Water Conservation Plan Guidelines, Document No. EPA-832-D-98-001

RECEIVED
2016 NOV -2 PM 1:19
OFFICE OF ADMINISTRATIVE
PROPERTY RESPONSIBILITY

U.S. Environmental Protection Agency

WATER CONSERVATION PLAN GUIDELINES

August 6, 1998

[blank page]

CONTENTS

RECEIVED
2016 NOV -2 PM 1:19
ENGINEERING SERVICES

Tables and Figures

Information for States

Worksheets

[blank page]

EXECUTIVE SUMMARY

The Safe Drinking Water Act (SDWA, 42 U.S.C. 300j-15), as amended in 1996, requires the United States Environmental Protection Agency (EPA) to publish guidelines for use by water utilities in preparing a water conservation plan. At their discretion, states may require water systems to prepare a plan consistent with the guidelines as a condition of qualifying for a loan under the Drinking Water State Revolving Loan Fund (SRF).

These Water Conservation Plan Guidelines are addressed to water system planners but use of the Guidelines is not required by federal law or regulation. States decide whether or not to require water systems to file conservation plans consistent with these or any other guidelines.

Although voluntary, the Guidelines may help bring conservation into the mainstream of water utility capital facility planning. The infrastructure needs of the nation's water systems are great. Strategic use of water conservation can help extend the value and life of infrastructure assets used in both water supply and wastewater treatment, while also extending the beneficial investment of public funds through the SRF and other programs.

This document is organized into six parts. The first part of the document introduces the Guidelines and provides information to the States about their nature and possible use. A number of topics are addressed: integrating water conservation and infrastructure planning, water conservation planning criteria, guidelines and measures, State roles, and current State programs. Also discussed is a capacity-development approach for very small systems suggesting that conservation planning and implementation assistance be provided as part of a State's capacity building efforts required by SDWA. The second part of the document, written for water systems, is an overview to the organization, content, and use of the Guidelines.

The next three parts contain the water conservation plan Guidelines: Basic, Intermediate, and Advanced.

- The Basic Guidelines are designed for use by water systems serving populations of 10,000 or fewer. Some water systems, especially those serving fewer than 3,300 people, may be included in a capacity-development approach, described above, instead of having a plan requirement. Systems should check with their state primacy agency for information and guidance about capacity development.

- The Intermediate Guidelines are designed for water systems serving between 10,000 and 100,000 people.

- The Advanced Guidelines are designed for water systems serving more than 100,000 people.

The Basic Guidelines contain five simplified planning steps. The Intermediate and Advanced Guidelines follow nine planning steps (with some variations in the scope of analysis and level

of detail requested): Specify Conservation Planning Goals, Develop Water System Profile, Prepare Demand Forecast, Describe Planned Facilities, Identify Conservation Measures, Analyze Benefits and Costs, Select Measures, Integrate Resources and Modify Forecasts, and Present Implementation and Evaluation Strategy.

A three-leveled structure is presented for water conservation measures. Level 1 contains four categories of measures that are recommended for consideration, at a minimum, in the Basic Guidelines. Additional measures and categories are added for Levels 2 and 3, and recommended for consideration in the Intermediate and Advanced Guidelines, respectively. Listed below are the three levels and the categories included in each:

Level 1 Measures
- Universal metering
- Water accounting and loss control
- Costing and pricing
- Information and education

Level 2 Measures
- Water-use audits
- Retrofits
- Pressure management
- Landscape efficiency

Level 3 Measures
- Replacements and promotions
- Reuse and recycling
- Water-use regulation
- Integrated resource management

Six appendixes to the Guidelines provide supporting information: detailed descriptions of conservation measures (Appendix A), conservation benchmarks (Appendix B), acronyms and a glossary (Appendix C), information resources (Appendix D), funding sources (Appendix E), and state contacts (Appendix F).

U.S. Environmental Protection Agency
Water Conservation Plan Guidelines

PART 1
INFORMATION FOR STATES

[blank page]

1. BACKGROUND AND INTRODUCTION

Introduction

The SDWA requires the U.S. EPA to publish water conservation plan guidelines that states may use in conjunction with their SRF programs. The law leaves implementation decisions up to the states.

The purpose of this part of the document is to introduce the Guidelines and provide information to the states about their nature and possible use. The 1996 Amendments to the Safe Drinking Water Act recognized the potential value of water conservation in infrastructure funding programs such as the Drinking Water State Revolving Fund (SRF). When water systems need to build facilities, the benefits of water conservation are greatly enhanced. Properly planned and implemented, water conservation programs can defer, reduce, or eliminate the need for not only water supply facilities but wastewater facilities, as well. Significant capital cost savings can result, which in turn translates to smaller loan amounts for SRF Programs. This frees up money in limited loan funds to finance more projects to help achieve a state's compliance and public health goals.

While the capital cost savings effects of water conservation are compelling enough, the potential benefits do not end there and also apply to customers. Water conservation extends water supplies, of course, but can also reduce utility operating costs. Energy use by customers and utilities can be reduced, which saves money and reduces greenhouse gas emissions. Reducing water withdrawals also helps improve water quality, maintain ecosystems, and protect water resources.

The SDWA Provision

The SDWA states:

> Sec. 1455. (a) Guidelines.--Not later than 2 years after the date of enactment of the Safe Drinking Water Act Amendments of 1996, the Administrator shall publish in the Federal Register guidelines for water conservation plans for public water systems serving fewer than 3,300 persons, public water systems serving between 3,300 and 10,000 persons, and public water systems serving more than 10,000 persons, taking into consideration such factors as water availability and climate.
>
> (b) Loans or Grants.--Within 1 year after publication of the guidelines under subsection (a), a State exercising primary enforcement responsibility for public water systems may require a public water system, as a condition of receiving a loan or grant from a State loan fund under section 1452, to submit with its application for such loan or grant a water conservation plan consistent with such guidelines.

This provision suggests parameters for water conservation policy in terms of the development of federal guidelines, the potential use of conservation guidelines for states in connection with the SRF, and the primacy role of the states in program implementation.

Benefits of Water Conservation

In order to meet the needs of existing and future populations and ensure that habitats and ecosystems are protected, the nation's water must be sustainable and renewable. Sound water resource management, which emphasizes careful, efficient use of water, is essential in order to achieve these objectives.

Efficient water use can have major environmental, public health, and economic benefits by helping to improve water quality, maintain aquatic ecosystems, and protect drinking water resources. As we face increasing risks to ecosystems and their biological integrity, the inextricable link between water quality and water quantity becomes more important. Water efficiency is one way of addressing water quality and quantity goals. The efficient use of water can also prevent pollution by reducing wastewater flows, recycling industrial process water, reclaiming wastewater, and using less energy.

Source: EPA Office of Water, *Statement of Principles on Efficient Water Use* (December 1992).

What is Required

The SDWA requires the U.S. EPA to publish conservation plan guidelines within two years of the Act's passage. The guidelines must take into account system size, water availability, and climate. The SDWA provides that states may require public water systems applying for SRF loans to submit a conservation plan consistent with the guidelines; there are no statutory mandates for states or municipalities in this section of the SDWA. The provision extends to SRF applicants and not to all water utilities under EPA and state primacy agency jurisdiction. Current federal SRF guidelines do not address the water conservation provision. States can choose to extend the use of the guidelines to systems other than SRF applicants.

How States May Use These Guidelines

The SDWA makes clear that using the conservation guidelines is at the discretion of the states. The states may decide whether to use the guidelines at all, whether to use the guidelines in conjunction with their SRF programs, and whether or not to tailor the guidelines to specific state needs or goals. Use of these water conservation guidelines with the SRF will necessitate consultation and coordination with federal SRF guidelines. States might also need to formulate a formal procedure for adopting the guidelines, depending on existing statutes and regulations governing the SRF and water conservation. States also can adopt the guidelines for use in other state programs in accordance with the rules governing those programs. Tribes and Territories are not states for the purposes of the SRF but can use the Guidelines to implement programs under their own laws.

An important implementation issue for states, as well as water utilities, is to define needs and goals with respect to water conservation. State goals might be defined narrowly in terms of infrastructure funding policy, or more broadly in terms of long-term water resource

management. The guidelines could be used in a wide range of contexts. Each state's goals should serve to shape the contents of water system plans and programs for implementation. States are encouraged to work with stakeholders from different regions and perspectives in formulating state water conservation goals. Public meetings and other forums are useful for this purpose.

State Policy Considerations

Water conservation must compete with other policy goals with respect to drinking water, and drinking water must compete with other community policy concerns. States should be cognizant of the implications of water conservation for environmental justice and other broad policy concerns. States should be aware of how implementation of conservation and other programs affect relevant groups and stakeholders in terms of the safety and affordability of drinking water.

Several specific areas of state policy are relevant to achieving water conservation goals. States are encouraged to closely examine state policies that might be at cross purposes with the goals of water conservation and impede beneficial conservation by community water systems.

The first area of concern is water rights. State systems for managing water rights and withdrawal permits sometimes provide that rights are lost to the extent less water is used, including where water is saved through conservation. The loss of water rights can be a significant disincentive to conserve and can undermine the achievement of the state's water efficiency goals. Recognizing that water users are less likely to conserve if future rights to use water are jeopardized, some state laws now authorize users to retain rights in the water they conserve (sometimes called the "conserved surplus") if it is put to beneficial use (for example, applied to other lands or uses, or transferred). In the absence of laws permitting such results, water systems will be forced to choose between complying with water conservation planning requirements (in which case the water right might be lost) and not complying (in which case SRF funding might be lost).

The second area of concern is economic regulatory policy. Typically regulated by state public utility commissions, investor-owned water utilities face potentially strong disincentives for conservation. The traditional model of utility regulation favors supply-side investment over demand-side investment in terms of cost recovery. Regulated utilities also might require approval to implement conservation measures, especially changes in rate design. Modern water conservation practices and these Guidelines recognize the salient role of pricing in water conservation, including the reconsideration of "promotional" rates that encourage use over conservation.

These Guidelines also recognize that conservation by customers can adversely affect the utility's financial condition because of the intrinsic relationship among sales, revenues, and profits. Regulators have tools to address these concerns if they have a clear policy basis for doing so. Clarification and coordination of state policies should include the role of the state

public utility commissions and the potential incentives for conservation that regulators could provide to investor-owned and other jurisdictional utilities.

Coordinating State Programs

Use of these Guidelines by some states might constitute the first and only state policy related to conservation planning by water systems. Many states, however, already have water conservation policies and programs in place (as discussed in Section 7 of this Part). In either case, the states should adapt the Guidelines to their needs. For the states that already have conservation programs in place, the Guidelines (or specific parts) could be used to supplement existing efforts. Similarly, states might choose to use existing requirements in lieu of all or part of these Guidelines.

Regardless of the approach taken, coordinating state programs and policies will enhance effectiveness, while avoiding redundant or excessive requirements on water systems. The intent of these Guidelines is not to have water systems prepare, nor to have states review, more than one water conservation plan for a system.

State agencies should find ways to coordinate requirements, as well as plan review and approval processes, so that water systems can comply efficiently. Similarly, water systems that prepare conservation plans to meet Bureau of Reclamation requirements could be allowed by states to use those plans to satisfy SRF planning requirements. In other words, one water conservation plan could satisfy the requirements of state primacy, resource, and revolving fund agencies, as well as those of federal agencies.

Implementing a water conservation program can be a significant challenge, including a commitment of state staff and other resources. As discussed below, some funding for technical assistance to water systems may be available through the SRF. Resource needs vary with the level of detail expected in water conservation plans and the extent of review and approval by the states. Although the resource implications of implementing a conservation program may be significant, many states have found that the investment in water conservation policy and planning yields important benefits.

Relationship to SRF

The SDWA refers specifically to the potential use of the Guidelines by the states in conjunction with the SRF. In 1997, EPA issued SRF program guidelines that do not address Section 1455 of the Act. However, several parts of the Act are relevant to the development and use of water conservation guidelines in relation to the SRF.

By suggesting that states may require SRF applicants to submit a conservation plan, Congress identified water conservation as a potential screening criterion for use in the SRF priority list process. The use of the SRF priority list process to encourage water conservation planning is at the discretion of the states.

At a state's option, water conservation plan preparation is eligible for SRF funding. States should consult current federal guidelines governing the use of SRF funds to determine whether conservation measures are eligible for funding.

These guidelines are intended to supplement, not supplant, state policies and programs in the area of water conservation, in furtherance of the broad objectives of the Safe Drinking Water Act and the SRF.

2. The Role of Water Conservation in Infrastructure Planning

Goals and Perspectives

The Water Conservation Plan Guidelines emphasize goal-oriented planning which can help water systems improve their capacity to provide safe and reliable water service, as well as to eliminate, downsize, or delay infrastructure projects.

These Guidelines are intended to help systems plan and implement effective and goal-oriented water conservation strategies. The Guidelines highlight the conservation goal of long-term reductions in capital facility costs. They provide a methodology for systems that are planning capital improvements (namely, SRF applicants) to incorporate conservation into their plans. The conservation plan can aid systems in making adjustments to planned capital improvements and demonstrating the system's commitment to efficient water supply operations.

Conservation planning can be beneficial to most water systems, not just those with an impending capital project. Even systems that consider supplies plentiful and facilities adequate find that conservation planning helps use existing resources more efficiently and save resources over the long term.

The planning approach reflected in these Guidelines is consistent with the idea of integrated resource planning (IRP), which emphasizes a balanced consideration of supply-management and demand-management options in meeting a water system's needs.[1] According to this perspective, conservation can help water systems avoid supply-side costs through cost-effective demand-side management strategies. Ideally, integrated planning combines the utility's best efforts in supply and demand management.

The benefits and costs associated with water conservation can be measured from a variety of perspectives: water suppliers, water customers, and society at large. For practical reasons, the Guidelines emphasize the perspective of the water supplier. Systems following the Advanced Guidelines are encouraged to examine conservation from other perspectives, including the broader societal viewpoint.

[1] Janice A. Beecher, "Integrated Resource Planning Fundamentals." *Journal American Water Works Association* (June 1995); Gary Fiske, *Integrated Resource Planning: A Balanced Approach* (Denver, CO: American Water Works Association, 1996).

Conservation and Infrastructure

Conservation may be viewed as a supplemental or even an alternative technology for meeting safe drinking water needs. Conservation should be implemented as part of a long-term strategy for providing safe and reliable drinking water.

Many water utilities already are experiencing the beneficial effects of efficiency through the standards in the Energy Policy Act of 1992 (see Appendix B).[2] Efficiency standards for plumbing fixtures and other conservation measures have long-lasting implications for water demand. Conservation planning can help water systems and the states recognize these effects and accelerate the pace of efficiency improvements.

One of the chief purposes of conservation is to avoid, postpone, or reduce capital costs associated with new facilities. Some hypothetical examples illustrate this point:

- The water source used by a small water utility becomes contaminated. Developing a new source would be very costly and withdrawal permits are backlogged; construction of a transmission main for purchasing wholesale water from a nearby community would be more affordable. However, available quantities of wholesale water are limited. A comprehensive conservation program could reduce water requirements to a level that would make the wholesale option feasible.

- A medium-sized water utility with a stable population base experiences "needle peaks" every summer, caused by intense lawn watering; average-day demand is well within the system's capacity. The community's older water treatment facility is being replaced with a state-of-the art facility. A public education campaign focusing on water-efficient landscaping principles, coupled with a seasonal water rate, facilitate cost-effective load management so that the new facility can be designed for optimal year-round performance.

- A large water system faces a series of capital projects throughout a regional service territory, including projects to remediate substantial water leakage that threatens both quality and quantity. Per-capita water use varies substantially throughout the area, as does the ability of consumers to afford their water bills. A comprehensive and integrated plan of supply and demand management, including conservation focused on the needs of low-income customers, allows the utility to adjust the timing and sizing of facilities and save both water and construction expenditures.

- A community's water system enjoys a reasonable margin of capacity, but its wastewater treatment system is increasingly short on capacity and faces potential violations of discharge permits. Working together, the managers of the two

[2] Amy Vickers, "The Energy Policy Act: Assessing its Impact on Utilities" *Journal American Water Works Association* (August 1993).

systems devise a long-term conservation strategy for the community that will help extend the useful life of both kinds of facilities and significantly downsize the capacity requirements of a planned wastewater treatment plant.

As the last scenario indicates, many communities may find that the potential to reduce wastewater treatment costs is among the most compelling reasons to implement water conservation. Wastewater collection and treatment, like water supply, is a rising-cost industry. Reductions in wastewater flows can save treatment costs as well as provide substantial environmental benefits in terms of reduced discharges.

Water and wastewater systems often are separately owned; even when these services are jointly provided the need for more coordinated infrastructure planning is great. Joint planning might provide opportunities for program partnerships and cost sharing. This model also can be extended to include regional partnerships and collaboration among water and wastewater utilities in order to achieve both economies of scale and efficiency. While emphasizing planning by water utilities, the Guidelines will clearly accommodate the consideration of wastewater issues and costs. Water utilities are encouraged to expand their analysis to include the wastewater perspective whenever feasible.

Planning and Funding

A major component of the reauthorized SDWA is the provision of funding to improve the nation's aging water delivery infrastructure. Conservation activities may alter the timing and sizing of new water system facilities, including source-of-supply, transmission, treatment, and storage facilities. Conservation can save water resources and financial resources used to support the cost of the water delivery system. In no case should the planning and implementation of a water conservation program be allowed to delay a project needed immediately to achieve compliance or public health goals.

In keeping with the spirit of the law and to enhance the beneficial impact of conservation on infrastructure planning, the Guidelines are crafted specifically for use in conjunction with capital funding, including the SRF. The guidelines can help SRF decision-makers make critical determinations about the system from an efficiency and conservation perspective:

- Is the water system reasonably efficient, given system size, climate, water availability and other factors?
- Is the water system expected to become more efficient over time through the implementation of conservation measures?
- Is the public's investment in the water system sound given the system's level of commitment to water conservation?

Implementation of the conservation plan might help some systems reduce or delay costs associated with the supply facility project for which SRF funding is sought. In many cases, however, conservation savings will materialize over a longer planning horizon.

Implementation Scenarios

These Guidelines allow several different state implementation scenarios. States may or may not establish conservation or planning requirements; states also may or may not require SRF applicants to provide a conservation plan. Also, state water conservation plan guidelines or planning requirements may or may not be consistent with EPA's Guidelines. The result of combining these possibilities is four different implementation scenarios.

In one scenario, a state requires conservation or planning and a conservation requirement also is included in the SRF application process. However, the SRF conservation requirement may be distinct from other requirements. In a second scenario, a state requires conservation or planning but does not require SRF applicants in particular to provide a conservation plan. Some states, for example, may believe that existing permitting, planning, or other requirements include sufficient conservation provisions. In fact, these processes may be more comprehensive than the SRF process, which covers only SRF applicants.

In a third scenario, a state does not have general planning or conservation requirements but includes conservation in the SRF application process. A state in this situation may want to use the SRF to institute a rudimentary conservation or efficiency policy. Finally, a fourth scenario suggests that a state may have neither a general conservation policy nor a specific conservation requirement in the SRF.

Another complexity is that implementation also will vary according to the correspondence, if any, between state conservation requirements (in general or as used with the SRF), and the EPA Guidelines. State conservation guidelines may be identical to the EPA Guidelines or largely different in content or scope. State guidelines may incorporate only parts of the EPA Guidelines. States may impose mandatory conservation requirements or use voluntary approaches. States may or may not use the size, climate, and water availability distinctions used in the EPA Guidelines or differentiate requirements based on these or other factors.

Many states already implement water conservation and planning requirements, although these requirements generally are implemented by state water resource agencies. Oversight of the SRF generally rests with the state drinking water primacy agencies, although some states also establish funding authorities to administer the SRF Program together with the primacy agency (an example is the Pennsylvania Infrastructure Investment Authority, or PENNVEST).

3. WATER CONSERVATION PLANNING CRITERIA

The Guidelines and System Size

The SDWA specifies three system-size categories for use in designing the guidelines, and also states that the guidelines should consider climate and water availability. These and other factors also can be used to design a framework for adapting the guidelines to state needs and purposes.

Three sets of water conservation planning guidelines are provided—Basic, Intermediate, and Advanced—based generally on system size. The three size categories specified in the Act refer to the service population of the community water system, not to customer connections or the general population (as defined by a census region or other designation).

A refinement of the SDWA-defined size categories was adopted for the purpose of developing the guidelines (see Table 1-1). The categories can be further refined according to the needs and capabilities of states and water systems. For example, states might find it appropriate to use different size categories or nonsize criteria to determine the appropriateness of the guidelines to some or all of their water systems.

Table 1-1: System Size Categories and Applicable Guidelines

System Size Category (SDWA)	Applicable Guidelines
Serves fewer than 3,300 people	Basic Guidelines or Capacity-Development Approach
Serves between 3,300 and 10,000 people	Basic Guidelines Up to 10,000 people served
Serves more than 10,000 people	Intermediate Guidelines Up to 100,000 people served
	Advanced Guidelines More than 100,000 people served

For many smaller systems (serving fewer than 3,300 people), preparing a water conservation plan is a considerable challenge. Although many small systems are capable of following the Basic Guidelines, an optional approach also is available for very small systems. The Capacity-Development Approach (see Section 5) integrates water conservation assistance (planning and implementation) with the state's general capacity-development program.

RECEIVED 2016 NOV 2 PM 1:49

Capacity development includes a variety of strategies to ensure the technical, managerial, and financial capacity of water systems. Many of the key indicators of water system capacity bear strong linkages to conservation and efficiency. States are encouraged to use a capacity-development approach to assist small systems in developing and implementing basic conservation measures in lieu of a plan requirement. States may use funds from the 10% capacity-development set-aside of their SRF allocation to provide systems with water conservation assistance if those systems have been identified in the state's capacity-development strategy.

The category of systems serving more than 10,000 persons is subdivided to better address the different needs and capabilities of medium-sized and larger systems. As discussed in the next section, the Basic, Intermediate, and Advanced Guidelines vary in terms of the conservation measures recommended for consideration in the planning process.

Any size cutoff used to prepare guidelines for planning will be arbitrary. The size categories are not meant to suggest precise distinctions or to preclude the application of the intermediate and advanced approaches to smaller systems. Many smaller systems implement a wide range of conservation measures, including measures not classified under the Basic Guidelines.

These guidelines encourage all systems to consider the fullest range of planning methods and conservation measures that is practical. States can encourage or require systems to go beyond the parameters of the Guidelines. Specifically, systems that fall into the Basic category can be asked to complete a plan under the Intermediate Guidelines; systems that fall into the Intermediate category can be asked to complete a plan under the Advanced Guidelines.

The Basic Guidelines provide water systems with simple tools for gathering information and planning.[3] The intention of the Guidelines is not to burden systems, especially very small ("micro") or resource-constrained systems, with unnecessary steps or details.[4] Rather, the Guidelines are intended to provide a straightforward means of planning and implementing generally accepted conservation practices.

The Intermediate and Advanced Guidelines introduce additional analytical tools and conservation measures to enhance water conservation planning efforts. The Intermediate approach builds substantially on the Basic approach, while also introducing additional planning concepts and conservation measures. The Advanced Guidelines take planning a step further, and depend on a sufficient level of planning and implementation resources. The Advanced Guidelines also recognize that larger utilities with more resources can develop models and methods that are appropriate to their specific needs.

[3] The Guidelines also are generally consistent with the capacity–development provisions of the SDWA that apply to small water systems.

[4] States can consider exempting severely constrained systems from planning requirements. However, even small water systems can benefit from planning and implementing certain conservation measures.

Climate, Water Availability and Other Factors

In addition to the consideration of system size, Section 1455 of the SDWA also requires the Guidelines to take into account climate and water availability. These variables have obvious relevance to water supply planning and conservation. Climate, particularly precipitation rates and temperature, affects *both* water supply and water demand. Water availability further addresses the capacity and condition of ground water and surface water supplies, which vary with climate as well as many other factors. These factors are not limited to natural or ecosystem circumstances; water availability might be affected by patterns of usage, pollution and other factors affecting water quality, and public policies concerning water management and regulation.

Climate and water availability vary *among* states and *within* states. States often are in a better position than the federal government to judge the extent to which climate and water availability should play a role in water conservation planning, and whether recommendations or requirements should vary within their jurisdictions. Thus, the Guidelines only suggest how to consider climate and water availability. States may adapt the Guidelines to their particular needs.

The Guidelines include one-page worksheets that systems can use to prepare a basic System Profile and an overview of System Conditions. The worksheet on Water System Conditions can be used to identify climate, water availability, and other relevant planning considerations. Systems also are encouraged to elaborate on other system characteristics, conditions, or factors relevant to water conservation planning.

Criteria for Adapting the Guidelines

Table 1-2 provides a number of criteria that can be used to adapt the Guidelines to the specific needs of a state or particular systems within a state; these criteria correspond to the Worksheet on System Conditions in Section 2 of the Guidelines.

Criteria classified as "other factors" can be determined by the states. These criteria might include: planning capacity and experience of systems, past water conservation achievements, size of planned capital improvements, amount of requested SRF funding.

Within each area, several specific indicators are provided. These indicators can be used to identify water systems that have particular planning needs. The Worksheet provides only a general, qualitative method of assessment (for example, low-moderate-high). These values can be substituted with numeric values at each state's discretion. *States are encouraged to develop quantified state-appropriate benchmarks for any of the indicators used.*

Table 1-2: Potential Criteria for Adapting the Guidelines

Conditions		Criteria suggesting the potential use of: Basic Guidelines ⇨	Intermediate Guidelines ⇨	Advanced Guidelines
A	**CLIMATE AND WATER AVAILABILITY**			
A1	Average precipitation	High	Moderate	Low
A2	Average temperatures	Low	Moderate	High
A3	Critical supply areas	No	At risk	Yes
A4	Competing water uses	No	Possibly	Yes
A5	Environmental constraints	No	Possibly	Yes
A6	Quality/quantity concerns	No	Possibly	Yes
A7	Seasonal variations in climate	Low	Moderate	High
A8	Instream flow problems	Low	Moderate	High
A9	Shortage or emergency frequency	Low	Moderate	High
B	**INFRASTRUCTURE CONDITIONS**			
B1	Age of the system	Newer	Middle	Older
B2	General condition of system	Good	Fair	Poor
B3	Water losses and leaks	Low	Moderate	High
B4	Unaccounted-for water	Low	Moderate	High
B5	Safe yield of supply exceeded	No	At risk	Yes
B6	Wastewater discharges exceeded	No	At risk	Yes
B7	Wastewater capacity exceeded	No	At risk	Yes
B8	Potential for recycling and reuse	Low	Moderate	High
B9	Improvement plans	Low	Moderate	High
B10	Anticipated investment	Low	Moderate	High
C	**SYSTEM DEMOGRAPHICS**			
C1	Rate of population growth per year	Low	Moderate	High
C2	Rate of demand growth per year	Low	Moderate	High
C3	Rate of economic growth per year	Low	Moderate	High
C4	Per capita water use (by class)	Low	Moderate	High
C5	Ratio of peak to average demand	Low	Moderate	High
C6	Presence of large-volume users	Low	Moderate	High
D	**OTHER FACTORS**			
D1				
D2				
D3				

[a] Specific (quantified) benchmarks for these indicators may be provided by the state, as in the following example:

Example:

B1 Age of the system Newer < 5 years Middle 5 to 15 years Older >15 years

Planning requirements can be adjusted in accordance with system conditions. For example, some states might want to require all systems in a state-designated critical water-use area to prepare plans that follow the Intermediate Guidelines at a minimum. Some states might recommend the Basic Guidelines for all systems. Other states might choose to exempt some systems from filing plans, based on specified system conditions.

No attempt is made to "weight" various criteria in terms of their importance to the water conservation planning process. However, states might want to assign special weight or consideration to certain system conditions. For example, the following characteristics tend to suggest a strong rationale for conservation planning:

- State-designated critical water or stressed areas
- Frequent droughts, supply emergencies, or safe yield problems
- Excessive water leakages or losses
- Entrance into major construction program
- Rapid growth in water demand

States might want to develop and use a simple screening method, based on these or other criteria, to adjust planning requirements to system conditions (in addition to or instead of the system-size criterion). The screening process can be used to relax planning requirements for some systems, as well as to expand or limit requirements based on system conditions.

For example, a state might expand or relax planning requirements based on one or more of the following conditions: system size (particularly with respect to very small systems), amount of loan application, volume of water withdrawals, amount of nonaccount or accounted-for water, and the state's determination of whether conservation will appreciably improve efficiency in relation to capital facility planning or funding. Some states might want to allow more time for small systems to complete their plans (as long as capital funding for priority projects is not jeopardized).

States can select screening criteria that they believe is most suited to their planning goals. States might consider state-wide water conditions in terms of whether it might be appropriate to exempt some systems from planning or to identify a minimal planning approach for all water systems.

4. GUIDELINES AND MEASURES

Planning Steps

The Guidelines follow the same essential process, although the scope and content of conservation plans will vary with the level of planning. The number and scope of conservation measures recommended for consideration increases from the Basic to the Intermediate to the Advanced Guidelines.

The Intermediate and Advanced Guidelines suggest nine basic planning steps that apply generically to water conservation planning:

1. Specify Conservation Planning Goals
2. Develop a Water System Profile
3. Prepare a Demand Forecast
4. Describe Planned Facilities
5. Identify Water Conservation Measures
6. Analyze Benefits and Costs
7. Select Conservation Measures
8. Integrate Resources and Modify Forecasts
9. Present Implementation and Evaluation Strategy

The Basic Guidelines contain five simplified steps.

Treat these steps as separate sections of a water conservation plan. Most of the steps include worksheets that can be used to simplify the planning process. Water systems also can provide additional information as needed throughout the planning process, including qualitative and quantitative data. In some cases, systems might want to substitute another format for the requisite worksheet. This generally will not present a problem, as long as the information is sufficient for later steps in the planning process. Information in several of the earlier worksheets is needed for later calculations.

The underlying logic and analytical approach are parallel for the Basic, Intermediate, and Advanced Guidelines. The methods of analysis presented in the Basic and Intermediate Guidelines are simplified to make them easier to use. A cost-effectiveness analysis is optional in the Basic Guidelines. The Advanced Guidelines encourage more sophisticated methods in forecasting and analysis. For advanced systems, more detailed approaches are provided for forecasting demand and supply capacity, analyzing the cost-effectiveness and net benefits of various conservation measures, and integrating selected measures into the utility's resource mix.

Throughout the Guidelines, system managers have opportunities to incorporate existing information (such as a demand forecast prepared for another purpose) and tailor their plans to system-specific needs and conditions. Additionally, the states may adapt the content of the Guidelines and worksheets to their needs and goals. States also might require systems to attach various kinds of supporting documentation as part of the conservation plan, including documents related to regulatory requirements.

Conservation Measures

Conservation measures are an integral part of the planning process. Like the Guidelines, measures are organized into three broad categories—Level 1, Level 2, and Level 3—each of which is further subdivided as follows:

- Level 1 Measures
  - Universal metering
  - Water accounting and loss control
  - Costing and pricing
  - Information and education

- Level 2 Measures
  - Water audits
  - Retrofits
  - Pressure management
  - Landscape efficiency

- Level 3 Measures
  - Replacements and promotions
  - Reuse and recycling
  - Water-use regulation
  - Integrated resource management

The organization of the measures is pragmatic, not prescriptive. It is *not* meant to preclude consideration of any measure by any type of water system, but rather to provide a logical framework for planning and management. Nor should this method of organizing the measures be construed as placing a higher value or priority on some measures over others. All conservation measures available now and in the future should be given due consideration based on the needs and capabilities of water systems.

Appendix A to the Guidelines provides a more detailed description of each measure recommended for consideration. The Appendixes provide additional resources for use in planning as well. States should include the complete set of Appendixes together with other appropriate supporting information with each set of Guidelines provided to water systems.

As illustrated in Table 1-3, the measures included in the Guidelines are cumulative, based very roughly on the level of knowledge and resources required for implementation. The Basic Guidelines suggest that Level 1 measures be considered *at a minimum*. These Level 1 Measures are widely—even universally—accepted by water industry professionals and regulators, not just in terms of conservation but in terms of prudent water utility management. The lists of measures contained in the Intermediate and Advanced Guidelines are also suggested to be considered at a minimum. The Intermediate Guidelines include an expanded list of Level 1 Measures plus the Level 2 Measures. The Advanced Guidelines include further expansion of the Level 1 and Level 2 Measures plus Level 3 Measures. The Level 3

Measures under the Advanced Guidelines are mostly applicable to larger systems, systems with substantial planning capability, and/or systems that have acute water conservation needs. The Level 3 Measures are particularly "proactive" in terms of the system's role in water conservation.

Together, the Guidelines and the measures recommended for consideration within them form a continuum of conservation strategies. This framework recognizes that the list of measures considered minimally appropriate will expand with the size and capability of the water utility, as well as with the conditions affecting the utility (such as climate, water availability, and other factors). In other words, conservation measures considered fundamental are not the same for very small systems as for much larger systems.

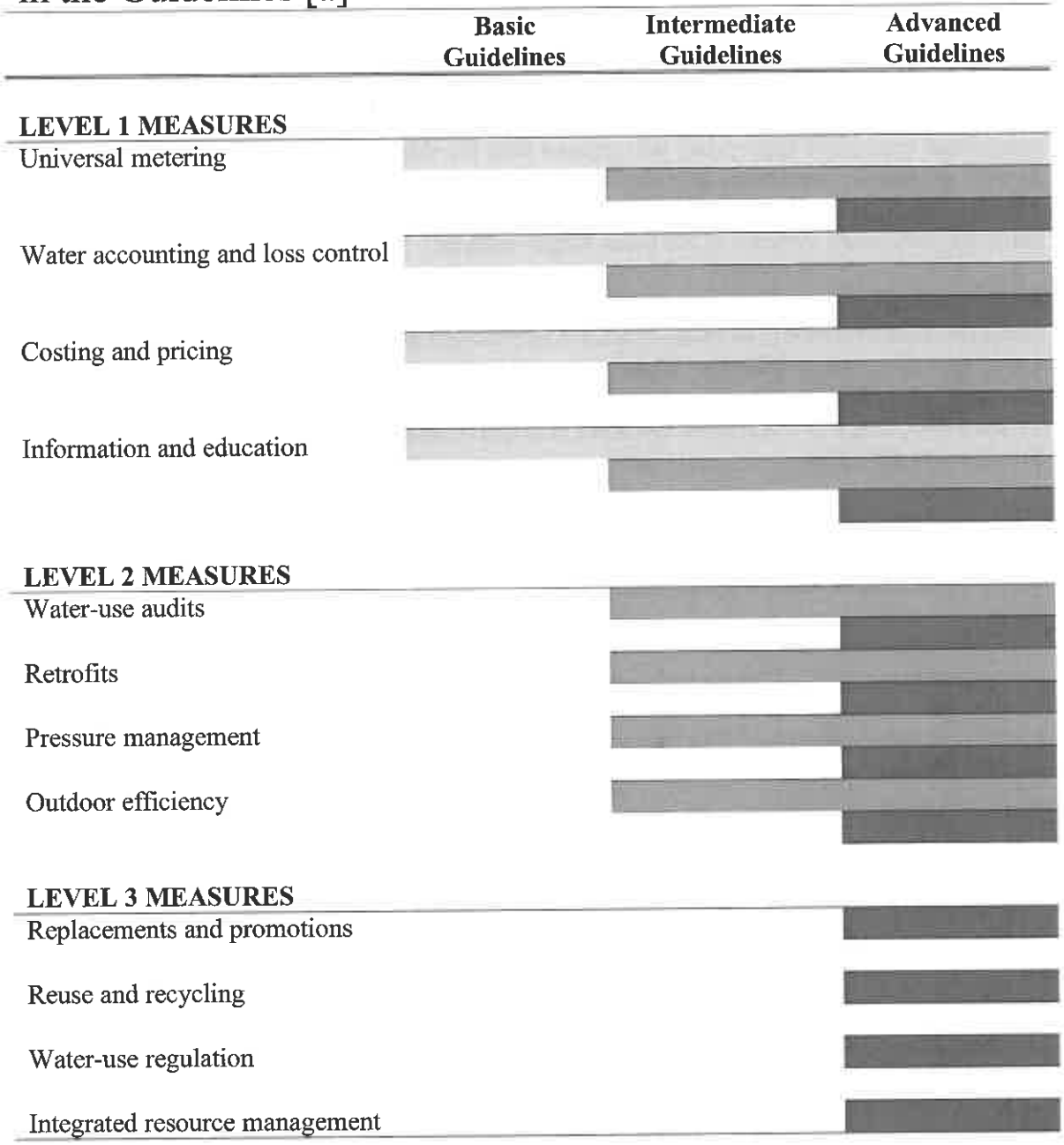
While each set of Guidelines suggests that water systems consider at least the listed measures, managers should consider as many measures as practical given their capability and the conditions they seek to address. Water systems may not necessarily implement every measure. The Guidelines suggest that systems give careful consideration to each measure; if systems choose not to implement measures considered minimally appropriate, they should provide an explanation.

As with other elements of the Guidelines, states may adapt or modify the list of conservation measures to fit their needs. States also could make some conservation measures mandatory and/or some conservation measures optional.

The categories used to organize the measures are based on current knowledge and experience in water conservation. Most specific conservation measures can be classified within this framework. Although the measures represent a broad spectrum of approaches, they are not necessarily comprehensive. The number of effective conservation measures will continue to expand. It will be important for water systems to stay current with available technologies and approaches to conservation.

RECEIVED
2016 NOV -2 PM 1:19

Table 1-3: Cumulative Nature of the Conservation Measures in the Guidelines [a]



[a] See the Guidelines and Appendix A for the specific conservation measures recommended for consideration within each of the levels and categories.

5. CAPACITY-DEVELOPMENT APPROACH

Conservation by Small Water Systems

For very small water systems, conservation planning can be accomplished in part through the state's capacity-development strategy. Strategies to improve the technical, managerial, and financial capacity of water systems are required under the SDWA. States can provide conservation planning assistance to small systems as part of their capacity-development efforts.

States should consider several factors when deciding whether to require small water systems to plan for water conservation. States can determine the appropriate approach to conservation planning for small water systems on a statewide or case-by-case basis.

Small water systems can benefit from efficiency and conservation as well as larger systems. In fact, the potential for eliminating, downsizing, or postponing capital projects through strategic supply and demand management may be *more* important for smaller systems given financial and other constraints. However, small systems face many competing challenges and their ability to devote resources to conservation *planning* may be very limited.

For systems serving under 3,300 people (approximately 1,000 connections), a Capacity-Development Approach is suggested. Use of the Guidelines could be based on each state's assessment of the needs and capabilities of their small water systems. The key component of this approach is to link conservation planning for small systems to state capacity-development strategies. Those systems identified as needing assistance could receive assistance from the state in planning and implementing a basic water conservation program as outlined below. Those small systems not identified in the state's capacity-development strategy could be required to submit a plan. The Basic Guidelines would be appropriate for those systems not being assisted by the state under the Capacity-Development Approach.

Capacity Development

Section 1420 (c) of the SDWA requires that, by August 6, 2000, in order to avoid withholding of SRF funds, states must develop and implement a strategy to assist public water systems in acquiring and maintaining technical, managerial, and financial capacity.[5]

[5] U.S. Environmental Protection Agency, *Information for the Public on Participating with States in Preparing Capacity Development Strategies* (Public Review Draft, EPA 816-D-97-003, January 8, 1998).

The three aspects of capacity have been defined in EPA Guidance as follows:[6]

- *Technical capacity* is the physical and operational ability of a water system to meet SDWA requirements. Technical capacity refers to the physical infrastructure of the water system, including the adequacy of source water and the adequacy of treatment, storage, and distribution infrastructure. It also refers to the ability of system personnel to adequately operate and maintain the system and to otherwise implement requisite technical knowledge.

- *Managerial capacity* is the ability of a water system to conduct its affairs in a manner enabling the system to achieve and maintain compliance with SDWA requirements. Managerial capacity refers to the system's institutional and administrative capabilities.

- *Financial capacity* is a water system's ability to acquire and manage sufficient financial resources to allow the system to achieve and maintain compliance with SDWA requirements.

Within the each area of capacity--technical, financial, and managerial--are several specific elements. Several basic conservation practices can be directly linked to these basic elements of capacity, as summarized in Table 1-4.

Table 1-4: Common Elements of Capacity Development and Water Conservation Planning

Type of Capacity	Elements of Capacity Development [a]	Elements of Basic Water Conservation
Technical	▪ **Source-water adequacy** ▪ **Infrastructure adequacy** ▪ **Technical knowledge and implementation**	Universal metering ▪ Source-water metering ▪ Service-connection metering and reading ▪ Meter public-use water Water accounting and loss control ▪ Account for water ▪ Repair known leaks
Managerial	▪ **Staffing and organization** ▪ **Effective external linkages** ▪ Ownership accountability	Information and education ▪ Understandable water bill ▪ Information available
Financial	▪ **Revenue sufficiency** ▪ **Fiscal management and controls** ▪ Credit worthiness	Costing and pricing ▪ Cost-of-service accounting ▪ User charges ▪ Metered rates

[a] Elements with direct relevance to water conservation appear in bold face.

