Texas Water Resources Institute

May, 1999
Volume 24
No. 3

Managing Water Demands

1998 Water for Texas Conference Emphasizes Education, Pricing, Water Use

In this issue of *Texas Water Resources*, we take a hard look at water demand issues - how to know how much water is being used for agricultural and landscape irrigation as well as household and industrial usage. The other side of demand management is finding measures - pricing strategies, conservation, retrofitting, and others - which can be used to lessen demands. We hope this issue of *Texas Water Resources* provides valuable examples to better manage water resources.

This is the second of three issues of *Texas Water Resources* which addresses new ways of looking at water resources in light of Texas Senate Bill 1 (SB1) - the 1998 omnibus water legislation which overhauled many of the ways in which Texas manages its water resources. The previous issue looked at water supply management, while the next issue will examine drought planning and response.

Much of the information in these three newsletters summarizes presentations given in December 1998 at the 25th Water for Texas Conference in Austin. The theme of that meeting was "Water Planning Strategies for Senate Bill 1." The Conference was sponsored by the Texas Water Resources Institute (TWRI), the Texas Agricultural Extension Service (TAEX), and the Texas Water Conservation Association.

Agricultural Irrigation

Many speakers at the Conference attempted to clarify the muddy issue of agricultural use and to offer some concrete ideas about how irrigation water use and agricultural conservation should be defined.

Guy Fipps of TAEX addressed projections for municipal and agricultural irrigation demands through 2050. He noted that, while agricultural irrigation is expected to drop from current levels of roughly 10.1 million acre-feet (MAF) to 8.1 MAF during that period, municipal irrigation is projected to rise from 3.2 MAF to 4.7 MAF. Much of the

decline in agricultural water use is attributed to anticipated improvements in efficiency, and this is where much of the problem lies. Fipps suggests the public is confused about what constitutes irrigation efficiency. To be truly accurate, Fipps says, one must understand many different but related principles, including application efficiency (measuring losses from the time water leaves a sprinkler head until it infiltrates into the soil), distribution efficiency (how uniformly water is applied over a field), overall efficiency (a combination of distribution and application efficiency), and water use efficiency (how much of the water which is applied is used by the crop). Why is all this so important? Fipps says that the way these terms are interpreted and used is essential to accurately estimate water savings in agricultural irrigation. Although many reports suggest that Low Energy Precision Application (LEPA) irrigation systems are up to 98% efficient, Fipps argues that the actual efficiency of LEPA can range from 30% to 95%, due to how well the systems are designed and whether individual nozzles are adjusted to properly reflect the layout of the field.

If agricultural irrigators were provided accurate, up-to-date, site specific meteorological information, how much water could they save? That's the question tackled by an interdisciplinary team of researchers and extension specialists including Thomas Marek and John Sweeten of the Texas Agricultural Experiment Station (TAES) at Amarillo, Leon New of TAEX in Amarillo, Terry Howell and Don Dusek of the U.S. Department of Agriculture Research Service (USDA/ ARS) in Bushland, and Guy Fipps of TAEX in College Station. At the Conference, Sweeten presented an overview of the development of potential evapotranspiration (PET) networks throughout Texas. Since 1992, TAEX, TAES, and USDA/ ARS have launched efforts to provide hourly and daily data to irrigators about PET, air and soil temperatures, solar radiation, rainfall, growing degree days, wind speed and direction, and water needs for specific crops. Innovative programs have been used to deliver this information to farmers, including faxes, WWW sites, and e-mail. According to Sweeten, agricultural irrigators can save substantial amounts of water when they utilize PET data. Roughly 325 individuals utilized the North Plains PET in 1998 to irrigate 400,000 acres, and use of the PET information resulted in a savings of roughly 62,500 AF. Side benefits of the use of PET include reduced pumping costs and lessened wear and tear on pumps. In the future, this team hopes to work with Jerry Michaels, a TAES entomologist in Amarillo, to use PET data in coordination with integrated pest management programs. Suppliers of electricity and natural gas may use PET data to predict heavy power demands from high irrigation use.

