Urban Landscape Guide Manual

Chris Brown
Chris Brown Consulting
San Antonio, Texas

Acknowledgements

The authors would like to thank the following for the contribution of their time and comments in completing this manual: Carole Baker, Carole Davis, Amanda Dewees, Elizabeth Drozda-Freeman, Toni Fox, Tony Gregg, Mary Gugliuza, Karen Guz, Nora Mullarkey, Yolanda Marruffo, Dana Nichols, Sandra Offutt, Anai Padilla, Scheretta Scott, and John Sutton.

Essential to this project were contributors to the Urban Landscape Guide database plant evaluation process facilitated by Drs. Dan Lineberger and Don Wilkerson Texas Cooperative Extension evaluators were:

Paula Craig, Barbara Storz, Landry Lockett, John Cooper, Cynthia McKenney, Tara McKnight, Daphne Richards, John Begnaud, Tom Leroy, George Gonzales, William Johnson, Dotty Woodson, Michael Womack, Steve Chaney, and Michael Arnold.

Particular thanks to Dr. Michael Arnold for the use of his photographs in the plant database.

1.0 Introduction

1.1 Purpose of the Manual

The Urban Landscape Guide Manual is designed to assist municipal water utilities in implementing Best Management Practices (BMP) 2.9 Landscape Irrigation Conservation and Incentives and BMP 2.10 Water Wise Landscape Design and Conversion Programs from the *Water Conservation Best Management Practices Guide 2004*. The *Water Conservation Best Management Practices Guide* is the result of the work of the Texas Water Conservation Implementation Task Force, a volunteer group of Texas citizens with experience in and commitment to using Texas water more efficiently. It details the Best Management Practice, or BMP, that is structured for delivering a specific water conservation measure or series of measures. Each BMP is designed to fit into the water resource conservation and planning process in order to meet future water needs by outlining implementation techniques, efficiency measures, cost effectiveness, and references. While the landscape and the irrigation BMPs are related, the programs are separated here because in most municipal conservation programs, the techniques for water efficiency separate along the lines of focus on landscape plant materials and programs which deal with turfgrass irrigation systems.

This manual contains more detailed information and links to additional resources for those considering implementing either or both BMP 2.9 Landscape Irrigation Conservation and Incentives or 2.10 Water Wise Landscape Design and Conversion Programs. In addition, the information in this manual can assist utilities in implementing BMP 2.2 Water Conservation Pricing, BMP 2.8 Water Survey for Single-Family and Multi-Family Customers, BMP 2.11 Athletic Field Conservation, BMP 2.12 Golf Course Conservation, and BMP 2.20 Park Conservation.

Section 2 of the Manual contains a discussion of the role of soil, plants, and atmosphere in water use – a useful background for developing effective programs. Readers interested in BMP 2.10 Water Wise Landscape Design and Conversion Programs will find information useful for implementation in Section 3, which is organized to follow the Seven Principles of Water Wise Landscape. Section 4 follows the organization of BMP 2.9 Landscape Irrigation Conservation and Incentives. Section 5 includes information to assist utilities in matching program size to available resources. It contains information on suggested staffing and resources needs for various programs. It also contains instructions to assist utilities with cost effectiveness analysis specifically for BMP 2.9 Landscape Irrigation Conservation and Incentives and BMP 2.10 Water Wise Landscape Design and Conversion Programs. The appendices include sample lists of potential measures which can be used for landscape ordinances, and drought ordinances. There are also bibliographical references and resource links.

1.2 Using the Manual with the Website

The Urban Landscape Guide Manual is the part of *The Urban Landscape Guide* Website designed for use by municipal water conservation programs. Focusing only on plant selection or only on irrigation of the landscape has not been as effective as programs which look at all aspects of the landscape affecting water use. This integrated approach can best be accomplished through one main resource that can be used as an

acknowledged general reference tool by everyone involved in water conservation in the landscape. The entire guide, available at http://urbanlandscapeguide.tamu.edu , includes information appropriate for individuals and landscape professionals. The core of the site is a plant selector database [http://floriculture.tamu.edu:7998/urbanlandscapeguide/zipcode.html] described in greater detail in Section 3.3. It is recommended that utilities using this manual to design landscape water conservation programs include links to *The Urban Landscape Guide* Website on their utility Websites and promote the use of the plant selector database as a lay resource for their customers and landscape professionals in their service areas.

2.0 Water in the Soil – Plant – Atmosphere Continuum

In managing water in the landscape, it is useful to keep in mind the ecosphere and the relationship of the environment to water demand. Simple observation of plants in their natural environment will confirm that even in environs with low rainfall rates and no irrigation, some plants will survive and even thrive. This is possible because nutrition and water needs of those plants are supplied by their environment. As people in an urban environment manage their landscape, understanding the relationships among the elements of the soil-plant-atmosphere continuum can help use water more efficiently.

Soils

The soil provides a porous reservoir in which water is stored. Water moves through the soils under the force of gravity and towards evaporative demands such as drier soil and up through the roots of plants. In order for plants to survive and thrive, the soil profile needs to be deep enough to store sufficient water for the plants. Soil structure can help hold water in the root zone or allow it to drain quickly below the root zone. Adding organic materials to soil can help increase its water holding capacity. The majority of roots are in the top 4 inches of soil, but roots from many plants can descend through several feet of soil if it is available. The deeper the soil profile, the more water can be stored. However, in sandy soils, water may percolate below the root zone before it is used by the plants. In rocky soils, including those with caliche, there can be reduction in water holding capacity. The soil chemistry is also important for plant health, as soils with too few nutrients or too many salts can limit the types of plants which thrive. Often, unnecessary watering is applied by customers who see plant stress and assume the plant needs water, when that stress is actually caused by soil chemistry. Understanding soil depth and chemistry is the first step to planning a healthy low water use landscape.

Plants

From the water perspective, plants move water from the soil to the air. The plant benefits from this by also moving nutrients from the roots to the shoots and leaves, and, on a hot summer day, by cooling the leaf surface. A healthy plant needs a soil environment which has sufficient water holding capacity, enough nutrients for plant growth, and a lack of soil pathogens and chemistry which are antagonistic to the plant. A proper balance of nutrients and water is necessary for plant health, each species has different needs for these. Some species need direct sunlight for part or most of the daylight hours to thrive, while others do best in shaded areas. The plants transpire water from the leaf to the

atmosphere through stomata, small openings in the leaves. During times of low water availability, the stomata on many plants partially or completely close, which lowers transpiration rates but increases tissue temperature. Other species-specific responses to water stress or low availability of water can include morphology like leaf thickening, hairs, different colored leaves, nocturnal photosynthesis processes, slowed growth rates, and, in some plants, wilting or leaf rolling.

Looking to the environment in areas nearby but outside the urbanized area can give clues to the native species which grow without soil amendments or irrigation in a region of the state. However, due to the disturbance of soils during construction processes, native species may not thrive in the urban environment. The Urban Landscape Guide database [http://floriculture.tamu.edu:7998/urbanlandscapeguide/zipcode.html] is available to assist customers in making plant choices. Utility personnel are encouraged to find expert horticulturalists in the local nursery, landscaping, and Texas Cooperative Extension that can also help customers make plant choices, and answer questions that they have beyond the information available on this site.

Atmosphere

The driving force behind water use in plants is the conversion of carbon dioxide from the atmosphere, nutrients from the soil, and energy from the sun through photosynthesis. During spring and summer, most plant growth rates increase with increasing sunlight and temperature. Water use by the plants rises as well. In addition to the water used by plants to move nutrients through the plant, as solar radiation heats the plant, many species cool the plant leaf surfaces by increased transpiration of water vapor. For shade-tolerant plants, water use rates are typically lower during the hot summer because less water is used for plant cooling. A landscape plan that takes into account the amount of heat and direct sunlight that plants will be exposed to can maximize water use efficiency by applying different amounts of water to different parts of the landscape.

In planning for a low water use or water efficient landscape, all three of the factors are important and should be taken into account: the soil type and depth; plant types; and the availability or lack of shade.

3.0 Water Wise Landscaping

Water Wise landscaping approaches combine seven principals of good landscape practices to produce water efficient landscapes which are an attractive alternative to the turfgrass lawn which does not always perform well in areas with rocky soil, high summer temperatures, and long periods without rain.[1] By proper planning, design, soil analysis and amendments, appropriate plant selection, efficient irrigation techniques, appropriate use of turf, mulches, and maintenance, a successful, appealing landscape can be developed without increasing peak summertime demands on our stressed water systems. The seven principals of Water Wise landscaping are described below, along with

1 Bormann, H., Balmori, D., and. Geballe, G. T., *Redesigning the American Lawn, A Search for Environmental Harmony*: *Second Edition,* Yale University Press, 2001

summary programmatic and ordinance approaches which can assist utilities engaged in implementing Best Management Practices for water conservation.