[6] U.S. Environmental Protection Agency, *Guidance on Implementing the Capacity Development Provisions of the Safe Drinking Water Act Amendments of 1996* (August 6, 1998).

As these linkages suggest, the conservation measures identified as basic actually can be interpreted much more broadly. These practices are considered reasonably appropriate for all community water systems because they correspond to some of the basic elements of capacity as well.

Under the Capacity-Development Approach states encourage and assist small water systems in making a variety of conservation-oriented improvements. States should provide technical assistance to water systems to help them implement at least the basic elements of a conservation program as shown in Table 1-4. As stated previously, systems that are not capacity-limited or that are interested in a more comprehensive planning approach may use the Basic Guidelines.

The Safe Drinking Water Act provides up to a 10% set-aside from a state's SRF allotments that can be used by states to develop and implement a capacity-development strategy for water systems. States may use part of those funds to assist water systems to develop water conservation programs as part of its capacity-development efforts.

6. STATE ROLES

Policy Issues

Implementing the water conservation plan guidelines will be a challenge for the states, as well as for water systems. State implementation issues include policy; technical assistance; plan review and approval; monitoring, reporting and updates; and coordination.

If states choose to use the guidelines, a number of specific decisions or actions may be needed to place the guidelines within the context of existing state policy and/or introduce new planning requirements for water systems. Among other policy determinations, the states should:

- Clarify state goals with respect to water conservation.
- Specify the role of conservation planning in SRF and other programs.
- Determine eligibility for public funding for conservation planning.
- Identify which water systems are expected to file water conservation plans, and under what circumstances.
- Decide whether any elements of the Guidelines should be made mandatory or permissive, based on specified system profiles and conditions.
- Provide state guidance manuals and other technical assistance.
- Provide state-specific benchmarks and standards for use by water systems in preparing plans.
- Review water rights laws and other potential disincentives to water conservation.

Technical Assistance for Systems

For many states, the availability of technical assistance for water system managers determines the success of water conservation planning efforts. Obviously, greater levels of assistance require a greater resource commitment on the part of the state. States may reduce these costs by coordinating efforts with existing programs, activities, and resources, such as the Bureau of Reclamation in the western states.

Systems using the Basic Guidelines might require more technical assistance, particularly if they have never prepared a conservation plan. As previously mentioned, some funding for technical assistance may be available through the SRF, particularly for small systems in conjunction with state capacity-development programs. Systems using the Intermediate and Advanced Guidelines may require less technical assistance in order to prepare plans, but they may ask states to respond to more complex technical questions. States can provide technical assistance in a number of ways, including workshops and training sessions; manuals, workbooks, and templates; and one-on-one assistance.

Workshops and Training Sessions

Workshops and training sessions are a useful means to acquaint utilities with SDWA provisions, including SRF procedures and conservation planning. Training sessions can focus on the steps in the planning process and the methodologies used in planning (such as demand forecasting and cost-effectiveness analysis).

In addition to state-sponsored programs, states should encourage systems to take advantage of industry-based technical training opportunities. Rural water associations, university agricultural extension offices, the American Water Works Association and sections, and other organizations also offer a network of resources and expertise to aid systems in water conservation planning.

Manuals, Workbooks, and Templates

Although the Guidelines are designed to be relatively comprehensive, supplemental materials may be needed to provide background and information to make their use easier and more effective. Materials on water conservation planning are widely available in published form (see Appendix D).

States can make planning easier for systems by providing additional materials, including workbooks, templates, guidebooks, sample plans, or responses to frequently asked questions. States also can help systems with some of the estimates required in the guidelines by providing accepted estimates for certain inputs (such as projected population data for forecasting). These materials can be made available through published documents, interactive computer software, or the internet. Care should be taken that the provided materials are consistent with state-adopted guidelines.

One-On-One Assistance

Providing one-on-one assistance to water systems for conservation requires an investment of resources on the part of the state, but it can be highly effective. States can provide one-on-one assistance on site, at state offices, or through telephone calls and electronic mail. For small systems, the one-on-one approach has been used to help managers prepare a basic business plan.

A variation of the one-on-one approach is to design a hands-on workshop for smaller systems. During the course participants would actually complete the conservation plan described in the Basic Guidelines.

Review and Approval

States may take various approaches to review and approval of conservation plans. The level and nature of the review and approval process might depend on state goals related to water conservation and the role of system plans in furthering these goals. States could simply

require systems to have a plan on file, or impose a formal review and approval process. Reviewing agencies could provide feedback on water conservation plans and suggest revisions. Loans, permits, or other approvals may depend on the state's review and approval of the conservation plan.

Responsibility for plan approval generally will rest with the agency requiring the plan. In some cases, a state agency that does not otherwise implement water resource or conservation policies might adopt the planning requirement. This might be the case, for example, if the agency administering the SRF adopts the guidelines for use. In such instances, the state should set up an interagency review and approval process.

Monitoring, Reporting, and Updates

Under the Guidelines, systems describe their intentions for evaluating and updating their water conservation plans. States may impose additional monitoring and reporting requirements, including a more specific schedule for updating plans.

State monitoring may be informal or formal. A more formal approach is to audit implementation and results at some water systems. States can provide systems with feedback and technical assistance during the audit process.

States may also ask water systems to file routine reports on their progress in meeting water conservation planning goals, in which case the states should be specific about what kinds of data and what level of detail are needed to fulfill reporting requirements. This could be a simple progress report, in the form of a Worksheet, or a more detailed analysis.

The states should determine the frequency of plan updates. For example, the Guidelines suggest regular five-year intervals. The frequency of updates could vary for water systems depending on state-specified criteria: systems using the Basic Guidelines could update their plans on a three-year schedule; systems following the Intermediate Guidelines could update their plans on a two-year schedule; and systems following the Advanced Guidelines could update their plans on an annual basis. Other system characteristics or circumstances could be used as well. States could link other approvals, including future funding applications, to plan updates.

Interagency Coordination

These guidelines should enhance state water management efforts, not create unnecessary or duplicative requirements on water systems. Coordination of state requirements and programs will help ensure effective water conservation efforts on the part of utilities.

As mentioned earlier in this information document, coordination of state water conservation planning will reduce redundancy and lower planning costs. States can use a number of techniques to share information and coordinate activities among state agencies with diverse

responsibilities. One approach is to conduct a joint review and approval process which can help close information gaps and avoid confusion. A less formal approach is for agencies to hold regular meetings to exchange information about water systems' progress in meeting planning and other regulatory requirements.

Another very useful technique for promoting interagency coordination is to adopt a Memorandum of Understanding (MOU), in which signatory agencies agree on their separate and joint responsibilities for implementing requirements. An MOU between the state SRF and resource agencies, for example, could help clarify roles and responsibilities for states that require conservation planning by SRF applicants. For example, the SRF agency might need the resource agency to review plans and assist in the priority ranking prior to granting loans. Coordination also would be helpful for technical assistance and plan monitoring purposes.

7. STATE CONSERVATION PROGRAMS

Many states already implement water conservation programs. Experience with these programs provides a wealth of information from which to draw when designing state water conservation policies.

State experience with water conservation is substantial, although planning approaches and requirements vary considerably from state to state. Planning requirements across state and federal jurisdictions were analyzed using published documents and other secondary research sources. As of late 1997, eighteen jurisdictions had instituted some kind of formal conservation planning guidelines for water utilities. Table 1-5 provides an overview of water conservation planning requirements, as well as conservation-oriented requirements under the state SRF programs.

Many states have water conservation planning guidelines or other requirements embedded in existing statutes or rules. For example, conservation planning might be required in connection with obtaining a water withdrawal permit, or some types of state funding. States that have conservation requirements do not necessarily incorporate existing requirements into their SRF programs. Several states, however, specify that compliance with existing regulations, including conservation-related regulations, is a prerequisite for loan applications.

EPA selected twelve jurisdictions for more detailed study of planning guidelines and related documents:[7]

- Arizona
- California
- Connecticut
- Kansas
- Massachusetts
- Nevada
- New Jersey
- New York
- Rhode Island
- Texas
- Washington
- U.S. Bureau of Reclamation (BOR)

These states and BOR represent substantial diversity in terms of location, water resource needs and issues, and approaches to water conservation planning. The conservation guidelines in these jurisdictions were reviewed along four key dimensions:

- *Authority and agencies.* What is the basis of authority for water conservation or conservation planning? When was this authority enacted? What agencies are involved in implementing and reviewing water conservation plans?

[7] Several of these guidelines also were included in a recent study by the American Water Works Association. See American Water Works Association. *Model Guidelines for Water Conservation Plans: Guidance for State Water Conservation Plans* (WITAF Project #559). Denver: AWWA, November 1997. Prepared by Maddaus Water Management, et al.

- *Planning requirements.* What are the requirements for water conservation plans? Who must submit plans? What triggers the requirement for planning? What variations are there in the planning requirement, especially in terms of utility size and water availability?
- *Format and content.* What issues are required or recommended for consideration in the plan? Are specific goals addressed in the plan? Does the plan provide a description and data for the water system? Is the plan required to analyze future needs and emergency management? What specific conservation measures are included in the plan?
- *Implementation and evaluation.* How will the plan be implemented? Are revisions and updates required? How are the plans enforced and can penalties be imposed? Is there a means to evaluate the plans?

A key finding of the review is that water conservation planning varies considerably among the jurisdictions. Conservation planning also is a relatively recent phenomenon in these states, in most cases less than ten years old. In these states, authority for conservation planning tends to be vested in the state water resource agency. Water conservation planning can either be a general requirement or triggered by a permit application. Only three of these states specifically require planning for a state revolving fund loan.

The states also address system size very differently in planning requirements. In five of the states, all water providers are included in the requirements; in the other states, certain size thresholds trigger plan submission. States use different units when considering system size, such as water volume or number of customers. Only three of the states (Kansas, Texas, and Washington) significantly vary their water conservation planning requirements according to system size.

State planning requirements differ most in terms of the format and content of plans. Most guidelines and statutes require or recommend that plans include a description of the service area and supply systems; quantification of past, current, and future water use and supply; emergency or contingency planning; and an implementation schedule. However, the importance placed on these items varies.

All of the states and the BOR suggest that plans discuss particular water conservation measures, although specific requirements vary. The conservation measures most frequently mentioned in the statutes and guidelines are:

- Metering and meter repair,
- Leak detection and repair,
- Rate design and conservation pricing,
- Plumbing retrofits and promotion of water-saving fixtures,
- Public information and education, and
- Landscaping.

Table 1-6 provides a summary of components of conservation planning in terms of whether these and other measures are suggested for consideration, must be addressed in the plan, or are required. All planning guidelines surveyed, however, require that utilities address public education, leak detection and repair, metering, and pricing.

Most of the state water conservation planning guidelines and associated statutes mention the need for an implementation schedule and revisions or updates. Connecticut provides a detailed form for this purpose. Most states that require revisions or updates specify five-year intervals.

Enforcement and penalties are not highly developed in most jurisdictions. A few states have the authority to levy fines for failure to submit or implement a conservation plan. However, most do not have rigorous enforcement procedures. Evaluation procedures also vary considerably; Massachusetts and the BOR mention the need for evaluation, while California specifies a relatively comprehensive approach.

In sum, flexibility in the planning process is suggested by many of the existing approaches. In particular, most jurisdictions seem to exercise discretion in terms of evaluating plans based on size, water availability, and other water system characteristics. However, the diversity of state experience in this area provided a wealth of information from which to draw in crafting these Guidelines. Also, attention to existing state and federal approaches help ensure that the federal Guidelines are complementary to these ongoing efforts.

Table 1-5: State Conservation Planning and SRF Activities (as of Fall 1997)

States or Agencies	States with Planning Guidelines	States with Planning Guidelines			Conservation Criteria in SRF	Nature of Conservation Criteria in SRF
		Guidelines by Water System Size	Guidelines by Water Availability/ Conditions	Planning as an SRF Requirement or Prerequisite		
Alabama	No	*Not applicable*			None planned	*Not applicable*
Alaska	No	*Not applicable*			None planned	*Not applicable*
Arizona	Yes	No	No	No	Considered elsewhere	*Not applicable*
Arkansas	No	*Not applicable*			None planned	*Not applicable*
California	Yes	No	No	No	None planned	*Not applicable*
Colorado	Yes	No	No	Yes	Yes	Ranking and planning
Connecticut	Yes	No	Generally	Yes	Yes	Ranking criterion
Delaware	No	*Not applicable*			Yes	Bonus points
Florida	Yes	No	No	No	None planned	*Not applicable*
Georgia	Yes	No	No	Yes	Yes	Planning compliance a prerequisite
Hawaii	No	*Not applicable*			None planned	*Not applicable*
Idaho	No	*Not applicable*			Yes	Planning compliance a prerequisite
Illinois	No	*Not applicable*			None planned	*Not applicable*
Indiana	No	*Not applicable*			Yes	Ranking criterion likely
Iowa	No	*Not applicable*			Yes	Plan required (SRF specific)
Kansas	Yes	Yes	No	Yes	Yes	Plan required
Kentucky	Yes	No	No	Yes	Yes	Plan required
Louisiana	No	*Not applicable*			None planned	*Not applicable*
Maine	No	*Not applicable*			None planned	*Not applicable*
Maryland	No	*Not applicable*			None planned	*Not applicable*
Massachusetts	Yes	No	No	Yes	Yes	Planning requirement likely
Michigan	No	*Not applicable*			None planned	*Not applicable*
Minnesota	Yes	No	No	Yes	Yes	Planning requirement likely
Mississippi	No	*Not applicable*			Yes	Planning compliance a prerequisite

Table 1-5 (continued)

States or Agencies	States with Planning Guidelines	States with Planning Guidelines			Conservation Criteria in SRF	Nature of Conservation Criteria in SRF
		Guidelines by Water System Size	Guidelines by Water Availability/ Conditions	Planning as an SRF Requirement or Prerequisite		
Missouri	No	*Not applicable*			None planned	*Not applicable*
Montana	No	*Not applicable*			Yes	Ranking criteria
Nebraska	No	*Not applicable*			None planned	*Not applicable*
Nevada	Yes	No	Generally	No	No	*Not applicable*
New Hampshire	No	*Not applicable*			Yes	Bonus points
New Jersey	Yes	Yes	No	No	Considered elsewhere	*Not applicable*
New Mexico	No	*Not applicable*			Possible	*Not applicable*
New York	Yes	No	No	No	Yes	Bonus points
North Carolina	No	*Not applicable*			None planned	*Not applicable*
North Dakota	No	*Not applicable*			Yes	Ranking criteria
Ohio	No	*Not applicable*			Yes	Bonus points
Oklahoma	No	*Not applicable*			None planned	*Not applicable*
Oregon	Recommended	No	No	No	Considered elsewhere	*Not applicable*
Pennsylvania	No	*Not applicable*			Not quantified	*Not applicable*
Rhode Island	Yes	No	No	No	Considered elsewhere	*Not applicable*
South Carolina	No	*Not applicable*			None planned	*Not applicable*
South Dakota	No	*Not applicable*			None planned	*Not applicable*
Tennessee	No	*Not applicable*			None planned	*Not applicable*
Texas	Yes	No (SRF)	Generally	Yes	Yes	Plan required
Utah	Recommended	No	No	Yes	Yes	Planning compliance a prerequisite
Vermont	No	*Not applicable*			None planned	*Not applicable*
Virginia	No	*Not applicable*			None planned	*Not applicable*
Washington	Yes	Yes	Generally	Yes	Yes	Plan required
West Virginia	No	*Not applicable*			Yes	Planning compliance a prerequisite
Wisconsin	No	*Not applicable*			Yes	Bonus points likely
Wyoming	*Not applicable*					
BuRec	Yes	No	No	No	*Not applicable*	
Delaware RBC	Yes	No	No	No	*Not applicable*	

Table 1-6: Components of State Water Conservation Plan Guidelines (as of Fall 1997)

	Pricing and Rates	Metering	Audits	Leak Repair	Retrofitting	Land-scaping	Reuse	Public education	Pressure Control	Other
Arizona	*Goal-oriented planning--specific measures are not required*									
California	P	P	P	P	P	P		P		
Colorado	P			P	P	P	P	P		
Connecticut	S	S	S	S	R		S	R	S	S
Florida	S	S		S	S	S	S	S		S
Georgia	P	P		P	P		P	P		
Kansas	P	P		P	P	P	P	P	P	
Kentucky		R		R						
Massachusetts	S	S		S				S		
Minnesota	R	P	P	P	P			R	P	
Nevada	R	R	S	R	R	R	R	R	R	
New Jersey	R	R		R	P		P	P		
New York	S	S	S	S	S	S		S		
Oregon*	P	P	P	P	P	P	P	P		
Rhode Island	R	R	R	R	R			R		
Texas	P	P	P	P	S	S	S	P	S	S
Utah*	S	S		S	S	S	S			
Washington	P	R		P	P	P	P	R		
Bureau of Reclamation	S	S	S	S	S	S	S	S		S
Delaware River Basin	P	P		P	P					

Key:
S = suggested consideration
P = plan must address
R = program or measures are required
* Water conservation plans are recommended, not required except under specified circumstances.

[blank page]

U.S. Environmental Protection Agency
Water Conservation Plan Guidelines

PART 2
OVERVIEW OF THE GUIDELINES

[blank page]

1. WATER CONSERVATION GUIDELINES AND THE SDWA

Section 1455 of the Safe Drinking Water Act (SDWA) requires the U.S. Environmental Protection Agency to publish these guidelines:

> Sec. 1455. (a) Guidelines.—Not later than 2 years after the date of enactment of the Safe Drinking Water Act Amendments of 1996, the Administrator shall publish in the Federal Register guidelines for water conservation plans for public water systems serving fewer than 3,300 persons, public water systems serving between 3,300 and 10,000 persons, and public water systems serving more than 10,000 persons, taking into consideration such factors as water availability and climate.
>
> (b) Loans or Grants.—Within 1 year after publication of the guidelines under subsection (a), a State exercising primary enforcement responsibility for public water systems may require a public water system, as a condition of receiving a loan or grant from a State loan fund under section 1452, to submit with its application for such loan or grant a water conservation plan consistent with such guidelines.

The guidelines are addressed to *water system managers.* Use of the guidelines is *not* required by federal law or regulation; however, water systems can benefit from conservation planning, whether or not it is required by law. It is up to each State to decide whether or not to require water systems to file conservation plans consistent with these or any other guidelines. *It is very important that water system managers understand and comply with their own state, regional, or local regulatory requirements.*

2. Benefits of Conservation and Planning

Water conservation consists of *any beneficial reduction in water losses, waste, or use.* In the context of utility planning, the term "beneficial" usually means that the benefits of an activity outweigh the costs. Conserving water can be beneficial in many ways, but one important reason for conservation is that it can help systems avoid, downsize, or postpone water and wastewater projects. The facilities used to treat and deliver drinking water (and to collect and treat wastewater) are sized to meet demand; if the level of demand is inflated by wasteful use, people pay more in both capital and operating costs than necessary to provide safe and adequate water supply and wastewater services. Moreover, when the cost of supplying drinking water and processing wastewater is reduced, financial resources can be used to meet other needs.

In connection with infrastructure funding, the value of conservation is appropriately assessed in terms of supply, treatment, and distribution costs that can be *avoided* because of planned reductions in water demand. Conservation becomes more valuable over time because future water supplies and the facilities needed to deliver them are expected to cost more (even when adjusting for inflation). In other words, permanent conservation savings that are realized today will have increasing value into the future.

Benefits of Water Conservation

In order to meet the needs of existing and future populations and ensure that habitats and ecosystems are protected, the nation's water must be sustainable and renewable. Sound water resource management, which emphasizes careful, efficient use of water, is essential in order to achieve these objectives.

Efficient water use can have major environmental, public health, and economic benefits by helping to improve water quality, maintain aquatic ecosystems, and protect drinking water resources. As we face increasing risks to ecosystems and their biological integrity, the inextricable link between water quality and water quantity becomes more important. Water efficiency is one way of addressing water quality and quantity goals. The efficient use of water can also prevent pollution by reducing wastewater flows, recycling industrial process water, reclaiming wastewater, and using less energy.

Source: EPA Office of Water, *Statement of Principles on Efficient Water Use* (December 1992).

Planning is a means of anticipating the future and organizing activities in response. Conservation planning can help water system managers take inventory of their existing efforts and identify new opportunities. Planning can help utilities manage competing goals and rising costs, such as those associated with SDWA compliance, infrastructure improvement, and meeting demand growth. The investment that water system managers make in conservation planning should yield savings that can be measured in terms of water and dollars.

The planning approach suggested by these Guidelines is designed to be accessible and relatively inexpensive. It is very important for utilities to know exactly what planning requirements apply in their states and how other plans already prepared by the system might be used in conjunction with these Guidelines.

3. Overview of the Planning Process

These Guidelines provide a framework that water managers can use to assess the cost-effectiveness of conservation, as well as the value of conservation in avoiding, lowering, or postponing supply-side capital and operating costs.

Table 2-1: System Size Categories and Type of Guidelines

System Size Category (SDWA)	Applicable Guidelines
Serves fewer than 3,300 people	Basic Guidelines or Capacity-Development Approach [a]
Serves between 3,300 and 10,000 people	Basic Guidelines Up to 10,000 people served
Serves more than 10,000 people	Intermediate Guidelines Up to 100,000 people served
	Advanced Guidelines More than 100,000 people served

[a] States also can promote water conservation planning by small water systems through their capacity-development strategies. Some states may provide assistance to small systems in the planning and implementation of water conservation programs through their capacity-development strategies.

EPA has prepared three sets of Guidelines (as summarized in Table 2-1):

- The Basic Guidelines are designed for use by water systems serving populations of 10,000 or fewer. Some water systems, especially those serving fewer than 3,300 people, may be included in a Capacity-Development Approach, which addresses water conservation through state capacity-development strategies required by the SDWA. (See Section 5 of Part 1.) Systems should check with their state primacy agency for information and guidance about capacity development.

- The Intermediate Guidelines are designed for water systems serving between 10,000 and 100,000 people.

- The Advanced Guidelines are designed for water systems serving more than 100,000 people.

Which Guidelines are appropriate also may depend on various factors and conditions affecting water systems and their need for conservation planning. For example, smaller systems with constrained water supply resources may want to follow the Intermediate Guidelines. *Water system managers should check with their own state's rules, regulations, and recommendations about which Guidelines to follow.*

Each of the Guidelines follows a similar framework for the planning process; however, the Basic, Intermediate, and Advanced Guidelines vary in terms of the scope of the analysis and the amount of detail required when preparing a conservation plan. The Basic Guidelines provide a very simplified planning approach. The Intermediate and Advanced Guidelines lead to a comprehensive conservation plan, as outlined in Table 2-2. The outline may be adapted to better meet system needs and state requirements.

Many of the worksheets refer to gallons as the unit for measuring water quantity. However, water systems should use the unit of measurement that they typically use for planning, reporting, and other purposes. Water systems also should use available information resources (such as current demand forecasts) whenever feasible in order to expedite preparation of the conservation plan and avoid duplication of other efforts.

The Guidelines also focus on the benefits of conservation for water systems. It may be appropriate for many systems to expand the analysis to include wastewater systems, particularly in the assessment of benefits and costs. Conservation can help communities reduce the cost of wastewater facilities, as well as water facilities, and the Guidelines can provide a framework for making this assessment.

One important distinction among the Guidelines is the number of conservation measures recommended for consideration by managers. The Guidelines reflect a cumulative approach to conservation measures, which are organized into three levels (see Tables 1-3 and 2-3). Each level includes additional categories of measures. For example, the Intermediate Guidelines include more measures than the Basic Guidelines and the Advanced Guidelines include more measures than the Intermediate Guidelines. This framework recognizes the general continuum of conservation measures available to water systems with different needs and capabilities.

This organization of measures should not be interpreted to place a higher value on some measures over others. Water system managers and planners are strongly encouraged to consider the full range of conservation measures, which are described in Appendix A.

Table 2-2: Contents of a Comprehensive Water Conservation Plan

1. SPECIFY CONSERVATION PLANNING GOALS
   - ☐ List of conservation planning goals and their relationship to supply-side planning
   - ☐ Description of community involvement in the goals-development process

2. DEVELOP A WATER SYSTEM PROFILE
   - ☐ Inventory of existing facilities, production characteristics, and water use
   - ☐ Overview of conditions that might affect the water system and conservation planning

3. PREPARE A DEMAND FORECAST
   - ☐ Forecast of anticipated water demand for future time periods
   - ☐ Adjustments to demand based on known and measurable factors
   - ☐ Discussion of uncertainties and "what if" (sensitivity) analysis

4. DESCRIBE PLANNED FACILITIES
   - ☐ Improvements planned for the water system over a reasonable planning horizon
   - ☐ Estimates of the total, annualized, and unit cost (per gallon) of planned supply-side improvements and additions
   - ☐ Preliminary forecast of total installed water capacity over the planning period based on anticipated improvements and additions

5. IDENTIFY WATER CONSERVATION MEASURES
   - ☐ Review of conservation measures that have been implemented or that are planned for implementation
   - ☐ Discussion of legal or other barriers to implementing recommended measures
   - ☐ Identification of measures for further analysis

6. ANALYZE BENEFITS AND COSTS
   - ☐ Estimate of total implementation costs and anticipated water savings
   - ☐ Cost effectiveness assessment for recommended conservation measures
   - ☐ Comparison of implementation costs to avoided supply-side costs

7. SELECT CONSERVATION MEASURES
   - ☐ Selection criteria for choosing conservation measures
   - ☐ Identification of selected measures
   - ☐ Explanation for why recommended measures will not be implemented
   - ☐ Strategy and timetable for implementing conservation measures

8. INTEGRATE RESOURCES AND MODIFY FORECASTS
   - ☐ Modification of water demand and supply capacity forecasts to reflect anticipated effects of conservation
   - ☐ Discussion of the effects of conservation on planned water purchases, improvements, and additions
   - ☐ Discussion of the effects of planned conservation measures on water utility revenues

9. PRESENT IMPLEMENTATION AND EVALUATION STRATEGY
   - ☐ Approaches for implementing and evaluating the conservation plan
   - ☐ Certification of the conservation plan by the system's governing body

RECEIVED
2016 NOV -2 PM 1:16
PUBLIC UTILITIES COMMISSION
FILED

Table 2-3: Guidelines and Associated Conservation Measures [a]

Measures	← Basic Guidelines →	← Intermediate Guidelines →	← Advanced Guidelines →
LEVEL 1 MEASURES			
Universal metering [B]	▪ Source-water metering ▪ Service-connection metering and reading ▪ Meter public-use water	▪ Fixed-interval meter reading ▪ Meter-accuracy analysis	▪ Test, calibrate, repair, and replace meters
Water accounting and loss control [A]	▪ Account for water ▪ Repair known leaks	▪ Analyze nonaccount water ▪ Water system audit ▪ Leak detection and repair strategy ▪ Automated sensors/ telemetry	▪ Loss-prevention program
Costing and pricing [B]	▪ Cost-of-service accounting ▪ User charges ▪ Metered rates	▪ Cost analysis ▪ Nonpromotional rates	▪ Advanced pricing methods
Information and education [B]	▪ Understandable water bill ▪ Information available	▪ Informative water bill ▪ Water-bill inserts ▪ School program ▪ Public-education program	▪ Workshops ▪ Advisory committee
LEVEL 2 MEASURES			
Water-use audits [B]		▪ Audits of large-volume users ▪ Large-landscape audits	▪ Selective end-use audits
Retrofits [A]		▪ Retrofit kits available	▪ Distribution of retrofit kits ▪ Targeted programs
Pressure management [A]		▪ Systemwide pressure management	▪ Selective use of pressure-reducing valves
Landscape efficiency [P]		▪ Promotion of landscape efficiency ▪ Selective irrigation submetering	▪ Landscape planning and renovation ▪ Irrigation management
LEVEL 3 MEASURES			
Replacements and promotions [B]			▪ Rebates and incentives (nonresidential) ▪ Rebates and incentives (residential) ▪ Promotion of new technologies
Reuse and recycling [B]			▪ Industrial applications ▪ Large-volume irrigation applications ▪ Selective residential applications
Water-use regulation [B]			▪ Water-use standards and regulations ▪ Requirements for new developments
Integrated resource management [B]			▪ Supply-side technologies ▪ Demand-side technologies

[a] See Appendix A for a description of the measures. Water systems should consider *at least* the measures listed under the guidelines applying to them.

[A] measure affects average-day demand

[P] measure affects maximum-day (peak) demand)

[B] measure affects both average and peak demand

U.S. Environmental Protection Agency
Water Conservation Plan Guidelines

PART 3
BASIC GUIDELINES FOR PREPARING WATER CONSERVATION PLANS

These Basic Guidelines are designed for use by water systems serving populations of 10,000 or fewer. Some water systems, especially those serving fewer than 3,300 people, may be included in a Capacity-Development Approach, which addresses water conservation through state capacity-development strategies required by the SDWA. (See Section 5 of Part 1.) Systems should check with their state primacy agency for information and guidance about capacity development.

Which Guidelines are appropriate also may depend on various factors and conditions affecting water systems and their need for conservation planning. For example, smaller systems with constrained water supply resources may want to follow the Intermediate Guidelines. *Water system managers should check with their own state's rules, regulations, and recommendations about which Guidelines to follow.*

1. Specify Conservation Planning Goals

Planning Goals

Specify conservation planning goals in terms of expected benefits for the water system and its customers. Involve affected members of the community in the development of conservation planning goals and throughout the implementation process.

Planning goals can be developed from different perspectives. These Guidelines emphasize a water supplier perspective. Lowering water demand can help water suppliers avoid, downsize or postpone the construction and operation of supply-side facilities.

Customers and society at large also benefit from conservation. Conservation benefits society by preserving environmental resources. Conservation can benefit customers by lowering energy and long-term water costs. Water conservation reduces demands on wastewater systems; in fact, the need to reduce wastewater treatment costs can be a strong rationale for water conservation. The Guidelines and the worksheets can be used to simultaneously address the potential effects of conservation on water and wastewater operations.

Water systems should state their goals in specific terms. Measurable goals are useful for evaluation purposes. For example, many water systems identify a specific water-use reduction goal (as a percentage of current water usage). Water conservation planning goals may include:

- Eliminating, downsizing, or postponing the need for capital projects.
- Improving the utilization and extending the life of existing facilities.
- Lowering variable operating costs.
- Avoiding new source development costs.
- Improving drought or emergency preparedness.
- Educating customers about the value of water.
- Improving reliability and margins of safe and dependable yields.
- Protecting and preserving environmental resources.

Managers should revisit the goals section before finalizing the conservation plan and periodically thereafter, because goals and the means to achieve them will evolve. As the water system accomplishes certain conservation goals, new objectives may emerge.

Community Involvement

The process of developing goals should involve community representation. Modern resource planning emphasizes an open process that gives all affected groups an opportunity to express their interests and concerns. Involving the community in goal development and implementation also serves an important public education function, and can greatly enhance

the success of conservation programs. Members of the community who might be interested in water conservation include:

- Residential water consumers
- Commercial water consumers
- Industrial water consumers
- Wholesale customers
- Environmental groups
- Civil rights groups
- Indian tribes
- Labor groups
- Business and commerce groups
- Recreational water users
- Agricultural users
- Educational institutions
- Government agencies

In addition to helping the water system specify planning goals, community participants also may have an ongoing role in a system's conservation program. Ongoing involvement helps maintain and build support for achieving conservation goals and "getting the word out" about the conservation effort. Participants can act as a focus group for exploring specific conservation measures (discussed in Section 4), and also can provide valuable linkages to key groups—consumers, businesses, and institutions—involved in implementing certain conservation measures. Participants also can offer input on the level of satisfaction with the system's programs. Finally, community groups can assist the water system in monitoring results and adjusting program implementation.

For many water systems, involving the community in water system planning will be a new experience. Community involvement does not have to consume excessive time or resources. Even a few "town hall" meetings or "brainstorming" sessions can be helpful. Most system managers will find that involving members of the community in developing goals, implementing programs, and evaluating results is a very worthwhile investment. Fortunately, guidance on this approach is available.[1]

[1] See *Public Involvement Strategies: A Manager's Handbook* (Denver, CO: American Water Works Association Research Foundation, 1996).

2. DEVELOP A WATER SYSTEM PROFILE

Developing a system profile by taking inventory of existing resources and conditions helps systems assess their present circumstances and design strategies to meet emerging needs. Most systems should maintain the information necessary for building a profile. Much information may already have been compiled for a facility plan or for other purposes.

Summarize the service and operating characteristics of the water system. Provide an overview of conditions and a description of climate, water availability, or other factors that might affect water conservation planning.

Systems can use Worksheet 3-1 to compile and present a system profile. The profile may be expanded to include additional information, for example, data on trends for some characteristics (such as supply and demand measures) that help describe the system. The first part of the worksheet lists system characteristics.

The second part of the worksheet provides an overview of conditions that might affect the conservation planning effort. This checklist can be used to review conditions affecting the supply or demand for water, focusing on conditions that most affect your system. The conditions outlined in the worksheet suggest the need for water conservation planning. While all water systems can benefit from efficiency improvements, water conservation is especially beneficial for systems experiencing water shortages or rapid increases in demand.

For some conditions, states might provide benchmark measures that water systems can use for comparison purposes. For example, a state might have specific criteria for defining critical use or stressed areas, for classifying per-capita water use, or for identifying the age of systems. Systems should try to compare significant conditions using generally accepted measures.

The last part of the worksheet is provided so that water systems can describe their current water conservation activities and programs.

Worksheet 3-1: Water System Profile

SUMMARIZE SYSTEM CHARACTERISTICS

A	SERVICE CHARACTERISTICS	Number
1	Estimated service population	
2	Estimated service area (square miles)	

B	ANNUAL WATER SUPPLY	Annual volume	Percent metered
3	Total annual water supply		%

C	SERVICE CONNECTIONS	Connections	Percent metered
4	Residential, single-family		%
5	Other		%
6	Total connections		%

C	WATER DEMAND	Annual volume	Percent of total	Per connection
7	Metered residential sales			
8	Metered nonresidential sales			
9	Other metered sales			
10	Unmetered sales			
11	Nonaccount water [a]			
12	Total system demand (total use)			

D	AVERAGE & PEAK DEMAND	Volume	Total supply capacity	Percent of total capacity
13	Average-day demand			%
14	Maximum-day demand			%

F	PRICING	Rate structure [b]	Metering schedule [c]	Billing schedule [c]
15	Residential rate			
16	Nonresidential rate			
17	Other rate			

G	PLANNING	Prepared a plan ☑☐	Date	Filed with state ☑☐
18	Capital, facility, or supply plan			
19	Drought or emergency plan			
20	Water conservation plan			

(Worksheet continues)

Worksheet 3-1 (continued)

SUMMARIZE SYSTEM CONDITIONS

H	PLANNING QUESTIONS	Yes	No	Comment
21	Is the system in a designated critical water supply area?			
22	Does the system experience frequency shortages or supply emergencies?			
23	Does the system have substantial unaccounted-for and lost water?			
24	Is the system experiencing a high rate of population and/or demand growth?			
25	Is the system planning substantial improvements or additions?			

SUMMARIZE CURRENT CONSERVATION ACTIVITIES

Water conservation measures	*Approximate* annual water savings [if known]	Implemented since (date)	Is continued implementation planned?

[a] Nonaccount water is water not metered and sold to customers (including authorized and unauthorized uses). See Appendix A, figure A-7 and Worksheet A-2.
[b] Uniform, increasing-block, decreasing-block, seasonal, or other.
[c] Quarterly, monthly, or other.

3. PREPARE A DEMAND FORECAST

Forecasting water use (or demand) can range from simple projections based on anticipated population growth to complex models. Forecasts can be made for the water system as a whole; however, forecasts are more accurate when they are prepared for separate classifications of water use.

Prepare a forecast of anticipated water demand for selected time periods. To the extent practical, the planner should take into account variations in demand based on type of water usage, as well as perform a "what if" (sensitivity) analysis.

Prepare forecasts for five-year and ten-year time points. Additional time points can be used as well. The longer the planning horizon, the greater will be the uncertainty of the forecast. Forecasts should be revisited and updated on a regular basis.

The demand forecast should recognize the effects of conservation measures already implemented. However, for the purposes of this conservation plan, anticipated demand effects from measures contemplated in the plan should not be included.

This section of the plan is optional if the population served by the water system is not growing at a rate of more than 2 percent per year (or another population-growth benchmark specified by the state). Additionally, it is not necessary for systems to prepare a separate forecast for the purposes of this plan if a forecast has already been prepared for the system within the suggested time frame. Managers should include the results of such forecasts in this plan.

Worksheet 3-2 provides a simple water demand forecasting methodology based on population. This method is reasonable for water systems that have little variation within their service populations (such as systems that serve only single-family residential customers in comparable housing) and stable water-use characteristics. The method calculates per capita water use and multiplies the result by projected population levels. Projected water use is compared to system capacity to calculate the anticipated surplus or shortage. Any adjustments to the forecasts for known and measurable factors that might affect demand should be explained. Worksheet 3-2 also provides a method for estimating average-day and maximum-day demand.

An alternative to calculating water use on a per-capita basis is to calculate water use on a per-connection (or per-household) basis. (Managers often use the median number of persons per household to make conversions.) For forecasting purposes, per-connection water use is multiplied by the number of current and projected connections (such as residential households). It may be easier to project households based on land-use planning data and construction estimates.

Care should be taken in using the per-capita or per-connection approach to forecasting, particularly if the service population is varied. Separate forecasts should be prepared for large-volume water users (such as a large industrial plant). When one large-volume user begins, changes, or terminates service from a relatively small utility, the effects can be felt throughout the utility's operations. Plant managers can be consulted about projected water needs for the industrial sector.

The per-capita and per-connection methods of forecasting have limitations. They assume that water use is essentially a function of population or changes in the number of connections and that usage patterns will not change with time. For example, customers are not expected to install water-saving fixtures or respond to future changes in rates. For this reason, managers should include a brief assessment of factors that could affect the level or pattern of demand in their service territory.

Worksheet 3-2: Water Demand Forecast [a]

Line	Item	Current Year	5-Year Forecast	10-Year Forecast
A	**TOTAL ANNUAL WATER DEMAND**			
1	Current total annual water demand (from Worksheet 3-1) [a]			
2	Current population served [b]			
3	Total water demand per capita (line 1 divided by line 2) [b]			
4	Projected population [b]			
5	Projected total annual water demand (line 3 multiplied by line 4)			
6	Adjustments to forecast (+ or -) [c]			
7	Adjusted total annual water demand (line 5 plus line 6)			
8	Current annual demand (line 1) and adjusted annual water demand forecast (line 7 for forecast years)			
9	Current and projected annual supply capacity (from Worksheet 3-1) [d]			
10	Difference between total annual water demand and total annual supply capacity (+ or -) (subtract line 8 from line 9)			
B	**AVERAGE-DAY AND MAXIMUM-DAY DEMAND**			
11	Current and forecast average-day demand (line 8 divided by 365)			
12	Current maximum-day demand (from Worksheet 3-1)			
13	Maximum-day to average-day demand ratio (line 12 divided by line 11)			
14	Projected maximum-day demand (line 13 multiplied by line 11 for all forecast years)			
15	Adjustment to maximum-day demand forecast [c]			
16	Current (line 12) and adjusted maximum-day demand forecast (add lines 14 and 15)			
17	Daily supply capacity (line 9 divided by 365)			
18	Ratio of maximum-day demand to daily supply capacity (line 16 divided by line 17)			

[a] Separate forecasts should be prepared for large-volume users, as well as for nonaccount water (water not billed to customers) if nonaccount water is a significant amount (such as more than 10 percent of total production).

[b] Managers can use connections instead of population and per-connection water use instead of per-capita water use.

[c] Please explain adjustments to your forecast (lines 6 and 15), including effects of installed conservation measures and rate changes.

[d] Supply capacity should take into account available supplies (permits), treatment capacity, or distribution system capacity and reflect the practical total supply capacity of the system, including purchased water.

RECEIVED 2016 MAR -2 PM 1:49

4. IDENTIFY AND EVALUATE CONSERVATION MEASURES

Conservation Measures

Identify the conservation measures that have been implemented, are planned, or are not planned. Provide an explanation for why recommended measures are not planned for the water system. For each measure chosen, estimate total implementation costs (dollars) and anticipated water savings (volume) and assess the cost effectiveness of the measure.

Water systems have a wide selection of specific conservation measures at their disposal. These measures include both supply-side and demand-side management techniques for saving water, and range from relatively simple educational tools to advanced water-efficient technologies. Use of any particular measure depends on whether it meets cost-effectiveness and other planning criteria and whether its use complies with applicable laws and regulations, including state and local plumbing codes.

The conservation measures identified in Table 2-3 of the Overview are organized into three levels: Level 1, Level 2, and Level 3. Each level includes four categories of measures. Specific water conservation measures are identified within each category. The number of specific measures included in each level expands from the Basic to the Intermediate and from the Intermediate to the Advanced Guidelines. In other words, the measures are cumulative. *Appendix A provides additional information and several worksheets on the conservation measures.*

All water systems, regardless of their size or the conditions under which they operate, should consider the very fundamental and widely accepted practices identified under Level 1. The measures in Levels 2 and 3 generally are considered appropriate for systems with significant conservation needs and interests. Managers are encouraged to explore the full range of potential conservation measures for their systems. Many systems will find it beneficial to expand their conservation programs beyond the minimum set of measures.

