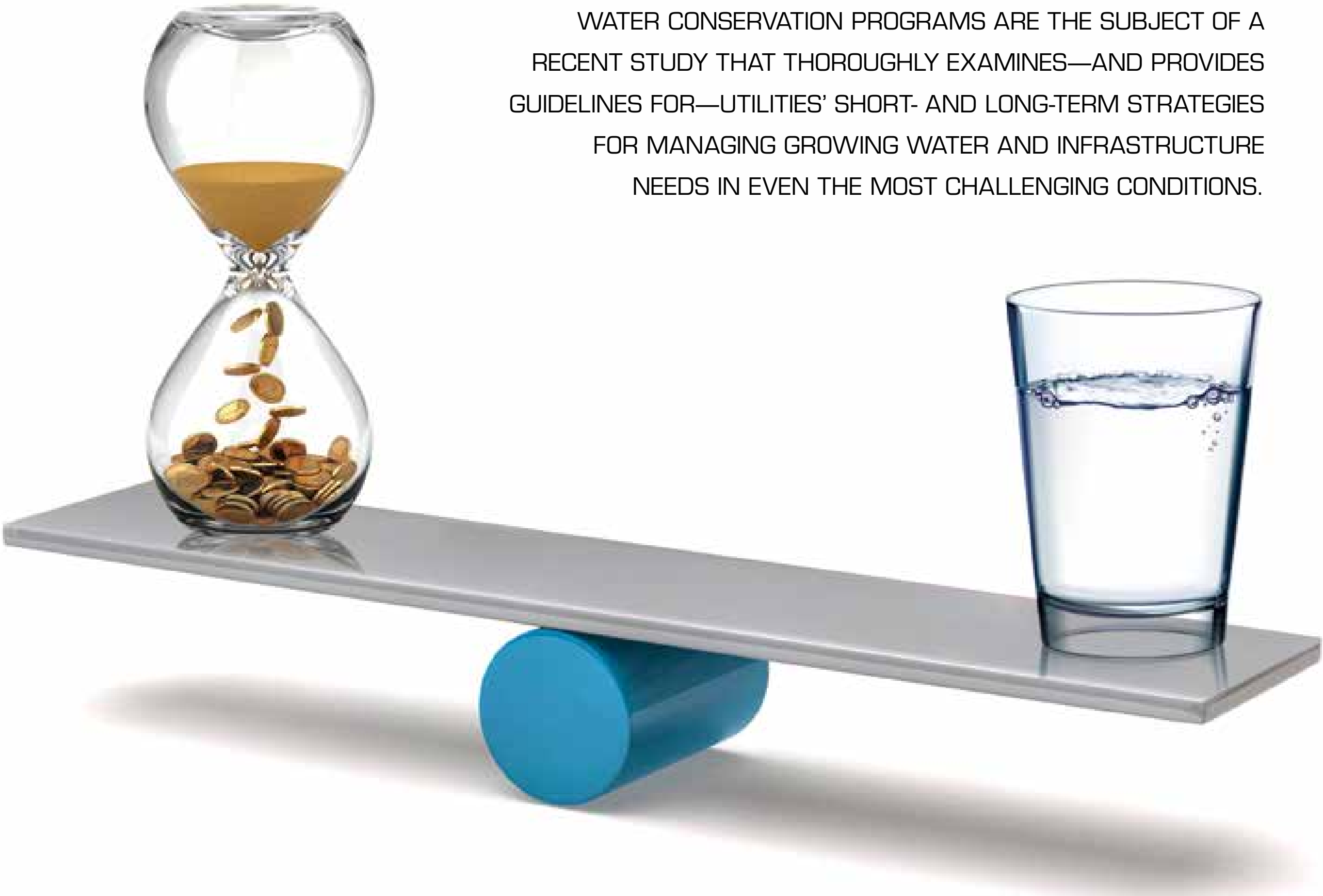


WATER CONSERVATION PROGRAMS ARE THE SUBJECT OF A RECENT STUDY THAT THOROUGHLY EXAMINES—AND PROVIDES GUIDELINES FOR—UTILITIES' SHORT- AND LONG-TERM STRATEGIES FOR MANAGING GROWING WATER AND INFRASTRUCTURE NEEDS IN EVEN THE MOST CHALLENGING CONDITIONS.

THOMAS W. CHESNUTT

A Balanced Approach to Water Conservation in Utility Planning

Water utilities across the nation are struggling with many challenges, including issues of water supply, water quality, wastewater disposal, stormwater management, environmental protection, climatic change, and financial stability. This article summarizes a Water Research Foundation study (WRF 4175) that rigorously examined the historical experience of water utilities employing water-use efficiency (WUE) programs to improve the delivery of water service. The study set forth a conceptual framework for water-conservation planning that distinguishes between short-term drought management and long-term WUE. WRF 4175 identified implementation barriers and solutions and provided detailed utility case studies and a user-friendly decision framework to help utility managers and planners sculpt WUE efforts to match their objectives. The stakes involved in meeting future water demand—to say nothing of infrastructure replacement needs and water quality requirements—strongly suggest a high payoff to science-based knowledge on how to best deploy short-term drought management and long-term WUE.