3.1 Landscape Planning and Design

Landscape planning and design is essential to water use efficiency and a common practice in new commercial and in some new residential development. Good design principles make use of existing contours, soil properties, and plant materials to reduce the use of supplemental irrigation and to control stormwater runoff. Good landscape design incorporates the use of hardscape (sidewalks, porches, patios, and decorative borders, with the impacts on water use in mind). The proper approach can marry the goals of efficient water use with water quality. Further, the use of rainwater catchment can replace the use of potable water in irrigation. In some cases air conditioning condensate can be included in a site's water budget as on alternative source of water.

Successful landscape water conservation practices in Texas have included programmatic approaches such as educational brochures and workshops, landscape conversion incentive programs, and ordinance approaches including – landscape ordinances requiring submission of a landscape design with specific provisions for trees, irrigation systems, and stormwater interception.

The Texas statewide licensed irrigator requirements assist in the implementation of good irrigation system design. However as of the writing of the 1st edition of the Urban Landscape Guide there is no statewide enforcement and compliance mechanism. Local compliance activities are needed to ensure that licensed irrigators are used in irrigation system design. This can be accomplished through the building permit and inspection process, or during backflow prevention inspections.

Landscape design can take advantage of terrain, soil types, shade and water sources to get the most out of water efficiency.

- Plants with similar water needs should be grouped together.
- Thirsty plants should be placed at the bottom of slopes, in the shade, and moved to alternative sources of water like rainwater systems catchment or graywater systems.
- Use terraces or barriers to minimize runoff.
- Plant ground covers and low water use turfs on slopes.
- Use pervious hardscape or mulch materials to minimize runoff, and ensure that rainfall replenishes the soil water reservoir
- Place the most drought tolerant plants in southern or western facing portions of the landscape which tend to be hottest, and driest.[2]

3.2 Soil Analysis and Improvement

Soil provides water and nutrient reservoir for plants. To grow a successful landscape, it is important to know the original status of the soil – its structure and nutrient content – in order to determine what plants will do well. Soil classification takes into account

[2] *Fundamentals of Xeriscaping and Water-Wise Landscape*, WD-WSEB-26-4 2001, http://www.des.state.nh.us/factsheets/ws/ws-26-4.htm

particle size, from silts and clays with the smallest particles to sands and gravels with the largest particles. The smaller the soil particles, the greater the surface area, and the slower the water moves through the soil. There are also geochemical properties of different soils which can promote the growth of adapted plants. Customers should be encouraged to get their soil tested as a first step in preparing a Water Wise landscape.

Increased soil depth provides a greater space for storing water, and adding organic materials provides the proper environment for healthy roots for many plants (care should be taken to ensure that plants which have evolved in low nutrient soils are not planted where excessive fertility may actually harm the plant). The first step in preparing a water wise landscape is getting soil tested to determine its depth, classification and nutrient levels. With that information, soil amendments can be added to increase soil depth, and add organic material.

Compost is used to supply nutrients to plants and improve the water holding capacity of the soil through the introduction of organic material. Introduction of compost as a top dressing can assist in replacing nutrients in soils which have been depleted. Top dressing has the advantage of not destroying or damaging the roots of existing landscape plants.

Programmatic approaches include education and incentives. Education can be offered in form of brochures, or workshops in conjunction with home and garden shows, or other garden or lawn care related events. Local Cooperative Extension officers may offer these services and may be willing to collaborate with a water conservation program to deliver an educational program involving soil improvement including compost.

Incentive approaches include offering free or discounted compost. Waste water treatment plants produce bio-solids which if properly managed, can be used to produce compost. Some utilities have marketed bio-solids based compost as an additional revenue stream for the utility. Free or discounted samples can be used to both increase water conservation through soil improvement and to promote the utility's compost product. Some caution in using bio-solids is important to ensure that temperatures in the composting operation are high enough to destroy fecal bacteria, and that the waste stream does not include large quantities of heavy metals, pesticides or other toxic chemical effluents. Properly composted materials generate sufficient heat (130 to 170 degrees Fahrenheit) to virtually eliminate human and plant pathogens. For example, the City of Austin produces *Dillo Dirt*^{TM},[3] through mulching of brush and plant material; combining with bio-solids from the water treatment plant(s); active composting for over a month; followed by curing for several months, and screening prior to sale.

Another important aspect of proper soil analysis and improvement is preparation for and increase in the landscape's drought tolerance. Especially important is adequate levels of potassium in the lawn, especially for turfgrass plants. And during times of low water availability, customers should be reminded not to fertilize with high nitrogen fertilizers, as they stimulate leaf growth and water demands for the plants.[4]

---

[3] *Introduction to Dillo Dirt*^{TM}, http://www.ci.austin.tx.us/water/dillo.htm

[4] McAfee, J., Chalmers, D., Havlak, R., County Extension Agent Turf News – Spring 2006, by Department of Soil and Crop Science, Vol. 1, No. 1 April 2006

3.3 Appropriate Plant Selection

Texas biomes vary widely across the state. Rainfall levels, temperature variation, wind and soils all affect the viability of different plant species in the landscape. Attractive landscapes with flowering plants, groundcovers, and trees are possible in all parts of the state. However, if plants which are not well adapted to local conditions are included in a landscape, the amount of extra maintenance including water use, fertilizers and pesticides, and soil conditions will increase dramatically. The Urban Landscape Guide Website database provides information about what plants are most well adapted to each of the bioregions of Texas.

3.3.1 Use Web-Based Database

The Urban Landscape Guide Plant Selector allows the selection of landscape ornamentals with proven environmental tolerance for the conditions prevalent in the different environmental regions of Texas. While it is acknowledged that Texas has literally hundreds of specific ecological niches that affect growth of plants in the landscape setting, the eight regions first proposed by the Texas Nursery and Landscape Association have been adopted here because they represent the consensus observations of the most experienced horticulturists in the state.

The user may select their region by either entering their zip code in the blank provided on the home page of the Plant Selector or by clicking on the appropriate region of the map of the state divided into regions A through H. The page that returns allows the user to enter the characteristics of the type of plant being sought, or if no criteria are selected, to see the entire collection of plants by clicking the "Search by EARTH-KIND™ Index." When the search is performed, the user is presented with a listing of ornamentals that meet the desired criteria on a page (or on pages if more than five plants meet the criteria) that lists the scientific name, common name, EARTH-KIND™ index, and thumbnail image. Clicking on the scientific name or the image thumbnail returns the entire plant information record of the selected plant. From the plant record page, clicking the thumbnail image returns a full screen image of the plant for more careful inspection. Many of the selections present more than one full screen image that are available by clicking the descriptive link below the thumbnail image.

Two features of the Urban Landscape Guide Plant selector distinguish it from all other similar plant information databases available. The most important feature is that the plants have been evaluated in terms of their by EARTH-KIND™ index, a unique number that represents a summation of the plant's ability to withstand heat stress, drought stress and poor soil conditions, to resist common insect and disease pests, and to require little in the way of fertilizer. These EARTH-KIND™ index ratings were assigned by cooperating horticulturists from Texas Cooperative Extension located in the region, individuals with decades of direct experience with landscape plantings in the different regions. Links to detailed explanations of the EARTH-KIND™ index ratings are contained on the plant information record for convenient access.
Another important feature of the by EARTH-KIND™ index approach to plant recommendations is that ALL ornamentals can be considered, not those which fall above a certain threshold of environmental tolerance. The user can view the assets of all

available ornamental species, and make a decision about whether the risks associated with planting ones with a low EARTH-KIND™ index rating are worth the ornamental merit of the plant. Placing plants with a lower EARTH-KIND™ index in the landscape generally mean increased inputs and attention, more water, more fertilizer, potentially spraying to control pests; while planting plants with a high EARTH-KIND™ index rating means having a better environmentally-adapted, more cost effective and potentially water conserving landscape, assuming proper management strategies are carried out by the property owner or manager.

3.3.2 Role of Sun versus Shade in Choices, Water Use

In addition to choosing plants that can tolerate drought conditions and are appropriate to the local soils, another important consideration is tolerance for shade or full sun.

In landscapes where mature trees provide a large shade canopy ,transpiration losses from turf and other plants below the canopy can be reduced. If soil depth is adequate, and root zones are not impinged by sidewalls, buildings, or streets, the trees (species which are well adapted to the bioregion) will need much less frequent watering than turf or small ornamental plants in full sun.

This fact provides water conservation incentives for leaving existing mature or established shade trees in new developments. Planting new trees requires significant irrigation to ensure that the plant overcomes the shock of transplanting and establishes a healthy root system.

Voluntary approaches to encourage developers to leave established trees can include points in a green-building program or structural permit. Ordinance approaches can include requirements to leave trees with larger than a certain amount of girth which are outside the new building's footprint in place – or to replace such trees with a certain number of new trees[5]

Urban landscapes with mature trees provide benefits in cooling of the urban landscape, water conservation, and habitat for birds and other wildlife.