Review of Measures

The minimum list of measures recommended for consideration appears in Worksheet 3-4. Systems should use the checklist to review and summarize the measures that are currently implemented, planned, or not planned at this time. Managers also can identify additional measures and practices as they develop their conservation plans

Measures should be selected on the basis of how well they can help the system achieve water savings, program costs, and other factors that are important to the water system. The planning document should discuss the criteria used in selecting the conservation measures and provide a summary of the results in terms of the measures planned for actual implementation.

The first step in the selection process is to identify criteria for evaluating the conservation measures. The cost-effectiveness of the measures is one criterion, but other factors should be considered as well. Managers are free to consider as many selection criteria as they believe are appropriate, but the relevance of the criteria should be explained in the conservation plan. The criteria that can be used in selecting conservation measures for implementation may include:

- Program costs
- Cost-effectiveness
- Ease of implementation
- Budgetary considerations
- Staff resources and capability
- Environmental impacts
- Ratepayer impacts
- Environmental and social justice
- Water rights and permits
- Legal issues or constraints
- Regulatory approvals
- Public acceptance
- Timeliness of savings
- Consistency with other programs

For each selection criterion, managers should identify whether, how, and why the factor affects the feasibility of implementing one or more conservation measures. Some factors might be more important than others. Planners also may want to bear in mind that techniques can be used to mitigate adverse effects and improve acceptance of measures. A cost-effective conservation measure should not be dismissed without careful consideration of how barriers to implementation might be overcome.

Budget

Developing a budget for each conservation measure is an invaluable part of the planning process. A simplified *cost-effectiveness* analysis can also be used to compare alternative conservation measures in terms of dollars per gallon of water saved. For example, one measure might produce savings at the rate of $.25/1,000 gallons while another produces savings at a cost of $.50/1,000 gallons.

Worksheet 3-3 should be completed for *each* planned conservation measure. In some cases, managers may want to combine measures based on the conservation program they envision. *All interrelated measures that are expected to result in an identifiable amount of water savings should be combined and treated as one measure in order to avoid counting the planned water savings more than once in the analysis.*

Worksheet 3-3 begins with an open-ended description of the measure. The anticipated life span for the measure should be indicated. Managers also should indicate whether the measure is targeted toward reduction in average-day demand, maximum-day demand, or both. A method for summing the total budget needed for implementing the measure is provided. All costs associated with implementation should be included. Managers should ascertain reasonable cost estimates by potential vendors whenever possible. Several different types of costs as indicated on the worksheet should be analyzed. When estimating costs, a realistic

implementation schedule should be considered. Any special circumstances affecting the schedule or cost of implementing the proposed measures should be discussed in the plan.

Worksheet 3-3 also includes a method for estimating annual water savings and total life-span savings that can be achieved by the measures. For each measure, the method used to calculate anticipated water savings should be provided. This might include, for example, a formula for converting daily per capita savings to annual savings. In some cases (such as a leakage control program), it might not be feasible to estimate savings for each unit, in which case total annual savings for the entire measure are sufficient. Cost per gallon of water saved can be used to compare conservation measures and to compare conservation to supply-side options.

If a system chooses not to implement any of the minimum measures, a complete explanation should be provided in the plan. If perceived costs and benefits are among the reasons for rejecting a measure a supporting analysis should be provided. This analysis can be based on a comparison of implementation costs to the system's average annual cost of production (or revenue requirements). Planners can consult the Intermediate Guidelines for more information about benefit-cost and cost-effectiveness analysis.

Conservation measures that affect the demand side of the water system have the effect of reducing water sales and utility revenues usually are a function of the quantity of water sold and the rate charge (per unit of water sold). Because revenue sufficiency plays an important role in ensuring the capacity of the water system, managers should consider conservation effects on revenues. The conservation plan should briefly address how planned conservation measures will affect water utility revenues (based on reduction in sales) and discuss strategies for addressing these revenue effects.

Summary

The plan should summarize and describe in general terms the range of conservation measures planned for implementation and the anticipated benefits, including effects on planned capital facility projects (if applicable). Measures planned for implementation can include Level 2 and Level 3 measures. The plan should discuss whether conservation can help the system avoid, downsize, or defer capital expenditures. The Intermediate Guidelines also provide some guidance on this issue.

The process of selecting measures can be summarized in Worksheet 3-4. For each recommended measure, managers should indicate whether the measure was selected for implementation. Managers also should identify the primary reason or reasons for selecting or rejecting the measure. Special conditions or actions that are required before a selected measure can be implemented (such as an approval from regulators) should be noted. In some cases, managers may conclude that a measure (or measures) cannot be implemented because of a constraint that exists in the short term. Conservation measures that might be planned for future implementation, once constraints are resolved, should be discussed in the plan.

Worksheet 3-3: Budget and Savings for Each Conservation Measure

Describe planned conservation measure:

_____

_____

_____

_____

Typical water savings from the measure: _____ per _____
Number of planned installations: _____
Anticipated life span for the measure: _____ years

The measure is designed to reduce:

- ❒ Average-day demand
- ❒ Maximum-day demand
- ❒ Both average-day and maximum-day demand

Line	Item	Amount	Amount
A	**BUDGET FOR EACH MEASURE [a]**	**Per unit [b]**	**Total cost of the measure**
1	Materials	$	$
2	Labor		
3	Rebates or other payments		
4	Marketing and advertising		
5	Administration		
6	Consulting or contracting		
7	Other		
8	Total program cost for the life of the measure (add lines 1 through 7) [c]		$
B	**TOTAL SAVINGS**		
9	Number of units to be installed [d]		
10	Anticipated annual water savings per unit in gallons [e]		
11	Total annual savings for the measure in gallons (multiply line 9 by line 10)		
12	Expected life span for the measure in years		
13	Total life span savings for the measure in gallons (multiply line 11 by line 12)		
14	Cost per gallon of water saved (divide line 8 by line 13)		$ /gallon

[a] A separate analysis should be performed for each conservation measure, but measures can be combined if they jointly produce water savings.

[b] Examples of a unit are a toilet, a retrofit kit, and an audit. A unit estimate may not be appropriate for each measure, in which case total program water savings and costs for the measure can be used.

[c] Include all recurring operation and maintenance costs over the life of the measure.

[d] Units can be individual product units (such as toilets) or groups of products (such as household retrofits), as long as the analysis is consistent. Leave blank if unit values do not apply.

[e] For example, water savings per retrofit. See Appendix B for benchmarks and sample calculations. Leave blank if unit values do not apply.

Worksheet 3-4: Selection of Conservation Measures

Line	Measure	Already implemented ☑	Plan to implement ☑	Primary criteria for selecting or rejecting the conservation measure for implementation [a]
Universal metering [B]				
1	Source-water metering			
2	Service-connection metering			
3	Meter public-use water			
Water accounting and loss control [A]				
4	Account for water			
5	Repair known leaks			
Costing and pricing [B]				
6	Cost-of-service accounting			
7	User charges			
8	Metered rates			
Information and education [B]				
9	Understandable water bill			
10	Information available			
Other Measures [b]				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20…				

[a] This space may also be used to note special issues related to this measure, including legal or obstacles to its use that preclude further consideration.

[b] See Appendix A for additional information on water conservation measures.

[A] = measure affects average-day demand

[P] = measure affects maximum-day (peak) demand)

[B] = measure affects average and peak demand

5. Present Implementation Strategy

In this final step in the conservation planning process, the water system specifies its strategy and timetable for implementation. It can be emphasized, however, that conservation planning will require an *ongoing* effort on the part of water utility managers. Ongoing planning and implementation will go hand in hand.

Present a strategy and timetable for implementing and assessing conservation measures and other elements of the conservation plan.

In the implementation strategy, managers should make note of any specific factors or contingencies that might affect or prevent the implementation of specific measures. For example, if a measure cannot be implemented prior to obtaining a special permit or other authority, this fact should be noted along with an explanation of the strategy for obtaining the necessary authority. Some measures might require implementation actions that take place over several years (in order to sustain conservation savings). The plan should provide sufficient detail to understand the utility's strategy with regard to implementing such measures.

Worksheet 3-5 is a simple template for summarizing the water system's implementation and evaluation strategy for the conservation plan. A plan for public involvement should discuss how and when the water system intends to involve members of the community in the development and implementation of the conservation plan. Systems may want to plan regular communications (meetings and mailings) with community groups to keep them informed of the system's progress in meeting goals.

A plan for monitoring and evaluation should address data collection, modeling, and other issues that will be important in tracking the effects of water conservation on demand over time. The system may want to collect new kinds of data for monitoring purposes as well as for future forecasting needs. Many systems might find, for example, that more detailed data on demand by customer class are needed, including more detail on contributions to average-day and maximum-day demands. More detailed data might also be needed to assess trends in nonaccount water.

A plan for updates and revisions will help keep the system's conservation plan current over time and account for the system's actual experience with conservation. Updating forecasts of water demand and supply capacity as new data become available is especially important. In some cases, the system might want to revise or expand its planning goals. Many systems update plans every five years. However, changing conditions or other concerns might justify more frequent updates. The schedule of updates and revisions might be affected by state or local requirements for conservation planning by the water system.

The conservation planning document also should include a record of the plan's adoption by the water system's governing body (such as a Board of Directors or City Council), as appropriate.

Worksheet 3-5: Implementation Strategy

A. PUBLIC INVOLVEMENT

Describe plan for public involvement:

B. MONITORING AND EVALUATION

Describe plan for monitoring and evaluation:

Describe plan to collect water demand data:

C. PLAN UPDATES

Describe plan for updates and revisions:

D. ADOPTION OF THE PLAN

Date plan completed:
Date plan approved:
Approved by [governing body]:
Signature:

[blank page]

U.S. Environmental Protection Agency
Water Conservation Plan Guidelines

PART 4
INTERMEDIATE GUIDELINES FOR PREPARING WATER CONSERVATION PLANS

These Intermediate Guidelines are designed for water systems serving between 10,000 and 100,000 people. Which Guidelines are appropriate may depend on various factors and conditions affecting water systems and their need for conservation planning. For example, mid-sized systems with constrained water supply resources may want to follow the Advanced Guidelines. *Water system managers should check with their own state's rules, regulations, and recommendations about which Guidelines to follow.*

1. SPECIFY CONSERVATION PLANNING GOALS

Planning Goals

Specify conservation planning goals in terms of anticipated benefits for the water system and its customers. To the extent practical, involve affected members of the community in the development of conservation planning goals and throughout the implementation process.

Planning goals can be developed from different perspectives. These planning Guidelines, including the analysis of the benefits and costs of conservation activities, emphasize a water supplier perspective. The value of conservation is defined primarily in terms of avoided supply-side costs to the water system. Lowering the level of water demand can help water suppliers avoid, downsize, or postpone the construction and operation of costly supply-side facilities.

The benefits of conservation also can be understood from the perspectives of customers, as well as society at large. Conservation benefits society by preserving environmental resources. Conservation can benefit customers by lowering energy and long-term water costs. Water conservation reduces demands on wastewater systems; in fact, the need to reduce wastewater treatment costs can be a strong rationale for water conservation. The Guidelines and the worksheets can be used to simultaneously address the potential effects of conservation on water and wastewater operations.

Conservation planning goals can take many forms. Water systems should state their goals in specific terms. Measurable goals are useful for evaluation purposes. For example, many water systems identify a specific water-use reduction goal (as a percentage of current water usage).

Water conservation planning goals may include:

- Eliminating, downsizing, or postponing the need for capital projects.
- Improving the utilization and extending the life of existing facilities.
- Lowering variable operating costs.
- Avoiding new source development costs.
- Improving drought or emergency preparedness.
- Educating customers about the value of water.
- Improving reliability and margins of safe and dependable yields.
- Protecting and preserving environmental resources.

Planners should plan on revisiting the goals section before finalizing the conservation plan and periodically thereafter, because goals and the means to achieving them will evolve. As the water system accomplishes certain conservation goals, new objectives may come into focus.

Community Involvement

The process of developing goals can involve representatives of various groups in the community (or stakeholders) who may be concerned about a water system and its future. Modern resource planning (such as integrated resource planning) emphasizes an open process that involves all affected groups so that they can have an opportunity to express their interests and concerns.

Involving the community in goal development also serves an important public education function. Moreover, it is widely believed that involving the community in developing goals, as well as in the implementation process, can greatly enhance the success of conservation programs.

Members of the community who might be interested in water conservation include:

- Residential water consumers
- Commercial water consumers
- Industrial water consumers
- Wholesale customers
- Environmental groups
- Civil rights groups
- Indian tribes
- Labor groups
- Business and commerce groups
- Recreational water users
- Agricultural users
- Educational institutions
- Government agencies

In addition to helping the water system specify planning goals, community participants also can have an ongoing role in a system's conservation program. Ongoing involvement can help maintain and build support for achieving conservation goals and "get the word out" about the conservation effort. Participants can act as a focus group for exploring specific conservation measures (discussed in Section 4). Participants also can provide valuable linkages to key groups—consumers, businesses, and institutions—who might be involved in implementing certain conservation measures. Participants also can provide input on the level of satisfaction or dissatisfaction with the system's programs. Finally, community groups can assist the water system in monitoring results and adjusting program implementation.

For many water systems, involving the community in water-system planning will be a new experience. However, most system managers will find that involving members of the community in developing goals, implementing programs, and evaluating results is a very worthwhile investment. Fortunately, guidance on this approach is available.[1]

[1] See *Public Involvement Strategies: A Manager's Handbook* (Denver, CO: American Water Works Association Research Foundation, 1996).

2. DEVELOP A WATER SYSTEM PROFILE

System Profile

Summarize the service and operating characteristics of the water system. Provide an overview of conditions and a description of climate, water availability, or other factors that might affect water conservation planning.

Taking inventory of existing resources and conditions is an important step in the planning process. A water system profile can help systems assess their present circumstances and design strategies to meet emerging needs.

Most water systems should maintain the data and information necessary for building a system profile. Much information may already have been compiled for a facility plan or for other purposes. Worksheet 4-1 profiles a relatively simple summary table that systems can use to compile and present key system characteristics. The system profile can be expanded to include additional information. For example, systems may want to present data on trends for some characteristics (such as supply and demand measures). Systems should include in their profile additional characteristics or details considered relevant for understanding the nature of the system.

System Conditions

Worksheet 4-2 provides a very simple overview of planning conditions that might affect the water system and its conservation planning effort. This checklist can be used to make a general review of conditions affecting the supply or the demand for water. For planning purposes, it is important to identify and focus on the conditions that most affect a particular system.

The conditions outlined in the worksheet suggest the need for water conservation planning. While all water systems can benefit from efficiency improvements, water conservation can be especially beneficial for systems experiencing water shortages or rapid increases in demand. For example, water systems facing one or more of the following conditions are strongly urged to consider the fullest range of conservation measures available to them in accordance with these guidelines:

- Systems in state-designated critical water or stressed areas
- Systems experiencing frequent droughts, emergencies, or safe yield problems
- Systems with excessive unaccounted-for water or water losses
- Systems entering into major construction cycles
- Systems anticipating rapid growth in water demand

For some conditions, states might provide benchmark measures that water systems can use for comparison purposes. For example, a state might have specific criteria for defining critical

use or stressed areas, for classifying per-capita water use, or for identifying the age of systems. When practical, systems should try to compare significant conditions using generally accepted measures.

In addition to the summary worksheet, planners also should prepare a brief written discussion of the significant conditions affecting their systems. Particular attention can be paid to climate and water availability, but other factors affecting the system can be considered as well. This information can be used to help systems identify problems and opportunities throughout the planning process.

Current Conservation Efforts

Worksheet 4-3 is provided so that water systems can describe their current water conservation activities and programs. For each conservation measure implemented, planners can indicate the approximate annual water savings achieved, when implementation for the measure began, and whether continued implementation is planned. Any other pertinent information on current efforts and their effectiveness can be provided in the plan as well.

Worksheet 4-1: Water System Profile

A	SERVICE CHARACTERISTICS	Number
1	Estimated service population	
2	Estimated service area (square miles)	
3	Miles of mains	
4	Number of treatment plants	
5	Number of separate water systems	
6	Interconnection with other systems	

B	ANNUAL WATER SUPPLY	Annual volume	Number of intakes or source points	Percent metered
7	Groundwater			%
8	Surface water			%
9	Purchases: raw			%
10	Purchases: treated			%
11	Total annual water supply			%

C	SERVICE CONNECTIONS	Connections	Water sales	Percent metered
12	Residential, single-family			%
13	Residential, multi-family			%
14	Commercial			%
15	Industrial			%
16	Public or governmental			%
17	Wholesale			%
18	Other			%
19	Total connections			%

D	WATER DEMAND	Annual volume	Percent of total	Per connection
20	Residential sales			
21	Nonresidential sales			
22	Wholesale sales			
23	Other sales			
24	Nonaccount water: authorized uses			
25	Nonaccount water: unauthorized uses			
26	Total system demand (total use)			

E	AVERAGE & PEAK DEMAND	Volume	Total supply capacity	Percent of total capacity
27	Average-day demand			%
28	Maximum-day demand			%
29	Maximum-hour demand			%

F	PRICING	Rate structure	Metering frequency	Billing frequency
30	Residential rate			
31	Nonresidential rate			
32	Other rate			

G	PLANNING	Prepared a plan ☑☐	Date	Filed with state ☑☐
33	Capital, facility, or supply plan			
34	Drought or emergency plan			
35	Water conservation plan			

Worksheet 4-2: Overview of System Conditions [a]

Line	Conditions	Increasing need for conservation→→→ Check applicable description ☑						Don't know ☑
A	**CLIMATE AND WATER AVAILABILITY**							
1	Average precipitation	High	☐	Moderate	☐	Low	☐	☐
2	Average temperatures	Low	☐	Moderate	☐	High	☐	☐
3	Critical supply areas	No	☐	At risk	☐	Yes	☐	☐
4	Competing water uses	No	☐	Possibly	☐	Yes	☐	☐
5	Environmental constraints	No	☐	Possibly	☐	Yes	☐	☐
6	Quality/quantity concerns	No	☐	Possibly	☐	Yes	☐	☐
7	Seasonal variations in climate	Low	☐	Moderate	☐	High	☐	☐
8	Instream flow problems	Low	☐	Moderate	☐	High	☐	☐
9	Shortage or emergency frequency	Low	☐	Moderate	☐	High	☐	☐
B	**INFRASTRUCTURE CONDITIONS**							
10	Age of the system	Newer	☐	Middle	☐	Older	☐	☐
11	General condition of system	Good	☐	Fair	☐	Poor	☐	☐
12	Water losses and leaks	Low	☐	Moderate	☐	High	☐	☐
13	Unaccounted-for water	Low	☐	Moderate	☐	High	☐	☐
14	Safe yield of supply exceeded	No	☐	At risk	☐	Yes	☐	☐
15	Wastewater discharges exceeded	No	☐	At risk	☐	Yes	☐	☐
16	Wastewater capacity exceeded	No	☐	At risk	☐	Yes	☐	☐
17	Potential for recycling and reuse	Low	☐	Moderate	☐	High	☐	☐
18	Improvement plans	Low	☐	Moderate	☐	High	☐	☐
19	Anticipated investment	Low	☐	Moderate	☐	High	☐	☐
C	**SYSTEM DEMOGRAPHICS**							
20	Rate of population growth per year	Low	☐	Moderate	☐	High	☐	☐
21	Rate of demand growth per year	Low	☐	Moderate	☐	High	☐	☐
22	Rate of economic growth per year	Low	☐	Moderate	☐	High	☐	☐
23	Per capita water use (by class)	Low	☐	Moderate	☐	High	☐	☐
24	Ratio of peak to average demand	Low	☐	Moderate	☐	High	☐	☐
25	Presence of large-volume users	Low	☐	Moderate	☐	High	☐	☐
D	**OTHER FACTORS**							
26								☐
27								☐
28								☐

[a] Specific (quantified) benchmarks for these indicators may be provided by the state.

Worksheet 4-3: Current Water Conservation Activities

Summarize the system's current water conservation activities/programs:

Water conservation measures	*Approximate* annual water savings [if known]	Implemented since (date)	Is continued implementation planned?

3. PREPARE A DEMAND FORECAST

Demand Forecasting

Prepare a forecast of anticipated water demand for selected time periods. To the extent practical, the planner should take into account variations in demand based on type of water usage, as well as perform a "what if" (sensitivity) analysis.

Forecasting water use (or water demand) is a critical part of the planning process. Forecasts can range from simple projections based on anticipated growth in the population to complex models using several variables to explain variations in water use. Forecasts can be made for a water system as a whole; however, forecasts are considered more accurate when they are prepared for separate classifications of water use or sectors.

The Guidelines suggest that planners prepare forecasts for five-year, ten-year, and twenty-year intervals. Additional time points can be used as well. The longer the planning horizon, the greater will be the uncertainty of the forecast. Forecasts should be revisited and updated on a regular basis.

The forecast should recognize the effects of conservation measures already implemented. The forecast also should recognize the demand effects of plumbing efficiency standards established under the 1992 Energy Policy Act (see Appendix B, Tables B-5 and B-6).[2] New construction and renovations will not contribute as much to total demand as in the past; systems that are not experiencing growth might detect declines in demand due to these effects. For the purposes of this conservation plan, anticipated demand effects from measures contemplated in the plan should not be included. A revision to the demand forecast based on implementing the planned conservation measures is made in Section 8 (Worksheet 4-12).

It is not necessary for systems to prepare a separate forecast for the purposes of this plan if a forecast has already been prepared for the system within a reasonable time frame. Planners should include the results of their forecasts in this plan.

Forecasting Method

Systems following the Intermediate Guidelines should use, at a minimum, the forecasting technique provided in Worksheet 4-4. This approach separates (at a minimum) residential and nonresidential customers. The forecast can be made on a per-capita or per-connection basis. However, for the nonresidential sector, planners should use employees, jobs, or another appropriate explanatory variable.

[2] A method for estimating the demand effect of efficient fixtures can be found in Amy Vickers, "The Energy Policy Act: Assessing its Impact on Utilities." *Journal American Water Works Association* (August 1993): 56-62.

The water demand forecast can be refined by considering customer classifications. For example, the nonresidential class can be subdivided into the commercial and industrial classes (as well as wholesale water customers). A separate forecast also should be prepared for nonaccount water, or water that does not produce revenues for the system. Nonaccount water includes authorized uses of water, as well as losses and leaks. (Worksheet A-2 in Appendix A can be helpful in understanding nonaccount water and water losses). Planners also should estimate average-day and maximum-day demand over the planning horizon. As discussed in Section 4, different types of supply-side facilities are designed to meet water demands (peak or average), and various conservation measures target different types of demand.

Each of the forecasts should be subjected to a basic "what if" analysis to address potentially important changes in the level or pattern of water demand. The forecasts should take into account and the plan should explain any known, planned, or measurable changes that will affect demand, *with the exception of the conservation measures contemplated in these guidelines.* Adjustments to the forecast based on expected savings from conservation will be made in Section 8 (Worksheet 4-12).

This method of forecasting also is very simple and limited. While it takes into account variation in water-use by customer class, the method also assumes that unit use (use per person, household, place of business, and so on) does not vary over time.

Worksheet 4-4: Preliminary Water Demand Forecast [a]

Line	Item	Current year	5-year forecast	10-year forecast	20-year forecast
A	**RESIDENTIAL DEMAND**				
1	Current annual water residential sales (total gallons)				
2	Current population served [b]				
3	Residential sales per capita (line 1 divided by line 2) [b]				
4	Projected population [b]				
5	Projected annual residential water demand (line 3 multiplied by line 4)				
B	**NONRESIDENTIAL DEMAND [C]**				
6	Current annual water nonresidential sales (total gallons)				
7	Current number of employees or jobs [c]				
8	Water use per employee or job (line 6 divided by line 7)				
9	Projected number of employees or jobs				
10	Projected annual nonresidential water demand (line 8 multiplied by line 9)				
C	**NONACCOUNT WATER (WATER NOT SOLD TO CUSTOMERS)**				
11	Current and forecast amount [d]				
D	**WATER SYSTEM TOTAL DEMAND**				
12	Current total annual water demand (add lines 1, 6, and 11)				
13	Projected total annual water demand (add lines 5, 10, and 11)				
14	Adjustments to forecast (+ or -)				
15	Current (line 12) and adjusted total annual water demand forecast (add lines 13 and 14) [e]				
16	Current and projected annual supply capacity [f]				
17	Difference between total use and total supply capacity (+ or -) (subtract line 12 from line 15)				
E	**AVERAGE-DAY AND MAXIMUM-DAY DEMAND**				
18	Average-day demand (line 15 divided by 365)				
19	Current maximum-day demand				
20	Maximum-day to average-day demand ratio (line 20 divided by line 19)				
21	Projected maximum-day demand (line 18 multiplied by line 20 for all forecast years)				
22	Adjustment to maximum-day demand forecast [e]				
23	Current (line 19) and adjusted maximum-day demand forecast (add lines 21 and 22)				
24	Daily supply capacity (divide line 16 by 365)				
25	Ratio of maximum-day demand to daily supply capacity (divide line 23 by line 24)				

[a] Separate forecasts should be prepared for large-volume users.

[b] Planners can chose to use service connections or households instead of population and per-connection water use instead of per-capita water use.

[c] Explanatory variables other than employees or jobs can be used as appropriate. The forecast should be disaggregated by sector of water use to the greatest extent possible (for example, commercial and industrial water use and nonaccount water) and a qualitative sensitivity analysis ("what if") should be performed for each sector's forecast.

[d] Please provide an explanation of the forecast of nonaccount water, including all relevant assumptions.

[e] Please provide an explanation of adjustments to your forecasts, including all relevant assumptions.

[f] Supply capacity should take into account available supplies (permits), treatment capacity, and distribution system capacity and reflect the practical total supply capacity of the system, including purchased water.

4. DESCRIBE PLANNED FACILITIES

Supply Forecasting

Describe improvements planned for the water system over a reasonable planning horizon, identify the types of improvements proposed, and estimate the total, annual, and unit cost of the improvements. Prepare a preliminary forecast of installed capacity.

In this part of the conservation plan, planners are asked to prepare an estimate of supply costs based on meeting the level of water demand specified in the unadjusted demand forecast (that is, unadjusted for additional conservation). This is a critical part of the analysis because it establishes the anticipated cost of *supply-side* improvements and additions and this cost estimate will be used to represent the value of conservation or *demand-side* activities.

Because the benefits of conservation extend into the future it is important to take a forward-looking approach to supply costs. The concept of marginal or incremental cost captures the idea that the "true" value of a supply resource can be measured in terms of the cost of the next increment of supply. If only high-cost supplies are available, the marginal or incremental cost will be high. For many communities, future increments of supply will be very costly. The value of a conserved amount of water at a future point in time will be equivalent to the most costly supply option available at that future time point, because that is the supply option being displaced by conservation.

Cost Analysis

A reasonable accounting of anticipated supply costs is needed in order to compare the cost of supply-side measures to the cost of demand-side or conservation measures (on a cost-per-gallon basis). Planners should choose an appropriate time horizon; a twenty-year or other suitable period can be used. The choice of time frame should be consistent with the demand forecast (Section 3), as well as the other planning considerations.

Planners should begin by preparing an estimate of major improvements and additions that will be required over the planning horizon in order to meet anticipated demand (including a safe reserve margin). Detailed cost estimates may be available from facility plans or other planning documents. Worksheet 4-5 can be used to summarize improvements and additions, which are disaggregated into three categories: source of supply, transmission and treatment, and distribution. (Additional categories can be used as needed.)

Planners should consider all capital facility improvements and additions. Improvements include renovations and expansions needed to maintain or enhance safety or reliability within existing facilities. Additions consist of new facilities. Routine maintenance improvements should not be included. Anticipated water purchases and costs also should be recorded on Worksheet 4-5. For this part of the analysis, the effects of conservation measures currently

being implemented should be considered, but the effects of new conservation measures on the need for supply capacity or water purchases should be excluded. (These effects are addressed in Section 8.)

If no capital improvements and additions are planned, "0" values can be entered and the estimate of supply costs can be based on operating costs (including the cost of energy, chemicals, and purchased water).

Estimating Incremental Supply Costs

Worksheet 4-6 provides a method for placing a value on supply-side improvements and additions. Improvements and additions are separated into categories: source of supply, water treatment facilities, treated water storage, and major transmission lines. Water purchases are separately recorded. Capital costs over the useful life of the anticipated projects (including financing costs) are *annualized* and reported on a per-gallon basis. Financing costs can be incorporated into the calculation of annualized cost by using the expected interest rate for financing the project(s) or the system's overall cost of capital.

Added to the annualized capital cost forecast is the variable operating cost-per-gallon of production for existing and planned facilities, including costs associated with energy, chemicals, and existing and new water purchases. The resulting estimates of total annual incremental costs by type of facility (peak and average) can be used by planners to arrive at a simple estimate of incremental supply costs, which can later be compared to the unit cost of implementing conservation measures.

Supply-side facilities are designed to meet different types of water demand (as summarized in Table 4-1); similarly, different conservation measures affect different types of water demand. Planners should identify, as reasonably possible, the extent to which improvements and additions are needed to meet average and/or peak demand.

Capital-cost reductions associated with conservation will depend on the extent to which supply-side facilities can be eliminated, postponed, or downsized. The effect of conservation on the need for facilities will depend on the demand pattern of the individual utility, as well as its construction cycle (that is, the timing of facilities currently under development). Conservation can be particularly beneficial for systems that have a sufficient planning horizon to integrate conservation with conventional resource options. In some cases, capital costs cannot be avoided but conservation can still yield savings in operating expenditures. A degree of analyst judgment is required in order to evaluate incremental costs and to integrate supply-side and demand-side resources.

Table 4-1: Relationship of Water Demand to Supply Facilities

Type of Water Demand	Type of Water Supply Facility
Average-day	Source of supply facilities, including raw water storage facilities (such as reservoirs)
Maximum-day (peak)	Water treatment plants Major transmission lines
Maximum-hour [a]	Treated water storage facilities Distribution mains [b] Pumping stations [b]

Source: Adapted from Charles W. Howe and F. Pierce Linaweaver, "The Impact of Price on Residential Water Demand and its Relationship to System Design and Price Structure, *Water Resources Research* 3 (First Quarter 1967): 13-32.

[a] Maximum-day demand plus fire-flow requirements.
[b] These facilities should be considered in the analysis if they could be affected by such conservation measures as leak detection and repair, pressure management, or integrated resource management.

This approach produces a very rough estimate of the value of supply-side options. Costs are not escalated (to account for the increasing value of water-supply resources over time), discounted (to account for the time value of money), or adjusted for inflation. The Advanced Guidelines address these adjustments.

Preliminary Supply-Capacity Forecast

Based on the anticipated improvements and additions, planners also can present a preliminary forecast of total supply capacity over the planning period. Worksheet 4-7 is provided for this purpose. The forecast, which can be presented in a table or graph, can be used to indicate when changes to capacity are expected to occur. The total supply forecast should reflect both additions to capacity and retirements. Improvements that allow the system to maintain capacity can be indicated with entries under both additions (to reflect the improvement) and retirements (to reflect the facilities taken out of service). A similar analysis can be used for wastewater facilities.

The supply forecast is *preliminary* because it can and will be revised later in the plan to reflect the effect of conservation on water supply needs.

Worksheet 4-5: Anticipated Improvements and Additions

Describe planned improvements and additions: _____

_____

_____

_____

_____

Describe time frame for planned improvements and additions (years): _____

_____

_____

_____

_____

Type of Project [a]	Improve-ment	Addition	State date	End date
Source of supply	☐	☐	_____	_____
Water treatment facilities	☐	☐	_____	_____
Treated water storage	☐	☐	_____	_____
Major transmission lines	☐	☐	_____	_____
Other _____	☐	☐	_____	_____

Need for Project(s) (Check all that apply)		Notes
Enhance compliance with regulations	☐	_____
Replace older equipment or facilities	☐	_____
Meet average-day demand	☐	_____
Meet maximum-day demand	☐	_____
Meet future growth needs	☐	_____
Other _____	☐	_____

Funding		Interest rate
Cost of financing	☐	_____
Overall cost of capital [if known]	☐	_____

Water purchases		
Anticipated future water purchases	_____	(gallons per year)
Cost of water purchases	_____	(dollars per gallon)

[a] Comprehensive plans can include wastewater facilities.

Worksheet 4-6: Cost of Supply-Side Facilities

Line	Item	Facilities for meeting average-day demand	Facilities for meeting maximum-day demand [a]			Water purchases needed to meet demand [b]	Estimate of simple incremental supply cost ($/gallon)
		Source of supply	Water treatment facilities	Treated water storage	Major transmis-sion lines		
A	**SUPPLY CAPACITY IN ANNUAL GALLONS [c]**						
1	Current installed capacity or water purchases						
2	Planned improvements and additions						
3	Planned retirements						
4	Future installed capacity or purchases (line 1 plus line 2 less line 3)						
B	**COST OF PLANNED IMPROVEMENTS AND ADDITIONS**						
5	Approximate total cost of planned improvements and additions identified in line 2 (including financing costs)						
6	Expected life of new facilities (years)						
7	Estimated annual capital costs (line 5 divided by line 6)						
8	Estimated annual operating costs [d]						
9	Estimated total annual costs (line 7 plus line 8) [e]						
10	Per unit cost of new facilities (line 9 divided by line 2)						
11	Simple incremental supply cost (add all entries from line 10)						

[a] Additional facilities or capital equipment can be included as appropriate.
[b] The plan should indicate whether purchases are needed to meet average-day or maximum-day demand or both.
[c] Planners should select a reasonable planning horizon for supply facilities and use the same time frame for all facilities.
[d] Annual variable operating cost (including energy, chemicals, and water purchases).
[e] This calculation of simplified value does not include a discount rate, an escalation rate, or an adjustment for inflation. This analysis also can be extended to include the incremental cost of wastewater collection and treatment.

RECEIVED
2010 JUN -2 PM 1:16
PUBLIC UTILITY COMMISSION
FILING CLERK

Worksheet 4-7: Preliminary Supply-Capacity Forecast

Year	Additions (+)	Retirements (-)	Total supply capacity for the system (annual or daily)
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

5. IDENTIFY CONSERVATION MEASURES

Levels and Measures

Review the list of conservation measures recommended for consideration and identify measures that have been implemented, are planned, or are not planned. Provide an explanation for why any measure is not planned for the water system.

Water systems have a vast array of specific conservation measures at their disposal. These measures include both supply-side and demand-side management techniques for saving water and range from relatively simple educational tools to the promotion of advanced water-efficient technologies. Use of any particular measure depends on whether it meets cost-effectiveness and other planning criteria and whether its use complies with applicable laws and regulations, including state and local plumbing codes.

The conservation measures are organized into three levels: Level 1, Level 2, and Level 3. Each level includes four categories of measures. Specific water conservation measures are identified within each category. Appendix A provides additional information and several worksheets on the conservation measures. Planners are encouraged to explore the full range of potential conservation measures for consideration in their conservation programs.

Identifying Conservation Measures

Worksheet 4-8 summarizes all measures and highlights the minimum set of measures recommended for consideration in the Intermediate Guidelines. Systems should use the checklist to review and summarize the measures that are currently implemented, planned, or not planned at this time. Planners also can identify additional measures and practices as they develop their conservation plans.

Water systems following the Intermediate Guidelines are expected to implement the very fundamental and widely accepted practices highlighted under Level 1. If Level 1 measures are not in place and not planned for implementation, planners should submit a strong justification, including a cost-effectiveness analysis if it is the basis for not implementing the measure.

Planners can screen the measures in terms of general feasibility. In some cases, it may not be possible for a system to implement a measure because of legal restrictions or for other compelling reasons. The conservation plan should provide an explanation if a measure cannot be implemented for the period of time covered by the plan. It is not necessary to prepare a cost effectiveness analysis for measures that cannot be implemented.

Worksheet 4-8: Checklist of Conservation Measures [a]

Measure [a]	Already implemented ☑☐	Plan to implement ☑☐	Comments [b]
LEVEL 1 MEASURES			
Universal metering [B]			
Source-water metering	☐	☐	
Service-connection metering	☐	☐	
Meter public-use water	☐	☐	
Fixed-interval meter reading	☐	☐	
Meter-accuracy analysis	☐	☐	
Test, calibrate, repair, and replace meters	☐	☐	
Water accounting and loss control [A]			
Account for water	☐	☐	
Repair known leaks	☐	☐	
Analysis of nonaccount water	☐	☐	
Water system audit	☐	☐	
Leak detection and repair strategy	☐	☐	
Automated sensors/telemetry	☐	☐	
Loss-prevention program	☐	☐	
Costing and pricing [B]			
Cost-of-service accounting	☐	☐	
User charges	☐	☐	
Metered rates	☐	☐	
Cost analysis	☐	☐	
Nonpromotional rates	☐	☐	
Advanced pricing methods	☐	☐	
Information and education [B]			
Understandable water bill	☐	☐	
Information available	☐	☐	
Informative water bill	☐	☐	
Water-bill inserts	☐	☐	
School program	☐	☐	
Public-education program	☐	☐	
Workshops	☐	☐	
Advisory committee	☐	☐	

[Worksheet continues. See footnotes at end of worksheet.]

Worksheet 4-8 (continued)

Measure [a]	Already implemented ☑☐	Plan to implement ☑☐	Comments [b]
LEVEL 2 MEASURES			
Water-use audits [B]			
Audits of large-volume users	❐	❐	
Large-landscape audits	❐	❐	
Selective end-use audits	❐	❐	
Retrofits [B]			
Retrofit kits available	❐	❐	
Distribution of retrofit kits	❐	❐	
Targeted programs	❐	❐	
Pressure management [A]			
Systemwide pressure regulation	❐	❐	
Selective use of pressure-reducing valves	❐	❐	
Landscape efficiency [P]			
Promotion of landscape efficiency	❐	❐	
Landscape planning and renovation	❐	❐	
Selective irrigation submetering	❐	❐	
Irrigation management	❐	❐	
LEVEL 3 MEASURES			
Replacements and promotions [B]			
Rebates and incentives (nonresidential)	❐	❐	
Rebates and incentives (residential)	❐	❐	
Promotion of new technologies	❐	❐	
Reuse and recycling [B]			
Industrial applications	❐	❐	
Large-volume irrigation applications	❐	❐	
Selective residential applications	❐	❐	
Water-use regulation [B]			
Water-use standards and regulations	❐	❐	
Requirements for new developments	❐	❐	
Integrated resource management [B]			
Supply-side technologies	❐	❐	
Demand-side technologies	❐	❐	

[a] For more information about measures see Appendix A. Non-italicized measures should be considered at a minimum.

[b] Note special issues related to the measure, including legal or other obstacles precluding implementation.

Note: Measures can affect average-day demand [A], maximum-day (peak) demand [P], or both [B], as indicated.

6. ANALYZE BENEFITS AND COSTS

Purpose

For each identified water conservation and other measures of interest, estimate total implementation costs (dollars) and anticipated water savings (volume), assess the cost-effectiveness of the measure, and compare the cost of conservation to benefits (measured in terms of the incremental cost of supply).

In this section, an analysis of benefits and costs is used to aid the comparison and selection of measures. Planners will consider criteria other than efficiency in Section 7 and estimate actual effects of conservation on planned capital facilities in Section 8.

Analyzing benefits and costs is an invaluable part of the planning process. A *cost-effectiveness* analysis can be used to compare alternative conservation measures in terms of dollars per gallon of water saved. For example, one measure might produce savings at a cost of $.25/1,000 gallons while another produces savings at a cost of $.50/1,000 gallons. Cost-effectiveness analysis also can be used to compare conservation measures to supply options. A simple *net benefit* analysis can be used to determine whether the benefits of implementing a measure outweigh the costs.

Water Savings

Worksheet 4-9 should be completed for *each* conservation measure identified in Section 5. In some cases planners may want to combine measures based on the conservation program they envision. *All interrelated measures that are expected to result in an identifiable amount of water savings should be combined and treated as one measure in order to avoid counting the planned water savings more than once in the analysis.*

The worksheet begins with an open-ended description of the measure and an estimate of water savings. The anticipated life span for the measure should be indicated. Planners also should indicate whether the measure is targeted toward reduction in average-day demand, maximum-day demand, or both. Estimates of potential water savings should be as realistic as possible, based on system and regional considerations. For some measures, particularly those dependent on customer responses (such as information and education programs), the estimation will reflect a high degree of uncertainty. Planners can choose to use a range of estimates under these circumstances.

The plan should indicate typical water savings from the measure, the number of planned installations, and the anticipated life span for the measure, as well as whether the measure is expected to reduce average-day or maximum-day demand (or both).

Implementation Costs

Worksheet 4-9 includes a method for summing the total cost of implementing the measure. All costs associated with implementation should be included. Planners should obtain reasonable cost estimates by potential vendors whenever possible. The types of costs that should be analyzed include:

- Materials
- Labor
- Rebates or other payments
- Marketing and advertising
- Administration
- Consulting or contracting
- Other

A realistic implementation schedule should be considered. Any special circumstances affecting the schedule or cost of implementing the proposed measures should be discussed in the plan.

