CHAPTER III
WATER CONSERVATION IN OKLAHOMA

Due to an abundance of cheap ground and stream water in Oklahoma, scarcity has only recently been envisioned as a problem, and thus, water conservation has not been emphasized. However, due to environmental and preservation concerns, water resource development has become increasingly difficult, as well as escalating dramatically in costs of planning and construction. Ground water supplies have reached their potential in many areas, and reservoir sites that are engineeringly suitable and politically acceptable have become scarce. Federal laws such as the National Environmental Policy Act (1969), the Water Pollution Control Act (1972), the Safe Drinking Water Act (1974) and the Clean Water Act (1977) have applied additional costs by imposing more stringent quality standards on the state's waters. Furthermore, the proposed national water policy has placed special emphasis on water conservation.

Water conservation is essential to the future well being of all Oklahomans. Although not sufficient in itself, conservation offers, at least in part, one realistic means of alleviating Oklahoma's water supply problems. New water source development and the conservation of existing water must be considered jointly in any plan for supplying the entire state with adequate water.

Recurring drought periods emphasize the need for conservation. Erratic annual and monthly precipitation patterns cause streamflows to cease and storage reservoirs to dry up or become so low that their waters are rendered unsuitable for most purposes. The water levels in shallow aquifers drop, causing water wells to dry up. Conservation enforced during dry periods and the sense of emergency that prevails during droughts are soon forgotten in times of plentiful rainfall. Although water supplies continue to decline, the demand for water continues to escalate.

Shortages of available surface supplies for existing water users, depletion of subsurface reservoirs, obsolete urban systems and the increasing water demands of an expanding population combine to exert mounting pressures on existing water supplies. Water conservation, then, must be practiced regularly and consistently — in times of plenty as well as in times of drought. Since water-saving practices conserve energy, they can also have a significant impact on energy requirements. High water consumption corresponds directly to increased pumpage and high wastewater facility use, which in turn, requires additional energy.

Water conservation most often has been approached in a technical sense, i.e., the implementation of mechanical methods or techniques to reduce water consumption. However, a more comprehensive definition of conservation may be more appropriate, one involving economic and institutional constraints, such as the formation of water management districts, conjunctive use of stream and ground water and water pricing practices. This broader concept should be emphasized in the development of a statewide water conservation strategy.

POTENTIAL WATER CONSERVATION MEASURES

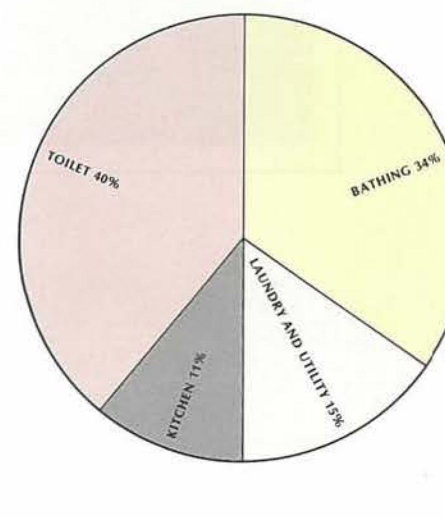
Municipal and Residential Water Conservation

There are many water conservation measures that can save significant amounts of water in the home. The following examples are only a few of many possibilities. An average family of four uses approximately 233 gallons of water each day, with 74 percent of that usage occurring in the bathroom. Toilets use more water than any other fixture in the home, consuming an estimated 40 percent of all water used indoors. By reducing the volume of water needed to flush to 3.5 gallons, as opposed to the five to seven gallons required by toilets of older design, new low-flush toilets effect great water saving. Older toilets using higher volumes can be modified through the installation of certain devices in the tank to reduce the flush volume. A brick in the toilet tank is a reliable means of reducing water volume, however carried to excess, it may deprive sewer lines of sufficient flow to drain properly. More promising is a sinkbob mechanism designed to use half the normal flush volume for removing liquid wastes, and allowing adjustment to full volume for the removal of solid wastes.

Bathing accounts for 34 percent of water consumed in the house with 60 percent of this total used in the shower. Many companies manufacture shower heads or adapters which conserve water by reducing the maximum flow rate or by producing a shower spray with a lower flow of water. Since conventional showers use up to 10 gallons per minute, and showers average five minutes in duration, water use can be reduced up to 70 percent by utilizing a flow control device which reduces the rate of flow to three gallons per minute.

