes and storm drains under those roads, remove illicit connections to the sewers and storm drains, repair leaks, and make any other necessary repairs. Bringing departments together can also foster solutions that address multiple problems. For example, rain barrels can be distributed to reduce the discharge of stormwater to a combined sewer system and to promote water conservation. By disconnecting roof leaders and driveway drains from the sewer system and
directing the runoff to rain gardens and vegetated swales, a community can reduce the frequency and duration of sanitary sewer flows and recharge the ground water. (Massachusetts Department of Environmental Protection, n.d.).

b) Perform More Comprehensive Demand Projections and Data Collection

Demand projections currently required by the Compact could be expanded to include additional data. In addition to collecting data by customer class and identifying expected growth, assembling data based on per capita income, commercial activity, industrial activity, and seasonal variations in water use could better identify trends and projections. Potential impacts from climate change, as well as current and future legal restrictions to water use, will also become increasingly important in future projections. Joint planning with local or regional planning agencies would assist utilities in collecting this data.

CASE STUDY: CALIFORNIA AND WASHINGTON DATA COLLECTION

In California, factors considered along with growth demographics during integrated resource planning include per capita income, commercial activity, and industrial activity (Davis, 2003). These statistics help to refine demand projections and to achieve a better overall understanding of how public water is used.

Washington monitors seasonal variations in water use for water systems with 1,000 or more connections to understand and manage the variations in water consumption trends (Washington Department of Health, 2009). Additionally, a narrative describing water sources and any foreseeable impacts to those sources (such as drought) is included in Washington’s integrated resource planning requirements.

c) Require Development of a Detailed Conservation Plan

Requiring utilities to develop a conservation plan that is tailored to the needs of their community would help encourage utilities to consider demand-side options in addition to supply expansion.

The steps recommended for developing a conservation plan are outlined below. These standards are based on criteria established in the “Water use Efficiency Guidebook” published by the Washington Department of Health (2009), the “Water Conservation Best Management Practices Guide” from the Texas Water Development Board (2004), and the “Integrated Resource Plan Review and Evaluation Checklist” from the US Department of Energy.

1. In the context of the utility’s larger water supply plan and through a public process, quantifiable goals should be established for a two-year horizon. Identifying these goals will help utilities make judgments concerning supply sources, increase the transparency of operations, and provide a method of evaluating whether the utility is meeting its objectives. These objectives should be approved by local communities, regional planning commissions, and the PSC or DNR.
2. Evaluate the effectiveness of any current and prior water conservation programs.
4. Estimate projected water savings from cost-effective measures.
5. Select measures that support established goals.
6. Set a timeline for implementation.
7. Solicit funding for the program. Consider combining financial resources and forming partnerships with other entities, such as nearby water systems to work towards mutual goals.
8. Educate customers about the benefits of conservation and specific elements of the conservation programs.
9. Evaluate programs for effectiveness on an annual basis and adjust them as necessary.

In addition, conservation measures that warrant consideration by all Wisconsin utilities are discussed in more detail in the following sections.

**CASE STUDY: FUNDING CONSERVATION PLANNING IN THE WESTERN UNITED STATES**

Texas is an example of a state that receives significant funding from state and federal sources through the Texas Water Development Board (TWDB). The TWDB is the state’s water planning and financing agency, charged with research, development, and financial assistance activities. Included with the financial assistance activities are the distribution of state revolving funds, bond programs, and grants. The state’s Water Conservation Implementation Task Force has proposed that a program of competitive grants be awarded to water utilities to fund the implementation of innovative water conservation programs (TWDB, 2004). Even if funding is limited for this program, it will still help to raise awareness and promote the importance of water conservation and innovation.

California and Oregon also have similar financial assistance programs that provide funding via bonds and grants for local activities and planning studies that seek to enhance the beneficial use of existing water supplies (Paulsen, 2004), or evaluate the feasibility of water conservation projects (Oregon Water Resource Department, 2008). California allocates $30 million each year for water conservation programs (Paulsen, 2004), and the Oregon Water Resources Department provides $1.6 million for funding under the Water Conservation, Reuse, and Storage Grant Program (Oregon Water Resource Department, 2008).

d) **ESTABLISH GUIDELINES FOR EVALUATING POTENTIAL CONSERVATION & EFFICIENCY MEASURES**

While Wisconsin Administrative Code § PSC 184.04 (d) requires that utilities proposing to construct additional supplies provide a brief description and analysis of the alternatives to the project, no specific requirements exist for consideration of conservation measures as supply options. In addition, Wisconsin’s comprehensive planning requirements instruct planning
agencies to project future system demands, but do not require an evaluation of supply options, nor a methodology for evaluating them. Providing explicit methodologies for assessing the cost-effectiveness of resource options (including conservation) in the analyses of future demand and supply options may lead to more effective outcomes.

Standard evaluation procedures would help ensure that the total costs and benefits of various supply and conservation options are evaluated consistently and appropriately. Several policy questions would need to be addressed in developing standards. For example, should ratepayer costs be minimized, or should total costs to society (including environmental externalities) be minimized? How should environmental impacts (such as water quality) be accounted for? What is the appropriate time horizon to consider? Should operating and maintenance costs of a new facility be factored in? In developing these guidelines, Wisconsin policy makers may benefit from the California Public Utilities Commission’s 2001 manual for evaluating demand-side management programs titled California Standard Practice Manual, Economic Analysis of Demand-Side Programs and Projects.

In addition, priorities could be determined and specifically stated, as is done in energy resource planning. Wisconsin’s state energy policy, the “energy priorities law” (Wisc. Stats. §1.12 (4)) establishes specific priorities in selecting supply options:

In meeting energy demands, the policy of the state is that, to the extent cost-effective and technically feasible, options be considered based on the following priorities, in the order listed:

(a) Energy conservation and efficiency.
(b) Noncombustible renewable energy resources.
(c) Combustible renewable energy resources.
(d) Nonrenewable combustible energy resources (Wisc. Stats. §1.12 (4))

A similar priority policy could be established for water resource planning in Wisconsin, with cost-effective conservation and efficiency options prioritized over the establishment of new groundwater withdrawals or surface water diversions, provided that they do not conflict health standards or other regulatory requirements.

e) REQUIRE FREQUENT PLANNING AND PUBLIC REPORTING

In order to be effective, planning should be more than a one-time exercise. Plans become more useful as living documents, with formal updates required periodically. Many states, including Texas, North Carolina, and Florida, conduct regional planning in five-year intervals with planning horizons of 20 years, while others such as Nevada require that regional plans be reviewed every three years and amended as necessary.

To ensure that plans are carried out, public reporting on implementation progress should be required, and these reports and plans should be submitted for public comment. The objective of
public reporting is an adaptive process in which a utility solicits feedback on goals from external entities and revises them as progress is made and priorities change.

f) **FUND AND SUPPORT PLANNING & IMPLEMENTATION EFFORTS**

Funding for utility conservation programs and planning efforts should be made a priority. One of the greatest barriers to conservation planning that utilities identified in their responses is the lack of funding. Less than eight percent of utilities surveyed by the PSC have a budget for water conservation programs (PSC 2008). Of the utilities that do fund conservation efforts, program budgets range from $1,000 to $75,000. This financial support comes from various sources including water rates, user fees, general-purpose tax revenue, and grants from government agencies.

**CONSERVATION PROGRAM FUNDING**

The PSC currently encourages utilities to request conservation program funding in their rate applications. The PSC has approved up to 1.5% of a utility’s revenues for well-designed conservation programs, which allows the utility to recover the costs through rates. However, the PSC does not currently require that utilities engage in conservation activities; thus in areas where rate increases face political opposition, conservation programs are less likely to be implemented.

Funds from the state revolving fund are another potential source of funding, and are used in this manner in Massachusetts. Wisconsin Administrative Code § NR 166.07(12) identifies projects eligible for funding through the Safe Drinking Water Loan Program, including the development of “water conservation plans, water rates and water system ordinances.”

**INTEGRATED RESOURCE PLANNING FUNDING**

Planning done in conjunction with RPCs could utilize financial resources available to the RPCs, such as Local Water Quality Planning Aid grants. Additional funding sources that can be explored include state and federal government appropriations such as bond initiatives, or loans and grants. (See for example the USEPA’s website: [http://www.epa.gov/efinpage/efinfin.htm](http://www.epa.gov/efinpage/efinfin.htm).)

g) **DEFINE REQUIREMENTS FOR SMALL SUPPLIERS**

Wisconsin statutes do not specify what is required of systems serving populations of less than 10,000 people. The water supply planning requirements only apply to Wisconsin’s 75 largest utilities. While many smaller utilities do not have the resources to carry out highly detailed long-term plans, they would benefit from less intensive planning requirements. In particular, even small utilities generally have the capacity to assess the feasibility of meeting increased demand through greater conservation efforts and to develop low-cost conservation programs.
D. SUGGESTED CONSERVATION MEASURES

Although each utility’s water consumption profile and supply situation is unique, the following conservation measures warrant evaluation in the development of any public water supply conservation plan.

- Public Education and Outreach
- Informative Billing Practices
- Plumbing Fixture Retrofit/Rebate Programs and Ordinances
- Distribution System Efficiency
- Water Audits and Custom Incentives for Large Customers
- Sub-Metering of Multi-Family Properties
- Conservation Rate Structures
- Water Reclamation and Reuse

1. PUBLIC EDUCATION AND OUTREACH

Public education and outreach efforts help utilities reach water users with information about general water management issues as well as specific initiatives, programs, and actions consumers can take. For example, initiating an educational program can show water users that investing in water use efficiency and conservation will provide long-term savings by avoiding economic and environmental costs of new water-resource related development. These programs can have a positive effect on the public’s attitudes toward water conservation (New Hampshire Department of Environmental Service, 2001).

Recognized best practices for water education (Andrews 2008) state the importance of providing data and information about what the customer can do to support community conservation goals. Showing customers that the result of their actions has made a difference has encouraged greater participation in conservation efforts among Texas water users (TWDB, 2008). Awards programs that publicly recognize businesses and community members that have achieved substantial water savings can act as another motivator.

Some specific strategies that can be implemented include: establishing informational websites, public advertising campaigns, and education programs in area schools (New Hampshire Department of Environmental Service, 2001). Making water conservation specialists available for public speaking engagements, coordinating joint advertising with local plumbing and water fixture suppliers, involving customers in the planning process, and coordinating with local non-profits or other state agencies with similar missions are also programs that have proven successful (New Hampshire Department of Environmental Service, 2001; Andrews 2008).
CASE STUDY: MINNESOTA WASTE WISE AWARDS

Minnesota Waste Wise presents awards annually to businesses that have shown leadership in sustainable business practices including water conservation. Businesses are often motivated to participate in the program to communicate their environmental commitments to the public and improve their environmental (or “green”) image. Members of Minnesota Waste Wise also have sponsorship opportunities in which they are recognized as an advanced supporter of the Minnesota Waste Wise program. These opportunities include events, publications, and fact sheets. (Minnesota Waste Wise website, n.d.) Such a sponsorship program could also be established by Wisconsin water utilities that supports water conservation awards, thereby expanding the number of area businesses aware of and involved in water conservation activities.

CASE STUDY: WAUKESHA COUNTY, WI WATER CONSERVATION CHALLENGE

In 2006, the Waukesha Water Utility formed a water conservation coalition together with environmental organizations, city and county officials, colleges and schools, scientists, engineers, attorneys, the Milwaukee Metropolitan Sewer District, and local citizens. The following year the coalition held a competition for county residents to cut their water usage over the course of a year (Michalets, 2009).

The competition sponsors held two informational seminars on how to conserve water inside and outside the home, in addition to listing tips in newsletters and on the utility’s website. Many families took numerous conservation steps, including taking shorter showers, not watering their lawn, and reusing some water, to achieve substantial reductions in water use. 257 residents registered for the competition, and the top 15 participants saved a cumulative total of 500,000 gallons of water (Michalets, 2009).

Prizes for the top five finishers included having their water bills paid for the past year, and the top winner received an additional $500 prize donated by Waukesha State Bank. The top winner, who reduced her consumption by 65 percent during the contest, donated her $500 prize to the Waukesha School District’s environmental education program (Michalets, 2009).

CASE STUDY: NORTH TEXAS REGIONAL OUTREACH PROGRAMS

Many communities in North Texas have begun to collaborate on their public outreach programs in order to convey a consistent, unified message, and to share the costs of the programs while reaching a larger audience. According to the City of Plano, in the fall of 2007, a small group of water education coordinators began meeting to share ideas and best practices. Over the course of approximately a year, the group had grown to 16 members, including several cities and three water districts (Alan Plummer Inc., 2008).

Water outreach directors in North Texas report that these collaborative efforts have been successful, noting the benefits from economies of scale. Table 8 includes a sample of the outreach programs currently taking place in North Texas.
Table 8: North Texas Outreach Programs

<table>
<thead>
<tr>
<th>Wholesale Water Providers</th>
<th>Public Outreach Programs</th>
<th>Annual Budget/Costs(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>City of Dallas</td>
<td>Public awareness campaign, school programs,</td>
<td>$1,200,000</td>
</tr>
<tr>
<td></td>
<td>brochures, speaking engagements, special</td>
<td></td>
</tr>
<tr>
<td></td>
<td>events and promotions, web site, water bill</td>
<td></td>
</tr>
<tr>
<td></td>
<td>inserts</td>
<td></td>
</tr>
<tr>
<td>City of Fort Worth</td>
<td>Training for students, Customer Advisory</td>
<td>$200,000</td>
</tr>
<tr>
<td></td>
<td>Committee, bill inserts, promotions, Speaker’s</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bureau, gardening seminars, web site</td>
<td></td>
</tr>
<tr>
<td>City of Denton</td>
<td>Bill stuffers, television advertising, radio</td>
<td>Not Reported</td>
</tr>
<tr>
<td></td>
<td>advertising</td>
<td></td>
</tr>
<tr>
<td>City of North Richland</td>
<td>WaterWise, flyers</td>
<td>$15,499</td>
</tr>
<tr>
<td>Hills</td>
<td>SmartWise classes and creek cleanups</td>
<td>$2,900</td>
</tr>
<tr>
<td>City of Mansfield</td>
<td>Coloring books, stickers, brochure</td>
<td>Not Reported</td>
</tr>
<tr>
<td>Rocket SUD</td>
<td>Pamphlets, reports, CDs, newspaper</td>
<td>Not Reported</td>
</tr>
<tr>
<td>City of Waxahachie</td>
<td>Recycle/reuse education day, mail outs, inserts</td>
<td>Not Reported</td>
</tr>
<tr>
<td></td>
<td>in bills</td>
<td></td>
</tr>
<tr>
<td>North Texas Municipal</td>
<td>School programs, state education program, Water</td>
<td>$1,600,000</td>
</tr>
<tr>
<td>Water District</td>
<td>IQ</td>
<td></td>
</tr>
<tr>
<td>Tarrant Regional Water</td>
<td>WaterWise, Major Rivers, Newspapers in Education,</td>
<td>Not Reported</td>
</tr>
<tr>
<td>District</td>
<td>Wetland Water Reuse Module, SAVE WATER</td>
<td></td>
</tr>
<tr>
<td>Trinity River Authority</td>
<td>Public forums, meet with city staffs</td>
<td>Not Reported</td>
</tr>
<tr>
<td>Upper Trinity RWD</td>
<td>Brochures, website, book covers, tree planting</td>
<td>Not Reported</td>
</tr>
<tr>
<td></td>
<td>program</td>
<td></td>
</tr>
</tbody>
</table>

(1) Annual budgets/costs do not include salaries, benefits, etc., related to personnel’s time committed to these programs.


2. Informative Billing Practices

Conducting billing on a monthly basis better informs customers about their water usage throughout the year and the associated costs. Frequent billing sends an accurate price signal to
consumers, but this method is not employed by all Wisconsin utilities. Many Wisconsin utilities currently bill on a quarterly or semiannual basis (DNR, 2008a).

Other information that will enable consumers to make more educated choices regarding their water use include: usage history, the total cost for that month, a graphical comparison of their current usage to previous years or to others in their service area, and an example of how much money they could save by lowering water use to a lower tier, if applicable (Georgia Department of Natural Resources, 2007). Georgia’s Environmental Protection Division has estimated that simply providing information on rate structures on customer bills can attain the same level of conservation as with a 30-40 percent lower rate increase (Georgia Department of Natural Resources, 2007). A brief description of conservation programs (e.g., informational websites, audits, plumbing fixtures and rebates) available from the utility or local government should also be included in each bill.

