Water Conservation in the United States: A Decade of Progress

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Introduction

Water conservation has only within the past twenty years become a policy issue in the United States, principally because of the general perception that there were seemingly endless supplies of available freshwater. But since 1950, the nation's total water supply withdrawals have nearly tripled, primarily due to rapid urban population growth and an improved standard of living for U.S. residents. At the same time that this increase in water withdrawals nationally has occurred, protective environmental laws and regulations were enacted between 1965 and 1990, intended to seriously limit the development of new water supply capacity in order to avoid further ecosystem impacts to sensitive watersheds. For the first time, the demand for water in the United States was beginning to outstrip the supply.

In the 1970's, water conservation and water efficiency began to emerge as a viable and affordable solution, one which could lessen the growing gap between available water supply and consumer demand, and one which also could save money by deferring into the future the need for constructing expensive new water supply facilities. Even where water supplies have been abundant, often the high costs of treating wastewater make water conservation financially attractive. By way of illustration, the nation is expected to pay over a quarter trillion dollars by the year 2020 to build needed new drinking water treatment and wastewater treatment facilities. Thus, every gallon conserved at the outset by the consumer reduces the need for construction of new additional water and wastewater treatment facilities. Conservation is therefore being implemented not only for conservation's sake, but as part of a long-term public strategy for providing reliable drinking water supplies and affordable wastewater treatment.

Supply and Demand

Rainfall patterns in the United States are far from uniform. In Las Vegas, the driest of America's major cities, precipitation averages barely four inches (102 mm) per year. Portland, Oregon has nine times the precipitation of Las Vegas. Miami, Florida is doused with over 55 inches (1,397 mm) per year. And in parts of the Northeast, a drought has been formally declared when precipitation drops below 70 inches (1,778 mm) a year.

For the most part, states east of the Mississippi have abundant water resources for water supply purposes. East of the Mississippi, and particularly east of the Rocky Mountains, precipitation is low enough that continuous water supplies are not possible without federally-subsidized engineered systems of large dams and aqueducts or pipelines. These systems were constructed from 1930 to 1960, costing billions of dollars and in many cases causing severe environmental impacts. Today the existing sources of water for these facilities are being used to capacity, and "new" future supplies are increasingly coming from conservation, recycling, reuse, and improved water-use efficiency rather than from expensive new water supply development projects.

About one quarter of the nation's renewable water supply of freshwater is being withdrawn for use by the nation's homes, farms, and industries. 76% of this amount comes from surface water sources, and the rest from groundwater. Per capita consumption, including all residential, commercial, agricultural, and industrial uses, averages 170 gallons (644 liters) per capita per day nationally.

In 1997 and 1998 a study was conducted in twelve North American cities to more accurately depict the water use within the individual residential household, using special computerized data loggers at each end use. Of interest to the researchers was how the water use changed in homes with conservation practices as compared with homes without conservation practices of any kind. The results showed that *without conservation*, the American household is likely to use 64.6 gallons (245 liters) per capita per day. *With conservation* in the household, the per capita per day figure is reduced to 44.7 gallons (169 liters). This represents a savings of approximately 30%.

Policies for Water Demand Management and Conservation

National policies on water conservation and water use efficiency were slow to be enacted. Not until 1992 were national standards set for plumbing fixtures, although many states had already adopted similar standards on their own. The Energy Policy Act of 1992 still remains the most significant federal action. It sets minimum water efficiency standards at the federal level for plumbing fixtures as follows:

Fixture	**U.S. Standard**	**Metric Equivalent**
Water Closets (Toilets)	1.6 gallons per flush	6 liters per flush
Showerheads	2.5 gallons per minute	9.5 liters per minute
Faucets	2.2 gallons per minute	8.3 liters per minute
Urinals	1 gallon per flush	3.8 liters per flush

These standards became effective in 1994 for residential and commercial plumbing fixtures, although the commercial water closet standard was not required until 1997 because of uncertainties regarding performance of the fixtures. In this respect, the United States is well behind many countries of Europe, where the 6 liter water closet has

been in use for many years and where horizontal axis washing machines are more common than in the United States.

In 1996, the U.S. Congress passed a reauthorization of the Federal Safe Drinking Water Act. For the first time, Congress formally recognized the need for water conservation planning by allowing individual states to mandate conservation planning and implementation as a condition of receiving federal grants for water supply treatment facilities. This was a significant step for the federal government. At about the same time, the U.S. Bureau of Reclamation set conservation and efficiency requirements for those agricultural and urban water agencies which receive federally-subsidized water from the Bureau facilities. This also was a significant step. Other federal statutes create incentives for farmers and landowners to participate in soil and water conservation programs, and to initiate voluntary water transfers of conserved water.