WRF 4175, *A Balanced Approach to Water Conservation in Utility Planning* (authors are Thomas W. Chesnutt, Gary Fiske, Eric Rothstein, David Pekelney, Janice Beecher, David Mitchell, and Dana Holt), provides concepts, information, and planning tools to better implement cost-effective water conservation. A balanced approach to water conservation requires understanding the role that improving efficiency of a customer's end uses of water can play in accomplishing water utility objectives. Water utilities have increasingly come to appreciate the value of WUE for accomplishing two types of utility objectives:

• **The long-term mission of providing a safe and reliable potable water supply.** Improved WUE is seen as a viable complement to—and in some instances a substitute for—investments in long-term water supplies and infrastructure. For purposes of this article, we call this long-term conservation.

• **The need to manage shortages associated with droughts or other short-term emergencies.** For purposes of this article, we call this shortage management. Improving WUE and reducing water waste are integral to reducing customer shortage costs induced by a water supply shortage.

Many water utilities are struggling with numerous challenges, including issues of water supply, water quality, wastewater disposal, stormwater management, environmental protection, climatic change, and financial stability. WUE (i.e., conservation) has been characterized as either the ultimate answer or a complete waste of money.

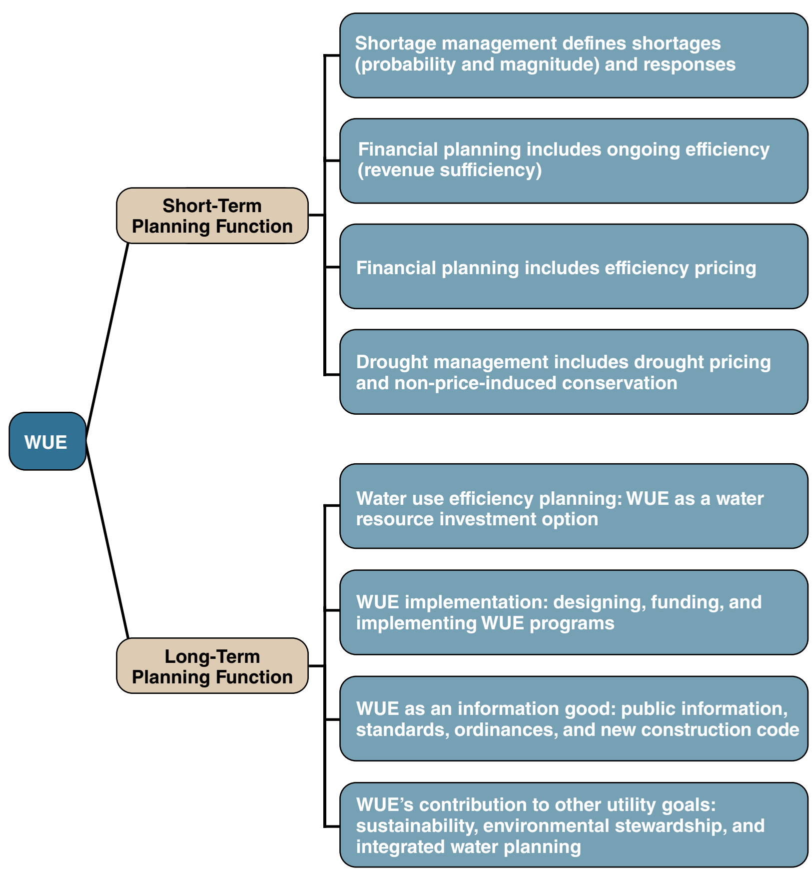
The possibility of supply shortages and the need to ask customers to reduce water consumption underline the importance of rigorously defining supply shortages (in probability and magnitude) and potential water utility responses (via voluntary or mandatory use restrictions, water-waste ordinances, or enforcement). Through shortage-management planning, water utilities can provide information and technical assistance that customers need to improve their WUE and reduce water waste.

The concept of malleable customer water demand, for example, implies that a long-term trend of ongoing improvements in customer end-use efficiency needs to be incorporated into short-term financial sales forecasts. Additionally, the possibility of intentionally changing the incentives offered to customers through conservation pricing needs to be incorporated into near-term financial planning. Last, the widely observed degrading water-system reliability in different parts of the world calls for the examination of how WUE and drought pricing fit into shortage-management planning. In the long term, decisions must be based on (1) whether to make conservation investments; (2) how to design, fund, and implement programs; and (3) how to evaluate the impacts of ongoing programs. These are, in essence, the same decisions that must be made for other resource or infrastructure investments. Moreover, the specific questions that must be answered to inform these decisions are similar. This article provides an analytic framework for evaluating long-term WUE investments.

CONCEPTUAL FRAMEWORK

For purposes of this article, WUE includes short-term shortage-management activities (associated with drought or other time-limited events) as well as long-term water conservation programs. It is important to clearly distinguish between the two because confusion about them has often put water utility efforts at cross-purposes. Therefore, it is important to show how planning for shortage management differs from planning for long-term conservation programs as part of an integrated plan for a portfolio of water resources and how these two types of planning should be linked. Figure 1 presents a schematic of a conceptual framework for WUE analysis that distinguishes short- and long-term planning functions.

