

*Promoting Plumbing Fixture and Fitting Replacement:  
Recommendations and Review for State and Local Water Resource Authorities*

*As Required by the Energy Policy Act of 1992*

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## I. *EXECUTIVE SUMMARY*

Lawrence Berkeley National Laboratory (LBNL) has prepared this report to facilitate compliance with the requirements of Section 123 of the Energy Policy Act of 1992 (EPACT). Section 123 requires the Department of Energy to issue recommendations for establishing state and local incentive programs to encourage acceleration of voluntary consumer replacement of existing water closets, urinals, showerheads and faucets with water-saving products meeting EPACT standards.

The authors recommend that state and local authorities working together and also with utilities:

- A. investigate the cost-effectiveness of voluntary replacement of plumbing fixtures and fittings as an effective component of a water efficiency incentive program;
- B. allow utilities to distribute the costs of water saving products by billing at pre-installation rates until devices have been paid for;
- C. encourage decreased water usage by establishing rate structures such as increasing block rates or seasonal pricing;
- D. add additional incentive to rebate programs by making the rebates untaxable income.
- E. require municipalities or utilities to exhaust every reasonable method of water conservation before applying for permits to construct water supply or water treatment systems;
- F. require high-efficiency toilets, urinals, showerheads, and faucets in new construction and changing plumbing codes to incorporate different pipe sizing needs;
- G. and mandate installation of meters to correctly measure water consumption.

Following the introduction, a general overview of these recommendations is presented. Each recommendation is discussed briefly. The first of the recommendations is broken down into five key sub-points detailing the process of investigating costs and benefits of voluntary plumbing fixture replacement programs. Whether replacing toilets, or showerheads, or utilizing other water conservation techniques, program designers should analyze: (1) water consumption by the community, (2) the history of local water conservation programs; (3) the program objectives and target audience; (4) the cost-effectiveness of different water conservation methods; and (5) the potential results of any instituted program.

After determining the cost-effectiveness of a plumbing replacement program (or plumbing replacement aspect of a larger program) states can encourage replacement of toilets, urinals, showerheads, and faucets in a number of ways. This report lists both legislative and economic measures that can be implemented on the state level that impact local programs.

Following the overview of recommendations, four case studies are provided. Each case study profiles a successful state water conservation effort. The states chosen were selected because their water conservation programs included the following elements:

1. the inclusion of high-efficiency plumbing products.
2. variable and flexible programs, translatable to other States and municipalities around the country.
3. demonstrated reduced water consumption.

The case studies are also designed to illustrate some of the ways in which different authorities have used different elements from this list of recommendations. Additionally, the cases touch on motivating factors behind State water conservation guidelines, ways in which the programs were funded, and profiles of the local aspects of the conservation programs. The descriptions' primary focus, however, is on the plumbing product replacement aspects of the various programs. City examples are also included, not because they are unique, but because they exemplify many other conservation programs within their respective states and around the country. The cases highlighted are by no means the only successful programs.

This report does not provide a spreadsheet or detailed account of the exact steps to take when developing a water conservation program. Such work has already been done. The American Water Works Association (AWWA), the U.S. Environmental Protection Agency (EPA), and others have generated accessible and thorough instruction guidebooks which take the reader step by step through the components of a water conservation program. Additionally, State agencies, such as Washington State Department of Ecology and Connecticut Department of Public Health, have produced guidebooks which provide blueprints for creating water conservation programs specific to their own states. After reviewing the critical points in devising a water conservation program, these guidebooks provide the next steps for designing cost-effective programs.

This preliminary report focuses on applications of water closets, showerheads, and faucets. Information on urinal replacement studies and programs is being compiled from examples in Seattle, Washington and Denver, Colorado. No programs targeting urinals had been completed at the time of publication.

## II. INTRODUCTION

There are many ways water conservation can benefit a community. The need for conservation is obvious in areas where water is in short supply. Efficient use of water helps communities meet current supply needs in times of drought and when population growth places pressure on existing supplies. Reducing demand can also protect future water resources by drawing more slowly upon reservoirs and aquifers.

Installing low-flow fixtures and fittings reduces water demand and is an important way for communities to realize conservation benefits. Less water passing through the system means less water and wastewater to treat. Studies have shown that the benefits from residential retrofit programs include: "reduced energy, chemical, and other costs associated with the treatment and distribution of water; reduced energy, chemical, and other costs associated with wastewater treatment and disposal; deferred costs associated with new or expanded water supply and distribution facilities; and residential savings from reduced energy bills" (Babcock, *et al.* 1993). The greatest energy savings will be due to decreased hot water use. With the installation of low-flow showerheads and faucets, national hot water savings are estimated at over 2 billion liters (560 million gallons) per day by 2010, 9% less than the level of hot water use forecasted without the standards (Kooimey, *et al.* 1994). If the country responds quickly to EPACT and replaces high-flow fixtures and fittings with models that conform to the low-flow national standard, conserved hot water could translate into a net national energy savings valued at 4.3 billion dollars per year. (See Appendix F)

In residential environments, faucets, showerheads and toilets account for as much as 56 percent of water usage (Kooimey, *et al.* 1994). Exchanging high-flow fixtures and fittings with low-flow models conforming to the new standards can considerably reduce water usage and could cut the water consumption level of the nation by as much as 11 billion liters (3 billion gallons) per day by the year 2010, 17% less than the residential plumbing water used in 1993 (Kooimey, *et al.*). In addition to hot water gas and electric cost savings, substantial savings would also be seen in consumer water bills.

### **Background**

National plumbing standards legislation grew out of the activities of local authorities around the country. These efforts began in the early 1970s with the increase of oil prices. Electric and gas utilities began programs to decrease hot water usage. The experience of Osage, Iowa is one example of how effective electric and gas conservation programs reduce hot water usage.

Osage Municipal Utilities developed an energy reduction program to delay the construction of an electrical generating plant. After implementing the energy savings program, which included the distribution of 2300 low-flow showerheads and 2000 low-flow faucet aerators to its community of 3500 residents, Osage Municipal Utilities reduced its annual growth of energy consumption from 7.2% down to 3%. (Birdsall, 1992)

Other water utilities initiated conservation programs in the early eighties. Drought inspired California

water utilities to promote water conservation among their consumers, to reduce demand on diminishing supplies. The public was introduced to low-flow fixtures, fittings, and activities that would extend the life of the area's water supplies. Goleta, California, is credited as one of the first communities to substitute conservation for the traditional approach of expanding supply. The Goleta Water District gave rebates to customers who replaced older toilets with ultra-low flush toilets. More than 35,000 low-flow showerheads were also distributed by the Goleta Water District. The utility managed to slow the annual rate of water consumption growth to their targeted 7%. In contrast, other area communities not participating in water conservation activities saw their annual water consumption rise between 13 and 15% in the same period. (Amrein, 1990)

On the state level, Massachusetts was the first to seek to extend its water supply by requiring installation of 6 liters (1.6 gallons) per flush toilets. Connecticut also initiated conservation efforts to defer projected water supply development expenditure due to population growth. In 1989, the Connecticut legislature passed a law "requiring a statewide residential retrofit program, more efficient plumbing fixtures, and uniform water conservation planning" (Ruzicka 1989).

More than a dozen states and municipalities passed water efficiency standards for plumbing fixtures and fittings prior to the passage of the Energy Policy Act of 1992 (EPACT). National maximum flow rates for showerheads, toilets, faucet aerators and urinals equalize the standards set by the states. EPACT standards slow the growth of national water usage as more efficient products gradually replace existing stock. Additional savings are derived from wastewater flow reduction, increased sewage treatment plant capacity, delays in construction of new treatment plants, improved performance of septic tanks, and soil absorption systems (PR Newswire 3/8/89).

EPACT standards resulted from a collaboration between the plumbing fixture industry, states and municipalities, environmental groups and Federal agencies. In October of 1992, EPACT set maximum flow rates for new showerheads, faucets, toilets and urinals in the United States. As shown in Table 1, these rates for showerheads and faucets are 9.5 liters per minute (LPM) (2.5 gallons per minute (gpm)), 3.8 liter per flush (LPF) (1 gpf) for urinals, and 6 LPF (1.6 gpf) for toilets (excluding flushometer type and those for commercial use). To increase the water saving benefits of the lowered flow rates more quickly, Section 123 of EPACT requires the Department of Energy (DOE) to issue recommendations encouraging state and local authorities to establish incentive programs. These programs should motivate individuals to voluntarily replace older plumbing fixtures and fittings with newer, more efficient showerheads, toilets, faucets, and urinals (Amrein 1990).

**Table 1: EPACT 1992 Flow Rate Standards for Plumbing Fixtures and Fittings**

<b>Device</b>	<b>EPACT 1992 Flow Rate Standards</b>
Showerheads and Faucets	9.5 liters per minute (2.5 gpm)
Toilets	6 liters per flush (1.6 gpf)
Urinals	3.8 liters per flush (1 gpf)



EPACT is not specific as to what kind of incentive program to recommend, and there are many kinds of successful incentive programs. Effective programs vary according to area and must take into account the age of housing stock, type of water supply and supplier, environmental conditions, and rate of population and industrial growth. Programs should be customized to produce the greatest results for the least cost. States and local authorities must compare different water conservation programs to determine which is most cost-effective for them. What may be appropriate for one part of the country may be counter-productive for another.