Trees also help prevent runoff by intercepting and slowing rainfall in the leaf and root systems. Many cities seek to reduce non-point source pollution in stormwater runoff and a mature tree canopy can assist in reducing total maximum daily load of contaminants to affected stream segments.

3.4 Practical Turf Areas

In the Water Wise landscape, turf plays a role where active use of the area for recreation is anticipated. Turf provides paths through out the landscape and properly chosen turf species with adequate soil depth can be managed with minimal supplemental irrigation. Turf can also help reduce soil erosion.

Turf areas should be:

Away from curbs or boundaries where waste due to overspray can occur,
Located on level or minimally sloped areas to reduce runoff,

[5] *Guidelines for Developing Tree Ordinances*, International Society for Arborists, http://www.isa-arbor.com/publications/ordinance.aspx

Shaped in patterns which make it easy to design irrigation sprays, patterns, or in shade where irrigation is less necessary
Not located in narrow strips between curbs, sidewalks and drive ways where irrigation systems will overspray onto the hardscape.
Have at least 8 inches of soil to ensure that there is an adequate soil water reservoir.

These objectives can be achieved through programmatic approaches focused on landscape design, or with ordinance approaches focused on width of irrigated turf areas. The ordinance approach typically focuses on turf in median strips, in buffer areas between sidewalks or driveways and the public right of way. Median strips or buffers are often managed by municipal crews or homeowners associations. The areas between the street and a hardscape such as a sidewalk or driveway may also be located on property covered by an easement. Turf areas that are on the interior of a property are not typically managed by ordinance.

3.5 Efficient Irrigation

The plants we like to see in our landscapes grew and reproduced for millennia with precipitation as their only source of water. However, in nature these plants are often found in conditions which cannot be duplicated in the urban landscape without supplemental irrigation. A water-conserving landscape will not only include a selection of plants which demand little or no supplemental irrigation, it will also include irrigation systems which minimize water waste and take advantage of water sources other than treated potable water, like rainwater harvesting, air-conditioning condensate, and graywater.

Efficient irrigation systems for large turf areas are dealt with a section 4.0 of this manual. For smaller turf areas, or mixed landscapes, subsurface, drip and micro irrigation systems can all assist in applying water in the root zone, and reducing water loss due to evaporation. Proper irrigation zoning can help to apply the correct amount of water to different plants with different water needs. Using alternative sources of water, rainwater harvesting, air conditioning condensate, or graywater, can save the energy and chemical costs of treated water.

In designing, installing and maintaining a Water Wise landscape, the use of automatic irrigation systems may occur where the need or preference of the customers is for plant materials which need supplemental irrigation. The use of handheld irrigation is often mandated during drought or water shortage restrictions[6], and should be considered as a recommendation for all Water Wise landscapes. The EPA reports that market studies have shown that, "Residences with automatic timers for irrigation, in-ground sprinklers, and drip irrigation systems use 47 percent, 35 percent, and 16 percent more water than residences without these systems respectively."[7]

Water Wise landscapes, in any case, should always use the most efficient irrigation system possible for the circumstances found. Rain sensors, "smart" water application technology, proper selection of equipment, zoning and use of alternate sources of water

[6] San Antonio City Ordinance Chapter 34-316, as amended, September 14, 2000.
[7] Tanner, S, *Every drop counts,* Irrigation Association Annual Conference, San Antonio, TX, 2006.

are all potential measures for efficient water use in landscape irrigation. In all cases, a rain sensor should be used to prevent the use of irrigation water when Mother Nature is providing for the plants.

Texas state law and regulation already requires that irrigation systems be designed by licensed irrigators.[8] However, without local enforcement, there is no mechanism for ensuring compliance with these regulations. Utilities that are concerned about water use by landscape irrigation must provide for legal mechanisms ensuring that irrigation designs and installations are performed by properly trained personnel. The Irrigation Association has provided both a detailed Best Management Practice[9] and training to irrigation professionals to help ensure that licensed irrigators provide high quality services to their customers, and efficient irrigation systems for the use of Texas' precious water supply. With regard to landscape irrigation, the utility's role is to help develop policies and procedures to support these efforts, and encourage compliance by customers either by incentive or by rule.

3.5.1 Irrigation zoning

Irrigation zones can be designed to increase the uniformity of application. A properly licensed irrigation designer should be used to ensure that zones do not overlap, are based upon the capacity of the anticipated equipment, and take into account the landscape materials to be planted (i.e., do not place overhead sprinklers heads where planned-for trees or shrubs will block their throw). Water conservation programs can help ensure these policies are followed by adopting the rules for irrigation system approvals for new construction, using plumbing inspectors and/or back flow assembly inspectors to ensure that plans were designed by licensed irrigators. Success is dependent upon the utility enforcing these state requirements by fines, or refusing to approve systems until properly designed plans are filed with the plumbing inspector. The cost of such programs can be added as an increment to existing plumbing inspection fees.

Proper choice of irrigation equipment is an essential part of good zoning. Drip and micro irrigation zones should be separated from overhead sprinkler zones, since less water is lost to evaporation. A "smart" water controller can be programmed for different run time for different zones. Minimum standards for irrigation controller features, such as the use of ET, variable run times, choice of different days for irrigation, can all be imposed by ordinance, or can be encouraged through incentives such as rebates.

3.5.2 Subsurface, Drip or Micro–Irrigation

Subsurface, drip or micro-irrigation are all typically found among the recommendations for Water Wise landscapes. The principal advantage of these systems is that water is not lost to evaporation as with overhead irrigation systems. However, a number of concerns should be addressed in proper design and installation of these types of systems. In clay soils, infiltration rates may be too slow for adequate spread of the water, and thus wet spots may develop around the emitter, or irrigation heads, while dry spots develop if spacing is too far apart. Similarly, subsurface irrigation will work if properly spaced for

[8] *Landscape Irrigation Licensing*, TECQ, http://www.tceq.state.tx.us/compliance/compliance_support/licensing/landscape_lic.html

[9] *Turf and Landscape Irrigation Best Management Practices*, Irrigation Association, April 2005

the type of plants and soil, but leave dry spots otherwise. As noted below, if using graywater, local ordinance may require the use of subsurface irrigation systems.[10]

Care should be taken when drip emitters are installed taking into consideration the anticipated growth of landscape plantings, proper filtration to prevent clogging, and regular maintenance to ensure proper operation. Subsurface irrigation requires similar attention to soil type and additional attention to proper depth of the system. Micro irrigation requires pressure reduction valves to operate properly and not damage the irrigation heads. Programmatic materials should point out these considerations when encouraging customers to use drip, micro- or subsurface irrigation.

3.5.3 Alternate Sources

Due to the large percentage of water used by outdoor irrigation, in many systems water conservation is achieved by replacing potable water use with alternate supplies. Commonly-used alternatives include rainwater harvesting, and graywater. In some commercial sites, air conditioning condensate or other on-site water sources such as filtration reject water may be used. Some communities provide treated effluent (reuse water) to large-scale irrigators. The use of reuse water is covered in BMP 2.16 Water Reuse.

For municipal water systems seeking to encourage the use of alternative supplies a number of considerations must be addressed:

Proper plumbing – including complete separation from potable systems or adequate backflow protection.
Health code requirements – for graywater or water which is limited for human contact.
Plant tolerance for higher you had used the term TDS here. My comment was to spell out the reference and then follow by (TDS) since this was first use of the abbreviation found in graywater or filter reject water.
The most important alternate source to irrigation water is rainwater that falls on the landscape itself. Fortunately, rain sensors are available today, which can not only stop irrigation runs while there is active precipitation, but also for several days if the soil has become saturated, when windy conditions would increase water wastes, and due to temperatures below freezing when the plants are dormant. The simplest approach to rain sensors is to require them by ordinance.[11] If a utility does not have ordinance-making powers, incentive programs are also possible, offering a rebate to customers who install rain sensors.[12]

3.6 Mulch

Mulch is a vapor barrier covering soil in landscape beds. It can be made of organic or inorganic materials, and in addition to slowing evaporation it can help suppress weeds, maintain soil temperature levels, and provide a decorative touch to the bed.

In choosing a mulch, the last factor in the paragraph above, aesthetics, is typically the most important concern of a homeowner or landscaper. A successful water conservation

[10] Chapter 12-4 of the 1992 Code of the City of Austin
[11] City of San Antonio Ordinance, Chapter 34, 2005,
[12] City of Dallas, *Water Conservation Five-Year Strategic Plan,* 2005.

program will educate the final user about proper application of mulch and maintenance in order to get the greatest water savings. Water savings are related to depth of mulch, slope of soil, irrigation system, and proper application. Mulch placed too close to trunks of plants can provide a habitat for pathogens (fungus or molds).