FIGURE 1 Conceptual framework for WUE analysis for short- and long-term planning functions



WUE—water-use efficiency

WUE AS A LONG-TERM WATER RESOURCE INVESTMENT

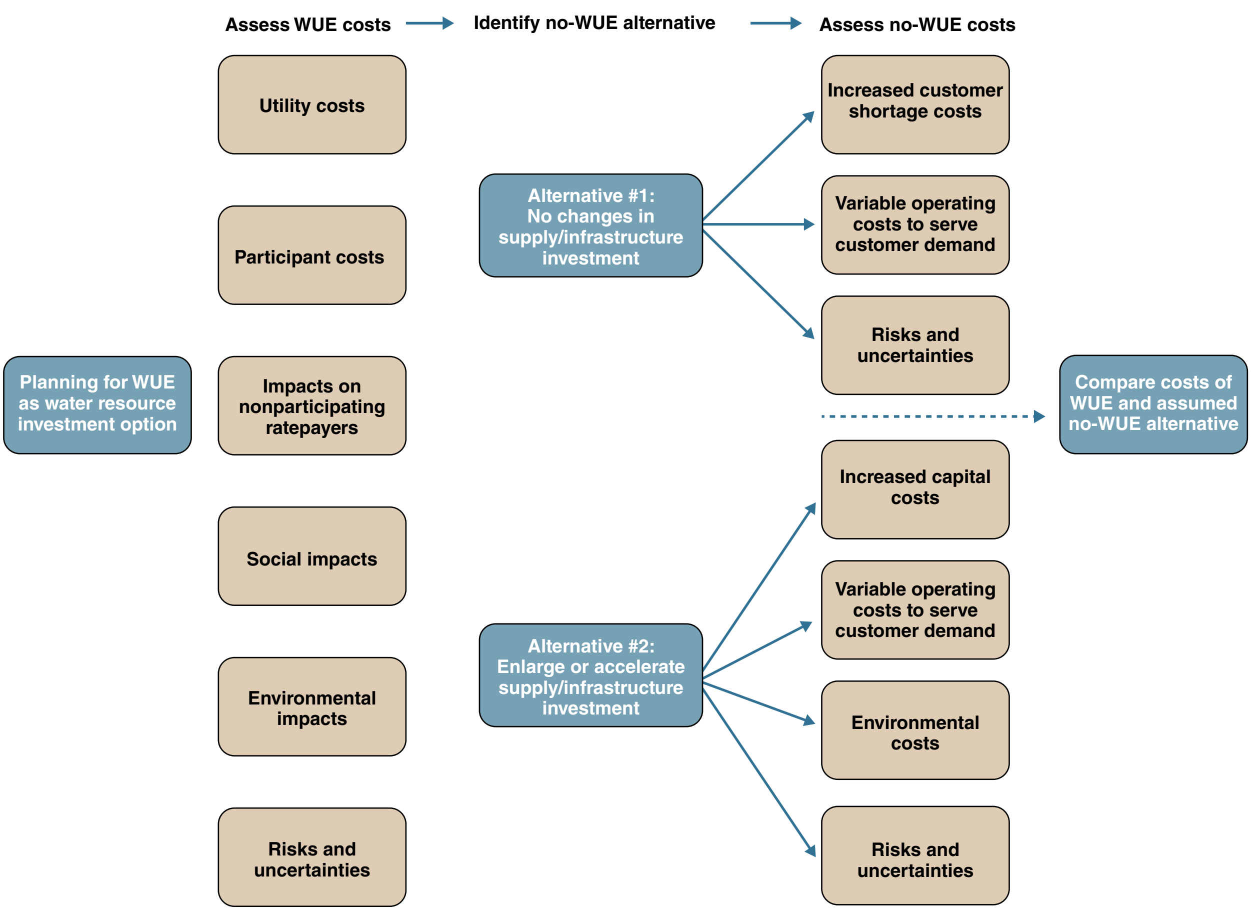
As shown in Figure 2, the first step is to carefully assess the costs of the conservation programs under consideration. These costs must be assessed from various perspectives, each of which may be important to decision-makers. The utility must then determine what it would do if conservation were not pursued. Just as in the case of a supply option, there are two conceptual alternatives:

- Future supply investments will remain unchanged, and customers will incur the costs associated with increased shortage magnitudes and/or frequencies.
- The size and/or timing of one or more future supply and/or infrastructure investments will be modified.

Design and implementation of conservation programs. Design and implementation of conservation programs require significant information on the customer-market potential, differentiated by type of customer. Conservation programs also specify not only the conservation measure or measures but also a delivery mechanism—How can customers be induced to enact water efficiency measures? The research presented a variety of delivery mechanisms ranging from providing information to incentives to direct installation to legal requirements. This spectrum of delivery options ranges from informing to motivating to requiring. The photograph on page 45 shows a result of the Inland Empire Utilities Agency Landscape Transformation Program that used multiple delivery options (i.e., marketing, incentives, awards).

Evaluating conservation programs. It is critical to address the real-world performance of conservation measures and practices as opposed to theoretical estimates or stipulations of water savings and cost. For example, if a new, supposedly more efficient toilet is part of a utility-sponsored program, then a toilet flapper that is short-lived as a result of inferior materials ultimately will become self-defeating

FIGURE 2 Analytical framework for long-term WUE investments



WUE—water-use efficiency

for the program. Improved short-term benefits (a cheaper toilet) have come at the cost of improved long-term water savings. Similarly, plumbing devices that reduce flow rates at the cost of low performance will not remain installed for long. Water utilities can play a central and productive role in setting standards, establishing performance metrics, and conducting performance testing; this role is a necessary ingredient for improvements in WUE. As part of this research, a compendium of water conservation cost and savings was created and hyperlinked into the decision framework CD-ROM included in the research report.

The Inland Empire Utilities Agency Landscape Transformation Program was named the 2014 Local Western Water-Wise Landscape Contest Winner in Ontario, Canada, for a landscape transformation program that used multiple delivery options, including marketing, incentives, and awards.