The information included in this report is not an exhaustive review of the literature on water conservation programs that exist. In an effort to assist people with information regarding water conservation, the American Water Works Association, with a grant from the U.S. Environmental Protection Agency, established an information distribution service called WaterWiser -- The Water Efficiency Clearing House. Available to the public via a toll-free number, WaterWiser provides assistance with planning, implementing and evaluating water efficiency programs and activities. (see Sources of Information, Appendix D)

### III. *RECOMMENDATIONS*

The authors' recommendations for promoting water conservation via fixture replacement are listed and categorized as follows:

Build a knowledge base--the essential first step:

- A. investigate the cost-effectiveness of voluntary replacement of plumbing fixtures and fittings as an effective component of a water efficiency incentive program;

Economic approaches:

- B. allow utilities to distribute the costs of water saving products by billing at pre-installation rates until devices have been paid for;
- C. encourage decreased water usage by establishing rate structures such as increasing block rates or seasonal pricing;
- D. add additional incentive to rebate programs by making the rebates untaxable income;

Legislative approaches:

- E. require municipalities or utilities to exhaust every reasonable method of water conservation before granting for permits to construct water supply or water treatment systems;
- F. require high-efficiency toilets, urinals, showerheads, and faucets in new construction and change plumbing codes to incorporate different pipe sizing needs;
- G. mandate installation of meters to correctly measure water consumption.

What follows is a brief discussion of each these recommendations.

## *Discussion:*

### A. *Evaluate Costs and Benefits of a Plumbing Replacement Program -- Considerations For a Successful Program:*

#### 1. *Calculating Water Usage*

Water demand projections should be broken into major categories of water use. Those categories could be residential, commercial, industrial, and agricultural. Differentiating between indoor and outdoor water use is also important.

#### 2. *Determining Past Practices*

By checking past plumbing codes, it can be determined what fixture and fitting standards were required in new construction. Targeting programs at older homes yields greater water savings than retrofitting homes constructed when plumbing standards were more stringent.

#### 3. *Setting Program Objectives and Target Audience*

Programs are not wholly transferrable from one area to another. Developing objectives for a water efficiency program requires an understanding of the water service area. In *Evaluating Urban Water Conservation Programs: A Procedures Manual* (Dziegielewski, 1993), a number of questions are suggested to help the program developer set water conservation program objectives:

- "(1) Is there a short-term (e.g., drought-related, source contamination, or other emergency condition) or long-term (e.g., inadequacy of long-term supplies or storage capacity) water supply problem?
- (2) Is there a distribution system problem (e.g., excessive sewer flows, water/wastewater treatment plant capacities)?
- (3) Is the problem localized (e.g. capacity problems of a single water or wastewater treatment plant) or system wide?
- (4) Is the problem a seasonal issue (e.g., summer demands, maximum daily demands, or average annual demands)?" (Dziegielewski, 1993)

The target audience can be defined on the basis of the following characteristics: type and age of housing, household income, water usage, water use type, geographic location, meter size (Dziegielewski, 1993).

#### 4. *Choosing the Most Appropriate Method*

To be successful, a water conservation program should reflect an area's needs. For residential retrofits, it is important to have information regarding market penetration for the potential retrofit products. Replacing showerheads in an area where consumers have already purchased low-flow

showerheads is obviously not cost-effective. The American Water Works Association (AWWA) calculated the national average for market penetration for the plumbing products.

**Table 2: Estimated Market Penetration and Overall Savings of Low Flow Plumbing Fixtures and Fittings**

Device	Consumption Savings -- liters per capita daily (gpcd)	Estimated Market Penetration	Estimated Overall Savings -- lpcd (gpcd)
Ultra-low flush toilets	60 (16.0)	5%	3 (0.8)
Low-flow showerheads	27 (7.2)	15%	4 (1.1)
Low-flow faucets	1.9 (0.5)	15%	0.4 (0.1)
Retrofit kits for showerheads and toilets	24.6 (6.5)	35%	8.7 (2.3)
Leak detection programs	22.7 (6.0)	15%	3.4 (0.9)

(source: Chansler and Pujals 1993)

Penetration rates vary depending on location. For example, New York City shows a higher percentage of low flow showerhead already installed in homes (32%) (Liebold, 1995). Water savings calculations which are not based on actual metering are improved when they reflect product penetration for the local area.

Each method has additional considerations. Disposal of old toilets or showerheads must be incorporated into replacement programs. Landfills may be a solution for some areas but not for others. Selecting fittings compatible with a majority of homes in a project area requires research. For more information on resolving potential difficulties in disposal or hardware matching, contact the American Water Works Association's Clearing House -- WaterWiser. (See Appendix D)

### 5. *Evaluating Results*

Evaluating program results reveals the degree to which program objectives have been met. Data is key to a thorough evaluation. Data should be collected prior, during and after program implementation. How much water was actually saved by the water conservation program is a key element for evaluation. Additional aspects for evaluation are the extent of program penetration, energy savings, and customer satisfaction.

### **Economic approaches:**

After the determination to see if plumbing product replacement can be a cost-effective method to reduce water consumption, states can explore legislative and economic means to assist municipalities or utilities with water conservation efforts. The following six recommendations suggest some economic and legislative tactics states can employ to encourage early replacement of plumbing fixtures and fittings, thereby reducing water demand.

B. *Utilize Assisted Financing*

Many types of assisted financing exist. Two of the most popular are low-interest loans and shared savings. Low-interest loans are used where the capital costs of conservation measures are a barrier to customer implementation. Shared savings use the customer billing system to allow customers to pay for conservation measures through the savings they achieve. Consumers can pay for water efficient products through their regular water bill. In such cases a consumer's bill would remain at its original amount, not reflecting savings until the installed products had been paid for (EBMUD 1994).

C. *Structure water rates to encourage decreased water use.*

Research over the past twenty years has shown that, when water prices are increased, consumers reduce water consumption and implement conservation measures including installation of high-efficiency plumbing fixtures and fittings. Two rate structures in particular produce water demand reduction: increasing block rates that charge higher prices per unit as the customer uses more water and seasonal rates that charge more for water during peak-demand seasons. (For complete report, see Water Conservation Rates Structures, Appendix C)

D. *Add an additional incentive to rebate programs by making the rebates untaxable.*

Untaxed rebates provide an added incentive to consumers replacing plumbing fixtures and fittings. Full financial benefits to program participants would then be realized -- particularly important for owners of multi-family units.

**Legislative approaches:**

E. *Require municipalities or utilities to exhaust every reasonable method of reducing water consumption before applying for permits to construct water supply or water treatment systems.*

In addition to forcing municipalities and utilities to look closely at all conservation options, this requirement can promote significant savings from postponement or avoidance of treatment plant construction. Provided existing treatment plants are operating at or above capacity, reducing water consumption through water conservation can postpone or cancel needs for plant expansion. In these cases, water conservation programs are a worthwhile cost savings alternative to the higher costs of construction.

F. *Require high-efficiency water fixtures and fittings in new construction and change plumbing codes to incorporate different pipe sizing needs.*

EPACT covers only the manufacture not the sale of plumbing fixtures and fittings. By installing high-efficiency fixtures and fittings in new construction, water savings would be guaranteed, requiring no

additional effort on the part of the utility or residents, and pipes would be sized to accommodate lower water flow.

G. *Mandate metering.*

Metering itself does not directly promote the installation of high-efficiency plumbing fixtures and fittings. Yet with meters in place, utilities can bill for quantity of water used, raising consumers' awareness of their water consumption patterns and encouraging voluntary conservation. Requiring meters in new construction and/or in building improvements, while recovering the metering costs by charging for connection, can make metering a cost-effective measure.

#### IV. CASE STUDIES

##### **New York State**

New York State has a range of environments with different water supply concerns. While the area around the Great Lakes is considered water rich, New York City has been affected by a series of droughts and must manage a high volume of wastewater. On Long Island, aquifers are declining. Throughout the State, "rising water supply costs have raised concerns about the adequacy of the state's drinking water supplies. The costs of developing, treating, and transporting additional water supplies can be financially and environmentally prohibitive. (See Capital Cost, Appendix B). Even with unlimited financial resources, there is not enough water to satisfy all potential water users without competition and without degrading in-stream environmental, recreational and commercial values." (Nechamen, 1993)

In seeking to manage this situation and promote conservation, New York State has taken a number of steps, including steps which mirror the authors' list of recommendations. New York's Department of Environmental Conservation (DEC) oversees approximately 1800 public water supply systems. Having built a knowledge base, DEC developed goals for differently sized water systems and areas with varying water supply conditions. Any applicant seeking a New York State water supply permit must meet standards which include a water conservation program. The water conservation standard stipulates that the program must be "in accordance with local water resource needs and conditions." At the local level, DEC is differentiating its approaches in an attempt to be flexible yet maintain performance standards. "[DEC] is revising a water conservation manual for local water supply operators. It will conduct a series of water conservation workshops around the state. It has developed a matrix of expected water conservation programs to help in the review of local water conservation plans." (Nechamen, 1993) Elements common to water conservation programs independent of area size and environmental conditions include: metering, water supply audits, leak detection and repair, pricing, mandating and directly promoting low-flow plumbing fixtures, education concerning outdoor water use reductions, and promoting cooperative programs (including retrofitting plumbing fixtures) with non-residential water consumers.