Most suppliers recommend from 1 to 3 inches of mulch on a highly sloped landscape. A hard rain will wash such material off the slope. Where slopes occur proper barriers must be installed to hold the mulch, and heavier materials, such as gravels or rocks, are recommended.

Rocks and gravel hold heat more than organic mulches so if they are used, plant selection must be made with heat tolerance in mind. Other inorganic mulch products include recycled rubber products. The principle advantage of inorganic mulches is the fact that organic materials decompose and must be replaced or added to every year.

Organic mulches include shredded bark, leaves, and chipped wood. After rainfall, mulches can compact, and if anaerobic spaces develop, "sour" mulch with ammonia, or other organic gases can develop which can damage or kill the plants.[13] Mulched beds with organic materials need regular turning to prevent such anaerobic processes. Since some types of mulches can hold water, drip or micro irrigation is recommended. Sprinkler irrigation which wets the entire mulched bed should be avoided.

3.7 Maintenance

- One of the advantages of Water Wise landscaping is reduced maintenance compared to the traditional "English" lawn. The reduced time spent in mowing, edging, weeding, and fertilizing was sited by San Antonio Water System customers in 1998 as one of the most attractive reasons to convert their lawns (Brown, 1998). However, even low water use landscapes require some maintenance. Several maintenance steps are recommended for the Water Wise landscape and can be encouraged by the utility through education:
- Pruning of shrubs and trees during winter months to promote blossoms and to remove dead or damaged branches, which could promote disease.
- Removing dead flowers prior to seed pod development which both promotes more flowers and reduces the potential for self-sown seedlings to over-run the landscape.
- Aeration of mulched beds and turf areas to ensure that roots are healthy and that anaerobic areas do not develop in mulched beds.
- Lawn mowing should be done frequently enough to remove less than 1/3 of blade area and at the recommended height for each species. Turf should not be mowed when wet, and should be fertilized based upon species specific recommendations.
- Implement Integrated Pest Management (IPM). IPM involves several steps: Discovering the problem, identifying the cause, monitoring the landscape and

[13] *About Mulch*, www.aboutmulch.com/aboutmulch.asp.

managing the problem, use of pest-resistant plants and organic pesticides, such as orange oil or BT bacteria using chemical pesticides or herbicides only as a last resort. [14]Healthy plants require less water, and homeowners are less likely to perceive incorrectly that their landscape needs more water when using IPM strategies.

3.8 Programmatic Approaches

Programmatic approaches to promote landscape planning and design for water conservation include both educational and incentive programs. Education can take advantage of local resources including, where found, Cooperative Extension offices, local chapters of the American Institute of Architects, local homebuilders associations, local landscape and nursery associations, Master Gardeners, and other and gardening groups. Educational materials can include pamphlets for customers with guidelines on how they can design their own home landscape, booths, and/or workshops at home & garden shows which are held throughout the state.

Following is an example of content of a WaterWise Brochure produced by the Texas Nursery & Landscape Association and the Texas WaterWise Council.

WaterWise Landscaping Principles

1. Planning and Design

Draw a layout of your yard showing existing structures, trees, shrubs, grass, and other plants. Determine your landscape budget, preferred style, function of the area(s), drainage needs, maintenance, and water requirements. Next, sketch your desired landscape plan. Be sure to group plants with like water needs together.

2. Soil Evaluation and Improvement

The very best thing you can do for your plants and be WaterWise is to build deep, high quality soil. A minimum depth of 6 inches of good soil is desirable, but 12-18 inches is preferable. Native and adapted plants do extremely well with native soils, but improved soils benefit most plant species.

Top-dress your turf with shallow layers of quality soil amendments to build a deeper, richer soil profile. This can be done periodically and goes a long way toward improving your turfgrass quality. *(continued)*

Waterwise Landscape Brochure Example (continued)

Composts and landscape soils are available. Incorporating generous amounts into planting beds will reward your landscape with a larger reservoir of moisture-holding matter. Contact the Soil Testing laboratory at 979-845-4816 for soil test information.

[14] Call, C., *What is Xeriscape,* Colorado Water Wise Council, www.xeriscape.org/maintainarticle.html.

3. Practical Turf Areas
Turfgrasses generally require more frequent watering than native or adapted plants, so use grass in functional areas that can be efficiently watered. For example, instead of grass, put ground cover in areas that are narrow, small, sloping, odd-shaped, or close to pavement. Many ground cover plants are more water conserving than turfgrass and require substantially less maintenance.

4. Appropriate Plant Selection
Choose trees, shrubs, and ground covers that are either native or adapted to your climate and soil. Consult with professional horticulturists in your area or Texas Cooperative Extension for plants best suited to your area.

5. Efficient Irrigation
Plants don't waste water, people do. Water early in the day to minimize water loss from evaporation. The sun is less intense and wind is likely to be light or absent.
Water only when plants need it. Too much watering not only wastes water, but also can push nutrients away from the plant roots and leads to more weeding and pruning. Excess water also causes development of shallow root systems and encourages more disease and insect problems. Plants in hot summer months need water only when they show signs of stress in the morning. Plants show stress in the afternoon due to the heat of the day and not necessarily the need for water.

Adjust sprinklers to water vegetation, not pavement, and sidewalks. Adjust automatic sprinklers to run at intervals appropriate for the season. Practice deep, infrequent watering to encourage deep root systems. Use sprinklers that produce large drops of water rather than a fine spray to minimize evaporation. Drip irrigation works well n non-turf areas.

When installing a new irrigation system or upgrading an old system, be sure to engage the services of a licensed irrigation contractor. It's the law. Lists of licensed individuals are available at www.tceq.tx.state.us

6. Use of Mulches
Use mulches wherever possible. Mulches reduce evaporation of water from the soil and limit wee d growth. They also help reduce soil water loss and erosion, help moderate soil temperatures, aid in good root development by adding rich organic matter to the soils (if the mulch is organic), slows or eliminate wee growth that competes for water and nutrias, and add beauty. *(continued)*

At least 3-4 inches of mulch should be maintained at all times around plants and trees. Replenish often since organic matter decomposes over time. Keep mulch from making direct contract with the trunks of trees or woody ornamentals. Extend mulch out to the drip line where possible. *(continued)*

Water Wise Landscaping Principles *(continued)*

7. Appropriate Maintenance

Weed lawn sand gardens as needed. Weeds rob plants of valuable water. Check irrigation systems for leaks. Control insect and disease problems when they arise and feed and fertilize only as needed. Mow grass at proper heights.

Fertilization

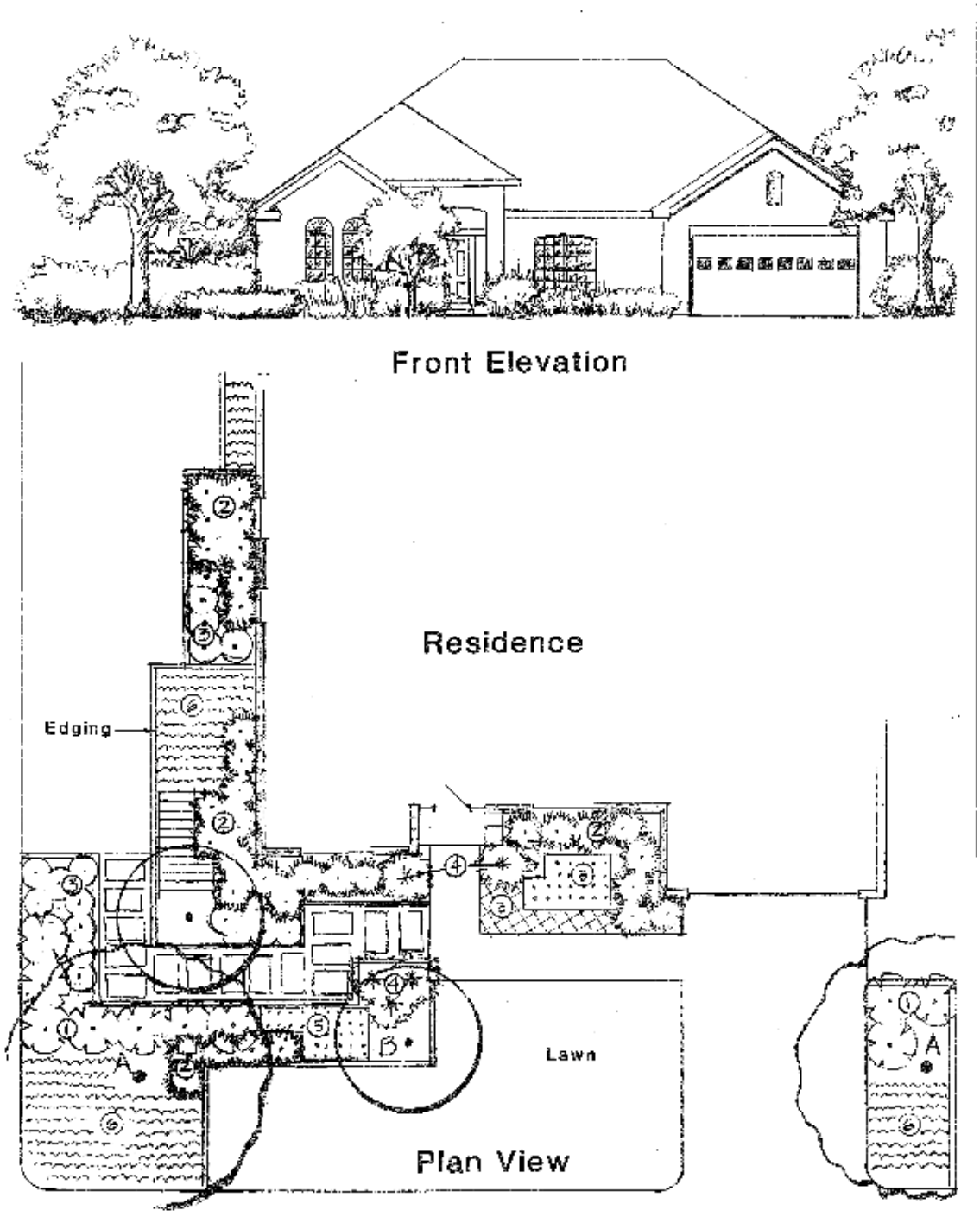
Proper application of nutrients assures healthy plants. Too much fertilizer causes plants to require additional mowing and irrigation. Leave lawn clippings on the lawn, instead of bagging. This enriches the soil and reduces fertilizer needs. Fertilizing once or twice a year is sufficient for most grasses and once a year is sufficient for other plants. Use slow release fertilizer for best results.