Figure 1: Sample Informative Water Bill

![Sample Informative Water Bill](image)
CASE STUDY: SAN ANTONIO, TX WATER BILLS

The San Antonio Water System (SAWS) encourages conservation through informative billing practices. San Antonio draws its water from the Edwards Aquifer, which can decline rapidly during droughts. A graphic on the water bill provides information on current aquifer levels in comparison to record highs and lows. The bill also displays graphs of the customer’s historical water consumption, and includes a personalized message for each customer based on actual water usage. In addition, the water bill gives information on SAWS programs and promotions, customer service locations, directions on how to read your meter, and a detailed, itemized breakdown of charges and calculations used to compute the bill total.

Given the effectiveness of frequent, informative billing practices, Wisconsin could consider requiring large utilities to implement this measure.

3. PLUMBING FIXTURE RETROFIT ORDINANCES AND PROGRAMS

Plumbing fixture rebate programs and retrofit ordinances can be an effective way to achieve substantial water savings without requiring that utility customers change their habits. One method of encouraging the adoption of water efficient fixtures is to develop a municipal retrofit ordinance for plumbing fixtures. Examples of such ordinances include requiring that all fixtures in residential households meet the new standards in 15 years, or making 10 percent of households eligible to receive retrofits each year (TWDB, 2008). Ordinances that require that fixtures be upgraded when there is a change in property ownership or a substantial renovation are used by numerous communities in California, although they have occasionally encountered resistance from realtor associations and some home sellers. Ensuring compliance may be difficult, although compliance has been shown to increase significantly when a rebate program is offered simultaneously (Goddard, 2008).

Toilets are one of the most popular targets for plumbing fixture rebate/retrofit programs, as water use by toilets is typically the largest source of indoor residential water demand, frequently accounting for more than 25 percent of a household’s water usage (Vickers, 2002). The most popular program type is a rebate program whereby customers submit proof of installation of a high efficiency toilet to the water utility, and the utility (or a contracting firm) reimburses the customer for a specified amount. While this program has been successful for residential customers in many areas, it does not always work as well for low-income customers or industrial, commercial, or institutional (ICI) customers. However, tailoring programs to suit the needs of these low income or ICI customers can result in significant additional savings, as demonstrated by the case studies below. Madison, Wisconsin, has offered a toilet rebate program. Other examples are provided below.

CASE STUDY: LOS ANGELES, CA LOW-INCOME TOILET PROGRAM

In the early 1990s, Los Angeles was offering customers rebates of $100 or more for purchasing and installing low-flow toilets. The nature of the rebate program necessitated that customers provide funds for the new toilet up front, which proved difficult for many low-income customers
who could not afford to wait for the water agencies to process the rebate check. A local group of activists, the Mothers of East Los Angeles (MELA), requested a program better tailored to their community’s needs. The water utility responded with a partnership agreement in which MELA would be paid $25 for every toilet that the group could guarantee was replaced, and the utility would provide the toilets free of charge. MELA performed the verification by marking water utility customer records when a toilet replacement was performed, and used the $25 per toilet to pay community workers in the toilet program, as well as for community development projects. The overall program cost to the water utility was identical to that of the original rebate program, and resulted in more than 50,000 toilet replacements by 1998 (Dickinson, n.d.).

CASE STUDY: TUCSON, AZ LOW-INCOME TOILET REPLACEMENT PROGRAM

Tucson’s water utility, in collaboration with the Tucson Community Services department and the Pima Council on Aging, are partnering with Plumbers’ Union Local 469 to offer a toilet replacement program for qualifying low-income residential and multi-family customers. The program is designed to allow those customers who could not otherwise afford to take part in the rebate programs to reduce their household water use. For the first year of the program, the water utility and collaborating organizations will contact eligible customers by mail to inform them of their eligibility for the program (City of Tucson, n.d.).

CASE STUDY: SEATTLE, WA UNIVERSITY TOILET REBATE PROGRAM

In 2003, Seattle Public Utilities (SPU) offered a rebate of $120 per toilet to the University of Washington and other qualifying customers. The university targeted the oldest toilets on campus (using 3.5 gallons per flush), and replaced 1,856 units with low-flow toilets for an annual water savings of 50.3 million gallons. While SPU’s rebates to the university amounted to $220,000, the university’s labor and material expenses totaled nearly $680,000. The university estimates that water and sewer bill savings total approximately $560,000 per year, making it an economic investment (Western Resource Advocates, 2008).

4. DISTRIBUTION SYSTEM EFFICIENCY

Water loss from public supply systems is an unavoidable result of inefficiencies during transport. However, water loss planning, monitoring, and investment can limit waste and ensure that most water withdrawn from the ground or surface waters is put to effective use.

Wisconsin Administrative Code § PSC 185.44 requires that each pumping station for regulated utilities keep a daily record of water pumped into the system, and that the pumping data be reported to the Public Service Commission on a monthly basis. Wisconsin Administrative Code § PSC 185.85 stipulates that pumping efficiency standards are based on the volume of water pumped and sold. Unaccounted-for water must be less than 25 percent of the total pumpage for Class C utilities (1,000 to 4,000 customers) and D utilities (less than 1,000 customers) and less than 15 percent for Class AB utilities (more than 4,000 customers). While Wisconsin’s reporting requirements for water loss are more comprehensive than many other states’, the water loss
standards are relatively loose when compared with the American Water Works Association’s 1996 recommendation of 10 percent (Beecher, 2002), and a senior USEPA official’s recent suggestion that utilities strive for four percent water loss (Brozozowski, 2009).

In 2008, median estimated water loss for Wisconsin utilities (including distribution system leaks, theft, and unaccounted for water, but excluding unmetered use for system maintenance) was greater than 12 percent for all classes of utilities. Yet water loss for some small utilities was significant: a quarter of Class D utilities reported losses of more than 20 percent (PSC, 2009a), and twelve utilities reported losses greater than 50 percent (PSC, 2009b). Detecting leaks and carrying out expensive infrastructure repairs can be a challenge for many small communities, particularly because federal financing of water infrastructure has declined significantly over the past three decades and communities often lack the revenue to finance repairs themselves (United States Environmental Protection Agency [USEPA], 2006). However, opportunities exist for assisting communities to obtain much needed funding through grants, loans, and rate increases. If the state’s public utilities are to lead the way in promoting water conservation and efficiency among their customers, they must set a good example themselves.

One method that can help gauge how efficiently a utility’s water distribution system is working is to perform water audits. The International Water Association (IWA) and American Water Works Association (AWWA) have developed the IWA / AWWA Water Audit Method, which provides a sound assessment of water consumption and losses while identifying several performance indicators that help evaluate system performance. AWWA provides a simple, free spreadsheet program that can be used to perform the water audit. It simplifies the Water Audit process for utility operators, and provides clear performance indicators that can be used to assess water loss control (AWWA, 2008).

The IWA / AWWA Water Audit Method provides the necessary metrics to evaluate a system's losses and efficiencies. It also establishes a rubric of system characteristics, such as the nature of the system and local water availability, to help identify what the desired targets for different performance metrics should be. Using this system, performance metric standards can be custom fit to the unique situation of each water utility in Wisconsin.

CASE STUDY: TEXAS AND THE AWWA WATER AUDIT METHOD

Texas currently mandates that IWA/AWWA water loss audits be performed every five years under the 2003 Texas House Bill 3338 (TWDB, 2008). The Texas Water Development Board offered a grant to a consultant in 2007 to assess the effectiveness of the program after the first water audit reports were due in early 2006. The report offered several recommendations that could be incorporated into Wisconsin’s program to enhance its effectiveness. One of these recommendations was to require audits be submitted every one or two years as opposed to every five. This would support active management among the utilities and facilitate more effective water conservation. A second recommendation was that utilities maximize their distribution efficiency by identifying their economic level of leakage (ELL) and use that value as their goal for controlling real losses (Alan Plummer Associates Inc., 2007).
a) **Securing Funding for Infrastructure Repair and Replacement**

Leaky distribution infrastructure is primarily responsible for Wisconsin utilities’ water loss, but financing infrastructure improvements can prove difficult. A 2007 report to Congress estimated that the nation’s 20-year infrastructure needs for public water systems totaled nearly 335 billion dollars (USEPA, 2009). Although the PSC allows public water utilities to recover reasonable infrastructure costs through rate increases, local elected officials are often reluctant to increase rates. The situation is even more complex for communities with small customer bases over which to spread costs, or with significant numbers of customers that are elderly or below the poverty line. Small systems may face additional challenges of insufficient managerial resources, which in turn limits their ability to apply for financial assistance through grants and loans (USEPA, 2006).

For many large and medium-size systems, the PSC may wish to focus on overcoming political opposition to rate increases necessary for infrastructure improvements. The PSC could evaluate whether utilities are requesting sufficient funds for infrastructure maintenance in their rate increase applications, and possibly establish a minimum level of infrastructure funding. For example, the City of Buckley, Washington, has mandated that 15 percent of revenues from water rates be deposited in a capital improvement fund which may be appropriated from time to time for facility replacement or construction of new facilities (City of Buckley, 2008). The PSC could require that utilities with system losses greater than 15 percent initiate a rate case to evaluate whether rates are adequate to ensure reliable and efficient water delivery.

Many of the systems reporting the highest loss rates are small systems, and these systems may have difficulty financing infrastructure improvements. Wisconsin Rural Water Association and Rural Community Assistance Program are two of the organizations that are available to provide communities with technical assistance in detecting water losses and addressing other issues. Communities also may have access to low-interest loans through the State Revolving Fund and other programs listed in the DNR’s publication *Drinking Water and Wastewater Funding Sources* (2009), but some utilities may even lack the capacity to apply for these loans, given personnel constraints or the complexity of the loan application process. To address these issues, some states have developed programs that could be replicated in Wisconsin, such as the approach described below.

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**CASE STUDY: MASSACHUSETTS COMPLIANCE SCHEDULE WITH THIRD-PARTY ASSISTANCE**

Massachusetts makes extensive use of third-party organizations such as the Rural Community Assistance Program, Massachusetts Water Works Association, New England Water Works Association, and Massachusetts Rural Water Association. This coalition of organizations provides seminars, one-on-one site visits, regional mentoring cooperatives, operator training, and other programs. When water systems are out of compliance, the state uses a compliance schedule to improve system performance. This compliance schedule allows the coalition of
assistance organizations to provide the necessary aid without involving the state enforcement agencies. When a small system becomes involved in these mentoring and training programs, the system owners and operators meet other experienced water professionals and develop a network of resources that allows them to better address future problems (USEPA, 2006).

Wisconsin could work closely with third-party assistance organizations to develop a compliance program that would provide utilities with training specific to infrastructure management and financing. The program could be composed of several steps, with the program progressing through the steps until compliance with a water loss target is achieved. For example:

1) Utility seeks assistance through third-party organizations
2) Utility demonstrates that it has applied for financial assistance through programs identified in DNR’s *Drinking Water and Wastewater Funding Sources*
3) If acceptable water loss is not achieved, utility must apply for a rate increase and allocate funds sufficient to improve infrastructure

5. **WATER AUDITS AND CUSTOM INCENTIVES FOR LARGE CUSTOMERS**

Once water is delivered from a utility to its customers, there are many things water users can do to maximize efficient use of the water. Just like the proposed large-scale water audit program, accurate accounting of water for industrial, commercial, and institutional customers can promote efficiency and identify areas where water can be conserved. In addition to audits, utilities can offer monetary incentives (including lower rates or technology grants) to large customers that reduce their overall or peak demands. Texas offers performance contracts in which the cost of water conservation improvements to state infrastructure (including schools and government buildings) can be paid for by the utilities using the cost of the saved water and energy.

In Wisconsin, customer audits and incentives for large customers are administered on the energy side by Focus on Energy. Funds from Wisconsin water utilities could be used to expand Focus on Energy to include water programs as well. Utilizing Focus on Energy’s already-existing program framework and network of engineers, administrators, and evaluators could result in significant cost savings compared to the costs faced by individual utilities in developing new programs and administrative capabilities.

**CASE STUDY: ALBUQUERQUE, NM VOLUNTARY WATER AUDITS**

Albuquerque, New Mexico, has implemented a voluntary Industrial-Commercial-Institutional (ICI) water audit program, through which ICI businesses are able to apply for assistance from the local utility to conduct a water audit of their buildings. If the application is approved, an engineering consultant is sent to perform a water audit. Included with the audit are: an inventory of existing water-using machinery, evaluation of current water use practices, and suggestions that will help ensure conservation and efficiency for the business (Albuquerque Bernalillo County Water Utility Authority [ABCWUA], 2007). As part of the audit, the engineering consultant calculates three-year historical water use, which can then be used in the future to
assess the effectiveness of the water conservation and efficiency measures implemented by the 
customer.

The effectiveness of a voluntary water audit program in Wisconsin would be dependent on how 
many ICI businesses choose to participate. Water savings increase as the total number of 
program participants increases. Albuquerque's program was implemented in 1999, and since 
then approximately 200 ICI businesses have had voluntary audits performed. The utility reports 
that the average reduction of water use for a program participant is approximately eight percent 
(ABCWUA, 2007).

The two most important inputs to a water audit program are engineers who have knowledge of 
water conservation audits and funding to provide this engineering expertise. Albuquerque's 
method of using engineering consultants is an excellent way for a public utility to avoid over-
extending staff resources in order to implement the program.

Albuquerque's ICI water audit program was originally funded from 1999 to 2005 with a $600,000 
grant. The total cost of implementing the program increased as more businesses participated, 
but as cost and scope increased, the cost to benefit ratio actually decreased significantly. 
(Smith, 2006).

The Albuquerque program involves voluntary participation. Conservation techniques provided 
by the engineering consultant are designed to cover costs over a maximum period of ten years. 
Follow-up audits by the consultant are offered by the utility, but there are no requirements for 
ICI businesses that request audits to actually implement any of the measures (ABCWUA, 2007).

CASE STUDY: SEATTLE, WA REGIONAL PARTNERSHIP COMMERCIAL PROGRAMS

The Saving Water Partnership (SWP) includes the City of Seattle and a group of 17 area 
utilities. The SWP initiated a water conservation program titled “the 1% Program” in 2000 with 
the long-term goal of reducing demand to 2000 levels by the end of 2010, which translated into 
a reduction of peak season per capita consumption of approximately one percent. SWP targets 
commercial, industrial, and institutional customers, including restaurants, ethnic businesses, 
medical facilities, and educational facilities. The partnership reaches out to ICI customers 
through vendors, trade groups, and agencies, and offers technical assistance as well as 
financial incentives (custom projects and standard rebates) for water efficiency projects (Saving 
Water Partnership, 2009).

One of SWP’s most successful projects stems from a partnership with a local clam and salmon 
house that reduced the restaurant’s water consumption by 50 percent. The program included 
replacement of ice machines, dish washers, water-cooled refrigeration systems, and the 
installation of efficient toilets and faucets. The restaurant’s water savings totaled more than 
27,000 gallons per day, with monetary savings expected to rise to more than one million dollars 
in ten years (Saving Water Partnership, n.d.).
CASE STUDY: TEMPE, AZ INDUSTRIAL GRANT PROGRAM

The City of Tempe reported savings of more than 93 million gallons of water in 1998, the first year of its Industrial Grant Program. The Industrial Grant Program targets manufacturing, hospitals, hotels and motels, office buildings, food and beverage businesses, laundry facilities, golf courses, educational institutions, and other businesses. Tempe, together with the Arizona Department of Water Resources, awards grants to companies that have updated their water processes or installed water-conserving technologies and saved at least 15% of their annual water consumption. Eligible projects include replacement, retrofit, or modification of existing water-using hardware or installation of new water-savings technologies. Examples of such projects include water recycle/reuse technologies, sanitation and housekeeping practices, landscaping, and process modifications to reduce water waste.

All industrial and commercial water users in the Tempe Water Service Area may apply for the Water Efficiency Incentives. Projects costing less than $10,000 are eligible to receive rebates of up to 75% of the total project cost and up to 50% with a maximum of $20,000 for larger projects. A rebate of up to $50,000 may be offered to one project of exceptional value.

The United Dairymen of Arizona was one of the first companies to participate in the program. They were awarded $50,000 toward the purchase of two water system polishers that will save the company 75 million gallons per year (mgy). The payback was one year.

Tempe stipulates that a final report of the project including photos, an accounting of all costs, and demonstrated savings be delivered to the City representative for final payment. This information is then used to transfer water saving technologies to other similar businesses. Program funds are limited and are distributed on a first come -first served basis (City of Tempe, n.d.; California Urban Water Conservation Commission, 2001).

6. **Sub-metering of Multi-Family Properties**

A conservation practice that is gaining in popularity is sub-metering of multi-family residences. Wisconsin law currently requires that water use in multi-family units only be metered for the entire unit, with the property owners passing along the cost of water use to the residents. Sub-metering involves the installation of a water meter for each unit within the larger building to measure each customer's water use.

