APPENDIX B: DESCRIPTIONS OF CONSERVATION MEASURES AND PROGRAMS

Following are brief descriptions of a range of water conservation measures and programs. These are broken down as follows:

- Demand-side measures
- Supply-side measures
- Demand-side programs
- Supply-side programs

These lists are by no means exhaustive. Planners are encouraged to review other sources, including the Metro Mayors' Best Management Practices in Appendix C and the web sites and publications in Appendix E, for additional information on water conservation measures and programs.

DEMAND-SIDE MEASURES

Water-efficient Fixtures and Appliances

Most water efficiency and conservation measures must be implemented by the end-user. Many are fixtures and appliances that provide the same or better level of service with less water than ordinary or older models. The following list includes many common fixture and appliance measures. It also includes some advanced and emerging measures. Some of these are proven technologies that not typically cost-effective for retrofits, but may be worth encouraging in reconstruction and new development. Others are developing technologies that could have significant impacts in the future as the designs are refined, their costs come down or local water costs rise to the point that more expensive water efficiency measures become cost effective.

Some of these technologies, like hot water recirculation, provide fairly small water savings. But multiple little savings add up. The fact that technologies for water savings, large and small, continue to emerge and evolve is encouraging news for regions where future water supplies are uncertain.

- *Ultra-low-flush toilet.* The Ultra-low-flush toilet (ULFT) uses 1.6 gallons per flush (GPF) or less. These toilets became widely available beginning in the late 1980s, and the Federal standard of 1.6 GPF maximum became effective in 1994. Toilets in many Colorado homes are still 3.5 GPF or even higher-flush models. Over the coming decades, virtually all these old toilets will be replaced as they wear out, a phenomenon known as "passive water conservation." A good water demand forecast must account for this passive conservation in the baseline forecast. Toilet replacement can be speeded up by "active conservation" programs such as those described later. Further, some very good ULFTs now on the market use as little as 0.8 GPF. Water providers might want to encourage use of these better models.[1]

- *Dual flush toilet*. The "6/3" toilet, which uses 1.6 gallons (6 liters) or less for a full flush and only 0.8 gallons (3 liters) or less for a urine flush, has recently become available in this country. Given the conservation ethic in many communities, local citizens could quickly learn to take advantage of the water savings of dual-flush toilets, as millions of Australians have done for decades. Recent studies by Seattle Public Utilities show that dual flush toilets save an additional 25 percent over standard ULFTs.
- *Waterless urinal*. Waterless urinals are a now well-proven technology that should be considered for wider implementation. As with *any* urinal, odor problems are typically the result of insufficient cleaning schedules.
- *Standard efficient showerheads and faucets*. The national standards for maximum flow rates are 2.5 gallons per minute (GPM) for both showerheads and faucets. Replacing old showerheads and faucets with 2.5 GPM models produces some water savings, but recent research has shown that the savings are typically small, probably because people do not always operate these fixtures at full throttle maximum flow rates (Mayer et al. 1999). Local utilities should instead promote beyond-standard (lower than standard flow) showerheads and faucets for both replacements and new construction.
- *Beyond-standard showerhead*. Most people find that many 2.0 to 2.2 GPM showerheads provide excellent quality showers (assuming adequate water pressure).

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[1] Several concerns are often raised about ULFTs. One is that these toilets don't work well and require water-wasting double-flushing and increased cleaning. It is true that some early ULFTs and unfortunately some current models (mostly cheaper ones) do not work well. Very many models work quite well. Customer satisfaction surveys run by large utility replacement programs consistently show that 80 percent or more of participants are satisfied or find their new toilet's performance as good or better than their old toilet (Osann and Young 1998, p. 20-24). There are also significant ongoing discussions among water conservation professionals over the longevity of ULFT savings, due in large part to unperformed or improper flapper replacements after several years' wear. Certain designs do not suffer from this problem. A utility should choose carefully which toilets it promotes, rebates or buys, and should provide consumers with information or sources of information on the performance of available products.

Some even find that models with maximum flow rates as low as 1.5 GPM are satisfactory.