##### **New York City's Rebate Program<sup>1</sup>**

New York City has adopted elements of the State's water conservation plan. The city's efforts are significant because of the water supply shortage it faces, and its high volume of residential indoor water use. The work of New York City's Department of Environmental Protection also exemplifies one successful approach to investigating a cost-effective water conservation program--the authors' first recommendation. Other of the authors' recommendations illustrated by the New York City example include implementing a rebate program and requiring water meters. This section highlights

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<sup>1</sup>For more information contact, Warren Liebold, Director of Conservation, Bureau of Water and Energy Conservation, Department of Environmental Protection. 59-17 Junction Boulevard, Elmhurst, New York, 11373-5107 (718) 595-6656

New York City's carefully constructed toilet rebate program. Water savings from this program to date are estimated between 110 - 250 liters (29 - 68 gallons) per participating household per day. (Speedwell, 1994)

### *Profile of the New York City Area*

The majority of New York City's population of 7,323,000 live in multi-family buildings that average 50 years in age. An average apartment uses approximately 1.2 kiloliters (335 gallons) per day. The amount can vary, however, between 150-7570 liters (40-2000 gallons) per day (Speedwell 1994). Water is supplied by a public utility from upstate reservoirs. The supply system is 90% gravity fed; no pumping is needed to move the water downstate.

In recent years, "A combination of system demands that exceed the safe yield and erratic precipitation patterns have caused four drought periods on the New York City system." (Nechamen, 1993) Unless New York City is able to reduce its demand for water, it will have to spend billions to expand its water supply and wastewater treatment infrastructure.

### *Program Selection and Development*

To delay or avoid expanding its water and water treatment infrastructure, New York City joined the statewide water efficiency effort. As a first step, and in order to comply with state requirements for areas of more than 5,000 people, New York City began metering all connections, auditing water supplies, and replacing plumbing fixtures.

New York City is one of the last cities in the country to install meters. With meter installation, billing is based on consumption and encourages water conservation on the part of the building owner. However, more than half of all apartment buildings in New York City are covered by either 'rent control' or 'rent stabilization' laws which prevent owners from passing increased water/sewer costs to tenants. Such laws limit the effectiveness of price-based conservation incentives. To date, New York City apartment buildings which have been metered have seen a reduction in their water-/sewer costs of 15-40% as a result of the rebate program (Liebold, 1994).

To augment metering benefits, New York City also chose to implement a toilet rebate program. Eighty percent of the city's existing toilets have a flush rate of 5.0 gpf, and in offering rebates for the purchase of low-flow toilets, the City will further its plans to save water, reduce excess flow to sewage treatment plants, provide rate relief for consumers, and adopt a least-cost solution.

The decision to target toilets was the result of careful study. "In 1989, New York City's Department of Environmental Protection (DEP) and Housing Preservation and Development -- along with the Plumbing Foundation in the City of New York -- undertook a demonstration program in city-owned buildings. Three similar apartment buildings in Manhattan were metered to measure water usage, but only one building had water efficient fixtures (low-flow toilets, low-flow showerheads, low-flow-restricting faucet aerators) installed. Later, four additional buildings in the Bronx were added as non-



conserving "control" buildings. Since monitoring began in February 1989, water usage in the retrofitted buildings consistently has been 40% lower than in the control buildings." (National Association of Plumbing Heating and Cooling Contractors (NAPHCC), 1994) In other trials, initial metering tests of tenement buildings showed that total water consumption dropped by 50% after replacing the 5.0 gpf toilets with 1.6 gpf toilets. Notes the NAPHCC, "(M)ulti-family buildings will be the primary users of the rebate program in New York City as they are being hit the hardest by increased water and sewer charges and the transition to metering in high-consumption buildings."

### *Program Goals*

"The goal of the three-year, \$270 million program has been to reduce citywide water use by about 320 megaliters (85 million gallons) per day." (Levin, 1994) In total, between 1-1.25 million toilets are to be replaced in the next three years.

### *Program Elements*

#### (a). *Rebate Level*

DEP offers a rebate of the installed cost up to \$240 for first bathroom in dwelling unit and \$150 for each additional unit. For non-residential units, DEP offers \$150 per toilet. At least 70% of the toilets in a multi-family or commercial building must be replaced to qualify for the rebate. Building owners must go through an application process before qualifying for a rebate. Installation of the toilet must be done by a licensed plumber.

#### (b). *Outreach*

The Bureau of Water and Energy Conservation, part of the DEP, hired a contractor to process the applications, perform the inspections (guaranteeing that the plumbing products are installed as claimed), issue rebate checks to building owners, design program materials, and do press work. The media campaign consists of mailings, radio public service announcements, newspaper ads, and slide shows. DEP employs two full time staff people to oversee the progress of the program.

In October of 1993, the DEP kicked-off the borough-wide rebate program in Jacob Javits Convention Center. Plumbers, building owners, housing associations and manufacturers attended. Packets and briefings are regularly provided to plumbers, manufacturers, building owners, and co-op boards. DEP phased in the program by beginning in the borough of the Bronx in March 1994. The program expanded into Manhattan in June of 1994 and the rest of the city in August.

#### (c). *Budget*

Funding for the DEP administered project is provided by New York City Water Board from receipts from water and sewer customers. The majority of the project funds are allocated for rebates. Fifteen million dollars have been paid out to date and DEP has \$250 million available for rebates. The

contracting company is paid on a unit basis. If one million toilets are replaced, the contractor could receive up to \$12 million. Press work and printing costs have reached \$2 million.

### *Evaluation*

DEP monitored buildings for water consumption rates before the rebate so a comparison can be made after the program has ended. As of the beginning of 1995, 85,000 toilets have been replaced. DEP has paid 65-66,000 rebates. Water savings are estimated between 9 - 22 megaliters (2.45 - 5.8 million gallons) per day. "DEP will let a contract for program evaluation in mid-1995. That project will involve monthly meter readings from 1,500 - 3,000 apartment buildings and a "customer satisfaction survey" of tens of thousands of end users, building managers and plumbers about toilet performance (Liebold 1995)."

The Toilet Rebate Program is only one part of New York City's larger water conservation effort. Since FY 1986, DEP's Ultrasonic Leak Detection program has surveyed about 6 megameters (20 million feet) of water pipe annually. The entire City is surveyed at least once every three years, with high-flow or problem areas surveyed either once every nine months (30% of the City) or once a year. The DEP began a Universal Metering Program in 1988 to install meters in the approximately 85% of residential properties which were not water metered. This program will be completed by 1998. Chronic problems with illegal use of fire hydrants are also being addressed through the installation of 30,000 new magnetic hydrant locking caps. These are three among a host of DEP programs. The Toilet Rebate Program should not be seen as the only efficiency program, but the latest program to be considered cost-effective (Liebold, 1995).

## California

In the preceding case, state powers were actively mobilized to promote specific water conservation methods. While such active state involvement is often effective, it may also be true that the mere threat of state involvement is sufficient to prompt independent conservation action from local and regional water authorities. To illustrate this point, the following case explores recent agreements promoting water conservation in California.

In 1991, water suppliers and environmental public interest organizations recognized that drought conditions and population growth were limiting California's available water supplies. These suppliers and organizations were concerned that the State Resources Control Board, the State regulatory agency, would restrict water availability to one or more groups as supplies diminished. The suppliers therefore decided to negotiate between themselves to reduce water consumption and better manage supplies, rather than have the State Board regulate how much water would be available to water suppliers or the environment.

An agreement called "Memorandum of Understanding Regarding Urban Water Conservation in California" (MOU) developed from the negotiations. A list of sixteen Best Management Practices (BMPs) comprises the agreement and are reflected in the authors' recommendations. The BMPs offer a variety of methods to conserve water, recognizing that one single program would not be appropriate for all suppliers. (Appendix E contains the full list of BMPs.) Participating water suppliers must agree to implement water conservation methods suggested by the MOU or methods that are at least as effective. Becoming signatories to the MOU enables water suppliers to participate in the overall discussions concerning the future apportionment of the State's water supply. (EBMUD, 1994)

The Metropolitan Water District (MWD) of Southern California and the Los Angeles Department of Water and Power (LADWP) both signed the MOU. What follows is a description of the plumbing fixture and fitting portion of the MWD and LADWP program for Los Angeles. Community outreach efforts made the Los Angeles program unique and more successful by reaching high water usage residential areas of the city that were unable to participate in the toilet rebate program. This program provides a different approach to the first recommendation of this paper: to determine a cost-effective water conservation activity through careful investigation and design.

### **Los Angeles Community/Utility Coalition<sup>2</sup>**

#### *Profile of the East Los Angeles Area*

East Los Angeles occupies an area of 16 square kilometers (10 square miles) with approximately 100,000 residents living in single family homes. Many residents live at or below the official poverty line. The area's water supplier is LADWP, a municipal utility. It buys its water from MWD and sells

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<sup>2</sup>For more information contact Matt Puffer, Metropolitan Water District, 350 South Grand Avenue, Los Angeles, CA 90054

to retail customers. Both of those organizations work together on water efficient practices.