RISK, UNCERTAINTY, AND INTEGRATED ANALYSIS OF A WATER RESOURCES PORTFOLIO

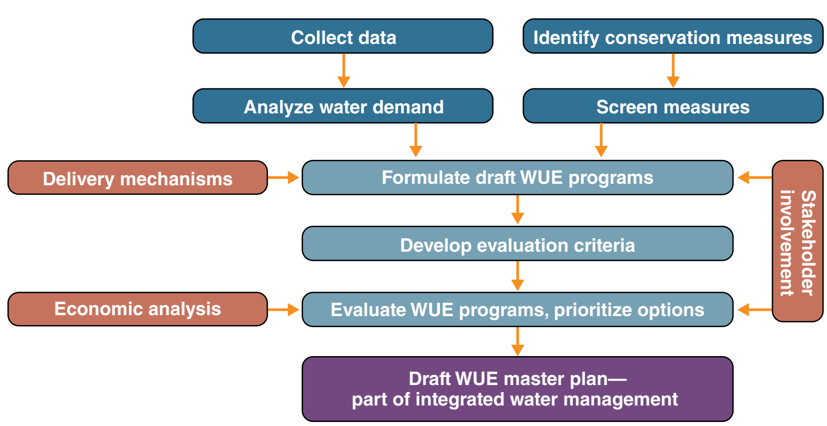
Although a benefit–cost analysis of how conservation programs can affect water system costs provides useful answers to some questions, the systematic effect of conservation programs is best considered in an integrated resource-planning or total-water-management framework. Simple examination of utility direct benefits and costs may not address important environmental values or examine the complex interactions of conservation with other water resources under different conditions of demand and hydrology. The methods contained in this article—avoided-cost analysis, utility benefit–cost analysis, customer benefit–cost analysis, and implementation analysis—are best viewed as useful building blocks for a more integrated water systems analysis. Figure 3 provides a schematic of how such an analysis might look.

ADAPTING THE TRADITIONAL UTILITY FINANCIAL MODEL FOR WUE IMPLEMENTATION

The WRF 4175 project also reviewed the elements of the traditional utility finance model—organized in sequence of the steps used to determine rates—to identify options for enhancing or revising the traditional utility finance model to more effectively support WUE implementation. In addition, a fundamental restructuring of the traditional utility finance model, centered on sustainability and WUE programs within that construct, is offered in a conceptual outline. This section illustrates a spectrum of possible enhancements and adaptations of the traditional utility finance model that may be used to more effectively support WUE implementation. Reassessing the definition of water service to include WUE objectives (sustainability and customer service) was a primary adaptation. Incorporating an efficient price signal into rate-setting objectives, including drought pricing, was another.

Efficient pricing in a nutshell. Analysts have shown that water rates can be used as an extremely valuable public policy tool. Water rates can be more than a means of meeting utility revenue requirements;

FIGURE 3 Example of integrated analysis in a conservation master plan



WUE—water-use efficiency

they also can help communicate the social costs of water scarcity. Water users then can base their consumption decisions on a more accurate accounting of the benefits and costs of using more or less water. If done correctly, the pricing of water can be a powerful means of conveying the cost and scarcity of the resource to water users, most of whom experience very little connection between their water use and their total bill. In an era in which customer water demands are changing while water supplies are variable or diminishing, it is important to apply economic tools to communicate the true value of freshwater.

Analysts have shown that water rates can be used as an extremely valuable public policy tool.

Drought pricing. In the short term, when customers are called on to conserve water in response to shortage, the revenue stream of the utility will be affected in a predictable way. How can water rates be designed in advance to ensure net revenue—that is, the difference between revenue and expenses—neutrality? The WRF Drought Response Model (on the WRF 4175 report CD-ROM) contains a model designed to facilitate this analysis.

The WRF Drought Response Model requires as inputs utility choices to plan out for each drought level:

- ***Summary of model drought response levels and water restrictions.*** This summary defines each drought response level and states whether the restrictions are voluntary or mandatory, the expected conservation targets, and the utility-defined drought stage or level.
- ***Set nonprice conservation targets and expected compliance rate.*** Once the nonprice conservation target and compliance rates are entered and net nonprice conservation percentage is created, proceed to next step.
- ***Enter costs of a drought response program.*** Marketing costs may be entered for mail stuffers, radio and newspaper ads, and public events, as well as supplemental costs for staff and site visits.
- ***Enter short-run avoided costs of water supply.*** These are the water supply expenses that will not be incurred during drought-induced curtailments.

As outputs, the WRF Drought Response Model provides results that embed customer-demand response, including both nonprice-induced and price-induced demand reductions. These outputs are

- Sales and commodity revenue under status quo
- Sales and commodity revenue under drought response level
- Difference in sales and revenues between status quo and drought response level
- Difference in net revenue

Water and wastewater avoided-cost models. Almost all energy utilities have production-cost models that are used in short- and long-term planning. Water utilities have not always been explicit about the cost consequences of additional use or non-use. The concept of avoided cost is one way to place a price tag on the value of not using additional water. The avoided cost also can be thought of as the quantified "benefit" produced by WUE; an empirical understanding of benefits and costs lies at the core of improved planning for WUE implementation. WRF and the California Urban Water Conservation Council (CUWCC) were involved in developing two companion models to estimate costs that are avoided on the water supply and wastewater systems as a result of conservation-induced demand reductions. Both of these models distinguish between two types of avoided costs:

- ***Long-run avoided costs.*** These involve the deferral and/or downsizing of planned additions and expansions of particular water supplies and/or facilities as a result of WUE.
- ***Short-run avoided costs.*** These are the variable operating costs that are avoided by the utility as a result of the reduced operations and/or flows through particular system components and/or reduced water purchases.