- *Beyond-standard faucet*. Faucet heads (commonly called aerators) that put out 2.2 to 2.5 GPM are necessary for kitchen faucets because of frequent volumetric uses such as pot-filling. For bathroom faucets, however, much lower flow rates are usually adequate. Faucet heads with 1.0 to 1.5 GPM are highly satisfactory to most people for residential bathrooms. For public bathrooms where hand-washing is the predominant use, 0.25 to 0.5 GPM faucet heads that produce multiple small streams of water are quite effective.
- *Fingertip faucet valve*. Some faucet heads have flip levers or buttons that allow a person to turn down the flow to a dribble. This allows one to effectively turn off the tap while maintaining the same hot/cold mix; for instance, while alternating between scrubbing dishes and rinsing. This type of faucet head enables a small but significant conservation behavior. A similar but more costly device is the foot pedal valve, which is available for residential as well as commercial applications.
- *Electronic faucet*. For public restrooms, electronic sensors that automatically turn water on and off when hands are present in the sink have improved to a level of reliability worthy of widespread implementation. Such faucets save water over standard faucets and metering (e.g., spring-dosed) faucets.
- *High-efficiency clothes washer*. Now that ULFTs are being widely implemented, water conservation professionals consider the clothes washer the next great "reservoir" of indoor residential water savings. New high-efficiency models, typically designed to spin on a horizontal axis, use one-third to one-half the water of conventional washers. They also save on water-heating energy and on detergent. While still more expensive than conventional washers, costs are coming down. Some utilities offer rebates to promote horizontal-axis washers.
- *High-efficiency dishwasher*. Dishwasher technology has steadily improved over the years. Today, the water efficiency of dishwashers both in homes and on sales floors varies widely. Small but cumulatively significant water savings are possible if consumers choose the more efficient models.
- *Extreme low-flush toilets.* Toilets using as little as 0.5 GPF are available. Some use special bowl coatings and vacuum withdrawal to insure effective flushing.
- *Waterless toilets*. Vault and composting toilets are now known to many people from highway rest areas and other remote locations. In addition, new waterless designs are being developed in Europe that use a 2-part bowl to separate urine and feces.

Keeping these forms of human waste apart greatly facilitates their subsequent management. These "separating toilets" are widely used in seasonal cottages in Scandinavia and are in experimental application in urban areas there as well.

- *Hot water recirculation systems.* These plumbing add-ons provide for instant hot water at the tap, saving the water that is wasted when users let water flow while waiting a few seconds, sometimes longer in larger buildings, for cold water in the lines to be cleared. Point-of-use water heaters achieve the same result. Optimizing location of conventional water heaters in new construction also helps.

Landscape Efficiency

- *Turf area reduction.* Grass lawns typically account for most of the irrigation water demand for home yards and other landscapes. Simply reducing turf areas, to where they are most needed, can produce significant water savings. Other, less water-intensive plantings and treatments are available for ground covers where turf is not essential.
- *Low-water use landscapes/plants.* Native plants tend to use much less water and tolerate drought better than non-native species, and their use should be encouraged.
- *Xeriscaping.™* Xeriscaping is a suite of techniques for producing pleasing landscapes that require no or very little irrigation to supplement natural precipitation. These types of landscapes are becoming more accepted throughout the West, particularly as the economic and environmental costs of standard landscaping become more apparent to people. Xeriscaping is an efficiency-oriented approach to landscaping that encompasses seven essential principles:
  - Planning and design
  - Limited turf areas
  - Efficient irrigation
  - Soil improvement
  - Mulching
  - Use of lower water demand plants
  - Appropriate maintenance

- *Drought-resistant vegetation.* Landscapes that use plants adapted to or suitable for Colorado's dry climate reduce summertime water demands. Many such plants can withstand prolonged periods without watering, giving landowners and water providers flexibility in dealing with periodic drought conditions.

- *Efficient irrigation equipment.* Surface and subsurface drip irrigation, micro-spray systems, bubblers and soaker hoses are typically more efficient than sprinkler systems, especially conventionally installed sprinklers. The type, spacing and aiming of sprinkler heads greatly affect the application uniformity and therefore the potential efficiency of sprinkler systems. With all irrigation systems, proper zoning to match the different water needs of different portions of a landscape is important. Irrigation experts typically find substantial water savings are possible from changing the type, spacing and zoning of irrigation equipment in both residential and larger landscapes.
- *Efficient irrigation scheduling.* Even with the very best irrigation equipment, poor scheduling is all too common. Irrigation schedules should be based on evapotranspiration (ET), which refers to the water requirements of plants and associated soil, and varies by plant, time of year, and weather. Water application in excess of ET requirements is wasteful. Many people water all of their landscape the same amount, and typically more than necessary, throughout the irrigation season. Water utilities or other agencies can calculate ET requirements of representative local landscapes on the basis of typical changes in plant ET requirements from the beginning to the end of the irrigation season, or actual changes based on recent weather, and distribute watering guidelines through a variety of means. Programmable irrigation timers provide a crude but "much better than nothing" approach to ET-based irrigation by allowing irrigation schedules to be automatically adjusted for typical ET requirements through the irrigation season. Unfortunately, many people do not know how to properly program their timers, so education must be provided.
- *Rain sensor.* When connected with irrigation controllers, these devices can automatically turn off irrigation systems when rain occurs, saving partial or entire irrigation cycles.
- *Soil moisture sensor.* These devices turn off or delay cycles on an irrigation controller when soil moisture is adequate. Thus, they partially gauge ET and help schedule irrigation in closer agreement with actual plant needs.
- *Remote dispatch of irrigation systems.* Irrigation scheduling can be optimized by centralized computer control. These systems maintain a running water balance based on actual precipitation and actual ET requirements resulting from recent weather, as measured by one or frequently several small weather stations within the districts they serve. They also incorporate a database of the ET requirements of each particular zone in the irrigation systems they control. The computer then