Mowing

Mowing height for turfgrass affects watering needs. Less frequent watering is required for plant material mowed at its optimum height. Evaporation from the soil is also reduced with a longer leaf blade. Use sharp blades on mowers and do not remove more than one-third of the leaf blade at each mowing.

This information is provided by the Texas WaterWise Council in cooperation with your Texas certified nursery/landscape professionals.

Sample of a Simple Landscape Design



Incentives to encourage proper planning and design can include awards programs, rebate programs for landscape conversion, and points toward a "green" business or landscape permit approval process. The first of these two awards and rebates are programmatic

approaches, the third, requirements for building permits or plan approvals, requires ordinance or service rules, and will be dealt with in the next section.

Awards programs which recognize good planning and design for low water-use landscapes can be run as part of a broader landscape award program which recognizes Xeriscape or native landscapes. These award programs are often run with local partners including Master Gardeners, Cooperative Extension agents, representatives of the "Green" industry, and landscape architects. Such programs often include signage and recognition in local media for the individual property owner, whether business or residential, a neighborhood association or homeowners association and sometimes include cash awards or free or discounted landscape supplies provided by local contest sponsors. Caution should be taken in designing and implementing an award program to ensure that aesthetic considerations do not outweigh water savings. Comparison of contestants' monthly water use to their neighborhood or citywide average can help show that award winners are conserving water.

Rebate programs which include design components include the San Antonio's Watersaver program which is multi-faceted and requires participants to submit a design as part of the rebate application process for a landscape conversion. Stand-alone rebates for design are unlikely to be found due to the relationship between the final converted landscape and water savings. The conversion is the "proof" of compliance with the design. However, good planning and design are essential to get the most water use efficient landscape.

3.8.1 Programmatic Approach to Landscape Plant Selection

Utilities interested in promoting plants which will demand less water have created programs focused both on education and on incentive(s). The database included on the Urban Landscape Guide website is provided as a tool to assist in educating utility customers and staff about the types of plants which will perform well without the need for excessive watering in all regions of the state. The database also includes information about nutrition needs and pest and disease resistance, attributes which affect water demand and water quality. Several utilities and water districts in Texas have created service area specific guides to assist their customers in plant selection. These can be used as models of how to organize a program while using the statewide database in the U.L.G. Three are listed below:

> **El Paso** offers a list of plants which are well adapted for the desert under the title *Dessert Blooms*; [http://www.epwu.org/conservation/plants.html] a more detailed guide to low water use landscapes in an arid environment is found in their CD-Rom, Desert Blooms which can be ordered from EPWU.[15]
>
> **Lower Colorado River Authority:** Produces the *Hill Country Landscape Options* for use by homeowners, developers and municipalities as a guide

[15] For copies of the CD contact: willie@epwu.org, or El Paso Water Utilities – Conservation Department, P.O. Box 511, El Paso, TX 79961-0001, (915) 594-5508

for low water use landscapes. The [hotlink: http://www.lcra.org/water/hillcountrylandscapes.html] contains plant lists, design and maintenance tips.

San Antonio: Landscape Care Guide includes seasonal guidance on landscape maintenance for low water use or Xeriscape™ landscapes. The attractive guidebook is available for sale, or free for those who attend water conservation workshops – an instructive example of how educational materials can help entice customers to learn more about water conservation. San Antonio has held a Water Saver Landscape competition annually since the early 1990s which is presented as a Case Study on p. 26.

Another educational program of interest is the City of Corpus Christi's ***Purple Water-Wise Plant Labels***. The Program involves cooperation among the City's conservation program, a non-profit, Xeriscape Corpus Christi, commercial nurseries, and Texas Cooperative Extension to bring to public awareness of plants that are proven performers and low water users in the Coastal Bend. Purple labels are affixed to Water Wise and drought-tolerant plants offered at retail nurseries. Utility customers and nurseries have expressed appreciation for the program, and sales figures indicate it has been successful at encouraging purchase of the labeled plant. Advertising includes 30 second PSAs on radio and TV, utility printed banners and handouts which are displayed at the nurseries.

3.8.2 Incentive Approach

Financial incentives for plant selection typically focus on turf replacement. Such programs can include rebates for replacement of existing turf, and care calculated on a basis of square footage of turf replaced. Fee rebates can be offered to homeowners in new developments who select a Water Wise landscape. By calculating the ET for the utility service area, the conservation staff can determine the potential water savings, and thus the cost of water saved.

Developing an Awards Program for Xeriscapes:
The San Antonio Water Saver Landscape Awards

Awards programs allow the utility to use a limited amount of financial resources to draw attention to the types of landscape practices that are desired in the community. The Water Saver Landscape Awards Program in San Antonio has been run for more than a decade with cooperation between the Edwards Aquifer Authority, San Antonio River Authority, San Antonio Parks and Recreation, San Antonio Botanical Garden, the San Antonio Water System, and the Garden Volunteers of South Texas. Each year, a committee is formed with representatives of these organizations. The criteria for determining award winners have been developed and adjusted over the years since the program started.

In the early years of the contest, both neighborhood associations and individuals could win a prize. Neighborhood associations were encouraged to enter if they had five or more qualifying yards within their neighborhood. Each yard had to be at least 50% Xeriscape. Prizes in the early version of the program were $500 for the neighborhood association and $100 each for each of the winning yards. In recent years, as neighborhood associations who were willing to participate and had potential to win have won the prize, ~~and so~~ that prize was dropped from the contest. Currently the awards have gone to individual homeowners and the prizes have been adjusted to reward 1st, 2nd, and 3rd prize winners.

Another important aspect of the program that was introduced in the late 1990's was that the water use patterns of the homeowner were included in the criteria for awarding the prize. This addressed a concern which arose because as a number of studies have found, some people convert to Xeriscape plants and continue to over over-water their landscapes.

The prizes are not cash, but gift certificates to local nurseries for the purchase of Xeriscape plants. The winners are determined based upon a score sheet which assigns values to each of the seven Water Wise principles. The water agencies which sponsor the contest send their representatives out for a full day in a van together to tour the yards of the contestants and score each yard. The Program is promoted by all the agencies with brochures, an application form, and announcements in local media outlets.

On Mother's Day each year, the award winners are expected to hold an open house event where they make their yards available to the public to see what they have done with their award-winning landscapes. The homeowner does not need to be present and may allow the back yard to viewed, but is only required to allow people to view the front yard as part of the contest.

The winning homes are staffed by Master Gardener volunteers during the open house, and the list of winners is publicized in the local paper. Local residents who are interested in viewing the yards then can tour around and talk with both the homeowner and/or the *Master Gardener* volunteer about what went in to producing the water-saving landscape.

Over the years of the contest, a change has happened in the nature of San Antonio landscapes. In the late 90s, if one drove through a San Antonio neighborhood which was part of the contest, one would see the yards of the contestants with Xeriscapes and few other yards within a neighborhood had Xeriscape landscapes. Now, it is not uncommon in San Antonio to see elements of Water Wise landscaping in many yards, small bedded plots along the curb or the sidewalks featuring attractive, flowering, low water use plants and the use of buffalograss, zoysiagrass, or other low water demanding turf. Thus, the Watersaver Award Program has not only helped, educate those who are already interested, but also rewarded those who have taken the steps to change their landscape, but also and helped the public in general to choose attractive, water saving plants for their yards.