In 2004, Aquacraft, Inc. concluded a two-year nation-wide survey of the effectiveness of conservation programs applied to multi-family residences. That study found that sub-metering can be expected to reduce water consumption by about 15 percent or 8,000 gallons per dwelling unit per year. The report also recommended coupling the change to a sub-metered billing system with the installation of water efficient fixtures to achieve even greater savings (Mayer et al, 2004).
CASE STUDY: STATE OF TEXAS

In the early 2000s, the Texas Water Code was amended to require that all multi-family residences constructed after January 1, 2003, provide sub-metering for individual units. The owner of the multi-family property is still billed for the property’s water use, but the metering of each unit now provides the owner with data on where the water is being used, which enables the owner to pass on these costs proportionately to the residents. The new Texas Water Code changes also require that owners who implement sub-metered billing also retrofit units with efficient faucets and showerheads, perform a water leak audit of each unit, and replace all toilets that use greater than 3.5 gallons per flush with new toilets that meet the 1.6 gallons per flush standard (Alan Plummer Associates, Inc., 2006).

Because sub-metering would only be mandatory for new construction, determining the baseline water use data for multi-family properties may be challenging. Historical water use data would need to be analyzed and separated based on regions, cities, building types, unit types, etc. to determine current average water use patterns. Once the program is implemented, the water use data from the new buildings may be compared to the historical averages to determine approximate water savings. Ideally the amount of water saved from sub-metered billing would be somewhere in the range of 15 percent, as determined by the national Aquacraft, Inc. report.

For the sub-metered billing program to be fully implemented, it would need to become a mandatory requirement for all Wisconsin water utilities. This would require amending the Wisconsin Administrative Code. As was done in Texas, sub-metered units should only be required for new buildings, and retrofitting existing buildings should be offered as a voluntary program. The Alan Plummer Associates report prepared for the City of Austin also advises that some funding be allocated to education programs (Alan Plummer Associates, Inc., 2006).

Because owners are currently billed for water use in their multi-family properties, no changes to water utilities’ billing structures will need to be made. The responsibility will be upon the building owners to equitably pass the costs along to their tenants.

Texas currently requires that only new construction projects provide for the measurement of water use in each unit. To reap the full conservation benefits of sub-metering requirements, Wisconsin could also amend the PSC’s billing requirements to mandate that all tenants be billed based on water use determined by the individual meters. Alan Plummer Associates made this same recommendation for the City of Austin's water conservation program (Alan Plummer Associates, Inc., 2006).

7. EFFECTIVE RATE STRUCTURES

The majority of Wisconsin water utilities currently use a declining rate structure to charge consumers for their water use. By definition, a declining rate structure charges less per unit as water consumption increases. There are certain advantages to this arrangement, including having one rate structure for all customer classes, generating revenue stability, and promoting water intensive economic growth. However, with the passage of the Great Lakes Compact,
Wisconsin is focusing on ways to reduce water consumption. This is where a declining rate structure is disadvantageous; it gives less of an incentive to conserve than inclining block rate structures in which the unit cost of water rises as consumption increases.

Wisconsin water utilities track customer usage with meters and bill customers based on their actual usage. Rates are set through rate cases before the PSC. PSC staff determines the utility’s revenue requirement, which includes revenue for operation and maintenance, depreciation, taxes, and a reasonable return on investment. Next, the PSC performs a cost-of-service study, which identifies the cost of serving the various customer classes. The intention of the cost-of-service study is to allocate system costs equitably. Utilities must maintain sufficient capacity to serve customers when water usage is at its peak; thus, customers exerting peak demands on the system primarily drive the need for expensive supply expansion and should bear a proportionate cost. Finally, the PSC designs a rate structure to recover the revenue requirement that is consistent with the cost-of-service study (PSC, n.d.).

Current law does not require the PSC or water utilities to consider conservation and efficiency as part of the rate-setting process. However, PSC can approve rates intended to promote conservation and efficiency as long as the rates are deemed to be just and reasonable under existing procedures (DNR, 2008a).

In 2007, Waukesha Water Utility became the first utility in Wisconsin to institute an inclining block water rate structure for residential customers. The inclining block structure is intended to encourage the conservation of water. Also known as a conservation rate structure, it is usually used as one tool in a larger comprehensive water conservation program, along with educational programs and other conservation incentives. Recently, several other communities have expressed to the PSC an interest in utilizing conservation rate structures, and as of June 2009, three additional communities had received PSC approval to implement inclining rate structures for residential customers (Vishwa Kashyap, personal communication, July 2009). See Table 9 for an overview of various rate structures.

### a) Types of Rate Structures

There are three basic types of conservation rate structures: increasing block, seasonal, and time-of-use rates. These rate structures can also be used in conjunction with one another to provide a comprehensive conservation rate structure. Table 9 defines each of the three conservation rate structures and provides an example of how pricing could be allocated for each tier.

Conservation rates are generally implemented for residential customers, as it is the residential demand that often drives the need for capacity expansion. Moreover, rates that penalize large volume industrial, commercial, or institutional customers may be difficult to implement without threat of such customers leaving the public water supply system. In special situations, however, there may be opportunity to collaborate with large users to develop appropriate individualized rate structures. An individualized rate structure is a version of inclining block rates in which tiers are determined for each customer by the customer’s usage history. It targets a customer’s peak
and average usage. The first block/tier is generally set based on the customer’s usage during the winter months and is typically re-evaluated annually (Loehman, 2008). Individualized rates can encourage conservation even at the lower volume range, but they are administratively more complex to implement.

### Table 9: Types of Conservation Rate Structures

<table>
<thead>
<tr>
<th>Type</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
</table>
| **Increasing Block Rates** | Cost per unit increases as water use increases within specified “blocks” or volumes.  
                           | The increase in cost between each block should be significant enough (25% or more and 50% between the last two steps) to encourage conservation. | Monthly Usage (Gallons)  
|                          | 0 – 6,000 $2.50  
|                          | 6,000 - 12,000 $3.15  
|                          | 12,000 + $4.00                                                                 | Surcharge method: $1.00/1,000 gallons is added on top of the regular fee schedule for all water use between May 1 and October 1. |
| **Seasonal Rates**       | The rate per unit increases in the summer to encourage the efficient use of water during peak demand periods caused by outdoor water uses.  
                           | Seasonal rates can take the form of a surcharge added to the normal rate or a separate fee schedule for winter and summer periods. | |
| **Time-of-Use Rates**    | Water rates are higher at times of the day when water use demands are high. This rate requires specialized meters that can monitor water use during specified segments of time, for instance, every 15 minutes.  
                           | Due to the impracticality of installing specialized meters for every customer, this rate type is generally most applicable to large customers that are able to modify their demand in response to price signals. | Rates reduced $0.75/1,000 gallons for customers that reduce their water usage during periods of peak water demand. |

Source: Adapted from Conservation Rates, Minnesota Department of Natural Resources (2008)  
[http://files.dnr.state.mn.us/waters/watermgmt_section/appropriations/conservation_rate_structures.pdf](http://files.dnr.state.mn.us/waters/watermgmt_section/appropriations/conservation_rate_structures.pdf)

### b) IMPLEMENTATION AND MANAGEMENT STRUCTURES

Designing an effective conservation rate structure can be difficult, as rates must be high enough to discourage peak demand, yet should not result in excessive revenue volatility for the utility. Conservation programs require diligence in monitoring water demand and revenues. With sufficient information, conservation rates can be an effective tool to improve the sustainability of water resources.
Customer education is a critical part of the implementation process for conservation rate structures. Once consumers understand the design of a water rate structure, they can make more informed choices about their water use, such as whether or not to use water saving equipment or appliances, what type of landscapes to install, or whether to irrigate or not.

**CASE STUDY: WAUKESHA, WI CONSERVATION RATES**

Waukesha’s water utility implemented a conservation rate structure for residential customers in June 2007. The city implemented a three-tiered fee structure, charging more to consumers with increasing consumption. Under the tiered rate structure, customers pay monthly rates of $1.95 per 1,000 gallons of water up to 30,000 gallons, $2.20 per 1,000 gallons for the next 10,000 gallons and $2.70 per 1,000 gallons for anything more than 40,000 gallons. In addition to the new rate structure, Waukesha introduced specific water use restrictions. Waukesha residents may only water their lawns two days per week, with compliance enforced by fines. These new initiatives have been accompanied by extensive public outreach campaigns in schools and community events, and through public service announcements and bill inserts. Public education programs have used slogans such as “Don't Flush Dollar$ Down the Drain,” and “Don’t Get $oaked by Overwatering Your Lawn” to help draw customers' attention to the cost implications of water use (Waukesha Water Utility, 2008).

Waukesha’s program has been effective. Water use in the Waukesha area has dropped by 47 million gallons during a two-year period ending April 30, 2008, despite an increase of 5,100 customers during the same period (Block, 2008).

**CASE STUDY: COLORADO SPRINGS, CO CONSERVATION RATES**

Colorado Springs bills customers on a monthly basis and adopted an inclining block rate structure in 2002. Colorado Springs Utilities estimates that approximately $127,800 was spent to develop and implement the new rate structure, with much of the cost stemming from increased staff time to design and annually review the rate structure. Over the course of five years, the utility reported that customer consumption had decreased by an average of 2,100 gallons per residential customer. The cumulative cost per acre foot of water conserved was $190, which is very low compared to the cost of developing new supplies in Colorado (Western Resource Advocates, 2008).

**8. WATER RECLAMATION AND REUSE: UTILITY SCALE**

The Great Lakes Compact provides an opportunity for the state of Wisconsin to extend its focus beyond traditional voluntary and demand-side conservation measures and explore a range of innovative strategies. One area that is often overlooked in conservation programs is water reclamation and reuse, whereby wastewater utilities treat wastewater and provide the reclaimed water to customers for reuse (Sinykin, McGee, & Scanlan, 2005).
Currently, some Wisconsin communities withdraw water from groundwater aquifers at a pace that exceeds recharge rates, and they use this water only once before it is discarded. There are no federal guidelines governing water reuse practices, and communities must act separately to develop strategies for implementation of new institutional and regulatory parameters for using reclaimed water.

One major concern especially related to water reclamation and reuse that may be preventing progress on this issue is water quality limits for nitrogen and coliform bacteria, which are frequently present in wastewater effluent. Installation of practices to completely remove these pollutants is cost prohibitive for large municipalities in Wisconsin (Sinykin, McGee, & Scanlan, 2005).

Despite those concerns, reuse practices hold promise as a conservation method. It is currently permissible to use treated wastewater for land applications once a WPDES permit has been obtained and state surface water quality conditions have been met. More than one hundred municipalities already use treated effluent in land-use applications across Wisconsin, although most of the technologies—primarily seepage cells, infiltration basins, and spray irrigation—are meant to be used as a means to treat, as opposed to reuse, water. The expansion of water reclamation and reuse practices can serve as an effective water conservation tool for uses where drinking water quality standards are not necessary.

a) Regulation of Reclamation and Reuse

Wastewater has many applications for reuse in both industry and agriculture. In order to produce a viable supply, however, it is necessary to define different classes of reclaimed water. The guidelines for delineating the different classes include the water's source and the process used to treat it.

Water that is not of potable quality can be reused to support industrial processes such as cooling system water, boiler feeder water, process water, washdown water, and fire protection (Government of South Australia Department of Human Services, 1999; USEPA, 1999). It can also be used in agriculture where its application does not pose direct health risks to farmers and consumers or potential environmental risks to watershed health. Wastewater effluent can include high salt contents, nutrients, organic carbon, pathogens, suspended solids, and industrial by-products.

Potable water has a much more extensive range of applications. It can be used to grow most crops, and it can also be released into local water sources to promote recharge within these systems.

Monitoring of water resources that may be affected by reclaimed groundwater discharge is essential to protect the integrity of the regional watershed. Guidelines from the South Australian Reclaimed Water program include routinely testing the reclaimed water directly for coliform bacteria (including *E. coli*), and treating it with processes used to remove pathogenic organisms. Australia also recommends monitoring samples collected from the point of entry to the reclaimed water distribution system, as well as to groundwater, surface water, and soil that may
be affected. Risk levels and specific handling procedure should be determined based on the reclaimed water class to ensure the safety of the community and environment.

Wisconsin could model its reclaimed water use and regulation after similar efforts that have been undertaken in Florida (Florida Senate Committee on General Government Appropriations, 2008). Within this framework, Wisconsin should fund research studies regarding the benefits and obstacles surrounding the use of reclaimed water, and eliminate any disincentives that exist in the permitting and implementation processes. Feasibility studies should also be incorporated into the new program to provide incentives for reclamation and reuse projects.

Efforts should also be made to establish public outreach projects to allay public concerns and inform developers, industries, and others when pursuing opportunities and requirements for water reclamation and reuse. Wisconsin could encourage local governments to require new development proposals to evaluate whether wastewater reclamation and reuse is an option to reduce or offset the impacts of development, particularly in Groundwater Management Areas (Rhode Island Water Resource Board, 2003). Also, increased water reclamation and reuse practices will require Wisconsin to create an infrastructure system that supports the transport of reclaimed water. While the costs of implementation may be prohibitive in many areas of the state, reclaimed water may be a viable option for utilities facing water shortages or seeking to increase their withdrawals from the Great Lakes.

**CASE STUDY: FLORIDA WATER RECLAMATION**

Florida’s wastewater treatment and reuse program reduced groundwater withdrawals by an average of five percent in 2000 (Turcotte, 1997). This number will likely increase as reuse capacity expands, and as the program receives returns on its success by demonstrating the ability of reuse systems to reduce new withdrawals and decrease the demand for additional freshwater supplies. State water policy in Florida has created a system of Water Resource Caution Areas (WRCA), wherein all wastewater treatment facilities must conduct a reuse feasibility study. Reuse is required in the WRCA unless the use is not “economically, environmentally, or technically sound” (Turcotte, 1997).

While Florida’s program is most likely not directly applicable to Wisconsin due to major regional differences in climate, the tenets behind it can be used to inform the recommended reclaimed water policy. Ultimately, it demonstrates the possibility for massive reductions in groundwater and surface water withdrawals through wastewater reclamation.

**CASE STUDY: EL PASO, TX WATER RECLAMATION**

El Paso Water Utilities (EPWU) has been reclaiming wastewater since 1963, primarily for industrial use and landscape irrigation. EPWU collects and treats wastewater using advanced secondary or tertiary treatment. The result of this treatment process is Type I quality water—the highest rating of reclaimed water as described in the Texas state regulations and monitored by the Texas Commission on Environmental Quality (El Paso Water Utility, n.d.).
Reclaimed wastewater is approved for the following uses in Texas:

- City Parks
- School Playgrounds and Sports Fields
- Landscape Nurseries
- Sports Complexes
- Golf Courses
- Street Median Landscaping
- Construction Projects
- Street Sweeping
- Fire Protection
- Residential Landscape
- Apartment Landscape
- Industrial Cooling Towers
- Industrial Processes

Currently EPWU supplies customers with over 5.25 million gallons per day of reclaimed water. Reclaimed water is also used for the operation of treatment plants (in-plant use) and for aquifer recharge through injection wells and infiltration basins (El Paso Water Utility, n.d.).

El Paso currently has four water reclamation projects. The city’s Northwest Reclaimed Water Project provides over 450 million gallons of reclaimed water per year through 25 miles of pipeline to various locations in northwest El Paso. A fully automated dispensing station operates continuously to provide uninterrupted service to contractors and others for construction, street sweeping, etc. The value of the project is $23 million paid for by grants from the U.S. Bureau of Reclamation, the Texas Water Development Board, and through City of El Paso Water and Sewer revenue bonds from EPWU (El Paso Water Utility, n.d.).

E. RECOMMENDATIONS

Wisconsin’s public water supply faces numerous challenges in the future, such as population growth and increased water demands. A formal statewide public utility conservation framework does not yet exist for Wisconsin. We recommend designing a framework that requires all public supply utilities to develop an individualized conservation plan and engage in a specified number of conservation best management practices. There are several components of this recommendation:

1. Incorporate principles of Integrated Water Resources Planning, including conservation planning, into utility planning requirements:
   a. Integrate water utility planning processes with other planning efforts, particularly with comprehensive plans developed through planning commissions and with stormwater and wastewater plans.
b. Require more comprehensive demand projections and data collection.

c. Require development of detailed conservation plans from individual utilities.

d. Establish guidelines for evaluating economics of potential conservation and efficiency measures.

e. Require frequent planning and public reporting.

f. Fund and support planning and implementation efforts.

g. Define requirements for small suppliers.