dispatches each zone's irrigation equipment according to actual ET needs and recent precipitation, via cable hookups, phone lines or other telemetry. One model for provision of this service is by subscription, just as one subscribes to cable or other services.

Industrial and Commercial Efficiency

- *Commercial, institutional and industrial (CII) measures.* Besides all the measures noted above, CII users often have many specific but fairly straightforward water-saving opportunities. Candidates for increased efficiency include food service and dishwashing equipment and procedures, cooling tower water recycling and adjustment of blow-down cycles, car wash recycling, cleaning and sanitation equipment (e.g., steam sterilizers, autoclaves, floor washing, etc.), recycling of process water, boiler and steam generator water recycling and optimization, ice-making equipment and much more.

SUPPLY-SIDE MEASURES

Water Reuse and Recycling

Water reuse typically refers to using treated–"reclaimed"–water for additional applications. Water recycling refers to direct application of water to an additional use after an initial use, with no or minimal treatment. An example is the increasing practice in commercial laundries of using rinse water from one cycle as wash water for another cycle. To the extent water reuse and recycling increase the proportion of consumptive use in a system, they may reduce return flows and impact water rights of downstream users. Water rights implications must be evaluated when considering reuse and recycling options.

- *Industrial applications.* Some industries can substantially reduce water demand through water recycling or use of reclaimed water in manufacturing processes. These opportunities are frequently uncovered during water use/water efficiency audits. Water utilities can work with their industrial customers to identify potential areas for reuse or recycling.
- *Large-volume irrigation applications.* Use of reclaimed water is often very cost-effective for large-volume irrigation such as parks and institutional campuses.
- *Selective residential applications.* In some areas, reclaimed water can be used in residential applications. The typical use is for irrigation of landscapes, but examples of using reclaimed water for toilet flushing exist. Water conservation

planners will need to check with local plumbing codes and ordinances for possible conditions and restrictions.

- *Graywater reuse.* This typically refers to directly using water from showers, washing machines, and bathroom faucets for irrigation. Health codes in Colorado are not favorable to legal use of graywater.
- *Onsite and cluster wastewater treatment and reuse.* Sand filters and other advanced treatment units can be added to conventional septic systems to produce effluent that is suitable for subsurface drip irrigation of landscapes. This can be implemented at the scale of individual homes or clusters of homes or other buildings. Proper management must be provided for, but this is not a difficult requirement. This type of reuse is especially appropriate for isolated homes and for subdivisions in areas where centralized sewerage is inappropriate or more expensive than onsite/cluster treatment. In some parts of the country, large urban wastewater districts are also implementing these decentralized wastewater treatment systems on the edges of expanding cities in lieu of sewer line extensions.
- *Wastewater "scalping."* Also known as "sewer mining" and "satellite treatment," this practice involves tapping into sewer lines close to points of significant reuse potential, such as commercial, institutional or industrial water users or large landscapes. A portion of the wastewater flow is withdrawn. A variety of small-scale wastewater treatment systems can be used to clean the wastewater to levels required for the intended reuse. Most such schemes return solids to the tapped sewer line. These systems avoid the costs of installing reclaimed water distribution lines and pumping treated effluent from distant, down-gradient wastewater treatment plants.
- *Potable reuse.* Wastewater can be treated to levels of sufficient quality that it can be re-introduced to potable water systems. "Indirect potable reuse" is the introduction of highly treated effluent to the upper end of stream and reservoir systems, where it mixes with the raw surface water supply. This is also sometimes accomplished through percolation basins or injection wells that recharge groundwater, mixing the high-quality treated effluent with a raw groundwater. "Direct potable reuse" is also possible, in which highly treated wastewater is introduced directly to the water treatment and distribution system. Historically, the social barriers to direct potable reuse have been insurmountable. In coming years it may have a role to play in some regions' water supply options.