Each worksheet also includes a place to estimate annual unit water savings (that is, savings per measure or "unit"), total annual water savings, and total life span water savings for the measure. For each measure, the method used to estimate water savings should be provided. This might include, for example, a formula for converting daily per capita savings to annual savings. In some cases (such as a leakage control program), it might not be feasible to estimate savings for each unit, in which case total annual savings for the entire measure are sufficient.

Cost-Effectiveness

The analysis of cost-effectiveness for each measure builds on the identification of supply-side costs in Section 4. Using this analysis, the cost of conservation (for example, $.50 per 1,000 gallons saved) can be compared to the simple incremental cost of supply (for example, $2.00 per 1,000 gallons produced). The difference between the per-gallon cost of conservation and the per-gallon cost of supply is a simple indicator of the potential benefits (or cost savings) from conservation.

It is not necessary for planners to prepare a cost-effectiveness or net benefit analysis of Level 1 measures if those measures are already implemented or planned for implementation. An analysis should be presented if cost-effectiveness is the basis for rejecting a Level 1 measure. If the analysis of Level 1 measures leads the planner to conclude that a proposed measure is not cost-effective or that it fails to meet other criteria for implementation, the plan should include an explanation of these findings and conclusions in Worksheet 4-11 (Section 7).

Net Benefits

These Guidelines take a somewhat narrow view of benefits and costs, both of which are considered from the perspective of the water supplier. The analysis excludes other potentially

important perspectives: water consumers, society, and the environment. Planners should keep in mind that this approach may somewhat understate certain types of benefits and costs. The value of implementing a conservation measure is estimated by using the simple incremental cost of supply. In other words, the benefits of conservation can be measured in terms of the potential to avoid supply-side costs.

The net benefit from implementing the measure is shown by subtracting total program costs from total program benefits (the dollar value of water saved). When benefits exceed costs (assuming that costs and benefits are adequately specified), a measure is considered reasonably efficient and a good candidate for implementation. However, as discussed in Section 7, the selection of measures can be based on additional considerations.

Comparison of Measures

Worksheet 4-10 can be used to compare the individual analyses of conservation measures in Worksheet(s) 4-9. Worksheet 4-10 can be used to screen measures for implementation on the basis of the relative cost-effectiveness and net benefits associated with each measure.

Worksheet 4-9: Analysis of Each Conservation Measure or Group of Measures

Describe conservation measure: _____

Typical water savings from the measure: _____ per _____
Number of planned installations: _____
Anticipated life span for the measure: _____ years

The measure is designed to reduce:
- ❒ Average-day demand
- ❒ Maximum-day demand
- ❒ Both average-day and maximum-day demand

Line	Item	Amount	Amount
A	**COST OF THE CONSERVATION MEASURE [a]**	**Per unit [b]**	**Total cost of the measure**
1	Materials	$	$
2	Labor		
3	Rebates or other payments		
4	Marketing and advertising		
5	Administration		
6	Consulting or contracting		
7	Other		
8	Total program costs for the life of the measure (add lines 1 through 7) [c]		$
B	**ESTIMATED SAVINGS**		
9	Number of units to be installed [d]		
10	Estimated annual water savings per unit in gallons [e]		
11	Total estimated annual savings for the measure in gallons (multiply line 9 by line 10)		
12	Expected life span for the measure in years		
13	Total life span estimated savings for the measure in gallons (multiply line 11 by line 12)		
C	**ANALYSIS OF COST EFFECTIVENESS**		**Amount**
14	Cost of water saved by the measure (line 8 divided by line 13)		/gallon
15	Simple incremental cost of water supply [f]		/gallon
16	Cost comparison (line 15 less line 14)		/gallon
D	**NET BENEFIT OF CONSERVATION**		**Amount**
17	Estimated value of water saved by the measure based on incremental supply cost (line 13 multiplied by line 15)		$
18	Net value of water saved by each measure (line 17 less line 8)		$

[a] This analysis is used to aid the comparison and selection of measures. Planners will estimate actual effects of conservation on planned capital facilities in Section 8. A separate analysis should be performed for each conservation measure, but measures can be combined if they jointly produce water savings.

[b] Examples of a unit are a toilet, a retrofit kit, and an audit. A unit estimate may not be appropriate for each measure, in which case total program water savings and costs for the measure can be used.

[c] Include all recurring operation and maintenance costs over the life of the measure.

[d] Units can be individual product units (such as toilets) or groups of products (such as household retrofits), as long as the analysis is consistent. Leave blank if unit values do not apply.

[e] For example, water savings per retrofit. See Appendix B for benchmarks and sample calculations. Leave blank if unit values do not apply.

[f] From Worksheet 4-6, line 11.

Worksheet 4-10: Comparison of Benefits and Costs of the Conservation Measures

Line	Conservation measure [a]	Total program cost for the measure [b]	Anticipated annual water savings in gallons [c]	Cost of water saved by the measure ($/gallon) [d]	Net benefit of implementing the measure(s) [e]
1		$		$	$
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20...					

[a] = Combined measures that produce joint conservation savings should be treated as one measure to avoid duplicate counting.
[b] = From Worksheet 4-9, line 8.
[c] = From Worksheet 4-9, line 11.
[d] = From Worksheet 4-9, line 14.
[e] = From Worksheet 4-9, line 18. This estimate of net benefit does not consider societal benefits and costs.

7. SELECT CONSERVATION MEASURES

Selection Criteria

Describe the process by which conservation measures were selected for implementation, including identification of selection criteria. Summarize the selected measures and total anticipated program costs for implementation.

The first step in the selection process is to identify criteria for evaluating the conservation measures. The cost-effectiveness of the measures (from Section 6) is one criterion, but other factors should be considered as well. Planners are free to consider as many selection criteria as they believe are appropriate, but the relevance of the criteria should be explained in the conservation plan.

Criteria that can be used in selecting conservation measures for implementation include:

- ☐ Program costs
- ☐ Cost-effectiveness
- ☐ Ease of implementation
- ☐ Budgetary considerations
- ☐ Staff resources and capability
- ☐ Environmental impacts
- ☐ Ratepayer impacts
- ☐ Environmental and social justice
- ☐ Water rights and permits
- ☐ Legal issues or constraints
- ☐ Regulatory approvals
- ☐ Public acceptance
- ☐ Timeliness of savings
- ☐ Consistency with other programs

For each selection criterion used, planners should identify whether, how, and why the factor affects the feasibility of implementing one or more conservation measures. Different factors might be assigned different weights. Planners also may want to bear in mind that techniques can be used to mitigate adverse effects and improve acceptance of measures. A cost-effective conservation measure should not be dismissed without careful consideration of how barriers to implementation might be overcome.

Selecting the Measures

Worksheet 4-11 provides a simple format for summarizing the selection of measures. For each measure, planners should indicate whether the measure was selected for implementation. Planners also should identify the primary reason or reasons for selecting or rejecting the measure. Special conditions or actions that are required before a selected measure can be implemented (such as an approval from regulators) should be noted.

In some cases, planners may conclude that a measure (or measures) cannot be implemented because of a constraint that exists in the short term. Conservation measures that might be planned for future implementation, once constraints are resolved, should be discussed in the plan. Planners should briefly discuss their implementation strategies with respect to such measures.

For the conservation measures selected for implementation, planners should estimate the expected reductions in average-day and maximum-day demand. These estimates will be used in the next section of the plan to integrate conservation savings with the system's plans for supply-side facilities.

Worksheet 4-11: Selection of Conservation Measures and Estimate of Water Savings

Line	Measure	Selected ☑	Primary criteria for selecting or rejecting the conservation measure for implementation	Estimated reduction in demand for selected measures (gallons per day) [a]	
				Average-day demand	Maximum-day demand
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20…					
Total					

[a] Based on Worksheet 4-9, line 11. Planners will need to convert estimates of annual water savings to estimates of reductions in average-day and maximum-day demand for each measure or group of measures.

8. INTEGRATE RESOURCES AND MODIFY FORECASTS

Integrating Options

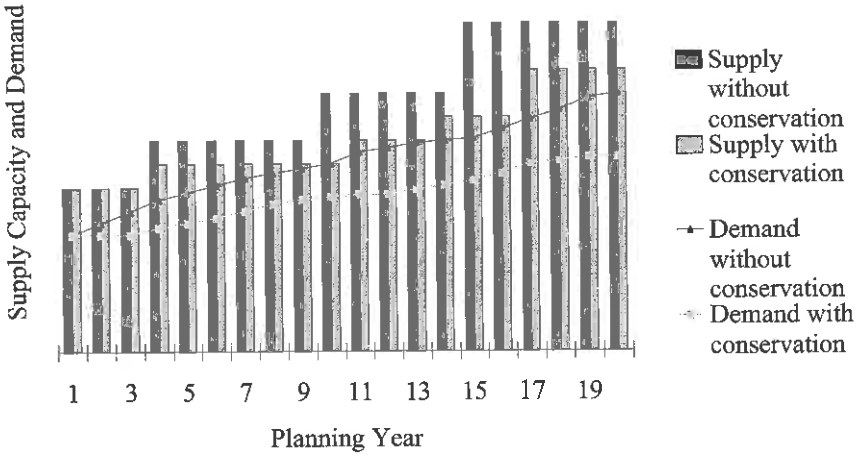
Modify water demand and supply-capacity forecasts to reflect the anticipated effects of conservation. Indicate whether and how water savings from conservation will allow systems to eliminate, downsize, or postpone supply-side projects or water purchases.

In this section, planners can revise the demand and supply-capacity forecasts made in earlier sections of the plan based on anticipated conservation savings. Pay particular attention to the effects of conservation on specific supply-facility projects.

Planners should be cautious to avoid counting demand-side or supply-side resources more than once in the analysis. Anticipated savings from conservation should be based on realistic estimates of savings associated with the planned measures. Similarly, supply projects that involve multiple facilities should be considered in terms of the total water supply capacity that is made available through those combined facilities. Timing is another issue. The plan should address how different supply-side and demand-side projects involve different life spans and implementation schedules. One twenty-year supply-side project, for example, might be offset by a series of conservation measures that begin and end at different times.

Some conservation plans use a graph to display anticipated annual supply capacity and demand without and with the implementation of conservation measures. Figure 4-1 is an example of this type of graph for a twenty-year planning horizon.

Figure 4-1
Sample Graph of Modified Supply and Demand Forecasts
Based on Implementing Conservation Measures



Modifying Demand Forecasts

Planners should use Worksheet 4-12 to collate information from previous worksheets and analyses in order to revise the demand forecasts made in Worksheet 4-4. Revisions should reflect changes based on the introduction of *new* conservation measures. The effects of measures already being implemented should be included in the original demand forecast.

Modifying the demand forecast requires a considerable degree of judgment, particularly in estimating the effects of conservation on average-day and maximum-day demand. The plan should include an explanation of the approach used in revising the demand forecasts.

Project-Specific Savings

Planners should identify the anticipated effects of conservation on planned supply-side improvements and additions (as specified in Section 4). Worksheet 4-13 is provided for this purpose. A worksheet should be completed for separable supply projects as appropriate. Ideally, water conservation strategies that reduce demand will translate into supply-side savings through one or more of the following actions:

- Eliminating a project for the foreseeable future
- Downsizing a project based on reduced capacity needs
- Postponing a project into the future
- Eliminating, reducing, or postponing water purchases

Adjustments to supply-capacity planning must be realistic, especially in terms of complex and sometimes competing goals. Supply projects cannot be eliminated, downsized, or postponed if doing so would compromise public health or safety, reduce operational efficiency, or inflate costs beyond a reasonable amount. Some systems (including systems that currently operate with inadequate or unreliable supply reserves) may not be able to translate all demand reductions into supply-capacity reductions. Planners should identify and describe such circumstances. On the other hand, supply projects that are not needed or oversized place an unnecessary burden on systems and their customers.

Modifying Supply Forecasts

The supply-capacity forecast is revised in Worksheet 4-14. The revision to the supply-capacity forecast should be based on Worksheet(s) 4-13 and consistent with accepted supply-capacity planning practices. The modification of forecasts should reflect reasonable assumptions about anticipated implementation schedules, which are summarized in Section 9. Planners also can indicate the anticipated capacity reserve (the difference between forecast supply capacity and demand).

Worksheet 4-14 also provides a method of summarizing savings in capital and operating costs, based on reductions in supply capacity. Planners also should estimate reductions in

operating costs at *existing* facilities that will occur with demand reductions (apart from operating costs associated with planned facilities). The total program cost of conservation can be compared with the savings in total capital and annual operating costs.

As recognized throughout these Guidelines, water conservation also has nonmonetary benefits. Planners should discuss, as appropriate, how implementation of the conservation program will help their system cope with any of the conditions identified in Section 2 (Worksheet 4-2). For example, the planned measures might help a system address problems related to safe yields or drought management.

Revenue Effects

The conservation plan should briefly describe how planned conservation measures will affect water utility revenues (based on reduction in sales) and discuss strategies for addressing these revenue effects. Reductions in water usage will affect the revenues of the water utility. Conservation will help the water utility reduce variable costs (such as energy, chemical, and purchased water costs). In the long term, conservation also will help the utility reduce fixed costs (associated with new capital facilities). In the short term, reductions and sales can lead to a shortfall in revenues needed to cover fixed costs and sustain the financial viability of the water system.

The planner can estimate the effect of conservation on revenues by multiplying current water rates by the adjusted level of sales (for the variable portion of the water bill). The adjusted level of sales should include the anticipated effects of conservation. Conservation-oriented rate structures have direct revenue effects that should be considered. Worksheet A-4 in Appendix A can be used to evaluate the revenue effects of rate changes.

Conservation planners should work closely with financial planners in order to integrate their analyses, identify potential revenue shortfalls, and devise strategies to ensure that the utility will meet its revenue requirements.

Adjustments to water rates may be needed. For some utilities, a change in rates requires approval from an oversight board or state public utility commission. When rate increases are offset by usage reductions, customer bills and utility revenues can be maintained. Customers and utilities eventually will realize savings from conservation through long-term reductions in costs.

Worksheet 4-12: Modified Demand Forecast

Line	Item	Current year	Year 5	Year 10	Year 20
1	Average-day demand before conservation [a]				
2	Reduction in average-day demand (line 1 less line 2) [b]				
3	Average-day demand after conservation				
4	Maximum-day demand before conservation [a]				
5	Reduction in maximum-day demand (line 4 less line 5) [b]				
6	Maximum-day demand after conservation				
7	Ratio maximum-day to average-day demand before conservation (line 4 divided by line 1)				
8	Ratio maximum-day to average-day demand after conservation (line 6 divided by line 3)				

[a] From Worksheet 4-4, line 6.
[b] Based on Worksheet 4-11.

Worksheet 4-13: Project-Specific Savings

DESCRIPTION OF PROJECT [a]

Describe the supply-side project(s): _____

_____

Project was scheduled to begin: _____

Purpose of the project: ❒ Improvement ❒ Addition

The project is designed to meet: ❒ Average-day demand ❒ Maximum-day demand

Type of project:
- ❒ Source of supply
- ❒ Water treatment facilities
- ❒ Treated water storage
- ❒ Major transmission lines
- ❒ Purchased water
- ❒ Other _____

CHANGES TO PROJECT [b]

Line	Item	Project supply capacity (daily)	Project Costs: Total capital costs ($)	Project Costs: Annual operating costs ($)
A	**CAPITAL PROJECT IS ELIMINATED**			
1	Original project			
2	Savings from elimination (equals line 1)			
B	**CAPITAL PROJECT IS DOWNSIZED**			
3	Original project			
4	Downsized project			
5	Savings from downsizing (line 3 less line 4)			
C	**CAPITAL PROJECT IS POSTPONED**			
6	Present value of original project			
7	Present value of postponed project			
8	Savings from postponement (line 6 less line 7)			
D	**NEED FOR PURCHASED WATER IS REDUCED [c]**			
9	Original estimate of purchases			
10	Revised estimate of purchases (can be "0")			
11	Savings from reduced purchases (line 9 less line 10)			

[a] Comprehensive plans can include wastewater facilities.

[b] Based on Worksheet 4-12 estimates of reductions in demand.

[c] For purchased water, report only annual operating costs and include costs associated with take-or-pay contract provisions. Transmission facilities needed to transport purchased water should include capital and operating costs associated with such facilities and reported as a capital project.

Worksheet 4-14: Modified Supply Forecast and Estimated Total Savings

MODIFIED SUPPLY FORECAST

Line	Item	Current Year	Year 5	Year 10	Year 20
A	**Forecast Supply Capacity (Daily)**				
1	Supply capacity before conservation program [a]				
2	Planned reduction in supply capacity [b]				
3	Supply capacity after conservation (line 1 less line 2)				
B	**Capacity Reserve**				
4	Supply capacity less demand (line 3 less line 2 on Worksheet 4-12)				

ESTIMATED TOTAL SAVINGS

Line	Item	Supply capacity (daily)	Project Costs: Total capital costs ($)	Project Costs: Annual operating costs ($)
C	**Total Estimated Savings from Changes to Supply Projects [c]**			
1	Cost of supply projects before conservation			
2	Cost of supply projects after conservation			
3	Savings (line 1 less line 2)			
D	**Total Estimated Savings from Reduced Operating Costs at Existing Facilities [d]**			
4	Operating costs before conservation			
5	Operating costs after conservation			
6	Savings (line 4 less line 5)			
E	**Conservation Program Costs**			Total program costs ($)
7	Total cost of implementing selected conservation measures [e]			

[a] From Worksheet 4-7.
[b] Based on Worksheet(s) 4-13.
[c] Based on Worksheet(s) 4-13.
[d] Based on annual variable operating cost (including energy, chemicals, and water purchases).
[e] Based on Worksheet 4-10.

9. PRESENT IMPLEMENTATION AND EVALUATION STRATEGY

Implementation

Present a strategy and timetable for implementing conservation measures and other elements of the conservation plan. Describe proposed approaches for implementing and evaluating planned conservation measures.

In this final step in the conservation planning process, the water system specifies its strategy and timetable for implementation. It can be emphasized, however, that conservation planning will require an *ongoing* effort on the part of water utility managers. Ongoing planning and implementation will go hand in hand. The implementation strategy should include a preliminary schedule for monitoring and evaluating program results and revisiting the plan for updates and modifications.

Implementation of Measures

Worksheet 4-15 is a simple template for summarizing the water system's implementation and evaluation schedule for the conservation measures. For each measure, the schedule can identify significant implementation actions, a beginning date, and a completion date. Implementation actions include:

- Securing budgetary resources
- Hiring of staff
- Procurement of materials
- Agreements with suppliers or consultants
- Acquisition of permits or other approvals from regulatory agencies
- Legislative actions (for changes in water-use regulations)
- Activity milestones (for example, system audits or distribution of retrofit kits)

Planners should make note of any specific factors or contingencies that might affect or prevent the implementation of specific measures. For example, if a measure cannot be implemented prior to obtaining a special permit or other authority, this fact should be noted along with an explanation of the strategy for obtaining the necessary authority.

Some measures might require implementation actions that take place over several years (in order to sustain conservation savings). The plan should provide sufficient detail to understand the utility's strategy with regard to implementing such measures.

Implementation and Evaluation

Worksheet 4-16 provides a very simple summary of the water system's general implementation and evaluation strategy for the conservation plan. Three areas are highlighted:

- Public involvement
- Monitoring and evaluation
- Updates and revisions

A plan for public involvement should discuss whether and when the water system intends to involve members of the community in the implementation of the conservation plan. Some systems may want to schedule regular meetings with community groups to keep them informed of the system's progress in meeting goals.

A plan for monitoring and evaluation should address data collection, modeling, and other issues that will be important in tracking the effects of water conservation on demand over time. The system may want to plan to collect new kinds of data for monitoring purposes as well as for future forecasting needs. Many systems might find, for example, that more detailed data on demand by customer class are needed, including more detail on contributions to average-day and maximum-day demands. More detailed data might also be needed to assess trends in nonaccount water.

A plan for updates and revisions will help keep the system's conservation plan current over time and account for the system's actual experience with conservation. Updating forecasts of water demand and supply capacity as new data become available is especially important. In some cases, the system might want to revise or expand its planning goals. Many systems update plans every five years. However, changing conditions or other concerns might justify more frequent updates. The schedule of updates and revisions might be affected by state or local requirements for conservation planning by the water system.

The conservation planning document also should include a record of the plan's adoption by the water system's governing body (such as a Board of Directors or City Council), as appropriate.

Worksheet 4-15: Implementation Schedule for Measures

Line	Measure	Required action	Beginning date	Completion date	Notes
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					

Worksheet 4-16: Implementation Strategy

A. PUBLIC INVOLVEMENT

Describe plan for public involvement:

B. MONITORING AND EVALUATION

Describe plan for monitoring and evaluation:

Describe plan to collect water demand data:

C. PLAN UPDATES

Describe plan for updates and revisions:

D. ADOPTION OF THE PLAN

Date plan completed:
Date plan approved:
Approved by [governing body]:
Signature:

[blank page]

U.S. Environmental Protection Agency
Water Conservation Plan Guidelines

PART 5
ADVANCED GUIDELINES FOR PREPARING WATER CONSERVATION PLANS

These Advanced Guidelines are designed for water systems serving more than 100,000 people. Which Guidelines are appropriate may depend on various factors and conditions affecting water systems and their need for conservation planning. *Water system managers should check with their own state's rules, regulations, and recommendations about which Guidelines to follow.*

1. Specify Conservation Planning Goals

Planning Goals

Specify conservation planning goals in terms of anticipated benefits for the water system and its customers. To the extent practical, involve affected members of the community in the development of conservation planning goals and throughout the implementation process.

Planning goals can be developed from different perspectives. These planning guidelines, including the analysis of the benefits and costs of conservation activities, emphasize a water supplier perspective. The value of conservation is defined primarily in terms of avoided supply-side costs to the water system. Lowering the level of water demand can help water suppliers avoid, downsize, or postpone the construction and operation of costly supply-side facilities.

The benefits of conservation also can be understood from the perspectives of customers, as well as society at large. Conservation benefits society by preserving environmental resources. Conservation can benefit customers by lowering energy and long-term water costs. Water conservation reduces demands on wastewater systems; in fact, the need to reduce wastewater treatment costs can be a strong rationale for water conservation. The Guidelines and the worksheets can be used to simultaneously address the potential effects of conservation on water and wastewater operations. Utilities using the Advanced Guidelines also are encouraged to expand the analysis of benefits and costs to consider the customer and societal perspectives, if only in very general terms.

Conservation planning goals can take many forms. Water systems should state their goals in specific terms. Measurable goals are useful for evaluation purposes. For example, many water systems identify a specific water-use reduction goal (as a percentage of current water usage).

Water conservation planning goals may include:

- Eliminating, downsizing, or postponing the need for capital projects.
- Improving the utilization and extending the life of existing facilities.
- Lowering variable operating costs.
- Avoiding new source development costs.
- Improving drought or emergency preparedness.
- Educating customers about the value of water.
- Improving reliability and margins of safe and dependable yields.
- Protecting and preserving environmental resources.

Planners should plan on revisiting the goals section before finalizing the conservation plan and periodically thereafter, because goals and the means to achieving them will evolve. As

the water system accomplishes certain conservation goals, new objectives may come into focus.

Community Involvement

The process of developing goals can involve representatives of various groups in the community (or stakeholders) who may be concerned about a water system and its future. Modern resource planning (such as integrated resource planning) emphasizes an open process that involves all affected groups so that they can have an opportunity to express their interests and concerns.

Involving the community in goal development also serves an important public education function. Moreover, it is widely believed that involving the community in developing goals, as well as in the implementation process, can greatly enhance the success of conservation programs.

Members of the community who might be interested in water conservation include:

- Residential water consumers
- Commercial water consumers
- Industrial water consumers
- Wholesale customers
- Environmental groups
- Civil rights groups
- Indian tribes
- Labor groups
- Business and commerce groups
- Recreational water users
- Agricultural users
- Educational institutions
- Government agencies

In addition to helping the water system specify planning goals, community participants also can have an ongoing role in a system's conservation program. Ongoing involvement can help maintain and build support for achieving conservation goals and "get the word out" about the conservation effort. Participants can act as a focus group for exploring specific conservation measures (discussed in Section 4). Participants also can provide valuable linkages to key groups—consumers, businesses, and institutions—who might be involved in implementing certain conservation measures. Participants also can provide input on the level of satisfaction or dissatisfaction with the system's programs. Finally, community groups can assist the water system in monitoring results and adjusting program implementation.

For many water systems, involving the community in water-system planning will be a new experience. However, most system managers will find that involving members of the community in developing goals, implementing programs, and evaluating results is a very worthwhile investment. Fortunately, guidance on this approach is available.[1]

[1] See *Public Involvement Strategies: A Manager's Handbook* (Denver, CO: American Water Works Association Research Foundation, 1996).

2. DEVELOP A WATER SYSTEM PROFILE

System Profile

Summarize the service and operating characteristics of the water system. Provide an overview of conditions and a description of climate, water availability, or other factors that might affect water conservation planning.

Taking inventory of existing resources and conditions is an important step in the planning process. A water system profile can help systems in terms of assessing their present circumstances and designing strategies to meet emerging needs.

Most water systems should maintain the data and information necessary for building a system profile. Much information may already have been compiled for a facility plan or for other purposes. Worksheet 5-1 profiles a relatively simple summary table that systems can use to compile and present key system characteristics. The system profile can be expanded to include additional information. For example, systems may want to present data on trends for some characteristics (such as supply and demand measures). Systems should include in their profile additional characteristics or details considered relevant for understanding the nature of the system.

System Conditions

Worksheet 5-2 provides a very simple overview of planning conditions that might affect the water system and its conservation planning effort. This checklist can be used to make a general review of conditions affecting the supply or the demand for water. For planning purposes, it is important to identify and focus on the conditions that most affect a particular system.

The conditions outlined in the worksheet suggest the need for water conservation planning. While all water systems can benefit from efficiency improvements, water conservation can be especially beneficial for systems experiencing water shortages or rapid increases in demand. For example, water systems facing one or more of the following conditions are strongly urged to consider the fullest range of conservation measures available to them in accordance with these guidelines:

- Systems in state-designated critical water or stressed areas
- Systems experiencing frequent droughts, emergencies, or safe yield problems
- Systems with excessive unaccounted-for water or water losses
- Systems entering into major construction cycles
- Systems anticipating rapid growth in water demand

For some conditions, states might provide benchmark measures that water systems can use for comparison purposes. For example, a state might have specific criteria for defining critical

use or stressed areas, for classifying per-capita water use, or for identifying the age of systems. When practical, systems should try to compare significant conditions using generally accepted measures.

In addition to the summary worksheet, planners also should prepare a brief written discussion of the significant conditions affecting their systems. Particular attention can be paid to climate and water availability, but other factors affecting the system can be considered as well. This information can be used to help systems identify problems and opportunities throughout the planning process.

Current Conservation Efforts

Worksheet 5-3 is provided so that water systems can describe their current water conservation activities and programs. For each conservation measure implemented, planners can indicate the approximate annual water savings achieved, when implementation for the measure began, and whether continued implementation is planned. Any other pertinent information on current efforts and their effectiveness can be provided in the plan as well.

Worksheet 5-1: Water System Profile

A	SERVICE CHARACTERISTICS	Number
1	Estimated service population	
2	Estimated service area (square miles)	
3	Miles of mains	
4	Number of treatment plants	
5	Number of separate water systems	
6	Interconnection with other systems	

B	ANNUAL WATER SUPPLY	Annual volume	Number of intakes or source points	Percent metered
7	Groundwater			%
8	Surface water			%
9	Purchases: raw			%
10	Purchases: treated			%
11	Total annual water supply			%

C	SERVICE CONNECTIONS	Connections	Water sales	Percent metered
12	Residential, single-family			%
13	Residential, multi-family			%
14	Commercial			%
15	Industrial			%
16	Public or governmental			%
17	Wholesale			%
18	Other			%
19	Total connections			%

D	WATER DEMAND	Annual volume	Percent of total	Per connection
20	Residential sales			
21	Nonresidential sales			
22	Wholesale sales			
23	Other sales			
24	Nonaccount water: authorized uses			
25	Nonaccount water: unauthorized uses			
26	Total system demand (total use)			

E	AVERAGE & PEAK DEMAND	Volume	Total supply capacity	Percent of total capacity
27	Average-day demand			%
28	Maximum-day demand			%
29	Maximum-hour demand			%

F	PRICING	Rate structure	Metering frequency	Billing frequency
30	Residential rate			
31	Nonresidential rate			
32	Other rate			

G	PLANNING	Prepared a plan ☑☐	Date	Filed with state ☑☐
33	Capital, facility, or supply plan			
34	Drought or emergency plan			
35	Water conservation plan			

Worksheet 5-2: Overview of System Conditions [a]

Line	Conditions	Increasing need for conservation→→→ Check applicable description ☑						Don't know ☑
A	**CLIMATE AND WATER AVAILABILITY**							
1	Average precipitation	High	☐	Moderate	☐	Low	☐	☐
2	Average temperatures	Low	☐	Moderate	☐	High	☐	☐
3	Critical supply areas	No	☐	At risk	☐	Yes	☐	☐
4	Competing water uses	No	☐	Possibly	☐	Yes	☐	☐
5	Environmental constraints	No	☐	Possibly	☐	Yes	☐	☐
6	Quality/quantity concerns	No	☐	Possibly	☐	Yes	☐	☐
7	Seasonal variations in climate	Low	☐	Moderate	☐	High	☐	☐
8	Instream flow problems	Low	☐	Moderate	☐	High	☐	☐
9	Shortage or emergency frequency	Low	☐	Moderate	☐	High	☐	☐
B	**INFRASTRUCTURE CONDITIONS**							
10	Age of the system	Newer	☐	Middle	☐	Older	☐	☐
11	General condition of system	Good	☐	Fair	☐	Poor	☐	☐
12	Water losses and leaks	Low	☐	Moderate	☐	High	☐	☐
13	Unaccounted-for water	Low	☐	Moderate	☐	High	☐	☐
14	Safe yield of supply exceeded	No	☐	At risk	☐	Yes	☐	☐
15	Wastewater discharges exceeded	No	☐	At risk	☐	Yes	☐	☐
16	Wastewater capacity exceeded	No	☐	At risk	☐	Yes	☐	☐
17	Potential for recycling and reuse	Low	☐	Moderate	☐	High	☐	☐
18	Improvement plans	Low	☐	Moderate	☐	High	☐	☐
19	Anticipated investment	Low	☐	Moderate	☐	High	☐	☐
C	**SYSTEM DEMOGRAPHICS**							
20	Rate of population growth per year	Low	☐	Moderate	☐	High	☐	☐
21	Rate of demand growth per year	Low	☐	Moderate	☐	High	☐	☐
22	Rate of economic growth per year	Low	☐	Moderate	☐	High	☐	☐
23	Per capita water use (by class)	Low	☐	Moderate	☐	High	☐	☐
24	Ratio of peak to average demand	Low	☐	Moderate	☐	High	☐	☐
25	Presence of large-volume users	Low	☐	Moderate	☐	High	☐	☐
D	**OTHER FACTORS**							
26								☐
27								☐
28								☐

[a] Specific (quantified) benchmarks for these indicators may be provided by the state.

Worksheet 5-3: Current Water Conservation Activities

Summarize the system's current water conservation activities/programs: _____

Water conservation measures	*Approximate* annual water savings [if known]	Implemented since (date)	Is continued implementation planned?

3. PREPARE A DEMAND FORECAST

Demand Forecasting

Prepare a forecast of anticipated water demand for selected time periods. To the extent practical, the planner should take into account variations in demand based on type of water usage, as well as perform a "what if" (sensitivity) analysis.

Forecasting water use (or water demand) is a critical part of the planning process. Forecasts can range from simple projections based on anticipated growth in the population to complex models using several variables to explain variations in water use. Forecasts can be made for a water system as a whole; however, forecasts are considered more accurate when they are prepared for separate classifications of water use or sectors.

The Guidelines suggest that planners prepare forecasts for five-year, ten-year, and twenty-year intervals. Additional time points can be used as well. The longer the planning horizon, the greater will be the uncertainty of the forecast. Forecasts should be revisited and updated on a regular basis.

The forecast should recognize the effects of conservation measures already implemented. The forecast also should recognize the demand effects of plumbing efficiency standards established under the 1992 Energy Policy Act (see Appendix B, Tables B-5 and B-6).[2] New construction and renovations will not contribute as much to total demand as in the past; systems that are not experiencing growth might detect declines in demand due to these effects. For the purposes of this conservation plan, anticipated demand effects from measures contemplated in the plan should not be included. A revision to the demand forecast based on implementing the planned conservation measures is made in Section 8 (Worksheet 5-13).

It is not necessary for systems to prepare a separate forecast for the purposes of this plan if a forecast has already been prepared for the system within a reasonable time frame. Planners should include the results of their forecasts in this plan.

Forecasting Method

Systems following the Advanced Guidelines should prepare a demand forecasting model appropriate to their capabilities and needs. Many systems in this category already employ advanced forecasting techniques. Current and reasonable forecasts already prepared by the system, including forecasts prepared under other planning or regulatory requirements, will be in accordance with the purpose of these guidelines.

[2] A method for estimating the demand effect of efficient fixtures can be found in Amy Vickers, "The Energy Policy Act: Assessing its Impact on Utilities." *Journal American Water Works Association* (August 1993): 56-62.

Advanced water demand forecasting generally involves:

- Disaggregated forecasts by customer class or other relevant groups, by average-day and maximum-day demand, and by off-peak and peak season.
- Multivariate models that seek to explain variations in water demand in terms of variations in other factors, such as climate, income, and price.
- Quantified sensitivity ("what if") analysis, which allows systems to address uncertainty by varying inputs and assumptions.

Disaggregating forecasts by customer class is important because of the different load factors that groups of customers present. Disaggregating forecasts according to type of demand is relevant for advanced demand management techniques that take into account how different types of demand affect the utility's functional costs. As discussed in Section 4, different types of supply-side facilities are designed to meet average-day or maximum-day water demands, and various conservation measures target different types of demand.

Multivariate models recognize that demand is dynamic and can change with changes in other variables. Sensitivity analysis helps planners deal explicitly with uncertainty that goes along with these dynamics. Addressing uncertainty is a very important part of advanced forecasting. With larger and more diverse service territories, uncertainties are greater; uncertainty also grows with the time horizon of the forecast. Contingency planning can help utilities cope with uncertainty.

Several computer models are available for advanced forecasting, many of which can be used in accordance with these guidelines. An example of an advanced forecasting tool is the widely-used IWR-MAIN model, which was developed by the U.S. Army Corps of Engineers.[3] Figure 5-1 is an illustration of the inputs and outputs of the model. The key features of IWR-MAIN are: spatial disaggregation, seasonal disaggregation, sector disaggregation, multiple determinants of water demand, user-added categories, and sensitivity analysis. The current version of the model also allows planners to incorporate the effects of demand-management into various planning scenarios. Use of empirical models, including but not limited to IWR-MAIN, clearly is consistent with the purpose of these guidelines.

The conservation plan should include a detailed summary of the forecast, results by customer class, and a description of the forecasting methodology used. Any adjustments to the forecasts should be explained in the plan. Worksheet 5-4 provides a template for summarizing the systemwide results of the forecast.

[3] Duane D. Baumann., John J. Boland, and W. Michael Hanemann. *Urban Water Demand Management and Planning* (New York: McGraw Hill, 1998).

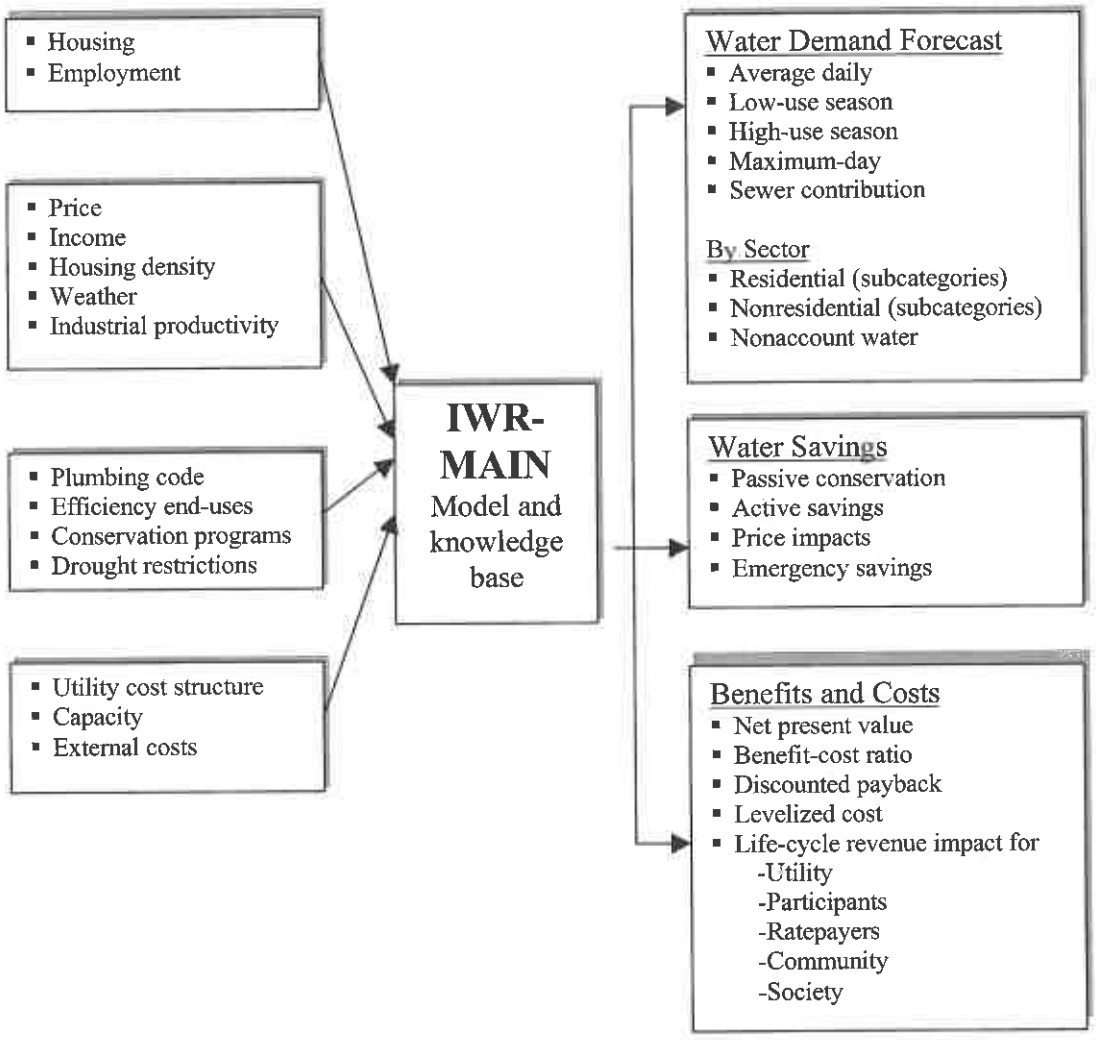


Figure 5-1. Inputs and Outputs of the IWR-MAIN Forecasting Model

Source: Duane D. Baumann, John J. Boland, and W. Michael Hanemann, *Urban Water Demand Management and Planning* (New York: McGraw-Hill, 1998): 109.

Worksheet 5-4: Summary of Preliminary Water Demand Forecast

Summary Results of Advanced Forecasting Model [a]

Line	Item	Current year	5-year forecast	10-year forecast	20-year forecast
A	**TOTAL ANNUAL WATER DEMAND**				
1	Current and projected total annual water sales to the residential sector [b]				
2	Current and projected total annual water sales to the nonresidential sector [b]				
3	Current and projected total annual water sales to the wholesale buyers [b]				
4	Current and projected total annual water sales to others [b]				
5	Current and projected total annual nonaccount water (authorized and unauthorized) [c]				
6	Current and projected total annual water demand in gallons (add lines 1 through 4) [d]				
7	Current and projected annual water supply capacity [e]				
8	Difference between total demand and total supply capacity (+ or -) (line 3 less line 2)				
B	**AVERAGE-DAY AND MAXIMUM-DAY DEMAND**				
9	Current and projected average-day demand [f]				
10	Current and projected maximum-day demand [g]				
11	Ratio of maximum-day to average-day demand (line 5 divided by line 4)				
12	Daily supply capacity (divide line 7 by 365)				
13	Ratio of maximum-day demand to daily supply capacity (divide line 10 by line 12)				

[a] This Worksheet presumes that the system has prepared a detailed demand forecast using an appropriate model. Include in the conservation plan a description of the forecasting methodology used and a detailed summary of the forecast.
[b] Current year corresponds to Worksheet 5-1, lines 20 through 23.
[c] Current year corresponds to Worksheet 5-1, lines 24 through 25.
[d] Current year corresponds to Worksheet 5-1, line 26.
[e] Supply capacity should take into account available supplies (permits), treatment capacity, and distribution system capacity and reflect the practical total supply capacity of the system, including purchased water.
[f] Current year corresponds to Worksheet 5-1, line 27.
[g] Current year corresponds to Worksheet 5-1, line 28.