Major water-using appliances in the kitchen are automatic dishwashers and garbage disposals. While older dishwasher models use 13 to 16 gallons for each 60-minute cycle, new water-saving models consume only 7.5 gallons per load. Washing and rinsing dishes by hand under a flowing stream of water is most wasteful, often consuming as much as 25 gallons. Faucet flow controls can

FIGURE 4 TYPICAL WATER CONSUMPTION IN THE HOME
Family of Four
(By Percent)



reduce up to 50 percent the rate at which water flows through the faucet.

Plumbing maintenance is an essential part of water conservation efforts because major losses of water can be traced to a water distribution system or to a consumer's system after the water has passed the home meter. An estimated 10 percent of the treated water in a utility system is wasted through such leakage. Contributing factors include broken water mains and joints, leakage from hydrants, and leakage from water utility storage and in main trunk facilities. A homeowner who wants to determine whether or not leaks are occurring in his home should turn off all water-using devices, then check the meter to insure no flow is registering.

There are other no-cost methods of conservation in the home such as using clothes washing and dishwashing machines only for full loads, taking shorter showers, using less bath water and reducing the use of disposals, among many others.

In urban areas the largest water saving outdoors can be effected by careful lawn watering. Heavier, less frequent watering encourages the development of healthy, deep-rooted grass, while overwatering wastes water and may damage grass and soil. Grass left at a longer length will remain greener and healthier and require less moisture. Water should be applied during the coolest part of the day to minimize evaporation losses.

Sweeping sidewalks and driveways rather than hosing them and washing a car from a pail instead of a hose conserve significant amounts of water. Hose attachments, moisture indicators on sprinklers and time-controlled sprinklers also contribute to outdoor water conservation.

Industrial Conservation

Industries have responded to the increased price of treated water and the huge cost of treatment after it has been used by practicing various conservation methods. Studies have shown that intake water use per unit of production has decreased markedly in the past 20 years, indicating that significant conservation measures are becoming widespread. This trend is expected to increase as technology improves and the cost of treatment continues to escalate.

The greatest use of water by industry is for dissipation of unwanted or excess heat. Water used in this cooling process is consumed through evaporation. One method of reducing consumption is to employ different means of dissipating the heat. Although they are costly, air cooling devices or dry cooling towers are alternatives. Soil warming — circulating heated industrial waters through subsurface pipes — is also a potential technique. Changing the process to reduce waste heat or putting the excess heat to other uses not only conserves water, but conserves energy. The use of sewage effluent offers a most promising means of fulfilling future cooling water requirements.

The vast amounts of water used in some industries can be reduced by substituting or altering procedures, such as those of many vegetable and fruit processors, who have replaced water-intensive peeling processes with dry peeling systems. Many procedures can be altered so that relatively clean water from one process can be reused in a process that does not require fresh water.

Water use can also be reduced by installing water conservation devices for employee sanitation, such as described previously.

Agricultural Conservation

Depletion of ground water sources has become a major concern for farmers in western Oklahoma. Without adequate irrigation water, many could be forced to revert to dryland farming, causing major reductions in crop production, lower on-farm profits, and adverse effects on the economy of the entire state. To alleviate this critical problem, agricultural water conservation should be expeditiously implemented.

Stubble mulch tillage and no-till planting keep plant residues on the soil surface to increase infiltration and reduce evaporation loss. Narrow row spacing and careful selection of the planting dates and growing practices that utilize available rainfall most effectively can also result in significant water conservation. Improved varieties of plants which require less water are also becoming available.

Weed control plays a significant role in water conservation. Water losses by weeds are highest in row crops that have not attained more than 60 percent ground cover. Water is also lost when water-loving plants (phreatophytes) such as salt cedar, cottonwood, willow and mesquite are permitted to grow in open ditches or in poorly drained areas. The consumption by phreatophytes across the state ranges from a fraction of an acre-foot of water to more than seven acre-feet per acre.

Significant water saving and other advantages can be realized by eliminating earthen irrigation ditches, a practice that reduced seepage and evaporation losses, while also reducing labor and system maintenance. Pipelines also require less land area than canals and produce more positive control in water management.

In 1977 there were 208 miles of earthen ditch and 182 miles of concrete-lined ditch in use by Oklahoma irrigators. The majority of ditch conveyance systems are in the W.C. Austin (Lake Altus) Irrigation District in Jackson County, where 1,470 miles of above-ground pipe and 1,388 miles of underground pipeline were in use in 1977.