Distribution System Efficiency

- *Repair known leaks.* The cost of water leakage can be measured in terms of the operating costs associated with water supply, treatment, and delivery; also, lost water produces no revenues for the utility. Repairing larger leaks can be costly, but it also can produce substantial savings in water and expenditures over the long run. Ten percent water loss is a common "guideline" in the industry. In a water-short region, a rate of 5 percent or less should be sought. Water providers should have in place a systematic program for leak detection (discussed in the supply-side programs section).
- *Pressure management.* Reducing excessive pressures in the distribution system can save a significant quantity of water. Reducing water pressure can decrease leakage, amount of flow through open faucets, and stresses on pipes and joints which may result in leaks. Lower water pressure may also decrease system deterioration, reducing the need for repairs and extending the life of existing facilities. Furthermore, lower pressures can help reduce wear on end-use fixtures and appliances.
- *System-wide pressure management.* For residential areas, pressures exceeding 80 pounds per square inch should be assessed for reduction. Pressure management and reduction strategies must be consistent with state and local regulations and standards, as well as take into account system conditions and needs. Obviously, reductions in pressure should not compromise the integrity of the water system or service quality for customers.
- *Pressure-reducing valves.* A more aggressive plan may include the purchase and installation of pressure-reducing valves in street mains, as well as individual buildings. Utilities might also insert flow restrictors on services at the meter. Restrictors can be sized to allow for service length, system pressure, and site elevation. Utilities can consider providing technical assistance to customers to address their pressure problems and install pressure-reducing valves to lower the customers' water pressure. This may be especially beneficial for large-use customers.
- *Removal of phreatophytes.* Phreatophytes are plants that obtain water from the water table or the unsaturated zone just above it. In water systems where water is conveyed in earthen canals, phreatophytes may remove substantial amounts of water. In some areas, phreatophytes intercept precipitation or snowmelt as it infiltrates into the soil, reducing the yield of aquifers underneath. Removal of phreatophytes may increase the efficiency or yield of water supply systems. Such

gains must be carefully weighed against the environmental and aesthetic impacts of phreatophyte removal. For instance, cottonwood trees and other water-loving vegetation along canals may provide greenery of substantial value to local residents.

Temporary Transfers from Agriculture

Municipal water providers can sometimes obtain water from agricultural water rights holders who are willing to share their water under specific conditions, in exchange for a financial return or other compensation. In *water salvage* programs, non-agricultural water users pay for water efficiency improvements in an agricultural water transmission, distribution, or irrigation system. The saved water then becomes available to the non-agricultural users, with no or small effect on agricultural users. *Dry year leasing* programs feature agreements in which agricultural users forgo their use in dry years, allowing participating municipal water providers to use the water, in exchange for compensation to the agricultural user(s). In *rotational fallowing* arrangements a group of farmers agree to rotate some acreage out of production and thereby make available a certain quantity of water. In all these arrangements, impacts to third parties and agricultural communities must be carefully considered.

Source Optimization

Source optimization refers to a host of techniques to better match water supply systems to water needs. For instance, operations of multiple reservoirs can sometimes be adjusted to maximize storage and synch withdrawals most efficiently with demand. Surface water and ground water supply systems can be integrated, in a practice known as *conjunctive use.* This refers to jointly operating both systems in ways that maximize the benefits provided by each. For instance, in aquifer storage and recovery schemes, water is pumping into aquifers from surface water at times when surface water is abundant, and withdrawn at times when it is not. Another approach to source optimization is *system integration with other utilities.* In this approach, water supply systems run by two or more water providers are physically linked. When one system is water-short and another is not, water can be shared across the systems. Of course, all source optimization options require careful consideration of water rights issues before adoption.

Demand-side Programs

Water providers and other stakeholders have available a host of ways to encourage or require end-users to implement water efficiency and conservation measures. Some of these—rebates and other incentives, for instance—have obvious monetary costs.

Others have costs in staff time, equipment, and acquisition of expertise to help develop or run programs. The premise of implementation is that these costs are *investments* that will produce economic returns to the water provider or the community by deferring, downsizing or avoiding altogether new water supply systems, new water or wastewater treatment capacity, upsizing of distribution systems, or other costs that would have to be borne in the absence of effective demand management.

In developing conservation programs such as those discussed in this section, water providers should consider approaches to implementation that may make programs more effective and/or less costly. For instance, *partnerships with other utilities* should be explored. As one example, cost sharing with energy utilities is often advantageous. Sharing costs of rebates for water-efficient clothes washers is a particularly appropriate, widely engaged partnership, as these machines save both water and energy. As another example, water and wastewater utilities can jointly plan and implement conservation programs to realize savings and share in the benefits. Utilities that provide wholesale water can work with wholesale customers to design a water conservation program that will be mutually beneficial. Partnerships often create mutual efficiencies in program administration and the application of technical expertise.