### *Program Selection and Development*

Continuing drought conditions prompted LADWP to bolster its water conservation efforts. Because the California communities of Goleta and Santa Monica both experienced reduced residential water consumption with the installation of ultra-low flush toilets, LADWP, with the support of MWD planned an extensive city-wide toilet rebate program. Low flow showerheads had already been distributed in the area as a result of a 1988 Los Angeles city ordinance requiring LADWP to replace showerheads and install toilet displacement bags. MWD studies had shown that toilet replacement could yield significant water savings. MWD's support included sharing half the financial costs of the program.

LADWP wanted a program that would yield high water savings and would require little supervision from the utility. The consumer "would select, buy, and install an approved ULFT, and provide the necessary documentation; then LADWP would provide a rebate (Fiske and Weiner 1994)." A low flush toilet replacement needs no conscious water saving action from the user as water conservation is built into the mechanism.

Participants in the LADWP toilet replacement program presented proofs of purchase of ultra-low flush toilets (ULFT) in order to receive rebates of \$110. Low-income residents, however, were generally unable to afford the new toilets and were therefore unable to participate in the program. Working through the Mothers of East L.A. (MELASI), a community-based organization, LADWP and MWD provided the ultra-low flush toilets to the low-income area of East Los Angeles. An incentive of \$25 per toilet installation was paid to MELASI.

### *Program Goals*

The goal of the one year city-wide program was to distribute and install 7500 ultra-low flush toilets as an alternative to continued mandatory rationing. In East Los Angeles, the goal was to retrofit 1000 toilets in a ten-week time frame.

### *Program Elements*

The rebate program was customized for the East Los Angeles area. In order to maintain a low supervisory role and reach into neighborhoods that were not participating in the toilet rebate program, LADWP and MWD agreed to channel funds designated for rebates to a subcontractor who would work with MELASI. The community-based organization had a respected reputation within the East L.A. community. MELASI proposed to work together with LADWP and MWD to promote water conservation. From money generated from the utilities, MELASI would fund community projects it would otherwise be unable to do.

#### (a). *Rebate Level*

LADWP and MWD shared the program costs, paying a subcontractor a total of \$110 per toilet which included the purchase and distribution of a toilet and administration of all other aspects of the neighborhood program. The subcontractor paid MELASI \$25 per toilet to publicize the program in East Los Angeles and assist with toilet installations.

(b). *Outreach*

MELASI walked door-to-door in the East L.A. section of Los Angeles explaining the toilet rebate program. The community organization provided services that included: bilingual installation instructions, instructional videos, tool kits, and back-up installation assistance. MELASI distributed the toilets from a central location to those residents who provided their water bill and photo identification. Replaced toilets were returned to the central depot for recycling. MELASI employed eight previously unemployed residents to publicize the program in the neighborhood and assist with the installations when necessary.

(c). *Budget*

Table 3 gives budget information for fiscal year 1992-1993 for the city-wide program.

**Table 3: Los Angeles Toilet Replacement Program 92-93 Budget**

Number of ULFTs installed	65,167
Rebates to customers	\$5,545,700
Payment to MWD for CBO Program (since June 1993)	\$ 86,400
Payment to the contractor (program administration)	\$ 846,800
LADWP expenses (1 FTE, printing brochures, etc.)	\$ 80,000
Subtotal	\$6,558,900
Reimbursement from MWD (@ 50% / ULFT)	(\$2,772,850)
Total	\$3,786,000

(source: Fiske and Weiner, 1994)

*Evaluation*

After one year in operation, MELASI oversaw the installation of 8000 toilets. LADWP estimates that for every retrofit toilet 110 liters/day (29 gallons/day) have been saved. This translates into 40 kiloliters/household/year (over 10,000 gallons/household/year).

Water savings in the East Los Angeles area are estimated at  $220 \pm 53$  liters ( $58.6 \pm 14$  gallons) per household per day. (A & N Technical Services, 1994) "Not only did this program replace ULF toilets in households unlikely to do so otherwise, the evidence also suggests a higher level of water saved from each replaced ULF toilet (A&N Technical Services, *et al.* 1994)." The greater number of persons per household attributed to the higher water savings in East Los Angeles as compared with the water savings in Los Angeles as a whole.

With funds received from LADWP for their retrofit work, MELASI has financed other community programs. "One of these has been the development of a community scholarship program in East L.A., working with students from two local high schools. A child immunization program has also been established in conjunction with Community Health Foundation, with the goal of raising immunization levels from less than 20% up to 80%, for local children up to two years of age. A third program, the Youth Graffiti Abatement Program, employs high school students to continually clean up the graffiti in their community (Hamilton and Craft 1993)."

## Texas

The population of Texas has grown over 300% in the last sixty years, and statewide water use has increased five-fold from 1930 to 1980. A limited water supply and a ballooning population pushed the Texas legislature to incorporate conservation into state water planning, policy and programs. In 1984, the legislature adopted an overall water plan directed by a governor-appointed task-force. Elements of this plan included a new Texas Water Development Board (TWDB) requirement that water conservation plans be included as a part of all loan applications and requests for water rights by water districts. Today, "state policy relating to water conservation can be grouped into four categories: regulatory requirements, water resources planning, technical and financial assistance, and research (Personett 1993)." Table 4 gives details on each of the four categories:

Regarding fixture and fitting replacement, TWDB estimated that if only 6 lpf (1.6 gpf) toilets were used in the State, 757 megaliters daily (200 MGD) of water could be saved, reducing the need to build additional water and wastewater treatment facilities by 15 %, and saving Texas \$3.4 billion over a 50 year period (Jensen 1991). "The value of fixture replacement programs and the magnitude of any financial incentives are directly related to what avoided costs the utility will realize. Avoided costs include avoided operating costs and the present value of avoided capital costs, on both the water supply and the wastewater side (Liebold 1995)."

**Table 4: State of Texas Water Conservation Policy**

<b>Regulatory Requirements</b>	<b>Water Resources Planning</b>	<b>Technical and Financial Assistance</b>	<b>Research (examples of projects)</b>
Require water conservation plans and measures before receiving a state water use permit.	Emphasize water conservation for demand projections and policy recommendations.	Assist utilities and local and regional water utilities with leak-detection and water audits.	Soil moisture monitoring for improved irrigation efficiency.
Require large loan recipients of Texas Water Development Board for water/wastewater projects to develop a water conservation programs	Incorporate water conservation into regional water and wastewater planning programs.	Dispense low-interest loans for wastewater reclamation and reuse projects, and rehabilitation of water distribution systems.	Wastewater reclamation and reuse.
Require large wastewater discharge permit holders to analyze reuse potential.	Promote regional water planning	Assist in development of water conservation and drought management.	Analysis of trends affecting per capita municipal water use.
Establish statewide standards for plumbing fixtures and fittings		Dispense low-interest loans for high-efficiency plumbing on Texas-Mexican border.	Evaluation of effectiveness of Xeriscape water conservation practices.
Require xeriscaping in state-owned facilities		Develop education and promotional activities for utilities and other agencies.	Evaluation of trends affecting industrial water use and conservation

(Personett, M. 1993)

The following section characterizes a municipality that employed water conservation programs as a means of qualifying for future water supply permits. Other recommendations featured are a toilet rebate program and an inverted block rate structure.

### **“Kick the Can” -- San Antonio’s Toilet Rebate Program<sup>3</sup>**

#### *Profile of the San Antonio Area*

San Antonio, with a population of 966,000, lies between Texas’ semi-arid western region and the wet coastal area to the east. Water from the Edwards Aquifer provides almost all San Antonio’s water needs. The area’s 76 centimeters (30 inches) per year rainfall replenishes the Edwards Aquifer which covers 273 kilometers (170 miles). The northeast section of the aquifer is home to vegetation and wildlife on the Endangered Species List. In the early 1990s, the Sierra Club filed a law suit against the city of San Antonio to protect and maintain the spring flow depleted by the city’s growing water demands. A federal ruling required San Antonio to reduce its pumping from the aquifer during drought years and to develop a drought management plan. (Rose, 1995)

#### *Program Selection and Development*

To comply with both the federal ruling and state law requiring efforts to reduce water consumption before construction of new water resources, the San Antonio Water System (SAWS) researched various ways to reduce demand on their primary water source -- the Edwards Aquifer. SAWS chose a \$75 toilet rebate program as the incentive to reduce consumer water demand. Toilet replacement was seen as a permanent solution to long-range conservation efforts. Another part of San Antonio’s water conservation program includes an inverted block rate.

#### *Program Goals*

SAWS expects to replace 12,000 toilets in their service area in the 1995-96 fiscal year. The long range goal is to replace 80 percent of the service area’s 250,000 toilets over the next 20 years through education, rebates, and natural replacement. (Rose, 1995)

#### *Program Elements*

SAWS paid a \$75 rebate for each replaced toilet for residential customers. The utility paid for the replacement of up to two toilets. Rebate application accompanied the water bills. To qualify for the rebate, customers have to submit original receipts along with their application and turn in their old toilet(s) for recycling at a SAWS service center. The \$75 rebate is then awarded as a credit on the customer bill. Funds generated from new residential conservation rates support the rebate program.