Programs of the Texas Water Development Board (TWDB) which encourage agricultural water conservation were described by Comer Tuck. Tuck emphasized that TWDB provides financial and technical assistance to facilitate irrigation water savings, including public education, direct assistance to farmers, and grants and loans which support conservation activities. TWDB staff regularly participate in local and regional fairs, agricultural shows, and producer meetings, where they distribute literature on efficient water use. Since 1989, TWDB has provided on-field assistance in which Board staff evaluate irrigation systems. Roughly 200 systems are assessed each year in this effort. The grant and loan programs represent a significant financial commitment to foster water conservation. Since 1986, TWDB has provided 165 grants to local water districts totaling

more than $1.1 million. Participating districts report that these grants have resulted in water savings of 10 to 30%. The TWDB loan program provides low interest funds to local water districts which then, in turn, make discounted loans to individual farmers, allowing agricultural producers to purchase and install efficient irrigation systems. Since this program began in 1986, nearly $36 million of loans have been provided, which have been utilized to upgrade roughly 1,000 irrigation systems. Data from TWDB and local water districts suggests that these loans often increase water conservation by as much as 33%.

Despite the emphasis on increasing water conservation in agriculture, there are questions about whether these technologies reduce water use. Byron Neal and Mike Smith of TWDB addressed this touchy issue. Neal presented evidence that, in spite of the introduction of water-saving methods on the Texas High Plains, agricultural water use is increasing. He presented data from TWDB irrigation surveys and examined irrigation trends in 10 regions. Results show that agricultural water use has increased in the Northern High Plains (from roughly 3 MAF in 1985 to nearly 4 MAF in 1996), due to more widespread farming of corn, which is a high water use crop. In the Southern High Plains, water use for agricultural irrigation jumped from less than 1.5 MAF in 1985 to nearly 2.5 MAF in 1996, due to new plantings of irrigated cotton. "Why has agricultural water use not decreased in the High Plains, even though we have introduced many water conserving technologies?" Neal asked. "The answer seems to be that farmers are finding they can grow higher water-using crops, and increase irrigated acreage, because adoption of water-saving technologies creates a 'new' water supply."

Urban Water Conservation

Although agriculture will continue to be Texas' biggest water user, projections suggest that urban water usage will increase most rapidly. It's critical that initiatives be developed which target Texas' urban residents and encourage them to become water efficient.

The "Learning to be WaterWise and Energy Efficient" conservation curriculum and plumbing fixure program was the focus of a presentation by Carole Baker of the Harris-Galveston Coastal Subsidence District. Baker described how this program incorporates hands-on learning in science and technology to encourage behaviors that lead to a lifetime of increased water conservation. The program teaches students, teachers, and families, how to become water wise through an interactive CD-ROM and educational material. It includes kits to introduce learners to plumbing retrofits, rainwater harvesting, and greywater reuse. Initially, students audit their homes for leaks, as well as inefficient plumbing and energy units. After they've installed these devices and changed behaviors, another audit is conducted. This program can involve individual homeowners, water utilities, and commercial businesses. Similar efforts have been utilized in Houston, El Paso, Lubbock, and Corpus Christi. Baker says the program has resulted in the installation of more than 170,000 efficient shower heads and aerators. As a result of WaterWise, water savings of roughly 238 million gallons per month are now being achieved (enough water to fill the Astrodome four and a half times).

The potential for achieving substantial water savings by retrofitting apartment complexes was illustrated in a presentation by Pat Truesdale, the Water Conservation Manager for the City of Houston. In 1996, the City of Houston's Water Conservation Branch and the City Housing Authority conducted a water conservation project at Kennedy Place - a 60 unit, low income, multi-family housing complex built in 1982. Kennedy Place includes 28 buildings and consists of two-, three-, four-, five-, and six-bedroom units. Typically, it houses 264 people and an average of 4.4 persons live in each apartment. Before the program began, average water use at Kennedy Place was 164 gallons per capita per day (gcd). City of Houston personnel replaced many toilets with ultra-low flush (ULF) units using 1.6 gallons per flush, and fixed many leaky faucets by repairing or replacing faulty gaskets. Many low-flow aerators (2.2 gallons per minute) and shower heads were installed and individual meters were read weekly to monitor for leaks. Customer education was provided for Kennedy Place residents. As a result, average water use plummeted to 46 gcd and the average monthly water bill dropped from $32 to $6. Truesdale says the total cost of the project was roughly $22,000 but, because of the water savings, the cost of the hardware will be recouped in less than two months. Because of the success of this program, the Housing Authority is now going forward with plans to implement similar measures at roughly 3,000 units throughout the city.