The use of tailwater recovery systems is an effective means of conserving water. The reuse of irrigation water captured in tailwater pits not only conserves water, but keeps the highly chemically concentrated water from degrading receiving streams. The nutrients in this water can be recycled by pumps on floating platforms to remove and reuse the surplus tailwater flows.

Modification of playa lakes in the Oklahoma Panhandle is another means of conserving water that would otherwise be lost to evaporation. Increasing the depth to surface area ratio reduces surface evaporation losses and makes the playa ideal for storing spring runoff and irrigation tailwaters.

The greatest single on-farm saving can be accomplished by selecting the most suitable irrigation method. Application efficiency depends on the uniform application of the water at a proper rate and at the proper time. Gravity (flood or furrow) irrigation and sprinkler irrigation are the two most common methods of applying water.

In 1978 approximately 430,400 acres, or 48 percent of the total land irrigated in Oklahoma, were irrigated by gravity application methods. Application efficiency for a typical gravity system averages about 50 percent, with a range of 30 to 75 percent efficiency. If water cannot be applied to a uniform depth over the field surface, application efficiency will decrease. High efficiency is difficult to achieve with gravity systems because of variables such as slope, duration of application, stream size and infiltration rate of the soil. Unless the field is almost perfectly level, it is difficult to apply a given depth without waste.

In 1978, 52 percent of the land irrigated in Oklahoma, or 466,300 acres, was irrigated with sprinkler systems. Sprinkler systems are generally more efficient than surface methods, averaging 70 percent, with a range of 55 to 90 percent. Evaporation loss from sprinklers is normally five to 10 percent of the discharge. Wind is a major factor in obtaining high efficiency. Center-pivot sprinkler systems have become popular in the past 10 years because they require little labor.

Water saving results when gravity irrigation is replaced with sprinkler systems, however, the high cost of conversion would need to be carefully evaluated.

A new technology, trickle or drip irrigation, is gaining popularity in many arid areas because it increases efficiency to near 100 percent by applying water to the base or root zone of each plant. The system uses plastic tubes with small outlets near each plant, applying smaller amounts of water and eliminating runoff and evaporation from wet soils. This method was initially used only on high value orchard crops, but its use is being extended to other fruit and vegetable crops. Results of research conducted thus far show irrigation water requirements can be reduced as much as 50 percent without appreciable loss in yield. However, capital cost of application equipment is very high compared to other methods of irrigation.

Regardless of the method, timeliness of water application is a key factor in conserving agricultural water. Allowing the crops to grow under controlled stress during certain growth stages when yield is not affected, and applying water only at critical stages of plant growth is up to 50 percent more efficient than conventional irrigation timing methods. Scientific tools and assistance are now available to give the irrigator precise information on when to irrigate each field.

Wastewater Reuse and Recycling

Wastewater or sewage effluent discharged by municipalities and industries constitutes an appreciable portion of the state's available stream water resources. This effluent must be recognized as a valuable resource that can be reused or recycled to help meet growing water requirements.

Proponents list as pluses for reuse savings in money and energy, particularly in the cost of treating wastewaters to make them acceptable for discharge. However, due to the availability of high quality water, most municipalities thus far have not sought to develop a market for treated wastewater, simply disposing of it as quickly as possible.

The use of municipal and industrial effluents for irrigation is gaining greater acceptance in the state. Their high nutrients, chiefly nitrogen and phosphorus, increase agricultural yields to levels higher than those realized from conventional irrigation and fertilization. Crops considered for such fertilization must be selected by their tolerance to the contaminants, and because the soil tends to retain buildups of certain metals and salts present in the wastewater, specific limits must be established. The buildup of dissolved solids such as sodium chloride or of heavy metals cannot be tolerated by vegetation.

Many crops are presently irrigated with municipal wastewater, however, its use is not recommended for the irrigation of crops intended for human consumption. Such precautions are based on the lack of reliable information on the survival and transmission of pathogenic bacteria and viruses.

The greatest undeveloped potential for reuse is that of municipal effluents by industries. Several public utility companies have built lakes to catch these return flows, and utilize the water successfully in their cooling towers. Cooling lakes can be used for recreation and fish farming, as well as aquaculture, which exhibits promise for growing aquatic species for food supplements.

Use of municipal wastewater for cooling may require additional treatment, especially if it is to be used in recirculation systems, but lower quality water has been used successfully in once-through cooling systems.

Recycling of process waters by Oklahoma industries has been limited because of the availability and abundance of high quality, inexpensive municipal water. Recycling which has been practiced has often been for the purpose of recovering wastewater components such as expensive metals. Increased consideration is being given to the reuse of industrial effluents in anticipation of escalating federal standards which propose zero pollution discharge by 1983.