Both of these avoided-cost components are differentiated by season, so the avoided costs in the peak-demand season may differ from those in the off-peak season. They also may change over time as cost components escalate and as system configurations change. Figure 4 is the logic flow of the CUWCC/US Environmental Protection Agency Wastewater Avoided-Cost Model in which clicking on a flow object takes the user to the model input or output sheet.

Figure 5 depicts the direct incremental costs of water supply as a vector over time. This cost structure is divided seasonally (peak versus off-peak) and is depicted graphically to make it easier to communicate upticks in avoidable water supply costs at expansion-path junctures.

Economic analysis of conservation programs. There are two robust models available to water utilities to assist them in their economic analyses of their conservation programs—one developed by WRF and one by the Alliance for Water Efficiency (AWE). (The AWE Water Conservation Tracking Tool is available free of charge to AWE utility members.)

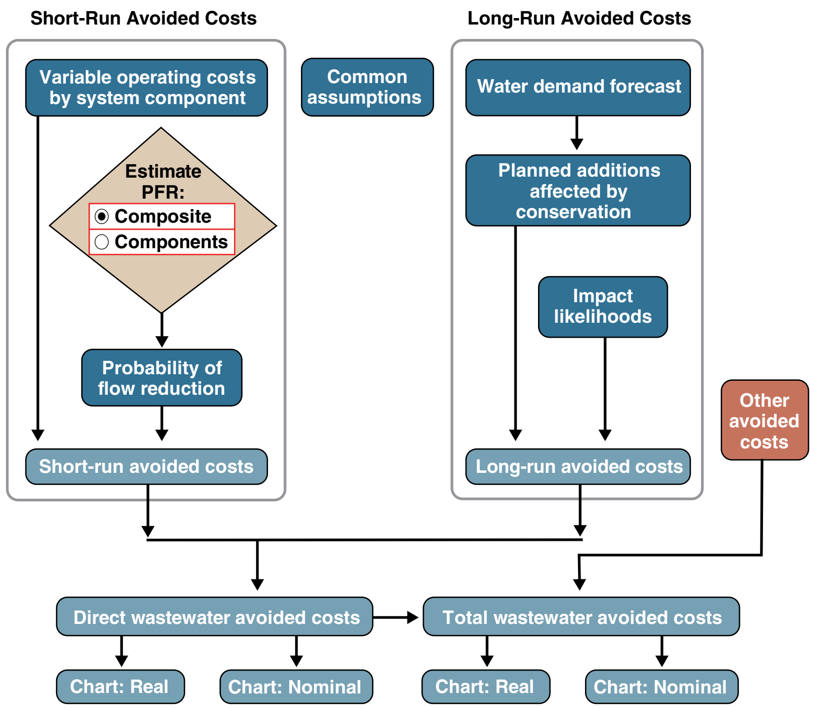
The WRF Conservation Benefit–Cost Model (WRF BCM) is an Excel spreadsheet that quickly calculates water savings, costs, economic benefits, benefit–cost ratios, net benefits, and water bill impacts for individual conservation programs. The user must first enter various assumptions that are common to all programs. These include forecasts of avoided water supply and wastewater costs, which can be imported directly from the two avoided-cost models described earlier. (It is not required that these avoided-cost forecasts come from these models. They may also be the result of other analyses performed by the utility.)

The user then enters program-specific savings and cost parameters, which the model uses to compute the associated benefit–cost results. The model also calculates combined results for all of the programs.

The WRF BCM computes net benefits and benefit–cost ratios (BCRs), which are the difference between, or quotient of, the present value of the program's economic benefit and the present value of the program's costs. Of course, both the benefits and costs will differ among subgroups. Examples follow.

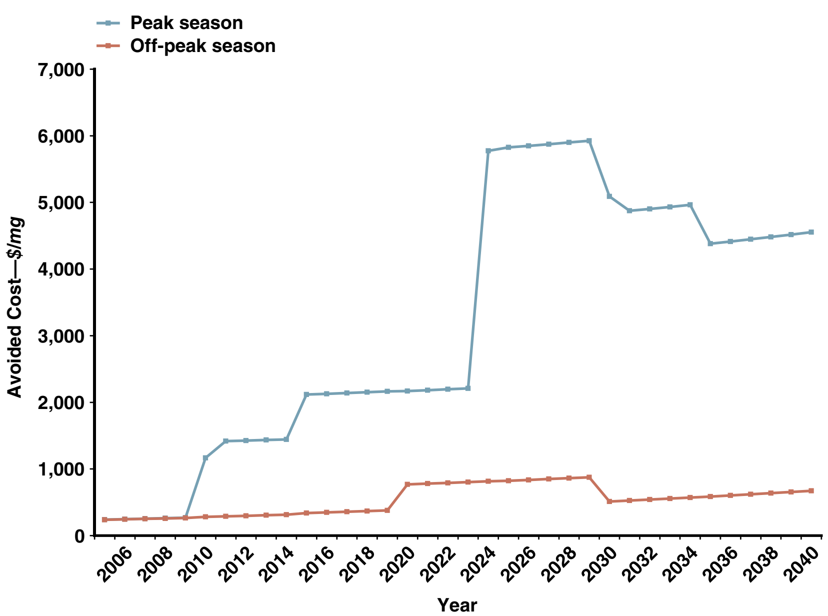
- From the perspective of all ratepayers (the so-called utility perspective), the economic benefit of a WUE program each year is the product of that year's forecasted water savings and avoided costs. Each year's cost is the program's total administrative and incentive costs.
- From the perspective of WUE program participants, the economic benefit is the water and sewer bill savings resulting from reduced water use. The cost is the participant's share of the program costs not paid by the utility. For example, if a utility incentive payment covers only a portion of the cost of a device or fixture, the remaining portion is a cost to the participant. In addition, participants may see changes in their energy bills or incur added (or reduced) ongoing maintenance costs as a result of the program. All of these affect how the program is viewed by potential participants.
- The bill savings that are the primary economic benefit to participating customers are an economic cost that is spread among all ratepayers. Thus, in addition to enjoying their portion of the benefits of the utility's avoided costs and bearing their portion of the WUE program costs, ratepayers who do not participate in