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<sup>3</sup>For more information contact Craig Rose, San Antonio Water System, 1001 East Market Street, San Antonio, TX 78205



In anticipation of a federal mandate requiring the use of recycled materials in projects such as road construction, SAWS is currently storing the recycled toilets. "Current uses of crushed vitreous china include trench fill material, rock/reed filter material, landscape decorative mulch and road base components." (Rose, 1995)

### *Evaluation*

Three thousand households have replaced 4200 toilets in the nine months the program has been in operation. The low flow fixtures have displaced units flushing as much as ten gallons per flush. This level of participation translates into current water savings estimated at 265 kiloliters (70,000 gallons) per day. That figure will grow as more toilets are replaced through the program.

### **Two More from Texas -- Replacement Programs in Austin<sup>4</sup>**

Situated in central Texas, and with a growing population of nearly half a million residents, the City of Austin has anticipated increased water demands by establishing a goal of reducing peak day water consumption by 76 megaliters (20 MGD) by the year 2005. Like San Antonio, Austin has sought to encourage toilet replacement as an important element in reducing overall water consumption. Two complimentary toilet replacement incentive programs are currently in place, a rebate program and a low-income outreach program.

Austin's toilet rebate program offers occupants of single family dwellings, multi-family dwellings, and commercial properties a water bill credit of up to \$40 for installing 6 lpf (1.6 gpf) toilets and, for commercial sites, up to \$75 for installing waterless urinals. For residences, credits are limited to a maximum of two toilets per family, and to families either receiving a City of Austin water bill or which are members of a Municipal Utility District. The program has been advertised in local newspapers, with utility bill inserts, and at plumbing supply houses. To date, over 2700 toilets have been replaced, with another 3000 toilets expected to be replaced by 1997. Total program expenditure was set at \$155,080 for FY 1995, with an estimated water saving of 513 kiloliters (135,000 gdp).

To encourage toilet replacement by low-income families, Austin has instituted the ULF Toilet Outreach Program. Residents qualify for a free toilet voucher on the basis of pre-established geographic and economic criteria. Residents can also qualify on the basis of past participation in a low-income weatherization program. Once installed, ULF toilets are inspected to insure there are no leaks. The inspection process is also used as a chance to distribute low-flow shower heads. After relatively unsuccessful attempts to generate interest in the program using utility bill fliers and newspaper advertising, program organizers sent a direct mailing to past participants of the city's energy conservation programs. This form of outreach proved successful, and today Austin encourages program participation using direct mailings to residents of specific zip codes with predominantly low-income households. In 1994--during the program's pilot stage-- 348 ULF toilets were installed.

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<sup>4</sup>This brief overview draws on information provided by A. Steven Dietz at the City of Austin: Dietz, A.S.; personal communication to Camilla Dunham; July 13, 1995.

Austin expects another 2700 toilets to be installed in 1995, and 4100 in 1996. In FY 1995, the city budgeted \$164,000 for the ULF Toilet Outreach Program, with water savings estimated at 651 kiloliters (172,200 gpd).

## Washington

Washington State views savings from water efficiency programs as another water source. Conservation programs are required for water rights applicants and of those petitioning for water systems and reservations of future water supplies. Washington State publishes requirements to assist water system managers to prepare for review and approval of water systems plans, for petitions to reserve future water supplies, and for water right applications. The state has not determined specific, rigid programs that meet their water conservation standards. "The guidelines for conservation emphasize flexibility. The selection and the criteria for the level of implementation to be achieved recognize regional differences in water supply and demand conditions (Washington Water Utilities Council, *et al.* 1994)." Water conservation programs developed from the Conservation Planning Requirements are submitted for approval by the Departments of Health and Ecology. Approval is based on whether the "selection and implementation of conservation measures (was) determined by the cost of a measure in relation to the value of the water conserved." Three elements must be included in the area's water conservation plan:

**"Water Use Data Collection Requirements.** Systems must report the best currently available data on water use for the categories of use.

**"Water Demand Forecast.** A complete forecast, including an estimate of reduction of water use from implementation of water conservation measures, must be developed.

**"Conservation Program.** Implementation of approved water conservation plans by public water systems will be a condition on . . . all subsequent water right permits and certificates issued by Ecology for public water systems. If the public water system has not been collecting data as required, the data which has been collected must be submitted, and collection of data will be a condition of new water rights and certificates, and will be required for future water system plan approvals. Implementation of the required conservation measures, conservation measures chosen for implementation, and data collection identified in this document will be made a condition of all new water right permits, and will be reviewed in future water system plan approvals." (Washington Water Utilities Council, 1994)

Table 5 shows recommended programmatic elements for water conservation in differently sized water utilities.

**Table 5: State of Washington Water Conservation Policy for Public Water Systems**

Measures	Public Water Systems			
	Large	Medium	Small	Region
<b>A. Public Education</b>				
1. School Outreach	X			X
2. Speakers Bureau	X			X
3. Program Promotion (implementation required)	X	X	X	X
4. Theme Shows and Fairs	X			X
<b>B. Technical Assistance</b>				
1. Purveyor Assistance	X	X		X
2. Customer Assistance	X	X		X
3. Technical Studies	X			X
4. Bill Showing Consumption History	X	X		
<b>C. System Measures</b>				
1. Source Meters (required if requesting water rights)	X	X	X	X
2. Service Meters	X	X	X	X
3. Unaccounted Water/Leak Detection	X	X		X
<b>D. Incentives/Other Measures</b>				
1. Single-Family/Multi-Family Kits	X	X		X
2. Nurseries/Agriculture	X	X		X
3. Landscape Management/Playfields	X	X		X
4. Conservation Pricing	X	X	X	X
5. Utility Financed Retrofit	X			X
6. Seasonal Demand Management	X			X
7. Recycling/Reuse	X			X

Washington Water Utilities Council, et al. 1994

The system size is determined by the total number of services served by the water system.

Large Systems: >25,001 services

Medium Systems: >1,000 and <25,000 services

Small Systems: <1,000 services

Regional Systems: Not defined by service number.

## **Seattle's Utility Partnership Program**

### *Profile of the Seattle Area*

Seattle's median annual rainfall of 94 centimeters (37 inches) feeds a surface water supply system serving the city's 500,000 population. The residential sector of Seattle's population comprises the area's largest single water consumer, using 64% of the water department's billed water consumption. (Brown and Caldwell, 1990)

### *Program Selection and Development*

The Seattle Water Department had determined in a 1989 pilot study that replacing showerheads was one of the most cost-effective measures to reduce water demand. (Fiske, 1994) A 2000 single-family home pilot study tested which distribution methods and installation rates were most cost-effective.

To respond to a 1992 drought, the Water Department chose the same door-to-door drop-off method used in the pilot study. Other utilities were encouraged to join the effort to increase water and energy savings, to reduce program costs and increase the credibility of the effort. The Seattle Water Department, Seattle City Light, and Puget Sound Power and Light formed, in partnership, the Home Water Savers Program to offer conservation kits to single family dwellings. The Bonneville Power Administration (BPA) and Washington Natural Gas provided financial support to encourage energy conservation.

### *Program Goals*

The utilities identified the goals of the program as reducing consumption of water and energy resources in their respective service territories. (Seattle City Light, 1993).

### *Program Elements*

#### (a) *Outreach*

The cooperative effort sought to distribute 330,000 Home Water Savers Kits to all one-to-four unit dwellings in Seattle Water Department's service area. The canvass and drop-off method was chosen as the most cost-effective approach to delivering the kits. During the pilot phase, that method achieved a 34% showerhead installation rate. For the Home Water Savers Program, organizers increased their installation rate goal to 68%. Radio advertising and newspapers spread the word about the free kits. The ad campaign focused on water, energy, money, and environmental resource savings from installing efficient showerheads.

#### (b). *Budget*

Table 6 describes the program costs for each participating utility.

**Table 5: City of Seattle Water Conservation Program Budget**

	Seattle Water Dept.	Puget Power	Seattle City Light	Program Total	Cost per Kit
Kit Items	\$712,070	\$284,912	\$1,255,779	\$2,252,761	\$6.83
Distribution	\$383,090	\$155,190	\$701,655	\$1,239,935	\$3.76
Marketing	\$156,000	\$35,000	\$125,000	\$316,000	\$0.96
Evaluation	\$25,336	--	\$43,200	\$68,536	\$0.20
<b>TOTAL</b>	<b>\$1,276,496</b>	<b>\$475,102</b>	<b>\$2,125,634</b>	<b>\$3,877,232</b>	<b>\$11.75</b>

(Fisk, 1994)

### *Evaluation*

In the full program, installation rates reached an estimated 43 percent. In the first three weeks of the campaign, when publicity was greatest, the installation rate was 68 percent. Participants were more inclined to install the high-efficiency showerhead and other kit materials if they had heard about the program from a friend or through the media. After the first year, sixty-four percent of the showerheads remained installed. The final report detailing water savings is expected to be published in late 1995.

### *Seattle II: Continuing Water Conservation Efforts*

In addition to the shower head replacement program, Seattle is also one of the first cities in the U.S. to begin commercial toilet and urinal replacement. Starting in the spring of 1995, toilets and urinals with use rates exceeding 30 times per day can be replaced with assistance from the Seattle Water Commercial Toilet Rebate Program. For every 6 lpf (1.6 gpf) toilet installed, the facility will receive \$100. For every 6 lpf (1.6 gpf) flush valve toilet or 3.8 lpf (1.0 gpf) urinal installed, the facility will receive \$150. Potential water and sewer bill savings are estimated at 30% depending on the existing plumbing fixture. Actual program results from metering studies will be available in late 1995.