4. DESCRIBE PLANNED FACILITIES

Supply Forecasting

Describe improvements planned for the water system over a reasonable planning horizon, identify the types of improvements proposed, and estimate the total, annual, and unit cost of the improvements. Prepare a preliminary forecast of installed capacity.

In this part of the conservation plan, planners are asked to prepare an estimate of supply costs based on meeting the level of water demand specified in the unadjusted demand forecast (that is, unadjusted for additional conservation). This is a critical part of the analysis because it establishes the anticipated cost of *supply-side* improvements and additions and this cost estimate will be used to represent the value of conservation or *demand-side* activities.

Because the benefits of conservation extend into the future it is important to take a forward-looking approach to supply costs. The concept of marginal or incremental cost captures the idea that the "true" value of a supply resource can be measured in terms of the cost of the next increment of supply. If only high-cost supplies are available, the marginal or incremental cost will be high. For many communities, future increments of supply will be very costly (that is, the marginal cost of developing new water sources will be high). The value of a conserved amount of water at a future point in time will be equivalent to the most costly supply option available at that future time point, because that is the supply option being displaced by conservation.

Cost Analysis

A reasonable accounting of anticipated supply-side costs is needed in order to compare the cost of supply-side measures to the cost of demand-side or conservation measures (on a cost – per-gallon basis). Planners should choose an appropriate time horizon; a twenty-year or other suitable period can be used. The choice of time frame should be consistent with the demand forecast (Section 3), as well as the other planning considerations.

Planners should begin by preparing an estimate of major improvements and additions that will be required over the planning horizon in order to meet anticipated demand (including a safe reserve margin). Detailed cost estimates may be available from facility plans or other planning documents. Worksheet 5-5 can be used to summarize improvements and additions, which are disaggregated into three categories: source of supply, transmission and treatment, and distribution. (Additional categories can be used as needed).

Planners should consider all capital facility improvements and additions. Improvements include renovations and expansions needed to maintain or enhance safety or reliability within existing facilities. Additions consist of new facilities. Routine maintenance improvements should not be included. Anticipated water purchases and costs also should be recorded on

Worksheet 5-5. For this part of the analysis, the effects of conservation measures currently being implemented should be considered, but the effects of new conservation measures on the need for supply capacity or water purchases should be excluded. (These effects are addressed in Section 8.)

If no capital improvements and additions are planned, "0" values can be entered and the estimate of supply costs can be based on operating costs (including the cost of energy, chemicals, and purchased water).

Estimating Incremental Supply Costs

The Advanced Guidelines recommend a method for determining the present value of supply-side costs. This analysis should be calculated separately for (1) improvements and additions needed to meet *average* demand, and (2) improvements and additions needed to meet *peak* demand so that the results can be compared to corresponding conservation measures. As illustrated in Worksheet 5-6, this spreadsheet method provides the planner with a year-by-year accounting of costs.

The resulting estimates of total annual incremental costs by type of facility (peak and average) can be used by planners to estimate the incremental cost of supply associated with meeting average or peak demand on a system-specific basis.

Supply-side facilities are designed to meet different types of water demand (as summarized in Table 5-1); similarly, different conservation measures affect different types of water demand. Planners should identify, as reasonably possible, the extent to which improvements and additions are needed to meet average and/or peak demand.

Two adjustments can be made to costs: one for the annual escalation rate and one for the discount rate. The escalation rate is used to ensure that the benefits of conservation are not undervalued. By using an escalation rate, the analyst assumes that incremental costs of supply measured at a future point in time will be greater than present incremental costs. Many planners, for example, believe that future water supplies will be much more costly to secure and develop, even in real-dollar (inflation adjusted) terms. In addition to supply costs, other infrastructure costs are expected to escalate with time. In general, the escalation rate will be higher for areas experiencing supply or other constraints that will put pressure on total system costs. Choosing the appropriate escalation rate requires analyst judgment; however, planners may want to investigate past escalation trends relevant to their system.

The second adjustment involves applying a discount rate, which is used to estimate the present value of costs that extend into the future. The discount rate reflects the time value of money (or opportunity costs) and can be based on the system's overall cost of capital.

Table 5-1: Relationship of Water Demand to Supply Facilities

Type of Water Demand	Type of Water Supply Facility
Average-day	Source of supply facilities, including raw water storage facilities (such as reservoirs)
Maximum-day (peak)	Water treatment plants Major transmission lines
Maximum-hour [a]	Treated water storage facilities Distribution mains [b] Pumping stations [b]

Source: Adapted from Charles W. Howe and F. Pierce Linaweaver, "The Impact of Price on Residential Water Demand and its Relationship to System Design and Price Structure, *Water Resources Research* 3 (First Quarter 1967): 13-32.

[a] Maximum-day demand plus fire-flow requirements.
[b] These facilities should be considered in the analysis if they could be affected by such conservation measures as leak detection and repair, pressure management, or integrated resource management.

Planners should note that discounting is not the same as adjusting for inflation. In order to simplify the presentation, Worksheet 5-6 does not include an adjustment for inflation. It is not necessary to convert nominal to real (inflation-adjusted) dollars for the purpose of assessing benefits and costs. However, if planners choose to represent costs in real dollars, the escalation rate and the discount rate also should be expressed in real dollar terms.

Given the uncertainty associated with the recommended adjustment factors, planners using the Advanced Guidelines also are encouraged to conduct a sensitivity analysis to establish a range of values based on different assumptions for the three adjustments.

Preliminary Supply-Capacity Forecast

Based on the anticipated improvements and additions, planners also can present a preliminary forecast of total supply capacity over the planning period. Worksheet 5-7 is provided for this purpose. The forecast, which can be presented in a table or graph, can be used to indicate when changes to capacity are expected to occur. The total supply forecast should reflect both additions to capacity and retirements. Improvements that allow the system to maintain capacity can be indicated with entries under both additions (to reflect the improvement) and retirements (to reflect the facilities taken out of service). A similar analysis can be used for wastewater facilities.

The supply forecast is *preliminary* because it can and will be revised later in the plan to reflect the effect of conservation on water supply needs.

Worksheet 5-5: Anticipated Improvements and Additions

Describe planned improvements and additions: _____

_____

_____

_____

_____

Describe time frame for planned improvements and additions (years): _____

_____

_____

_____

_____

Type of Project [a]	Improve-ment	Addition	State date	End date
Source of supply	☐	☐	_____	_____
Water treatment facilities	☐	☐	_____	_____
Treated water storage	☐	☐	_____	_____
Major transmission lines	☐	☐	_____	_____
Other _____	☐	☐	_____	_____

Need for Project(s) (Check all that apply)		Notes
Enhance compliance with regulations	☐	_____
Replace older equipment or facilities	☐	_____
Meet average-day demand	☐	_____
Meet maximum-day demand	☐	_____
Meet future growth needs	☐	_____
Other _____	☐	_____

Funding		Interest rate
Cost of financing	☐	_____
Overall cost of capital [if known]	☐	_____

Water purchases		
Anticipated future water purchases	_____	(gallons per year)
Cost of water purchases	_____	(dollars per gallon)

[a] Comprehensive plans can include wastewater facilities.

Worksheet 5-6: Present Value of Planned Supply-Side Facilities [a]

Year [b]	Annual incremental capacity from improve-ments/ additions [c]	Annualized incremental capital cost [d]	Annual operating cost [e]	Un-discounted total annualized incremental cost [f]	Escalated value of supply cost in nominal dollars [g]	Present value of supply cost in nominal dollars [h]	Present value of supply cost Per gallon in nominal dollars [i]
	gallons	$	$	$	$	$	$/gallon
0							
1							
2							
3							
4							
5							
6							
7							
8							
9							
10...							
20							
Total							

Source: Adapted from Pekelney, Chesnutt, and Hanemann (1996). See Glossary (Appendix C) for definitions.

[a] = This analysis should be calculated separately for (1) improvements and additions needed to meet **average** demand, and (2) improvements and additions needed to meet **peak** demand so that the results can be compared to corresponding conservation measures. The analysis also can be expanded to include the incremental cost of wastewater collection and treatment.

[b] = The number of years should correspond to the anticipated useful life of the project(s).

[c] = Total gallons of capacity made available through the project(s).

[d] = Annualized incremental capital cost (K):

$$K = \frac{C \times i \times (1+i)^n}{(1+i)^n - 1}$$

where: K = annualized capital costs
C = total expenditures required
n = the useful service life of the capital expenditure (see [b])
i = the appropriate interest or financing rate

[e] = Annual variable operating cost (including energy, chemicals, and water purchases).

[f] = [d] + [e]

[g] = [f] x $(1 + s)^t$ where s is the selected annual escalation rate and t is the year. The escalation rate can be tailored to the nature of capital expenditures.

[h] = [g]/$(1 + r)^t$ where r is the selected annual discount rate and t is the year. The escalation rate can be tailored to the nature of capital expenditures.

[i] = [h]/[c]

Worksheet 5-7: Preliminary Supply-Capacity Forecast

Year	Additions (+)	Retirements (-)	Total supply capacity for the system (annual or daily)
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

5. IDENTIFY CONSERVATION MEASURES

Levels and Measures

Review the list of conservation measures recommended for consideration and identify measures that have been implemented, are planned, or are not planned. Provide an explanation for why any measure is not planned for the water system.

Water systems have a vast array of specific conservation measures at their disposal. These measures include both supply-side and demand-side management techniques for saving water and range from relatively simple educational tools to the promotion of advanced water-efficient technologies. Use of any particular measure depends on whether it meets cost-effectiveness and other planning criteria and whether its use complies with applicable laws and regulations, including state and local plumbing codes.

The conservation measures are organized into three levels: Level 1, Level 2, and Level 3. Each level includes four categories of measures. Specific water conservation measures are identified within each category. Appendix A provides additional information and several worksheets on the conservation measures. Planners are encouraged to explore the full range of potential conservation measures for consideration in their conservation programs.

Identifying Conservation Measures

Worksheet 5-8 summarizes the minimum set of measures recommended for consideration in the Advanced Guidelines. Systems should use the checklist to review and summarize the measures that are currently implemented, planned, or not planned at this time. Planners also can identify additional measures and practices as they develop their conservation plans.

Water systems following the Advanced Guidelines are expected to implement the very fundamental and widely accepted practices under Level 1. If Level 1 measures are not in place and not planned for implementation, planners should submit a strong justification, including a cost-effectiveness analysis if it is the basis for not implementing the measure.

Planners can screen the measures in terms of general feasibility. In some cases, it may not be possible for a system to implement a measure because of legal restrictions or for other compelling reasons. The conservation plan should provide an explanation if a measure cannot be implemented for the period of time covered by the plan. It is not necessary to prepare a cost effectiveness analysis for measures that cannot be implemented.

Worksheet 5-8: Checklist of Conservation Measures

Measure [a]	Already implemented ☑	Plan to implement ☑	Comments [b]
LEVEL 1 MEASURES			
Universal metering [B]			
Source-water metering	☐	☐	
Service-connection metering	☐	☐	
Meter public-use water	☐	☐	
Fixed-interval meter reading	☐	☐	
Meter-accuracy analysis	☐	☐	
Test, calibrate, repair, and replace meters	☐	☐	
Water accounting and loss control [A]			
Account for water	☐	☐	
Repair known leaks	☐	☐	
Analysis of nonaccount water	☐	☐	
Water system audit	☐	☐	
Leak detection and repair strategy	☐	☐	
Automated sensors/telemetry	☐	☐	
Loss-prevention program	☐	☐	
Costing and pricing [B]			
Cost-of-service accounting	☐	☐	
User charges	☐	☐	
Metered rates	☐	☐	
Cost analysis	☐	☐	
Nonpromotional rates	☐	☐	
Advanced pricing methods	☐	☐	
Information and education [B]			
Understandable water bill	☐	☐	
Information available	☐	☐	
Informative water bill	☐	☐	
Water-bill inserts	☐	☐	
School program	☐	☐	
Public-education program	☐	☐	
Workshops	☐	☐	
Advisory committee	☐	☐	

[Worksheet continues. See footnotes at end of worksheet.]

Worksheet 5-8 (continued)

Measure [a]	Already implemented ☑☐	Plan to implement ☑☐	Comments [b]
LEVEL 2 MEASURES			
Water-use audits [B]			
Audits of large-volume users	❐	❐	
Large-landscape audits	❐	❐	
Selective end-use audits	❐	❐	
Retrofits [B]			
Retrofit kits available	❐	❐	
Distribution of retrofit kits	❐	❐	
Targeted programs	❐	❐	
Pressure management [A]			
Systemwide pressure regulation	❐	❐	
Selective use of pressure-reducing valves	❐	❐	
Landscape efficiency [P]			
Promotion of landscape efficiency	❐	❐	
Landscape planning and renovation	❐	❐	
Selective irrigation submetering	❐	❐	
Irrigation management	❐	❐	
LEVEL 3 MEASURES			
Replacements and promotions [B]			
Rebates and incentives (nonresidential)	❐	❐	
Rebates and incentives (residential)	❐	❐	
Promotion of new technologies	❐	❐	
Reuse and recycling [B]			
Industrial applications	❐	❐	
Large-volume irrigation applications	❐	❐	
Selective residential applications	❐	❐	
Water-use regulation [B]			
Water-use standards and regulations	❐	❐	
Requirements for new developments	❐	❐	
Integrated resource management [B]			
Supply-side technologies	❐	❐	
Demand-side technologies	❐	❐	

[a] For more information about measures see Appendix A.
[b] Note special issues related to the measure, including legal or other obstacles precluding implementation.
Note: Measures can affect average-day demand [A], maximum-day (peak) demand [P], or both [B], as indicated.

6. ANALYZE BENEFITS AND COSTS

Purpose

For each identified water conservation and other measures of interest, estimate total implementation costs (dollars) and anticipated water savings (volume), assess the cost-effectiveness of the measure, and compare the cost of conservation to benefits (measured in terms of the incremental cost of supply).

In this section, an analysis of benefits and costs is used to aid the comparison and selection of measures. Planners will consider criteria other than efficiency in Section 7 and estimate actual effects of conservation on planned capital facilities in Section 8.

Analyzing benefits and costs is an invaluable part of the planning process. Use a *cost-effectiveness* analysis to compare alternative conservation measures in terms of dollars per gallon of water saved. For example, one measure might produce savings at a cost of $.25/1,000 gallons while another produces savings at a cost of $.50/1,000 gallons. Cost-effectiveness analysis also can be used to compare conservation measures to supply options. Use a *net benefit* analysis to determine whether the benefits of implementing a measure outweigh the costs.

It is not necessary for planners to prepare a cost-effectiveness or net benefit analysis of Level 1 measures if those measures are already implemented or planned for implementation. An analysis should be presented if cost-effectiveness is the basis for rejecting a Level 1 measure. If the analysis of Level 1 measures leads the planner to conclude that a proposed measure is not cost-effective or that it fails to meet other criteria for implementation, the plan should include an explanation of these findings and conclusions in Worksheet 5-12 (Section 7).

Water Savings

Worksheet 5-9 should be completed for *each* conservation measure identified in Section 5. In some cases planners may want to combine measures based on the conservation program they envision. *All interrelated measures that are expected to result in an identifiable amount of water savings should be combined and treated as one measure in order to avoid counting the planned water savings more than once in the analysis.*

The worksheet begins with an open-ended description of the measure and an estimate of water savings. The anticipated life span for the measure should be indicated. Planners also should indicate whether the measure is targeted toward reduction in average-day demand, maximum-day demand, or both. Estimates of potential water savings should be as realistic as possible, based on system and regional considerations. For some measures, particularly those dependent on customer responses (such as information and education programs), the estimation will reflect a high degree of uncertainty. Planners can choose to use a range of estimates under these circumstances.

The plan should indicate typical water savings from the measure, the number of planned installations, and the anticipated life span for the measure, as well as whether the measure is expected to reduce average-day or maximum-day demand (or both).

Implementation Costs

Worksheet 5-9 includes a method for summing the total cost of implementing the measure. All costs associated with implementation should be included. Planners should ascertain reasonable cost estimates by potential vendors whenever possible. The types of costs that should be analyzed include:

- Materials
- Labor
- Rebates or other payments
- Marketing and advertising
- Administration
- Consulting or contracting
- Other

A realistic implementation schedule should be considered. Any special circumstances affecting the schedule or cost of implementing the proposed measures should be discussed in the plan.

Each worksheet also includes a place to estimate annual unit water savings (that is, savings per measure or "unit"), total annual water savings, and total life span water savings for the measure. For each measure, the method used to estimate water savings should be provided. This might include, for example, a formula for converting daily per capita savings to annual savings. In some cases (such as a leakage control program), it might not be feasible to estimate savings for each unit, in which case total annual savings for the entire measure are sufficient.

Analyzing Benefits and Costs

Worksheet 5-10 also provides a detailed and relatively precise method for calculating the cost effectiveness and net benefit of each conservation measure. The spreadsheet format allows planners to incorporate year-to-year changes in benefits and costs. The number of years represented in the spreadsheet will vary with the anticipated life span of the measure.

For some water conservation measures, savings will be constant from year-to-year. The same value will appear for each year. However, the spreadsheet also allows the analyst to recognize changes in the effectiveness of the conservation measures over time.

The benefits of conservation are displayed in terms of the incremental cost of supply (from Worksheet 5-6). The estimate of benefits should reflect differences in savings from reduction in average-day demand versus reductions in maximum-day demand. This can be accomplished by using the disaggregated estimates of capital in the calculation of benefits.

For example, benefits from measures that reduce only average-day demand can be adjusted to include only the incremental capital cost of source facilities, plus annual operating costs; both are measured on a per gallon basis. The method also allows the planner to incorporate incremental additions and improvements at different years.

The costs are represented in terms of total program costs for the measure. Most conservation program costs take the form of one-year (year 0) expenditures; costs in the subsequent years drop to zero. However, some measures may require recurring expenditures. When this is the case, the same discount rate used in the estimation of supply costs (in Worksheet 5-6) should be applied to the conservation expenditures.

The net present value of conservation is simply the difference between net present benefits and net present costs. The spreadsheet uses nominal dollars to represent net present value. The worksheet reports only nominal dollars. However, planners can adjust their estimates of benefits and costs for anticipated inflation and convert nominal to real (inflation-adjusted) dollars. If real dollars are reported, the escalation rate and discount rate should be expressed in real dollar terms as well.

Comparison of Measures

Worksheet 5-11 can be used to compare the individual analyses of conservation measures in Worksheet(s) 5-10. Worksheet 5-11 can be used to screen measures for implementation on the basis of the relative cost-effectiveness and net benefits associated with each measure.

Worksheet 5-9: Program Costs for Each Conservation Measure or Group of Measures

Describe conservation measure: _____

_____

_____

Typical water savings from the measure: _____ per _____
Number of planned installations: _____
Anticipated life span for the measure: _____ years

The measure is designed to reduce:

- ❒ Average-day demand
- ❒ Maximum-day demand
- ❒ Both average-day and maximum-day demand

Line	Item	Amount	Amount
A	**COST OF THE CONSERVATION MEASURE [a]**	**Per unit [b]**	**Total cost of the measure**
1	Materials		
2	Labor		
3	Rebates or other payments		
4	Marketing and advertising		
5	Administration		
6	Consulting or contracting		
7	Other		
8	Total program costs for the life of the measure (add lines 1 through 7) [c]		
B	**ESTIMATED SAVINGS**		
9	Number of units to be installed [d]		
10	Estimated annual water savings per unit in gallons [e]		
11	Total estimated annual savings for the measure in gallons (multiply line 9 by line 10)		
12	Expected life span for the measure in years		
13	Total life span estimated savings for the measure in gallons (multiply line 11 by line 12)		

[a] A separate analysis should be performed for each conservation measure, but measures can be combined if they jointly produce water savings.

[b] Examples of a unit are a toilet, a retrofit kit, and an audit. A unit estimate may not be appropriate for each measure, in which case total program water savings and costs for the measure can be used.

[c] Include all recurring operation and maintenance costs over the life of the measure.

[d] Units can be individual product units (such as toilets) or groups of products (such as household retrofits), as long as the analysis is consistent. Leave blank if unit values do not apply.

[e] For example, water savings per retrofit. See Appendix B for benchmarks and sample calculations. Leave blank if unit values do not apply.

Notes on analysis: _____

_____

_____

_____

Worksheet 5-10: Analysis of Each Conservation Measure or Group of Measures

Year [a]	Annual water savings from the conservation measure [b]	Present value of supply cost per gallon in nominal dollars [c]	Undiscounted cost of the conservation measure [d]	Present value cost of conservation in nominal dollars [e]	Net savings from conservation in nominal dollars [f]	Net benefit from implementing the measure [g]
	gallons	$/gallon	$/gallon	$/gallon	$/gallon	$
0	0	$	$	$	$	$
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
Totals						
Average annual savings [h]						

Source: Adapted in part from Pekelney, Chesnutt, and Hanemann (1996).

[a] = The number of years analyzed should cover the expected useful life of the measure.
[b] = Anticipated annual conservation savings. Include attrition or rebound effects if applicable.
[c] = From corresponding column in Worksheet 5-6 (last column).
[d] = Recurring expenditures should be included in the table at the appropriate year.
[e] = $[d]/(1 + r)^t$ where r is the selected discount rate and t is the year. The discount rate should be the same used in Section 4. This column assesses the per-gallon cost of each measure.
[f] = [c] – [e].
[g] = [f] x [b]. This column assesses the total net benefit of the measure.
[h] = Based on the total number of years in the planning horizon.

RECEIVED
2016 NOV -2 PM 1:19
WATER CONSERVATION

Worksheet 5-11: Comparison of Benefits and Costs of the Conservation Measures

Line	Conservation measure [a]	Total program cost for the measure [b]	Anticipated annual water savings in gallons [c]	Cost of water saved by the measure ($/gallon) [d]	Net benefit of implementing the measure(s) [e]
1		$		$	$
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20...					

[a] = Combined measures that produce joint conservation savings should be treated as one measure to avoid duplicate counting.
[b] = Based on Worksheet 5-9, line 8.
[c] = Based on Worksheet 5-10, average annual water savings from the conservation measure.
[d] = Based on Worksheet 5-10, present value of supply cost in nominal dollars.
[e] = Based on Worksheet 5-10, net benefit from implementing the measure. This estimate of net benefit does not consider societal benefits and costs.

7. SELECT CONSERVATION MEASURES

Selection Criteria

Describe the process by which conservation measures were selected for implementation, including identification of selection criteria. Summarize the selected measures and total anticipated program costs for implementation.

The first step in the selection process is to identify criteria for evaluating the conservation measures. The cost-effectiveness of the measures (from Section 6) is one criterion, but other factors should be considered as well. Planners are free to consider as many selection criteria as they believe are appropriate, but the relevance of the criteria should be explained in the conservation plan.

Criteria that can be used in selecting conservation measures for implementation include:

- ❒ Program costs
- ❒ Cost-effectiveness
- ❒ Ease of implementation
- ❒ Budgetary considerations
- ❒ Staff resources and capability
- ❒ Environmental impacts
- ❒ Ratepayer impacts
- ❒ Environmental and social justice
- ❒ Water rights and permits
- ❒ Legal issues or constraints
- ❒ Regulatory approvals
- ❒ Public acceptance
- ❒ Timeliness of savings
- ❒ Consistency with other programs

For each selection criterion used, planners should identify whether, how, and why the factor affects the feasibility of implementing one or more conservation measures. Different factors might be assigned different weights. Planners also may want to bear in mind that techniques can be used to mitigate adverse effects and improve acceptance of measures. A cost-effective conservation measure should not be dismissed without careful consideration of how barriers to implementation might be overcome.

Selecting the Measures

Worksheet 5-12 provides a simple format for summarizing the selection of measures. For each measure, planners should indicate whether the measure was selected for implementation. Planners also should identify the primary reason or reasons for selecting or rejecting the measure. Special conditions or actions that are required before a selected measure can be implemented (such as an approval from regulators) should be noted.

In some cases, planners may conclude that a measure (or measures) cannot be implemented because of a constraint that exists in the short term. Conservation measures that might be planned for future implementation, once constraints are resolved, should be discussed in the plan. Planners should briefly discuss their implementation strategies with respect to such measures.

For the conservation measures selected for implementation, planners should estimate the expected reductions in average-day and maximum-day demand. These estimates will be used in the next section of the plan to integrate conservation savings with the system's plans for supply-side facilities.

Worksheet 5-12: Selection of Conservation Measures and Estimate of Water Savings

Line	Measure	Selected ☑	Primary criteria for selecting or rejecting the conservation measure for implementation	Estimated reduction in demand for selected measures (gallons per day) [a]	
				Average-day demand	Maximum-day demand
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20…					
Total					

[a] Based on Worksheet 5-9, line 11. Planners will need to convert estimates of annual water savings to estimates of reductions in average-day and maximum-day demand for each measure or group of measures.

8. INTEGRATE RESOURCES AND MODIFY FORECASTS

Integrating Options

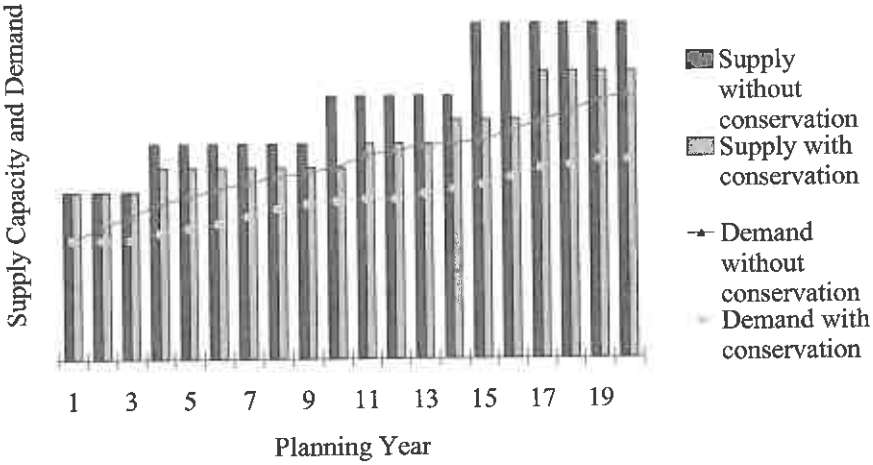
Modify water demand and supply-capacity forecasts to reflect the anticipated effects of conservation. Indicate whether and how water savings from conservation will allow systems to eliminate, downsize, or postpone supply-side projects or water purchases.

In this section, planners can revise the demand and supply-capacity forecasts made in earlier sections of the plan based on anticipated conservation savings. Pay particular attention to the effects of conservation on specific supply-facility projects.

Planners should be cautious to avoid counting demand-side or supply-side resources more than once in the analysis. Anticipated savings from conservation should be based on realistic estimates of savings associated with the planned measures. Similarly, supply projects that involve multiple facilities should be considered in terms of the total water supply capacity that is made available through those combined facilities. Timing is another issue. The plan should address how different supply-side and demand-side projects involve different life spans and implementation schedules. One twenty-year supply-side project, for example, might be offset by a series of conservation measures that begin and end at different times.

Some conservation plans use a graph to display anticipated annual supply capacity and demand without and with the implementation of conservation measures. Figure 5-2 is an example of this type of graph for a twenty-year planning horizon.

Figure 5-2
Sample Graph of Modified Supply and Demand Forecasts
Based on Implementing Conservation Measures



Modifying Demand Forecasts

Planners should use Worksheet 5-13 to collate information from previous worksheets and analyses in order to revise the demand forecasts made in Worksheet 5-4. Revisions should reflect changes based on the introduction of *new* conservation measures. The effects of measures already being implemented should be included in the original demand forecast.

Modifying the demand forecast requires a considerable degree of judgment, particularly in estimating the effects of conservation on average-day and maximum-day demand. The plan should include an explanation of the approach used in revising the demand forecasts.

Project-Specific Savings

Planners should identify the anticipated effects of conservation on planned supply-side improvements and additions (as specified in Section 4). Worksheet 5-14 is provided for this purpose. A worksheet should be completed for separable supply projects as appropriate. Ideally, water conservation strategies that reduce demand will translate into supply-side savings through one or more of the following actions:

- Eliminating a project for the foreseeable future
- Downsizing a project based on reduced capacity needs
- Postponing a project into the future
- Eliminating, reducing, or postponing water purchases

Adjustments to supply-capacity planning must be realistic, especially in terms of complex and sometimes competing goals. Supply projects cannot be eliminated, downsized, or postponed if doing so would compromise public health or safety, reduce operational efficiency, or inflate costs beyond a reasonable amount. Some systems (including systems that currently operate with inadequate or unreliable supply reserves) may not be able to translate all demand reductions into supply-capacity reductions. Planners should identify and describe such circumstances. On the other hand, supply projects that are not needed or oversized place an unnecessary burden on systems and their customers.

Modifying Supply Forecasts

The supply-capacity forecast is revised in Worksheet 5-15. The revision to the supply-capacity forecast should be based on Worksheet(s) 5-14 and consistent with accepted supply-capacity planning practices. The modification of forecasts should reflect reasonable assumptions about anticipated implementation schedules, which are summarized in Section 9. Planners also can indicate the anticipated capacity reserve (the difference between forecast supply capacity and demand).

Worksheet 5-15 also provides a method of summarizing savings in capital and operating costs, based on reductions in supply capacity. Planners also should estimate reductions in

operating costs at *existing* facilities that will occur with demand reductions (apart from operating costs associated with planned facilities). The total program cost of conservation can be compared with the savings in total capital and annual operating costs.

As recognized throughout these Guidelines, water conservation also has nonmonetary benefits. Planners should discuss, as appropriate, how implementation of the conservation program will help their system cope with any of the conditions identified in Section 2 (Worksheet 5-2). For example, the planned measures might help a system address problems related to safe yields or drought management.

Revenue Effects

The conservation plan should briefly describe how planned conservation measures will affect water utility revenues (based on reduction in sales) and discuss strategies for addressing these revenue effects. Reductions in water usage will affect the revenues of the water utility. Reductions in water usage will affect the revenues of the water utility. Conservation will help the water utility reduce variable costs (such as energy, chemical, and purchased water costs). In the long term, conservation also will help the utility reduce fixed costs (associated with new capital facilities). In the short term, reductions and sales can lead to a shortfall in revenues needed to cover fixed costs and sustain the financial viability of the water system.

The planner can estimate the effect of conservation on revenues by multiplying current water rates by the adjusted level of sales (for the variable portion of the water bill). The adjusted level of sales should include the anticipated effects of conservation. Conservation-oriented rate structures have direct revenue effects that should be considered. Worksheet A-4 in Appendix A can be used to evaluate the revenue effects of rate changes.

Conservation planners should work closely with financial planners in order to integrate their analyses, identify potential revenue shortfalls, and devise strategies to ensure that the utility will meet its revenue requirements.

Adjustments to water rates may be needed. For some utilities, a change in rates requires approval from an oversight board or state public utility commission. When rate increases are offset by usage reductions, customer bills and utility revenues can be maintained. Customers and utilities eventually will realize savings from conservation through long-term reductions in costs.

Worksheet 5-13: Modified Demand Forecast

Line	Item	Current year	Year 5	Year 10	Year 20
1	Average-day demand before conservation [a]				
2	Reduction in average-day demand (line 1 less line 2) [b]				
3	Average-day demand after conservation				
4	Maximum-day demand before conservation [a]				
5	Reduction in maximum-day demand (line 4 less line 5) [b]				
6	Maximum-day demand after conservation				
7	Ratio maximum-day to average-day demand before conservation (line 4 divided by line 1)				
8	Ratio maximum-day to average-day demand after conservation (line 6 divided by line 3)				

[a] From Worksheet 5-4, line 6.
[b] Based on Worksheet 5-12.

Worksheet 5-14: Project-Specific Savings

DESCRIPTION OF PROJECT [a]

Describe the supply-side project(s): _____

_____

Project was scheduled to begin: _____

Purpose of the project: ❒ Improvement ❒ Addition

The project is designed to meet: ❒ Average-day demand ❒ Maximum-day demand

Type of project:
- ❒ Source of supply
- ❒ Water treatment facilities
- ❒ Treated water storage
- ❒ Major transmission lines
- ❒ Purchased water
- ❒ Other _____

CHANGES TO PROJECT [b]

Line	Item	Project supply capacity (daily)	Project Costs: Total capital costs ($)	Project Costs: Annual operating costs ($)
A	**CAPITAL PROJECT IS ELIMINATED**			
1	Original project			
2	Savings from elimination (equals line 1)			
B	**CAPITAL PROJECT IS DOWNSIZED**			
3	Original project			
4	Downsized project			
5	Savings from downsizing (line 3 less line 4)			
C	**CAPITAL PROJECT IS POSTPONED**			
6	Present value of original project			
7	Present value of postponed project			
8	Savings from postponement (line 6 less line 7)			
D	**NEED FOR PURCHASED WATER IS REDUCED [c]**			
9	Original estimate of purchases			
10	Revised estimate of purchases (can be "0")			
11	Savings from reduced purchases (line 9 less line 10)			

[a] Comprehensive plans can include wastewater facilities.
[b] Based on Worksheet 5-13 estimates of reductions in demand.
[c] For purchased water, report only annual operating costs and include costs associated with take-or-pay contract provisions. Transmission facilities needed to transport purchased water should include capital and operating costs associated with such facilities and reported as a capital project.

Worksheet 5-15: Modified Supply Forecast and Estimated Total Savings

MODIFIED SUPPLY FORECAST

Line	Item	Current Year	Year 5	Year 10	Year 20
A	**Forecast Supply Capacity (Daily)**				
1	Supply capacity before conservation program [a]				
2	Planned reduction in supply capacity [b]				
3	Supply capacity after conservation (line 1 less line 2)				
B	**Capacity Reserve**				
4	Supply capacity less demand (line 3 less line 2 on Worksheet 5-13)				

ESTIMATED TOTAL SAVINGS

Line	Item	Supply capacity (daily)	Project Costs: Total capital costs ($)	Project Costs: Annual operating costs ($)
C	**Total Estimated Savings from Changes to Supply Projects [c]**			
1	Cost of supply projects before conservation			
2	Cost of supply projects after conservation			
3	Savings (line 1 less line 2)			
D	**Total Estimated Savings from Reduced Operating Costs at Existing Facilities [d]**			
4	Operating costs before conservation			
5	Operating costs after conservation			
6	Savings (line 4 less line 5)			
E	**Conservation Program Costs**			Total program costs ($)
7	Total cost of implementing selected conservation measures [e]			

[a] From Worksheet 5-7.
[b] Based on Worksheet(s) 5-14.
[c] Based on Worksheet(s) 5-14.
[d] Based on annual variable operating cost (including energy, chemicals, and water purchases).
[e] Based on Worksheet 5-11.

9. PRESENT IMPLEMENTATION AND EVALUATION STRATEGY

Implementation

Present a strategy and timetable for implementing conservation measures and other elements of the conservation plan. Describe proposed approaches for implementing and evaluating planned conservation measures.

In this final step in the conservation planning process, the water system specifies its strategy and timetable for implementation. It can be emphasized, however, that conservation planning will require an *ongoing* effort on the part of water utility managers. Ongoing planning and implementation will go hand in hand. The implementation strategy should include a preliminary schedule for monitoring and evaluating program results and revisiting the plan for updates and modifications.

Implementation of Measures

Worksheet 5-16 is a simple template for summarizing the water system's implementation and evaluation schedule for the conservation measures. For each measure, the schedule can identify significant implementation actions, a beginning date, and a completion date. Implementation actions include:

- Securing budgetary resources
- Hiring of staff
- Procurement of materials
- Agreements with suppliers or consultants
- Acquisition of permits or other approvals from regulatory agencies
- Legislative actions (for changes in water-use regulations)
- Activity milestones (for example, system audits or distribution of retrofit kits)

Planners should make note of any specific factors or contingencies that might affect or prevent the implementation of specific measures. For example, if a measure cannot be implemented prior to obtaining a special permit or other authority, this fact should be noted along with an explanation of the strategy for obtaining the necessary authority.

Some measures might require implementation actions that take place over several years (in order to sustain conservation savings). The plan should provide sufficient detail to understand the utility's strategy with regard to implementing such measures.

Implementation and Evaluation

Worksheet 5-17 provides a very simple summary of the water system's general implementation and evaluation strategy for the conservation plan. Three areas are highlighted:

- Public involvement
- Monitoring and evaluation
- Updates and revisions

A plan for public involvement should discuss whether and when the water system intends to involve members of the community in the implementation of the conservation plan. Some systems may want to schedule regular meetings with community groups to keep them informed of the system's progress in meeting goals.

A plan for monitoring and evaluation should address data collection, modeling, and other issues that will be important in tracking the effects of water conservation on demand over time. The system may want to plan to collect new kinds of data for monitoring purposes as well as for future forecasting needs. Many systems might find, for example, that more detailed data on demand by customer class are needed, including more detail on contributions to average-day and maximum-day demands. More detailed data might also be needed to assess trends in nonaccount water.

A plan for updates and revisions will help keep the system's conservation plan current over time and account for the system's actual experience with conservation. Updating forecasts of water demand and supply capacity as new data become available is especially important. In some cases, the system might want to revise or expand its planning goals. Many systems update plans every five years. However, changing conditions or other concerns might justify more frequent updates. The schedule of updates and revisions might be affected by state or local requirements for conservation planning by the water system.

The conservation planning document also should include a record of the plan's adoption by the water system's governing body (such as a Board of Directors or City Council), as appropriate.

Worksheet 5-16: Implementation Schedule for Measures

Line	Measure	Required action	Beginning date	Completion date	Notes
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					

Worksheet 5-17: Implementation Strategy

A. PUBLIC INVOLVEMENT

Describe plan for public involvement:

B. MONITORING AND EVALUATION

Describe plan for monitoring and evaluation:

Describe plan to collect water demand data:

C. PLAN UPDATES

Describe plan for updates and revisions:

D. ADOPTION OF THE PLAN

Date plan completed:
Date plan approved:
Approved by [governing body]:
Signature:

[blank page]

APPENDIX A
WATER CONSERVATION MEASURES

This Appendix to the EPA Guidelines for Preparing Water Conservation Plans describes the water conservation measures that water utilities can use in designing water conservation programs. As part of their conservation plans, planners should consider, *at a minimum,* each of the measures specified in the Basic, Intermediate, or Advanced Guidelines, depending on which set of Guidelines apply to the water system.

The measures are organized into three general categories: Level 1, Level 2, and Level 3. Within each level are four subcategories that are used to organize a variety of specific conservation measures:

- Level 1 Measures
  - Universal metering
  - Water accounting and loss control
  - Costing and pricing
  - Information and education
- Level 2 Measures
  - Water-use audits
  - Retrofits
  - Pressure management
  - Landscape efficiency
- Level 3 Measures
  - Replacements and promotions
  - Reuse and recycling
  - Water-use regulation
  - Integrated resource management

This system of organizing the conservation measures recognizes that the measures considered can vary with the size and capability of the system. *Water systems are strongly encouraged to explore the fullest range of conservation measures practical, including measures beyond the minimum measures suggested in the Guidelines that they are following.* Many smaller and middle-sized utilities have been very successful in implementing a wide range of beneficial conservation programs.

What follows is a description of each of the twelve subcategories of measures. The Guidelines provide checklists that planners can use in reviewing measures. However, planners are encouraged to consider as many measures as practical given their capability and the conditions they seek to address. In some cases, planners may choose to consider and implement selected measures beyond those minimally recommended for consideration.

Although this list of conservation measures is relatively current and comprehensive, planners should not limit their analysis only to the measures mentioned here. Planners also should consider new technologies and approaches as they become available. Letters next to each category indicate whether the measures in that category are considered particularly useful in reducing average-day demand [A], maximum-day or peak demand [P], both [B]. Worksheets for some of the conservation measures are provided at the end of this Appendix.

Level 1 Measures

Universal Metering [B]

Measures	← Basic Guidelines →	Intermediate Guidelines →	Advanced Guidelines →
Universal metering [B]	▪ Source-water metering ▪ Service-connection metering and reading ▪ Meter public-use water	▪ Fixed-interval meter reading ▪ Meter-accuracy analysis	▪ Test, calibrate, repair, and replace meters

Metering is a very fundamental tool of water system management and conservation. Worksheet A-1 can be used by systems to assess their metering practices.

Source-water metering. Both the supplier and the customer benefit from metering. Source metering is essential for water accounting purposes.

Service-connection metering. Service-connection metering is needed to inform customers about how much water they are using; suppliers use metering data to more accurately track water usage and bill customers for their usage.

Public-use water metering. All water provided free of charge for public use should be metered and read at regular intervals. This will allow the utility to more accurately account for water. Lack of metering undermines loss control, costing and pricing, and other conservation measures.

Fixed-interval meter reading. A program of fixed-interval meter reading is essential to determine the amount of nonrevenue-producing water. Source meters and service connection meters should be read at the same relative time in order to facilitate accurate comparisons and analysis. Readings generally should occur at regular intervals, preferably monthly or bimonthly. Estimated bills should be kept at a minimum, subject to state and local regulations.

Meter accuracy. Water meters can be damaged and deteriorate with age, thus producing inaccurate readings. Inaccurate readings will give misleading information regarding water

usage, make leak detection difficult, and result in lost revenue for the system. All meters, especially older meters, should be tested for accuracy on a regular basis. The system also should determine that meters are appropriately sized. Meters that are too large for a customer's level of use will tend to under-register water use.