2. In addition, we recommend that a statewide conservation and efficiency program include the following measures as required or highly recommended for public utilities, provided they are cost-effective and technically feasible.

a. Initiate an educational or outreach program to demonstrate the benefits of conservation measures and practices to water users.

b. Use informative billing practices.
   - Bill frequently, preferably on a monthly basis.
   - Design bills to convey information regarding the design of the rate structure, financial savings from moving to a lower tier, comparison of customers’ current usage to historical consumption or to neighbors, conservation programs available, etc.

c. Use plumbing fixture retrofit ordinances and programs
   - Establish an ordinance requiring plumbing fixtures to be replaced upon sale or remodel.
   - Provide rebates for water-saving appliances, and develop programs that also target low-income and ICI customers.

d. Improve distribution system efficiency.

e. Perform annual or semi-annual water audits using the IWA / AWWA Water Audit Method.
   - Carry out water audits for large customers and provide custom incentives such as grants and rebates to customers who could reduce their consumption significantly.
   - Potentially partner with Focus on Energy to administer audits and incentive programs.
f. Increase sub-metering of multi-family properties.
   - All new multi-unit residences should be required to provide for sub-metering of water use.
   - Offer a voluntary sub-metering retrofit to existing multi-unit residences.

g. Adopt effective rate structures.
   - Adopt a conservation rate structure for residential customers.
   - Include customer education as part of a rate structure program to heighten awareness of cost implications of excessive water consumption.

h. Evaluate feasibility of reclaiming wastewater and distributing it for reuse by large industrial customers or outdoor irrigation.
III. PRIVATE WATER SUPPLY

Private water supplies are utilized by a wide variety of sectors in the state of Wisconsin. The sectors that currently account for the greatest amount of private water use include: agricultural, industrial, and domestic wells. The water withdrawn from private wells plays a major role in supporting the state’s economy and quality of life.

A. PRIVATE WATER USE AND REGULATION IN WISCONSIN

1. WISCONSIN WATER STATISTICS

Manufacturing industries use approximately 600 million gallons per day (8 percent of total use) and agriculture and irrigation use approximately 335 million gallons per day (5 percent of total). A majority of the water used in manufacturing is obtained from groundwater wells. Manufacturing withdrawals are generally large enough to be classified under Wisconsin’s definition of high capacity wells, which are defined as one or more wells, drill holes or mine shafts on a property that have a combined pumping capacity of greater than 70 gallons per minute (100,000 gpd) (Wisc. Admin. Code ch. NR 812).

Wisconsin has a total of 8,933 registered private water systems (USEPA, 2007). Seven of these are categorized as “water cooperatives,” which are consumer utility cooperatives, and are normally classified as non-profit organizations (Ruiz-Mier et al., 2006). These utility cooperatives are found primarily in rural areas and provide water and wastewater services on a non-profit basis. Ten are “homeowners’ associations,” or “water associations,” which function like cooperatives in that they are non-profit, member-owned organizations (USEPA, 2007). In addition, Wisconsin has approximately 750,000 private wells (Masarik, 2006).

2. WISCONSIN'S “REASONABLE USE” DOCTRINE

Wisconsin has a history of using federal and state legislation and policies to protect its water resources. For example, the earliest legal guidance regarding limitations set on water use originates from the 1903 Supreme Court decision in the case of Huber v. Merkel. The Supreme Court's interpretation of the State Constitution was that a landowner could use as much groundwater as he wanted, regardless of how that water usage affected adjoining property owners.

The Huber v. Merkel decision remained a law in Wisconsin until 1974 when the State Supreme Court overturned the ruling. The Court's decision in the State of Wisconsin v. Michels Pipeline Construction ruled that the state holds authority over groundwater usage and has the power to regulate groundwater for the common good. The ruling also restricted private property owners from using water that was not or could not be defined as “reasonable,” or that potentially negatively impacts other users. However, despite using language such as “potentially negatively impact” to prevent certain water uses, the law has not always successfully protected neighbors.
and down-stream citizens from adverse impacts and has forced those affected to claim
compensation after the fact through civil lawsuits.

The Michels Pipeline decision also advanced the concept of “reasonable use;” however, the
definition and decision-making authority remain ambiguous. Current Reasonable Use Rule
defines a “reasonable use” as a withdrawal of water that serves a beneficial purpose while not
causing “unreasonable harm” to neighboring citizens. “Unreasonable harm” has been defined
as lowering the water table, reducing artesian pressure, or impacting the water levels of lakes
and streams.

The following section analyzes the systems and structures that are currently in place to define
and monitor “reasonable use” for the agricultural and industrial sectors. This discussion is
followed by measures that can be undertaken within the private use sector to mitigate the
negative impacts of water use on ground water levels.

3. Current Institutional Structures

Under 2003 Wisconsin Act 310, owners seeking to operate private high capacity wells must
obtain DNR approval, pay a $500 fee, and submit an annual pumping report to the DNR. Upon
receiving approval, the permitees must submit a monthly report with water use totals from each
well to the DNR. Aside from the permitting process, there are few measures currently in place to
curb water use. Most industrial water regulations within Wisconsin tend to pertain to water
quality and fines only exist for the most egregious violations. The combination of the low cost of
water and the presence of few fees and structures to curb use suggests the potential for
excessive water waste in large withdrawals.

The use of private wells for irrigation purposes is standardized by two primary Wisconsin
Administrative codes. The first of these codes, Wisconsin Administrative Code ch. NR 812,
establishes standards for obtaining groundwater and protecting aquifers through adequate
construction of water systems. This standard deals mostly with the construction, maintenance
and abandonment of wells monitored by the DNR. The second primary code, Wisconsin
Administrative Code ch. NR 820, provides the legal framework for managing groundwater
pumping where potential environmental impacts exist. It sets up criteria for reviewing wells near
springs, trout streams, Outstanding Resource Waters, and Exceptional Resource Waters. In
Wisconsin, wells used for irrigation are considered high capacity wells and are managed under
ch. NR 820.

B. Approaches to Private Supply Conservation Programs

Statewide private supply conservation programs are less common than programs for public
utilities. The diversity of private supply uses makes one comprehensive program difficult to
implement. However, some states have developed sector-specific programs, such as Arizona’s
agricultural BMP program.
Arizona’s agricultural water conservation program began in 2002 as an alternative to the mandatory water allotment program (the Base Program). The program consists of four BMP categories, from physical engineering farm aspects to water/agronomic management. Varying numbers of points are awarded for each measure, and points are multiplied by the fraction of farm acreage employing each measure (Arizona Department of Water Resources, 2006b). An enrollee must accumulate at least one point in each category and acquire at least ten total points. All farm and field improvements must be in place at the time of program enrollment. Two irrigation management services, funded by various public and private agencies, provide free conservation services and scientific measurements for the farm operators. Program compliance is routinely checked through on-farm observation (Arizona Department of Water Resources, 2006b). Table 10 lists selected measures and corresponding points. A program could specify practices for domestic well use and industrial water conservation.

Table 10: Arizona’s Agricultural BMP Program

<table>
<thead>
<tr>
<th>Best Management Practice</th>
<th>Points</th>
<th>% of Farm Acreage</th>
<th>Total Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Farm Irrigation Systems</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slope systems without uniform grades</td>
<td>0 points</td>
<td>x</td>
<td>%</td>
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<tr>
<td>Uniform slope systems without tailwater reuse</td>
<td>1 point</td>
<td>x</td>
<td>%</td>
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<tr>
<td>Uniform slope systems with tailwater reuse</td>
<td>2 points</td>
<td>x</td>
<td>%</td>
</tr>
<tr>
<td>Modified slope systems</td>
<td>2 points</td>
<td>x</td>
<td>%</td>
</tr>
<tr>
<td>Low pressure sprinkler systems</td>
<td>3 points</td>
<td>x</td>
<td>%</td>
</tr>
<tr>
<td>Trickle irrigation systems</td>
<td>3 points</td>
<td>x</td>
<td>%</td>
</tr>
<tr>
<td><strong>Irrigation Water Management</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternate row irrigation</td>
<td>1 point</td>
<td>x</td>
<td>%</td>
</tr>
<tr>
<td>Furrow checks</td>
<td>1 point</td>
<td>x</td>
<td>%</td>
</tr>
<tr>
<td>Angled rows/contour farming</td>
<td>1 point</td>
<td>x</td>
<td>%</td>
</tr>
<tr>
<td>Participation in an educational irrigation water management program</td>
<td>1 point</td>
<td>x</td>
<td>%</td>
</tr>
<tr>
<td>Soil moisture monitoring</td>
<td>1 point</td>
<td>x</td>
<td>%</td>
</tr>
<tr>
<td><strong>Agronomic Management</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop rotation</td>
<td>1 point</td>
<td>x</td>
<td>%</td>
</tr>
<tr>
<td>Crop residue management</td>
<td>1 point</td>
<td>x</td>
<td>%</td>
</tr>
<tr>
<td>Pre-irrigation surface conditioning</td>
<td>1 point</td>
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<td>%</td>
</tr>
<tr>
<td>Transplants</td>
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<td>%</td>
</tr>
<tr>
<td>Mulching</td>
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<td>x</td>
<td>%</td>
</tr>
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<td>Shaping furrow or bed</td>
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<td>%</td>
</tr>
</tbody>
</table>

Total points must equal 10 or greater.
C. DOMESTIC USE

1. INFORMATION AND OUTREACH PROGRAMS

Domestic private well conservation presents a unique challenge for regulation, given the sheer number of private wells and the difficulty in conducting an outreach program or ensuring compliance. Approximately 3.7 million individuals get their drinking water from one of the approximately 750,000 private wells in Wisconsin (Masarik, 2006). It is normally the homeowner’s responsibility to provide for the upkeep and repair of private wells. Lack of knowledge regarding water quality and quantity issues can be a health hazard to users of private water systems. Negligent management of private wells can result in water supplies that go untested and without maintenance. Occasionally unethical businesses take advantage of homeowners by selling them unnecessary equipment, using dishonest water testing techniques, or providing inaccurate advice for the construction of wells, all of which are risk factors not only to the health and well-being of owners, but also to the quality and quantity of groundwater aquifers (Clemens et al., 2007).

Education on proper well maintenance and water management may be a means to combat some of these problems, and will be an essential component of any conservation and efficiency program that intends to include private well owners (Clemens et al., 2007). Partnering with the University of Wisconsin-Extension service and local units of government could offer a means to disseminate information and encourage awareness of conservation and efficiency measures. Once an educational program in the state is established, it can be combined with a progressive legislative agenda to create a framework for private water management.

CASE STUDY: PENNSYLVANIA MASTER WELL OWNER NETWORK

In Pennsylvania, over three and a half million people get their water from private wells, with 20,000 new wells drilled yearly. Penn State Cooperative Extension paired up with Penn State Institutes of the Environment and received funding from the USDA Research Education and Extension Service to create a Master Well Owner Network (MWON). The MWON is a voluntary network group in Pennsylvania committed to educating private well owners about ways to better manage their water supply. The goal of the program is to provide information to as many private well users as possible. The Extension Service is able to reach a large number of people by dispersing its legions of trained volunteers throughout the state to carry the banner of better water management (Clemens et al., 2007).

The MWON program employed a state coordinator to organize workshops and communicate with the statewide volunteers. The state coordinator was aided by eight cooperative extension educators, who were assigned to the six Penn State Extension Regions. In areas of the state that produced an ample supply of volunteers, MWON implemented a program of training workshops. Eight training workshops were held and a total of 242 volunteers were trained from 55 counties throughout Pennsylvania. Volunteers who successfully completed the training
workshops were given a goal of educating 100 private well owners over the course of two years (Clemens et al., 2007).

Approximately 7,000 private water system owners were educated about a wide range of water quality issues by MWON volunteers from May 2004 through October 2005. Volunteers reported talking to neighbors, informing local officials and residents at township meetings, and canvassing at county fairs. MWON volunteers also reported educating approximately 29,000 private water users through media outlets such as newspapers and television. Additionally, the internet reporting system received over 90 percent of all the reports. Overall, the method of using volunteers proved to be a successful tool in educating a large audience about water management. Of the participants who were communicating with the MWON, 82 percent of those had taken steps to better manage their water management system (Clemens et al., 2007).

2. Rainwater Harvesting

One method for reducing reliance on private well supplies is through rainwater harvesting. Technologies for rainwater harvesting can range from very complex to strikingly simple. However, all of them involve components that satisfy the basic process of inducing, collecting, storing, and conserving runoff specifically for use at a later date (Kinkade-Levario et al., 2003). Rainwater harvesting retrofits on existing buildings are generally more expensive than installing a system on a building during construction. Given this economic reality, focusing on installing rainwater harvesting infrastructure on new housing and commercial structures is the most effective way to initiate such a program.

Some specific methods of rainwater harvesting and reuse techniques include rain barrels, vertical storage units, and cisterns (Figure 3). These methods of storage are favorable because they are versatile and can be used in systems ranging from small residential rain barrels to large multi-unit systems serving multiple needs. Rain barrels and vertical storage units usually rest against a building to collect drainage from roof leaders and downspouts, and cisterns are designed to hold large volumes of water. Cisterns are more common for large-scale commercial use and can be incorporated into or under building elements such as paths and walkways.

Figure 3: Rainwater Harvesting Methods

The use of these technologies for water reuse is extensive. Some uses include reuse for irrigation and landscaping, storage for fire needs, storage during storm events to reduce runoff, and reuse for graywater needs, such as flushing toilets (Cahill Associates Inc, 2005). They can be tailored to the demands of projects of any size, and the water they store can be applied to a myriad of applications. Wisconsin could provide information on technologies for water reclamation and reuse to the general public, developers, and commercial water users.

CASE STUDY: NEWCASTLE, NEW SOUTH WALES, AUSTRALIA

From 1998-1999, a two-year evaluation was undertaken of Fig Tree Place, a 27-unit suburban redevelopment demonstration community in Newcastle, Australia (Coombes et al, 1999). This project used a wide array of techniques including rainwater tanks, infiltration trenches, and a central detention basin. In this project, stormwater runoff from paths, lawns and gardens was collected and put into a grassed depression used as a detention basin. The runoff water was then pumped for irrigation and bus washing.

This project was considered very successful, since rainwater stored in hot water storage systems and tanks met drinking water guidelines. Furthermore, water in tanks treated by flocculation, settlement, and bio-reaction also met drinking water standards. Total water savings of a residence using roof water for hot water systems and toilets is expected to be 45 percent. The total water savings of the community, including irrigation, is expected to be 60 percent.

This program was designed in a redeveloped demonstration community, so it would be most useful in new housing developments, particularly in rural or cluster developments. This project showed that rainwater and graywater could be adapted on a variety of different scales and to a variety of contexts. However, this type of system would need to be adapted to accommodate the snow and ice of Wisconsin.

CASE STUDY: SYDNEY, NEW SOUTH WALES, AUSTRALIA

The Kogarah Town Square project began in 1997 as a multiple use site including medium density residential, commercial, retail, and municipal land uses (Mitchell, 2006). In total the site included 194 residential apartments, 224 parking spaces, 2500 square meters of commercial space, 2500 square meters of retail outlets, 240 square meters of community exhibition space and a town square. This site was designed so that rainwater could be used for toilet flushing, car washing, watering and for irrigation. Efficiency measures included water-efficient toilets, showerheads, appliances, flow restrictors and aerating taps. In addition, landscaping was designed to improve stormwater quality and to manage flow. This project resulted in a 42 percent reduction in potable water use through combined rainwater, stormwater, and efficiency measures. Furthermore, rainwater and stormwater leaving the site was reduced by 85 percent.

As with most new design techniques, this approach would work best in new developments where it could be included from the beginning of the project. The main challenge would be to encourage developers to take such comprehensive measures in their design. However, many of
the design ideas in developments such as these could be adapted to already developed areas if the incentives are present.

D. IRRIGATION AND AGRICULTURAL USE

1. CURRENT IRRIGATION AND AGRICULTURAL USES

In 2000, Wisconsin agricultural irrigation use accounted for 195.2 million gallons of water per day, with 99 percent, or 193.3 million gallons, from groundwater withdrawals. Non-irrigation agricultural use accounted for 136.5 million gallons per day, with 74 percent, or 101.0 million gallons of water per day, from groundwater withdrawals. All agricultural uses account for 22 percent of the total non-thermoelectric water use in Wisconsin (USGS, 2000a).

Water loss from Wisconsin’s private agriculture water supply is mainly due to four factors:

- Runoff from overwatering
- Evaporation of water in open irrigation channels or from sprinkling
- Transpiration of water intensive crops
- Consumptive use of water by exporting crops out of the basin

Implementing metrics for wasteful use could establish conservation practices. Even without these metrics, there are several ways the state can promote water conservation, including educational programs and requirements to implement best management practices where appropriate.