In addition, *regional cooperation* should be considered. The implementation techniques noted here can be carried out by individual water systems, or through collaboration among multiple water systems. Given the small size of most water providers in parts of Colorado, regional cooperation may be necessary to mount some of these efforts, and should offer substantial benefits. A regional approach should achieve economies in administration, in bulk purchase of efficient end-use technologies and in acquisition of technical expertise. Consider, for instance, joint purchase of low-flow faucets and showerheads for giveaways, and bulk orders of other fixtures and appliances. Or consider how multi-entity cooperation to hire an outside expert to perform water audits in several communities would benefit all.

Technical Assistance

- *Audits of large-volume users.* Utilities can facilitate water audits for large-volume users, including commercial, institutional and industrial (CII) customers. Audits of buildings and sites by qualified water efficiency and conservation experts typically identify significant water savings that are highly cost-effective for facility owners. Water utilities should target large customers, typically CII accounts, first. Audits often provide each customer with estimates of financial savings on water, sewer, energy and other business costs. Water audits should begin by identifying the categories of water use for the large-volume user. These may include process, sanitary, domestic, heating, cooling, outdoor, and other water uses. Second, a water audit should identify areas in which overall water use efficiency can be improved through alternative technologies or practices.

- *Large landscape audits.* Audits targeting only large landscapes—golf courses, cemeteries, parks and recreation fields, "campuses" of large businesses and institutions, etc.—are particularly cost-effective for both utilities and customers. For landscape audits in particular, but with building audits as well, the audit scope can include evaluation of opportunities for water reuse, as well as efficiency options.
- *Residential audits.* Residential water audits may focus on plumbing fixtures, lawn and garden water practices, and customer behavior. Residential water audits can be used to make immediate simple repairs and retrofits such as changing water faucet heads. All water audits should include a written report to the customer that includes specific ideas for conservation. Water audits can be planned and implemented in conjunction with electric power companies or others interested in promoting conservation practices.
- *Selective end-use audits.* An audit program can be selective in terms of targeting customer groups that have particular needs or for which water conservation could be particularly beneficial. These often focus on typical water-use practices and conservation opportunities within each class. Audits targeted to older housing, for example, can be particularly beneficial in terms of identifying and fixing plumbing leaks.
- *Water conservation expert available.* Water providers can make qualified staff available to consult with customers on ways to reduce water usage. Alternatively, water providers can arrange for outside conservation experts to be available.
- *Landscape planning and renovation.* Existing landscapes can be renovated to incorporate water-conserving practices. Public parks, for example, could be managed to incorporate water-efficient landscaping and reduce or eliminate irrigation. Utilities can work with commercial and industrial customers to plan and renovate landscaping in accordance with water conserving practices.

Rate Structures and Billing Systems Designed to Encourage Efficiency

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

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

Planners also should consider the effect of introducing a new rate structure on revenues. Conservation-oriented pricing requires planners to make certain assumptions (based on the available empirical evidence) about the elasticity of water demand; that is, the responsiveness of water usage to a change in price. Elasticity is measured by the ratio of a percentage change in quantity demanded to a percentage change in price. Changes in the rate structure should allow the system to achieve demand reduction goals while still recovering water system costs. In allocating costs, the impact of the rate structure on user demand and revenues for specific customer classes should be considered. Obviously, the pricing strategy must be consistent with overall system goals and approved by regulatory or other governing bodies.

- *Cost analysis.* Planners should conduct a cost analysis to understand what types of usage drive system costs. For example, planners should analyze patterns of usage by season and class of service.
- *Cost-of-service accounting.* Water managers should use cost-of-service accounting, consistent with generally accepted practices. Many resources are available for this purpose. Understanding and tracking system costs also is a capacity-development strategy for small systems.
- *User charges.* Once costs are established, planners and managers can develop more accurate user charges (rate structures).
- *Volume billing (aka "metered rates).* Volume billing should be used so that the customer's water bill corresponds to their water usage. For many systems, change in water rates must be approved by regulators or other oversight bodies. It is important for water utilities to communicate with regulators about costs and the need for cost-based pricing.
- *Nonpromotional rates.* Planners also should consider whether their current rate structures promote water usage over conservation; nonpromotional rates should be implemented whenever possible in order to enhance the conservation signal of rates.
- *Conservation rate structures (aka "inclining-block rates" or "tiered rates").* This refers to a pricing structure in which two or more tiers of volume per customer are

established. Higher volume tiers are priced higher per unit of water. This sends a price signal indicating points at which use may be inefficient or above average. Fairness and effectiveness usually requires that different inclining-block rate structures be developed for different customer classes.

