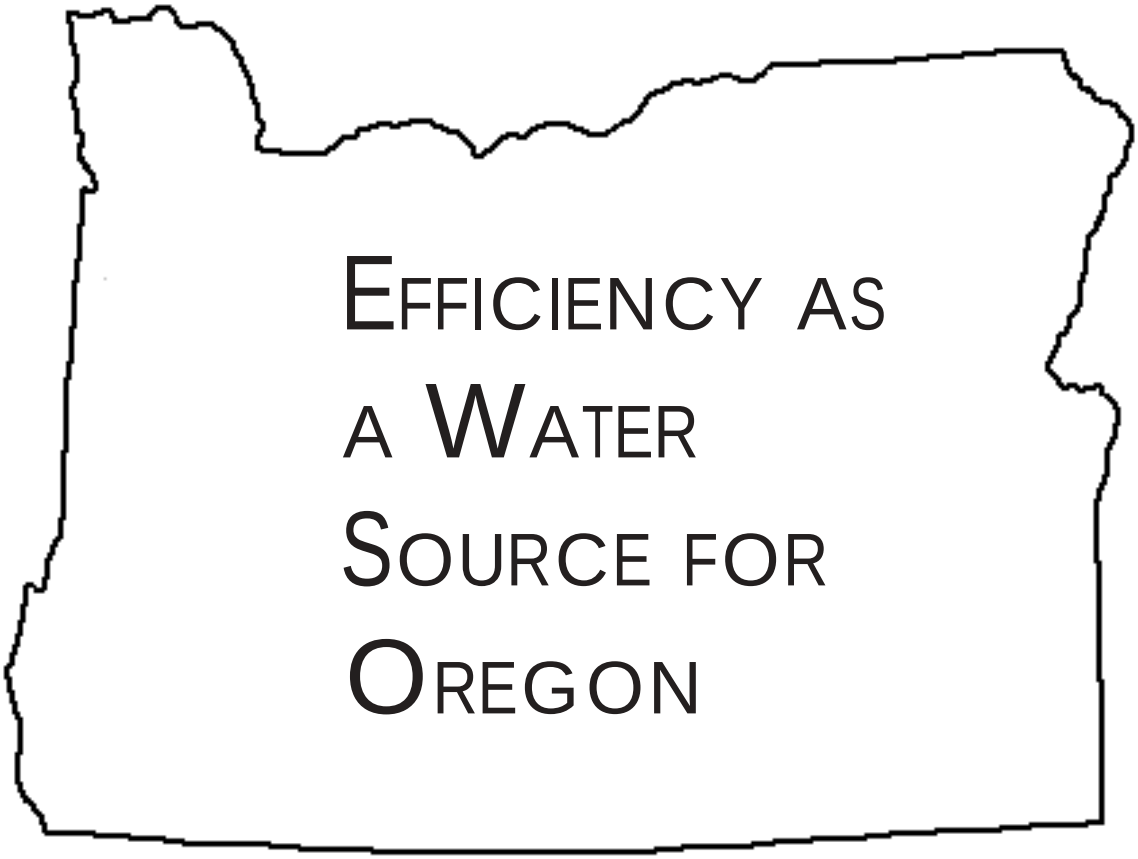
Oregon's Untapped Water Supply



A Report by the Oregon Environmental Council

Oregon's Untapped Water Supply:

Efficiency as a Water Source for Oregon

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Oregon Environmental Council

Clean air
Clean water
Clear thinking

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Executive Summary

Everyone knows that Oregon is short of water this year. The Pacific Northwest is suffering the second-worst drought since 1892, when the National Weather Service began keeping track of things like temperature and precipitation for the entire country. As of September 2001, Governor Kitzhaber had issued state drought declarations for 18 of Oregon's 36 counties and the United States Department of Agriculture had issued federal drought declarations for four. While recreationalists are enjoying the prolonged summer, farmers, ranchers, water providers, fish and wildlife biologists and assorted stream-lovers across the state are foot-tappingly anxious for the winter's rains to begin. If, when and where the rains will come is still anyone's guess.

What not everyone might know is that Oregon has an ongoing water shortage – one that has nothing to do with the weather. All of Oregon's 18 drainage basins face water shortages caused by people withdrawing or withholding water from the streams for residential, commercial, industrial or agricultural use. And it's only going to get worse from here, because there are competing demands for what water is left in the streams and aquifers:

- Oregon's population is estimated to increase by over 2 million people by 2040. These people, along with the people already living here, will need drinking water, food, jobs and recreational opportunities.
- Instream flows are necessary for the protection of habitat for fish and wildlife, including threatened and endangered species.
- Healthy streams protect human health. Healthy streams require flows sufficient to cleanse them of pollutants.

These competing demands have the potential to shape up into a classic debate: economy vs. environment. This dilemma, the great American tragedy of the last hundred years, has been playing itself out in numerous venues throughout the country. But Oregon has an opportunity to side step this seemingly inevitable confrontation. Water conservation, implemented through common sense policies supported by economic incentives, can promote efficient water use and allow both prosperity and environmental restoration.

This report details successful water conservation programs with examples taken from across the United States, and lays out the range of funding options available to water providers. Most water users can improve their water-use efficiency by 30-50%, or more using existing technologies, and without reducing their economic activity or quality of life. All that is required is that we start investing in efficiency as seriously as we've invested in dams, pumps and reservoirs. Specific recommendations for Oregon include:

- Float a statewide bond package to fund water conservation programs.
- Establish a state fund to assist in infrastructure improvements for inefficient or outdated water supply systems.
- Establish a water-conservation tax-credit program aimed at the commercial and industrial sectors.
- Set aside funds from the Oregon Watershed Enhancement Board (OWEB) to lease agricultural water rights.

- Require all water users to meter and report their water use.
- Adopt legislation requiring all water providers, including irrigation districts, to implement water-wise billing structures.
- Explicitly allow water conservation measures to be capitalized (that is, recorded in asset accounts and then depreciated or amortized, as is appropriate for expenditures for items with useful lives longer than one year).

By acting to implement water conservation programs before there is a water crisis, we will be doing a big favor for the environment, the economy and the people of Oregon.

2. Waste Not, Want Not

A recent study identified 40 Oregon streams as having serious low flow problems. Many of these streams fail to meet the state's water quality standards due to low flows during critical times of the year. These low flows are not naturally occurring; they are the result of human activities. Every one of Oregon's 18 drainage basins faces water shortages caused by people withdrawing or withholding water from the streams for residential, commercial, industrial or agricultural use.

Increasingly, the scientific evidence proves that we must take less water from our streams and aquifers, not more. Low flows threaten fish and wildlife, including endangered and threatened species. Low flows also concentrate pollution and disrupt healthy stream functions, threatening human health and impeding the ability of streams to flush pollutants out of the system. In some places, groundwater pumping lowers the aquifers that naturally provide water to the streams during periods of low flow. This creates a double whammy for the stream system, upping the threats to fish, wildlife, and people. Without sufficient instream flows, we cannot have healthy ecosystems.

As Oregon's economy and population continue to grow, however, so will the pressures and demands on Oregon's water supply. Over half a million people moved to Oregon during the past 10 years, bringing the state population to over 3.42 million people. Some predictions put the state's 2040 population has high as 5.19 million. As many as 1.7 million of these people are likely to settle in the Willamette Valley, which is predicted to have a population of nearly 4.0 million by 2050. Wherever they settle, those people will need drinking water, food, jobs and recreational opportunities, all of which are dependent on a finite supply of water.

There simply is not enough water in Oregon's streams and aquifers to provide a safe, dependable water supply for 5.19 million people at current per capita consumption levels, to meet the needs of fish and wildlife, and to meet the needs of business, industry and agriculture. Something has to change, or else. Or else we see increasing instances of state and federal governments being forced to choose between water for farmers and water for fish, between water for commercial and industrial uses and water for recreational uses, between a thriving economy and a healthy environment for people and for other species.

The choice doesn't have to be either or. The simple fact is that we can increase the efficiency of our water use dramatically. We can have both a thriving economy and a healthy environment if we rethink the ways we use water and change the ways we use water. By providing incentives and options to help business, industry, agriculture and individuals become for efficient water users, we can guide Oregon's economy and environment into a more sustainable and stable relationship.

Just as computers that used to fill entire buildings now fit in your palm, industries and farms that might once have required millions of gallons of fresh water can function on far, far less. Today, for example, almost 80% of the water withdrawn from streams is used for agricultural production. Some estimates say that nearly half of that water is not needed or used by the crops; more water wise irrigation or cropping systems can reduce withdrawals and increase water use efficiency in fields and on ranches.

Changes at the individual level can have a much larger impact than most of us realize. Residential water users can save significant amounts of water by installing water efficient plumbing fixtures and appliances. Over a twenty-year period, national water use could be reduced by up to 8% annually, for a saving of $127 per day per person (this estimate includes a reduction in operations and maintenance costs and smaller, or even deferred, capital projects for water providers as well as a significant energy savings as less hot water is used).

We have many of the technologies we need, and efficiency gains are already beginning. With smart public policies and economic incentives, we can accelerate it further. And we must, if we are to prosper, restore our natural environment, and cope with the continuing high growth that is projected over the coming decades.

3. Water Conservation Programs

Excessive or wasteful water use is a result of human behavior and the choices upon which that behavior is based. Providing information, incentives and alternatives to wasteful water use is the goal of water conservation programs. Water audits, billing structures that provide customers with a financial incentive for water conservation, rebates and tax credits for the installation of water efficient appliances and systems, community outreach and education promoting water conservation in all sectors, award programs and water recycling are the most common water conservation programs.

3.1 Audits

Before people can reduce their water consumption, they first must understand how and where they currently are using excessive amounts of water. Water audits are the means for gathering that information.