2. MONITORING IRRIGATION USES

Historically Wisconsin has had minimal metering of agriculture water usage; estimating water withdrawals from private wells for irrigation is an important step in establishing an effective agricultural water use monitoring program. There are several methods of estimating irrigation withdrawals that water resource managers can use: estimating theoretical crop requirements based on calculated volumes per acre, measuring application rates, and calculating transportation losses. The preferred USGS method to calculate irrigation consumption is to subtract return flows and water transportation losses from total withdrawals; however, monitoring and calculating losses during the transfer of water is difficult, so most withdrawal calculations are only approximations of actual conditions (Solley, et al, 1998).

Irrigation experts, soil scientists, and agricultural specialists have found that estimating average consumptive agriculture water usage with evapotranspiration (ET) rates is the most accurate and useful metric. ET rates vary with a variety factors including, the type of crop, soil waterholding capacity, the depth of the crop root zone and climate variability. Scientists can use these variables to create models that guide the construction of irrigation schedules and project crop water requirements over time (Pebbles, 2003).
Irrigation schedules that are produced from the scientifically calculated ET rates can prevent water loss and runoff from over watering. These can also lead to increased water efficiency and higher yields with the same amount of water used by increasing the percentage of water applied to crops (Howell, 2001).

3. **IRRIGATION TECHNIQUES THAT PROMOTE WATER EFFICIENCY**

Technological advances in water efficiency available to irrigators can also play a key role in reducing water use. Agronomic, engineering, and management technologies can reduce nonproductive water use in irrigated agriculture (Howell, 2001). Applying less water per acre also reduces pumping costs.

In the arid Western United States, drip irrigation is employed as a water conservation measure, but the practice is rarely utilized in Wisconsin. Drip irrigation reduces water runoff by applying water at rates that match soil infiltration rates. Drip irrigation is also more water efficient because the water is applied directly at the base of the crops, which helps reduce losses due to evaporation. In addition to saving water, drip irrigation saves energy costs by reducing the amount of power needed to maintain adequate pressure (Caswell et al., 1985). However, drip irrigation is not practical for all types of crops and can have expensive overhead costs.

E. **PRIVATE INDUSTRIAL WATER USE**

1. **WISCONSIN'S CURRENT REGULATIONS**

The current fee for obtaining a high-capacity well permit in Wisconsin is $500. Outside of this upfront fee, Wisconsin employs few incentives to encourage water conservation and reuse by high-capacity well owners. An opportunity exists to implement a variety of policies geared towards decreasing water usage in the industrial sector.

2. **ON-SITE INDUSTRIAL WATER REUSE AND RECYCLING**

In order to reduce industry’s reliance on groundwater supply, reuse practices can be used in the forms of graywater recycling and rain barrel collection, similar to those for domestic use.

   a) **INDUSTRIAL REUSE**

Many industries employ recirculation of their own process waters for use in cooling towers or other plant purposes. A Canadian study demonstrates how many industrial operations incorporate water recycling measures into plant design (Exall, 2004). Millar Western's bleached chemi-thermomechanical pulp mill in Meadow Lake, Saskatchewan, was built as a zero liquid effluent system, with rotary screening, flotation clarifiers, settling ponds and three mechanical vapor recompression evaporators that treated the water before recirculation of the distillate. Some water is lost in process steam and evaporation from storage ponds, but demand for
make-up water is 2 to 10 percent of that required for a typical mill. Initial problems with high polymer demand, foaming and fouling were overcome by process modifications in the first years of operation (Exall, 2004).

The technical feasibility of industrial effluent reuse depends on the type of industry, characteristics of the wastewater, the applied treatment system, and the requirements for water quality. The economic feasibility of effluent reuse will be determined by the cost of obtaining and disposing water, as compared to treatment costs. In the Canadian paper industry, ultra-filtration resulted in water that met the requirements for reuse, with operational costs that were comparable to or lower than the costs of drinking water/groundwater (Exall, 2004). Other costs and convenience factors should be considered as well.

A study of the industrial sector of Thailand showed that 60 to 80 percent of the industrial water demand in Bangkok was used for cooling purposes that do not require high-quality water, but a survey of industrial reuse practices in Thailand showed that only 10.5 percent of the industries surveyed reused their treated effluent. The main reason given for the lack of reuse was the investment cost for new technologies and the cost of treatment. Other reasons given included the inconvenience of reuse when the water supply is very cheap, a lack of incentives for reuse, and a lack of awareness of new technologies. A number of potential policy approaches to deal with institutional, management and financial aspects were suggested, including the development of an industrial water reuse permit structure and legislation, development of an institutional structure to develop water reuse, subsidies for adoption of reuse strategies, implementation of fines for industrial wastewater discharge, and other enforcement tools (Bohannon et al., 2005).

b) Rainwater and Stormwater Collection

Along with graywater, rainwater and stormwater could be used in industrial facilities where high water quality is not required. Rainwater and stormwater reuse is currently practiced in many countries, with examples reported from Australia, Canada, China, France, Germany, Japan, Singapore, the United Kingdom, and the United States (Furmai, 2008). Rainwater and stormwater collection for industrial reuse is similar to the process for domestic rainwater harvesting described in the Section III.C. Domestic Use. Rainwater/stormwater capture and reuse provides double benefits, as mitigation of stormwater runoff and provision of secondary water supplies. Some level of treatment may be required depending on the quality needs of the factory. Stormwater reuse as a sub-potable water supply is generally possible, and often fairly feasible, particularly when using roof runoff. As with all water sources (particularly in densely populated urban areas), the collected rainwater must be monitored and treatment measures taken to reduce health risks associated with its reuse. Several types of benefits are attained: savings on potable water supply, environmental benefits arising from reduced discharges of runoff and associated pollutants into receiving waters, and economic benefits.
CASE STUDY: THE STATE OF TEXAS

The State of Texas has encouraged rainwater harvesting to be used for irrigation purposes by exempting rainwater harvesting equipment at commercial businesses from sales and property taxes (Krishna, 2005). This program was expanded in 2001 when the Texas legislature created a law allowing “taxing units of government the option to exempt from taxation all or part of the assessed value of the property on which water conservation modifications have been made.” These statewide initiatives encourage support for conservation programs at the county and city level. For example, Hays County, Texas, now offers a $100 rebate on property development application fees if rainwater harvesting equipment is being installed and also exempts these properties from paying property taxes on the rainwater harvesting equipment. The City of Austin offers substantial rebates of up to $40,000 for commercial businesses on the purchase of rain barrels and rainwater harvesting systems. Likewise San Antonio offers large equipment rebates depending on the acre-feet of water that will be conserved with the new system.

Most of Texas’ water retention programs appear to be quite successful measured in terms or rainwater harvested and thus conserved. It also provides excellent opportunities for grassroots and community involvement that solves water quantity problems while simultaneously promoting a conservation ethic.

CASE STUDY: FRANCE STORMWATER REUSE

A study of potential rainfall reuse in France (at Renault MCA automobile plant) resulted in new technology to evaluate the reuse of stormwater. The authorities required the facility to treat stormwater by settling, prior to discharge into receiving waters. Renault MCA’s considerations of associated costs led to the proposal of reusing such treated stormwater rather than simply disposing of it. The designer developed Software for Industrial Rainwater ReUSe (SIRRUS) for evaluation of technical and economic feasibility of stormwater reuse at industrial sites.

Using this software program, the Renault MCA plant in France determined that at the plant site, about 300,000m³ of stormwater could be collected, treated, and reused in plant operations. The payback period was calculated as almost 8 years, which is five years more than the plant requires. Using SIRRUS, the facility found that a governmental grant/subsidy would be required to take the rate of return down to 2.33 years. Other simulations were carried out demonstrating the obvious impact of other parameters such as water consumption, operating costs, and leakages in the basins and in the collecting system. The project is an example of solutions that can be carried out for manufacturers and local communities to improve resources and reduce consumption and discharges (Thomas et al, 2002).

F. PRICING AND TRADING PRIVATE USE PERMITS

As detailed previously, Wisconsin Act 310 requires owners seeking to operate private high capacity wells to pay a $500 permit fee. Following DNR approval, the well-owner can pump up to the maximum approved amount. This system is essentially a flat-fee pricing structure, and does not vary with water usage. Moreover, an owner does not recoup any of the permit cost if
he or she no longer uses the well. Two options for encouraging conservation would be to 1) institute tiered monthly permit fees, and 2) set a cap on the number of permits issued based on a water budget and allow trading of permits.

1. **Volumetric Permit Pricing**

   Because permit fees for high capacity wells do not vary based on volume pumped, permits do not overtly encourage conservation. Were permit fees to increase based on the volume of water pumped, owners would have an incentive to reduce their water usage as much as possible.

   One difficulty in implementing volumetric permit pricing to encourage conservation is that water demand is not always “elastic,” meaning that demand may not change significantly in response to an increase in price. However, a study of Canadian industries found that volumetric pricing of water could have a measurable conservation effect on usage (Dupont and Renzetti, 2001). Further studies with Canadian water pricing have shown that volumetric pricing schemes are more effective than annual fees (Renzetti and Dupont, 1999). Annual fees function in a similar fashion to permit fees – once they are paid, companies can use the maximum volume of water allowed. Simulations demonstrate that even when required to pay annually, minimal incentives exist for companies to conserve water; thus, volumetric permit fees may be most effective when collected on a monthly basis.

   While the potential for water conservation associated with volumetric permit pricing could be great, there are many obstacles associated with this approach. Many pricing methods have been used in climates and regions that typically do not have an abundance of water. For these regions, implementing these policies is a necessity to maintain minimum water levels for public and private use. While the entire state of Wisconsin has not reached the point where these policies are perceived as a necessity, there are some areas in the state that are currently experiencing water supply deficiencies and for which this approach may be appropriate. However, Wisconsin does not currently have the legal or administrative structure in place to implement monthly volumetric permit pricing for private wells, which would requires accurate monitoring and frequent billing. In addition, volumetric pricing for well permits may adversely affect business decisions if pricing and regulation structures differ substantially in other states.

2. **Permit Trading**

   Another possible mechanism for promoting industrial water conservation is the creation of a permit trading system for groundwater pumping permits or for Great Lakes withdrawals. For groundwater, The state would need to assess the water budget of a particular aquifer and determine the maximum volume of water that could sustainably be withdrawn. For the Great Lakes Basin, DNR could use the information it currently has regarding water withdrawn from the Great Lakes to cap the amount of water withdrawn. This system would function similar to a cap-and-trade model, with a limited number of permits issued to extract a specific volume of water. Once the maximum number of permits is reached, trading of pumping permits could take place. A water trading system would maximize water allocation efficiency by allowing water users who
are willing to pay more to extract more water. Assessments of localized impact on hydrologic systems would need to be completed to determine the feasibility of potential trading systems.

**CASE STUDY: PERMIT TRADING IN THE WESTERN UNITED STATES**

In the Western United States, several water trading structures have been used. In Idaho and California, water rights can be sold to other companies or groups that are willing to purchase them. These water transactions take place through state-regulated water banks. The process of trading water rights maximizes water allocation efficiency by allowing those that are willing to pay the most to purchase excess water. It also creates an incentive for the holders of water rights to conserve water and sell their excess water rights for a profit (Green et al, 1999). There is the potential for a permit trading system in Wisconsin to achieve the positive benefits yielded by the Western US water rights system.

One major problem experienced in both Idaho and California were complications that arose when transfers were allowed between basins. This issue is of particular importance to Wisconsin because of the stipulations in the Great Lakes Compact that prevent out-of-basin transfers. Water that is removed from the hydrologic basin from which it is taken can have significant deleterious environmental and sustainability effects. The water rights systems in Idaho and California have been found to work best if unused water is returned to the basin from which it is taken as return flows (Green et al, 1999).

**G. PRIVATE WATER SUPPLY RECOMMENDATIONS**

The following recommendations may assist the State Wisconsin improve water conservation and efficiency programs related to private water supply:

1. Educational programs
   - a. Expand programs to educate private well users on proper well maintenance and water management techniques.
   - b. Encourage use of rainwater harvesting technologies for some domestic uses.
   - c. Provide industries with information, assistance, and financial incentives for reducing wastewater use through process changes, reclamation, and rainwater harvesting.
   - d. Target outreach efforts toward the agricultural industry to promote efficient watering systems.

2. Regulation
   - a. Require implementation of best management practices for industry and agriculture, as appropriate. Program could be modeled on Arizona’s agricultural BMP points program, with tiered requirements based on location, size of enterprise, water loss ratios, or other criteria.
b. Establish localized caps for water usage based on ecological criteria.

c. Where appropriate and feasible, require water-saving technology adoption to decrease water waste.

d. Improve monitoring and loss estimates for irrigated agriculture.

3. Permit pricing and permit trading

   a. Consider increasing well permit fees based on volume pumped.

   b. Evaluate the potential for enacting a regulated tradable permit system in areas where a cap on water pumping or withdrawals is feasible or necessary (i.e., in the Great Lakes Basin and Groundwater Management Areas.
IV. WATER USE IN POWER GENERATION

Thermoelectric power generation is the process of producing electricity from a heat source such as fossil fuels or nuclear energy. Thermoelectric power plants use large quantities of water to produce steam to turn turbines and for cooling purposes. Nationwide, thermoelectric water withdrawals accounted for 40 percent of all freshwater withdrawals in the year 2000 (Dziegielewski et al., 2006), and thermoelectric power plants produced 90 percent of the energy for the United States (USGS, 2000a).

Because they require considerable amounts of water, nearly all thermoelectric plants are located near bodies of water with sufficient quantity available to cool the system. The consumptive and non-consumptive uses of this water should be critically assessed to improve efficiency. The power plant’s fuel source and cooling technology significantly affect the quantity of water withdrawn and the consumption rates. The following sections discuss the options available for thermoelectric, nuclear, and hydroelectric power plants that can play a pivotal role in ensuring a sustainable water future for the state of Wisconsin.

A. ELECTRIC POWER GENERATION IN WISCONSIN

According to the United States Geological Survey, in the year 2000, withdrawals used for power production accounted for 79 percent of Wisconsin's water withdrawals (USGS, 2000a). Most of the water used for power generation is surface water. Despite withdrawing such vast amounts of water, thermoelectric consumptive use is only one to two percent, as most of the water is returned to its source (Pebbles, 2003).

The majority of power generated in Wisconsin comes from fossil fuel thermoelectric plants. As of 2006, fossil fuels—natural gas, petroleum, and coal—produced 74.9 percent of Wisconsin’s power, with coal as the primary fossil fuel source. Other significant contributors were nuclear (20.4 percent) and hydroelectric power (2.4 percent) (United States Energy Information Administration, 2009). Throughout the state, there are 50 thermoelectric power plants that use fossil fuels and two nuclear power plants (Wisconsin Water Library, 2008). Wisconsin plants use a mixture of closed-loop and open-loop cooling systems.

Multiple stakeholders may be affected by water quantity regulations related to thermoelectric power generation. These include but are not limited to:

- Public: The citizens of Wisconsin rely on the power-generation industry to provide electricity at a reasonable rate; at the same time, they expect that the power-generation industry will utilize environmentally sound practices.
- Industry: Several industries in Wisconsin, including the timber and paper industries, utilize dams to generate energy and depend on existing hydroelectric and thermoelectric facilities for consistent and reliable sources of energy.
• Utilities: Many of the companies that sell the energy produced in thermoelectric and hydroelectric power plants are investor-owned utilities; a few municipalities have their own hydroelectric or thermoelectric plants.

B. REGULATORY STRUCTURES GOVERNING THERMOELECTRIC AND HYDROELECTRIC POWER GENERATION

1. Federal

The quality of Wisconsin's surface waters is protected on both the federal and the state levels, but within the context of water quantity, protective measures are less widespread. The dominant piece of federal legislation protecting surface water quantity is Section 316(b) of the Clean Water Act, regulated by the Environmental Protection Agency (USEPA). Section 316(b) provides that "any standard established pursuant to sections 301 or 306 of the Clean Water Act and applicable to a point source shall require that the location, design, construction, and capacity of the cooling water intake structures reflect the best technology available for minimizing adverse environmental impact."

This provision of Section 316(b) is unique in that it applies to the withdrawal or intake of water and not the discharge. A major goal of this regulation is to minimize the impingement (trapping against intake screens) and entrainment ("sweeping up" into the water intake system) of aquatic organisms and fish into the intake systems of large-scale water users such as power generation plants. It is noteworthy that this provision of Section 316(b) calls for the “best technology available for minimizing adverse environmental impact,” but doesn’t specify any basic guidelines around permitted withdrawal quantities.