FIGURE 4 CUWCC Wastewater Avoided-Cost Model flow chart



CUWCC—California Urban Water Conservation Council, PFR—probability of flow reduction

FIGURE 5 WRF/CUWCC Direct Utility Avoided-Cost Model: Sample water supply avoided-cost chart



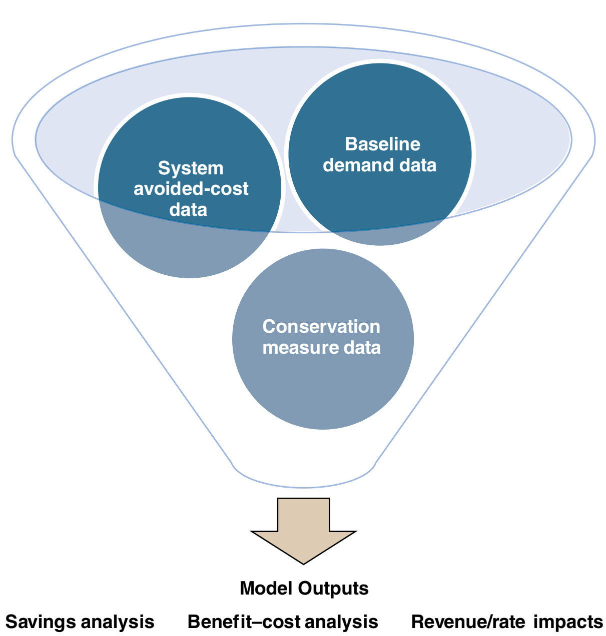
WRF/CUWCC—Water Research Foundation/California Urban Water Conservation Council a conservation program must make up for a portion of the revenue losses associated with the reduced use by program participants.

It is often useful to measure the economic impact of a WUE program on all or a subset of utility ratepayers by the effect on that group's average monthly water bills. The WRF BCM estimates these bill changes by year, which are based on estimates of annual water savings and WUE program costs and on forecasts of water rates. For any ratepayer subgroup, a positive net benefit (i.e., the BCR is greater than 1) means the present value of average bill changes for that subgroup is negative (i.e., bill amounts decrease); a negative net benefit (i.e., a BCR that is less than 1) means that the present value of average bill changes for that subgroup is positive (i.e., bill amounts increase). It is particularly important to realize that a positive net benefit from the utility perspective means that the present value of the water bill changes to all customers will be negative (i.e., on average, across all participating and nonparticipating customers, the typical water bill will go down).

The AWE Water Conservation Tracking Tool is an Excel-based tool for evaluating the water savings, costs, and benefits of urban water conservation programs. In addition to providing users a standardized methodology for water savings and benefit–cost accounting, the tool includes a library of predefined, fully parameterized conservation activities from which users can construct conservation programs.

Figure 6 is a schematic of the AWE Water Conservation Tracking Tool, which is sophisticated in its depiction of active and passive conservation while emphasizing user-friendliness. Though the AWE tool displays water demand, it is not a water-demand forecasting model. The forecast of base water demand by customer class is required as an input for the AWE tool.

FIGURE 6 AWE Water Conservation Tracking Tool: Inputs to outputs



AWE—Alliance for Water Efficiency

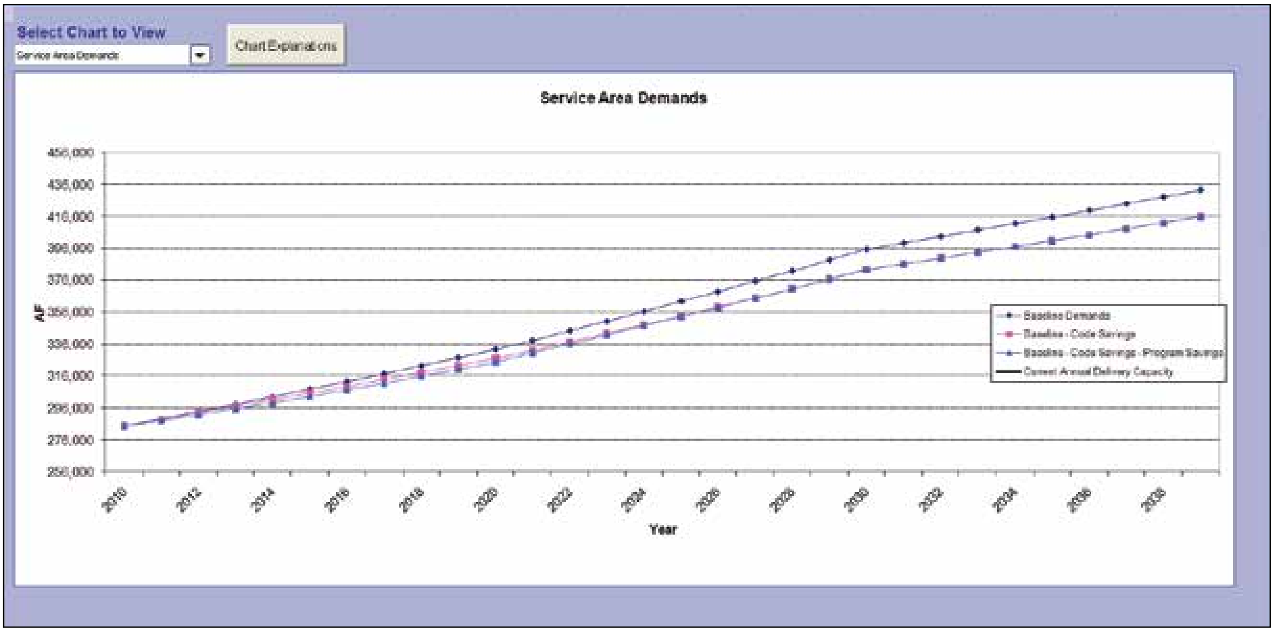
Water agencies and their staff can use the tool in a variety of ways to aid their water resource planning and operations:

- The tool can be used to quickly compare alternative conservation measures in terms of their water-savings potential, impact on system costs, and potential benefits to utility customers.
- The tool can be used in the development of long-range conservation plans. It can be used to construct conservation portfolios containing up to 50 separate conservation program activities.
- The tool can be used as an accounting system for tracking the implementation, water savings, costs, and benefits of actual conservation activities over time.

It was the AWE's intention to provide a tool that utilities could adapt to a wide variety of user situations regardless of geographic location, water system size, or extent of previous conservation program experience. To meet this objective, the tool provides a generic framework for characterizing water system demands and costs and for specifying the attributes of water conservation activities. This generic framework uses several key assumptions and simplifications that are discussed in the accompanying *AWE Water Conservation Tracking Tool User Guide*. The screenshot on page 49 is a graphic output of the AWE Water Conservation Tracking Tool that plots annual average per capita water demand with and without conservation.

UTILITY CASE STUDIES

A Balanced Approach to Water Conservation presents case studies to illustrate the methods and tools needed to balance water conservation for short- and long-term objectives. Utility Case Study 1 examined short-term drought management in the Padre Dam Water District in San Diego County, Calif. Padre Dam Water District provides water, wastewater, recycled water, and recreation services to more than



This screen shot shows a graphic output of the Alliance for Water Efficiency's Water Conservation Tracking Tool that plots annual average per capita water demand with and without conservation.

150,000 residents in the San Diego suburbs of Santee, El Cajon, Lakeside, Flinn Springs, Harbison Canyon, Blossom Valley, Alpine, Dehesa, and Crest.

Padre Dam adopted a local drought ordinance consistent with the model drought ordinance developed by the San Diego County Water Authority. After extensive modeling using an earlier version of the WRF Drought Response Model, drought pricing was incorporated into the district's revised water rate structure to achieve the following:

- Minimize customer impacts
- Preserve utility financial capabilities
- Better manage the recurring drought shortages currently affecting California

Utility Case Study 2 examined the City of Atlanta's efforts to ensure a sustainable water supply to the Atlanta metropolitan area. In 2004, the State of Georgia Environmental Protection Division (EPD) adopted rules regulating outdoor water use for users of public water supply systems in the state. The rules included graduated increases in restrictions based on the level of severity of a drought and imposed the lowest level of restrictions at the time of adoption. Even-numbered and unnumbered street addresses could water on Mondays, Wednesdays, and Saturdays, and odd-numbered street addresses could water on Tuesdays, Thursdays, and Sundays (in each case, with no hourly limits imposed). However, from 2006–2009, Georgia experienced an extreme drought. In September 2007, the EPD imposed the highest level of restrictions: no outdoor watering except for exempt activities. Water suppliers were mandated to achieve a 10% reduction in water withdrawals at that time. The ban on outdoor watering was lifted in June 2009 after wet-weather patterns had enabled reservoirs to return to normal levels.

In large part as a response to this drought experience, the Georgia state legislature enacted the Georgia Water Stewardship Act. The act, which went into effect in June 2010, allows daily outdoor watering for purposes of planting, growing, managing, or maintaining groundcover, trees, shrubs, or other plants only between 4:00 and 10:00 a.m. and exempts certain activities from water use restrictions (e.g., water reuse, manual watering). Outdoor water use for any purposes other than watering of plants, such as power washing or washing cars, is restricted to an odd/even use schedule.

Utility Case Study 3 examined long-term WUE as embodied in West Basin Municipal Water District's conservation master plan. West Basin, located in South Los Angeles County, Calif., was formed in 1947 by the public to preserve underground water supplies by providing supplemental water. Today, with 185 square miles of territory and a growing population, the West Basin Municipal Water District fully recognizes the importance of careful planning for future resource needs.

A balanced approach to water conservation must address both short-term drought management issues and long-term planning problems.

Conservation is a critical component of its integrated resource-planning process; West Basin decided to create a conservation master plan to develop a portfolio of conservation programs that delivers a high volume of water savings in a cost-effective manner. West Basin and its retail water agencies identified the benefits of implementing such a portfolio:

• **Cost avoidance for purchased water.** Although West Basin has projected an adequate water supply for the near future, the cost of water has risen dramatically and is expected to continue to do so. An important way to avoid purchasing expensive imported water is to use less through WUE.