An important caution for programs which choose to reward their customers financially for replacing turf is that the plants do not control watering schedules and thus there is no guarantee that water savings will be achieved. To ensure that water savings goals are met it is recommended the utility include provisions specific to water consumption. For example, if a customer's water use increases in the year after installation of the new landscape (compared month to month), the utility could require all or part of the financial incentive to be refunded. One potential difficulty of this approach is that all plants require

additional water during establishment to assist in root growth and the plant's stress reaction to transplanting. Transplanted trees may require additional water for as much as two years in order to develop a healthy root system and become well established.

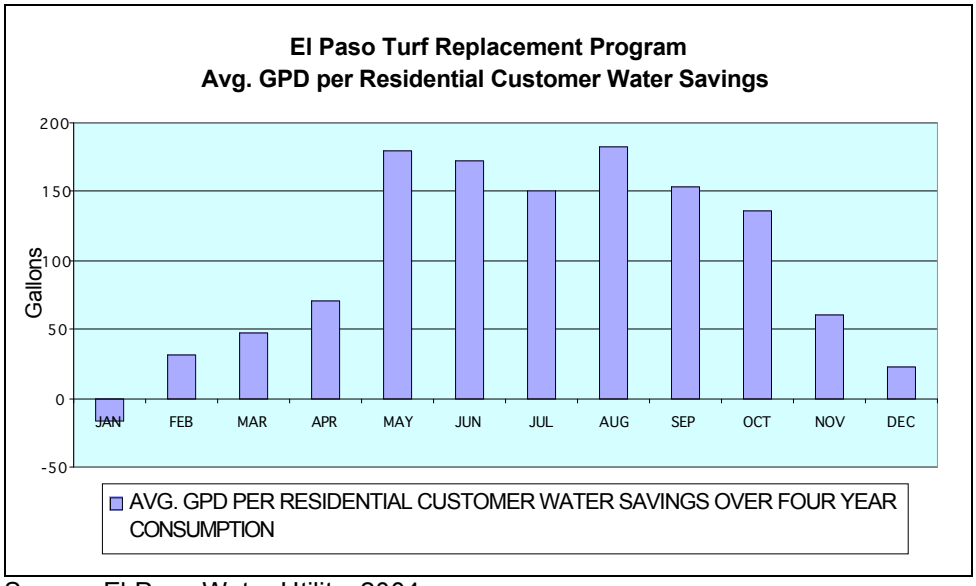
Water Wise Landscape incentives can be based upon square footage of landscape installed with low water use features (plants and permeable non-plant material) or by the size and type of plants installed [http://www.ci.austin.tx.us/watercon/landscape.htm]. The city of Austin also provides additional incentives for soil amendments [http://www.ci.austin.tx.us/watercon/soilrebate.htm]. The city of El Paso's program is designed to replace turfgrass, and like the Austin program, specifies the types and sizes of species to be planted. Builders of developments and commercial properties can also receive incentives [http://www.ci.austin.tx.us/watercon/soilbuilders.htm], including lowered impact fees, or points toward a required landscape elements for installation of Water Wise landscapes or improved soil amendment.

Rebate amounts in Texas range from $0.025 per square foot to $1 per square foot of turfgrass landscape replaced. Austin's landscape rebate is tied to the specific plants used in the WaterWise landscape. Pre-approval steps for landscape rebates include an application form; a landscape plan including the size of the yard to be converted; and a pre-installation inspection to ensure that information in the application is accurate. Specific measures of the programs often differ in details and can be examined on their websites. Most have a maximum allowable turf limit (usually 50%); San Antonio and Austin cap their rebate at $500 per customer, and Austin has a requirement that customers maintain water savings while San Antonio [http://www.saws.org/conservation/h2ome/landscape/] offers additional funds to those who meet water saving goals, or who use native plants or no irrigation system. El Paso's program [http://www.epwu.org/conservation/turf_rebate.html] offers the highest rebate amount in Texas and is examined in a Case Study on page 27. Landscape rebate programs also require post-inspections to determine that the plan has been followed.

El Paso's Turf Replacement Program

El Paso's turf replacement program is designed to remove turf from the desert environment and replace it with plant materials and landscaping that are more appropriate to the local climate. El Paso receives on average approximately 8 inches of water each year. The program is targeted both to residential and commercial customers. The minimum amount of turf that must be removed to qualify for a rebate is 100 square feet. The rebate amount is $1.00 per square foot of turfgrass removed. Program qualification requires landscape plans and an approved application prior to replacing the turf. The funds are limited by program budget, so it is run on a first come, first served basis. Funds are not limited for an individual landscape, so it is possible for very large landscapes to eat up a large amount of the program budget in any particular month or year.

Research indicates the program has been successful in reducing water use by El Paso customers. A 2004 study indicated that the average savings were 36,000 gallons per year per participating household, with the bulk of those savings achieved between May and October. The chart below shows the average gallons per day of residential customer water savings over 4-year program delivery.



Source: El Paso Water Utility, 2004

3.8.3 Water Smart Homes, Green Building, LEED ratings

Several incentive programs for builders and architects have been developed to address energy efficiency. Over the past several years similar efforts have been started to encourage water efficiency in new construction. LEED (Leadership in Energy Efficiency Design) and local Green Building initiatives have a few existing water efficiency elements, and their leaders have been examining ways of increasing their incentives for water efficiency. Water Smart Homes [http://www.snwa.com/html/cons_wshome.html], a

program based in Las Vegas, Nevada, gives builders specific requirements for water efficiency for either individual homes, or a Water Smart Neighborhood designation.

Florida Water Star[SM] [http://www.floridawaterstar.com/] and the EPA's new Water Sense [www.epa.gov/**watersense**/] labeling program[16] are water-specific initiatives to encourage water efficiency. In today's real estate market, the "Green" label can assist builders in selling designs which deliver savings in utility bills, recognition in the community and the satisfaction of developing and using a building with reduced impacts on the environment.

Utility water conservation programs can work directly with existing recognition/certification programs or consider starting a program specific to their community. Some of the utility specific incentives could include:

- lower impact fees for meter hookup
- publicity for the builder and/or developer paid for by the utility
- education of consumers about the benefits of lower water bills, maintenance time, and increased future value of energy and water efficient homes
- rebates and other financial incentives from energy and water utilities for installing efficient appliances, using efficient construction methods and materials, and reduced use of water wasting outdoor practices.

The list below gives a series of contacts for conservation programs which are interested in pursuing certification incentives:

- LEED [http://www.usgbc.org/] – Includes points for rainwater harvesting systems: This program is coordinated by the U.S. Green Building Council. At the time of publication of this Manual, guidelines and points for water efficiency measures are being upgraded. The Council's website should be consulted for the latest program guidelines.
- Green Building programs like those in San Antonio [http://www.buildsagreen.org/] and Austin [http://www.austinenergy.com/Energy%20Efficiency/Programs/Green%20Building/index.htm] include use of plant lists, Water Wise landscape principles, rainwater harvesting, landscape guidelines limiting turf to no more than 50% of the landscape, and minimum soil depth, are typically coordinated between city and local homebuilders associations.
- Water Smart Homes [http://www.snwa.com/html/cons_wshome.html] an initiative of the Southern Nevada Water Authority (SNWA) provides incentives for new home builders to limit turf, reduce overall outdoor water use, limit the size of pools, and install efficient irrigation systems. The detailed rules are included in appendix. ????
- Water Star Florida [http://www.floridawaterstar.com/] is an effort similar to SNWA's Water Smart Homes. One of the technologies they promote is soil

[16] A decision-making process for the items to include in a Water Sense labeled home began in 2006, and the final criteria should be decided in the 2007/2008 timeframe. Water Sense labeling for irrigator certification is already available, see chapter 4 for more information on this program. Utilities with interest can look for opportunities to participate in public input on the developing program.

moisture sensors. They also provide workshops for homebuyers, homebuilders and independent certifiers as part of their promotional/educational mission.

Each of these incentive programs also has indoor water conservation elements and could provide an opportunity to implement indoor conservation BMPs (BMPs 2.4, 2.5, 2.6) or the Rainwater Harvesting BMP 2.18. For some utilities who have home rule authority or who lack the infrastructure to implement incentive programs, some of the elements of the programs above can be pursued through local ordinance powers.

3.9 Ordinance Approach (Utility Service Rules) [17]

Local ordinances can take numerous forms to assist in improving landscape planning and design for water conservation. Ordinance provisions include local compliance plus enforcement of state requirements for irrigation licenses; tree ordinances; landscape ordinances; stormwater permits and building permits including plat or site plan approvals. Each of these approaches provide unique opportunities to save water by ensuring that new landscape installations are planned and designed with water conservation in mind.