Meter testing, calibration, repair, and replacement. After determining the accuracy of the metering system, the utility should provide a schedule of activities necessary to correct meter deficiencies. Meters should be recalibrated on a regular basis to ensure accurate water accounting and billing.

Water Accounting and Loss Control [A]

Measures	← Basic Guidelines →	Intermediate Guidelines →	Advanced Guidelines →
Water accounting and loss control [A]	▪ Account for water ▪ Repair known leaks	▪ Analyze nonaccount water ▪ Water system audit ▪ Leak detection and repair strategy ▪ Automated sensors/ telemetry	▪ Loss-prevention program

In many respects, water conservation begins on the supply side. All water systems will benefit from a water accounting system that helps track water throughout the system and identify areas that may need attention, particularly large volumes of nonaccount water. Nonaccount water includes water that is *metered but not billed*, as well as *all unmetered* water. Unmetered water may be authorized for such utility purposes (such as operation and maintenance) and for certain public uses (such as fire hydrant maintenance). Unmetered water also includes unauthorized uses, including losses from accounting errors, malfunctioning distribution system controls, thefts, inaccurate meters, or leaks. Some unauthorized uses may be identifiable. When they are not, these unauthorized uses constitute *unaccounted-for water.*

Implementing a system of water accounting is a necessary first step in developing strategies for loss control. A system of water accounting is provided in Figure A-1. This system for tracking water begins with total water produced and ends with unaccounted-for water. Worksheet A-2 (which follows figure A-1) and Worksheet A-3 can assist water systems in developing a water accounting and loss control strategy.

Account for water. All water systems, even smaller systems, should implement a basic system of water accounting (as appears in Worksheet A-3). This accounting exercise provides a basis for a strategy to control losses over time.

Repair known leaks. The cost of water leakage can be measured in terms of the operating costs associated with water supply, treatment, and delivery; water lost produces no revenues for the utility. Repairing larger leaks can be costly, but it also can produce substantial savings in water and expenditures over the long run.

Water accounting is less accurate and useful when a system lacks source and connection metering. Although the system should plan to meter sources, unmetered source water can be estimated by multiplying the pumping rate by the time of operation based on electric meter readings.

Analysis of nonaccount water. Nonaccount water use should be analyzed to identify potential revenue-producing opportunities, as well as recoverable losses and leaks. Some utilities might consider charging for water previously given away for public use or stepping up efforts to reduce illegal connections and other forms of theft.

System audit. A system audit can provide information needed to make a more accurate analysis of nonaccount water.

Leak detection and repair strategy. Systems also should institute a comprehensive leak detection and repair strategy. This strategy may include regular on-site testing using computer-assisted leak detection equipment, a sonic leak-detection survey, or another acceptable method for detecting leaks along water distribution mains, valves, services, and meters. Divers can be used to inspect and clean storage tank interiors.

Automated sensors/telemetry. Water systems also consider using remote sensor and telemetry technologies for ongoing monitoring and analysis of source, transmission, and distribution facilities. Remote sensors and monitoring software can alert operators to leaks, fluctuations in pressure, problems with equipment integrity, and other concerns.

Loss-prevention program. This may include pipe inspection, cleaning, lining, and other maintenance efforts to improve the distribution system and prevent leaks and ruptures from occurring. Utilities might also consider methods for minimizing water used in routine water system maintenance procedures in accordance with other applicable standards.

Costing and Pricing [B]

	← Advanced Guidelines →		
	← Intermediate Guidelines →		
Measures	← Basic Guidelines →		
Costing and pricing [B]	▪ Cost-of-service accounting ▪ User charges ▪ Metered rates	▪ Cost analysis ▪ Nonpromotional rates	▪ Advanced pricing methods

Costing and pricing are conservation strategies because they involve understanding the true value of water and conveying information about that value, through prices, to water customers. The use of user charges often is considered a necessary (but not always sufficient) part of a water conservation strategy. Many resources are available on how to account for costs and design water rates.

Cost-of-service accounting. Water systems should use cost-of-service accounting, consistent with generally accepted practices. Many resources are available for this purpose. Understanding and tracking system costs also is a capacity-development strategy for small systems.

User charges. Once costs are established, systems can develop more accurate user charges (or rate structures).

Metered rates. Metered rates should be used so that the customer's water bill corresponds to their water usage. For many systems, change in water rates must be approved by regulators or other oversight bodies. It is important for water systems to communicate with regulators about costs and the need for cost-based pricing.

Cost analysis. Systems should conduct a cost analysis to understand what types of usage drive system costs. For example, systems should analyze patterns of usage by season and class of service.

Nonpromotional rates. Systems also should consider whether their current rate structures promote water usage over conservation; nonpromotional rates should be implemented whenever possible in order to enhance the conservation signal of rates.

Systems seeking to encourage conservation through their rates should consider various issues: the allocation between fixed and variable charges, usage blocks and breakpoints, minimum bills and whether water is provided in the minimum bill, seasonal pricing options, and pricing by customer class.

Systems also should consider the effect of introducing a new rate structure on revenues. Worksheet A-4 is provided for this purpose. Conservation-oriented pricing requires planners to make certain assumptions (based on the available empirical evidence) about the elasticity of water demand, or the responsiveness of water usage to a change in price. Elasticity is measured by the ratio of a percentage change in quantity demanded to a percentage change in price. Changes in the rate structure should allow the system to achieve demand reduction goals recovering water system costs. In allocating costs, the impact of the rate structure on user demand and revenues for specific customer classes should be considered.

Advanced pricing methods. Advanced pricing methods generally allocate costs by customer class and/or type of water use. Advanced pricing might consider seasonal variations or other methods for pricing indoor and outdoor usage based on differing contributions to system peaks. The conservation orientation of the rate structure can be enhanced by considering the elasticity factors for different classes of water use. Marginal-cost pricing, which considers the value of water relative to the cost of the next increment of supply, can be considered as well. Systems also can consider special ratemaking provisions (such as cost-recovery or lost-revenue mechanisms). Potential revenue instability can be addressed with additional rate structure modifications (such as revenue-adjustment mechanisms).

Obviously, the pricing strategy must be consistent with overall system goals and approved by regulatory or other governing bodies.

Information and Education [B]

Measures	← Basic Guidelines →	Intermediate Guidelines →	Advanced Guidelines →
Information and education [B]	▪ Understandable water bill ▪ Information available	▪ Informative water bill ▪ Water-bill inserts ▪ School program ▪ Public-education program	▪ Workshops ▪ Advisory committee

Information and education are critical to the success of any conservation program. Information and education measures can directly produce water savings, as when customers change their water-use habits. These savings can be difficult to estimate. Also, public education alone may not produce the same amount of sustained water savings as other, more direct approaches (such as leak repairs and retrofits).

But educational measures also can enhance the effectiveness of other conservation measures. For example, it is widely believed that information plays a role in how water consumers respond to changes in price. More generally, customers that are informed and involved are more likely to support the water system's conservation planning goals. Worksheet A-5 is provided for systems to use in assessing their information and education programs.

Understandable water bill. Customers should be able to read and understand their water bills. An understandable water bill should identify volume of usage, rates and charges, and other relevant information.

Information available. Water systems should be prepared to provide information pamphlets to customers on request. Public information and education are important components of every water conservation plan. Consumers are often willing to participate in sound water management practices if provided with accurate information. Furthermore, providing information and educating the public may be the key to getting public support for a utility's water conservation efforts. An information and education program should explain to water users all of the costs involved in supplying drinking water and demonstrate how water conservation practices will provide water users with long term savings.

Informative water bill. An informative water bill goes beyond the basic information used to calculate the bill based on usage and rates. Comparisons to previous bills and tips on water conservation can help consumers make informed choices about water use.

Water bill inserts. Systems can include inserts in their customers' water bills that can provide information on water use and costs. Inserts also can be used to disseminate tips for home water conservation.

School program. Systems can provide information on water conservation and encourage the use of water conservation practices through a variety of school programs. Contacts through schools can help socialize young people about the value of water and conservation techniques, as well as help systems communicate with parents.

Public education program. Utilities can use a variety of methods to disseminate information and educate the public on water conservation. Outreach methods include speakers' bureaus, operating booths at public events, printed and video materials, and coordination with civic organizations.

Workshops. Utilities can hold workshops for industries that might be able to contribute to water conservation efforts. These might include, for example, workshops for plumbers, plumbing fixture suppliers, and builders or for landscape and irrigation service providers.

Advisory committee. A water conservation advisory committee can involve the public in the conservation process; potential committee members include elected officials, local business people, interested citizens, agency representatives, and representatives of concerned local groups. The committee can provide feedback to the utility concerning its conservation plan and develop new material and ideas about public information and support for conservation in the community. Of course, to be meaningful, the utility must be receptive to ideas offered by the committee.

Level 2 Measures

Water-Use Audits [B]

Measures	← Advanced Guidelines → ← Intermediate Guidelines → ← Basic Guidelines →
Water-use audits [B]	▪ Audits of large-volume users ▪ Selective end-use audits ▪ Large-landscape audits

Water-use or end-use audits can provide water systems and their customers with invaluable information about how water is used and how usage might be reduced through specific conservation strategies.

Audits of large-volume users. Utilities can facilitate water audits for large-volume users, both commercial and industrial. Water audits should begin by identifying the categories of water use for the large-volume user. These may include process, sanitary, domestic, heating, cooling, outdoor, and other water uses. Second, a water audit should identify areas in which overall water use efficiency can be improved through alternative technologies or practices.

Large-landscape audits. Water audits can be used for outdoor usage, as well as for indoor processes. Audits of irrigation practices can provide large-volume commercial, industrial, and public users with information about usage and usage-reduction techniques. These audits

can be used in conjunction with irrigation submetering and other landscaping efficiency practices.

Selective end-use audits. Water audits can be widened to include selective end-use audits by customer class, focusing on typical water-use practices within each class. An audit program can be selective in terms of targeting customer groups that have particular needs or for which water conservation could be particularly beneficial. Audits targeted to older housing, for example, can be particularly beneficial in terms of identifying and fixing plumbing leaks.

End-use audits also can be tailored to the usage practices within user groups. For example, residential water audits may focus on plumbing fixtures, lawn and garden water practices, and customer behavior. Residential water audits can be used to make immediate repairs and retrofits. Worksheet A-6 summarizes the components of a residential water audit. All water audits should include a written report to the customer that includes specific ideas for conservation. Water audits can be planned and implemented in conjunction with electric power companies or others interested in promoting conservation practices.

Retrofits [A]

	← Advanced Guidelines →	
	← Intermediate Guidelines →	
Measures	← Basic Guidelines →	
Retrofits [A]	▪ Retrofit kits available	▪ Distribution of retrofit kits ▪ Targeted programs

Water systems can promote conservation through a retrofit program. Retrofitting involves making an improvement to an existing fixture or appliance (versus replacement) in order to increase water-use efficiency. Retrofit programs usually target plumbing fixtures.

Retrofit kits available. A basic retrofit kit may include low-flow faucet aerators, low-flow showerheads, leak detection tablets, and replacement flapper valves. Retrofit kits may be made available free or at cost.

Calculating the savings from a retrofit program requires planners to make a number of assumptions about water use and savings. Some of the assumptions used in retrofitting are:[1]

- Toilets (4-6 flushes per person per day)
- Showerheads (5-15 shower-use minutes per person per day)
- Bathroom Faucets (.5-3 faucet-use minutes per person per day)
- Kitchen Faucets (.5-5 faucet-use minutes per person per day)

[1] Duane D. Baumann, John J. Boland, and W. Michael Hanemann, *Urban Water Demand Management and Planning* (New York: McGraw Hill, 1998): 254.

Many useful textbooks and manuals are available to help planners estimate typical water use and potential savings from retrofits (See Appendixes B and D.)

Distribution of retrofit kits. Water systems can actively distribute retrofit kits directly or through community organizations. Retrofit kits also can be distributed in conjunction with audit programs.

Targeted programs. Utilities might institute targeted programs for different customer classes (residential, commercial, industrial, public buildings, and so on). Retrofits of industrial premises can include facilities used by the public and employees, as well as facilities used for production purposes. A program to retrofit low-income housing units may conserve considerable water in older residential housing units with inefficient plumbing fixtures. Targeted programs also could be designed in cooperation with community organizations. An active retrofit program might be part of a residential water-use audit program. It is important that planners ensure that retrofit programs conform to local plumbing codes and ordinances.

Pressure Management [A]

Measures	← Basic Guidelines →	Intermediate Guidelines →	Advanced Guidelines →
Pressure management [A]		▪ Systemwide pressure management	▪ Selective use of pressure-reducing valves

Reducing excessive pressures in the distribution system can save a significant quantity of water. Reducing water pressure can decrease leakage, amount of flow through open faucets, and stresses on pipes and joints which may result in leaks. Lower water pressure may also decrease system deterioration, reducing the need for repairs and extending the life of existing facilities. Furthermore, lower pressures can help reduce wear on end-use fixtures and appliances.

Systemwide pressure management. For residential areas, pressures exceeding 80 psi should be assessed for reduction. Pressure management and reduction strategies must be consistent with state and local regulations and standards, as well as take into account system conditions and needs. Obviously, reductions in pressure should not compromise the integrity of the water system or service quality for customers.

Pressure-reducing valves. A more aggressive plan may include the purchase and installation of pressure-reducing valves in street mains, as well as individual buildings. Utilities might also insert flow restrictors on services at the meter. Restrictors can be sized to allow for service length, system pressure, and site elevation. Utilities can consider providing technical assistance to customers to address their pressure problems and install pressure-reducing valves to lower the customers' water pressure. This may be especially beneficial for large-use customers.

RECEIVED
2001 NOV -2 PM 1:19

Landscape Efficiency [P]

Measures	← Basic Guidelines →	Intermediate Guidelines →	Advanced Guidelines →
Landscape efficiency [P]		▪ Promotion of landscape efficiency ▪ Selective irrigation submetering	▪ Landscape planning and renovation ▪ Irrigation management

Outdoor water usage drives maximum-day demand, which in turn drives requirements for transmission and treatment facilities. Reducing outdoor usage can thus be a very effective conservation strategy. Outdoor water use can be reduced through efficiency-oriented landscaping principles.

Promotion of landscape efficiency. Utilities can promote the development of water conserving principles into the planning, development and management of new landscape projects such as public parks, building grounds, and golf courses. Utilities can also promote low water-use landscaping by residential and nonresidential customers, especially those with large properties. Utilities can cooperate with local nurseries to ensure the availability of water conserving plants.

Water systems may promote Xeriscaping™, an efficiency-oriented approach to landscaping that encompasses seven essential principles:

- Planning and design
- Limited turf areas
- Efficient irrigation
- Soil improvement
- Mulching
- Use of lower water demand plants
- Appropriate maintenance

Selective irrigation submetering. Selective submetering for irrigation water can be used to improve irrigation management, as well as to introduce irrigation pricing.

Landscape planning and renovation. Existing landscapes can be renovated to incorporate water-conserving practices. Public parks, for example, could be managed to incorporate water-efficient landscaping and reduce or eliminate irrigation. Utilities can work with commercial and industrial customers to plan and renovate landscaping in accordance with water conserving practices.

Irrigation management. Irrigation management systems, using metering, timing, and water-sensing devices, also can be promoted by the water utility for large-volume customers.

Level 3 Measures

Replacements and Promotions [B]

Measures	← Advanced Guidelines → ← Intermediate Guidelines → ← Basic Guidelines →
Replacements and promotions [B]	▪ Rebates and incentives [nonresidential] ▪ Rebates and incentives [residential] ▪ Promotion of new technologies

Rebates and incentives. In order to accelerate the replacements of older fixtures, utilities can offer rebates and other incentives. Utilities can install water-efficient fixtures by providing fixtures at no cost, giving a rebate for consumer purchased fixtures, or arranging suppliers to provide fixtures at a reduced price. Utilities can design incentive rebate programs that are targeted to the nonresidential and residential sectors, and to indoor and outdoor uses.

The feasibility and effectiveness of replacements may depend on state and local plumbing codes. A program to accelerate replacements, coupled with high-efficiency standards, can yield substantial water savings.

Promotion of new technologies. Utilities also can get involved with promoting new technologies by manufacturers and distributors of fixtures and appliances. Demonstrations and pilot programs, and even contests, can be used to introduce and promote new products (such as high-efficiency washing machines).

Reuse and Recycling [B]

Measures	← Advanced Guidelines → ← Intermediate Guidelines → ← Basic Guidelines →
Reuse and recycling [B]	▪ Industrial applications ▪ Large-volume irrigation applications ▪ Selective residential applications

Industrial applications. An alternative water source for some systems is "graywater," or treated wastewater for nonpotable water uses. Water reuse and recycling practices reduce production demands on the water system. Water utilities should work with their nonresidential customers to identify potential areas for reuse or recycling. Some industries can substantially reduce water demand through water reuse (or multiple use) in manufacturing processes. Recycled wastewater can be used for some industrial purposes, agricultural purposes, groundwater recharge, and direct reuse.

Large-volume irrigation applications. Reuse and recycling can be encouraged for large-volume irrigation.

Selective residential applications. In some areas, reuse and recycling can be used in residential applications. Water systems will need to check with local plumbing codes and ordinances for possible conditions and restrictions.

Water-Use Regulation [B]

Measures	← Basic Guidelines → / ← Intermediate Guidelines → / ← Advanced Guidelines →
Water-use regulation [B]	▪ Water-use standards and regulations ▪ Requirements for new developments

Water-use standards and regulations. Regulations should be in place to manage water use during droughts or other water-supply emergencies. In some cases, utilities may find it desirable to extend water-use regulations to promote conservation during nonemergency situations. Examples of water-use regulations are:

- Restrictions on nonessential uses, such as lawn watering, car washing, filling swimming pools, washing sidewalks, and irrigating golf courses.
- Restrictions on commercial car washes, nurseries, hotels, and restaurants.
- Standards for water-using fixtures and appliances (in addition to the federal efficiency standards, which can be found at the end of this Appendix).
- Bans or restrictions on once-through cooling.
- Bans on non-recirculating car washes, laundries, and decorative fountains.
- Bans on certain types of water use or practice.

Requirements for new developments. Another type of regulation is to impose standards on new developments with regard to landscaping, drainage, and irrigation practices.

Many water systems, including privately owned systems, lack authority to implement this measure. Systems that have such authority must exercise it carefully. In general, restrictions on water use should be justified by the system's circumstances and should not unduly compromise the customer's rights or quality of service.

Integrated Resource Management [B]

Measures	← Advanced Guidelines → ← Intermediate Guidelines → ← Basic Guidelines →
Integrated resource management [B]	▪ Supply-side technologies ▪ Demand-side technologies

Supply-side technologies. The idea of integrated resource management is that water often is used jointly with other resources. Systems following the Advanced Guidelines might have opportunities to consider and implement measures that can accomplish integrated resource management, where water conservation is jointly accomplished with the conservation of other resources. On the supply-side, the utility can institute operating practices (including various automation methods, strategic use of storage, and other practices) that achieve energy, chemical, and water savings. Source-water protection strategies, including land-use management methods, can be used to conserve water resources and avoid costly new supplies. Water and wastewater utilities can jointly plan and implement conservation programs to realize savings and share in the benefits.

Demand-side technologies. Integrative practices also can be accomplished on the demand side. Water and energy utilities can conduct comprehensive end-use audits and jointly promote conservation practices by end-users. Large-volume users can work with the utility to make adjustments to processes that reduce water and energy usage and wastewater flows, while saving other resources as well. Utilities that provide wholesale water can work with wholesale customers to design a water conservation program that will be mutually beneficial.

Worksheet A-1: Metering

A. BASIC GUIDELINES

Source metering

What percentage of source withdrawals is metered? _____

Connection metering

Percent of connections metered by customer class:		Percentage of meters that are outdoors:	
Residential	_____ %	_____	%
Industrial	_____ %	_____	%
Commercial	_____ %	_____	%
Public	_____ %	_____	%
Other	_____ %	_____	%

Number of meters needed:		Estimated cost/meter	Estimated total cost
Residential	_____	_____	_____
Industrial	_____	_____	_____
Commercial	_____	_____	_____
Public	_____	_____	_____
Other	_____		

B. INTERMEDIATE GUIDELINES [Basic Guidelines above plus the following]

Frequency of meter reading		Billing frequency	Estimated bills/year
Residential	_____	_____	_____
Industrial	_____	_____	_____
Commercial	_____	_____	_____
Public	_____	_____	_____
Other	_____	_____	_____

Are authorized uses of nonaccount water metered? _____

Schedule for testing source water meters: _____

Schedule for testing connection meters: _____

Are meters correctly sized? _____

C. ADVANCED GUIDELINES [Basic and Intermediate Guidelines above plus the following]

Describe the systems' program to test, calibrate, repair, and replace meters (including schedules): _____

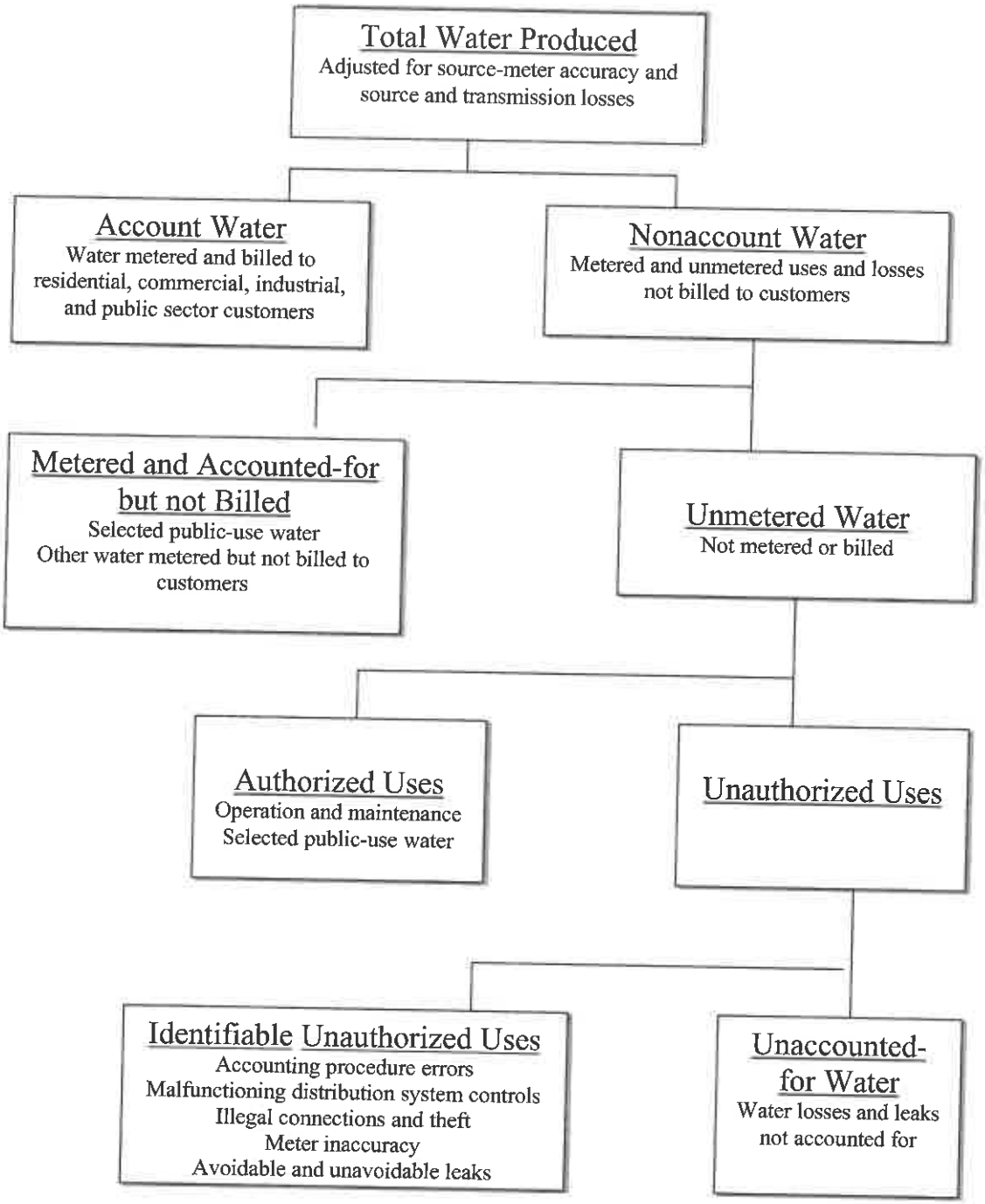


Figure A-1. Water Accounting System

Worksheet A-2: Water Accounting and Loss Control

Line	Item	Volume (gallons)	% of Amount in Line 1
1	**Total Source Withdrawals and Purchases**		100%
2	*Adjustments to source water supply [a]*		
2A	Adjustment for source meter error (+ or -)		
2B	Adjustment for change in reservoir or tank storage (+ or -)		
2C	Adjustment for transmission line losses (-) [a]		
2D	Adjustments for other source contributions or losses (+ or -) [a]		
3	Total adjustments to source water (add lines 2A through 2D))		
4	**Adjusted Source Water (subtract line 3 from line 1)**		%
5	*Metered Water Sales*		
5A	Metered residential sales		
5B	Metered commercial sales		
5C	Metered industrial sales		
5D	Metered public sales		
5E	Other metered sales		
6	Total metered sales (add lines 5A through 5D)		
7	Adjustment for meter reading lag time (+ or -)		
8	Adjustment for meter errors (+ or -) [a]		
9	Adjusted total meter sales (add lines 6 through 8)		
10	**Nonaccount Water (subtract line 9 from line 4)**		%
11	*Metered and accounted-for but not billed*		
11A	Public-use water metered but not billed		
11B	Other water metered but not billed		
12	*Authorized unmetered water: operation and maintenance*		
12A	Main flushing		
12B	Process water at treatment plant		
12C	Water quality and other testing		
13	*Authorized unmetered water: public use*		
13A	Storm drain flushing		
13B	Sewer cleaning		
13C	Street cleaning		
13D	Landscaping in large public areas		
13E	Firefighting, training, and related maintenance		
14	*Other authorized unmetered use*		
14A	Swimming pools		
14B	Construction sites		
14C	Other unmetered uses		
15	Total authorized unmetered water (add lines 11A through 14C)		
16	**Total Unauthorized Losses (subtract line 15 from line 10)**		%
17	*Identifiable water losses and leaks*		
17A	Accounting procedure errors [a]		
17B	Malfunctioning distribution system controls		
17C	Illegal connections and theft		
17D	Meter inaccuracy		
17E	Unavoidable water leaks		
17F	Avoidable water leaks		
18	Total identifiable water losses and leaks (add lines 17A through 17F)		
19	**Unaccounted-For Water (subtract line 18 from line 16)**		%

[a] Methodology subject to industry and regulatory standards.

Worksheet A-3: Strategies for Reducing Water Losses

A. TRANSMISSION LOSSES

Describe strategy for reducing transmission line losses: _____

Estimated annual water savings: _____

B. NONACCOUNT WATER

Describe strategy for reducing authorized unmetered uses: _____

Estimated annual water savings: _____

C. LOSSES AND LEAKS

Describe strategy for reducing identifiable leaks: _____

Estimated annual water savings: _____

D. UNACCOUNTED-FOR WATER

Describe strategy for reducing unaccounted-for water: _____

Estimated annual water savings: _____

Worksheet A-4: Evaluating Effects of Water Rate Changes

Line	Item	Value
1	Current price per gallon	$
2	Current revenue-producing gallons (or cubic feet)	gallons
3	Current annual revenues (line 1 multiplied by line 2)	$
4	Conservation goal (reduction in water use)	gallons
5	Conservation goal as percentage of current annual revenue-producing gallons (line 4 divided by line2)	%
6	Estimate price elasticity of demand (by customer class and/or type of use if applicable)	%
7	Percentage change in price needed to induce conservation (line 5 divided by line 6)	%
8	Calculate revised price level (line 1 multiplied by (1.00 plus line 7))	$
9	Revised annual water usage (line 1 less line 4)	gallons
10	Revised revenues (line 8 multiplied by line 9)	$
11	Annualized fixed costs	$
12	Annual variable costs for revised water usage	$
13	Revised revenue requirements	$
14	Net revenue effect (line 10 less line 13)	$

Note: Prepare for each customer class to the extent feasible.

Worksheet A-5: Checklist for Information and Education

BASIC GUIDELINES	☑
Understandable water bill	
Understandable information about water rates and usage	☐
Information available	
Pamphlet on basic home water conservation practices	☐
Pamphlet on plumbing retrofits and replacements	☐
Pamphlet on summer lawn watering and conservation landscaping	☐
INTERMEDIATE GUIDELINES [Basic Guidelines above plus the following]	☑
Informative water bill	
Compare to past usage (previous month, same period previous year)	☐
Flag unusually high recorded uses and notify customers	☐
Information tailored to customer class	☐
Water-bill inserts	
Information on the cost and value of water	☐
Basic water conservation tips	☐
Information on conservation programs	☐
School program	
Visit classrooms	☐
Distribute curriculum materials, such as worksheets and coloring books	☐
Show short information films or slide shows	☐
Field trips to water system facilities	☐
Contests and recognition for posters, ideas, etc.	☐
Public-education program	
Press releases, public space advertising, and public service announcements (various media)	☐
Conservation information centers and mobile information booths	☐
Speakers bureau, films, and slide shows for community organizations	☐
Coordination with civic and professional organization resources	☐
Special events, such as water conservation fairs	☐
Displays at home shows, garden shows, fairs, libraries, and town halls	☐
Cooperation with retail plumbing to promote conservation	☐
Recognize conserving businesses and industries	☐
ADVANCED GUIDELINES [Basic and Intermediate Guidelines above plus the following]	☑
Workshops	
Workshops for plumbers, plumbing fixture suppliers, and builders	☐
Workshops for landscape and irrigation service providers	☐
Advisory committee	
Creation of a public advisory committee	☐

Worksheet A-6: Checklist for a Residential Water Audit

	☑
Service Meter	
Calibration/flow test	☐
Leak test	☐
Report findings to maintenance personnel	☐
Kitchen	☑
Check faucet flow rate	☐
Offer to install aerator or flow restrictor	☐
Check for drips and leaks	☐
Bath	☑
Shower	
Check showerhead flow rate	☐
Offer to install low-flow showerhead or flow restrictor	☐
Check for drips and leaks	☐
Sinks	
Check faucet flow rate	☐
Offer to install aerator or flow restrictor	☐
Check for drips and leaks	☐
Toilets	
Check for leaks (dye test)	☐
Clean or replace flapper	☐
Check the adjustment of the float arm	☐
Offer to install retrofit devices	☐
Provide information on available rebates	☐
Outside Water Use (Irrigation Season)	☑
Measure the flow rate of sprinklers	☐
Check for leaks in the sprinkler, hose, or sprinkler system	☐
Check the position of sprinklers	☐
Instruct homeowner on efficient water techniques	☐
Recommend a watering schedule based on:	☐
▪ Any water restrictions imposed by local government	☐
▪ Best time of day for watering	☐
▪ Frequency of watering	☐
▪ Length of time for watering	☐
Provide information about water-efficient landscaping practices	☐

Source: Adapted from American Water Works Association, Pacific Northwest Section, *Water Conservation Guidebook for Small and Medium-Sized Utilities* (August 1993). Appendix B.

APPENDIX B
BENCHMARKS USED IN CONSERVATION PLANNING

Table B-1: Recent Estimates of Indoor Water Use With and Without Conservation

Type of Use	Without conservation		With conservation		Savings
	Amount (gpcd)	Percent of total	Amount (gpcd)	Percent of total	
Toilets	18.3	28.4%	10.4	23.2%	44%
Clothes washers	14.9	23.1%	10.5	23.4%	30%
Showers	12.2	18.8%	10.0	22.4%	18%
Faucets	10.3	16.0%	10.0	22.5%	2%
Leaks	6.6	10.2%	1.5	3.4%	77%
Baths	1.2	1.9%	1.2	2.7%	0%
Dish washers	1.1	1.6%	1.1	2.4%	0%
Total indoor water use	64.6	100%	44.7	100%	31%

Source: AWWA WaterWiser, "Household End Use of Water Without and With Conservation," *1997 Residential Water Use Summary - Typical Single Family Home* (http://www.waterwiser.org/wateruse/tables.html).

gpcd = gallons per capita per day

Note: These data are provided for illustrative purposes only and may not be applicable to a given situation. To the extent practical, planners use system-specific assumptions and estimates.

Table B-2: Benchmarks for Estimating Residential End Uses of Water

Type of use	Units	Likely range of average values
INDOOR USES		
Average household size	Persons	2.0-3.0
Frequency of toilet flushing	Flushes/person/day	4.0-6.0
Flushing volumes	Gallons/flush	1.6-8.0
Fraction of leaking toilets	Percent	0-30
Showering frequency	Showers/person/day	0-1.0
Duration of average shower	Minutes	5-15
Shower flow rates	Gallons/minute	1.5-5.0
Bathing frequency	Baths/person/day	0-0.2
Volume of water	Gallons/cycle	30-50
Washing machine use	Loads/person/day	0.2-0.5
Volume of water	Gallons/cycle	45-50
Dishwasher use	Loads/person/day	0.1-0.3
Volume of water	Gallons/cycle	10-15
Kitchen faucet use	Minutes/person/day	0.5-5.0
Faucet flow rates	Gallons/minute	2.0-3.0
Bathroom faucet use	Minutes/person/day	0.5-3.0
Faucet flow rates	Gallons/minute	2.0-3.0
OUTDOOR USES		
Average lot size[a]	Square feet	5000-8000
Average house size[a]	Square feet	1200-2500
Landscape area[a]	Square feet	4000-5000
Fraction of lot size in turf[a]	Percent	30-50
Water application rates[a]	Feet/year	1-5
Percent of homes with pools	Percent	10-25
Pool evaporation losses	Feet/year	3-7
Frequency of refilling pools	Times per year	1-2
Frequency of car washing	Times/month	1-2

Source: Duane D. Baumann, John J. Boland, and W. Michael Hanemann, *Urban Water Demand Management and Planning* (New York: McGraw Hill, 1998), 254.

[a] Reflects single-family averages.

Note: These data are provided for illustrative purposes only and may not be current or applicable. To the extent practical, planners should regionally appropriate or system-specific assumptions and estimates.

Table B-3: Sample Calculation of Water Savings from Showerhead Replacement

The following calculations represent the water savings expected as the result of a showerhead retrofit program. The savings rate represents a difference in average winter water use between homes with low-flow showerheads and homes without low-flow showerheads.

- Nonconserving showerhead flow rate = 3.4 gallons/minute
- Low-flow showerhead flow rate = 1.9 gallons/minute
- Estimated showering time = 4.8 minutes/person/day
- Average winter household water use = 200 gallons per household per day
- Average household size = 2.5 persons
- Water use with nonconserving showerhead = (3.4 gal/min) x (4.8 min/person/day) = 16.3 gpcd
- Water use with low-flow showerhead = (3.4 gal/min) x (4.8 min/person/day) = 9.1 gpcd
- Water savings = 16.3 gpcd – 9.1 gpcd = 7.2 gpcd

At an average household size of 2.5 persons, the savings rate would be 18.0 gallons per household per day (2.5 persons x 7.2 GPCD). The formula for calculating the reduction factors representing the fraction of, for example, single-family winter water use is

R = (18.0 GPHD)/(200 GPHD during winter) = 0.09 (or 9 percent)

Source: Duane D. Baumann, John J. Boland, and W. Michael Hanemann, *Urban Water Demand Management and Planning* (New York: McGraw Hill, 1998): 255.

Note: These data are provided for illustrative purposes only and may not be current or applicable. To the extent practical, planners should regionally appropriate or system-specific assumptions and estimates.

Table B-4: Benchmarks for Savings from Selected Conservation Measures

Category	Measure	Reduction in end use	Life span (years)
LEVEL 1 MEASURES			
Universal metering	Connection metering	20 percent	8 to 20
	Submetering	20 to 40 percent	8 to 20
Water accounting and loss control	System audits and leak detection	Based on system	na
Costing and pricing	10% increase in residential prices	2 to 4 percent	na
	10% increase in nonresidential prices	5 to 8 percent	na
	Increasing-block rate	5 percent	na
Information and education	Public education and behavior changes	2 to 5 percent	na
LEVEL 2 MEASURES			
End-use audits	General industrial water conservation	10 to 20 percent	na
	Outdoor residential use	5 to 10 percent	na
	Large landscape water audits	10 to 20 percent	na
Retrofits	Toilet tank displacement devices (for toilets using > 3.5 gallons/flush)	2 to 3 gpcd	1.5
	Toilet retrofit	8 to 14 gpcd	1.5
	Showerhead retrofit (aerator)	4 gpcd	1 to 3
	Faucet retrofit (aerator)	5 gpcd	1 to 3
	Fixture leak repair	0.5 gpcd	1
	Governmental buildings (indoors)	5 percent	na
Pressure management	Pressure reduction, system	3 to 6 percent of total production	na
	Pressure-reducing valves, residential	5 to 30 percent	na
Outdoor water-use efficiency	Low water-use plants	7.5 percent	10
	Lawn watering guides	15 to 20 percent	na
	Large landscape management	10 to 25 percent	na
	Irrigation timer	10 gpcd	4
LEVEL 3 MEASURES			
Replacements and promotions	Toilet replacement, residential	16 to 20 gpcd	15 to 25
	Toilet replacement, commercial	16 to 20 gpcd	10 to 20
	Showerhead replacement	8.1 gpcd	2 to 10
	Faucet replacement	6.4 gpcd	10 to 20
	Clothes washers, residential	4 to 12 gpcd	12
	Dishwashers, residential	1 gpcd	12
	Hot water demand units	10 gpcd	na
Reuse and recycling	Cooling tower program	Up to 90 percent	na
Water-use regulation	Landscape requirements for new developments	10 to 20 percent in sector	na
	Graywater reuse, residential	20 to 30 gpcd	na
Integrated resource management	Planning and management	Energy, chemical, and wastewater treatment costs	na

Source: Compiled from various sources. Actual water savings can vary substantially according to a number of factors. These data are provided for illustrative purposes only and may not be current or applicable. To the extent practical, planners should regionally appropriate or system-specific assumptions and estimates.
na = not available

Table B-5: Water Efficiency Standards Established by The Energy Policy Act of 1992

Faucets. The maximum water use allowed by any of the following faucets manufactured after January 1, 1994, when measured at a flowing water pressure of 80 pounds per square inch, is as follows:

Faucet type	Maximum flow rate (gallons per minute or per cycle)
Lavatory faucets	2.5 gpm
Lavatory replacement aerators	2.5 gpm
Kitchen faucets	2.5 gpm
Kitchen replacement aerators	2.5 gpm
Metering faucets	0.25 gpc

Showerheads. The maximum water use allowed for any showerhead manufactured after January 1, 1994, is 2.5 gallons per minute when measured at a flowing pressure of 80 pounds per square inch.

Water Closets. (1) The maximum water use allowed in gallons per flush for any of the following water closets manufactured after January 1, 1994, is as follows:

Water closet type	Maximum flush rate (gallons per flush)
Gravity tank-type toilets	1.6 gpf
Flushometer tank toilets	1.6 gpf
Electromechanical hydraulic toilets	1.6 gpf
Blowout toilets	3.5 gpf

(2) The maximum water use allowed for any gravity tank-type white two-piece toilet which bears an adhesive label conspicuous upon installation of the words "Commercial Use Only" manufactured after January 1, 1994 and before January 1, 1997, is 3.5 gallons per flush.

(3) The maximum water use allowed for flushometer valve toilets, other than blowout toilets, manufactured after January 1, 1997, is 1.6 gallons per flush.

Urinals. The maximum water use allowed for any urinals manufactured after January 1, 1994, is 1.0 gallons per flush.

Note: These standards were developed in 1992. New and emerging technologies can increase the cost effectiveness of conservation measures, affect demand forecasts, and eventually lead to the establishment of new standards.

Table B-6: Potential Water Savings From Efficient Fixtures

Fixture [a]	Fixture capacity [b]	Water use (gpd)		Water savings (gpd)	
		Per capita	2.7-person household	Per capita	2.7-person household
Toilets [c]					
Efficient	1.5 gallons/flush	6.0	16.2	na	na
Low-flow	3.5 gallons/flush	14.0	37.8	8.0	21.6
Conventional	5.5 gallons/flush	22.0	59.4	16.0	43.2
Conventional	7.0 gallons/flush	28.0	75.6	22.0	59.4
Showerheads [d]					
Efficient	2.5 [1.7] gal/min	8.2	22.1	na	na
Low-flow	3.0 to 5.0 [2.6] gal/min	12.5	33.8	4.3	11.7
Conventional	5.0 to 8.0 [3.4] gal/min	16.3	44.0	8.1	22.0
Faucets [e]					
Efficient	2.5 [1.7] gal/min	6.8	18.4	na	na
Low-flow	3.0 [2.0] gal/min	8.0	21.6	1.2	3.2
Conventional	3.0 to 7.0 [3.3] gal/min	13.2	36.6	6.4	17.2
Toilets, Showerheads, and Faucets Combined					
Efficient	Not applicable	21.0	56.7	na	na
Low-flow	Not applicable	34.5	93.2	13.4	36.4
Conventional	Not applicable	54.5	147.2	33.5	90.4

Source: Amy Vickers, "Water Use Efficiency Standards for Plumbing Fixtures: Benefits of National Legislation," *American Water Works Association Journal*. Vol. 82 (May 1990): 53.

na = not applicable

[a] Efficient = post-1994
Low-flow = post-1980
Conventional = pre-1980

[b] For showerheads and faucets: maximum rated fixture capacity (measured fixture capacity). Measured fixture capacity equals about two-thirds the maximum.