The significant water efficiency and conservation activity, however, takes place at the state and regional levels. Interest in water efficiency is primarily highest in those regions of the country where precipitation is lowest, or where wastewater treatment costs have skyrocketed. Seventeen states, representing over 60% of the nation's population, had already adopted their own plumbing efficiency standards long before passage of the Federal law in 1992. Fifteen states have also adopted specific conservation programs, which vary from mandating conservation planning by water utilities to requiring actual implementation of specific water efficiency programs. The states most active in conservation activities are: Arizona; California; Colorado; Connecticut; Florida; Kansas; New Jersey, Oregon; Texas; and Washington State. Even where states do not have detailed conservation programs, certain individual cities within those states have adopted water efficiency programs where necessary (New York City, Boston, and Las Vegas are examples).

In general, where water supply withdrawals are regulated by State agencies, water conservation is usually a prominent planning requirement for water utilities. A number of states not only require plans of their water utilities, but also require that progress be demonstrated in water efficiency programs before approvals for continued water supply withdrawals are given. Many states also condition state grants for new facility construction upon a satisfactory demonstration of conservation planning and implementation by the water utility.

Water efficiency measures practiced across the U.S. are based on the profile of water use within the region, and the extent to which demand reduction is necessary and cost-effective. The measures used nationwide include the following:

- 100% metering of all end-use customers;
- comprehensive leak detection programs for utility piping;
- plumbing fixture replacements (toilets, showerheads, faucet aerators);
- audits of household water use to determine wasteful practices;
- audits of commercial and industrial water use to determine where water use can be minimized or recycled;

- outdoor landscape audits and installation of computer-controlled irrigation systems to carefully meter out water usage;
- drip irrigation systems in agriculture;
- public education programs, both for the average consumer and the grade school student;
- ordinances at the local level to discourage water waste;
- review of new development plans at the local level to assure water efficiency; and
- rate structures which do not encourage overconsumption of water.

The Role of Water Conservation in Water Resource Management

Reducing the need for new water supply, particularly with increasing population growth, allows more equitable allocation of water resources for other purposes. By way of illustration, the installation of 1.6 gallon (6 liter) per flush toilets under the plumbing code and through retrofits will be saving over two billion gallons (7,750,820 cubic meters) per day nationwide by the year 2010. These saved water resources can be directed toward future water supply growth or other uses for the water. It "stretches" the available supply.

Perhaps most significantly, it has become clear in recent decades that the development of new water supplies has had a major impact on the quality of the natural environment. Facilities built to dam, divert, transport, pump, and treat water are massive projects which often leave an irreversible "footprint" of environmental impacts. In addition, diversions from one watershed to another can disrupt the watershed of origin, leaving streambeds dry or estuaries increasingly salty and less productive.

As a result, water conservation is playing an important role in helping meet the environmental goals of many states and communities. Although these benefits are often difficult to quantify, the qualitative effect is significant. Conservation programs have been required in numerous areas to help achieve some of the following results:

- Maintaining the habitat along rivers and streams and restoring their fisheries;
- Protecting groundwater supplies from excessive depletion and contamination;
- Improving the quality of wastewater discharges;
- Reducing excessive runoff of urban contaminants; and
- Restoring the natural values and functions of wetlands and estuaries.

One State's Experience: Water Conservation in California

California, perhaps more than any other state, has been a leader in water efficiency experiments. It adopted plumbing standards in 1978 for showerheads and faucets, and water closet standards in 1992. Comprehensive conservation planning was adopted in 1983 for all water agencies serving more than 3,000 connections or 3,000

people. And in 1991, a Memorandum was signed by the major water agencies and environmental groups statewide pledging to undertake water efficiency practices (the "Best Management Practices") in an attempt to help save the dying Bay-Delta Estuary.

California Statistics

But first, let's discuss California in general. Roughly 80% the size of Spain, California has a wide range of climate types, from snowy alpine environments to arid desert landscapes. Yet California is basically a dry state. It has only 6 percent of the nation's available water, but it has 8 percent of the nation's population, and that percentage is rapidly increasing.

Five of the nation's ten most congested metropolitan areas are located in the state of California. As of January 1997, some 32,600,000 people called California home, with more than 423,000 new residents arriving in the state annually. At this rate, by 2010 the state's population could reach 40 million. This is 25% growth, *double the national average*.