• **Planning for continued limited state resources.** California's water resources are becoming increasingly stretched because of population housing growth and decreased water supply from state water projects. Agencies need to stretch water supplies and increase efficiencies.

• **Drought preparedness.** California is currently in a drought and can expect this to occur again in the future. The big question is when and how severe the next drought will be. One way to lessen the severity of a drought's effect on West Basin is to prepare in advance for this event by creating a community that operates at a high level of efficiency.

• **Environmental sustainability.** As a signatory to CUWCC's Memorandum of Understanding, West Basin and its agencies undertook the obligation to implement the best management practices for water conservation.

With a commitment to achieve a water-demand reduction of 12% over 10 years, West Basin has elected to strive for responsible environmental leadership. The conservation master plan—sculpted from three stakeholder workshops—forms the blueprint for implementation of this goal.

WATER RESEARCH FOUNDATION'S DECISION FRAMEWORK FOR WATER CONSERVATION

WRF 4175 was designed to provide water utilities with tools and guidance to facilitate implementation of effective WUE programs consistent with and supportive of their long-term resource-planning objectives, shortage-management requirements, customer service goals, and financial constraints. In service of this objective, the researchers developed a decision framework to walk users through a logical process that arrives at recommended best planning and implementation practices for a balanced approach to conservation in the short term and the long term. The WRF Decision Framework moves through a series of guided steps:

1. Start. The decision framework starts with a series of questions to identify potential utility interest in, and justification for, water conservation:

• Are you experiencing or do you anticipate problems with water supply
  ◦ availability?
  ◦ reliability?
  ◦ sustainability?

• Are your water supply production and/or purchase costs high?

• Would you like to offer your customers additional options to control their water bills?

• Does your utility have stewardship responsibility for environmental resources?

• Are you facing legal or regulatory requirements to reduce per capita usage?

• Do you need to better manage periodic water shortages resulting from droughts or other emergencies?

If there is no identified need for water conservation in the short term or the long term, the first thing lacking for conservation is a justification.

2. Long-run WUE. The decision framework provides two tracks to follow for either encouraging adoption of water-saving technologies or for encouraging conserving behaviors.

3. Water-saving technologies. The decision framework provides a list of water-saving technologies broken out by customer sector: residential (single family and multiple family); commercial, industrial, and institutional; large landscape; distribution system efficiency; and other. Each technology is hyperlinked to a compendium of water savings and costs.

4. Delivery mechanisms for technologies. The decision framework describes a set of delivery mechanisms that can be used to bring about the adoption of water-saving technologies:

• Customer rebates or vouchers

• Vendor, distributor, and contractor incentives

• Distribution (by utility, community group, vendor)

• Direct installation

• Surveys and audits

• Legal or regulatory requirements (retrofit on resale ordinances, new construction ordinances or guidelines, new-construction conservation offsets)

- Water budgets
- Conservation rate designs
- Increased billing frequency
- Information and education

5. Water-conserving behaviors. The decision framework describes a list of indoor and outdoor water-conserving behaviors. The decision framework then addresses how these can be brought about.

6. Delivery mechanisms addressing conserving behaviors. The decision framework describes a broader set of delivery mechanisms to encourage long-term conserving behaviors. These delivery mechanisms include surveys and audits, water budgets and rates, conservation rate designs, increased billing frequency, legal or regulatory standards, and information and education.

7. Information and education. The decision framework describes different information and education approaches, including public engagement, vendor–utility promotional partnerships, networking and awards, utility leadership by example, community involvement, school programs, and affordability.

8. Analytical resources. The decision framework provides links to analytical resources developed as part of this research project and in a prior project. Additional links to other Internet resources are provided.

9. Shortage management. The decision framework provides links to guidance documents for drought/shortage management. In addition, links are provided to the WRF Drought Response Model developed as part of this research project.

10. End. The decision framework ends with a suggestion for how the previous steps can be integrated into the conservation master-planning process.

CONCLUSION

A balanced approach to water conservation must address both short-term drought management issues and long-term planning problems. Conservation, in the short term, is often associated with shortage management, whereas in the long term, it is associated with WUE—programs that improve the efficiency of the end uses of water. While one of the objectives of WUE programs is to reduce the cost of water service in the long term and thus the financial burden on customers, these programs can also have revenue impacts in the short term. A balanced approach to conservation requires addressing the short-term effects of these long-term programs. In the long term, a balanced approach to WUE programs requires planning and implementing programs for which the benefits exceed the costs.

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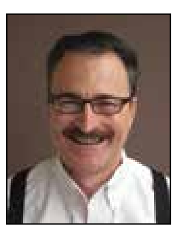
ABOUT THE AUTHOR



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AWWA RESOURCES

- Guidance Document for Water Utilities: A Guide to Customer Water-Use Indicators for Conservation and Financial Planning. Vickers, A., et al, 2013. PDF available at www.awwa.org.
- Understanding Utility Disincentives to Water Conservation as a Means of Adapting to Climate Change Pressures. Kenney, D.S., 2014. *Journal AWWA*, 106:1:36. Product No. JAW_0079405.
- Water Conservation Measurement Metrics. Dziegielewski, B. & Kiefer, J.C., 2010. PDF available at www.awwa.org.
- AWWA Water Conservation Division Subcommittee. PDF available at www.awwa.org.

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