2. State

Section 316(b) of the Clean Water Act is perhaps more well-known for its regulation of point-source discharges directly into water bodies. Under this law, power generation plants (and other dischargers of effluent water) must apply for a permit to discharge effluent into a water body. The USEPA has delegated authority to Wisconsin to regulate this permitting process, under the Wisconsin Pollutant Discharge Elimination System (WPDES) program, which is similar to the USEPA’s National Pollutant Discharge Elimination System (NPDES). WPDES only regulates discharges, not withdrawals. The State’s role in regulating point-source discharges is codified in Wisconsin State Statute Chapter 283.

Wisconsin State Statute Chapter 30.18 requires permitting of water withdrawals for the purposes of agriculture or irrigation, or for “maintaining or restoring the normal level of a navigable lake or… stream.” In addition, permits are required for withdrawals that will “result in a water loss averaging 2,000,000 gallons per day in any 30-day period.” This leaves much room for large, unpermitted water withdrawals that are legal.
According to Wisconsin Administrative Code ch. NR 142.03(1), withdrawals of more than 100,000 gallons per day in any 30-day period shall register the withdrawal with the DNR. Thermoelectric power generating facilities must determine their consumptive use and report it to the DNR. As of October 2008, the Wisconsin Department of Natural Resources (DNR) did not require the reporting of water intake quantities by power generation plants (Eric Ebersberger, personal communication, November 4, 2008).

In order to promote conservation and efficiency of water, the state should address all large-scale users of water in its statutes and administrative codes. Additionally, as mentioned above, the state should enforce its existing regulations that require the reporting of intake volumes of water. The implementation of Act 227 should achieve this measure. Also, as noted in the Introduction to this report, the Public Trust Doctrine may apply to ensure "The navigable waters leading into the Mississippi and St. Lawrence…shall be common highways and forever free….

C. TYPES OF THERMOELECTRIC COOLING SYSTEMS

With thermoelectric power, the type of power plant and the cooling system technology utilized directly affect water use and consumption. Contemporary thermoelectric plants use one of two main types of cooling systems, discussed below. However, prior to further discussion the following key terms related to thermoelectric power generation are defined:

Withdrawal is the total amount of water taken from a source (Feeley et al., 2008). With regard to power production in Wisconsin, this water source is primarily surface water.

Consumption is the amount of water withdrawn from, but not returned to the source (Feeley et al., 2008). An example of consumption is evaporation.

Megawatt-hour (MWh) and kilowatt-hour (kWh) are two standard measurements of power commonly used to describe the energy-generating capacity of power plants. One MWh is equal to the amount of power used if 1,000,000 watts are used for 1 hour, or 1000 kWh.

1. OPEN-LOOP (ONCE-THROUGH) COOLING SYSTEMS

The majority (91 percent) of thermoelectric plants in the United States employ open-loop cooling systems (USGS, 2000a), which are cooling systems that require the continual intake of cooling water. Water is withdrawn from a source body of water, circulated through the heating system, and returned to the source.

Open-loop cooling maintains the lowest evaporative losses of any type of thermoelectric cooling system, with 99 percent of water withdrawals returned to the source. Open-loop cooling systems are typically the least expensive to build, but result in cooling water being returned to the source at a considerably higher temperature. This "thermal pollution" potentially increases evaporation rates and likely contribute to water quality and habitat problems at discharge.
2. **Closed-Loop (Recirculating) Cooling Systems**

The second primary type of cooling system is *closed-loop cooling*. These are systems that withdraw water from the source, circulate it through the heating system as a coolant and then pipe the water to the top of a cooling tower. The water is allowed to fall down the tower, and on the fall the water contacts air, which dissipates heat and causes evaporation. The water remaining at bottom of the tower is then cool enough to reuse in the cooling process.

In closed-loop cooling systems, evaporation is up to 50 percent greater than in open-loop cooling systems (Dziegielewski et al., 2004). However, because water in closed-loop systems is reused, total water withdrawals are 30 to 50 times less than open-loop systems. (Pace University, 2000). In addition to evaporation, water in closed-loop systems is also lost through blowdown, drift, and leakage (USGS, 2004). Blowdown is the process by which water that has collected impurities from multiple cycles of reuse is pumped out of the closed-loop system, which prevents damage to the system from scaling. Thus although closed-loop systems require smaller withdrawals than open-loop systems, significant withdrawals are still made to supplement the water lost through evaporation and other processes.

Table 11: Consumptive Use and Withdrawal Rate for Thermoelectric Plants

<table>
<thead>
<tr>
<th>Fuel Source</th>
<th>Consumptive Use (gal/kWh)</th>
<th>Withdrawal (gal/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coal</strong>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open-loop (once-through)</td>
<td>0.14</td>
<td>27.1</td>
</tr>
<tr>
<td>Closed-loop (recirculating)</td>
<td>0.46</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Oil &amp; Natural Gas</strong>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open-loop</td>
<td>0.09</td>
<td>22.7</td>
</tr>
<tr>
<td>Closed-loop</td>
<td>0.16</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>Nuclear</strong>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open-loop</td>
<td>0.14</td>
<td>31.5</td>
</tr>
<tr>
<td>Closed-loop</td>
<td>0.62</td>
<td>1.1</td>
</tr>
<tr>
<td><strong>All types combined for WI†</strong></td>
<td>0.49</td>
<td>NA</td>
</tr>
</tbody>
</table>

Sources: *Feeley et al, 2008  †Torcellini et al, 2003
3. **Impact of Various Cooling Methods on Water Consumption**

There are several different ways to estimate the amount of water consumed by different types of thermoelectric plants. Several studies and papers provide estimates of the amount of water consumed in gallons/kWh. A sampling of data from these studies is provided in Table 11.

D. **Hydroelectric Power Plants**

Hydroelectric power in Wisconsin accounts for nearly three percent of the state’s electricity (EIA, 2007). Hydroelectric power plants back up water behind a dam to form a “head”—an elevation differential whereby the falling of water from higher to lower elevation produces energy. Currently there are approximately 200 hydroelectric dams licensed by the Federal Energy Regulatory Commission (FERC) in Wisconsin.

Hydroelectric power plants do not consume water through the same processes as thermoelectric plants. In hydroelectric plants, the consumption of water is a secondary effect that results from the creation of an impoundment or reservoir behind a dam. After water is stored in the reservoir, it is released through turbine-generators to produce electricity. The impounding of water behind the dam creates a larger water surface area than a natural river, and water is lost through evaporation at an increased rate.

In the western United States, an analysis of Lake Mead and Lake Powell—impoundments created by Hoover and Glen Canyon dams, respectively—showed an increase of 2.4 percent and 4.0 percent in evaporation in gal/year in comparison to a free flowing river (Torcellini et al, 2003). While these dams are considerably larger than anything found in Wisconsin and Wisconsin’s climate is much cooler than that of the American Southwest (and consequently evaporation rates are not as great) this example illustrates that hydroelectric power plants, through the construction of dams, are actively consuming water. Further research is necessary to determine how much water different types of hydroelectric power plants consume.

Wisconsin has different types of dams for hydroelectric plants:

- **Run-of-river dams** typically create relatively small impoundments; the amount of water running through the powerhouse is determined by natural river flow. Small run-of-river dams are the most common type of hydroelectric dams in Wisconsin.

- **Pumped-storage dams** pump water from a lower reservoir to an upper reservoir at off-peak times when electrical costs are cheaper. During periods of high electrical demand, the water is then released back to the lower reservoir to generate additional electricity.

E. **Opportunities for Increased Efficiency in Thermoelectric Water Use**

Technological improvements may play a key role in the improved efficiency of power generating plants. It is difficult to analyze specific technological improvements that could improve the efficiency of power plants without addressing the specific components of each type of plant. In
other words, a full-scale analysis would be needed to determine whether a specific technological improvement would be feasible within each particular power plant. This report does not provide that level of analysis. However, below are specific issues that the proper technological improvements could potentially address—and in doing so, allow for the highest level of efficiency possible.

1. **Closed-Loop Systems and Water Recycling**

Wisconsin is aiming to reduce water withdrawals by encouraging closed-loop thermoelectric power plants. Additionally, the DNR and PSC recommend water recycling to save potable water. Given the scale of water use in power plants, evaporative losses constitute an area where significant efficiency improvements could be made. A typical coal-fired power plant loses an estimated 480 gal/MW to evaporation (Wolfe, 2008). Recycling evaporated water through condensation offers one option for reducing losses. According to a recent study, “small-scale tests of one technology, which uses crosscurrents of ambient air for condensation, show potential for capturing 12 percent to 30 percent of evaporative losses if engineered to full scale” (Wolfe, 2008).

**CASE STUDY: PLEASANT PRAIRIE, WI THERMOELECTRIC PLANT**

Pleasant Prairie is a thermoelectric coal plant located five miles from Lake Michigan and operated by We Energies. It has a 1,210 MW total net generation capacity. The Pleasant Prairie plant utilizes a closed-loop cooling system for its two coal-powered units, which share a cooling chimney.

The plant uses 200,000 gallons of water per minute per unit, pumped continuously between turbine generator condensers and cooling towers, to convert the exhaust steam from the turbine back into water for reuse. This amounts to 100,000 gallons recirculating back to each unit. In order to replace evaporative losses from the cooling system of the two units, 3,000-4,000 gallons of water are pumped per minute from Lake Michigan (DNR, 2008b).

**CASE STUDY: OAK CREEK, WI THERMOELECTRIC PLANT**

Oak Creek Power Plant is a 1,135 MW thermoelectric plant with four coal-based units that utilize an open-loop cooling system. It is owned by We Energies and is located twenty miles south of Milwaukee in Oak Creek. 800,000 gallons of water from Lake Michigan are used every minute to convert the exhaust steam from the turbine back into water for reuse (DNR, 2008b).

**Analysis of Pleasant Prairie and Oak Creek**

Lacking any measurements of the actual amounts of withdrawals and discharges from the power plants, it is difficult to accurately determine the rate of consumptive water use by the plants. However, estimation rates can be used as a proxy to get a relative idea of the water withdrawal and consumption based on kWh (kilowatt-hours) generation rates. Using efficiency estimates presented in Table 11 (above), it is possible to estimate the potential effects of...
decreased rates of withdrawals and consumption at the Pleasant Prairie and Oak Creek power plants. The aforementioned efficiency estimations for fossil fuel open-loop and closed-loop cooling systems were 53 percent and 67 percent, respectively. Using a combination of available and feasible technologies like those described in this chapter, it could be possible to increase efficiency by roughly 10 percent at each of the plants. This would mean increasing the efficiency at the two plants from 53 percent to 63 percent and from 67 percent to 77 percent, respectively. These measures could result in significant water withdrawal savings.

2. **Improved Operating Efficiency**

Improving the overall efficiency of power plants will also reduce the water withdrawals necessary to produce a kilowatt of electricity. A 2004 report estimated the efficiency of open-loop cooling systems to be 52 percent for fossil fuel plants and 70 percent for nuclear; closed-loop systems averaged 67 percent for fossil fuel plants and 81 percent for nuclear. Increased efficiency would mean smaller consumptive uses and withdrawals of water and therefore greater conservation (Dziegielewski et al, 2004).

3. **Reduction of Blowdown Losses**

With the continual evaporation of water from closed-loop systems, concentrations of suspended and dissolved solids accumulate in significant amounts (Wolfe, 2008). Blowdown is water that is used to flush out the cooling systems to prevent the buildup of concentrated solids, which can result in corrosion and scaling of the cooling system. Thus the development of cooling systems that tolerate higher concentrations of impurities and are resistant to scaling and corrosion will reduce the loss of cooling water through blowdown (Wolfe, 2008).

4. **Dry Cooling (Air-Cooled Condensers)**

Dry cooling is a water-free cooling method used primarily in arid, water-scarce climates. Cooling occurs in these systems via air blown across the exterior surfaces of the tubes that carry heated water. The down side of this technology is that it is very expensive to construct, it requires significant physical space, and may increase plant emissions (as compared to wet cooling). As such, it is generally used only in water-scarce regions where the costly technological investment in dry cooling generates adequate savings in water use.

**CASE STUDY: PARALLEL CONDENSING SYSTEMS**

**Xcel Energy's Comanche Station Project (Pueblo, CO)**

Parallel condensing "pairs two proven technologies: a conventional cooling tower system and an air-cooled condenser (ACC)" (Schimmoller, 2005). "Parallel condensing systems unite conventional wet cooling technology with dry cooling technology to reduce water use; the steam exhausted from the steam turbine is split between a steam surface condenser (tied to a conventional wet cooling tower) and an air-cooled condenser (ACC)" (Schimmoller, 2005).
Cooling duties can be shifted between towers (wet) and ACC (dry). When water is unavailable (or too costly) the ACC can assume the plant’s cooling load. In this way, parallel condensing “can occupy a middle ground between wet and dry cooling…” permitting an estimated 50 percent reduction in water consumption (Schimmoller, 2005).

Xcel Energy’s Comanche Station plant will require three times the capital cost of a conventional wet cooling tower system, but 40 percent less than the cost of an all-dry cooling system. Bottom-line cost impact will be around 5 percent of total project cost for a standard air-cooled condenser system, relative to a wet cooling system. In areas with limited water supply the efficiency is very important.

5. **Flue Gas Desulfurization ("Scrubbing")**

Scrubbing is required to reduce SO₂ (sulfur dioxide) emissions. While water use for scrubbing operations is considerably less than cooling systems, it still represents an area where technological improvements may reduce overall use and consumption of water. “Wet scrubbing” captures flue gas emissions and associated pollutants (SO₂) in a spray and is removed via an alkaline “slurry” (Wolfe, 2008). “Dry scrubbing” is a water-free alternative to wet scrubbing where alkaline particles are injected directly into the flue gas stream, but it results in lower pollutant removal rates (Wolfe, 2008). Scrubbing operation slurry also has implications for water quality.

6. **Use of Reclaimed Water**

As detailed in the Public Supply chapter of this report, water reclamation for cooling is another option to reduce water withdrawals. Water quality is not paramount for this use of reclaimed water, however the integrity of cooling systems may be compromised if reclaimed water is too low in quality. For this reason, effluent water from sewage plants, subjected to rigorous treatment, may be a logical source for cooling water at a discounted cost (Wolfe, 2008).

**CASE STUDY: USE OF RECLAIMED WATER**

**Burbank Water & Power’s Magnolia Power Project (Burbank, CA)**

Burbank Water & Power’s (BMP) Magnolia Power Project is a 310-MW combined-cycle natural gas-fired plant that utilizes reclaimed water in place of potable water. Using Puretec’s “Reclaimed Water Demineralizer System,” a combination of microfiltration, chemical treatment, reverse osmosis and polish demineralization (ion exchange) purifies to a significantly high level of water quality, which is used for the boiler system (Hansen, 2006). Through this system, the plant uses reclaimed water a second and third time and is ultimately able to produce approximately 220,000 gallons of demineralized water daily (Hansen, 2006).

Additionally, the Magnolia Plant also uses a zero liquid discharge (ZLD) system developed by Aquatech International Corporation, which processes effluent and blowdown waste that has been concentrated five times in the cooling tower system. The system is 90 percent efficient, with the rejected 10 percent of concentrated water evaporated in a crystallizer.
Though this particular case study would be challenging to implement in Wisconsin, it is informative for the implementation of the Great Lakes Compact. Challenges include the requirement that skilled operators run the ZLD system, the management and disposal of waste brine, and difficulties in system start up and maintenance (Hansen, 2006). This case study highlights the potential for using reclaimed water in Wisconsin. Using reclaimed water would reduce the amount of surface water needed to operate cooling systems. Implementing a system similar to the Burbank Magnolia plant may allow Wisconsin plants to employ reclaimed water, and then use it several more times in the cooling process. Whether or not this technology is applicable to thermoelectric plants in Wisconsin should be analyzed.

**CASE STUDY: GEORGIA WATER CONSUMPTION MANAGEMENT AND STATE REGULATION FOR THERMOELECTRIC POWER PLANTS**

**The State of Georgia**

Georgia regulates the water withdrawals of thermoelectric plants located in the state. The water supply of Atlanta, Georgia’s largest city, is stored in a reservoir (Lake Lanier) and is delivered to the city via a river. As such, the state’s goal is to preserve their limited water supplies by maintaining in-stream flows and limiting intakes. This has a significant impact on power producers due to their need for large water withdrawals.

Following an analysis of water use in Georgia power plants, Barczak and Kilpatrick (2005) recommend a much stronger push on the demand side to lower energy demand which would decrease the need for power. "Many energy efficiency measures cost significantly less than conventional power sources, thereby offsetting any increased marginal costs associated with renewable supplies" (Barczak & Kilpatrick, 2005). Furthermore, the authors recommended that Georgia phase out open-loop cooling systems at thermoelectric plants and retrofit them with closed-loop systems. Additionally, in light of increasing costs and scarcity of water in the southeastern United States, the authors advocate evaluating dry-cooling economic feasibility.