Water audits are completed by a trained specialist who visits the site in question (home, workplace, factory, farm or park) and determines the amount of water consumed at that site. After determining how and where water is used, the auditor can recommend means for using water more effectively or efficiently at that particular site. One of the most common recommendations made by water auditors is leak detection and repair.

3.1.A Leak Detection

Leak detection is a straightforward method of directly improving the efficiency of a water distribution system. The overall industry goal for water lost to leakage is 10% of total water consumed, but in some regions as much as half of the water consumption is unaccounted for. Leakage for a water provider is often due to seepage through junctions in water lines, tampered fire hydrants, and cracks in pipes and water mains.

Many water users ignore apparently small leaks in appliances and utilities. However, those "small" leaks, when left unrepaired, account for a major percentage of water lost by water users. Many of these leaks are easily detected and easy to repair. For example, a leak inside a toilet bowl can cause the loss of up to 200 gallons of water a day, and could simply be detected by placing a few drops of food coloring to the water inside the toilet tank. If the colored water disappears, there is a leak. The best way to promote conservation through leak detection is

an efficient leak repair system and aggressive community involvement with respect to reporting leaks within their home, workplace, and community.

3.1.B Types of Audits

Audits can be done for any type of water use. There are specific audits for the different types of water users – residential, commercial/industrial, and agricultural.

3.1.B.1 Residential Audits

Municipal water providers often offer residential water audits to customers as a means of encouraging more efficient water use in homes. To be cost-effective, publicly funded water audits need to be targeted at larger users, where the potential savings can offset the cost of the audits.

Trained auditors visit people in their homes and teach them how to read the water meter, review water use patterns and billing, check for delivery system leaks both indoors and outdoors using the water meter, and check for toilet leaks. Leakage is a major cause of water waste. A study by the American Water Works Association showed that average home wastes 21.9 gallons per day through leakage. The study also found that while 67% of homes tested had leakage rates of less than 10 gallons per day, a full 5.5% had leakage rates of over 100 gallons per day.

Once the water audit is complete, the auditors can make recommendations for more efficient water usage around the home. Some municipalities have programs that subsidize, or partially subsidize, the costs of installing water conservation devices, such as shower heads, faucet aerators, auto-shut off nozzles and other apparatus for increasing water use efficiency.

3.1.B.2 Commercial and Industrial Audits

Water providers may also offer water audits to members of the commercial/industrial community. As with residential audits, a trained auditor will provide commercial and industrial customers with a free evaluation of all water consumption aspects in the facility to determine how water is used and how water consumption can be reduced. Audits are also available from various private consulting firms whose focus is on refining the economic and environmental efficiencies of businesses or industrial facilities.

3.1.B.3 Agricultural Audits

Audits assessing water consumption in agricultural settings are essentially the same as those completed in residences and commercial/industrial settings. Because irrigation systems play a major role in the agricultural settings, they are particularly emphasized in agricultural audits. When leaks are detected, simple changes can often be made to repair the leaks, resulting in more water efficiency.

Water audits for agricultural customers can also be used to suggest a more efficient irrigation system. Factors such as the type of crops being grown, how the different types of crops are arranged, soil type, and irrigation schedule can be evaluated for water use efficiency. After reviewing crucial factors such as the timing and rate of water use, suggestions for a more efficient irrigation system or an alternative cropping system can be made.

3.1.C Examples of Audit Programs

Most of the information about the success of individual audit programs comes from municipal water suppliers.

3.1.C.1 Eugene, OR

In Eugene, Oregon, the Eugene Water and Electric Board (EWEB) developed a home audit program that not only identified possibilities for wiser water use, but contained an aggressive education and outreach component as well. EWEB's three-year evaluation of the audit program indicated that between 1996 and 1998 approximately 67% of the audit customers did reduce peak summer water use, while during the same period only 31% of EWEB's non-audit customers reduced peak summer water use. Follow-up studies have continued to indicate that, in general, audit customers either have maintained their initial reduction in peak summer water use or have continued to lower that use. For EWEB and Eugene, Oregon, water audits have been a successful means for encouraging water conservation among residential customers.

3.1.C.2 Contra Costa, CA

Water audits were a successful water conservation tool for the Contra Costa Water District as well. The district began a residential indoor/outdoor water audit program in 1988. Auditors recommended the installation of low-water use appliances, alternative irrigation schedules, new sprinkler systems, and they provided educational materials. The averaged savings per home per day was approximately 48 gallons.

Other municipalities have not been as satisfied with the results of their auditing programs. Austin, Texas, for example, established a water audit program targeting residential, commercial, industrial and institutional customers. Those that used more than 20,000 gallons of water annually were eligible for a free water audit. The response to the audit program was meager, and the city determined that the water conservation gains resulting from the audit program did not offset the costs of the program. Austin has turned to other water conservation policies to promote wiser water use among its customers. Portland, Oregon, is another city that has abandoned water audits as a conservation tool. There the city water supplier found that one hundred dollars would be spent on the audit, with only a minor reduction in water use and a an ultimate savings of $10 a year per individual customer.

3.1.D Benefits and Drawbacks to Audits as a Means for Achieving Water Conservation

An audit pinpoints where, when and how water is used at a particular site. Honing in on this information is an important and beneficial first step in water conservation. By identifying inefficiencies or flaws in a given water system, audits provide water users with possible options for improving the efficiency of their water use.

Unfortunately, identifying water use inefficiencies is no guarantee that action will be taken to conserve water. A major downfall of the water audit program is that in many cases it is not cost-effective for a city to maintain a water audit program.

Once it is clear how and where water is being wasted, incentives for changing the behavior of water users or upgrading/repairing/replacing wasteful water delivery systems and appliances must be set in place. Absent a perceived need or reason to change, people are most comfortable maintaining the status quo. Economic incentives, further education and rewards for water-wise behavior have proven effective in providing the impetus for changes in water use.

3.2 Billing Structures

The goals of implementing a water-wise billing scheme are to curb consumer water usage, to provide a direct method of displaying the consequences of excessive water use to consumers, and to increase consumer awareness as to the importance of maintaining our water system. Increasing the rate per unit of water consumed can influence customers to decrease their wasteful actions and incorporate water conservation techniques into their daily lives, reducing the amount of water used and decreasing the strain on the environment. Billing statements have the ability to show the customers the direct affect of their actions and give incentive to further alter their usage in the future. Overall, the most direct way to promote conservation is to change and adjust the way the public views their water consumption.

3.2.A Types of Billing Structures

Conventional billing structures have not encouraged customers to think about efficient water use. Altering the billing structure of water providers to encourage customers to minimize rather than maximize their water use gives those customers a financial incentive to conserve water.

3.2.A.1 Traditional Billing Structures

The three billing structures traditionally used by water providers are the decreasing block rate, the flat rate and the uniform rate.

The decreasing block rate, probably the most common billing structure, rewards a high volume of use with a decrease in rates. Under a decreasing block rate billing structure, a set of pricing blocks, usually called "tiers," is established. Defined by gallons consumed, each tier is assigned a price per gallon rate. Within each tier, the customer's cost per gallon remains the same no matter how much water the customer uses. However, if a customer's use increases and moves into the next tier, the cost per gallon of water used decreases. This rate structure indirectly encouraging customers to use more water to get a lower rate, increasing the likelihood of excessive or needless water consumption.

Water providers using a flat rate billing structure do not measure the amount of water used by customers. Instead, they simply charge customers the same fixed amount every billing period. Vancouver, Canada, in an effort to reduce water waste, removed their declining block rate structure in 1998 and replaced it with a flat rate structure. This was a wise move, as it removed the economic incentive for excessive water use. However, because there is no relationship between the amount of water customers use and the amount of money they pay for that water, there still is no incentive for customers to conserve water.

The uniform rate billing structure charges the same amount for every gallon of water used by the customer. This rate structure has advantages over both the decreasing block rate and the flat rate. Uniform billing does not subsidize excessive water use, as does the decreasing block rate water use. And, unlike the flat rate, uniform billing does provide water users with a limited level of financial feedback related to levels of water consumption, perhaps encouraging slightly more responsible water use. However, this is damning with faint praise, for there is nothing about the uniform rate billing structure that encourages water conservation per se.

3.2.A.2 Billing Structures That Encourage Water Conservation

As the awareness of the significant role water conservation can play in reducing the need to develop increasingly expensive new water supplies, as well as increasing instream

flow for the protection of endangered species and ecosystems, new, innovative rate structures are being developed and implemented. These rate structures are designed to encourage people to use less water by making excessive water use more expensive. They include increasing block rates, seasonal rates, wastewater fees and budgeted rates.

Not surprisingly, the increasing block rate structure is the opposite of the decreasing rate structure. As water consumption increases, the customer is charged increasing more per gallon used, providing a financial incentive for water conservation. For example, in a three-tier system, the first pricing tier rate is set at a level that reflects below-average water use and has the lowest price per gallon. The middle tier is set at a level that reflects average water usage and has a moderate price per gallon charge. The last tier is set at a high level of water use and has very high rates. Those customers who exceed the average consumption level will pay the very high price per gallon of the last tier for water consumed over and above the average amount. The increasing block rate billing structure sends near-immediate feedback to water users, providing an economic incentive for water conservation. In order for an increasing rate structure to be effective, however, it is important that the pricing blocks are set at levels that affect both residential and commercial customers.