In average years, only 63% of the state's rain and snowfall becomes usable surface water. The rest soaks into the ground, evaporates or is used by native vegetation. Of the remaining water:

- 36% flows out to the ocean;
- 28% is legally committed to wild and scenic rivers and the San Francisco Bay-Delta outflow;
- 28% is used by agriculture; and
- only 7% is used by cities and industry.

But perhaps the most interesting statistic about California is that 75% of the annual precipitation falls *north* of Sacramento, the capital city in the center of the state, while more than 75% of the demand for the state's water is *south* of the capital city. This poses a significant distribution problem. Also, most of the rain and snowfall occurs between October and April, whereas the consumer demand for water is highest during the hot and dry summer months between June and September.

Because of these water distribution issues and the rising population growth, a massive water storage and delivery system in California was constructed over the past 80 years. The projects include more than 1,000 federal, state and local reservoirs, totaling more than 14.4 million acre-feet (17,762,100,000 cubic meters).

Yet, even with these massive projects, it became apparent during the 1980's that demands for water for the growing California population would greatly exceed the available supply from the constructed water projects, even in normal or wet years. It is now estimated that this shortfall of supply may approach between 4 and 6 million acre-feet (4,933,930 to 7,400,890 cubic meters) by the year 2010. And that's in years of

normal rainfall. Droughts, or long periods of greatly reduced precipitation, have been common in California and have had significant impact on the availability of water for supply purposes. The six year drought beginning in 1986 was a timely signal to water agencies and consumers alike that water usage throughout the state needed to be made more efficient, and that water conservation was a political as well as environmental and financial necessity.

The Bay-Delta

Nowhere in California was the drought of the 1980's more acutely felt than in the Sacramento-San Joaquin Bay-Delta region. A 780,000 acre (315,655 hectare) estuary at the confluence of two major California rivers which drain the snowmelt of the Sierra Nevada mountains, the Bay-Delta region is the main source of surface water supply for the State. 66% of the water supplied by drinking water agencies flows through the Delta. 200 different agricultural crops --representing *45% of the nations produce* -- are irrigated with water from the Delta. The Delta is the heart of California's trillion dollar economy.

With the drought of the 1980's severely reducing the amount of snow and precipitation flowing to the Delta, the flows within the Delta dwindled. Withdrawals for water supply purposes had to be curtailed to all users in order to ensure adequate flows for fishery resources. Irrigation of crops had to be limited. Urban water supplies were rationed. These curtailments resulted in contentious disagreements among the urban, agricultural, and environmental interests over how the Delta system should be managed. To further compound the crisis, the federal government listed nine different fish and bird species as endangered or threatened in the Delta system, thus further restricting water withdrawal options.

Something had to be done. Key leaders in the environmental and urban water supply community began discussing the role that water use efficiency and conservation could play in helping the Delta -- what role reducing consumption would play in preserving the Delta's fragile estuary and ecosystem, and in reducing the demands of urban and agricultural water agencies for yet more supplies of water. In 1989 the urban water community and the environmental community began to negotiate what the terms of "water efficiency" might be and how it might best be done statewide. By September, 1991, the document was ready for ratification by all parties concerned. To date, the "Memorandum of Understanding", forged by this historic consensus process, has now been signed by 228 signatories. These signatories represent about 41% of the urban water use in California.

Best Management Practices

The Memorandum of Understanding included a list of sixteen "Best Management Practices" for water conservation and a schedule for their implementation. These sixteen practices, first ratified in 1991, were revised in 1997 and formed into fourteen. It was recognized that implementation of the practices would take a number of years, from a minimum of three years to a maximum of ten years. By signing the memorandum, the individual signatory agencies were pledging a "good faith effort" to continue these water efficiency improvements until they were all completed, although water agencies would be expected to undertake only those Practices which would be cost-effective for their system. (If the cost of any Practice exceeds the expected incremental cost of adding new water supplies, then the measure is not considered cost-effective.) New supply costs vary widely across the state, depending upon the region. As can be expected, in the more arid regions the costs for new water are such that nearly all the Best Management Practices are cost-effective.

The California Urban Water Conservation Council was created by a section of the ratified Memorandum. The Council was envisioned as a consensus agency of water suppliers and environmental groups, charged with the responsibility to monitor and evaluate the progress of water agencies and utilities in implementing the Best Management Practices, to provide technical assistance in the form of publications and reports on specific research topics, and to report the results of the collective actions to the State of California Water Resources Control Board. The governance of the Council is split equally between the water agencies and environmental groups, with each group having full veto power over the other. Thus, all the decisions made by the Council are made in a consensus process. It is the only organization of its kind in the United States.