An ongoing effort to develop a model framework which cities and water utilities can use to create effective landscape ordinances was the emphasis of a presentation given by Marilyn Good of the Texas Nursery and Landscape Association (TNLA). The need for this project emerged because of TWDB rules which mandate that water conservation plans be submitted by entities which seek loans from TWDB. "Addressing peak water use, which usually involves landscape maintenance, is a key component of these plans," Good says. She noted that some of the early water conservation plans which were submitted to comply with SB1 contained provisions which either had the wrong effect or unfairly punished the landscape industry. "In one case, a turfgrass was virtually outlawed, even though it didn't require much supplemental irrigation," she says. "Many of the cities which implemented even-odd day water systems found that this strategy actually increased water use because people would water as much as possible on their day." The project to create a model landscape ordinance framework was a joint venture of TNLA and the Texas WaterWise Council. In this effort, Good and Jan Gerston of TWRI conducted an informal poll of Texas municipal utilities to determine which landscape ordinances they employ, which features of these ordinances are thought to be most or least effective, and what types of assistance they feel may be most useful to them in the future. Ultimately, 141 utilities responded. Results show that 45% of respondents have some type of management ordinances, with most of these (75%) consisting of drought management plans. Residential landscape watering schedules were often incorporated into these rules. Only 45% reported that their ordinances were "fairly effective" or "good" at saving water. "After this process is finished, we hope to have a tool water providers can utilize to reduce peak water use which, at the same time, is fair to all parties involved in landscape water use," she said.

Landscape water use was addressed by Gene Taylor of TAEX. Taylor began by presenting an overview of landscape irrigation in Texas today. Current estimates suggest

that there are now 3.5 million acres of turfgrass spread across Texas, Taylor said. Most of the turf areas consist of single-family home lawns (58%), while only 3% of turfgrass is utilized for golf courses. Roughly 2.6 MAF of irrigation water is applied to residential lawns each year. Taylor suggests that professionals recommend management strategies homeowners can use to increase their landscape water use efficiency, including teaching consumers how to program irrigation controllers, and educating them to realize how much water their turf areas need as well as how much is really being applied. Taylor recommends that installing rain sensors should be encouraged for all automatic irrigation systems, that controllers be utilized which can be programmed for multiple irrigation cycles, and that consumers be reminded to maintain irrigation systems. Taylor encourages water providers to try to develop a mindset in which consumers will regard water conservation as a regular activity - not a last resort when there is a drought or a water supply interruption. "Once homeowners are educated about the actual needs of the turf, the water-holding capacity of soils, and irrigation system management, we will make significant strides towards landscape water conservation," he said.

Conservation Education

A theme that ran throughout the Conference was that water providers and regulators must be able to communicate to the public, inspire them to care, and help them incorporate wise water management decisions into their everyday habits.

"Water Smart," a program to encourage efficient water use, was the topic of a presentation by Linda Fernandez, a media consultant with Fernandez Associates in Austin who was instrumental in developing this campaign for the Texas Natural Resource Conservation Commission (TNRCC), in coordination with TWDB. "Water Smart" is a public education program designed to help urban areas and utilities in efforts to get customers to conserve drinking water. Initially, the "Water Smart" program was targeted to the Lower Rio Grande Valley, but it was expanded to areas which experienced high water demands during the 1998 drought, including the Houston, Tyler, and Dallas-Fort Worth regions. The effort consists of a public information campaign which includes public service announcements, billboards, and print advertising. It also includes education materials for the general public on how a water utility works and how to use water efficiently inside and outside the home. "The ultimate dilemma will be to achieve buy-in from the public, which has not always been privy to the scientific facts, the analytic procedures, the technical evaluations, and perhaps couldn't care less," Fernandez says. "The public needs a greater understanding of the issues but the challenge is to raise the general knowledge of water issues within individual communities." Fernandez suggests that water providers work with and be responsive to local media, foster education in the schools, and put water issues in context so that the public can touch base with the need to conserve.

Programs to educate public school students, as well as adult learners, about the importance of water conservation were the focus of a presentation by Lisa Whittlesey and Doug Welsh of TAEX. Whittlesey described how the Master Gardener and Master Gardener Specialization programs teach participants how to incorporate resource-

efficient practices into gardening efforts including, landscape water management, xeriscaping, and other environmental stewardship practices. Roughly 4,000 individuals now participate in the Master Gardener program in 54 Texas counties. In the MEDIC - "Make Every Drop Count" - program, TAEX teaches people how to conduct residential landscape irrigation audits and develop and implement site-specific irrigation schedules. In 1998, a pilot MEDIC program was begun in Bexar, Nueces, and Aransas counties. To help youth become excited about water conservation, TAEX is now developing the Junior Master Gardener program. The goal is to develop curriculum units and hands-on activities which can be incorporated into grade 3-12 lesson plans. This can be used to teach students about soil and water resources, plant growth and development, and environmental and garden ecology. The "Investigating Water" 4-H curriculum is an effort to teach 4th to 6th graders about water resources issues. This program includes curriculum units which explain the chemical and physical properties of water, the hydrologic cycle, aquifers, watersheds, wetlands, and efficient water use. TAEX also sponsors an educational week-long "State 4-H Water Camp" each summer in Monahans.