Seasonal rate billing structures are designed to encourage wise water use during the summer months when water demand is the highest and supply is the lowest. Most commonly, seasonal rates are used in tandem with flat rates. During the peak usage months, customers are charged on an increasing rate per gallon. During off-peak months, a flat rate billing structure is implemented. Alternatively, a seasonal rate method can be integrated into an increasing block rate billing structure. This means that the water provider would simply increase the per-gallon charge of the higher-than-average-use tier during peak months. During non-peak months, the higher-than-average-use tier would have lower price-per-gallon rates than during peak months, but throughout the year, customers with higher than average use would pay higher-than-average rates per gallon. Both of these seasonal rate billing structures increase the customer's cost during periods of low water availability, providing a fiscal incentive for water conservation.

Wastewater fees are a penalty-based way to discourage excessive or careless water use. Customers whose water use rise above a set standard are charged a penalty fee in addition to their regular water rate. In other words, customers must pay a penalty for water use in excess of an administratively determined level. If a customer is a repeat violator, the fees for wasting water increase. Wastewater fees provide an incentive for water conservation, in that customers will reduce their water consumption patterns as to avoid the penalties. In Albuquerque, NM, customers are charged wastewater fees when their bill indicates that an unusual or excessive amount of water was used. The fees increase for repeat violators. After eight violations, a flow restriction device is applied to the water meter, only allowing enough water for basic drinking and sanitation needs.

The budgeted rate billing structure is fundamentally different from any other billing structure in two ways. First, it gives unprecedented flexibility to water providers. Most water providers generate revenue by charging customers for water delivery. Water providers using budgeted rate billing structures charge a flat monthly connection fee to all customers, and then an additional charge is levied for the amount of water delivered. By charging an ongoing connection fee, the budgeted rate billing structure frees the water provider from an economic dependence on the amount of water

delivered by the water system. This freedom permits the water provider to completely embrace water conservation without the conflict of balancing a commitment to water conservation with a loss of revenue.

Second, while most billing structures charge all customers using the same amount of water the same price per gallon, budgeted rate billing structures are designed to account for the specific situation of each customer. For each customer, a maximum water budget is established, one that will provide an adequate supply of water for his needs. The water provider takes into account factors such as the number of residents and the size of the yard or landscaped area when determining the maximum amount of water allotted to each customer. If necessary, the customer's water budget can be reevaluated in light of changed circumstances. When a customer's water use exceeds her water budget, a penalty fee is charged for the amount of non-budgeted water used. The penalty fee serves to warn the customer that she has a problem with her water usage.

A budgeted rate structure can work very well for residential customers or in urban settings. It is much more difficult and expensive to apply a budgeted rate billing structure to industrial or agricultural water users. Water budgets would be extremely difficult to establish, given the wide variation in volume, rate and timing of water use by both industrial and agricultural water users.

In 1992, the Irving Ranch Water District, CA, became the first water district to implement a budgeted rate structure in the United States, and the program remains a model for the effective and efficient use of a billing structure to promote water conservation. Audits, retrofitting and educational programs complement the billing structure. When a customer's water bill signals an excessive use of water, that customer is first provided with educational information on efficient and acceptable water use levels. If there is still a problem with the customer's water use, the customer is provided with additional assistance in the form of water audits and financial assistance with retrofitting projects.

According to the district, the water rate structure has been a successful way to get customers to take responsibility for their water use. The customers see the rate structure as a fair and reasonable water rate system. The penalty takes the water use problem directly back to the customers, the root of the problem: those who use excessive amounts of water pay for their actions.

3.2.B Submetering

When water wise billing structures are in place, monthly water bills provide direct feedback to water users about the consequences of their water use behavior. For billing structures to work most effectively at encouraging water conservation, all water use must be metered. However, in order to save time and effort, many rental organizations include the cost of water and sewer directly into the rental cost of the office, apartment, etc. The flat cost applied to each rental agreement does not necessarily reflect the amount of water used by the tenant, and defeats the purpose of water-wise billing structures.

Water submetering makes tenants directly responsible for their own water consumption. Receiving a monthly water bill creates incentives for them to conserve water. Water submetering also encourages tenants to report leaks, because they are held directly responsible for the amount of water lost to the leak, instead of the relying on the building owner to absorb the cost.

Once submeters are installed, property owners may recover almost the entire monthly water bill. This, in turn, increases their cash flow, saves on water and repair costs. The renter is responsible for her own water consumption and may be able to lower her monthly rent through water wise behavior.

Water submetering usually is implemented after the water provider has initiated a water conservation program. Submetering has a relatively high installation cost, but most property owners get make that money back. Owners recoup anywhere from 70-90% of the building's water costs. Setting up a submetering system is relatively straightforward.

1. Small water meters are installed in each apartment and linked via a wireless Inovonics System, which collects water use information.
2. Software allows the submetering contractor to read the meters via a computer modem and send a monthly bill to each tenant.
3. The building owner pays the master meter bill to the local water provider.
4. The submetering contractor resets the account monthly. The water bills collected from each resident reimburse the building owner for the expense of the master meter bill.

Accurately measuring water use is an important component of water conservation. Retrofitting older buildings with submetering systems and installing the systems in all new buildings will provide a financial incentive for individual tenants to take responsibility for implementing water wise technologies and behaviors.

3.2.C Benefits and Drawbacks to Billing Structures as a Means for Achieving Water Conservation

Billing structures that encourage water conservation provide a financial incentive for water conservation, and financial incentives are usually extremely effective. However, that effectiveness is undermined if costumers are not aware of the goal of changes in the rate structure. Particularly in localities where the public considers water supplies adequate, support for a water conservation-oriented billing structure is unlikely. Rate changes that appear to be increases or penalties can spark public backlash. In the western Oregon cities of West Linn and Oregon City, for example, voters repealed rate increases by initiatives.

Even where the public supports water conservation, the success of a water-wise rate structure depends on the quality of community education and outreach. Without an effective outreach program designed to educate water users about the goals of water conservation and the rationale behind increasing water rates to promote conservation, a water provider that changes or raises water rates may be courting failure.

The implementation of a conservation-friendly rate structure should be a gradual process, ensuring that the community has enough time to process the changes and respond to the new rate structure. If customers are educated about the goals and effects of the new billing structure, they can adjust their water use before the rate structure change is made.

Billing frequency is an important means for establishing the link between water consumption patterns and a water conservation-oriented rate structure. Monthly billing is the most effective means for creating this perceptual link. Customers are more likely to respond to a high

water bill with water conservation efforts if the relationship between the water bill and consumption patterns is clear.

For better or worse, most water providers rely on revenues generated by the levels of water use practiced by the customers. Therefore, it is important to consider the effects of conservation rates on a water provider's revenue. If the water provider anticipates a dramatic loss in revenue due to a reduction in customers' water use, some means of backfilling that shortfall must be established in order to cover operating expenses and to maintain the water purification and delivery system.

Water-wise billing structures provide direct financial incentives for water conservation. Rebates and tax credits are another means for providing those incentives.

3.3 Rebates

Education provides people with an understanding about water conservation, but does not ensure that people will engage in water conservation activities. Often, people need some sort of incentive to create sufficient motivation for them to commit time and financial resources to water conservation.

Awards and billing structures that encourage water-wise choices are two types of incentives that have been discussed earlier. Rebates and tax credits create another type of incentive. Water providers, municipalities, state governments and the federal government, run most rebate programs.

Rebates most commonly are given for the use of low-water use appliances and fixtures. Product manufacturers occasionally offer rebates with the purchase of their water efficient devices.

3.3.A Low-Water Use Products

There are a variety of products on the market that reduce water use directly by limiting the amount of water used by plumbing devices, appliances, toilets and landscape irrigation systems. The various products are manufactured and tested to minimize the product's water used during operation without interfering with the product's performance or effectiveness. From toilets to faucets, aerators to appliances, showerheads to urinals, these devices have been re-engineered to provide optimum efficiency while using a fraction of the water necessary to support the conventional models.

Using low-water use fixtures and appliances reduces the amount of water a person consumes in his day-to-day life without requiring a change in that person's behavior. Water users get direct feedback about the amount of water conserved; the effectiveness of low-water use devices shows up on the next billing statement. Low-water use appliances and fixtures can be installed anywhere, from residential communities to commercial dwellings, in public parks and buildings or in industrial settings. These devices can be installed and maintained at the same, or a slightly higher, cost as conventional models while simultaneously promoting efficient water use. In an average home, the installation of water efficient appliances and minimizing leaks decreases water consumption by approximately 30%.

3.3.A.1 Low-Water Use Toilets

Conventional toilets are water hogs, using 7.0 gallons of water per flush and consuming 15% of the water used in the average residence. Not surprisingly, toilets are a prime target for water conservation programs. Some water savings can be achieved even with conventional toilets by not using the toilet as a garbage disposal and by keeping the toilet in good

operating condition and repairing leaks. A leaky toilet can waste up to 200 gallons of water a year. However, a more effective, long-term solution to reducing toilet water-use is the installation of low-flow toilets, which use 1.6 gallons of water per flush.

Low-flow toilets incorporate design features such as large drain passages, redesigned bowls and tanks for easier wash down, and water supply line pressure or pumps to supplement the traditional gravity system of disposal. In 1995, the National Energy Policy Act mandated the installation of toilets for all new construction that use no more than 1.6 gallons of water per flush. Preliminary estimates show that the installation of high-efficiency toilets will save in excess of 7.6 billion gallons per day by 2020, approximately 19% of the total amount of water supplied by U.S. public water systems in 1995.

Although the installation of low-flow toilets is mandatory for new construction, it is important to recognize the benefits achieved by replacing conventional toilets with low-flow models. The city of Santa Monica, CA, recently completed a toilet replacement project, achieving permanent reductions in water usage and wastewater flows of over 1.9 million gallons per day. The cost of the program was $5.4 million and the program is expected to have a net savings of $6 million in 2002 due to avoided costs of water imports and wastewater treatment.