Landscape guidelines in municipal ordinances in Texas are often found in the zoning code. Understanding all of the potential measures which could be passed by ordinance requires a review of zoning codes for numerous types of land uses, and potentially of specially designated zones within a community. To pass the water conserving features of an ordinance, the utility water conservation staff must work with city planners, and be prepared to go to Planning and Zoning Commissions for adoption of proposals prior to presenting to a city council for approval. Each Home Rule City has the potential of approaching this problem uniquely, and the conservation staff should work closely with utility legal staff and city attorney(s) to ensure that ordinance provisions fit with local ordinance structures.

Local ordinances which focus on compliance with state irrigation licenses need to provide a point in the planning process and plan or permit review where the licensed irrigator can submit proof of license and penalty for non-compliance. An advantage of this approach is that the state license procedures and requirements are in existence, and require certain standards of training. The training ensures that irrigators have the knowledge to produce plans with appropriate irrigation uniformity, pressure management, and zoning principle in mind. However, without compliance activities to ensure that plans are followed the water savings are not likely to be realized.

Tree ordinances can assist in limiting the area of existing or native landscape which is disturbed or destroyed, thus reducing the amount of water needed for an entirely new landscape.

3.9.1 Ordinance Elements

Landscape ordinances can be included as elements in a city's zoning ordinance, water conservation code, or as a separate stand alone set of guidelines. This manual will offer

[17] For utilities without ordinance making powers, service rules may be used to require certain landscape practices prior to a customer receiving a meter, or in order for the customer to continue receiving water service, or may be used to fine a customer who does not follow service rules.

an approach to designing a landscape water conserving ordinance, or service rules for those utilities which do not have ordinance-making powers. It is not a comprehensive list of all possible ordinance language – many time cities have distinct ordinance structures or landscape rules related to the history of ordinance passage, and these distinctions will need to be addressed as new and improved ordinances are passed by a city council. Some of the distinctions necessary for utilities which are privately held or otherwise do not have ordinance powers are dealt with at the end of this section. Such utilities may use service rules as a method for addressing required or recommended elements in landscape design and implementation.

There is not one comprehensive model ordinance in Texas, although there are numerous water conservation provisions in various ordinances throughout the state. California has produced a model ordinance [http://www.owue.water.ca.gov/docs/WaterOrdIndex.cfm], and Cities of San Antonio [http://www.saws.org/conservation/ordinance/], El Paso [http://www.epwu.org/conservation/ordinance.html], and Austin all have ordinance provisions impacting water conservation year-round. Many more cities in Texas have year-round or summer restrictions on time of day watering, and water waste. Examining the wide variety of approaches which are possible, ordinances and/or service rules can include provisions which restrict, permit, encourage, or provide incentives for:

- Plant Selection
- Soil depth
- Determination of soil texture, indicating the percentage of organic matter.
- Hydrozone grouping of plants
- Regionally adapted plant lists (use the U.L.G. Database!)
- Preferences for native species
- Landscape design plan specifications
- Requirements for properly prepared landscape plans following landscape design practices recommended by the American Landscape Association for Xeriscape landscapes.
- Grading Design Plans with limits on slopes or requirements for specific groundcovers on slopes.
- Minimum depth of mulch application (2” to 3”) in beds
- Listing of turfgrass approved species
- Excluding species such as invasive plant species, or species not adapted to bioregional climate conditions.
- Water Budget
- Limits on turf/landscaped area

3.9.2 Medians, Buffers, Basins and Entrances

Size of medians is an essential concern when determining whether a landscape can thrive, and whether it can be irrigated efficiently. Plant health is affected by the heat island effect

of small landscape areas surrounded by pavement, as well as the room available for roots to grow. Approaches focused on irrigation system choices are dealt with in Chapter 4. Landscape ordinances can limit the types of plants based upon the size of these small landscaped areas and the specific environmental stresses that plant materials encounter in them.

3.9.3 Ensuring Success

In pursuing landscape ordinances or services rules, it is important that a utility evaluate its ability to ensure or enforce compliance. Compliance activities by a municipal government may require code enforcement personnel such building inspectors, plumbing inspectors or as 3rd party certifiers to certify that an ordinance has been properly followed. Conservation staff should communicate with all personnel involved in compliance and enforcement prior to finalizing ordinances or service rules. Some activities which should be anticipated, depending upon the approach taken include:

- Landscape design approval
- Backflow prevention review and approval
- Meter installation/permit
- Ability to identify recommend plant species, and excluded invasive species
- Measuring soil depth.
- Education about the ULG plant database.

Education

Like the programmatic approaches dealt with in Section 3.8, successful ordinances and rules require education. Without an understanding of the ordinances, local builders, developers, irrigation, and landscape professional and homeowners are unlikely to comply. During the passage of an ordinance, public meetings and hearings can help introduce the concept to the most affected parties. But this will not be sufficient. Some annual reminders of the rules in the form of bill stuffers, Public Service Announcements on radio, TV and in newspaper, and flyers or brochures will all assist the utility in informing the public and explaining its program.

Workshops for landscape professional can also provide an opportunity to inform the professional and development community about the ordinance provisions as well as voluntary or incentive programs the utility may sponsor. The need for continuing education by many of these professional can be met by utility cooperation with certifying agencies, like the TCEQ or the Texas Nursery & Landscape Association. TCEQ list of trainers [http://www.tceq.state.tx.us/compliance/compliance_support/licensing/li_basic_train.html] can be consulted to find a trainer near your utility who may be willing to work with your workshop efforts.

4.0 Landscape Irrigation Conservation and Incentives

A number of different program approaches can help utilities promote and achieve irrigation efficiency, from setting appropriate water budgets for landscapes to surveying irrigation and dedicated meters, to ensuring proper irrigation system design and setting irrigation system standards.

Using the landscape irrigation conservation and incentives the utility provides non-residential and residential customers with one or more of the following:

- Customer support
- Education
- Rebates or recognition, and
- Assistance in improving their landscape water-use efficiency.

Incentives can include rebates for purchase and installation of water-efficient equipment, pricing which discourages water waste outdoors, and recognition for irrigators and customers who implement desired practices. The BMP includes four basic approaches. The following sections provide conservation or utility staff with a more detailed guide to implementing conservation programs focused on reducing the amount of water used in landscape irrigation.

4.1 ETo-Based Water Budgets

Water budget approaches involve assisting customers to use the correct amount of water for the landscape. Landscapes provide aesthetic value to customers, but are often over watered. By determining the actual water needs of the landscape, education, incentive or regulatory approaches can help limit watering to the amount of water that plants can use without waste.

Numerous studies have been done on plant water needs, but not all plants have been studied. The Urban Landscape Guide plant database can assist customers and landscape designers in choosing low water use plants and thus a landscape with a lower water budget. A utility can assist in this process by providing incentives and educational material promoting lower water use landscapes.

Ordinance approaches can provide simpler approaches to the water budget. A model landscape with limited turf and use of some non-irrigated materials including mulches and ornamental features can be used to allocate water use outdoors. This approach can be promoted with education and reinforced with water rates or fees, charging customers higher amounts for water used above the allocation,[18] or an excess use fee can be charged to those who consistently exceed their allocation. BMP 2.2 Water Conservation Pricing can be met by implementing a water budget rate structure.

[18] The Geographic regions of Los Angeles are grouped by zip codes, with different budgets for each grouping, the link for the charts showing regional water budgets can be found at http://www.ladwp.com/ladwp/cms/ladwp001068.jsp. Irvine Ranch Water District uses a water budget tailored to each customer [http://www.irwd.com/AboutIRWD/rates_residential.php].

As BMP 2.9 indicates, evapotranspiration is the combined amount of the water transpired by plants and the water evaporated from the soil. ETo is defined as the estimate of evapotranspiration that occurs from a standardized reference crop such as clipped grass. The amount of supplemental irrigation water needed is the shortfall between plant water need (which is a fraction of ETo) and natural precipitation.

If the utility chooses the water budget approach, the utility also develops reference evapotranspiration ("ETo")-based water-use budgets equal to no more than 80% of ETo per square foot of irrigated landscape area for customers participating in its Landscape Irrigation Conservation Program. More aggressive landscape conservation programs can utilize stress coefficients lower than 80%. See Text box for more detailed discussion.

Educational approaches to water budgets include providing an ETo-based budget to a customer for their landscape with proposed water use by month. This can be compared to the customer's historical use to show them the financial savings in using the budget. (See Austin Case Study). Customers with designated irrigation meters will find it easier to follow a water budget, but those with meters serving indoor and outdoor use can be evaluated using an estimated assigned value for indoor use. Recommended values are 70 qpcd for residential indoor with a non-conserving home and 50 qpcd for a conserving home[19] a value of 10.5 qpcd can be used for commercial office and retail customers to estimate water use where the number of employees is known and where there is not a lot of foot traffic or water use is not intrinsic to the business. For commercial customers with intrinsic water uses (i.e. restaurants) or large water using equipment (cooling towers), additional information about non-landscape water use will need to be gathered.