- *Increased billing frequency.* Moving from quarterly to bimonthly or monthly billing, or from bimonthly to monthly billing, provides more immediate feedback to water users on their levels of water use. This feedback, combined with the price signals send by metered rates (and inclining-block rates, if in use), often results in customer decisions that conserve water.
- *Summer surcharges.* In a region where peak summer use is driving water supply concerns, summer surcharges to encourage more efficient irrigation technologies, water-wise landscapes and other ways to beat the peak are a tool that should be seriously considered.
- *Advanced pricing methods.* Advanced pricing methods generally allocate costs by customer class and/or type of water use. Advanced pricing might consider seasonal variations or other methods for pricing indoor and outdoor usage based on differing contributions to system peaks. The conservation orientation of the rate structure can be enhanced by considering the elasticity factors for different classes of water use. Marginal-cost pricing, which considers the value of water relative to the cost of the next increment of supply, can be considered as well. Planners also can consider special ratemaking provisions such as cost-recovery or lost-revenue mechanisms. Potential revenue instability can be addressed with additional rate structure modifications such as revenue-adjustment mechanisms.

Regulations/Ordinances

Legal requirements and policy guidelines are a useful implementation tool. Sometimes they are the best way of assuring certain important technologies or behaviors are implemented. Requirements and guidelines can be enacted in municipal and county ordinances, and in local and county plans and design review overlays. Regulatory tools include but are not limited to the list below.

Many water utilities, including those managing privately owned systems, lack authority to implement regulations or ordinances. Utilities that have such authority must exercise it carefully. In general, regulations should be justified by the system's circumstances and should not unduly compromise the customer's rights or quality of service. Entities may need to consult with their legal advisors regarding some of the regulations and ordinances discussed below.

- *Water waste ordinances.* Local governments could enact and enforce prohibitions against street flooding from irrigation systems, single pass cooling systems in new buildings, non-recirculating systems in all new conveyer car wash and commercial laundry systems, non-recycling decorative water fountains and other unnecessary water uses and wastes.
- *Turf restrictions.* Municipalities and private developers can cap amounts of turf on private parcels through ordinances and covenants that limit the percentage of a lot that can be covered in grass, or other parameters addressing amounts of turf. It may also be possible to require certain types of grasses that require less water than others.
- *Landscape design standards.* Another type of regulation is to impose standards on new developments with regard to landscaping, drainage, and irrigation design and layout.
- *Soil preparation standards.* One useful landscape standard is to require that poor soils be appropriately amended, or supplemented with additional topsoil, to increase their water-holding capacity. This allows for less frequent, more efficient irrigation schedules.
- *Irrigation equipment standards.* This is another area of potential regulatory interest. Some irrigation equipment and systems are more efficient than others.
- *Standards for water-using fixtures and appliances*. Water providers can adopt standards for new construction or retrofits that are higher than the federal efficiency standards.
- *Time of sale upgrades*. Typically water providers or local governments cannot require established homeowners to replace inefficient fixtures and appliances with more efficient models. However, it is sometimes possible to require replacements at the time a house is sold.
- *Submetering requirements.* Requiring developers of multi-family housing to install meters at each housing unit produces water savings by providing residents with financial feedback on how much water they use as an individual or family.
- *Large users policy.* Some communities—Albuquerque, New Mexico, for instance—have required CII customers using water over a certain threshold volume to develop and implement a conservation plan for their facilities and landscapes.
- *Transferable savings programs.* Transferable savings programs require developers to supply water for each new unit by retrofitting existing homes or businesses in

the community. They have been used by communities as a way to prevent or lift building moratoriums resulting from water supply shortfalls, and could be used in non-crisis situations as well.

- *Water shortage ordinances.* While not quite the same type of implementation technique as the others mentioned here, because the hope is to never invoke the ordinance, it is important that all communities have in place plans for times of water shortfalls, so citizens will know what to expect—what actions will be encouraged, required or prohibited. Examples of water-supply emergencies regulations include restrictions on nonessential uses, such as lawn watering, car washing, filling swimming pools, washing sidewalks, and irrigating golf courses; bans or restrictions on once-through cooling; bans on non-recirculating car washes, laundries, and decorative fountains; and bans on certain other types of water use or practices.

Incentives

Water utilities can provide end-users with financial incentives for adoption of water conservation measures.

- *Rebates for fixtures, appliances and other technologies.* Rebates are popular with customers, and are especially appropriate for more expensive items such as toilets and efficient clothes washers. Clothes washer rebates are a favorite new conservation program across the country. Specific irrigation equipment, such as drip systems, soil moisture monitors and certain controller devices may also be appropriate for rebates.
- *Fixture giveaways*. Free distribution, by a variety of means, is especially appropriate for water-efficient technologies that can be purchased in bulk at low cost; for example, beyond-standard showerheads and faucet heads, and fingertip control faucet heads. Free retrofit kits may also include leak detection tablets and replacement flapper valves. Retrofit kits may be made available free at one or more central locations. Also, water providers can actively distribute retrofit kits directly or through community organizations. Retrofit kits also can be distributed in conjunction with audit programs.
- *Price reductions*. Utilities can arrange for home centers and other suppliers to provide fixtures and/or appliances at a reduced price.
- *Turf reduction incentives.* Sometimes called "cash for grass," this type of tool essentially rebates to end-users some of the costs of converting portions of their landscape from turf to lower water-use plants or other ground cover.