Educating professionals who maintain athletic fields about how they can use water most wisely was the focus of a presentation by David Smith of TAEX. Smith described a 1998 pilot study in which he, Guy Fipps and James McAfee of TAEX, and other county extension agents worked with landscape managers at public schools and colleges to audit irrigation systems at 28 football, baseball, and softball fields. These efforts were conducted as part of TAEX's Sports Athletic Field Education (SAFE) program. The goal was to identify sources of inefficiency as well as to measure the actual performance of irrigation systems. Afterwards, custom-designed irrigation schedules were developed for each site, based on historic PET rates, water requirements of turfgrasses, average weather data, and how well watering systems applied and distributed water supplies. What did the SAFE team learn by evaluating irrigation systems? It was obvious that many athletic facilities experienced such hardware problems as misaligned sprinkler heads and broken underground piping. Many of the systems did a "poor" job of distributing water efficiently. The use of pre-set schedules at many sites meant that often too much water was being applied, especially during the spring and fall when rainfall may be abundant. If SAFE practices were applied, Smith suggests that water savings of roughly 60% could be achieved during years with normal rainfall, and up to 24% of current water use could be conserved during dry years. "The real benefit will come through education, when we change long-held, inefficient, habits and help managers make better decisions," Smith says.

Outreaching to industrial, commercial, and institutional (ICI) water users to help them conserve was the emphasis of a presentation by John Sutton of TWDB. Sutton identified types of ICI customers which are present in many cities (public schools and universities, office and commercial buildings, manufacturing plants, hospitals and health care centers, apartment complexes, restaurants and others). When evaluating ICI water use and identifying ways to conserve, Sutton urged participants to consider the wide range of water use. Most of the water use in restaurants may be linked to food service operations. In schools, water use may be more evenly split between sanitary systems, heating and cooling, and landscape irrigation. Sutton highlighted ICI conservation success stories,

including cases in which 35 commercial establishments and more than 100 apartment complexes reduced water use by as much as 40% in Austin, and a garment industry plant in Harlingen which utilizes wastewater reuse and saves up to 2 million gallons per day. He provided examples of the amounts of water which can be saved and the amount of time it may take for ICI investments to pay for themselves. He showed where a hotel could install ULF toilets and faucet aerators, put solenoid valves on ice machines, improve washing machine efficiencies, and modify irrigation practices and save as much as 8 million gallons annually. In this case, the improvements could pay for themselves in roughly 2.5 years.

Conservation Pricing

In many instances, the best and perhaps only way to get people to change their behavior is to hit them where it hurts - in the wallet. One of the few positive consequences of the 1970s oil embargo is that the rise in gas prices eventually got consumers and car makers thinking more about developing and using fuel efficient cars. The same principle may apply in water resources - pricing strategies, it has been argued, may be a good way to encourage efficient water use.

A paper by Anai Padilla and Ed Archuleta of El Paso Water Utilities (EPWU) explained efforts to develop a water conservation pricing strategy. In 1989, the utility began efforts to create a water resources management plan. The goal was to respond to seasonally high peak water demands and to meet growing long-term water needs. The effort to create this new pricing structure was guided by three principles - equity and fairness to all customers, minimizing the impact on customers, and the ease of implementing these policies. Ultimately, the utility chose a seasonal-excess water rate structure which assesses a monthly minimum charge (based on the size of the water meter) and adds a volume charge based on how much water customers use each month above their average winter consumption. For large turf areas, customers were allotted a set amount of water each month, based on evapotranspiration rates and the amount of acreage irrigated. Recently, EPWU implemented a discounted rate for customers who choose to use reclaimed water at a price roughly 33% less than the charge for potable quality water. The program has been a tremendous success. Per capita daily water use dropped to an average of 167 gcd while residential water use has dropped to only 95 gcd. The goal is to decrease average water use to 160 gcd by the year 2000. At the same time, utility rates are some of the lowest in the region. Keys to making this program work include the creation of customized bills (which let consumers see how much water they are now using compared to previous periods), the establishment and use of advisory committees, and strategies to cultivate widespread public support.