Some individuals are hesitant to retrofit conventional toilets with low-flow models because they feel that low flow toilets do not perform satisfactorily. However, field and laboratory studies over the last 13 years have shown very little overall difference in the incidence of clogging and multiple flushes between low-flow and conventional toilets, although differences among different makes and models have been noted. Generally, customer surveys show high satisfaction with the 1.6-gpf toilets, and toilet technology continues to improve. Much of the anecdotal evidence for poor performance by low-flow toilets should be considered outdated.

3.3.A.2 Some Other Low-Water Use Fixtures

Although toilets use a majority of water in a typical household, showers use approximately 13% of the water used in the home, laundry appliances 5%, and faucets 5%. Simply focusing on water-wise behavior results in water savings even when conventional fixtures and appliances are retained. Again, however, a more effective, long-term solution lies in the installation of low-water use appliances and fixtures. Typically, conventional faucets and showerheads don't compensate for changes in inlet pressure, so the greater the water pressure, the more water one uses; new technology compensates for pressure and provides the same flow regardless of pressure. Low-flow showerheads use about 2½ gallons of water per minute compared to the 4-5 gallons per minute used by traditional showerheads; low-flow faucet aerators can cut water usage of faucets by as much as 40%, from four gallons per minute to 2½ gallons per minute.

The use of high-efficiency toilets and other low-water use plumbing products and appliances significantly reduces both water demand and wastewater generation, with positive environmental and economic effects. The capital investment needed for water supply and wastewater treatment infrastructure can be reduced or deferred altogether. In addition, reducing water withdrawals and avoiding the development of new sources help to maintain aquatic habitats, restore wetlands and fisheries, protect groundwater from depletion and contamination, and reduce the amount of energy used to pump, heat, and treat drinking water and pump and treat wastewater.

3.3.B Types of Rebates

The public is more likely to engage in water conserving activities if they have some financial incentive to do so. Rebates are programs for refunding some part of the financial investment made by water users when they switch to water-wise technologies. Given that the rebate returns a significant portion of the water user's outlay, rebates can be effective incentives for all the residential, commercial/ industrial and agricultural sectors. Tax credits function as an abstract form of rebate, since no real money is returned to the water user, but, instead, the investment in water-wise technology is credited in some proportion against state or federal taxes owed.

The rebates provided in each sector are fundamentally the same. Water users are refunded money after purchasing or installing appliances or techniques that meet set water efficiency criteria.

3.3.B.1 Residential Rebates

Residential rebates are commonly available through municipalities or water providers to residential water users for irrigation systems, clothing and dishwashing machines, toilets, low-water use landscaping or xeriscaping, rain barrel installation, and rain water harvesting systems. Examples of residential rebate programs include rebates for:

- Irrigation systems: Irrigation system rebates are given to customers who replace inefficient irrigation systems, or upgrade existing or planned irrigation systems. In some cities, the amount refunded to the customer depends on the amount of water saved, and in other cities, there is a set rebate fee (for example $150).
- Clothing and dish washing machines: Rebates for the replacement of inefficient clothing and dish washing machines usually range from $100 to $150.
- Toilet rebate: The most typical rebate offered, toilet rebates are given for the replacement of high volume toilets (typically 3.5 gallons) with a low-volume toilet (typically 1.6 gallons). The rebates range from $60 to $100.
- Xeriscaping or low-water use landscaping: Xeriscaping or low-water use landscaping rebates are offered to homeowners who install or convert to low-water use or xeriscape landscapes. In some cases, a set percentage of the development fee is refunded to the customer and in others, there is a set fee.
- Rain barrel installation: Rebates can be received for the installation of rain barrels to collect runoff from roofs. A typical amount refunded is $30.
- Rainwater harvesting system: An unusual rebate may be offered to those who install a rainwater harvesting system. One city offers a rebate up to $500.

3.3.B.2 Commercial and Industrial Rebates

Commercial and industrial rebates are similar to those offered residential water users. Rebates are offered to businesses to offset the costs of replacing or upgrading inefficient irrigation systems, dishwashers and clothes washing machines, toilets, and landscaping that requires high water inputs. Because the water savings resulting from increasing water-wise technologies or behaviors is far larger in the commercial or industrial sectors than in the residential sector, the rebates may be proportionally larger for those sectors. For example, businesses can receive up to $350 for the installation of an efficient clothes washing machine.

A rebate unique to commercial/industrial sector is a comprehensive rebate for the installation of water-efficient devices. Commercial and

industrial water users can also receive rebates for employing more water-efficient production or processing techniques, such as cutting down on the amount of water used in an industrial process.

3.3.B.3 Agricultural Rebates

Encouraging the upgrading or replacement of inefficient irrigation systems is the primary focus of agricultural rebates. Several states have passed legislation using tax credits or low-income loans to encourage farmers to invest in improved on-farm irrigation technology. Rebates are another means of providing farmers with the incentive to take such action. The amounts rebated will most often depend on the amount of water saved and the amount of money spent installing the more efficient irrigation system. Rebates can be provided to those customers who install more efficient irrigation systems.

3.3.C Benefits and Drawbacks of Rebates and Tax Credits as a Means for Achieving Water Conservation

A rebate program encourages the use of water efficient devices by providing water users with a financial incentive. An additional benefit to water users is that the installation of water efficient devices is likely to cut down on their water bill, providing them with long-term financial savings. There is clearly an economic benefit to water conservation for the customer through the money refunded and the overall savings.

Unfortunately, rebate programs and tax credit programs rarely live up to their potential as an effective means for achieving water conservation. Most major appliances, irrigation systems and household water supply devices are fairly long-lived. Most rebate or tax credit programs do not provide a significant financial incentive for water users to replace appliances, irrigation systems or household water supply devices before they wear out. Moreover, when water users are ready to replace these items, they often find that the most water-efficient replacement is also the most expensive. Rebates and tax credits do not supply enough of a financial incentive to encourage most water users to opt for the more expensive items, absent regulatory requirements.

In addition, there is a perception that water-efficient devices perform less satisfactorily – people commonly comment that low-flow shower heads don't provide as much pressure, that water-efficient appliances take longer to do their jobs or require more work from the user than they are used to, that extremely efficient irrigation systems are sometimes too efficient and fail to deliver sufficient water to satisfy the needs of crops or landscaping. These stories and perceptions may or may not be true, but undoubtedly they do influence the choices water users make, or people would not keep repeating them to one another as justifications for their not-so-water-wise choices.

3.4 Education

Financial incentives are an economic key to changing human behavior. But a personal commitment to water conservation by each water user is equally important. Time and time again, using outreach and education to change people's behavior has proven essential to integrating environmentally sound practices into the fabric of day-to-day life.

Educating the public about the importance of water conservation and steps that individuals, businesses, governments and others can take to conserve water is an essential component in achieving water conservation goals. Once the public takes the need for water conservation

seriously, people are more likely include wise water use in their decision-making.

3.4.A Types of Educational Outreach

Education plays a central role in the water conservation programs developed by municipal water providers. Most of these programs target residential users, focusing on outreach to the community at-large, to targeted community groups (such as neighborhood groups or PTAs), and to schools, although outreach to the commercial sector can be valuable as well.

Without the support of the entire community, water conservation efforts cannot be successful. Focused, effective, ongoing outreach to the entire community is essential. The public desperately needs to be educated about the general importance of water for environmental and human health; about the specific role of, and particular threats to, water quantity and water quality in their community; and about the many different steps they can take to conserve water and to encourage others to conserve water as well.

3.4.A.1 Workshops

There are many different ways to introduce entire communities and community groups to the concepts of water conservation. The most popular outreach method is to hold workshops about a particular topic. Workshops are often geared towards a specific sector, either residential, agricultural, commercial and/or industrial. Workshop topics for residential audiences include conserving water in the home; water-wise landscaping; and water-efficient, small-scale irrigation techniques. Workshops aimed at the commercial and/or industrial sector introduce the concept of water conservation, teach about efficient water use in a particular industrial or commercial setting, and, most importantly, show how water-wise business practices can result in economic gains.

3.4.A.2 Demonstrations

Once the community embraces the need for water conservation, the most effective way of educating the community about various means for implementing water-wise practices is through demonstrations. Demonstrations inform the public about specific water conservation techniques. Landscaping design, water-wise irrigation systems, and the effectiveness of in-home water-wise technologies and behavior are the most popular type of demonstrations for the general public.

Commercial, industrial and agricultural workshops need to focus on specific incentives for good corporate behavior. For example, a commercial workshop might focus on how some hotel chains have saved both money and water, as well as educated their customers in water-wise behavior, by pursuing successful conservation programs that include allowing guests to reuse towels and linens, and installing low-water use devices. By pointing out these water saving options to their customers, these chains educate the public and promote themselves as "good corporate citizens." Such demonstrations, providing real-world examples as well as an opportunity for asking questions of "the experts" are extremely popular and effective educational tool for promoting water conservation.

3.4.A.3 School Outreach

Outreach to schools is an effective means for promoting environmentally protective practices, such as water conservation. Making water conservation an integral part of the school curriculum assures that it is something every child is taught. Independent water conservation programs can be established, or a water conser-

vation module can be integrated into existing programs. Independent programs have been developed based on the circuit rider model. These programs employ a trained professional to travel from school to school. This allows the water conservation program to be taught throughout the school system without requiring extensive retraining of existing teaching staff.

Incorporating water conservation modules into already existing courses is a more challenging effort for school systems. Water conservation can be worked into science classes (discussing the ecological role of water and the importance of keeping water in the rivers); into math courses (focusing problem solving skills on water conservation problems, such as calculating the amount money/ water that would be saved if people participated in water conserving activities); into reading and literature courses (reading about fiction and creative nonfiction about the relationship between water and ecological, as well as human, health); and into social science courses (studying the politics of water-use decisions and the social outcomes of those decisions).