## V. *CONCLUSION*

It is important to emphasize that there are many types of potentially successful fixture and fitting replacement programs. As the case studies above should indicate, there is no one universally best program. Nonetheless, for each specific location, there is likely to be a combination of steps and measures which can give rise to a program well tailored to the area's needs. The key to achieving this "fit" lies in carefully evaluating the specifics of a given situation, paying close attention to the potential benefits and costs of plumbing product replacement.

This element of critical forethought is at the heart of the first recommendation -- investigating the cost-effectiveness of water-efficient plumbing replacement programs -- which should be viewed as an essential first-step for any water conservation program. Possible subsequent steps are suggested in succeeding recommendations. While not necessarily appropriate for every situation, these recommendations should be regarded as serious policy options which--as the case studies demonstrate--have been tried successfully in a number of guises.

To begin the process of assessing the potential for plumbing fixture and fitting replacement, as well as other water conservation policy options, please consult the sources listed below (see especially Appendix D).

## APPENDIX A: TYPES OF WATER CONSERVATION MEASURES

### TYPICAL LONG-TERM WATER CONSERVATION MEASURES BY WATER USE TYPE

Area of Application	Conservation Method
General	Public information In-school education Metering Pressure reduction Pricing policies
Interior residential use	(1) Increasing block rate  (2) Seasonal rates Leak detection and repair System rehabilitation
Power generation	Low-flow showerheads Shower-flow restrictors Toilet-tank inserts Faucet aerators Water-efficient appliances Ultra-low-flush toilets
Industrial use	Recirculation of cooling water Reuse of treated wastewater In-system treatment
Landscape irrigation/design	Recirculation of cooling water Reuse of cooling and process water Reuse of treated wastewater Efficient landscape irrigation Low-water-using fixtures Process modification  Efficient landscape design Low-water-use plant material Scheduled irrigation Efficient irrigation systems Reduction or limitation of high water use plant materials such as turf

(Maddaus, W.O. 1987.) *Water Conservation*. American Water Works Association. Denver, CO.



## APPENDIX B: NATIONAL CAPITAL COST AVERAGES AND EXAMPLE

In 1980 and 1981, the EPA published three reports showing average national costs for municipal wastewater plant construction, municipal wastewater conveyance system construction, and operation and maintenance costs for municipal wastewater facilities. EPA has published updated information in their document *Detailed Costing Document For The Centralized Waste Treatment Industry*. EPA's information is summarized here. For additional information on avoided costs, the American Water Works Association (AWWA) Research Foundation is preparing a report "Impact of Demand Reduction on Water Utilities" for release in 1995.

### Standard Capital Cost Factors

Factor	Capital Cost
Equipment	Technology-Specific Cost
Installation	25 to 55 percent of equipment cost
Piping	31 to 66 percent of equipment cost
Instrumentation Controls	6 to 30 percent of equipment cost
<b>Total Construction Cost (TCC)</b>	<b>Equipment + Installation + Piping + Instrumentation and Controls</b>
Engineering	15 percent of TCC
Contingency	15 percent of TCC
<b>Total Indirect Cost</b>	<b>Engineering + Contingency</b>
<b>Total Capital Cost</b>	<b>Total Construction Cost + Total Indirect Cost</b>

(EPA, 1995.)

**Standard O&M Cost Factors**

<b>O &amp; M Factors</b>	<b>O&amp;M Cost (1989 \$)</b>
Maintenance	4 percent of Total Capital Cost
Taxes and Insurance	2 percent of Total Capital Cost
Labor	\$30,300 to \$31,200 per person-year
Electricity	\$0.08 per kilowatt-hour
Residuals Management	Technology-Specific Cost
Chemicals	variable
<b>Total O&amp;M Cost</b>	<b>Maintenance + Taxes and Insurance + Labor + Electricity + Chemicals + Residuals</b>

(EPA, 1995.)

### San Francisco Oceanside Water Pollution Control Plant Example

Oceanside Water Pollution Control Plant in San Francisco, California was designed in 1987 and became operational in 1993. The plant was built to provide secondary treatment for wastewater and designed to treat 163 megaliters (43 million gallons (MGD)) of water per day. The costs for the plant's construction are itemized below. Funding was generated through state loans (\$130 million), from state and federal grants (\$30 million), and from local bond issues and user service fees. Oceanside replaced an older plant, increasing from 50% to 95% the amount of water treated and the removal of wastewater pollutants.

Oceanside Water Pollution Control Plant (San Francisco, CA)	
Cost	\$220 Million to design and build
Cost to Operate (includes salaries, maintenance parts, electricity, process chemicals, lab analysis, facility upkeep biosolids hauling, employee technical and safety training)	\$2,055/Hour \$18.0 Million/Year
Plant Service Area	280,000 People
Plant Size	12 acres, 70% underground
Average Annual Dry Weather Flow	79 MLD (21 MGD)
Actual Annual Dry Weather Flow	64 MLD (17 MGD)
Peak Secondary Flow	163 MLD (43 MGD)
Peak Wet Weather Flow	246 MLD (65 MGD)
Energy Recovery	Engine Generator runs on biogas, produces 550 kilowatts-hours/hour (20% plant needs)

## APPENDIX C: WATER CONSERVATION RATES STRUCTURES<sup>5</sup>

It has been known for at least twenty years that an increase in water prices can induce customers to reduce their consumption of water.<sup>C-1</sup> Research has shown that this response exists for all types of customers (from residential<sup>C-2</sup> to industrial<sup>C-3</sup>), though the level of response is dependent on the customer receiving accurate and timely information.<sup>C-4</sup>

Researchers also have shown that customer response to significant price changes is rapid and sustained -- resulting in usage reductions remaining in place even after temporary rate surcharges are eliminated. Specifically, Agthe and Billings found that "water use adjusts relatively rapidly from current rates to desired use rates" as prices change.<sup>C-5</sup> Similarly, Hogarty and Mackay reached the following conclusions:

"(1) residential water consumption, even for domestic [indoor] use, is highly sensitive to large increases in (marginal) rates, (2) response to rate increases is as great in the short run (3 months) as in a longer period (1 year); and (3) residential water consumption, at least for domestic use, is relatively insensitive to decreases in (marginal) rates following large increases."<sup>C-6</sup>

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<sup>5</sup>The information on rate structures here is provided courtesy of Scott Rubin, Public Utility Consulting, (717) 743-2233

<sup>C-1</sup>Hogarty, T.F. and R.J. Mackay, The Impact of Large Temporary Rate Changes on Residential Water Use, *Water Resources Research* Vol. 11 No. 6 (Dec. 1975), pp. 791-94.

<sup>C-2</sup>Nieswiadomy, M.L. and D.J. Molina, Comparing Residential Water Demand Estimates Under Decreasing and Increasing Block Rates Using Household Data, *Land Economics* Vol. 65 No. 3(August 1989), pp. 280-89; Agthe, D.E. and R.B. Billings, Dynamic Models of Residential Water Demand, *Water Resources Research* Vol. 16 No. 3 (June 1980), pp. 476-80; Morgan, W.D., Residential Water Demand: The Case from Micro Data, *Water Resources Research* Vol. 9 No. 4 (August 1973), pp. 1065-67.

<sup>C-3</sup>DeRooy, J., Price Responsiveness of the Industrial Demand for Water, *Water Resources Research* Vol. 10 No. 3 (June 1974), pp. 403-06; Renzetti, S., Estimating the Structure of Industrial Water Demands: The Case of Canadian Manufacturing, *Land Economics*, Vol. 68, No. 4 (Nov. 1992), pp. 396-404.

<sup>C-4</sup>Chicoine, D.L. and G. Ramamurthy, Evidence on the Specification of Price in the Study of Domestic Water Demand, *Land Economics* Vol. 62 No. 1 (February 1986), pp. 26-32.

<sup>C-5</sup>Agthe and Billings, Dynamic Models of Residential Water Demand, *supra*.

<sup>C-6</sup>Hogarty and Mackay, The Impact of Large Temporary Rate Changes on Residential Water Use, *supra*.

Generally, there are two major types of rate structures which could be used to encourage conservation during peak-demand periods: increasing block rates and seasonal (or peak use) rates.<sup>C-7</sup> There are also several variations and combinations of these types of pricing mechanisms.<sup>C-8</sup> At their simplest, increasing block rates become more expensive per unit as the customer uses more water. Seasonal rates become more expensive when water is used during one peak-demand season (or when the off-peak usage is exceeded by a certain amount during the on-peak period).<sup>C-9</sup>

At least as early as 1974, water utilities began using higher rates during periods of peak demand (usually the summer) in order to reduce the level of customer demand.<sup>C-10</sup> Indeed, Griffith reports that in one utility from 1974 to 1979, maximum day requirements were reduced from 160% of average day to 145% of the average day, reducing the size of needed treatment capacity by over 90 megaliters (24 MGD).<sup>C-11</sup> Experience at other utilities through the 1980's continued to show that changes in the design of rates -- either through seasonal pricing, peak-use pricing, or increasing block rates -- could induce customers to reduce their water usage, particularly during peak periods.<sup>C-12</sup>

These once-novel rate structures have become much more common during the past several years. By 1990, a survey of state utility commissions found that 15 employed increasing block rates and

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<sup>C-7</sup>Beecher, J.A., P.C. Mann, and J.R. Landers, *Cost Allocation and Rate Design for Water Utilities* (Columbus, OH 1990), pp. 118-126.