As the water use increases, so will the volume of wastewater. The scarcity of new water sources, more stringent treatment requirements and increased costs of treatment will greatly influence future water reuse policy and practice.

Conjunctive Use of Stream and Ground Water

In some areas of the state, hydrologic conditions exist which make stream and ground water available for use on a complementary basis. In such areas, communities should be encouraged to employ conjunctive use practices utilizing both sources.

Such conditions are present in eastern Oklahoma, where high recharge levels and abundant rainfall produce large quantities of ground and stream waters. Ground water has not been extensively developed as a primary water source in eastern Oklahoma, and while some commumities and irrigators utilize ground water, it accounts for only a small percentage of the area's total water use. Increased reliance on ground water, particularly during periods of drought, could play a significant role in future water planning.

Conjunctive use of stream and ground water can also be effectively employed in central Oklahoma, where the Garber-Wellington and Vamoosa Formations provide immense yields and stream water is also available, although it is often limited by quality considerations. Several central Oklahoma cities currently practice conjunctive use to maximize water supplies, and such use is expected to expand.

Western Oklahoma has little or no stream water available for appropriation, and the area's reliance on ground water is threatened by depletion. Thus, conjunctive use is generally not realistic in most of the west, however, the practice should be implemented in those few areas where it is appropriate.

Water Management Districts

Although local water management districts have proven highly successful in neighboring states, their worth as an effective water management and conservation tool has not yet been widely recognized in Oklahoma.

Irrigation and water resources associations have long existed in the three Panhandle counties. A countywide district for the conservation and management of Texas County's water resources was created under authority of Oklahoma law, but has not been active due to local problems associated with the assessment and administrative functions of the district. Hopefully, such problems will be resolved, allowing the district to become active and efficient in the management, development, conservation and protection of the area's valuable water resources.

Among the limited number of other irrigation or conservancy districts is the federally sponsored Altus-Lugert Irrigation District in southwestern Oklahoma, which negotiates contracts for water from Altus Lake, a Bureau of Reclamation water development project. An irrigation district exists below Canton Lake in the northwest, although it has been relatively inactive, and new districts are being organized near Waurika Lake in south central Oklahoma and below Fort Cobb Reservoir in the Washita River area of Caddo and Grady Counties. Master conservancy districts exist throughout Oklahoma, and others are being formed.

All of these local, state and federally supported districts present a viable mechanism for the efficient use, development, conservation, protection and management of the state's valuable water resources. Their increased utilization is especially important in areas of insufficient water supplies or those faced with depletion. In those areas faced with shortages, efforts must be made to maximize existing local supplies before importation of water from other areas can be considered as a realistic alternative. Thus, widespread organization of water management districts must be an integral part of any meaningful plan that proposes the development, management and intrastate conveyance of water.

Water Pricing

As with any other commodity, increasing the price is a proven and effective means of reducing water consumption. Pricing techniques to encourage the conservation of water rely primarily on the premise that as the price increases, the quantity purchased decreases. The effect of such a price change on quantity is called demand elasticity.

There is substantial elasticity in the demand for water. The price of water affects the amount consumers will demand; if the price goes up, consumers will use less water. While the response may vary between different classes of consumers, or even between individual consumers within a class, there will be a response from the customer if the price increase, is significant in relation to his income.

The response to price increases will also vary in water use categories; it will be greater in the lawn watering category than the in-house use category. In Oklahoma's water systems, consumer demands exhibit dramatic seasonal variation, with the peak demand occurring in the summer. The cost to the system of expanding to meet the peak demand has far exceeded the price charged for the water. Consumers have made decisions based on the underpriced peak water, and have increased their consumption beyond the point at which the cost and the value of output are in balance. At the same time, off-peak water is relatively inexpensive to provide, but by charging more for it, consumers are discouraged from overusing it. Water conservation can be promoted by a system of marginal cost pricing, with the consumers using to their satisfaction and the suppliers minimizing their costs.

RATE STRUCTURES

There are four basic rate structures commonly used for water pricing, and these, along with their definitions and effects on conservation, are shown in Figure 5 .