**Application of Georgia’s Model to Wisconsin**

Georgia’s model for monitoring the average monthly average withdrawal for each power plant could apply to water intake regulation implementation of Act 227. The DNR currently uses a similar model for pollution levels in point source pollution. In this model, the registration of a high pollution reading triggers increased monitoring to determine if the source is over their allowable limit.

The recommendation of phasing out open-loop cooling systems in Georgia corresponds to a similar push in Wisconsin. Wisconsin is moving towards retrofitting older plants with closed-loop cooling systems for a variety of reasons, primarily because more efficient technologies are available, and water conservation and efficiency is rapidly becoming a priority in the power generation industry.
F. RECOMMENDATIONS

Water used for power generation in Wisconsin is significant. The implementation of Act 227 will help document the extent of water use in this sector. Act 227 requires the reporting of water intake levels by power plants, which will allow the DNR to more accurately monitor and regulate these large, previously unreported withdrawals of water. The case studies in this section represent some of the options available to improve conservation and efficiency of water use in this industry, and should be explored further for potential implementation in Wisconsin.

To further improve the conservation and efficiency of water use in the power generation industry, we recommend that the DNR:

1. Encourage education and energy efficiency to reduce energy demand.

2. Continue to encourage movement from open-loop cooling systems to closed-loop cooling systems, to minimize large-scale water withdrawals and thermal pollution. A new system of incentives or mandates could help support power plant conversion to the best available water-efficient technologies.

3. Evaluate technologies such as the use of reclaimed water, parallel condensing systems, and zero liquid discharge systems as potential “best available technology” language in the Clean Water Act Section 316(b).

4. Recognize the water quality issues resulting from technologies that improve water use efficiency. For example, “Recirculating cooling water (closed-loop systems) concentrate dissolved constituents in cooling water blowdown” (Wolfe, 2008) and may require post-treatment.

5. Calculate and document annual consumption of hydroelectric plant water due to evaporation of impounded surface waters.
V. LAND USE AT THE LANDSCAPE SCALE

When we think of water diversions, the first uses that come to mind are those with specific purposes such as drinking, manufacturing, power generation or agricultural irrigation. Consequently, the majority of this report has dealt with measures designed to increase the efficiency of these uses. However, these measures deal only with intentional water diversions and do not address the unintentional diversions of ground and surface water due to anthropogenic landscape changes. While intentional diversions may be less complex to quantify, there is increasing acknowledgement that the manner in which we use and change landscapes can dramatically influence the availability of usable water.

Precipitation in the form of rain and snowfall are the primary inputs to the hydrological cycle. After it falls, precipitation is integrated into the local hydrology in one of three manners: surface runoff to streams and lakes, infiltration into the groundwater system, and evaporation back into the atmosphere (Wisconsin Groundwater Coordinating Council [WGCC], 2002). The amount and rate by which precipitation runs off, infiltrates, or evaporates in any locale is determined by many factors such as the topography, soil type, vegetative cover, land use, and climate. In most cases, anthropogenic landscape changes such as residential and agricultural development have the net effect of increasing surface runoff and decreasing the infiltration of water. This occurs primarily through increased construction of impervious surfaces, reduction of vegetative ecosystems, and rerouting of temporal streams. By reducing groundwater recharge, increased runoff effectively speeds water through the local hydrological system.

Where water quality is concerned, increased runoff can cause significant impacts as soil, nutrients, and other pollutants are washed off developed lands into neighboring surface waters (Brabec et al, 2002). Furthermore, water quality can be degraded as pollutants infiltrate to an aquifer. However, where water quantity is concerned, decreased infiltration reduces groundwater supply. The effects of land use change are multiplied by increasing withdrawals of groundwater for consumption while simultaneously decreasing infiltration (WGCC, 2002). By using a water supply faster and limiting its ability to renew itself, land use changes can consume a seemingly renewable resource.

A. WATER RELATED LAND USE IN WISCONSIN

In recent years, it has become increasingly clear that groundwater levels in parts of Wisconsin have been declining. This has been most notable in the Milwaukee metropolitan area, yet similar decreases have been seen in other urban areas around Madison and in the Fox River Valley. In addition, the combined effects of urban and agricultural use have been seen in several areas of the state; the occasional disappearance of the Little Plover River is the most visible. Since the unintentional diversion of groundwater recharge usually coincides with increased intentional withdrawals, it is very difficult to separate the effects of the two. There are few, if any precise estimates of the amount of Wisconsin groundwater recharge that is unintentionally diverted.
Overall, there are few institutional structures in place directly aimed at reducing the amount of groundwater recharge that is unintentionally diverted due to land use changes (DNR, 1997). An attempt to address this gap is the creation of Groundwater Management Areas in southeast Wisconsin (Waukesha County and surrounding counties) and the Lower Fox River Valley (Brown County and portions of counties to the south), codified by State legislature in 2003 Wisconsin Act 310. These were intended to coordinate government actions in groundwater management areas if the drawdown of a deep aquifer exceeds 150 feet.

Much of the policy and legislation designed to improve or protect water quality has the additional effect of protecting quantity. Wisconsin’s stormwater management law and wetland protections are prime examples of this. Many efforts of open space conservation and preservation have the additional benefit of protecting wetlands and headwater areas, which are critical for groundwater recharge. As pressures for land development increase it is also necessary to mitigate or prevent negative impacts on the quantity of groundwater.

B. LAND USE POLICY FOR WATER PROTECTION

This section discusses policy options for mitigating the impacts that land development and use have on water resources. The following case studies represent approaches to protecting groundwater recharge areas and addressing the effects of diversions. These examples were drawn from regional, national and international approaches and can be placed into three groups: those intended to protect groundwater recharge, those intended to mitigate the effects of land use change, and those addressing both. These cases are by no means exhaustive but were selected to represent a range of approaches.

1. PROTECTING UNDEVELOPED LANDS FOR GROUNDWATER RECHARGE

The following case studies, address the idea of protecting the specific regions that are necessary for recharging groundwater supplies. As the groundwater to surface water interconnections are better understood, it is increasingly important to address the impact of land use on the quantity of groundwater. This can be done through identifying and protecting undeveloped lands where recharge of groundwater is most likely, and therefore allowing natural processes to increase groundwater supply.

CASE STUDY: NORTHEASTERN WISCONSIN

The Wild Rivers Legacy Forest (WRLF) was specially recognized for its exceptionally rich diversity and the quantity of surface water that flows into and contributes to the water quality of Green Bay and the larger Great Lakes systems. The forest provides important ecosystem functions for animals including eagles, songbirds and wolves, as well as providing jobs in forestry and recreation. Establishing the forest was a collaborative project of the Wisconsin Department of Natural Resources, Conservation Forestry LLC, Forest Investment Associates, and The Nature Conservancy. Through this arrangement, the State of Wisconsin owns 5,629
acres of the WRLF to be managed by the DNR. The remainder of the land, 58,988 acres, is owned by Conservation Forestry LLC and Forest Investment Associates and is managed for sustainable timber production. The Nature Conservancy holds the conservation easement on this land to ensure that opportunities for public access and recreation are provided and that forestry practices are sustainable.

The WRLF was largely achieved through the purchase of 69,000 acres from International Paper for $84.7 million, negotiated by The Nature Conservancy and the DNR. Funding was provided through a combination of Wisconsin's Knowles-Nelson Stewardship Fund, private equity from Conservation Forestry LLC, Forest Investment Associates, and private funds from The Nature Conservancy. While expensive, this effort illustrates how watershed protection can be used to achieve the triple bottom line of social, economic and ecological benefits. Specifically, it provides protection for a critical area of groundwater recharge while providing water quality benefits, recreational opportunities, habitat, and a sustainable source of timber.

CASE STUDY: SAN ANTONIO, TX

In 1973 the Edwards Aquifer in San Antonio became the first USEPA designated sole source aquifer. In 1993, the Trust for Public Lands (TPL) working with San Antonio Water System (SAWS) acquired land for the second-largest, state-owned natural area in Texas—Government Canyon State Natural Area that now totals over 8,600 acres (Ernst, 2004). SAWS has partnered with the Trust for Public Lands, The Nature Conservancy of Texas and the Bexar Land Trust to identify and acquire sensitive recharge zone land. Through their efforts, SAWS has effectively leveraged funds from city, state, and private sources to purchase lands or development rights on over 10,000 acres in the Edwards Aquifer Recharge zone since 2000. On two separate occasions in 2000 and 2005, San Antonio voters passed propositions to increase the sales tax, with the sole purpose of raising money to purchase undeveloped land in the Edwards Aquifer recharge zone. These protected lands now provide critical recharge to the Edwards Aquifer as well as natural habitat and recreational opportunities.

These programs have strong support from area residents. San Antonio provides a good example of how Wisconsin cities could partner with state agencies and NGOs to delineate and protect recharge zones to important aquifers both in the Great Lakes Basin and non-Great Lakes Basin. This could be particularly useful in the Central Sands region or in the recharge zones for Waukesha County. The approach of protecting large areas of natural land cover to promote groundwater recharge may be feasible in many parts of Wisconsin.

CASE STUDY: NEW JERSEY

New Jersey has given special anti-degradation protection to waterbodies that are of exceptional quality and protect headwater areas, support endangered species, or allow recreation (Ernst, 2004). This is included in New Jersey state stormwater rules, which have provisions for protection of groundwater recharge and wellhead protection areas. The state combines Drinking Water State Revolving Funds with Clean Water State Revolving Funds to provide low interest
loans for water protection. Specifically, they make use of Environmental Infrastructure Financing 
Program (EIFP) Smart Growth loans, which have highly favorable terms to cover projects 
serving urban centers and complexes. To accomplish this, New Jersey's guidelines for natural 
land acquisition were rewritten to give priority to land that protects wetlands, aquifers, or 
floodplains.

A statewide program such as this would seem to be highly beneficial in Wisconsin. However, 
success would depend on the prioritization of headwaters and groundwater recharge areas and 
the ability to fund the loan programs. New Jersey's rules are relevant given their specific focus 
on groundwater recharge.

CASE STUDY: SEATTLE, WA

From the early 1900s to 1996, Seattle Public Utilities acquired all of the land in the Cedar River 
Watershed (over 100,000 acres) and 70 percent of the land in the South Fork Tolt River 
Watershed from the US Forest Service and private logging companies (USEPA, 1999). The 
Cedar River flows through two reservoirs creating hydroelectric power for Seattle. Only 22 
percent of the river’s flow is diverted for Seattle water use whereas the remaining water 
provides instream flows for spawning salmon and flow to operate locks between Lake 
Washington and Puget Sound. Access is largely prohibited within watershed lands, with the 
exception of educational tours. In 1997, a 50-year habitat conservation plan was created for the 
watershed that included the formation of a multi-agency in-stream-flows commission. As a 
result, 64 percent of the watershed (including all of the old growth forest) was designated a 
forest reserve with logging prohibited. This unpopulated mountainous watershed is now 
protected from land use change and managed for water quality and quantity protection, long-
term forestry, and wildlife habitat.

The current system is successful. This aggressive land acquisition and protection program has 
not only protected the quantity and quality of water supply for the City of Seattle but has 
provided a place to educate students and residents about watershed processes. It also protects 
valuable habitat for many threatened and endangered species. It is unlikely that Wisconsin 
communities would seek this degree of land acquisition expressly for water supply; however, as 
with Wisconsin’s Wild River Legacy Forest, protected lands could provide multiple beneficial 
uses, including erosion control, flood control, limited recreational opportunities, or even timber 
production, if managed properly.

CASE STUDY: STOCKHOLM, SWEDEN

Stockholm is a city of 1.8 million people for whom water supply and sewage disposal are 
municipal responsibilities. The city has contracted with The Stockholm Vatten Company to 
manage the lands encompassing much of the watershed that supplies the city’s water (Dudley 
and Phillips, 2006). In total, the company manages about 40 percent of the watershed’s 13,000 
acres as a working forest of spruce, pine and birch. Management focuses on reducing soil 
erosion into the lake, protecting wetlands and preserving water quality. All timber products from
the company’s managed forest are certified under Swedish Forest Stewardship Council standards.

Although this area was not purchased or declared a national park or reserve, the strong emphasis on conservation and restoration has resulted in very high water quality and stable water quantities. With a biotic community similar to that in northern Wisconsin, this program could be emulated in urban areas or around small towns. As with the Wild Rivers Legacy Forest, this solution promotes economic as well as ecological goals.

2. Mitigating the Effects of Development on Groundwater Supply

As large areas of undeveloped land are limited in Wisconsin, especially near larger metropolitan areas, it is important to address possibilities for developed land as well. Land use plans and policies have been created in order to mitigate the effects of land use on groundwater infiltration.

CASE STUDY: CROSS PLAINS, WI

The St. Frances subdivision in the Village of Cross Plains, Wisconsin, was one of the first residential developments in Wisconsin to use bio-retention systems to minimize stormwater runoff (Morzaria-Luna et al, 2004). The developer needed to consider the Village’s stormwater ordinance and Wisconsin’s NR 216 stormwater permit process, which required control of post-development stormwater flows to predevelopment levels for two-year storm events. Furthermore, a DNR permit was required for any "land disturbance greater than two hectares that discharge into state waters." The developer included rain gardens, vegetated swales, trenches, and infiltration basins in the site plan.

The process of including bio-retention was not easy, taking over three years during which many compromises were made and successes were not readily apparent. This included foregoing some of the water quality requirements in exchange for use of bio-retention systems. One particular problem was that the rain gardens were to be planted on each individual’s property. However, since the gardens were part of a publicly managed stormwater system, municipal maintenance was required; a responsibility neither the developer nor the Village wanted. This eventually led to the removal of rain gardens from the storm-water plan. Despite these challenges, the developer gained six plots in the subdivision by using infiltration systems with little or no negative impact observed in preliminary water quality data collected by the Land Conservation Department.

3. Connecting Groundwater and Surface Water Supplies with Land Development

The first two sections address increasing groundwater recharge by protecting land from development as well as utilizing techniques that increase groundwater recharge on developed
lands. Case studies in this section highlight a combination of these efforts as well as addressing the groundwater and surface water interconnections.

**CASE STUDY: PLOVER, WI**

The Little Plover River ran dry during the summers of 2005 and 2006 (and 2009) as groundwater removal for irrigation and municipal use exceeded groundwater recharge (Thornton, 2006; River Alliance of Wisconsin, 2008). A group of citizens, scientists, and DNR personnel responded by forming the Friends of the Little Plover River to ensure the waterway’s future. With the cooperation of the DNR, a collaborative watershed management plan was proposed that would involve conservationists, farmers dependent on irrigation and the village of Plover. The village of Plover agreed to refrain from using the wells with the greatest impact on the Plover River throughout much of the year. However, local agricultural irrigators had not yet committed to voluntary pumping reduction measures. A coalition of conservation and environmental organizations have requested that the state set a minimum flow requirement for the Little Plover River and identify critical recharge areas.

With the current efforts, flows have increased to four cubic feet/second (cfs). However, water levels in the Little Plover River have not returned to their previously recorded 10 cfs. This situation will likely remain an ongoing process that will require collaboration among the DNR, growers, conservationists, concerned citizens, and municipal leaders. This case demonstrates the need for growth planning and cooperation between stakeholders as well as the increased recognition of the inseparability of ground and surface water. Further, it highlights that comprehensive integration of water quantity decisions requires participation from a range of stakeholders.

**CASE STUDY: AUSTIN, TX**

The City of Austin gets its public water supply from the Highland Lakes, a series of reservoirs on Texas’ Colorado River that are also used heavily for water recreation (Ernst, 2005). Barton Springs is located in Austin and is part of the Edwards Aquifer system, the major source of recharge for the Highland Lakes.

Beginning in 1980, Austin voters passed several successively stronger ordinances creating mandatory mitigation strategies requiring non-degradation of water quality from any new development in the recharge zone and contributing zone of the Barton Springs section of the Edwards Aquifer. These ordinances set limits for the amount of impervious surface in new developments and buffer zone setbacks, required stormwater treatment, and provided incentives for the transfer of development rights to critical recharge lands to the City as parkland. Developers transferring rights from recharge lands to the City were able to increase building density on land elsewhere. The Austin City Council also enacted a Smart Growth Initiative in 1998 designating the most sensitive third of the Austin region—land that drains into Barton Springs and the Highland Lakes—as a Drinking Water Protection Zone (DWPZ). The remaining two-thirds they designated a Desired Development Zone (DDZ), which included the
urban and commercial core districts of the city. The DWPZ contained much stronger land development restrictions than the DDZ.