<sup>C-8</sup>See Beecher, *et al.*, *Cost Allocation and Rate Design for Water Utilities*, *supra*, and American Water Works Association, *Alternative Rates Manual M34* (Denver, CO 1992)

<sup>C-9</sup>*Id.*

<sup>C-10</sup>Griffith, F.P., Jr., Policing Demand Through Pricing, *Journal American Water Works Association*, Vol. 74 No. 6 (June 1982), pp. 288-91, reporting on the experience of Fairfax County, Virginia, which adopted peak use pricing in 1974.

<sup>C-11</sup>Griffith, Policing Demand Through Pricing, *supra*.

<sup>C-12</sup>Cuthbert, R.W., Effectiveness of Conservation-Oriented Water Rates in Tucson, *Journal American Water Works Association* Vol. 81 No. 3 (March 1989), pp. 65-73 (inverted, seasonal rates have reduced per capita usage by 20%); Gilbert, J.B., W.J. Bishop, and J.A. Weber, Reducing Water Demand During Drought Years, *Journal American Water Works Association* Vol. 82 No. 5 (May 1990), pp. 34-39 (increasing block rates coupled with extensive conservation campaign reduced residential usage by 27%); Schlette, T.C., Water Rate Surcharges as a Conservation Mechanism, American Water Works Association Annual Conference, June 1991 (summer surcharge in North Wales, Pennsylvania, reduced maximum day demand by 7% to 15%, even though number of customers increased by 14%).

14 used seasonal pricing for at least some of their water utilities.<sup>C-13</sup> Indeed, by 1992, it was found that over half of the large water systems in the Western, Eastern, and Southern United States no longer used declining block rates.<sup>C-14</sup> Today, then it can be concluded that changing the design of rates is a recognized and widely practiced method to encourage customers to use water more efficiently. This includes reducing usage during periods of peak demand.

Recently, it has been shown that conservation pricing also can be a useful strategy for reducing a water utility's risk and may promote revenue stability.<sup>C-15</sup> Amatetti concludes that "conservation-oriented rate structures that target peak demand rather than average demand are generally much less likely to have an adverse effect on a utility's revenue stream and, therefore, on its financial risk profile. In fact, they may have a favorable effect." He also finds that peak period pricing means that "only a small reduction in demand is necessary to have a significant effect on future capacity requirements. This means that the utility does not have to sacrifice as much in revenues to achieve its goal of reducing future capacity requirements." Furthermore, peak period pricing can "actually promote revenue stability." Indeed, Amatetti states:

"It may be argued that any loss in revenues, even revenues related to peak demand, is undesirable. However, in the long run, a revenue stream with smaller peaks and valleys, as is promoted through rate structures that target peak demand, lowers a utility's risk profile. Furthermore, peak-period or seasonal pricing relates the cost of maintaining excess capacity directly to the sources of these costs: the peak user. In this way, this pricing strategy is also consistent with efficient cost allocation, which is another important risk management tool for finance managers."<sup>C-16</sup>

In short, it is well-established that properly designed pricing structures can effectively induce customers to reduce peak demands. This has several salutary effects, including reduction in the size of need treatment capacity, reduction in seasonal variations in the revenue stream, closer alignment of rates to cost causation, and reductions in the utility's financial risk.

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<sup>C-13</sup>Beecher, *et al.*, *Cost Allocation and Rate Design for Water Utilities*, pp. 134-35.

<sup>C-14</sup>Ernst & Young, *Ernst & Young's 1992 National Water and Wastewater Rate Survey* (1992), pp. 16-17.

<sup>C-15</sup>Amatetti, E.J., Managing the financial condition of a utility, *Journal American Water Works Association*, Vol. 86 No. 4 (April 1994), pp. 176-187.

<sup>C-16</sup>*Id.*, p. 184.

## APPENDIX D: GUIDES AND MANUALS

In conducting their own surveys, state and local authorities should also consult the following sources:

### **WATERWISER. Water Efficiency Clearing House**

Sponsor: American Water Works Association and U.S. Environmental Protection Agency

Contact: 666 West Quincy Avenue, Denver, CO 80235-9913, 800-559-9855,

watwiser@awwa.org

Internet access can be found at: gopher: uwin.siu.edu or <http://www.uwin.siu.edu>

WaterWiser provides information services that help with planning, implementing and evaluating water efficiency programs and activities.

### **Customer Incentives For Water Conservation: A Guide.** Fiske, Gary S. and Ronnie Ann Weiner, Barakat & Chamberlin, Inc.

Source: California Urban Water Agencies, California Urban Water Conservation Council and U.S. Environmental Protection Agency, 1994. EPA 230-R-94-001

Contact: Barakat & Chamberlin, Inc., 1800 Harrison, Oakland, CA 94612 (510) 893-7800

As urban water conservation programs grow and mature, there is strong interest in many communities in providing incentives, monetary and otherwise, to stimulate further involvement of consumers. But the questions of which types of incentives to offer, and how to manage and optimize incentive programs have remained largely unanswered. This report provides solid information on a variety of water conservation incentive programs to help water agencies design and evaluate programs on a more rational, thoughtful basis.

### **Evaluating Urban Water Conservation Programs: A Procedures Manual.** Planning and Management Consultants, Ltd.

Source: American Water Works Association, 1993. ISBN 0-89867-676-2.

Contact: Planning and Management Consultants, Ltd. (PMCL), P.O. Box 1316, Carbondale, IL 62903, (618) 549-2832

This manual was prepared to assist managers in developing the information needed to analyze the role of water conservation in meeting growing demands.

### **Ultra Low Flush Toilet Rebate Programs: Evaluation of Program Outcomes and Water Savings.** A&N Technical Services, Inc.

Source: Metropolitan Water District of Southern California, 1994

Contact: Matt Puffer

To assist water planners in reliably accounting for water savings achieved through ULF toilet rebate programs, this report details the continuing impact evaluation.

**Water Audits and Leak Detection.**

Source: American Water Works Association, 1990

Contact: American Water Works Association

The manual provides step-by-step instructions for conducting a system-wide water audit, including sample worksheets and forms for each step of the process. It details leak detection-repair programs and how they work, and can help determine if a leak detection survey is feasible and cost-effective.

**The Water Conservation Manager's Guide to Residential Retrofit.** Babcock, Thomas M., Mary Ann Dickinson, Thomas E. Pape, and David Schultz, eds.

Source: American Water Works Association, 1993

Contact: AWWA Customer Service, 6666 West Quincy Avenue, Denver, CO 80235, (800) 926-7337

This handbook is designed to provide water conservation administrators with an awareness of retrofit alternatives in the residential sector and the pros and cons of each alternative. Each water provider should adapt the alternatives to achieve the best retrofit management strategy for the local community.

**Water Conservation Guidebook for Small and Medium-Sized Utilities.** Pacific Northwest Section of the American Water Works Association.

Source: American Water Works Association, 1993

Contact: Cynthia Dietz, Conservation Program Manager, Portland Water Bureau, 1120 SW 5th Avenue, 6th floor, Portland, OR 97204, (503) 823-6133

This guidebook is written for the small and medium-sized water utility (1,000 to 25,000 connections) considering a water conservation program. It is intended to provide a general overview of water conservation planning, and to describe the specific steps to follow to design the best plan. The guidebook offers a "menu" of possible conservation techniques and approaches from which to choose. In this way, it can be used by utilities in all parts of the country, operating under various circumstances.

**Water Conservation Planning Handbook for Public Water Systems.** Yelton, Tiffany and Jerry Parker, Water Resources Program

Source: Washington State Department of Ecology and Washington State Department of Health 1991

Contact: Washington State Department of Ecology Water Resources Program, Mail Stop PV-11, P.O. Box 47600, Olympia, Washington 98504-7600

This handbook is provided to assist public water systems planners in the development of a conservation plan. It is hoped that this handbook will encourage planners to consider the creative ways conservation measures can be used to reduce new facility development costs and to correct



system inefficiencies.

**APPENDIX E: CALIFORNIA'S MEMORANDUM OF UNDERSTANDING (EBMUD, 1994)**

Compliance with 16 Best Management Practices (BMPs) is required of signatories to the 1991 Memorandum of Understanding Regarding Urban Water Conservation in California (MOU). It is recognized by all parties that a single implementation method for a BMP would not be appropriate for all water suppliers. Any implementation method used should be at least as effective as the methods described in the MOU. These methods are listed.

1. Interior and Exterior Water Audits and Incentive Programs for Single-family Residential, Multi-family Residential, and Governmental/institutional Customers

Implementation methods shall be at least as effective as identifying the top 20 percent of water users in each sector, directly contacting them (e.g., by mail and/or telephone and offering the service on a repeating cycle; providing incentives sufficient to achieve customer implementation (e.g., free showerheads, hose end sprinkler timers, adjustment to high water use bills if customers implement water conservation measures, etc.). This could be a cooperative program among organizations that would benefit from its implementation.