Flat rates are generally calculated by dividing total operating and capital costs for a given time

FIGURE 5 RATE STRUCTURES FOR WATER PRICING

TYPE OF RATE STRUCTURE	DEFINITION AND COMMENTS	EFFECT ON WATER CONSERVATION
Flat Rates	A fixed amount is charged per time period, regardless of water services used. Usually found in unmetered areas. The rate is often varied according to the size of delivery line.	NONE
Average Uniform Rates	A constant price per unit of water is charged, regardless of the quantity used.	SLIGHT
Decreasing Block Rates	The price per unit of water decreases as the quantity of use increases. Most commonly used rate structure in Oklahoma.	ADVERSE
Increasing Block Rates	The price per unit of water increases as the quantity of use increases. Rarely used in Oklahoma.	MAJOR

period by the number of customers. This method does not reward the customer who conserves water.

Average or uniform rates, commonly used by many utilities, are determined by dividing the total water produced into the total operating and annual capital costs to supply that quantity. It slightly encourages water conservation by reducing the total bill when less water is used.

Decreasing block rates, based on the premise that it costs less to service large users than small, encourage water use. This is the rate structure most commonly used in Oklahoma. It subsidizes the larger user at the expense of the small user, and is often used to attract industry to an area. The net effect of such a policy is a water use subsidy for large users.

Increasing block rates are the most effective in encouraging water conservation. As larger quantities are used, the consumer has to pay a higher increased amount for the latter portions used. Water departments in Oklahoma interested in conservation should consider the appropriateness of adopting an increasing block rate structure.

PROBLEMS ASSOCIATED WITH WATER CONSERVATION

Although water conservation must play an important role in meeting Oklahoma's future water supply needs, it cannot be considered a panacea. There are potential legal and institutional barriers to implementing conservation measures in areas of water shortage, as well as possible adverse impacts to wildlife habitat.

Water conservation and reuse do not increase the natural water supply of a basin, as do weather modification or water importation. Conservation practices simply permit increased beneficial use of the existing supply.

In western Oklahoma most stream water of good to marginal quality has been appropriated to existing beneficial uses, and the area's ground water supplies are being rapidly depleted. Water conservation will not provide additional water to western Oklahoma farmers, and utilizing the existing supply more efficiently through conservation will only buy time until additional water supply facilities can be planned and constructed.

Conservation can adversely impact both water quantity and quality in downstream receiving streams. All communities and industries in Oklahoma that utilize stream water sources practice a form of indirect reuse, as wastewater from treatment plants mixes with natural flows to be reused downstream. As this water is impounded, evaporated, used and reused, diverted and reintroduced into the streams again and again, chemical constituents such as sulfates, chlorides and nitrates accumulate with each cycle of use. The affect on downstream areas with already marginal quality water will prove extremely detrimental because the chemical constituents that build up with each reuse are those that are so costly to remove by treatment.

The increasing costs of treating sewage effluent to comply with state and federal discharge standards are forcing municipalities and industries to seek more economical means to consumptively use or effectively eliminate their wastewater through use of evaporation ponds and land application for irrigation. Such practices eliminate the wastewater as a source of water for potential downstream consumers. Litigation sponsored by downstream users to preserve the integrity of their supply is possible whenever conservation measures affect existing downstream waters. Although such situations have not yet developed, they can be expected as water supplies become more precious. Based on interpretation of Oklahoma's stream water law, upstream users could possibly be denied the right to totally reuse their effluent, so that downstream users granted prior or vested water rights can be assured of water supplies.

Conservation practices and reuse could also adversely affect the state's ground water supplies. The shallow alluvium deposits along the banks of river channels and creek beds which are naturally recharged by streamflow have been developed extensively for municipal and irrigation uses in some areas of Oklahoma. The potential loss of streamflow from the reuse and total retention of municipal sewage effluents would diminish this recharge, thus drying up the alluvium ground water basins.

Implementation of irrigation conservation methods can exert significant adverse impact on fish and wildlife habitat as well. Waterfowl and other species dependent on wetlands and seeps would be deprived of habitats provided by conveyance losses, tailwaters and operational spills. Similar negative effects could impact on both the variety and quantity of fish and habitat for endangered species along water courses. Removal of weeds and phreatophytes to reduce incidental water losses would discourage nesting waterfowl, small animals, upland game and other animals that depend on them for food and cover.

CONCLUDING NOTE

Many ways to conserve water have been discussed, but incentives must be provided if these measures are to be implemented. Federal, state and local water agencies should encourage water conservation through public education programs and tax incentives to those who develop enduring conservation practices on their land. All state agencies should consider the soil and water conservation needs of their construction projects at the beginning of the planning phase. Conservation in both the public and private sector is vital if the life of existing water supplies is to be prolonged. Such "stretching" of the available water will pay substantial dividends, if only to provide time for new water source development.