Essential to the success of school outreach program where water conservation is fully integrated into existing course work is a commitment to teacher education and program implementation. Workshops or classes about water conservation and how to effectively teach children about water conservation must be provided for teachers and, if necessary, support staff such as librarians and laboratory assistants. A commitment to program implementation also may require special reading materials and other support materials for student use. In San Juan, CA, the Waterbucks Program provides a financial incentive for schools to introduce water conservation into schools. Schools receive "water bucks" to pay for the needs of the water conservation education program. Funds do not need to be taken from other resources within the school to pay for the water conservation education program. The waterbucks program provides a great incentive for schools to adopt water conservation education programs.

3.4.A.4 Media

Because the media plays an ever-powerful role in our society, it is extremely important for a water conservation educational outreach campaign to integrate a strong media presence into the campaign. Billboards, radiobroadcasts, televisions, newspapers, and mailings all serve as effective ways to spread the messages of water conservation. Ongoing water-wise media reminds people about water conservation until it becomes a daily routine.

3.4.B An Example of a Well-Coordinated Water Conservation Educational Outreach Program: Phoenix, AZ

Phoenix, AZ, has developed a unique water conservation program that is directly responsive to public concerns and desires. The city conducted a survey and determined that water conservation education was what the public felt to be the most crucial measure needed for increasing responsible, water-wise behavior throughout the city. The city developed its water conservation plan around this desire for a water conservation education program. Because the public is directly represented in the water conservation plan, they have been extremely responsive to the educational program and have adopted many water conservation measures. The budget for the program was more easily approved by the city council because the plan was shown to be directly responsive to public needs, wants and perceptions. The program is well integrated into the schools and the community.

As a result, Phoenix has an extensive water conservation program in its schools. The program has developed a water conservation cur-

riculum for kindergarten through 12th graders, trains teachers on the curriculum, and distributes materials to schools. Curriculum material includes teacher's guides, student books and materials. Teachers are trained by the Project for Water Education for Teachers (WET) contractors. (Project WET is a program developed by the University of Arizona Water Resource Research Center to train teachers on teaching water conservation in schools.) The students are encouraged to engage in hands-on learning experiences through such experiences as field trips to Tres Rios constructed wetlands and desert house, a demonstration of water and energy efficient desert living. Students are also involved with school-site based desert gardens.

The city also launched many community outreach programs to supplement water conservation education efforts in schools. Conservation staff has taught workshops on efficient watering practices for homeowners since 1989. Homeowner irrigation classes teach fundamentals of drip and sprinkler irrigation, and landscape workshops introduce xeriscape and low-water use residential landscape design. Public events such as community fairs, and home and garden shows promote efficient water usage.

Non-residential workshops are held for facility managers and city employees to introduce them to the concept of water conservation, providing them with technical assistance and materials from programs such as Smartscape, a statewide xeriscape-training program for professional landscaper designers and landscape maintenance professionals. Assistance and training on efficient water use is also provided for the city's trained professional staff.

Phoenix's water conservation program has focused on collaborating with other city programs to bring about results that improve the city in more ways than one. For example, the water conservation program has worked extensively with development programs to integrate water conservation into larger community-building efforts.

3.4.C Benefits and Drawbacks to Education as a Means for Achieving Water Conservation

Bringing awareness to the community about water conservation issues through schools, community outreach programs and the media can be a very effective consciousness-raising tool. However, educational programs can be expensive to implement, and no matter how well planned and extensive, no water conservation educational outreach program can be effective if the public does not perceive of water quantity as an issue in their community.

Once people are aware of what constitutes good behavior, some system of rewards is essential. Public recognition for water-wise behavior helps to firmly establish that behavior as socially and personally desirable behavior.

3.5 Awards for Wise Water Use

Awards are popular non-financial incentives that reward and encourage wise water use. Awards are given to individuals or businesses; they are a way to recognize publicly those who have incorporated water conservation into their daily lives or practices. Water conservation award winners usually are recognized in some public forum: at public events, in newsletters, on web pages, or in the media.

3.5.A Types of Awards

Awards recognizing conscience water conservation efforts serve as a way to reinforce water conservation behavior, and encourage people to act in a manner that supports water conservation in the future. Award programs can be established for all types of water users:

residential, commercial/industrial and agricultural. While the principal behind receiving an award is similar for all sectors, the technical basis for granting the award may vary.

3.5.A.1 Residential Awards

Residential awards are aimed at water conservation efforts in and around households. They recognize any residential customer who stands out as having shown an outstanding commitment to wise water use through the implementation of behavioral or technical strategies resulting in dramatic increases in water use efficiency or dramatic reductions in actual water use. Award systems not only recognize such commitment, but also establish efficient water use as an attainable and desirable contribution to the environmental health of the community.

3.5.A.2 Commercial and Industrial Awards

Commercial or industrial water conservation awards are presented to those in the commercial or industrial sector who have exhibited exceptional water savings in their business or management practices. Award programs for these sectors are aimed at commercial or industrial water users who stand out in the community as taking an active role in conserving water through retrofitting, water saving practices and/or offering water conservation services to the public.

3.5.A.3 Agricultural Awards

Amongst agricultural customers, irrigation systems are a major source of water waste. Agricultural award programs can be established to recognize outstanding efforts by agricultural producers to increase water use efficiency by adopting water efficient technologies, installing efficient irrigation systems, or showing a marked increase in irrigation efficiency.

3.5.B Examples of Award Programs

A number of successful award programs has been established.

3.5.B.1 Irving Ranch Water District, CA

Irving Ranch Water District in southern California has an extensive award program aimed at residential, commercial and industrial water users. Members of the community can nominate friends, businesses, or even themselves for an Irving Ranch Water District Conservation Award all year round. Awards are given to residential, industrial and commercial customers who stand out as conscientious water users. Actions that deserve an award include conservation-conscious designs and efforts to retrofit the home, industry or business for increased water efficiency, as well as exceptionally effective conservation management, (changes in water use habits that result in notable water savings). Awards are also presented to businesses that offer water conservation services to the public. Award winners are announced on a regular basis as nominations are received and water conservation impacts are verified. Winners are recognized in a number of public forums: on the district's web site, in the district's newsletter (which comes with the water bill), at a meeting of the district's board of directors, and through news releases to local media.

3.5.B.2 Portland, OR

The Water Bureau of Portland, Oregon, and various Portland community organizations co-sponsor the Businesses for an Environmentally Sustainable Tomorrow (BEST) awards. BEST awards are presented to industrial, commercial and business water users who have made a significant achievement in reducing waste and/or conserving energy and resources (including water). In many cases the Business, Industry

and Government Water Conservation Program of the Water Bureau has provided technical assistance to these companies.

3.5.C Benefits and Drawbacks to Awards as a Means for Achieving Water Conservation

Awards are a relatively inexpensive way to reward members of the residential, commercial, industrial and agricultural communities who have engaged in highly effective water conservation practices to be recognized for their admirable practices. Award winners receive positive reinforcement for their actions. Those who receive awards serve as role models for the entire community, demonstrating that efficient water use practices are both achievable and desirable goals.

Winning a wise water use award also gives industrial, commercial or agricultural customers positive recognition within the community as a sustainable business, a "good corporate citizen." This not only reinforces their practices within their own sector, but also gives them a possible financial reward, in that more people in the community may choose to support them as a result of their award-winning behavior.

Though awards provide positive feedback to the customer and the public about efficient water use, awards for efficient water use usually do not make the headlines. To be truly effective, awards programs must be coupled with a promotional campaign designed to increase the desirability of the award. Unfortunately, it is nearly impossible to measure the extent to which awards programs contribute to water conservation.

3.6 Water Recycling or Reuse

Using less water whenever and wherever possible is a means for conserving water. The real goal of water conservation, however, is to remove less water from the natural environment than we do now. Reducing water use through various technological or behavioral changes is one way to achieve this goal. Reusing "waste" water offers another way to reduce our need to withdraw increasing amounts of water from the natural environment.

Most people don't realize that in most places all the water supplied by the local water provider is potable, that is, fit for human consumption. This means that all the water supplied by water providers – drinking water, the water used in toilets, used by commercial car washes, used by golf courses, used by streets weeping machines, used almost everywhere except for agricultural irrigation – is water that has been treated to make it safe enough for people to drink. Americans accept this as the norm, but water recycling offers an alternative to this scenario.

Water reclamation or recycling is the process of treating "used" water so that water users can and will use it again. Water recycling has proven to be an effective way of creating a new sustainable and reliable local water source. The use of recycled water reduces the total amount of "new" water extracted from the local water supply.

Recycled water can be used to supply all residential, commercial, industrial and agricultural water needs, provided the "used" water undergoes sufficient treatment. If people consume or are exposed to reclaimed water, health concerns demand more extensive and more expensive treatment of the "used" water than is necessary for many commercial, industrial or agricultural uses. Currently, in this country

reclaimed water is used almost exclusively for non-potable (non-drinking water) purposes.

3.6.A Types of Water Recycling

Water can be recycled in many ways, for many uses.

3.6.A.1 Residential Sector

Most of the water used in residential situations must be potable. However, because the two potential residential uses of non-potable water – landscaping and toilet flushing – both use large amounts of water, the residential use of non-potable recycled water could significantly reduce the amount of "new" water required by the residential sector. There is little or no public support for the use of recycled water to satisfy residential uses requiring potable water. As one water conservation professional pointed out, the American public does not want to drink sewage, even very clean sewage.