The citizens of Austin also have voted (both in 1992 and in 1998) to increase their property taxes and water rates to purchase large tracts of sensitive recharge land in the DWPZ. These ballot initiatives were organized by the Citizens for Open Space Coalition with the support of the Austin Parks Board, Planning Commission, and the City Council and presented as protection of water supply as well as creation of recreational lands. Indeed, passage of public funding in 1998 created the popular 1,000 acre Barton Creek Wilderness Park within Austin. The land use regulations and land purchases have served the multiple functions of protecting water supply quantity and quality, preserving habitat for rare and endangered species, and providing recreational opportunities for Austin.

Austin’s initiatives provide an example of grassroots support for regulation and taxes used to protect water quantity. While most of Wisconsin does not face Austin’s widespread water limitations, some areas could benefit from such actions. At the least, identification and protection of groundwater recharge zones could be made a requisite component of comprehensive planning. Protection of these areas can also help to meet green and open space needs of communities.

CASE STUDY: SUFFOLK COUNTY, NY

Suffolk County Water Authority is the largest groundwater supplier in the nation, serving 1.2 million residents from this federally designated sole source aquifer (Ampher, 2008). After a long court battle in which the Long Island Pine Barrens Society sued several townships and Suffolk County to stop development over the aquifer, the New York Assembly passed the Long Island Pine Barrens Protection Act in 1993. The act formed the Central Pine Barrens Joint Planning and Policy Commission composed of the three townships located above the aquifer, Suffolk County, and the New York Department of Environmental Protection. The act also divided the Central Pine Barrens area into a core protection area (a 53,000 acre sensitive groundwater recharge area), where new development is prohibited and a compatible growth area in which environmentally friendly development is allowed. They also recommended that 75 percent of the land in the core preservation area be purchased through publicly funded acquisition. The various land use and zoning tools being used to accomplish the preservation goals of the act include transfer of development rights, cluster zoning, and conservation easements. Voters have consistently approved use of public funds to purchase lands in the core protection area and the Commission works with the Trust for Public Lands and the Nature Conservancy to acquire development rights to properties in this sensitive area.

Thus far, the success of this program is not as clear as in the Austin, Texas, example. In fact, the transfer of development rights program has only been used moderately. As of 2007, the program had protected 2,180 of 52,000 acres in the Core Preservation Area. High land prices and small land parcel sizes seem to be the most prohibitive factors. Still, this program has been widely supported by voters and demonstrates a public willingness to fund land purchases and limit development for the sake of water resources protection.
CASE STUDY: BRICK TOWNSHIP, NJ

The Brick Municipal Utility Authority (MUA) provides drinking water to over 100,000 residents in Brick Township and Point Pleasant Beach, drawing 75 percent of its water from the Metedeconk River and 25 percent from wells (Trust for Public Lands, 2003; Ernst, 2005). Throughout the Metedeconk Watershed, seven other communities also draw their drinking water from wells. The watershed has abundant wetlands and riparian forests and sandy soils, all leading to good aquifer recharge capability. Yet urban development is encroaching on the watershed, and more of the water is running off into the river and out to the ocean, but not recharging into the shallow aquifers. These aquifers are the major source of water to the Metedeconk River.

Several approaches have been employed to conserve the water in the Metedeconk watershed including a ban on all non-essential water use during drought, acquisition of headwater wetland forests, and comprehensive planning for watershed water quality and quantity. The Metedeconk Watershed was selected as a Source Water Stewardship Pilot Project funded by the USEPA and developed in collaboration with the Trust for Public Lands, the US Forest Service, and the University of Massachusetts. The project is locally led and driven by a steering committee comprised of representatives from the Brick Municipal Utilities Authority, Brick Township, Freehold Soil Conservation District, and Monmouth and Ocean Counties. Brick MUA has worked with the University of Massachusetts to create a Watershed Management Model to estimate runoff and pollutant loads and map priority areas for land protection, restoration, and stormwater management throughout the watershed.

It may be too early to determine the success of these efforts since much of the watershed planning for the Metedeconk River Watershed is still in the implementation phase. Still, the highly collaborative and comprehensive approach seems to be supported by the townships in the watershed as they all levy property taxes to be spent on open space preservation. This approach has potential for Wisconsin.

CASE STUDY: CUENCA, ECUADOR

Cuenca, Ecuador has a population of 277,000 whose water is provided by Municipal Company of Telecommunications, Potable Water, Sewage and Wastewater Treatment (ETAPA) (Proaño, 2005). ETAPA also manages Cajas National Park (CNP) and other watersheds; CNP is the only national park in Ecuador managed by local government. Since 1980, ETAPA has purchased nearly 10,000 hectares, which include Andean wetlands. These highland wetlands are considered to be the city’s water source. The headwaters for the town, managed by CNP Municipal Corporation, are now treated as a decentralized protected area and are the first of its kind in Ecuador. A major focus is on reducing pressure on the watershed by local communities in the park and buffer zone; for example, minimizing effects of agriculture, community tourism, and promoting environmental education. A fee of one percent on the water bill helps fund the conservation efforts that protect the water supply.

Hydrological and ecological baseline information on water flow and quality has not been collected, so it is difficult to monitor changes due to the water fee. However, it is estimated that
60 percent of Cuenca’s water comes from the park. Such a model of decentralized protection could be useful in Wisconsin, especially where protective natural systems (e.g., forest, wetland) still exist, albeit in a fragmented form. As with the other examples, land protection also provides habitat and recreational benefits.

**CASE STUDY: MUNICH, GERMANY**

Munich gets its drinking water from springs in the Bavarian foothills. For decades Stadtwerke München (Munich Waterworks) has supported local farming efforts in the Mangfall Valley and Loisach Valley with its “Eco-Farmers” campaign to protect the city’s water supply (City of Munich, 2007). In order to accomplish this goal, the company has been buying up land within the basin area, which is then farmed sustainably. Since 1992, the waterworks company has been specifically promoting organic farming. Currently, 1,900 hectares of land are under long-term contracts with farmers pledging ecological and organic agriculture. Additionally, 2,900 hectares of forest are managed to protect water quality. As a result of these efforts, Munich has one of the cleanest water supplies in all of Europe.

The Munich Waterworks has been working on watershed management practices for a number of years and most likely has extra capital to engage in such conservation/sustainable farming efforts. While their focus is primarily on water quality, quantity is certainly at stake with these Munich efforts, and conservation of the watershed is in effect improving efficiency. The Munich area is very comparable in climate, ecology, and land use to much of Wisconsin, and successful efforts there could well apply to much of the state. As a variation, it may be effective to redirect current agricultural incentive programs to focus specifically on lands over groundwater recharge areas.

**4. CASE STUDIES COMPARED**

This section has presented three approaches toward dealing with unintentional diversions of groundwater recharge: 1) land preservation; 2) mitigation; and 3) combinations and blended efforts. The first, land preservation, has historically been one of the most effective tools for protecting water supplies. It was the impetus for New York City to preserve the Adirondacks as a wildland in the late 1800s and was a primary and explicit reason behind the establishment of the US National Forests. In addition, much of the public land in the northeast and Great Lakes region was initially protected to prevent loss of soil and water resources following destructive timber harvests of the early 20th century. While these efforts had the ultimate effect of protecting groundwater recharge, they also had the additional benefits of protecting critical habitat and providing large areas for outdoor recreation. With these additional benefits, land preservation can be used to promote social, economic, and ecological benefits. Unfortunately, preservation of additional land is becoming prohibitively expensive. However, unique partnerships between public and private groups are able to form to protect areas such as the Wild Rivers Legacy Forest here in Wisconsin.

While preservation efforts have a very long history, efforts to directly mitigate the effects of land development are relatively new. Most have emerged to reduce the impact of development by
diverting and capturing the water that would ordinarily runoff. Bio-retention and decreased impervious surfaces can limit the effects of development. Many of the most innovative and proactive efforts have been enacted in arid environments where precipitation is prone to evaporation. However, most of these efforts are also applicable to the northern temperate climate of Wisconsin. The main advantage of these mitigation efforts is that they are diffuse and consequently relatively affordable. The primary disadvantage is that they take widespread support and adoption by the public, land developers, and local governments.

Many groundwater recharge protection projects combine elements of protection and mitigation, often through more comprehensive or integrated planning. As such, water quantity protection only plays a part of the overall planning process. In this way, water quantity is integrated and interconnected with many other issues and social processes.

These cases were funded through a variety of mechanisms, using federal, state, local, and private resources. The Wisconsin DNR already has several relevant grants available for watershed land acquisition such as Lake Protection Grants, River Protection Grants, Stewardship Funds, and Wetland Protection Grants, which favor applications with multiple collaborating governmental units. Likewise, 10 percent of State Revolving Funds from the Drinking Water program can be used to protect water sources. This leaves it open to local governments to come up with the remaining funding match, which would depend on political support and the urgency of the water supply problem.

C. RECOMMENDATIONS

Addressing interactions between land use, surface water, and groundwater requires a comprehensive approach, which includes both the protection of natural areas and the implementation of programs that promote groundwater recharge on developed lands.

1. It is important to identify and protect sensitive land areas that will aid groundwater recharge. The integrated nature of water quantity and quality highlight the multiple benefits that can be achieved by protecting and promoting groundwater recharge in large undeveloped areas. Recommendations from multiple successful land acquisition programs throughout the country include:


   b. Land preservation for multiple uses, such as water quantity and quality protection, flood protection, species habitat conservation, recreational use and/or sustainable resource use, offer greater opportunity for public support than single use land acquisitions.
c. Land acquisition guidelines for water quantity should give priority to land that protects groundwater recharge zones and sensitive headwater lands.

2. There are numerous ways to promote groundwater recharge in developed lands as well: decrease impervious surface area; decrease run off; increase bio-retention systems (rainwater harvesting tanks, infiltration trenches, detention basin, retention ponds). Wisconsin has a wealth of land conservation programs that could help support these water conservation and groundwater protection activities.

Overall impacts of groundwater-sensitive land use policies and practices can be difficult to measure due to uncertainties regarding the nature of groundwater recharge. As with other programs, quantifying the effects of policies will draw upon complex groundwater-watershed modeling. Program evaluation measures and indicators should be developed in collaboration with stakeholders.
VI. SUMMARY RECOMMENDATIONS

The objective of this report was to provide an assessment of the current state of water use in Wisconsin, and to identify potential opportunities for improving conservation and efficiency through regulatory or voluntary programs. This is a complex but essential task in ensuring the sustainable use of Wisconsin’s waters. The report focused on water quantity and took a comprehensive approach toward identifying programs, policies, and technologies that may support implementation of Wisconsin Act 227 and the Great Lakes-St. Lawrence River Basin Water Resources Compact.

The breadth of the subject matter is such that our assessment, though broad in its scope, likely just scratches the surface of potential solutions to improving water conservation and efficiency efforts statewide. Wisconsin has a relative abundance of water, and our patterns of water use suggest we have come to take it for granted. Re-establishing sustainable water use in Wisconsin requires understanding our complex interdependence and basic value assumptions regarding the resource.

The findings and recommendations in each section are intended to be contributions toward the building of a sustainable water policy in Wisconsin. Many of the suggested management tools include not only policies relating to surface water, but also to land use, urban planning and the interconnection of groundwater and surface water.

For Public Water Supply, we recommend designing a framework that requires all public supply utilities to develop an individualized conservation plan and engage in a specified number of conservation best management practices. There are several components of this recommendation:

2. Incorporate principles of Integrated Water Resources Planning, including conservation planning, into utility planning requirements:
   a. Integrate water utility planning processes with other planning efforts, particularly with comprehensive plans developed through planning commissions and with stormwater and wastewater plans.
   b. Require more comprehensive demand projections and data collection.
   c. Require development of detailed conservation plans from individual utilities.
   d. Establish guidelines for evaluating economics of potential conservation and efficiency measures.
   e. Require frequent planning and public reporting.
   f. Fund and support planning and implementation efforts.
   g. Define requirements for small suppliers.
3. In addition, we recommend that a statewide conservation and efficiency program include the following measures as required or highly recommended for public utilities, provided they are cost-effective and technically feasible.

   d. Initiate an educational or outreach program to demonstrate the benefits of conservation measures and practices to water users.

   e. Use informative billing practices.

      - Bill frequently, preferably on a monthly basis.

      - Design bills to convey information regarding the design of the rate structure, financial savings from moving to a lower tier, comparison of customers’ current usage to historical consumption or to neighbors, conservation programs available, etc.

   f. Use plumbing fixture retrofit ordinances and programs

      - Establish an ordinance requiring plumbing fixtures to be replaced upon sale or remodel.

      - Provide rebates for water-saving appliances, and develop programs that also target low-income and ICI customers.

   d. Improve distribution system efficiency.

   e. Perform annual or semi-annual water audits using the IWA / AWWA Water Audit Method.

      - Carry out water audits for large customers and provide custom incentives such as grants and rebates to customers who could reduce their consumption significantly.

      - Potentially partner with Focus on Energy to administer audits and incentive programs.

   f. Increase sub-metering of multi-family properties.

      - All new multi-unit residences should be required to provide for sub-metering of water use.

      - Offer a voluntary sub-metering retrofit to existing multi-unit residences.

   g. Adopt effective rate structures.

      - Adopt a conservation rate structure for residential customers.
- Include customer education as part of a rate structure program to heighten awareness of cost implications of excessive water consumption.

h. Evaluate feasibility of reclaiming wastewater and distributing it for reuse by large industrial customers or outdoor irrigation.

**For Private Water Supply**, we recommend several initiatives:

1. Educational programs
   
   a. Expand programs to educate private well users on proper well maintenance and water management techniques.
   
   b. Encourage use of rainwater harvesting technologies for domestic use.
   
   c. Provide industries with information, assistance, and financial incentives for reducing wastewater use through process changes, reclamation, and rainwater harvesting.
   
   d. Target outreach efforts toward the agricultural industry to promote efficient watering systems, such as drip irrigation.

2. Regulation
   
   a. Require implementation of best management practices for industry and agriculture, as appropriate. Program could be modeled on Arizona’s agricultural BMP points program, with tiered requirements based on location, size of enterprise, water loss ratios, or other criteria.
   
   b. Establish localized caps for water usage based on ecological criteria.
   
   c. Where appropriate and feasible, require water-saving technology adoption to decrease water waste.
   
   d. Improve monitoring and loss estimates for irrigated agriculture.

3. Permit pricing and permit trading
   
   a. Consider increasing well permit fees based on volume pumped.
   
   b. Evaluate the potential for enacting a regulated tradable permit system in areas where a cap on water pumping or withdrawals is feasible or necessary (i.e., in the Great Lakes Basin and Groundwater Management Areas).

**For Water Use in Power Generation**, we would encourage several steps for water conservation and efficiency improvement:

1. Encourage educational programs and energy efficiency to reduce energy demand.

2. Continue to encourage movement from open-loop cooling systems to closed-loop cooling systems to minimize large-scale water withdrawals and thermal pollution. A new
system of incentives or mandates could help support power plant conversion to the best available water-efficient technologies.

3. Evaluate technologies such as the use of reclaimed water, parallel condensing systems, and zero liquid discharge systems as potential “best available technology” language in the Clean Water Act Section 316(b).

4. Recognize the water quality issues resulting from technologies that improve water use efficiency. For example, “Recirculating cooling water (closed-loop systems) concentrate dissolved constituents in cooling water blowdown” (Wolfe, 2008) and may require post-treatment.

5. Calculate and document annual consumption of hydroelectric plant water due to evaporation of impounded surface waters.

Finally, for Land Use Considerations Related to Water Use and Efficiency, we suggest the following:

1. It is important to identify and protect sensitive land areas that will aid groundwater recharge. The integrated nature of water quantity and quality highlight the multiple benefits that can be achieved by protecting and promoting groundwater recharge in large undeveloped areas. Recommendations from multiple successful land acquisition programs throughout the country include:


   b. Land preservation for multiple uses, such as water quantity and quality protection, flood protection, species habitat conservation, recreational use and/or sustainable resource use, offer greater opportunity for public support than single use land acquisitions.

   c. Land acquisition guidelines for water quantity should give priority to land that protects groundwater recharge zones and sensitive headwater lands.

2. There are numerous ways to promote groundwater recharge in developed lands as well: decrease impervious surface area; decrease run off; increase bio-retention systems (rainwater harvesting tanks, infiltration trenches, detention basin, retention ponds). Wisconsin has a wealth of land conservation programs that could help support these water conservation and groundwater protection activities.

The state, through reports such as this and future studies, should continue to analyze how we can more responsibly use water in Wisconsin. The mandates of the Great Lakes Compact highlight the timeliness of these issues. In order to comply, the State of Wisconsin will have to act quickly and effectively. We hope this report will be beneficial in these efforts.


http://www.midwestadvocates.org/media/publications/Protecting%20Wisconsin%27s%20Waters%20Report%20MEA.pdf


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