Since 1991, the Council has existed as a voluntary organization with financial resources largely contributed by member signatories. Its budget for the 1998-1999 Fiscal Year totals nearly $750,000, or 107,662,500 Pesetas. 1999 marks the first year that the Council has permanent staff. The timing is excellent. Although implementing the Best Management Practices has always been voluntary, an official recommendation has been made by a government program that the Practices should be made mandatory as a condition of receiving new water supplies from the Delta. If this requirement is enacted by the California Legislature, the Council will then become a regulatory agency for water conservation programs, and its responsibilities and staffing will greatly increase.

The Best Management Practices have quite specific language. Included within each Practice is language clarifying procedures for implementation, deadlines for completion, and benchmarks for interim compliance. Percent targets for completion are specified, giving guidance to the water agency as to when they have officially satisfied the requirements of the Practice. Annual reports are required of each signatory, detailing the progress being made on each of the Practices. These reports are then aggregated and filed yearly in one summary document with the State.

The following table summarizes the practices.

BEST MANAGEMENT PRACTICES
California Urban Water Conservation Council
(Completion Requirements in Italics)

1. **Water Survey Programs for Single-Family and Multi-Family Residential Customers** *(Survey 15% of residential customers within 10 years)*
2. **Residential Plumbing Retrofit** *(Retrofit 75% of residential housing constructed prior to 1992 with low-flow showerheads, toilet displacement devices, toilet flappers and aerators)*
3. **System Water Audits, Leak Detection and Repair** *(Audit the water distribution system regularly and repair any identified leaks)*
4. **Metering with Commodity Rates for All New Connections and Retrofit of Existing Connections** *(Install meters in 100% of existing unmetered accounts within 10 years; bill by volume of water use; assess feasibility of installing dedicated landscape meters)*
5. **Large Landscape Conservation Programs and Incentives** *(Prepare water budgets for 90% of all commercial and industrial accounts with dedicated meters; provide irrigation surveys to 15% of mixed-metered customers)*
6. **High-Efficiency Washing Machine Rebate Programs** *(Provide cost-effective customer incentives, such as rebates, to encourage purchase of these machines that use 40% less water per load)*
7. **Public Information Programs** *(Provide active public information programs in water agencies to promote and educate customers about water conservation)*
8. **School Education Programs** *(Provide active school education programs to educate students about water conservation and efficient water uses)*
9. **Conservation Programs for Commercial, Industrial, and Institutional Accounts** *(Provide a water survey of 10% of these customers within 10 years and identify retrofitting options; reduce water use by an amount equal to 10% of the baseline use within 10 years)*
10. **Wholesale Agency Assistance Programs** *(Provide financial incentives to water agencies and cities to encourage implementation of water conservation programs)*
11. **Conservation Pricing** *(Eliminate non-conserving pricing policies and adopt pricing structure such as uniform rates or inclining block rates, incentives to customers to reduce average or peak use, and surcharges to encourage conservation)*
12. **Conservation Coordinator** *(Designate a water agency staff member to have the responsibility to manage the water conservation programs)*
13. **Water Waste Prohibition** *(Adopt water waste ordinances to prohibit gutter flooding, single-pass cooling systems in new connections, nonrecirculating systems in all new car wash and commercial laundry systems, and nonrecycling decorative water fountains)*
14. **Residential Ultra-Low-Flush Toilet Replacement Programs** *(Replace older toilets for residential customers at a rate equal to that of an ordinance requiring retrofit upon resale)*

Cost of the Measures

The cost of each Best Management Practice varies widely, and these costs are in the process of being documented in a current Council study. On average, the collective implementation produces water for about $300 per acre-foot, or roughly 35 Pesetas per cubic meter, which is far less than the cost of new water supply development in California. The cost-effectiveness benchmark is key. Agencies are not expected to implement measures that cost more than their incremental cost of new water supply.

Statewide, approximately $416 million or 5,637,000,000 Pesetas has been spent on water efficiency programs over the last seven years. 60-70% of the money has been spent on the retrofitting of over 1.5 million low-flow toilets. This is a very cost-effective practice, generally producing saved water at about $150-200/AF, or 17-23 Pesetas per cubic meter.

Water Yield from the Measures

California's investment in conservation will yield approximately 1.4 million acre-feet or 1,726,870,000 cubic meters -- enough to serve about 7 million people. However, given the projected shortfall between supply and demand by the year 2020, much more conservation will need to be accomplished. In southern California alone, the target yield for water efficiency programs by the year 2020 is 442,000 acre-feet, or 545,199,000 cubic meters *annually.* Despite this ambitious target, conservation alone cannot make up the full shortfall. The remainder will need to be made up with water recycling programs.