3.6.A.2 Commercial, Industrial and Municipal Sectors

The use of reclaimed water in the industrial, commercial and municipal sectors has great potential for conserving an enormous amount of "new" water. Because a large majority of water used in this sector is not consumed by or comes into contact with humans, recycled water can be widely used for industrial and commercial uses. Uses of recycled water in industry include cooling water for power plants and oil refineries, paper mills and carpet dyers. Some industries, such as the semi-conductor industry, require extremely high quality water for their industrial needs. The quality of recycled water currently available in most places would not be a satisfactory substitute for "new" water in those industries. Where available, recycled water is commonly used for watering for parks and golf courses, construction purposes, concrete mixing and artificial lakes.

3.6.A.3 Agricultural Sector

Agricultural irrigation places a high demand on "new" water sources. Recycled non-potable water can meet the demand for large amounts of irrigation water without depending on "new" water, provided that the crop being grown is not a food source. Because non-potable recycled water typically has a greater nutrient content (particularly nitrogen and phosphorus) than potable water sources, it can provide an added benefit to agricultural producers. The additional nutrients found in the water source may lessen the need for additional synthetic fertilizers.

3.6.B Examples of a Successful Water Recycling Program

Water recycling is still relatively unusual in this country. There are, however, a few examples of extremely successful programs.

3.6.B.1 Centreville, VA

Centreville, VA, has managed to implement a highly successful water-recycling program that has passed public scrutiny. Great pressure was placed on the Occoquan watershed just outside of Washington, D.C, as the area experienced rapid population growth and increased urbanization throughout the '80s and '90s. Rapid growth increased pressure on the water supply and overextended the capacity of sewage treatment facilities, resulting in a great decline of water quality in the watershed. The area had no choice but to search for alternative water supply sources.

Eleven sewage treatment plants were replaced by a large central treatment plant (the Upper Occoquan Sewage Authority [UOSA]

Regional Water Reclamation Plant) that discharges water of drinking quality into the water reservoir. The new, highly sophisticated water reclamation plant has drinking water standards that may be the most stringent in the world. During periods of drought, the treatment plant supplies up to 90% of the drinking water reservoir inflow. Initially, the community was skeptical about the fact that wastewater was converted into drinking water. But, as regular testing of the discharged water has indicated the quality of water discharged into the reservoir is purer and more sterile than any of the reservoir's other water supplies, the community has become more accepting of the alternative water source. All in all, the UOSA Regional Water Reclamation Plant has been successful in reducing the amount of discharge to and withdrawals from the local water supply while increasing the amount of potable water available to the area's growing population.

3.6.B.2 St. Petersburg, FL

St. Petersburg, FL, established a regional reclamation system in the late 1970s in an attempt to stabilize potable water demand and reduce discharges to the adjacent coastal waters of Tampa Bay. Since the program began, St. Petersburg has become the largest city in the United States to achieve zero discharge of treated wastewater into surface waters. At first, recycled water use was limited to golf courses, parks, schools and large commercial buildings. Today, extensive research has resulted in the expansion of the program to residential customers, although the water is not suited for human or animal consumption because of the chemical salts that remain in the water from the treatment. St. Petersburg's recycled water is used primarily for residential irrigation systems and industrial processes. The city currently has four reclamation facilities and an extensive (over 250 miles) piping network that provides water for residential customers irrigation systems throughout the city. In 1995, over 8,000 customers used almost 21 million gallons of reclaimed water each day. When completely implemented, the program is expected to provide water to approximately 17,000 residential, industrial, commercial and agricultural customers, and to irrigate almost 9,000 acres. The reclaimed water system has greatly reduced St. Petersburg's demand for potable water.

3.6.C Benefits and Drawbacks to Water Recycling as a Means for Achieving Water Conservation

There are many environmental benefits to water reclamation. Most important to the ultimate goal of water conservation is the direct and assured reduction of water extracted from ecosystems. However, recycling "used" water also prevents the discharge of wastewater into rivers, bays and other water bodies. Most secondary wastewater systems rely on dilution to render remaining pollutants and bacteria "safe" for the environment, and dilution is only effective if a water body has a sustained input of clean water from upland sources. Too much discharge from too many sources can permanently foul a water body.

Arguments have been made to the effect that wastewater discharges have become an integral part of the flow regime for some rivers and other water bodies. According to proponents of this perspective, reducing wastewater discharge into water bodies can actually reduce the amount of water available for withdrawal by other water users. The validity of this stance must be evaluated on a case-by-case basis. This argument does not provide a sound reason for dismissing water reclamation as an efficient and effective water conservation strategy.

Unfortunately, water recycling has an extremely high start-up cost. Though cost-effective in the long-term, the initial installation

of water treatment plants can be prohibitively expensive. However, unlike audits, water-wise education programs and incentives for water conservation, water reclamation assures a reduction in the amount of water removed from an ecosystem. Water reclamation is controlled by the municipality, and therefore does not rely on the good intentions of water users to achieve water conservation goals. In combination with the water conservation efforts of individual water users, water recycling offers the opportunity to greatly reduce water consumption.

3.7 Aquifer Storage and Recovery

Aquifer storage and recovery is a conservation technique that is growing in popularity and acceptance in much of the nation. Aquifer storage can provide means of retaining a constant water supply throughout the year. Water providers can use aquifer storage to increase the amount of storage area in the winter when supply is at peak, and increase the water supply in the summer when demand is at peak. Excess water can be pumped into underground storage aquifers during the wet winter months, and withdrawn during the dry summer months when the water supply typically is at its low point.

Aquifer storage and recovery (ASR) is a water management tool for storing excess water for future use. The stored water can be used on either a yearly basis (e.g., during the summer months) or it can be used as a system back up, in the case of a natural disaster or drought. ASR is especially effective in areas where water availability is limited on a seasonal basis because it functions in much the same way as a reservoir, but without evaporative losses and environmental impacts associated with traditional storage facilities. ASR can also be used by wastewater systems reusing reclaimed water for irrigation purposes. Treated wastewater can be stored during the wet weather periods for use during the dry periods when irrigation demands are highest. ASR can be used to reduce the size of water treatment facilities. Because ASR typically satisfies peak daily and monthly demands by withdrawing and directly distributing water to customers, the average daily demands of the community are not those which need to go through the treatment process. Finally, ASR may be used as way of recharging areas where groundwater levels and aquifer yields have been reduced by over consumption.

3.7A How ASR Works

The first step in the ASR process is the identification of a successful storage zone. The zone must be in an area that facilitates the transmission of water to the consumer. The zone must also be in an aquifer or geologic formation with moderate permeability, confined above and below by low-permeability sediments. The aquifer used for storage must have a high level of existing water quality.

Once a site has been determined, test wells are installed and the infrastructure constructed. There are many components to an ASR system that must be installed prior to the initial use of the system. ASR wells must be dug, pumps and piping systems installed from the water source to the aquifer and from the aquifer to the distribution center, and electrical equipment and instrumentation configured to control the flow of the system. Some type of water quality treatment is usually necessary before water from the ASR system may be distributed to the consumer, and therefore a treatment facility is usually installed as well.

Treated or untreated fresh water may be stored, although potable water is preferable. In the process of injecting the water, brackish groundwater may be flushed out of the aquifer, improving the quality of the groundwater for

consumer use. This method of water management is relatively cheap when compared to above-ground storage. Aquifer storage can accommodate a much larger volume of water – as much as one billion gallons of treated water may be stored and later directly distributed to customers. A well-designed system can deliver recoveries of more than 80% of the injected water. Because typically the native groundwater in the aquifer is not of desirable water quality, returns less than 100% only enhance the quality of the native groundwater.

The cost of implementing ASR systems varies according to location, need and further treatment measures required for the recovered water. For example, the city of Salem implemented an ASR system in 1996 in hopes of providing an additional 10 MGD of water to meet the city's growing demand during the summer. The city installed four wells, distribution pipelines and buildings for three and a half million dollars, more than a million dollars under budget (personal conversation with Paul Eckley, 4/2/01).

3.7.B Examples of Successful ASR Programs

Like water recycling, ASR is still a relatively new technology. The wet winters and dry summers of the western Pacific Northwest would suggest that here, of all places, would be a proving ground for this technology.

3.7.B.1 Salem, OR

The North Santiam River is the drinking water source for the city of Salem. Salem began work on an ASR system in 1996, hoping to minimize the environmental impact associated with increased water demand in the most economical way possible.

Under the South Salem Hills are numerous cavities formed by volcanic activity millions of years ago, which provide a prime storage area for the ASR system. During the winter, the city pipes treated drinking water from the North Santiam River into the aquifer, recovering the water during the summer when demand is high or during emergency situations. The city of Salem's ASR system currently provides 9.2 million gallons a day of water via four injection wells, and should be ready for full operation during the summer of 2001 following the installation of a new chlorination system and final testing and tuning of the system as a whole. The construction of the four wells, pipelines, and treatment and distribution facilities cost approximately three and a half million dollars and was funded by an increase in consumer water rates.

By relying on water stored by the ASR system during periods of peak demand or in emergency situations, more water is left in the North Santiam River for recreational and wildlife purposes. An additional benefit of Salem's ASR system is an increase in water quality during periods of low flow. Water withdrawn from the ASR system during the summer is colder and less susceptible to contamination than water withdrawn from a surface water source. Because the water from the ASR system is added to the existing water supply system; no additional water delivery infrastructure is needed.

3.7.B.2 Portland, OR

The city of Portland, OR, has recently drilled three new wells in aquifers along the Columbia River in order to begin test an ASR system. The city will inject water from the city's current drinking water source, the Bull Run watershed, into the new wells. Drinking water from Bull Run is of exceptionally high quality, and surveys of the Portland metropolitan area

show consumers greatly prefer drinking Bull Run water to well water. The city hopes to increase public acceptance of well water as a supplementary drinking water source for the city and to increase the water quality of current backup wells. The system would also provide an emergency water supply for the city.