- *Incentive-based hookup fees.* Reductions in hookup fees could be put in place for new development that beats current plumbing codes and/or includes particular measures such as xeriscape, state-of-the art irrigation systems, dual plumbing, etc.
- *Targeted programs.* Utilities can design incentive programs that are targeted to particular customer classes (residential, commercial, industrial, public buildings, and so on), and to indoor and outdoor uses. A program to retrofit low-income housing units may conserve considerable water in older residential housing units with inefficient plumbing fixtures. Targeted programs also can be designed in cooperation with community organizations. An active, targeted incentive program might also be part of a water-use audit program.
- *Performance contracting with water users.* Performance contracts are initiated by a utility offering to pay customers (usually CII customers) for provable savings. A utility can offer to pay for any savings up to a pre-determined cost per unit (typically less than or equal to its marginal cost for the next feasible supply project), or it can open the offer to competitive bidding, notifying customers it will accept the least-costly proposals up to some maximum amount. The offer also has a service value to the utility in countering any concerns (usually unwarranted) that rate increases will "drive away" CII customers. (Rate increases would be an independent action by the utility; they are not required for performance contracting.)
- *Performance contracting by water users.* In a slightly different approach—this is not a direct financial incentive from the water utility itself—utilities can educate large water users about the “shared savings” approach and help put parties together. This type of performance contracting is an agreement between a water user and a company that finances retrofitting of a user’s fixtures, equipment, etc. This company is paid back a portion of the water, sewer, energy and other costs savings that the water user experiences.

Education/Information Dissemination

Education and information dissemination are discussed last because while they are often the first conservation activities communities undertake, they are too often the only ones. Few communities in Colorado are in a position to consider education and information dissemination alone a sufficient water conservation program.

Educational measures can enhance the effectiveness of other conservation measures. For example, it is widely believed that information plays a role in how water consumers respond to changes in price. More generally, customers that are informed and involved are more likely to support the water system's conservation planning goals.

For those communities without educational programming, beginning this activity is an important step. For those communities now doing good education work, there is always more to be done—new conservation measures and practices to be promoted and taught, and new, more effective ways of reaching people.

- *Understandable water bill.* Customers should be able to read and understand their water bills. An understandable water bill should clearly identify volume of usage, rates and charges, and other relevant information.
- *Informative water bill.* An informative water bill goes beyond the basic information used to calculate the bill based on usage and rates. Comparisons to previous bills and tips on water conservation can help consumers make informed choices about water use.
- *Information available.* Water utilities should be prepared to provide information pamphlets to customers on request. Public information and education are important components of every water conservation plan. Consumers are often willing to participate in sound water management practices if provided with accurate information. Furthermore, providing information and educating the public may be the key to getting public support for a utility's water conservation efforts. An information and education program should explain to water users all of the costs involved in supplying drinking water and demonstrate how water conservation practices will provide water users with long term savings.
- *Water bill inserts.* Utilities can include inserts in their customers' water bills that provide information on water use and costs. Inserts also can be used to disseminate tips for home water conservation.
- *School program.* Utilities can provide information on water conservation and encourage the use of water conservation practices through a variety of school programs. Contacts through schools can help socialize young people about the value of water and about conservation techniques, as well as help utilities communicate with parents.
- *Public education program.* Utilities can use a variety of methods to disseminate information and educate the public on water conservation. Outreach methods include speakers' bureaus, operating booths at public events, printed and video materials, and coordination with civic organizations.

- *Workshops.* Utilities can hold workshops for industries that might be able to contribute to water conservation efforts. These might include, for example, workshops for plumbers, plumbing fixture suppliers, builders, or landscape and irrigation service providers.
- *Advisory committee.* A water conservation advisory committee can involve the public in the conservation process. Potential committee members include elected officials, local business people, interested citizens, agency representatives, and representatives of concerned local groups. The committee can provide feedback to the utility concerning its conservation plan and develop new material and ideas about public information and support for conservation in the community. Of course, to be meaningful, the utility must be receptive to ideas offered by the committee.
- *Promotion of new technologies.* Utilities also can get involved with promoting new technologies by manufacturers and distributors of fixtures and appliances. Demonstrations and pilot programs, and even contests, can be used to introduce and promote new products (such as high-efficiency washing machines).
- *Water-saving demonstrations.* A useful education tool is to develop one or more homes and/or landscapes that implement the full range of the most efficient technologies. Tours familiarize the public with specific technologies and tell the story that water conservation does not have to mean lifestyle restrictions. Collaboration with energy utilities and plumbing, fixture, appliance and irrigation equipment vendors is common in the development of demonstration homes. In lieu of building a dedicated demonstration home, tours of private homes with selected technologies can be arranged.
- *Evapotranspiration-based irrigation scheduling information.* Water utilities or other agencies can calculate ET requirements of representative local landscapes on the basis of typical changes in plant ET requirements from the beginning to the end of the irrigation season, or actual changes based on recent weather. They can then make irrigation scheduling information available via the newspaper, public service announcements, or other approaches.