Ongoing Research

The most important contribution that the Council makes to its members is the sponsorship of detailed evaluations of efficiency programs. To date, studies have been completed on evaluating ultra-low flush toilet savings, designing and implementing conservation rate structures, preparing cost-effectiveness analyses of best management practices, and customer incentives for water conservation programs. Studies currently underway include a review of landscape water use and rates, a landscape procedures manual, a study on determining urban water conservation savings and costs, and a study of horizontal-axis washing machines.

Toilet Retrofits by Community Organizations: A Case Study

Best Management Practice #14, requiring ultra-low-flush toilet replacement, can be met in a variety of ways. A city could adopt an ordinance requiring that every property be retrofitted at the time of resale. A water utility could offer its customers "rebates" of $50 to $100 (7,100 to 14,400 Pesetas) upon proof that the customer replaced their existing water closet with the new water-saving one.

However, rebate programs have been less successful in low-income communities, where people frequently do not have the financial resources to purchase the toilet and wait six to eight weeks to receive a rebate. In order to address the special needs of low-income communities, the city of Los Angeles adopted an innovative marketing strategy -- working with community organizations within the city to help distribute the toilets.

Under this strategy, the community organizations organize and administer a program to provide residents with low-flush toilets at no charge. The City pays for the toilets, and the community organization is paid $25.00 (3,600 Pesetas) for each toilet replaced and recycled. The first to undertake this program was the Mothers of East Los Angeles, a community group within the Hispanic area of East Los Angeles. They hired local Spanish-speaking residents to go door to door offering customers these new toilets. They provided installation assistance and instructions in Spanish. The response was overwhelming. Not only were customers happy to have a new free toilet, but they were benefiting their own community as well. The money raised by the toilet replacement program funded a number of community programs, such as college scholarships, graffiti abatement, and childcare for single mothers.

At present there are dozens of these community organizations -- and even high schools -- doing toilet replacement programs. In Los Angeles alone, over 1,000 homes per week are reached. The mutual benefit to the community of conservation and funding for community action has been positively noted, by both water agencies and city officials. Not only large cities like Los Angeles have undertaken these programs. Smaller cities like Anaheim (the size of Zaragoza) have also successfully carried out these community organization programs.

More than 50% of the 1.5 million ultra-low-flush toilets replaced throughout the state were replaced through the community organization and high school programs.

Protector Del Agua: A Case Study

Although less than half of the residential water use is for landscape irrigation, it nonetheless represents a significant conservation opportunity. In southern California in particular, the arid climate has resulted in widespread installation of irrigation systems for residential use. These systems are often not well maintained or operated, and as a result, water is wasted on the landscape. Thus, landscape conservation depends upon both technological advances in irrigation systems and upon changing the way that people use water on the landscape. To further complicate matters, most California residents employ small landscape maintenance companies whose employees are often non-English-speaking Hispanic laborers. How to communicate to these companies about efficient water use?

In cooperation with California Polytechnic University, an educational program was developed for these landscape contractors. Called “Protector del Agua” (The Water Protector) the program is a bilingual class in Landscape Water Management and Irrigation Systems Maintenance and Repair. Students are taught the basic

interrelationship between soils, plants, and water, how to properly evaluate the moisture needs of a landscape, how to effectively measure the efficiency of the existing irrigation system, how to adjust the system to prevent water wastage, and how to repair or replace older, less efficient components. New classes have recently been added: one on plant material and one for residential homeowners who self-maintain their landscapes.

Since 1993, the curriculum has been expanded to six sessions of three to four hours each. 40-50 students attending are average, and so far 3000 have completed the series. The cost is free to the participants, as the cost is absorbed by the water agency, but the per student cost runs approximately $25.00 or 3,600 Pesetas per student. Half the classes are offered in Spanish. The program has been very successful, primarily because the classes are "hands-on" -- that is, the classes are interactive with the students and conducted in the field. Thus, the classes appeal to those who are not comfortable in a formal education setting. At the completion of the program, students receive certificates that also qualify for continuing education credits.

Summary

The United States has made significant progress in water efficiency during the past decade. Although the amount of conservation varies from region to region, water efficiency has become the first choice for many water utilities in lieu of expanding facilities or purchasing more expensive sources of water. In California, water efficiency has become an important policy issue, figuring prominently in statewide discussions of Delta restoration. The next ten years promise to be a period of advanced efficiency program implementation, refinement and research.