The $2.6 million pilot project will entail the injection of one billion gallons of water in four wells during the winter of 2001, when the water at the Bull Run watershed is running its highest. During the summer of 2002, the city is expected to pump approximately 10 million gallons a day or 6-8% of the summer usage to most of the city's 840,000 customers. ASR seems to be a safe and low-cost method of expanding the supply of Bull Run water and improving the current quality of the city's back-up water supply.

3.7.C Advantages and Disadvantages to Aquifer Storage and Recovery as a Water Conservation Technique

The primary advantage to installing an ASR system is the increased capacity of the current water distribution system without any known negative environmental consequences. Another advantage to ASR is the decreased cost of operating such system. It is much more expensive, with respect to area, construction and maintenance costs, to store above ground rather than underground. There is a relatively minimal land requirement of an acre or two per well for the ASR system. Also, treatment facilities do not need to be sized to support the high peak demands because the peak water demands may be met with the ASR system.

However, there are some reported disadvantages with the system. Often the native groundwater contains constituents that will require more extensive treatment in order to achieve potable standards. Some constituents include radium, hydrogen sulfide, iron, and manganese, all of which will lower the quality of the fresh water pumped into the aquifer. Another problem lies with the location of the existing aquifers, for they must meet the storability and transitivity requirements in sufficient magnitude to meet the demand of the community.

A significant disadvantage to ASR are the uncertainties associated with long-term ASR use. ASR technology is still a relatively new concept and many water consumers question its effectiveness in providing quality water. One uncertainty associated with ASR use is the compatibility of the injected water with the aquifer water: in order to decrease the need for mixing and further treatment, it is desirable to have water that is relatively of the same quality. Another uncertainty concerns the effects that injecting large quantities of water can have on the confining unit. The recovery efficiency of an aquifer is not known until the system has been installed and used, therefore it is impossible to project accurate estimates concerning supply effectiveness before the system has been built.

4. Funding Options for Water Conservation

Making the policy changes required to support the design and implementation of an effective, well-coordinated wise water use program requires a stable source of funding and sound financial planning. Because water conservation is a relatively new concept for most state and local agencies, as well as local water providers and their customers, it is often difficult to secure a creative and flexible funding source for water conservation.

4.1 Background: How Water Providers are Funded

Water utilities can by publicly owned, privately owned or owned by a local cooperative. Most of the water utilities in Oregon are publicly owned and operated by a municipality, such as the Eugene Water and Electric Board (EWEB) or by a special district, such as the Oak Lodge Water District in Milwaukie. Irrigation districts are another type of special district that provides water for non-residential uses. (Special districts have many quasi-governmental powers, including the ability to assess taxes within the district and to issue bonds.)

The rest of Oregon's water utilities are either privately owned or are owned by cooperatives established by homeowners associations or other groups of local citizens. Although there are a very few large, privately owned systems, such as the Avion Water Company in Bend, for the most part, the privately owned water utilities in Oregon are small systems. Cooperatively owned water systems, such as the Carver Water Co-op Association in Clackamas County, are generally small as well.

Water providers, including irrigation districts, have two basic types of expenses. Operating expenses are the day-to-day costs of running the utility, including maintenance programs, salaries, ongoing water treatment costs, etc. Water providers rely on the revenue generated by their customers to cover operating expenses for the utility.

Capital expenses are the costs of improvements to system capacity or functionality. For water systems, capital investments usually include replacing, upgrading or installing new pipelines, pump stations, treatment plants or storage facilities. There are many ways for a water utility to generate funds for capital improvements, including loans, grants, bonds and system development charges or revenue financing (see below).

Once a water utility is established, most of its capital expenses are related to the development of new water sources and new treatment facilities to meet the demands of new customers. The need to develop or increase water storage facilities can be delayed or even removed by a deliberate and thorough-going commitment to water conservation techniques and programs. Decreasing water use by existing customers frees up water in existing storage facilities for distribution to new customers.

For example, a residential customer can save up to 7,000 gallons of water a year by using a water-efficient washing machine. If 20 existing customers install and use a water efficient washing machine, enough water is freed up to meet all the water needs of one new customer. A rebate program designed to encourage the use of water-wise washers can act as a "new" source of water supply. And until the new customer comes on line to use that water, the treatment capacity of the utility is freed up as well, saving the utility money for operating expenses.

Unfortunately, Oregon does not allow water conservation projects to be capitalized in the same way that the traditional system improvements described above are capitalized. A new storage facility can be capitalized under the rules laid out in Oregon Revised Statute 223 (ORS 223), but a water conservation project that would, over the life of the loan or bond, save enough money to make new storage unnecessary cannot.

4.2 Funding Sources for Water Conservation

Water conservation programs can be funded by revenue financing, debt financing, general obligation bonds, double barrel bonds, special assessment bonds, system development charges, grants, environmental charges, and private firms. Each of these funding sources can be used independently or in conjunction with another type of funding source, although water utilities may find that some sources of funding are more flexible and, therefore, more suitable to water conservation programs and projects.

4.3 Revenue Financing

Water conservation can be funded by setting aside a portion of the budget for the purpose of funding wise water use programs. For example, every year a utility can set aside 1% of the annual budget for funding the water conservation program. The customer base of the water provider directly pays for the water conservation program, investing in creating a secure future water supply.

Revenue financing assures the water provider of a secure funding source for the water conservation program by "billing" the costs of the program directly to the water users, who are the ultimate beneficiaries of the water conservation program. Water providers that are entirely revenue-dependent must either raise their rates or shift funding from another program to support the water conservation program, which may make revenue financing an unpopular funding source from the point of view of a water utility's customers.

4.4 Debt Financing

Water providers can borrow against their revenues to fund water conservation programs. A well-established water utility can get a lower interest rate than a newly established utility because the loaning institution or individual is confident of the mature utility's ability to maintain a stable revenue stream from which to draw loan payments.

Going into debt has the same pluses and minuses for a water provider as for an individual. Fortunately, because water conservation has societal benefits, there are low-interest loan programs available to water providers. While those programs may have strings attached, they provide opportunities that can offset potential tangles in those strings.

4.5 Bonds

A bond is a formal certificate of indebtedness issued in writing by a government or a business in return for a loan. Essentially, a bond acknowledges a loan. The bond outlines the interest to be paid and the amount of money to be paid to the holder after a period of time (generally 10 to 20 years). General obligation bonds, revenue bonds and double-barrel bonds can be issued to fund water utility conservation efforts.

4.5.A General Obligation Bonds

General obligation bonds are the most common type of bond issued to utilities, and are generally considered an effective and reliable source of funding for water conservation projects. General obligation bonds are backed by the full faith, credit and taxing power of the issuing government. The loan funds secured by a general obligation bond are drawn from taxes, and usually are based on property values in a community. Generally, the voters in a community must approve the issuance of a general obligation bond. General obligation bonds are typically low-cost and low-risk.

A major benefit of general obligation bonds is that the general government backs them. A drawback is that it often requires voters' approval and/or full support of the government, and therefore can be hard to approve. Due to various state restrictions on property taxes, general obligation bonds generally are not an option for Oregon water utilities.

4.5.B Revenue Bonds

The revenue that a water system acquires from user fees backs a revenue bond. Essentially, the water provider is borrowing money from the government and borrowing against its revenue stream. The annual income of the water utility is used to support the loan.

Funding through bonds backed by annual revenue has its benefits. One benefit is that the general public is not involved and therefore voter approval is not required. Revenue bonds can eliminate a water provider's need to gain widespread public approval for specific water conservation projects. A second benefit to revenue bonds is that they do not count against the debt of the general government. The interest on revenue bonds is usually higher than the interest on general obligation bonds, but only by one or two percentage points. Even though revenue bonds are not affected by Oregon's restrictions on property taxes, they are subject to restrictions under state law that narrowly limit the types of projects that can be capitalized. This makes it difficult to use revenue bonds to fund most types of water conservation programs.

4.5.C Double Barrel Bonds

A double barrel bond is a combination of revenue financing and bond-generated funds, that is, of user fees and tax revenues. Double barrel bonds are used most often when systems are just starting up and do not have significant revenue backing them.

A very large plus for of this type of bond is its combination of stable, reliable funding sources. On the other hand, it combines the drawbacks of general obligation bonds and revenue financing: it requires general voter approval and presumes that the water provider has a stable, committed base of support for water conservation amongst its clients.

4.5.D Special Assessment Bonds

A special assessment bond is a bond paid for by the taxes of the community benefiting from the bond-funded project. Areas experiencing growth may approve a special tax (such as a sales tax) and/or user fee assessments to pay for special assessment bonds. For example, voters can approve a sales tax for a special water conservation project that is collected until the project is complete and paid for. Upon the project's completion, the sales tax will sunset. Special assessment bonds result in low financing costs and short-term financing.

The benefit of using special assessment funds is that the water users directly impacted by the program have voted to support the program. As discussed above, the success of any water conservation program requires commitment and support from the affected population. Unfortunately, that plus can also be a minus, as the voters of the district must approve the project and tax increases in order for the project to be funded. In an area where the general population of water users has not grasped the importance of water conservation, a special assessment bond to institute some sort of water conservation program is unlikely to pass without a large investment of time and money in public outreach and education. Obviously, given Oregon's ongoing refusal to accept a sales tax as a source of state revenue would make a sales tax

an unlikely special assessment for Oregon water utilities.

4.6 Grants

Grants are one of the most popular sources of funding for water conservation. Federal and state agencies have grants available for water conservation projects. Most typically, government agencies will fund a portion of a water conservation program, requiring the water provider or other entity establishing the program to come up with matching funds from another source.