2. Plumbing, New and Retrofit

- a. Enforcement of Water-conserving Plumbing Fixture Standards Including Requirement for Ultra Low Flush Toilets (ULFTS) in All New Construction Beginning January 1, 1992.

Implementation methods shall be at least as effective as contacting local building departments and providing information to inspectors; and contacting major developers and plumbing supply outlets to inform them of the requirement.

- b. Support of State and Federal Legislation Prohibiting Sale of Toilets Using More than 1.6 Gallons per Flush

- c. Plumbing Retrofit

Implementation methods shall be at least as effective as delivering retrofit kits including high-quality low-flow showerheads to pre-1980 homes that do not have them and toilet displacement devices or other devices to reduce flush volume for each home that does not already have ULF toilets; offering to install the devices; and following up at least three times.

3. Distribution System Water Audits, Leak Detection and Repair

Implementation methods shall be at least as effective as at least once every three years completing a water audit of the water supplier's distribution system using methodology such as that described in the American Water Works Association's Manual of Water Supply Practices, Water Audits and Leak Detection; advising customers whenever it appears possible that leaks exist on the customer's side of the meter; and performing distribution system leak detection and repair whenever the audit reveals that it would be cost-effective.

4. Metering with Commodity Rates for All New Connections and Retrofit of Existing Connections

Implementation methods shall be requiring meters for all new connections and billing by volume of use; and establishing a program for retrofitting any existing unmetered connections and billing by volume of use; for example, through a requirement that all connections be retrofitted at or within six months of resale of the property or retrofitted by neighborhood.

5. Large Landscape Water Audits and Incentives

Implementation methods shall be at least as effective as identifying all irrigators of large (at least 3 acres) landscapes (e.g., golf courses, green belts, common areas, multi-family housing landscapes, schools, business parks, cemeteries, parks, and publicly owned landscapes on or adjacent to road rights-of-way); contacting them directly (by mail and/or telephone); offering landscape audits using methodology such as that described in the Landscape Water Management Handbook prepared for the California Department of Water Resources; providing cost-effective incentives sufficient to achieve customer implementation; providing follow-up audits at least once every five years; and providing multi-lingual training and information necessary for implementation.

6. Landscape water conservation requirements for new and existing commercial, industrial, institutional, governmental, and multi-family developments

Implementation methods shall be enacting and implementing landscape water conservation ordinances, or if the supplier does not have the authority to enact ordinances, cooperating with cities counties, and the green industry in the service area to develop and implement landscape water conservation ordinance pursuant to the Water Conservation Landscaping Act (California Government Code §§ 65590 *et seq.*). The ordinance shall be at least as effective as the Model Water Efficient Landscape Ordinance being developed by the Department of Water Resources. A study of the effectiveness of this BMP will be initiated within two years of the date local agencies must adopt ordinances under the Act.

7. Public Information

Implementation methods shall be at least as effective as ongoing programs promoting water conservation and conservation-related benefits, including providing speakers to community groups and the media; using paid and public service advertising; using bill inserts; providing information on customers' bills showing use in gallons per day for the last billing period compared to the same period the year before; providing public information to promote other water conservation practices; and coordinating with other governmental agencies, industry groups, and public interest groups.

8. School Education

Implementation methods shall be at least as effective as ongoing programs promoting water conservation and conservation-related benefits, including working with school districts in the water supplier's service area to provide educational materials and instructional assistance.

9. Commercial and Industrial Water Conservation

Implementation methods shall be at least as effective as identifying and contacting the top 10 percent of industrial and commercial customers directly (by mail and/or telephone); offering audits and incentives sufficient to achieve customer implementation; and providing follow-up audits at least once every five years if necessary.

10. New Commercial and Industrial Water Use Review

Implementation methods shall be at least as effective as assuring the review of proposed water uses for new commercial and industrial water service and making recommendations for improved water use efficiency before completion of the building permit process.

11. Conservation Pricing

Implementation methods shall be at least as effective as eliminating non-conserving pricing and adopting conserving pricing. For signatories supplying both water and sewer service, this BMP applies to pricing of both water and sewer service. Signatories that supply water but not sewer service shall make good faith efforts to work with sewer agencies so that those sewer agencies adopt conservation pricing for sewer service.

Non-conserving pricing provides no incentives to customers to reduce use. Such pricing is characterized by one or more of the following components:

- a. Rates in which the unit price decreases as the quantity used increases (declining block rates);

- b. Rates that involve charging customers a fixed amount per billing cycle regardless of the quantity used;
- c. Pricing in which the typical bill is determined by high fixed charges and low commodity charges.

Conservation pricing provides incentives to customers to reduce average or peak use, or both. Such pricing includes:

- a. Rates designed to recover the cost of providing service; and
- b. Billing for water and sewer service based on metered water use.

Conservation pricing is also characterized by one or more of the following components:

- c. Rates in which the unit rate is constant regardless of the quantity used (uniform rates) or increases as the quantity used increases (increasing block rates);
- d. Seasonal rates or excess-use surcharges to reduce peak demands during summer months;
- e. Rates based on the long-run marginal cost or the cost of adding the next unit of capacity to the system;
- f. Lifeline rates.

12. Landscape Water Conservation for New and Existing Single-Family Homes

Implementation methods shall be at least as effective as providing guidelines, information, and incentives for installation of more efficient landscapes and water-saving practices (e.g., encouraging local nurseries to promote sales and use of low water using plants, providing landscape water conservation materials in new home owner packets and water bills, sponsoring demonstration gardens); and enacting and implementing landscape water conservation ordinances or, if the supplier does not have the authority to enact ordinances, cooperating with cities, counties, and the green industry in the service area to develop and implement landscape water conservation ordinances pursuant to the "Water Conservation in Landscaping Act (California Government Code §§ 65590 *et seq.*). The ordinance shall

be at least as effective as the Model Water Efficient Landscape Ordinance being developed by the Department of Water Resources.

13. Water Waste Prohibition

Implementation methods shall be enacting and enforcing measures prohibiting gutter flooding, sales of automatic (self-regenerating) water softeners, single-pass cooling systems in new connections, non-recirculating systems in all new conveyer car wash and commercial laundry systems, and non-recycling decorative water fountains.

14. Water Conservation Coordinator

Implementation methods shall be at least as effective as designating a water conservation coordinator responsible for preparing the conservation plan, managing its implementation, and evaluating the results. For very small water suppliers, this might be a part-time responsibility. For larger suppliers this would be a full-time responsibility with additional staff as appropriate. This work should be coordinated with the supplier's operation and planning staff.

15. Financial Incentives

Implementation methods shall be at least as effective as:

- a. Offering financial incentives to facilitate implementation of conservation programs. Initial recommendations for such incentives will be developed by the Council within two years of the initial signing of the MOU, including incentives to improve the efficiency of landscape water use; and
- b. Financial incentives offered by wholesale water suppliers to their customers to achieve conservation.

16. Ultra Low Flush Toilet Replacement

Water suppliers agree to implement programs for replacement of existing high-water-using toilets with ultra-low-flush toilets (1.6 gallons or less) in residential, commercial, and industrial building. Such programs will be at least as effective as offering rebates of up to \$100 for each replacement that would not have occurred without the rebate, or requiring replacement at time of resale, or requiring replacement at time of change of service. This level of implementation will be reviewed by the Council after development of the assumptions included in the following two paragraphs.

- a. Assumptions for determining estimates of reliable savings from installation of ultra-low-

flush toilets in both existing and new residential, commercial, and industrial structures will be recommended by the Council to the State Water Resources Control Board by December 31, 1991, for use in the Bay/Delta proceedings.

- b. Should the Council not agree on the above assumptions, a panel will be formed by December 31, 1991, to develop such assumptions. The panel shall consist of one member appointed from the signatory public advocacy group; one member appointed from the signatory water supplier group; and one member mutually agreed to by the two appointed members. The assumptions to be used for this BMP will be determined by a majority vote of the panel by February 15, 1992, using the criteria for determining estimates of reliable savings included in this MOU. The decision of the panel will be adopted by the Council and forwarded to the State Board by March 1, 1992.

## APPENDIX F: NATIONAL ENERGY SAVINGS EQUATION

The following equation estimates energy savings from decreased hot water demand due to the installation of low-flow showerheads and faucets.

Energy savings = (specific heat of H<sub>2</sub>O) ( $\Delta T$ ) (liters/day saved) (density of H<sub>2</sub>O) (% electric water heaters price of electricity/electrical water heater efficiency + % gas water heaters price of gas/gas water heater efficiency )

Specific Heat of H<sub>2</sub>O: ..... 4.2 kJ/(kg °C)  
 $\Delta T$ : ..... (57 °C - 15 °C)  
Water saved: 4.12 X 10<sup>9</sup> liters/day (1.09 X 10<sup>9</sup> gallons/day)  
                    . projected savings with new efficiency standards  
Percentage of electric water heaters: ..... 50%  
Price of Electricity: ..... \$0.08/kWh  
Electrical Water Heater Efficiency: ..... 0.98  
Percentage of gas water heaters: ..... 50%  
Price of Gas: ..... (\$0.60/therm) \* (1 therm/1.05 X 10<sup>5</sup> kJ)  
Gas Water Heater Efficiency: ..... 0.76



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