[c] Assumes four flushes per person per day; does not include losses through leakage.

[d] Assumes 4.8 shower-use-minutes per person per day.

[e] Assumes 4.0 faucet-use-minutes per person per day.

APPENDIX C
ACRONYMS AND GLOSSARY

Acronyms

AWWA	American Water Works Association
BAT	Best available technology
BMP	Best management practice
BuRec	United States Bureau of Reclamation
DOI	United States Department of the Interior
DSM	Demand-side management
EPA	United States Environmental Protection Agency
gpcd	Gallons per capita per day
gpf	Gallons per flush
gpm	Gallons per minute
IRP	Integrated resource plan (or planning)
mgd	Million gallons per day
MOU	Memorandum of understanding
NAWC	National Association of Water Companies
SRF	State Revolving Fund
SDWA	Safe Drinking Water Act
ULFT	Ultra-low-flush toilet

Glossary

appropriation. The right to withdraw water from its source.

audit (end-use). A systematic accounting of water uses by end users (residential, commercial, or industrial), often used to identify potential areas for water reduction, conservation, or efficiency improvement.

audit (system). A systematic accounting of water throughout the production, transmission, and distribution facilities of the system.

available supply. The maximum amount of reliable water supply, including surface water, groundwater, and purchases under secure contracts.

average-day demand. A water system's average daily use based on total annual water production (total annual gallons or cubic feet divided by 365); multiple years can be used to account for yearly variations.

avoided cost. The savings associated with undertaking a given activity (such as demand management) instead of an alternative means of achieving the same results (such as adding supply); can be used to establish the least-cost means of achieving a specified goal. Can be measured in terms of **incremental cost.**

baseline. An established value or trend used for comparison when conditions are altered, as in the introduction of water conservation measures.

beneficial use. A use of water resources that benefits people or nature. State law may define beneficial use.

benefit-cost analysis. A comparison of total benefits to total costs, usually expressed in monetary terms, used to measure efficiency and evaluate alternatives. See also **cost-effectiveness** and **avoided-cost.**

best management practice. A measure or activity that is beneficial, empirically proven, cost-effective, and widely accepted in the professional community.

block. A quantity of water for which a price per unit of water (or billing rate) is established.

budget (water-use). An accounting of total water use or projected water use for a given location or activity.

capital facilities. Physical facilities used in the production, transmission, and distribution of water.

commodity charge. See variable charge.

community water system. According to the SDWA, a drinking water conveyance system serving at least 15 service connections used by year-round residents of the area served by the system or regularly serving at least 25 year-round residents.

conservation (water). Any beneficial reduction in water losses, waste, or use.

conservation pricing. Water rate structures that help achieve beneficial reductions in water usage. See **nonpromotional** rates.

consumptive use. Use that permanently withdraws water from its source.

cost-effectiveness. A comparison of costs required for achieving the same benefit by different means. Costs are usually expressed in dollars, but benefits can be expressed in another unit (such as a quantity of water). See **net benefits.**

customer class. A group of customers (residential, commercial, industrial, wholesale, and so on) defined by similar costs of service or patterns of water usage.

decreasing-block (or declining-block) rate. A pricing structure for which the dollar amount charged per unit of water (such as dollars per gallon) decreases with the amount water usage.

demand forecast. A projection of future demand that can be made on a systemwide or customer-class basis.

demand management. Measures, practices, or incentives deployed by water utilities to permanently reduce the level or change the pattern of demand for a utility service.

demographic. Having to do with population or socioeconomic conditions.

discount rate. A percentage that is used to adjust a forecast of expenditures to account for the time value of money or opportunity costs; it can be based on the utility's cost of capital.

distribution facilities. Pipes, treatment, storage and other facilities used to distribute drinking water to end users.

drought. A sustained period of inadequate or subnormal precipitation that can lead to water supply shortages, as well as increased water usage.

end use. Fixtures, appliances, and activities that use water.

end user. Residential, commercial, industrial, governmental, or institutional water consumer.

escalation rate. A percentage that is used to adjust a forecast of expenditures to account for the increasing value of a good or service over time (apart from the discount rate and inflationary effects).

evapotranspiration. Water losses from the surface of soils and plants.

fixed charge. The portion of a water bill that does not vary with water usage.

fixed costs. Costs associated with water service that do not vary with the amount of water produced or sold.

graywater. Treated wastewater used for nonpotable purposes, such as irrigation.

increasing-block (or inclining-block) rate. A pricing structure for which the dollar amount charged per unit of water (such as dollars per gallon) increases with the amount water usage.

incremental cost. The additional cost associated with adding an increment of capacity.

instream flow. River and stream waters that maintain stream quality, aquatic life, and recreational opportunities.

integrated resource planning. An open and participatory planning process emphasizing least-cost principles and a balanced consideration of supply and demand management options for meeting water needs.

investor-owned utility. A private utility owned by investors and typically regulated by a state public utility commission.

irrigation scheduling. An automated method for optimizing outdoor water use by matching the watering schedule to plant needs.

large-volume user. A water customer, usually industrial or wholesale, whose usage is substantial relative to other users; large-volume users may present unique peaking or other demand characteristics.

leak detection. Methods for identifying water leakage in pipes and fittings.

life span. The expected useful life of a supply-side or demand-side project, measure, or practice. (The life span may not be identical to useful life for tax purposes.)

load management. Methods for managing levels and patterns of usage in order to optimize system resources and facilities.

losses (water). Metered source water less revenue-producing water and authorized unmetered water uses.

low water-use landscaping. Use of plant materials that are appropriate to an area's climate and growing conditions (usually native and adaptive plants). See **Xeriscape.**™

market penetration. The extent to which an activity or measure is actually implemented compared to all potential uses or markets.

marginal-cost pricing. A method of rate design where prices reflect the costs associated with producing the next increment of supply.

master metering. A large meter at a point of distribution to multiple uses or users that could be further submetered. Includes metered wholesale sales.

maximum-day demand. Total production for the water system on its highest day of production during a year.

meter. An instrument for measuring and recording water volume.

mixed-use meter. A meter measuring water use for more than one type of end use (such as indoor and outdoor use).

needle peaks. Persistent levels of **peak demand** that drive the capacity needs of a water system despite reductions in **average demand.**

net benefits. The numerical difference between total benefits and total costs, both of which must be expressed in the same unit (usually dollars). See **cost-effectiveness.**

net present value. The present value of benefits less the present value of costs.

nominal dollars. Forecast dollars that are not adjusted for inflation.

nonaccount water. Metered source water less metered water sales.

nonconsumptive use. Water withdrawn and returned to the source.

nonpromotional rates. Rates that do not encourage additional consumption by water users.

nonresidential customer. A commercial or industrial utility customer.

normalization. Adjustment of a variable to a "normal" level based on averaging over an accepted period of time; used in forecasting.

opportunity cost. The value of a foregone opportunity that cannot be pursued because resources are taken up by a chosen activity.

peak demand. The highest point of total water usage experienced by a system, measured on an hourly and on a daily basis.

per-capita use. Total use divided by the total population served.

per-capita residential use. Residential use divided by the total population served.

precipitation rate (sprinkling). The surface application rate for landscape watering, usually expressed in inches per hour.

present value. Future expenditures expressed in current dollars by adjusting for a discount rate that accounts for financing costs.

pressure regulator. A post-meter device used to limit water pressure.

price elasticity of demand. A measure of the responsiveness of water usage to changes in price; measured by the percentage change in usage divided by the percentage change in price.

rationing. Mandatory water-use restrictions sometimes used under drought or other emergency conditions.

raw water. Untreated water.

real dollars. Forecast dollars that are adjusted for inflation.

retrofit. Replacement of parts in an existing plumbing fixture or water-using appliance in order to improve its operational efficiency.

revenue-producing water. Water metered and sold.

reuse (water). Beneficial use of treated wastewater.

Safe Drinking Water Act (SDWA). Federal drinking water quality legislation administered by the U.S. Environmental Protection Agency (EPA) through state primacy agencies; amended in 1996.

safe yield. The maximum reliable amount that can be withdrawn from a source without compromising quality or quantity, as defined by hydrological studies; can be based on acceptable withdrawals during a critical supply period or drought with a specific probability of occurrence.

seasonal rate. A pricing structure for which the dollar amount charged per unit of water (such as dollars per gallon) varies by season of use; higher rates usually are charged in the season of **peak demand.**

sensitivity analysis. An analysis of alternative results based on variations in assumptions; a "what if" analysis.

service territory. The geographic area served by a water utility.

source-of-supply. Facilities used to extract and/or store raw water prior to transmission and distribution.

source meter. A meter used to record water withdrawn from a surface water or groundwater source, or purchased from a wholesale supplier.

State Revolving Fund (SRF). State loan funds for water utilities established under the Safe Drinking Water Act.

supply management. Measures deployed by the utility that improve the efficiency of production, transmission, and distribution facilities.

submetering. Metering for units comprising a larger service connection, such as apartments in a multifamily building.

surcharge. A special charge on a water bill used to send customers a specific pricing signal and recover costs associated with a particular activity.

system (water). A series of interconnected conveyance facilities owned and operated by a drinking water supplier; some utilities operate multiple water systems.

take-or-pay. A contract provision obligating a purchaser to pay for a commodity whether or not delivery is taken.

tariff. The schedule of a utility's rates and charges.

toilet tank displacement device. A plastic bag or dam installed in a toilet tank to reduce flush volume. Considered effective only for fixtures using more than 3.5 gallons per flush.

toilet flapper. Valve in the toilet tank that controls flushing.

transfers (water). Exchange of water among willing buyers and sellers.

transmission facilities. Pipes used to transport raw or treated water to distribution facilities.

treated water. Water treated to meet drinking water standards.

ultra-low-flush toilet. A toilet that uses not more than 1.6 gallons per flush.

unaccounted-for water. The amount of **nonaccount** water less known or estimated losses and leaks.

uniform rate. A pricing structure for which the dollar amount charged per unit of water (such as dollars per gallon) does not vary with the amount of water usage.

universal metering. Metering of all water-service connections.

unmetered water. Water delivered but not measured for accounting and billing purposes.

user class. See customer class.

variable charge. The portion of a water bill that varies with water usage; also known as a commodity charge.

variable cost. Costs associated with water service that vary with the amount of water produced or sold.

water right. A property right or legal claim to withdraw a specified amount of water in a specified time frame for a beneficial use.

watershed. A regional land area, defined by topography, soil, and drainage characteristics, within which raw waters collect and replenish supplies.

weather-adjusted. Water demand, revenues, or other variables adjusted to a "normal" weather year; also known as weather **normalization.**

wholesale water. Water purchased or sold for resale purposes.

Xeriscape.™ Landscaping that involves seven principles: proper planning and design; soil analysis and improvement; practical turf areas; appropriate plant selection; efficient irrigation; mulching; and appropriate maintenance.

[blank page]

Appendix D
Information Resources

Note: Inclusion on this resource list does not constitute an endorsement by the U.S. Environmental Protection Agency.

Guides and Handbooks

American Water Works Association. *Before the Well Runs Dry. Volume I. A Handbook for Designing a Local Water Conservation Plan.* Denver, CO: American Water Works Association, 1984.

_____. *Evaluation of State Guidelines: Guidelines for State Water Conservation Plans* (WITAF Project #559). Denver, CO: American Water Works Association, August 1997. Prepared by Maddaus Water Management, et al.

_____. *Model Guidelines for Water Conservation Plans: Guidance for State Water Conservation Plans* (WITAF Project #559). Denver, CO: American Water Works Association, November 1997. Prepared by Maddaus Water Management, et al.

Baumann, Duane D., John J. Boland, and W. Michael Hanemann. *Urban Water Demand Management and Planning.* New York: McGraw Hill, 1998.

California Department of Water Resources. *Urban Drought Guidebook.* Sacramento, CA: Department of Water Resources, March 1991.

California Urban Water Conservation Council. *Memorandum of Understanding Regarding Urban Water Conservation in California.* Sacramento, CA: California Urban Water Conservation Council, as amended April 8, 1998.

California Urban Water Management Planning Act. Established AB797, 1983, Amended AB 2661, 1990; AB11X, 1991; AB 1869, 1991; AB 892, 1993; SB 1017,1994; AB 2853, 1994; AB 1845, 1995; SB 1011, 1995.

Colorado State Office of Water Conservation. *Sample Water Conservation Plan for Cherry Creek Valley Water & Sanitation District.* Denver, OWC, not dated. Prepared with AquaSan, Network, Inc.

Connecticut Department of Environmental Protection, et al. *Water Companies Planning Guidance for Water Conservation.* Connecticut Department of Environmental Protection, Connecticut Department of Health Services, Connecticut Department of Public Utility Control, Connecticut Office of Consumer Counsel, Connecticut Office of Policy and Management, December 1990.

Dziegielewski, Benedykt, Eva M. Opitz, Michael Hanemann, and David L. Mitchell. *Urban Water Conservation Programs, Volume III: Experience and Outlook for Managing Urban Water Demands.* Carbondale, IL: Planning and Management Consultants, Ltd., 1995.

Kansas Water Office. *Water Conservation Planning Guidelines.* Topeka, KS: Kansas Water Office, 1986.

_____. *Municipal Water Conservation Plan Guidelines.* Topeka, KS: Kansas Water Office, November 1990.

Massachusetts Water Resources Commission. *Guidelines for Preparing a Concept Plan for the Protection and Management of Water Resource.* Boston, MA: Massachusetts Water Resources Commission, January 1990.

_____. *Water Conservation Standards for the Commonwealth of Massachusetts.* Boston, MA: Executive Office of Environmental Affairs, Massachusetts Water Resources Commission, October 1992.

New York Department of Environmental Conservation. *Water Conservation Manual for Development of a Water Conservation Plan.* Albany, NY: Bureau of Water Resources, DEC, Division of Water, January 1989.

_____. *Water Conservation Program Form.* Albany, NY: Bureau of Water Resources, DEC, June 29, 1989.

Phoenix Water Conservation and Resources Division. *Water Conservation Planning Guide.* Phoenix, AZ: City of Phoenix Water Conservation and Resources Division, November, 1990.

Ploeser, Jane H., J. Douglas Kobrick, and Betsy A. Henderson. "Non-Residential Water Conservation in Phoenix: Promoting the Use of Best Available Technologies," *1990 Annual Conference Proceedings; American Water Works Association.* Denver, CO: American Water Works Association, 1990.

Pontius, Frederick W. and Albert E. Warburton. "Conservation Legislation," *Journal of the American Water Works Association* Vol. 33, No. 10 (October 1991): 10-12.

Rhode Island Department of Environmental Management. *Rules and Regulations for Water Supply Management Planning,* Regulation DEM-DWSM-01-92. Providence, RI: Department of Environmental Management, Division of Water Supply Management. Amended August 13, 1992.

Rocky Mountain Institute. *Water Efficiency: A Resource for Utility Managers, Community Planners, and Other Decisionmakers.* Snowmass, CO: The Water Program, Rocky Mountain Institute, November 1991.

Shelton, Theodore B. and Susan E. Lance. *Designing a Water Conservation Program, An Annotated Bibliography of Source Materials.* New Brunswick, NJ: Rutgers Cooperative Extension, Rutgers University Cook College. U.S. Environmental Protection Agency, Office of Water, September 1993.

U.S. Bureau of Reclamation. *Achieving Efficient Water Management, A Guidebook for Preparing Agricultural Water Conservation Plans.* Washington, DC: Bureau of Reclamation, U.S. Department of the Interior, December 1996. Prepared by Hydrosphere Resource Consultants. http://209.21.0.235/documents/index.htm

_____. *1996 CVPIA Criteria for Water Management Plans.* Washington, DC: Bureau of Reclamation, U.S. Department of the Interior, 1996. http://209.21.0.235/documents/index.htm

_____. *CVPIA Water Management Planning Guidebook.* Washington, DC: Bureau of Reclamation, U.S. Department of the Interior, 1997. http://209.21.0.235/documents/index.htm

_____. *Reclamation Policy for Administering Water Conservation Plans Pursuant to Statutory and Contractual Requirements.* Washington, DC: Bureau of Reclamation, U.S. Department of the Interior, 1996.

Watson, Montgomery. *Water Conservation Guidebook for Small and Medium-Sized Utilities.* Denver, CO: American Water Works Association, Pacific Northwest Section Water Conservation Committee, August 1993.

Washington State Department of Ecology and Department of Health. *Conservation Planning Requirements, Guidelines and Requirements for Public Water Systems Regarding Water Use Reporting, Demand Forecasting Methodology, and Conservation Programs.* Olympia, WA: Ecology Publication #94-24 and Health PUB 331-008, March 1994.

Wescoat, James L., Jr. *Integrated Water Development: Water Use and Conservation Practice in Western Colorado.* Chicago, IL: University of Chicago, Department of Geography, 1984.

Integrated Resource Planning

Beecher, Janice A. "Integrated Resource Planning Fundamentals," *Journal American Water Works Association* (June 1995): 34-48.

Beecher, Janice A. and Patrick C. Mann. *Integrated Resource Planning for Water Utilities.* Columbus, OH: National Regulatory Research Institute, 1992.

Call, Chris. "Demand Management as a Component of IRP: The Long and Winding Road," *Proceedings of Conserv96: Responsible Water Stewardship.* Denver, CO: American Water Works Association, 1996.

Domenica, Michael F., ed. *Integrated Water Resources Planning for the 21st Century: Proceedings of the 22nd Annual Conference, Cambridge, Massachusetts, May 7-11, 1995.* Cambridge, MA: American Society of Civil Engineers, 1995.

Fiske, Gary. *Integrated Resource Planning: A Balanced Approach.* Denver, CO: American Water Works Association, 1996.

Melendy, Cynthia A. "Integrated Resource Planning Overview and Benefits," *Proceedings of Conserv 96: Responsible Water Stewardship.* Denver, CO: American Water Works Association, 1996.

Small Systems

American Water Works Association, Pacific Northwest Section. *Water Conservation Guidebook for Small and Medium-Sized Utilities.* Denver, CO: American Water Works Association, (Prepared by Montgomery Watson, Inc. under the direction of the Water Conservation Committee), August 1993.

Community Resource Group, Inc. *Small Systems Guide to Developing and Setting Water Rates.* Springdale, Arkansas.

Male, J.W., J.B. Moriarty, T.H. Stevens, and C.E. Willis. "Water Supply Costs for Small Private Utilities," *Water Resources Bulletin* Vol. 27, No. 3 (June 1991): 521-526.

Rhorer, Kyle. "Small Systems -- Conservation: It's Not Just for Big Systems," *Journal American Water Works Association.* May 1996.

Rural Community Assistance Program. *Household Water Conservation.* Leesburg, VA. (Not dated.)

_____. *Leak Detection and Repair.* Leesburg, VA. (Not dated.)

_____. *Small Community Water Conservation.* Leesburg, VA. (Not dated.)

_____. *Water Audits.* Leesburg, VA. (Not dated.)

_____. *Water Reuse.* Leesburg, VA. (Not dated.)

Trauth, K.M., B.J. Claborn, and L.V. Urban. "Water Resources Audit for Small Communities," *Journal of the American Water Works Association* Vol. 79, No. 5 (May 1987): 48-51.

Forecasting

Billings, Bruce R. and C. Vaughan Jones. *Forecasting Urban Water Demand.* Denver, CO: American Water Works Association, 0-89867-827-7, 1996.

Darmody, John, William Maddaus, Russell Beatty, Les Taylor, and Watana Yuckpan. "Water Use Surveys-An Essential Component of Effective Demand Management," *1996 Annual Conference Proceedings; American Water Works Association Water Resources.* Denver, CO: American Water Works Association, 1996.

Davis, W.Y. "Forecasting Municipal Water Demand and Conservation Evaluation: The IWR-MAIN System 5.1," *Water –Use Data for Water Resources Management: Proceedings of a Symposium.* American Water Resources Association, 1988: 787-795.

Feather, Timothy D. and Nick Braybrooke. "Conservation Planning, End-Use Analysis, and the Impacts on Maximum-Day Demand," *Proceedings of Conserv96: Responsible Water Stewardship.* Denver, CO: American Water Works Association, 1996.

Nieswiadomy, Michael and Thomas P. Fox. "Calculating Water Savings Using a Spreadsheet Program," *Proceedings of Conserv96: Responsible Water Stewardship.* Denver, CO: American Water Works Association, 1996.

Planning and Management Consultants, Ltd. *IWR-MAIN Water Demand Analysis Software Version 6.0 (copyright): User's Manual and System Description.* Carbondale, IL: Planning and Management Consultants, Ltd., June 1994.

Weber, J.A. "Forecasting Demand and Measuring Price Elasticity," *Journal of the American Water Works Association* Vol. 81, No. 5 (May 1988): 57-65.

Measures

Ahlstrom, Scott B. "Obstacles to Implementing Reuse Projects," *Municipal Wastewater Reuse: Selected Readings on Water Reuse.* (EPA 430/09-91-022), September 1991.

American Water Works Association. *Water Audits and Leak Detection.* Denver, CO: American Water Works Association, 1990.

_____. *The Water Conservation Manager's Guide to Residential Retrofit.* Denver, CO: American Water Works Association, 1993.

_____. *Water Meters – Selection, Installation, Testing, and Maintenance.* Third Edition, Denver, CO: American Water Works Association, 1986.

Arizona Department of Water Resources. *Water Conservation Alternatives Inventory.* Tucson, AZ: Arizona Department of Water Resources, July 1990.

Asano, Takashi and Richard A. Mills. "Planning and Analysis for Water Reuse Projects," *Journal of the American Water Works Association.* (January 1990): 38-47.

Baghdadi, A.H.A. and H.A. Mansy. " Mathematical Model for Leak Location in Pipelines," *Applied Mathematical Modeling* Vol. 12, No.12 (February 1988): 25-30.

Ball, Ken. *Xeriscape™. Programs for Water Utilities.* Denver, CO: American Water Works Association, 1990.

Beecher, Janice A. and Ann P. Laubach. *Compendium on Water Supply, Drought, and Conservation.* Columbus, OH: National Regulatory Research Institute, 1989.

Bennett, Richard E. and Michael S. Hazinski. *Water Efficient Landscape Guidelines.* Denver, CO: American Water Works Association, 1993.

Borland, Dorothy, Liz Inman, Jill Kotewicz, Mark Leese, and Mark Upshaw. *Landscape Design and Maintenance Guidelines for Water Conservation.* January 1993.

California Department of Water Resources. *Water Conservation Reference Manual Urban Conservation Measures.* Sacramento, CA: California Department of Water Resources, office of Water Conservation, March 1984.

Chaplin, Scott Whittier. *Water-Efficient Landscaping, A Guide for Utilities and Community Planners.* Snowmass, CO: Rocky Mountain Institute Water Program, 1994.

Chesnutt, Thomas W., Anil Bamezai and Casey McSpadden. *Mapping the Conserving Effect of Ultra Low Flush Toilets: Implications for Planning.* Santa Monica CA: A&N Technical Services, Inc., June 1992.

Culpin, C. "Revenue Analysis of a Water Meter System," *Journal of the New England Water Works Association* Vol. 102, No. 4 (December 1988): 249-253.

Dean, Robert B. and Edda Lund. *Water Reuse: Problems and Solutions.* New York: Academic Press, 1981.

DeHart, D. "Conservation: A Benefit of Good Management," *Journal of the New England Water Works Association* Vol. 105, No. 1 (March 1991): 43-45.

Easton, W.P. "What is a Water Audit?" *Journal of the New England Water Works Association* Vol. 104, No. 2 (June 1990): 141-145.

Feucht, James R. *Xeriscaping.* A Series of Reports, Colorado State University Cooperative Extension, No. 7.228-7.232, June 1987.

Fiske, Gary S. and Ronnie Ann Weiner. *A Guide to Customer Incentives for Water Conservation.* Barakat & Chamberlin, Inc. California Urban Water Agencies, California Urban Water Conservation Council and U.S. Environmental Protection Agency, February 1994.

Flory, John E. and Thomas Panella. *Long-Term Conservation & Shortage Management Practices.* Tabors Caramanis & Associates. California Urban Water Agencies, February 1994.

Gadbury, D. "Metering Trials for Water Supply," *Journal of the Institution of Water and Environmental Management* Vol. 3, No. 2 (April 1989): 182-187.

Hanke, S.H. "Water Metering and Conservation," *Water/Engineering and Management* Vol. 128, No. 10 (1981): 57-59.

Kiefer, Jack. "Issues in the Estimation of Water Savings: Case Studies from Plumbing Retrofit Programs in Southern California," *Proceedings of Conserve93.* December 1993: 1439-1454.

Laird, Colin. *Water-Efficient Technologies, A Catalog for the Residential/Light Commercial Sector.* Snowmass, CO: Rocky Mountain Institute Water Program, 1991.

Lund, J.R. "Metering Utility Services: Evaluation and Maintenance," *Water Resources Research* Vol. 24, No.6 (June 1988): 802-816.

Maddaus, William O. *Water Conservation.* Denver, CO: American Water Works Association, 1987.

Maloney, Stephen W. *Preventing Water Loss in Water Distribution Systems: Money Saving Leak Detection Programs.* Washington, DC: US Army Corps of Engineers, Construction Engineering Research Laboratory (Technical Report, N-86/05), 1986.

Metcalf & Eddy, Inc. *Wastewater Engineering: Treatment, Disposal, and Reuse.* Third Edition. New York: McGraw Hill, 1991.

Miller, K.J. "U.S. Water Reuse: Current Status and Future Trends," *Water, Environment, and Technology* Vol. 2, No. 11 (November 1990): 83-89.

Moyer, Ellen E. *Economics of Leak Detection – A Case Study Approach.* Denver, CO: American Water Works Association, 1985.

Ploeser, J.H., C.W. Pike, and J.D. Kobrick. "Nonresidential Water Conservation: A Good Investment," *Journal of the American Water Works Association* Vol. 84, No. 10 (October 1992): 65-73.

RECEIVED
2016 NOV -2 PM 1:50

Rathnau, N.M. "Submetering = Water Conservation," *Water Engineering and Management,* Vol. 138, No. 3 (1991): 24-37.

Shuval, H.I. "Development of Health Guidelines for Wastewater Reclamation," *Water, Science, and Technology* Vol. 24, No. 7 (1991): 149-155.

Slater, William and Peter Orzechowski. *Drought Busters.* Los Angeles: Living Planet Press, 1991.

Smith, R.G. and M.R. Walker. "Water Reclamation and Reuse," *Research Journal of the Water Pollution Control Federation* Vol. 63, No.4 (June 1991): 428-430.

Southworth, W.P. "What is a Water Audit?" *Journal of the New England Water Works Association* Vol. 104, No. 2 (June 1990): 141-145.

Sullivan, J.P. and E.M. Speranza. "Proper Metering Sizing for Increased Accountability and Revenue," *Journal of the American Water Works Association* Vol. 84, No. 7 (July 1992): 53-61.

U.S. Environmental Protection Agency. *Cleaner Water Through Conservation.* Washington, DC: USEPA (EPA/841/B/95/002), April 1995. http://www.epa.gov/OW/you/intro.html

_____. *Fact Sheet: 21 Water Conservation Measures for Everybody.* Washington, DC: USEPA, Office of Water (EPA 570/9-91-100), 1991.

_____. *Guidelines for Water Reuse.* Cincinnati: USEPA Municipal Environmental Research Laboratory (EPA 600/88-80-036), 1980.

_____. *Manual: Guidelines for Water Reuse.* Washington, DC: USEPA, Office of Water (EPA/625/R-92/004), 1992.

_____. *Xeriscape Landscaping, Preventing Pollution and Using Resources Efficiently.* Washington, DC: USEPA, Office of Water (EPA/840/B/93/001), 1993.

Vickers, Amy. "Conservation Matters: What Makes a True Conservation Measure?" *Opflow.* June 1996: 8-9.

_____. "The Emerging Demand-Side Era in Water Management." *Journal of the American Water Works Association.* October 1991: 38-43.

_____. "The Energy Policy Act: Assessing its Impact on Utilities." *Journal of the American Water Works Association* Vol. 85 no. 8 (August 1993): 56-62.

_____. *Handbook of Water Use and Conservation.* New York: Lewis Publishing, 1999.

Vickers, Amy and E.J. Markus. "Creating Economic Incentives for Conservation," *Journal of the American Water Works Association* Vol. 84, No. 10 (1992): 42-45.

Wallace, Lynn P. *Water and Revenue Losses: Unaccounted for Water.* Denver, CO: American Water Works Association, 1987.

Walker, Robert E. and Gary F. Kah. *Landscape Irrigation Auditor Handbook.* Irrigation and Research Center, California Polytechnic State University, Version 5.5, June 1990.

Cost-Effectiveness Analysis

Andrews, Laurel, Bill Gavelis, Steve Scott, and Mike King. *Cost-Benefit Analysis of Water Conservation Measures, Part I & II.* Synergic Resources Corporation and Gary Kah Agtech, SRC Report, No. 7363-R6, July 1988.

Baumann, D.D., J.J. Boland, and J.H. Sims. *The Evaluation of Water Conservation for Municipal and Industrial Water Supply: Procedures Manual.* Carbondale, IL: Planning and Management Consultants, Ltd. (Army Engineer Institute for Water Resources Contract Report 80-1), April 1980.

Boland, John, Benedykt Dziegielewski, Duane Baumann, and Chuck Turner. *Analytical Bibliography for Water Supply and Conservation Techniques.* Carbondale, IL: Planning and Management Consultants, Ltd. (U.S. Army Engineer Institute for Water Resources, IWR Contract Report 82-C07), January 1982.

Brown and Caldwell Consultants. *Assessment of Water Savings from Best Management Practices.* Walnut Creek, CA: Brown and Caldwell Consultants, April 1991.

California Urban Water Conservation Council. *Guidelines to Conduct Cost-Effectiveness Analysis of Best Management Practices for Urban Water Conservation.* Los Angeles, CA: Californian Urban Water Conservation Council. Prepared by A&N Technical Services. September 1996.

Campen, James T. *Benefit, Cost and Beyond: The Political Economy of Benefit-Cost Analysis.* Cambridge, MA: Ballinger Publishing, 1986.

Davis, William Y. and Ben Dziegielewsi. "Estimating the Benefits and Costs of Implementing Conservation Measures," *Proceedings of CONSERV 90: The National Conference and Exposition Offering Water Supply Solutions for the 1990s.* Phoenix, AZ, 1990.

Dziegielewski, Benedykt , Duane D. Baumann, and John J. Boland. *The Evaluation of Drought Management Measures for Municipal and Industrial Water Supply.* Institute for Water Resources, U.S. Army Corps of Engineers, CR 83-C-3, December 1983.

Dziegielewski, B., E. Opitz, J. Kiefer, and D. Baumann. *Evaluating Urban Water Conservation Programs: A Procedures Manual.* Carbondale, IL: Planning and Management Consultants, Ltd. (California Urban Water Agencies and American Water Works Association), 1993.

Macy, P.P. and William O. Maddaus. "Cost-Benefit Analysis of Conservation Programs," *Journal of the American Water Works Association* Vol. 81, No. 3 (March 1989): 43-47.

Maddaus, William O. "Evaluating the Benefits and Costs of Proposed Water Conservation," *Proceedings of CONSERV 90: The National Conference and Exposition Offering Water Supply Solutions for the 1990s.* Phoenix, AZ, 1990.

Maddaus, William O. and Peter P. Macy. *Benefit and Cost Analysis of Water Conservation Programs.* Pleasant Hill, CA: Brown and Caldwell Consulting Engineers, 1989

O'Grady, Kevin L., Eva M. Opitz, and Benedykt Dziegielewski. *Evaluating Urban Water Conservation Programs: Workbook.* Carbondale, IL: Planning and Management Consultants, Ltd. (Metropolitan Water District of Southern California), February/March 1994.

Pekelney, David M., Thomas W. Chesnutt, and W. Michael Hanemann. *Guidelines to Conduct Cost-Effectiveness of Best Management Practices for Urban Water Conservation.* Sacramento, CA: California Urban Water Conservation Council, 1996.

Pekelney, David M. and Thomas W. Chesnutt. *Reference Document: Program Design Tool and Savings Estimates.* Sacramento, CA: California Urban Water Conservation Council, 1996.

Sakrison, Rodney G. *Water Supply Source Selection Criteria: Determination of Cost-Effectiveness Thresholds.* Olympia, WA: Washington Department of Ecology.

Rates and Revenues

Agthe, Donald E. and Bruce Billings. "Equity, Price Elasticity, and Household Income Under Increasing Block Rates for Water," *American Journal of Economics and Sociology* Vol. 46 (July 1987): 273-286.

American Water Works Association. *Water Rates and Related Charges.* Denver, CO: American Water Works Association, 1986.

_____. *Managing the Revenue and Cash Flow Effects of Conservation.* Denver, CO: American Water Works Association, 0-89867-845-5, 1996.

Beecher, Janice A., Patrick C. Mann, Youssef Hegazy, and John D. Stanford. *Revenue Effects of Water Conservation and Conservation Pricing: Issues and Practices*. Columbus, OH: National Regulatory Research Institute, 1994.

Beecher, Janice A. and Patrick C. Mann. "The Role of Price in Water Conservation Evidence and Issues," *Proceedings of Conserv96: Responsible Water Stewardship*. Denver, CO: American Water Works Association, 1996.

Beecher, Janice A., Patrick C. Mann, and James R. Landers. *Cost Allocation and Rate Design for Water Utilities*. Columbus, OH: National Regulatory Research Institute, 1990.

Bhatt, N.R. and C.A. Cole. "Impact of Conservation on Rates and Operating Costs," *Journal of Water Resources Planning and Management* Vol. 111, No. 2 (April 1985): 192-206.

California Department of Water Resources. *Water Conservation Guidebook No. 9 – Guidebook on Conservation-Oriented Water Rates.* Sacramento, CA: State of California Department of Water Resources, October 1988.

California Urban Water Conservation Council. *Handbook for the Design, Evaluation, and Implementation of Conservation Rate Structures.* Los Angeles, CA: Californian Urban Water Conservation Council, (Prepared by Thomas W. Chesnutt, A&N Technical Services, et al.), September 1996.

Caswell, M., E. Lichtenberg, and D. Zilberman. "Effects Of Pricing Policies on Water Conservation and Drainage," *American Journal of Agricultural Economics* Vol. 72, No. 4 (November 1990): 883-890.

Chestnutt, Thomas W., Casey McSpadden, and John Christianson. "Revenue Instability Induced by Conservation Rates," *Journal American Water Works Association. (*January 1996): 52-63.

Chesnutt, Thomas W., John Christianson, Anil Bamezai, Casey N. McSpadden, and W. Michael Hanemann. *Revenue Instability and Conservation Rate Structures.* Denver, CO: American Water Works Association, 0-89867-818-8, 1995.

Chicone, David L., Steven C. Deller, and Ganapathi Ramamurthy. "Water Demand Estimation Under Block Pricing: A Simultaneous Equation Approach," *Water Resources Research* Vol. 22 (June 1986): 859-863.

Comer, D. and R. Beilock. "How Rate Structures and Elasticities Affect Water Consumption," *Journal of the American Water Works Association* Vol. 74, No. 6 (June 1982): 192-206.

Cuthbert, R.W. "Effectiveness of Conservation-Oriented Water Rates in Tucson," *Journal of the American Water Works Association* Vol. 81, No.3 (March 1989): 65-73.

Deming, J.L. "Establishing an Income Based Discount Program," *Journal of the New England Water Works Association* Vol. 106, No. 3 (September 1992): 203-205.

Farnkopf, John W. "Dissecting Rate Structures: Identifying Where Further Refinements are Warranted," *Proceedings of Conserv96: Responsible Water Stewardship.* Denver, CO: American Water Works Association, 1996.

Fox, Thomas P. "Analysis, Design and Implementation of a Conservation Rate Structure" *Proceedings of Conserv96: Responsible Water Stewardship*. Denver, CO: American Water Works Association, 1996.

Griffith, F.P. "Peak Use Charge: An Equitable Approach to Charging for and/or Reducing Summer Peak Use," *Canadian Water Resources Journal* Vol. 9, No. 3 (November 1984): 17-21.

Hasson, D.S. and D.G. Ovard. "Using Peaking Factors to Update Water Rates," *Journal of the American Water Works Association* Vol. 79, No. 6 (June 1987): 46-51.

Mann, Patrick C. and Don M. Clark. "Marginal-Cost Pricing: Its Role in Conservation," *Journal of the American Water Works Association.* August 1993.

Martin, W.E., H.M. Ingram, N.K. Laney, and A.H. Griffin. *Saving Water in a Desert City.* Washington, DC: Resources for the Future, 1984.

Martin, W.E. and S. Kulakowski. "Water Price as a Policy Variable in Managing Urban Water Uses: Tucson, Arizona," *Water Resources Research,* Vol. 27, No. 2 (1991): 157-166.

McNeill, Roger and Donald Tate. *Guidelines for Municipal Water Pricing.* Ottawa, Canada: Environment Canada, Social Science Series No. 25, 1991.

Mui, B.G., K.W. Richardson, and J.F. Shannon. "What Water Utility Managers Should Know About Developing Water Rates," *Water Engineering and Management,* Vol. 138, No. 12 (1991): 18-20.

Nieswiadomy, M.L. "Estimating Urban Residential Water Demand: Effects of Price Structure, Conservation, and Education," *Water Resources Research,* Vol. 28, No. 3 (1992): 609-615.

Ozog, Michael T. "Price Elasticity and Net Lost Revenue," *Proceedings of Conserv96: Responsible Water Stewardship*. Denver, CO: American Water Works Association, 1996.

Renshaw, E.F. "Conserving Water Through Pricing," *Journal of the American Water Works Association* Vol. 74, No. 1 (January 1982): 2-5.

Sang, W. H. "The Financial Impact of Water Rate Changes," *Journal of the American Water Works Association* Vol. 74, No. 9 (September 1982): 466-469.

Schlette, T.C. and D.C. Kemp. "Setting Rates to Encourage Water Conservation," *Water Engineering and Management* Vol. 138, No. 5 (May 1991): 25-29.

U.S. Bureau of Reclamation. *Incentive Pricing Handbook for Agricultural Districts.* Washington, DC: Bureau of Reclamation, U.S. Department of the Interior, April 1997. Prepared by Hydrosphere Resource Consultants. http://209.21.0.235/documents/index.htm

_____. *Incentive Pricing Best Management Practice for Agricultural Irrigation Districts.* Washington, DC: Bureau of Reclamation, U.S. Department of the Interior, June 1998. http://209.21.0.235/documents/index.htm

Public Involvement

American Water Works Association Research Foundation. *Public Involvement Strategies: A Manager's Handbook.* Denver, CO: American Water Works Association Research Foundation, 1996.

Baumann, D.D. "Information and Consumer Adoption of Water Conservation Measures," *Proceedings of the National Water Conservation Conference on Publicly Supplied Potable Water.* June 1982:179-190.

Bickel, Blaine W., Hoback, Paul E., and Lamb, Conrad. "Match Your Vision and Image – A Lee's Summit, Missouri Case Study," *1995 Annual Conference Proceedings; American Water Works Association; Management and Regulations.* Denver, CO: American Water Works Association, 1995.

Chaplin, Scott. *Water Efficiency Sampler.* Snowmass, CO: Rocky Mountain Institute Water Program, December 1991.

Darilek, Alice. "Forming a State Water Conservation Program through Public Involvement," *Proceedings of Conserv93: The New Water Agenda.* Denver, CO: American Water Works Association, 1993.

DeHart, D. "Conservation: A Benefit of Good Management," *Journal of the New England Water Works Association* Vol. 105, No.1 (March 1991): 43-45.

Dyballa, Cynthia. "Water Conservation Education and Outreach in the U.S.," *Hydrology and Water Resources Education, Training and Management, Water Resources Publication.* Littleton, CO: 1991.

Henning, Richard W. "How to Obtain and Maintain Public Involvement: The Key to Successful Conservation Programs," *Proceedings of Conserv96: Responsible Water Stewardship*. Denver, CO: American Water Works Association, 1996.

National Wildlife Federation. *A Citizen's Guide to Community Water Conservation.* Washington, DC: U.S. Environmental Protection Agency, 1989.

U.S. Environmental Protection Agency. *Building Support for Increasing User Fees.* Washington, DC: Office of Water, 1989.