Because they do not require repayment, grants can be a wonderful source of "free" money for water conservation programs. In truth, however, grants do not provide free money nor are they necessarily stable or reliable sources of funding.

The grant application process can be very time-consuming. A great deal of work must be done "up front." Typically, a grant requires justification for the project, and a thorough and detailed outline of the goals, objectives, strategies and tasks involved in designing and implementing the program. Anyone requesting grant funds will face a non-recoverable outlay of time and money in preparing the request. This can be an enormous stumbling block for smaller water providers or municipalities.

Because grants rely on available state and/or federal monies, they are subject to the whims and vagaries of state or federal budgetary processes. In general, the size of grants available to water utilities and others for water conservation projects through federal and state programs is shrinking. In this area as in many others, the pools of money available for grant programs have an unfortunate tendency to dry up with little or no forewarning.

4.7 Environmental Charges

Environmental charges are property charges that provide specifically for environmental infrastructure. Environmental charges place the burden of funding water conservation directly on those creating the need for a water conservation program. Typically, an environmental charge is an additional, unrecoverable charge added to each water user's bill specifically for funding water conservation projects. Other examples of environmental charges include summer surcharge rates and "water waste" fees.

Environmental charges are similar to revenue funding or special assessments, in that those creating the need for water conservation pay for the program. Because both the water-using public and the government must approve an additional water conservation fee, a challenge even in the most prosperous of times, environmental charges are rarely implemented. Once established, however, they can provide a stable, reliable funding mechanism.

4.8 Private Funding and Contributions

Private funding is a widely used source for funding water conservation. Private businesses, individuals or public interest groups may provide money, products or services to assist in the implementation of water conservation programs. For example, some toilet companies have provided the funding for retrofitting high water use toilets as well as providing rebates for replacing high water use toilets with low water use toilets.

Both parties gain from these types of partnerships. Private funding and contributions can provide a struggling water conservation program with materials and money with little or no cost to the program. Because the firm, group or

individual donating professional services, products or money to the program may be able to deduct such donations from their taxes and because it increases their profile as a good (corporate) citizen, there may be an incentive for private businesses, individuals or public interest groups to participate in, and even initiate, such partnerships.

Private sources of funding often have "deep pockets," which makes them a plus in the funding arena. Unfortunately, they do not provide stable or sustainable sources of funding in the long-term. Additionally, most private funding sources have an agenda of their own, which may inhibit the effectiveness of the water conservation program because of restrictions they place on what can be done with the funds or the contributed materials or products. All in all, private firms are an easy and quick way to fund water conservation programs.

4.9 Actual Funding Strategies Used to Achieve Water Conservation

Many water providers and municipalities have used one or more of these funding sources to develop effective and ongoing water conservation programs. Some of the most successful strategies are detailed below.

4.9.A Irvine Ranch Water District

The Irvine Ranch Water District has used a combination of capital funds and general obligation bonds to finance the construction of new infrastructure required to meet the demands of the district's increasing customer base. Its budget rate billing system generates capital funds for the program from the connection fees collected from each water user. The district issues general obligation bonds in one or more of its water and sewer improvement districts. This has the added benefit of ensuring that the costs of the program are allocated according to the benefits received.

The district secures funds for water conservation programs, such as audits and education, from penalties paid for excessive water usage. Excessive water use penalties are placed in a separate account from those that fund daily operations. Penalty monies are used to help those paying the penalties become more efficient in their water use.

4.9.B California

In March 2000, the "Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Bond Act" was approved by the voters of California. The act authorized $2 billion in bond funds for various water-related purposes. Included in the $1,412.6 million dollar grant and loan fund is over $350 million for water recycling and water conservation programs.

4.9.C Los Angeles Water District

The Los Angeles Water District uses an environmental assessment fee to fund its water conservation program. A monthly fee is charged on each person's water bill for the water conservation program.

4.9.D California Office of Water Recycling

California has issued a general obligation bond that funds water recycling programs administered by the Office of Water Recycling. In November of 1996, the voters of California approved a bond issue, Proposition 204. Of the $995 million raised through this bond issuance, $60 million is earmarked for state assistance for water recycling projects. In some cases, the money generated by the bond is being used to

match federal grant funds, making much more money available for California's water conservation commitments.

The funds are to be used by public agencies to provide low-interest loans for the design and construction of projects and to provide grants for planning facilities. The State Water Resources Control Board adopted the "Water Recycling Funding Guidelines" setting forth the policy and procedures for implementation of this provision of the proposition. The loan provisions of bond issue Proposition 204 supplement past bonds for low-interest loans to public agencies and are collectively called the Water Recycling Loan Program. Loans are provided to projects for the reuse of treated wastewater. There is a $15 million limit per project on loans and may be issued for a period of up to 20 years with an interest rate of 50% of the interest rate paid by the state on the most recent sale of general obligation bonds.

Additionally, Proposition 204 authorizes a water recycling facilities planning grant program. The Water Recycling Facilities Planning Grant Program finances planning studies for the reuse of treated municipal wastewater for water supply purposes. The grant will cover 50% of the study costs with a maximum grant of $75,000.

4.9.E Utah Water Conservation Credit Program

The Central Utah Water Conservation District developed a Water Conservation Credit program under the Central Utah Project Completion Act. The credit program fulfills the requirement of the act by directing the Central Utah Water Conservation District to develop a continuous process for the identification, evaluation and implementation of water conservation measures. The credit program serves two purposes. First, it funds efforts to identify, evaluate and implement water conservation measures that maximize the efficient use of existing water supplies and aid the district in monitoring progress toward meeting the district's water conservation goals. Second, the program allocates $50 million in authorized federal monies to fund the implementation of those conservation measures. Since the credit program was established in July of 1993, 99 applications for water conservation measures have been received, 38 of which have completed all of the steps of the credit program. A majority of the projects deal with agricultural conservation.

5. Recommendations for Developing and Increasing Funding for Water Conservation Policies in Oregon

The key to dramatic changes in Oregon's water conservation policies is a commitment by all water users to adopt water-wise practices. In order to achieve this commitment, the state must directly increase the money available for water conservation and create a statewide mandate for water conservation.

One means for moving water users of all scales towards a whole-hearted integration of water conservation policies into their day-to-day functioning is the use of financial incentives and assistance. The state has a key role to play in facilitating funding of water-wise policies and programs. In addition to increasing money available for water conservation, Oregon should create a climate that fosters, rather than discour-

ages, water-wise behavior and technologies. Language supporting water conservation concepts and commitments are nestled in the rhetoric of many of the state's voluntary programs. Only a few existing programs require any consideration of water conservation. A statewide mandate must be clearly articulated and enforced in order to effectively move water users in the direction of water conservation.

Specifically, Oregon should:

- Float a statewide bond package (similar to the water conservation portion of California's Prop 204) to fund water conservation policies and programs. The bond package should coordinate with federal funding currently available for water conservation. Most federal grant programs, such as the Safe Drinking Water Revolving Loan Fund, require matching state funds to support the development and implementation of water conservation policies and programs. A statewide effort, similar to California's Proposition 204, could leverage substantial federal funds for water conservation efforts of benefit to all sectors.

    - o Establish a state fund from the above bond package to assist in infrastructure improvements for at-risk water systems. Small water providers are often most at risk for extensive systemic water loss from inadequate or aged infrastructure. State-backed, low-interest loans could assist these smaller systems with capital improvements that would reduce inefficiencies in water use. Requiring the development and implementation of a water conservation plan as a prerequisite for obtaining such a loan could provide an incentive to some smaller water systems to complete a plan.

    - o Establish partnerships between various water resource-related state agencies, federal agencies, and associations or groups such as the Oregon Association of Water Utilities or Soil and Water Conservation Districts. Partnerships between these groups can leverage a variety of funding sources into a comprehensive program of on-the-ground water conservation efforts supported by integrated policy changes designed to promote water-wise behavior on all fronts. Groups or agencies eligible for federal funds can leverage federal funds if a state water conservation fund is established to provide matching funds for those groups or agencies.

- Establish a water conservation tax credit program aimed at the commercial and industrial sectors. Businesses that upgrade or replace existing inefficient water systems should receive a tax credit. Businesses seeking the tax credit must be able to should a required minimum level of water conservation as a result to the improvements.

- Levy an environmental charge on all individual water users or water providers that withdraw water from a stream acknowledged to have insufficient instream flows at any time of the year. The funds generated by this charge should fund water conservation efforts within the specific watershed. The fee could be dropped once an adequate instream flow was achieved. The fee should be reinstituted, however, if at any time the stream has insufficient stream flow due to excessive withdrawals or inefficient water use.

- Set aside funds from the Oregon Watershed Enhancement Board (OWEB) to lease agricultural water rights. Leasing water rights reduces the amount of water withdrawn from streams by agricultural producers for the period of time

covered by the lease. OWEB should also provide educational and technical assistance through outreach programs to water users in basins suffering low instream flows.

- Explicitly allow water conservation measures to be capitalized (that is, recorded in asset accounts and then depreciated or amortized, as is appropriate for expenditures for items with useful lives longer than one year). Capitalization should be allowed, provided the costs of the particular investment meet pre-established cost standards for that type of water conservation measure. Difficulties in capitalizing water conservation measures can be a stumbling block for water providers seeking to increase their water efficiency.

- Adopt legislation requiring all water providers, including irrigation districts, to adopt water-wise billing structures. A statewide requirement for water-wise billing structures would make it easier for water providers to deal with local opposition to increases in water rates.

- Require all water users to meter and report their water use. Without reliable measurement of existing water use, the state has no way to track water inefficiencies and/or water withdrawals in excess of permitted rights or to make scientifically based assessments of water conservation needs. Submetering should be included in this requirement.

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