What factors need to be considered when utilities develop pricing schemes intended to promote conservation and efficient use? Ronald Griffin of the TAMU Agricultural Economics Department addressed these issues. Griffin noted that pricing remains underutilized as a water management tool in Texas and most of the United States, in part because water is perceived as an "all-important, God-given resource" which all people need to survive. The thought of charging customers for how much water they use is an

aberration to many policy makers. If water prices are going to be changed to encourage conservation, Griffin suggests that water use should be viewed as an "opportunity cost," in which a customer's decision to use water in a certain way ultimately influences the full cost utilities incur to develop, treat, and distribute water. Individual water use choices may also mean that other uses of water may not be easily accommodated. Marginal costs include the marginal value of raw water, not including the supporting infrastructure. The marginal capacity cost reflects the expense of developing additional facilities due to increased demands. Griffin cited examples of the use of pricing to set water rates. Perpetual water rights in the Lower Rio Grande have been estimated to be worth roughly $0.10 per 1,000 gallons and Griffin believes these costs should be incorporated into water rates. Research at TAMU suggests that groundwater in the Bryan-College Station area may be worth roughly $1 per 1,000 gallons, based on marginal costs. Griffin illustrated how the use of a "flat fee," which may raise water bills for individual consumers, could lessen water use and produce net benefits for the utility and its customers. "The strategy is to redesign water rates so they reflect the actual opportunity costs of water use. This will go a long way towards aligning water supply and demand across the State," Griffin says.

Robert Collinge of the Economics Department of the University of Texas-San Antonio spoke about how interruptible and "market clearing" pricing policies can prevent urban water crises. Rather than implement traditional "command and control" strategies (in which a government agency tells utilities what they must do to save water), Collinge favors market clearing strategies. "Market clearing uses the proper price to allocate water efficiently to its highest valued uses," he said. "They reward conservation and penalize waste in the right amount so there are fewer shortages." By themselves, market-clearing prices are not revenue-neutral, meaning that a utility in a water-scarce region could collect revenue in excess of costs. Collinge points out that this source of revenue would be efficient and not taxing upon the poor. However, municipal water utilities are often bound by law or custom to operate in a revenue-neutral manner. Utilities can still capture the advantages of market clearing prices. Market clearing could be incorporated into current utility practices by issuing discount coupons to customers, which they could market to others. Collinge favors the use of feebates, in which fees for excessive water use are combined with rebates for those who conserve. The effect of the fees and rebates would be revenue neutral, but still save water.

Determining if the price people pay for water can be correlated with water use was addressed in a presentation by Tony Gregg of the City of Austin Planning, Environmental, and Conservation Services Division, and John Whitcomb of Stratus Consulting in Boulder, CO. Gregg described efforts to survey 3,000 Texas water users in Austin, Corpus Christi, and San Antonio about subjects pertaining to water use and pricing. Later, that information was fitted to 1990-97 water use data for these cities. Scenarios which were examined included the effect of marginal and average water price, with and without associated wastewater prices. The results, Gregg suggests, are revealing. Most (83%) of those surveyed can readily tell you the price of gasoline while only 24% know the cost of water. Gregg suspects this is due to the fact that gas is sold in easily understood units (gallons) while water is billed in harder to fathom increments

(thousands of gallons per month). Also, gas is paid for at the time of use (when you fill up) while water costs are charged once a month. The study suggests that there are clear regional trends about how price influences water use. Marginal price drives water use in Austin, while wastewater costs strongly influence water consumption in Corpus Christi. An analysis of Austin water prices and uses for 1994-97 suggests that block rates were not effective in significantly reducing consumption. After those prices were adjusted to reflect broader economic trends, the block rates may have actually helped dampen potential water demands and usage.

Summary

In many aspects, water resources agencies in Texas have been increasing efforts to manage water demands. A common thread that runs through many of these programs is education - whether it be teaching schoolchildren about the basics of the hydrologic cycle or working on-site with farmers, landscape managers, and industry professionals. It seems obvious that the most lasting changes in water demands will come about only when we help individuals realize how much water they are using and how to conserve. At the same time, we must introduce a new way of thinking in which people will truly want to become water efficient - not because experts tell them to - but because they will have a desire in their hearts to conserve and preserve this vital resource.