Internet Resources

American Water Works Association
http://www.awwa.org/

American Water Works Association WaterWiser: The Water Efficiency Clearinghouse
http://www.waterwiser.org/

American Water Works Research Foundation
http://www.awwarf.com/

American Water Resources Association
http://www.uwin.siu.edu/orgs/awra.html

American Society of Plumbing Engineers
http://www.aspe.org

Association of Metropolitan Water Agencies
http://www.amwa-water.org/water

Bureau of Reclamation, U.S. Department of the Interior.
http://www.usbr.gov/tcg/written/wc.html

Eco Watch
http://www.eacvision.com/Home_Page/accounts/vut/toilet/htm

Green Seal
http://www.greenseal.org

Institute for Water Resources, U.S. Army Corps of Engineers
http://www.wrsc.usace.army.mil/iwr/

National Drinking Water Clearinghouse
http://www.estd.wvu.edu/ndwc/

National Drought Mitigation Center
http://enso.unl.edu/ndmc

National Ground Water Association
http://www.h2o-ngwa.org/

National Watershed Network
http://www.ctic.purdue.edu/watershed/US_watersheds_8digit.html

Natural Resource Conservation Service, U.S Department of Agriculture.
http://www.nrcs.usda.gov/

Rural Community Assistance Program
http://www.rcap.org/

Rural Water Association
http://www.ruralwater.org

Universities Council on Water Resources
http://www.uwin.sin.edu/ucowr.index.html

U.S. Department of Agriculture, Natural Resource Conservation Service
http://www.nrcs.gov/

U.S. Environmental Protection Agency
http://www.epa.gov/owm/genwave.htm

U.S. Geological Survey
http://www.usgs.gov

U.S. Water News
http://www.uswaternews.com

Water Education Foundation
http://www.water-ed.org

Water Environment Federation
http://www.wef.org

Water Online
http://www.wateronline.com/

Water Quality Association
http://wqa.org/

Water Share, U.S. Department of the Interior, Bureau of Reclamation
http://www.watershare.usbr.gov

APPENDIX E
FEDERAL FUNDING SOURCES FOR WATER CONSERVATION

Agency	Elements	Information
U.S. Environmental Protection Agency	Program	Drinking Water State Revolving Fund (DWSRF) Program
	National contact	Jamie Bourne, (202) 260-5557
	Regional contacts	Each state has an agency that administers the program. See Appendix F. Contact information can be found at www.epa.gov/ogwdw/dwsrf.html
	Type of assistance	Primarily loans.
	Eligibility	Drinking water systems including public and private community water systems and non-profit non-community water systems.
	Eligible activities	Construction of facilities which will facilitate compliance with national primary drinking water regulations or further the health protection objectives of the Safe Drinking Water Act.
	Eligible measures	Residential water meters are eligible for DWSRF funding if part of an eligible project.
U.S. Environmental Protection Agency	Program	Clean Water State Revolving Fund (CWSRF) Program
	National contact	Richard Kuhlman, (202) 260-7366. Also see CWSRF website at www.epa.gov/OWM/finan.htm
	Regional contacts	Each state has an agency that administers the program. For state contact call (202) 260-7359.
	Type of assistance	EPA capitalizes state revolving loan funds. States issue or refinance loans, purchase or guarantee local debt, or purchase bond insurance.
	Eligibility	Eligibility varies according to each state's program and priorities. Eligible recipients generally include communities, individuals, citizen's groups, non-profits, Indian Tribes, and others.
	Eligible activities	Eligible projects may include a wide range of water-quality projects, such as: ▪ municipal wastewater treatment facilities ▪ agricultural, rural, and urban runoff control ▪ estuary improvement projects ▪ wet weather flow control ▪ groundwater protection projects
	Eligible measures	At a state's option, the following publicly-owned water conservation measures may be eligible for loan funding: Structural Measures ▪ Meters ▪ Plumbing fixture retrofits or replacements ▪ Efficient landscape irrigation equipment ▪ Gray water recycling ▪ Wastewater reuse Nonstructural Measures ▪ Incentive wastewater service charges ▪ Water use ordinances or regulations ▪ Public education programs

Agency	Elements	Information
Bureau of Reclamation, U.S. Department of the Interior	Program National contact	Water Conservation Field Services Program/Efficiency Incentives Program Cindy Dyballa (202) 208-7589. Also, see the Bureau's Watershare website at www.watershare.usbr.gov
	Regional contacts	Reclamation has five regional offices and 21 area offices located in the 17 western states. For contact information visit the Bureau's Watershare website (see above).
	Type of assistance	Grants are awarded but each program office may administer the program differently.
	Eligibility	Eligible recipients generally include water systems that contract for water supplies through the Bureau of Reclamation.
	Eligible activities	Eligible projects may include a wide range of water conservation projects, including planning, education, demonstration of innovative technologies, and implementation of measures.
	Eligible water conservation measures	The following water conservation measures may be grant eligible: Structural Measures ▪ Meters ▪ Leak detection and control equipment ▪ Plumbing fixture retrofits or replacements ▪ Water efficient appliances (e.g. clothes washers) ▪ Efficient landscape irrigation equipment ▪ Gray water recycling ▪ Commercial/institutional conservation equipment ▪ Industrial reuse or recycling ▪ Wastewater reuse Nonstructural Measures ▪ Conservation or non-promotional rate structure ▪ Water use ordinances or regulation ▪ Public education programs
Rural Utilities Service, U.S. Department of Agriculture	Program	Rural Utilities Service, Water and Wastewater Loan/Grant Program
	National contact	Richard Mansfield (202) 690-2670
	Regional contacts	USDA has an office in each state; contact information can be found on the RUS website www.usda.gov/rus/water
	Type of assistance	Grants and loans (loans are more common).
	Eligibility	Cities and towns with populations less than 10,000 that cannot find private funding.
	Eligible activities	The program primarily funds the construction of drinking water and wastewater infrastructure (approximately 60% of assistance is allocated to drinking water improvements).
	Eligible water conservation measures	Structural Measures ▪ Meters ▪ Leak detection and control equipment ▪ Gray water recycling ▪ Wastewater reclamation and reuse

Agency	Elements	Information
Rural Business-Cooperative Service, U.S. Department of Agriculture	Program	Rural Economic Development Loans and Grants
	National contact	Director, Specialty Lenders Division (202) 720-1400
	Regional contacts	Consult phone directory for the number of the local Office of Rural Development
	Type of assistance	Direct loans (most often) and project grants
	Eligibility	Electric and phone utilities that have current loans with the Rural Utilities Service (RUS) or Rural Telephone Bank loans can apply for zero interest loans or grants, and can in turn offer loans to local businesses, nonprofit organizations, etc.
	Eligible activities	Establishment or expansion of rural businesses or community development projects with job creation, including water and sewer industrial development parks and other infrastructure.
	Eligible water conservation measures	Structural Measures ▪ Meters ▪ Leak detection and control equipment ▪ Plumbing fixture retrofits or replacements ▪ Water-efficient appliances ▪ Commercial/institutional conservation measures ▪ Industrial reuse or recycling ▪ Wastewater reclamation and reuse
National Resources Conservation Service, U.S. Department of Agriculture	Program	Resource Conservation and Development
	National contact	Terry D=Addio, National Program Manager, 202-720-2241
	Regional contacts	Each state has a Natural Resources Conservation Service Office.
	Type of assistance	Advisory service and counseling, project loans and grants possible when funding levels allow. The program can offer technical support in the form of a coordinator for adopted projects (including activities pertaining to water management). While funds are not awarded, the agency can help projects find additional funding elsewhere.
	Eligibility	Applicants must be state or local governments and nonprofit organizations with the authority to plan or carry out activities relating to resource use and development in multi-jurisdictional areas (including Puerto Rico, Virgin Islands, Guam, and Northern Marina Islands). Beneficiaries must be located in a designated resource conservation and development area.
	Eligible activities	Resource conservation and development
	Eligible water conservation measures	Indirect support for both structural and nonstructural measures may be obtained.

Agency	Elements	Information
Economic Development Administration, U.S. Department of Commerce	Program	Economic Development Administrations Public Works and Development Facilities Grants Program
	National contact	David McIlwain (202) 482-5265
	Regional contacts	Each state has a representative; contact information can be found on the Commerce Department website www.doc.gov/eda
	Type of assistance	Grants only.
	Eligibility	Activities to assist in the economic development of economically distressed areas (high unemployment or low income). Most grants are made to rural communities, but urban communities are eligible as well.
	Eligible activities	The program funds public works infrastructure and development facilities, including improvements to drinking water systems and wastewater systems (especially industrial wastewater). Projects that provide immediate assistance will receive special emphasis. Funds may not be used for residential systems.
	Eligible water conservation measures	Structural Measures ▪ Meters ▪ Leak detection and control equipment ▪ Plumbing fixture retrofits or replacements ▪ Gray water recycling ▪ Commercial/institutional conservation measures ▪ Industrial reuse or recycling ▪ Wastewater reclamation and reuse
Appalachian Regional Commission	Program	Appalachian Regional Commission Grant Program
	National contact	Harry Roesch (202) 884-7774
	Regional contacts	Each state has a representative; contact information can be found on the Appalachian Regional Commission website (www.arc.gov).
	Type of assistance	Grants only.
	Eligibility	Activities that expand infrastructure to encourage economic development and meet state environmental statutes in economically distressed areas in Appalachian states from Northeast to Mississippi. Program needs federal agencies (for example RUS, HUD, and Tennessee Valley Authority) to administer funds and requires at least a partial match from either federal, state, or local sources. States make final decisions on whether projects are eligible for funding.
	Eligible activities	The program funds public works infrastructure only, including improvements to drinking water systems and wastewater systems. The water conservation measures can be funded only if they are part of a larger economic-development package.
	Eligible water conservation measures	Structural Measures ▪ Meters Leak detection and control equipment ▪ Gray water recycling ▪ Commercial/institutional conservation measures ▪ Industrial reuse or recycling ▪ Wastewater reclamation and reuse

Agency	Elements	Information
U.S. Department of Housing and Urban Development	Program	Community Development Block Grants
	National contact	Yvette Aidara (202) 708-1322 ext. 4378
	Regional contacts	Each state has a HUD office; contact information can be found on the HUD website www.hud.gov
	Type of assistance	Grants and loans (loans are more common).
	Eligibility	Intended to primarily assist low to moderate income communities. Approximately 70% of the total money goes directly to urban areas, mostly low to moderate income; the remaining 30% is allocated to state programs that target nonentitled low to moderate income areas (population less than 50,000/county population less than 200,000).
	Eligible activities	All kinds of activities are eligible, including planning and management efforts, as long as they are a part of a community economic development project. State programs may choose to prioritize infrastructure funding.
	Eligible water conservation measures	Structural Measures ▪ Meters ▪ Leak detection and control equipment ▪ Plumbing fixture retrofits or replacements ▪ Water-efficient appliances ▪ Water-efficient landscaping or irrigation equipment ▪ Gray water recycling ▪ Commercial/institutional conservation measures ▪ Industrial reuse or recycling ▪ Wastewater reclamation and reuse Nonstructural Measures ▪ Development of nonpromotional water rate structures ▪ Developing water use regulations or wastewater ordinances
Community Planning and Development, U.S. Department of Housing and Urban Development	Program	Empowerment Zones Program (Urban)
	National contact	National Office of Community Planning and Development (202) 708-6339, 1-800-998-9999
	Regional contacts	Directors of Community Planning and Development at regional HUD
	Type of assistance	Grants related to revitalization planning.
	Eligibility	An applicant must be nominated by a local government or state where the area is located. Applicants on behalf of nominated beneficiaries may also include, but are not limited to, state and local governments, regional planning agencies, non-profit organizations, community-based organizations, or partnerships of community members and other entities. The beneficiary (urban area) is eligible if it (1) meets certain population requirements; (2) is an area of pervasive poverty, unemployment, and general distress; (3) does not exceed 20 square miles, and (4) meets other locative requirements. While Round I Zones have been selected, Congress has authorized the selection of 15 additional urban Empowerment Zones.

Agency	Elements	Information
	Eligible activities	Potential Empowerment Zones submit creative plans for revitalization and, if chosen, receive grants to help execute these plans.
	Eligible water conservation measures	Structural Measures ▪ Meters ▪ Leak detection and control equipment ▪ Plumbing fixture retrofits or replacements ▪ Water-efficient appliance ▪ Water-efficient landscaping or irrigation equipment ▪ Gray water recycling ▪ Commercial/institutional conservation measures ▪ Industrial reuse or recycling ▪ Wastewater reclamation and reuse
U.S. Department of Health and Human Services	Program	Empowerment Zones Program (Rural)
	National contact	Victor Vasquez (202) 619-7980
	Regional contacts	Jim Gatz (202) 260-0397 can help identify appropriate state agencies.
	Type of assistance	Project grants
	Eligibility	A rural applicant must be nominated by a local government or state where the rural area is located. Applicants on behalf of nominated beneficiaries may also include, but are not limited to, state and local governments, regional planning agencies, non-profit organizations, community-based organizations, or partnerships of community members and other entities. An area is eligible if it (1) has a maximum population of 30,000; (2) is an area of pervasive poverty, unemployment, and general distress; (3) is smaller than 1,000 square miles; and (4) meets other locative requirements. Round I zones have been selected, 5 additional zones have been authorized by Congress.
	Eligible activities	Potential Empowerment Zones submit creative plans for revitalization and, if chosen, receive grants to help execute these plans.
	Eligible water conservation measures	Structural Measures ▪ Meters ▪ Leak detection and control equipment ▪ Plumbing fixture retrofits or replacements ▪ Water-efficient appliance ▪ Water-efficient landscaping or irrigation equipment ▪ Gray water recycling ▪ Commercial/institutional conservation measures ▪ Industrial reuse or recycling ▪ Wastewater reclamation and reuse
Pacific Northwest Laboratory, U.S. Department of Energy	Program	Pacific Northwest National Laboratory
	National contact	Michael Baechler (503) 417-7553. www.pnl.gov/energystar
	Regional contacts	Not applicable
	Type of assistance	Market transformation.
	Eligibility	Bulk purchase of water-efficient clothes washers by high volume purchasers, including multifamily residential units, builders, utilities, energy commissions, and developers, but not retailers.
	Eligible activities	The program provides access to a specific model of high performance water-conserving clothes washers selected in a national competition.
	Eligible water conservation measures	Structural Measures ▪ Water-efficient appliances

APPENDIX F
STATE CONTACT LIST

State	Primacy Agency	Drinking Water SRF Agency	Water Resource Agency
Alabama	Water Division Department of Environmental Management P.O. Box 301463 Montgomery, AL 36130-1463 334-271-7774 or 334-271-7823 http://www.adem.state.al.us/	Department of Environmental Management 1751 Cong. WM Dickinson Drive P.O. Box 301463 Montgomery, AL 36130-1463 334-271-7773 http://www.adem.state.al.us/	Office of Water Resources Department of Economic and Community Affairs Montgomery, AL 36130 334-242-5499 http://www.state.al.us/govern/adeca3.html
Alaska	Drinking Water Program Division of Environmental Health Department of Environmental Conservation 555 Cordova Street Anchorage, AK 99501-2617 907-269-7647 http://www.state.ak.us/local/akpages/ENV.CONSERV/deh/dec_denh.htm	Facility Construction and Operations Division Department of Environmental Conservation 410 Willoughby Avenue, #105 Juneau, AK 99801-1795 907-465-5136 http://www.state.ak.us/local/akpages/ENV.CONSERV/deh/dec_denh.htm	Water Resources Section Division of Mining and Water Department of Natural Resources 3601 C Street, Suite 200 Anchorage, AK 99503-5929 907-269-8400 http://www.dnr.state.ak.us/mine_wat/water/wrfact.htm
Arizona	Department of Environmental Quality 3033 North Central Avenue Phoenix, AZ 85012 602-207-2300 http://www.adeq.state.az.us/	Drinking Water Section Department of Environmental Quality 3033 North Central Avenue Phoenix, AZ 85012-2809 602-207-4617	Department of Water Resources 500 N. Third Street Phoenix, AZ 85004 602-417-2408
Arkansas	Department of Health 4815 W. Marham Little Rock, AR 72205 501-661-2623 http://health.state.ar.us/	Department of Health 4815 W. Marham Little Rock, AR 72205 501-661-2623 http://health.state.ar.us/	Soil and Water Conservation Commission 101 East Capitol Street Little Rock, AR 72201
California	Division of Drinking Water and Environmental Management Department of Health Services 601 North 7th Street, MS 92, Sacramento, CA 95814 Mail: P.O. Box 942732, Sacramento, CA 94234-7320 916-323-6111 http://www.dhs.cahwnet.gov/prevsrv/ddwem/index.htm	Division of Drinking Water and Environmental Management Department of Health Services P.O. Box 942732 Sacramento, CA 94234-7320 916-323-4344	Department of Water Resources 1020 9th Street, 3rd Floor Sacramento, CA 95814 916-327-1655 http://wwwdwr.water.ca.gov/

State Contact List (continued)

State	Primacy Agency	Drinking Water SRF Agency	Water Resource Agency
Colorado	Water Quality Control Div., Department of Public Health and Environment 4300 Cherry Creek Drive S. Denver, CO 80222-1530 303-692-3500 http://www.state.co.us/gov_dir/cdphe_dir/wq/wqhom.html	Water Quality Control Division Department of Public Health & Environment 4300 Cherry Creek Drive Denver, CO 80222-1530 303-692-3554	Division of Water Resources, Dept. of Natural Resources 1313 Sherman St., Rm. 818 Denver, CO 80203 303-866-3586 http://water.state.co.us/default.htm
Connecticut	Div. of Environmental Health, Bureau of Regulatory Services, Dept. of Public Health 410 Capitol Avenue, P.O. Box 340308 Hartford, CT 06134-0308 860-509-8000 http://www.state.ct.us/dph/	Water Supplies Section Department of Public Health P.O. Box 340308 450 Capitol Avenue (MS# 51 WAT) Hartford, CT 06134-0308 860-509-7333	Bureau of Water Management, Department of Environmental Protection 79 Elm Street Hartford, CT 06106-5127 860-424-3704 http://dep.state.ct.us/water/watrhome.htm
Delaware	Health Systems Protection Division of Public Health Health and Social Services P.O. Box 637 Dover, DE 19903 302-577-4501 http://www.state.de.us/govern/agencies/dhss/irm/dph/hsp.htm	Division of Public Health Department of Health & Social Services P.O. Box 637 Dover, DE 19903 302-739-5410	Division of Water Resources, Department of Natural Resources and Environmental Control 302-739-4860 http://www.dnrec.state.de.us
Florida	Division of Water Facilities Dept. of Environmental Protection Twin Towers Building, 2600 Blair Stone Road, Mail Station #70 Tallahassee, FL 32399 904-488-2996 http://www.dep.state.fl.us:80/	Bureau of Local Government Wastewater Financial Assistance, Dept. of Environmental Protection Twin Towers Building 2600 Blair Stone Road Tallahassee, FL 32399 850-488-8163 http://www.dep.state.fl.us:80/	Office of Water Policy Dept. of Environmental Protection Twin Towers Building 2600 Blair Stone Road Tallahassee, FL 32399 850-488-1554 http://www.dep.state.fl.us:80/ecosystem/waterpol/
Georgia	Water Resources Branch Environmental Protection Division, Dept. of Natural Resources 1152 East Tower 205 Butler Street, SE Atlanta, GA 30334 404-656-4807 http://www.Georgianet.org/dnr/environ/	Environmental Protection Division Drinking Water Permitting & Engineering Program Department of Natural Resources Floyd Towers East, Suite 1362 205 Butler Street, SE Atlanta, GA 30334 404-656-0719	Water Resources Branch, Environmental Protection Division Department of Natural Resources 1152 East Tower 205 Butler Street, SE Atlanta, GA 30334 404-656-4807 http://www.Georgianet.org/dnr/environ/

State Contact List (continued)

State	Primacy Agency	Drinking Water SRF Agency	Water Resource Agency
Hawaii	Safe Drinking Water Branch, Environmental Management Division, Environmental Health Administration, Department of Health 919 Ala Moana Blvd. Honolulu, HI 96814 808-586-4258 http://www.hawaii.gov/health/sdohpg61.htm	Safe Drinking Water Branch, Environmental Management Division, Environmental Health Administration, Department of Health 919 Ala Moana Blvd. (308) Honolulu, HI 96814 808-586-4258 http://www.hawaii.gov/health/sdohpg61.htm	Division of Water Resource Management Land and Natural Resources Department 1151 Punchbowl Street Honolulu, HI 96813 808-587-0214 http://www.hawaii.gov/dlnr/dwrm/dwrm.html
Idaho	Division of Environmental Quality Department of Health and Welfare 1410 North Hilton Boise, ID 83706-1255 208-373-0502 http://www.state.id.us/dhw/hwgd_www/home.html	Bureau of Drinking Water and Wastewater Division of Environmental Quality Department of Health and Welfare 1410 North Hilton Boise, ID 83706-1255 208-373-0291 http://www.state.id.us/dhw/hwgd_www/home.html	Department of Water Resources 1301 N. Orchard Street Boise, ID 83706 208-327-7910 http://www.idwr.state.id.us/idwr/idwrhome.htm
Illinois	Bureau of Water Environmental Protection Agency 2200 Churchill Road, Springfield, IL 62794-9276 217-782-1654 http://www.epa.state.il.us/org/bow/	Division of Public Water Supplies Environmental Protection Agency P.O. Box 19276 Springfield, IL 62794-9276 217-785-8653 http://www.epa.state.il.us/org/bow/	Office of Water Resources, Department of Natural Resources 310 South Michigan Avenue, Room 1606 Chicago, IL 60604 312-793-3129 http://dnr.state.il.us/ildnr/offices/water.htm
Indiana	Office of Water Management Department of Environmental Management 100 N. Senate P.O. Box 6015 Indianapolis, IN 46206-6015 317-232-8476 http://www.ai.org/idem/owm.html	Drinking Water Branch Department of Environmental Management 100 North Senate Avenue P.O. Box 6015 Indianapolis, IN 46206-6015 317-308-3281 http://www.ai.org/idem/owm.html	Division of Water Department of Natural Resources 402 West Washington Street, Indianapolis, IN 46204. 317-232-4161 http://www.dnr.state.in.us/water/index.htm
Iowa	Water Supply Section Water Quality Bureau Environmental Protection Division, Dept. of Natural Resources Wallace State Office Bldg. Des Moines, IA 50319 http://www.state.ia.us/government/dnr/organiza/epd/wtrq/wtrqbur.htm	Water Quality Bureau Department of Natural Resources Wallace Office Building 900 East Grand Street Des Moines, IA 50319 515-281-8869	Water Resources Section Water Quality Bureau Environmental Protection Division, Department of Natural Resources Wallace State Office Bldg. Des Moines, IA 50319 http://www.state.ia.us/government/dnr/organiza/epd/wtrq/wtrqbur.htm

State Contact List (continued)

State	Primacy Agency	Drinking Water SRF Agency	Water Resource Agency
Kansas	Bureau of Water Department of Health and Environment Forbes Field, Building 283 Topeka, KS 66620 785-296-5500 http://www.state.ks.us/public/kdhe/bow.html	Public Water Supply Supervision Bureau of Water Department of Health & Environment Forbes Field, Building 283 Topeka, KS 66620 785-296-5503 http://www.state.ks.us/public/kdhe/bow.html	Kansas Water Office 109 S.W. Ninth Street Suite 300 Topeka, KS 66612-1249 785-296-3185 http://www.ink.org/public/kwo/
Kentucky	Drinking Water Branch Natural Resources and Environmental Protection Cabinet 14 Reilly Road Frankfort, KY 40601 502-564-3410 http://www.state.ky.us/agencies/nrepc/nrhome.htm	Division of Water Drinking Water Branch Department of Natural Resources & Environmental Protection Cabinet 14 Reilly Road Frankfort, KY 40601 502-564-3410	Division of Water, Water Resources Branch Natural Resources and Environmental Protection Cabinet 14 Reilly Road Frankfort, KY 40601 502-564-3410
Louisiana	Office of Public Health Department of Health and Hospitals 1201 Capitol Access Road, P.O. Box 629 Baton Rouge, LA 70821-0629 504-342-9500 http://204.58.127.20/dhh/	Municipal Facilities Division Department of Environmental Quality P.O. Box 82215 Baton Rouge, LA 70884-2215 504-765-0810	Office of Water Resources, Department of Environmental Quality P.O. Box 82215 Baton Rouge, LA 70884 http://www.deq.state.la.us/owr/owr.htm
Maine	Department of Human Services 221 State Street Augusta, ME 04333 207-287-3707 http://www.state.me.us/dhs/main/welcome.htm	Department of Human Services 10 State House Station 157 Capitol Street Augusta, ME 04333-0010 207-287-5685	Water Resource Regulation Division Bureau of Land and Water Quality Department of Environmental Protection 17 State House Station Augusta, ME 04333-0017 207-287-7789 http://www.state.me.us/dep/l&w.gif
Maryland	Water Management Administration Department of the Environment 2500 Broening Highway Baltimore, MD 21224 410-631-3567 http://www.mde.state.md.us/wma/water.html	Public Drinking Water Program Department of the Environment 2500 Broening Highway Baltimore, MD 21224 410-631-3702 http://www.mde.state.md.us/wma/water.html	Water Management Administration Department of the Environment 2500 Broening Highway Baltimore, MD 21224 410-631-3567 http://www.mde.state.md.us/wma/water.html

State Contact List (continued)

State	Primacy Agency	Drinking Water SRF Agency	Water Resource Agency
Massachusetts	Water Resources Commission Department of Environmental Protection 1 Winter Street Boston, MA 02108 617-292-5948 http://www.magnet.state.ma.us/dep/dephome.htm	Department of Environmental Protection 1 Winter Street Boston, MA 02108 617-292-5529 http://www.magnet.state.ma.us/dep/dephome.htm	Water Resources Commission Department of Environmental Protection 1 Winter Street Boston, MA 02108 617-292-5948 http://www.magnet.state.ma.us/dep/brp/dws/dwspubs.htm
Michigan	Drinking Water and Radiological Protection Division Department of Environmental Quality P.O. Box 30630 Lansing, MI 48909 517-335-9218 http://www.deq.state.mi.us/dwr/	Drinking Water and Radiological Protection Division Department of Environmental Quality P.O. Box 30630 Lansing, MI 48909 517-335-8326 http://www.deq.state.mi.us/dwr/	Department of Environmental Quality P.O. Box 30630 Lansing, MI 48909 517-373-7917 http://www.deq.state.mi.us/dwr/
Minnesota	Department of Health 121 East Seventh Place St. Paul, MN 55101 612-215-0700. http://www.health.state.mn.us/	Drinking Water Protection Section Department of Health 121 7th Place East Suite 220 St. Paul, MN 55164-0975 612-215-0746 http://www.health.state.mn.us/	Division of Waters Department of Natural Resources 500 Lafayette Road Saint Paul, MN 55155 612-297-2835
Mississippi	Office of Health Regulation State Department of Health 2423 North State Street P. O. Box 1700 Jackson, MS 39215-1700 601-960-7518 http://www.msdh.state.ms.us/	Division of Water Supply State Department of Health P.O. Box 1700 Jackson, MS 39215-1700 601-960-7518 http://www.msdh.state.ms.us/	Office of Land and Water Resources Department of Environmental Quality P.O. Box 10631 Jackson, MS 39289 http://www.deq.state.ms.us/
Missouri	Public Drinking Water Program Division of Environmental Quality Department of Natural Resources P.O. Box 176 Jefferson City, MO 65102 573-751-5331 http://www.state.mo.us/dnr/deq/pdwp/homepdwp.htm	Public Drinking Water Program Department of Natural Resources P.O. Box 176 Jefferson City, MO 64102 573-751-5331 http://www.state.mo.us/dnr/deq/wpcp/home_wpc.htm	Department of Natural Resources P. O. Box 176, Jefferson City, MO 65102 1-800-334-6946 http://www.state.mo.us/dnr/deq/pdwp/homepdwp.htm

State Contact List (continued)

State	Primacy Agency	Drinking Water SRF Agency	Water Resource Agency
Montana	Department of Environmental Quality P.O. Box 200901 Helena, MT 59620-0901 406-444-2544 http://www.deq.mt.gov/	Technical and Financial Assistance Bureau Department of Environmental Quality P.O. Box 200901 Helena, MT 59620-0901 406-444-6776	Water Resources Division Department of Natural Resources and Conservation 48 N. Last Chance Gulch Helena, MT 59620-2301 406-444-6601 http://www.dnrc.mt.gov/wrd/home.htm
Nebraska	Division of Environmental Health Department of Health and Human Services 301 Centennial Mall South P.O. Box 95007 Lincoln, NE 69509 402-471-2541 http://www.hhs.state.ne.us/enh/index.htm	Department of Health & Human Services 301 Centennial Mall South, 3rd Floor P.O. Box 95007 Lincoln, NE 68509-5007 402-471-2541 http://www.hhs.state.ne.us/enh/index.htm	The Nebraska Natural Resources Commission 301 Centennial Mall South Lincoln, NE 68509 402-471-2081 http://www.nrc.state.ne.us/
Nevada	State Health Division Department of Human Resources 505 East King Street, Room 203 Carson City, NV 89706-7921 702-687-3600 http://www.state.nv.us/health/bhps/sdwp.htm	Bureau of Health Protection Service State Health Division Department of Human Resources 1179 Fairview Drive Carson City, NV 89701-5405 702-687-6615 http://www.state.nv.us/health/bhps/sdwp.htm	Division of Water Planning, Department of Conservation and Natural Resources 1550 E. College Parkway, Suite 142 Carson City, NV 89706-7921 702-687-3600
New Hampshire	Division of Water Resources Department of Environmental Services 64 No. Main Street Concord, NH 03301-4913 603-271-3406 http://www.state.nh.us/des/biowrd.htm	Water Supply Engineering Bureau Department of Environmental Services 6 Hazen Drive P.O. Box 95 Concord, NH 03302-0095 603-271-3503	Division of Water Resources Department of Environmental Services 64 No. Main Street Concord, NH 03301-4913 603-271-3406 http://www.state.nh.us/des/biowrd.htm
New Jersey	Office of Water Policy Analysis Department of Environmental Protection CN-426 Trenton, NJ 08625 609-292-7219 http://www.state.nj.us/dep/	Water Supply Element Department of Environmental Protection CN 426 401 E. State Street, 3rd Floor Trenton, NJ 08625 609-292-7219 http://www.state.nj.us/dep/	Bureau of Water Allocation, Department of Environmental Protection CN-426 401 E. State Street, 3rd Floor Trenton, NJ 08625 609-292-2885 http://www.state.nj.us/dep/

State Contact List (continued)

State	Primacy Agency	Drinking Water SRF Agency	Water Resource Agency
New Mexico	Drinking Water Compliance Section, Field Operations Division, Drinking Water and Community Services Bureau Environment Department 525 Camino de los Marquez, Suite 4 Santa Fe, NM 87502 505-827-7536 http://www.nmenv.state.nm.us/field_op.html	Drinking Water Bureau Environment Department 525 Camino De Los Marquez Suite 4, P.O. Box 26110 Santa Fe, NM 87502 505-827-7536	Office of the State Engineer Interstate Stream Commission P.O. Box 25102 Santa Fe, NM 87504-5102 505-827-6175 http://www.seo.state.nm.us/
New York	Bureau of Public Water Supply Protection, Div. of Environmental Protection Department. of Health 50 Wolf Rd., Room 302 Albany, NY 12233-3505 518-458-6423 http://www.health.state.ny.us/	Bureau of Public Water Supply Protection Department of Health 2 University Place, Room 410 Albany, NY 12203-3313 518-458-6731 http://www.health.state.ny.us/	Division of Water Department of Environmental Conservation 50 Wolf Rd., Room 302 Albany, NY 12233-3505 518-457-2470
North Carolina	Public Water Supply Section Div. of Environmental Health Department of Environment, Health and Natural Resources P.O. Box 29536 Raleigh, NC 27626 919-733-2321 http://www.deh.ehnr.state.nc.us/pws/index.htm	Public Water Supply Section Department of Environment, Health & Natural Resources P.O. Box 29536 Raleigh, NC 27626 919-733-2321 http://www.deh.ehnr.state.nc.us/pws/index.htm	Division of Water Resources, Department of Environment, Health and Natural Resources 512 N. Salisbury Street Raleigh, NC 27604 919-715-3047 http://www.dwr.ehnr.state.nc.us/home.htm
North Dakota	Div. of Municipal Facilities Environmental Health Section Department of Health 1200 Missouri Ave. P.O. Box 5520 Bismarck, ND 58506-5520 701-328-5150 http://www.ehs.health.state.nd.us/ndhd/environ/homepage.htm	Division of Municipal Facilities Department of Health 1200 Missouri Avenue Bismarck, ND 58506 phone: (701) 328-5211 http://www.ehs.health.state.nd.us/ndhd/environ/homepage.htm	North Dakota State Water Commission 900 E. Boulevard Avenue Bismarck, ND 58505 701-328-4989 http://water.swc.state.nd.us/
Ohio	Division of Drinking and Ground Waters Environmental Protection Agency 1800 Watermark Drive P.O. Box 1049 Columbus, OH 43216-1049 614-644-2752 http://www.epa.ohio.gov/ddagw/ddagwmain.html	Division of Drinking Water/ Groundwater Environmental Protection Agency P.O. Box 1049 1800 Watermark Drive Columbus, OH 43216-1049 614-644-2752 http://www.epa.ohio.gov/ddagw/dwsrf.html	Department of Natural Resources Building E-2 1939 Fountain Square Court Columbus, OH 43224 614-265-6610 http://www.dnr.state.oh.us/odnr/soil+water/soil+water.html

State Contact List (continued)

State	Primacy Agency	Drinking Water SRF Agency	Water Resource Agency
Oklahoma	Water Quality Division Department of Environmental Quality 1000 Northeast 10th Street Oklahoma City, OK 73117-1212 405-271-5205 http://www.deq.state.ok.us/water.html	Water Quality Division Department of Environmental Quality 1000 Northeast Tenth Street Oklahoma City, OK 73117-1212 405-271-5205 http://www.deq.state.ok.us/water.html	Water Resources Board 3800 North Classen Blvd. Oklahoma City, OK 73118 405-530-8845
Oregon	Drinking Water Program Health Division Department of Human Resources 500 Summer Street, NE - Salem, OR 97310-1012 503-731-4010 http://www.hr.state.or.us/	Health Division Department of Human Resources 800 NE Oregon Street P.O. Box 14360 Portland, OR 97293-0460 503-731-4010 http://www.hr.state.or.us/	Water Resources Department Commerce Building 158 12th Street Salem, OR 97310 503-378-3739
Pennsylvania	Bureau of Water Supply Management Office of Water Management Department of Environmental Protection P.O. Box 8467 Harrisburg, PA 17105 717-787-5017 http://www.dep.state.pa.us/dep/deputate/watermgt/wsm/wsm.htm	Municipal Financial Assistance Division Department of Environmental Protection P.O. Box 8467 Harrisburg, PA 17105-8467 717-772-4054	Bureau of Watershed Conservation Office of Water Management Department of Environmental Protection P.O. Box 8467 Harrisburg, PA 17105 717-787-5267 http://www.dep.state.pa.us/dep/deputate/watermgt/wc/wc.htm
Rhode Island	Division of Drinking Water Quality Department of Health Three Capitol Hill, Providence, RI 02908-5097 401-277-2231 http://www.state.ri.us/stdept/sd29.htm	Drinking Water Quality Division Department of Health 3 Capitol Hill 209 Cannon Building Providence, RI 02908 401-277-6867	Water Supply Management Division Department of Environmental Management 235 Promenade Street Providence, RI 02908 401-277-4700
South Carolina	Bureau of Water Department of Health and Environmental Control 26 Bull Street Columbia, SC 29201 803-734-5342 http://www.state.sc.us/dhec/eqcburea.htm#	Water Pollution Control Department of Health and Environmental Control 2600 Bull Street Columbia, SC 29201 803-734-5283	Water Resources Division, Department of Natural Resources 1201 Main Street, Suite 1100 Columbia, SC 29201 803-737-0800 http://water.dnr.state.sc.us/water/index.html

State Contact List (continued)

State	Primacy Agency	Drinking Water SRF Agency	Water Resource Agency
South Dakota	Drinking Water Division Department of Environment and Natural Resources 523 E. Capitol Avenue Pierre, SD 57501-3181 605-773-3754 http://www.state.sd.us/state/executive/denr/denr.html	Water and Waste Funding Assistance Department of Environment & Natural Resources Joe Foss Building 523 East Capitol Pierre, SD 57501-3181 605-773-4216 http://www.state.sd.us/state/executive/denr/denr.html	Drinking Water Division Department of Environment and Natural Resources 523 E. Capitol Avenue Pierre, SD 57501-3181 605-773-3754 http://www.state.sd.us/state/executive/denr/denr.html
Tennessee	Division of Water Supply Department of Environment and Conservation L and C Tower, 6th Floor 401 Church Street Nashville, TN 37243 615-532-0191 http://www.state.tn.us/environment/	Division of Water Supply Department of Environment & Conservation 401 Church Street, 6th Floor L&C Tower Nashville, TN 37243-1549 615-532-0155	Division of Water Supply Department of Environment and Conservation L and C Tower, 6th Floor 401 Church Street Nashville, TN 37243 615-532-0191 http://www.state.tn.us/environment/
Texas	Public Drinking Water Section of the Water Utilities Division Natural Resource Conservation Commission P.O. Box 13087 Austin, TX 78711-3087 512- 239-1000 http://www.tnrcc.state.tx.us/	Natural Resources Conservation Commission P.O. Box 13087 Austin, TX 78711-3087 512-239-6020	Water Development Board P.O. Box 13231, Capitol Station Austin, TX 78711 512-463-8061
Utah	Division of Drinking Water, Department of Environmental Quality P.O. Box 144830 Salt Lake City, UT 84114-4830 801-536-4188 http://www.eq.state.ut.us/eqdw/welcome.htm	Division of Drinking Water, Department of Environmental Quality P.O. Box 144830 Salt Lake City, UT 84114-4830 801-536-4197 http://www.eq.state.ut.us/eqdw/welcome.htm	Board of Water Resources P.O. Box 146201 Salt Lake City, UT 84114-6201 801-538-7299 http://www.nr.state.ut.us/wtresc/brddivbf.htm
Vermont	Water Supply Division Department of Environmental Conservation Agency of Natural Resources 103 South Main Street Waterbury, VT 05671-0403 802-241-3600 http://www.anr.state.vt.us/	Water Supply Division Department of Environmental Conservation Old Pantry Building 103 South Main Street Waterbury, VT 05671-0403 802-241-3400	Water Resources Board, Environmental Board National Life Records Center Building, Drawer 20 Montpelier, VT 05602 802-828-3309 http://www.state.vt.us/wtrboard/index.htm

State Contact List (continued)

State	Primacy Agency	Drinking Water SRF Agency	Water Resource Agency
Virginia	Division of Water Supply Engineering Office of Water Programs Department of Health Room 109 1500 East Main Street, Richmond, VA 23219 804-371-2885 http://www.vdh.state.va.us/owp/water_supply.htm	Division of Water Supply Engineering Department of Health 1500 East Main Street, Room 109-31 Richmond, VA 23219 804-786-1768 http://www.vdh.state.va.us/owp/water_supply.htm	Department of Environmental Quality 629 East Main Street Richmond, VA 23240 804-698-4471 http://www.deq.state.va.us/envprog/watqual.html
Washington	Division of Drinking Water Department of Health Airdustrial Way, Building 3 P.O. Box 47822 Olympia, WA 98504-7822 360-586-5207 http://198.187.0.42:80/default.htm	Division of Drinking Water Department of Health Airdustrial Way, Building 3 P.O. Box 47822 Olympia, WA 98504-7822 360-236-3093 http://198.187.0.42:80/default.htm	Department of Ecology Water Resources Program PO Box 47600 Olympia, WA 98504-7600 360-407-6602 http://www.wa.gov/ecology/wr/wrhome.html
West Virginia	Bureau for Public Health Environmental Engineering Division Office Of Environmental Health Services 304-558-2981	Bureau for Public Health Office of Environmental Health Services 815 Quarrier Street #418 Charleston, WV 25301-2616 304-558-2981	Office of Water Resources Division of Environmental Protection 1201 Greenbriar Street Charleston, WV 25311 304-558-2108 http://charon.osmre.gov/wr/wr.html
Wisconsin	Bureau of Drinking Water/ Groundwater Department of Natural Resources P.O. Box 7921 Madison, WI 53707 608-266-0821 http://www.dnr.state.wi.us/eq/wq/dw/	Bureau of Drinking Water/ Groundwater Department of Natural Resources P.O. Box 7921 Madison, WI 53707-7921 608-267-7651 http://www.dnr.state.wi.us/eq/wq/dw/	Water Management Department of Natural Resources 101South Webster Street, WT-2 Madison, WI 53707 608-267-2375 http://www.dnr.state.wi.us/
Wyoming	Water Quality Division Department of Environmental Quality Herschler Building 122 West 25th Street Cheyenne, WY 82002-0600 307-777-7075	Water Quality Division Department of Environmental Quality Herschler Building 122 West 25th Street Cheyenne, WY 82002-0600 307-777-7075	State Engineer Office Herschler Building, 4 East Cheyenne, WY 82002 307-777-5927 http://www-wwrc.uwyo.edu/wrds/seo/seo.html Water Development Comm. 4 West Herschler Building Cheyenne, WY 82002 307-777-7626 http://www-wwrc.uwyo.edu/wrds/wwdc/wwdc.html