SUPPLY-SIDE PROGRAMS

Metering

Metering is a very fundamental tool of water system management and conservation. Both the supplier and the customer benefit from metering because of the water use information it provides. Lack of metering undermines loss control, costing and pricing, and other conservation measures.

- *Source-water metering.* Source metering is essential for water accounting purposes.
- *Service-connection metering.* Service-connection metering is needed to inform customers about how much water they are using. Also, suppliers use metering data to more accurately track water usage, which allows the utility to bill customers for their actual usage and to design effective conservation programs.
- *Public-use water metering.* All water provided free of charge for public use should be metered and read at regular intervals. This will allow the utility to more accurately account for water, and to identify sites where water use might be reduces through implementation of various conservation measures.
- *Fixed-interval meter reading.* A program of fixed-interval meter reading is essential to determine the amount of nonrevenue-producing water. Source meters and service connection meters should be read at the same relative time in order to facilitate accurate comparisons and analysis. Readings generally should occur at least monthly or bimonthly. Estimated bills should be kept at a minimum, subject to state and local regulations.
- *Meter accuracy.* Water meters can be damaged and deteriorate with age, thus producing inaccurate readings. Inaccurate readings will give misleading information regarding water usage, make leak detection difficult, and result in lost revenue for the system. All meters, especially older meters, should be tested for accuracy on a regular basis. The utility also should determine that meters are appropriately sized. Meters that are too large for a customer's level of use will tend to under-register water use.
- *Meter testing, calibration, repair, and replacement.* After determining the accuracy of the metering system, the utility should develop a schedule of activities necessary to correct meter deficiencies. Meters should be recalibrated on a regular basis to ensure accurate water accounting and billing.
- *Selective irrigation submetering.* Selective submetering for irrigation water can be used to improve irrigation management, as well as to introduce irrigation pricing.
- *Automated customer leak detection.* Advanced meters and associated devices can detect constant low-level flows that indicate slow leaks and other flow profiles that indicate catastrophic, home-damaging leaks. End-users can then be notified of leaks either directly by the device, or more typically through the local utility or another

provider of this service that maintains notification information for enrolled customers. This is just one example of how information technology will ultimately lead to "smart buildings" that are highly efficient in their use of water, energy and other resources.

Water Accounting and Loss Control

With appropriate metering in place, water providers will benefit from a water accounting system that helps track water throughout the system and identifies areas that may need attention, particularly large volumes of nonaccount water. Nonaccount water includes water that is *metered but not billed*, as well as *all unmetered* water. Unmetered water may be authorized for utility purposes (such as operation and maintenance) and for certain public uses (such as fire hydrant maintenance). Unmetered water also includes unauthorized uses, including losses from accounting errors, malfunctioning distribution system controls, thefts, inaccurate meters, or leaks. Some unauthorized uses may be identifiable. When they are not, these unauthorized uses constitute *unaccounted-for water.* Implementing a system of water accounting is a necessary first step in developing strategies for loss control. Appendix F diagrams a basic water accounting system.

- *Account for water.* All water utilities, even those with smaller systems, should implement a basic system of water accounting. Water accounting provides a basis for a strategy to control losses over time. Water accounting is less accurate and useful when a utility lacks source and connection metering (see metering section above). Although the utility should plan to meter sources, unmetered source water can be estimated by multiplying the pumping rate by the time of operation based on electric meter readings.
- *Analysis of nonaccount water.* Nonaccount water use should be analyzed to identify potential revenue-producing opportunities, as well as recoverable losses and leaks. Some utilities might consider charging for water previously given away for public use or stepping up efforts to reduce illegal connections and other forms of theft.
- *System audit.* An audit of the water production and distribution system can provide information needed to make a more accurate analysis of nonaccount water.
- *Leak identification and repair strategy.* Utilities also should institute a comprehensive leak detection and repair strategy. This strategy may include regular on-site testing using computer-assisted leak detection equipment, a sonic leak-detection survey, or another acceptable method for detecting leaks along

water distribution mains, valves, services, and meters. Divers can be used to inspect and clean storage tank interiors.

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

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