Sources for historical ET data include the statewide Texas Evapotranspiration Network (http://texaset.tamu.edu/) and the http://amarillo2.tamu.edu/nppet/whatpet.htm. These Websites also have useful information for calculating watering budgets and schedules.

[19] Residential End Use Study, 1999 data / WCITF Report to Legislature, 2004

Evapotranspiration

Evapotranspiration (ET) is the term used to describe the combined loss of water from plant and soil surfaces through evaporation and transpiration. Transpiration serves two basic functions for plants:

- to help move nutrients from the roots to the leaves of the plant, and
- to help keep the plant cool.

Actual water flux through ET is measured by tracking the change in water balance in soil and plant tissues over time. In practical terms, actual ET (ETa) is measured change in soil water balance after irrigation and precipitation are accounted

$$ETa = I + P - \Delta S - Q - D;$$

where I = irrigation,
P = precipitation,
ΔS = change in soil water,
Q = runoff and
D = drainage.

Since changes in water loss to drainage or runoff and soil water status are difficult to measure a number of simpler relationships have been determined.

The measurements for ETa parameters require a level of equipment and destruction of plant material so as to be impractical in all but research applications. As a result, several decades ago equations were developed to express the relationship between environmental factors, such as temperature, wind, solar radiation, relative humidity, and precipitation to the flux of water through ET. These equations, of which there are several, are collectively referred to as reference or potential ET. A more thorough discussion of the ET equations can be found at [http://www.kimberly.uidaho.edu/water/asceewri/ASCE_Standardized_Ref_ET_Eqn_Phoenix2000.pdf.] This manual introduces enough information to understand the basic limits and attributes of ET so that water conservation personnel can better understand how it can be used in planning for and implementing a water conservation program.

In order to apply reference or potential ET (ETo or PET) to a lawn or specific plants a crop coefficient which has been empirically determined is used. This coefficient is used to ensure that the water replaced by irrigation does not exceed that used by the plant since the last irrigation event. Rainfall occurring between irrigation events scan *can* be used to offset some of the irrigation as long as it is measured. The original research to evaluate these coefficients assured that the soil water reservoir would be refilled to 100% of its capacity at each irrigation event. Subsequent research and simple observation over the years since the original coefficients were developed have determined that landscape plants can survive and even thrive with less than 100% replacement of soil water. This is due to mechanisms in the plant itself which reduce the transpiration rate in response to less water availability in the root zone.

Evapotranspiration Continued…

Deficit Irrigation and Smart Controllers

Researchers who have quantified these reductions in water use refer to these approaches as "deficit irrigation", and calculate the water savings by introducing an additional coefficient into the equation. The resulting equation for calculating irrigation amounts is:

$$I = (Kc * PET * Dc) - R$$

Where I = irrigation amount (in.)
Kc = Crop coefficient
PET = Potential evapotranspiration
Dc = deficit irrigation coefficient
R = rainfall

Multiply I by 0.62 to convert inches and by square feet of irrigated landscape to gallons.

The ET equation above can be used, when irrigated area is known to develop water budgets in terms of volume of water to be applied. Water budges can be used to develop rate structure, which increase dramatically when a customer exceeds the amount of water budgeted for their landscape. Water budgets can also be used to determine a demand forecast based upon service area size, total irrigated landscape area, and a "typical" landscape palette from which an "average" crop coefficient can be estimated.

Due to difference in plant structure, photosynthetic pathways, and responses to water stress, there is no one crop coefficient which can be applied for all plants. Many of the low water use plants found in urban landscapes do not have empirical Kc values determined by study. Their water use rates have been estimated by field observation of horticulturalists around the State. Due to the large amount of anecdotal evidence, such estimates are reasonable, although continued research in plant water use, especially under limited water supply will be helpful to water conservation efforts.

Smart Water Application Technology (S.W.A.T.) has been developing irrigation controllers which can mechanically use ET information to limit the amount of water applied. Irrigation controller technology has been improving over the past several years with controllers using both historical ET and some using satellite feeds of current ET measurements. Not all controllers can be adjusted to meet irrigation schedules or deficit irrigation goals but continued improvement in technology can be anticipated in future years.

In addition to education about watering needs of plants, the water budget is useful when a utility intends to focus on helping customers reduce waste by providing a target water use rate that can be used as a benchmark to compare with the customer's monthly water use patterns. To help a customer increase the efficiency of their irrigation system, water audits (surveys) and dedicated metering are recommended approaches.

4.2 Water-Use Surveys, Metering, and Budgeted Water Use

Irrigation surveys[20] are designed to determine water use rates of irrigation systems and the steps needed to improve irrigation efficiency through ensuring that water is distributed uniformly over each hydrozone. The primary principle in irrigation efficiency is the same level of irrigation volume applied across landscape materials with similar water needs, and limited to the amount that replenishes soil water in the root zone. (If using reclaim water or water with high TDS, an additional volume or "leaching fraction" of water should be applied in order to force salts below the root zone). The Irrigation Association (IA) has detailed BMPs and training for irrigation professionals to perform on irrigation system survey. The Texas A&M University (TAMU) turf program also offers irrigation training.

In addition to education about watering needs of plants, the water budget is useful when a utility intends to focus on helping customers reduce waste by providing a target water use rate that can be used as a benchmark to compare with the customer's monthly water use patterns. To help a customer increase the efficiency of their irrigation system, water audits (surveys) and dedicated metering are recommended approaches.

Irrigation surveys[21] are designed to determine water use rates of irrigation systems and the steps needed to improve irrigation efficiency through ensuring that water is distributed uniformly over each hydrozone. The primary principle in irrigation efficiency is the same level of irrigation volume applied across landscape materials with similar water needs, and limited to the amount that replenishes soil water in the root zone. (If using reclaim water or water with high TDS, an additional volume or "leaching fraction" of water should be applied in order to force salts below the root zone). The Irrigation Association (IA) has detailed BMPs and training for irrigation professionals to perform on irrigation system survey. The Texas A&M University (TAMU) turf program also offers irrigation training.

Utilities should begin by performing irrigation system surveys on municipally-owned and/or other publicly-owned irrigation systems. Customers who could benefit from surveys include golf courses, schools, churches, other commercial facilities with large turf area, and possibly residential customers with large irrigated areas. The water-use surveys, at a minimum, should include:

- Measurement of the landscape area

[20] The use of the terms "irrigation audit" and "irrigation survey" are used interchangeably in this manual. Some Texas cities have found that the word "survey" has a more positive association with their customers than "audit."

[21] The use of the terms "irrigation audit" and "irrigation survey" are used interchangeably in this manual. Some Texas cities have found that the word "survey" has a more positive association with their customers than "audit."

- Measurement of the total irrigable area
- Irrigation system checks for:
    - Leaks
    - Head spacing
    - Pressure
    - Head-to-head coverage
    - Proper design of hydrozones
    - Proper selection of heads per hydrozone
    - Distribution uniformity
- Distribution uniformity analysis
- Review of irrigation schedules or development of schedules as appropriate
- Provision of a customer survey report and information packet
- Development of a volumetric water budget

When cost-effective, the utility should offer the following:

- Landscape water-use analyses and surveys
- Voluntary water-use budgets
- Installation of dedicated landscape meters
- Acceptance of site conservation plans
- Follow up to water-use analyses and surveys

Due to size of staff or budget constraints, some utilities may wish to use an abbreviated form of irrigation survey to gain some savings while not performing all steps of a uniformity analysis. The list above shows a potential program's elements which can be included from a rudimentary program, all the way through a sophisticated full survey program. The City of Austin Case Study shows an approach to targeting high water use customers, educating them, and providing encouragement to implement survey findings and reduce their water use.

Even well-designed irrigation systems require regular maintenance to perform efficiently. To get the best results from irrigation surveys, they should be performed at the beginning of the irrigation season. The utility can include notices in bills to remind customers of seasonal maintenance needs. For accounts with water budgets, the utility should provide notices each billing cycle showing the relationship between budgeted water usage and actual consumption. Websites and software improvements allow utilities to provide month-to-month feedback to customers with water budgets. For larger utilities, additional services can be provided. Simpler comparisons of average water use of all customers or customers in same billing cycle can be used to give a customer a "measuring stick" of their water use. This is useful because many customers do not irrigate or only irrigate at a fraction of ETo and thus the average use is typically lower than ETo for a larger utility. (Smaller utilities serving suburban customers should use this approach with caution, as per capita suburban use is typically higher than urban or rural water usage.) Soil moisture technology can be used when soil conditions allow, and landscape managers are familiar with their use and maintenance to provide a closer estimate of actual evapotranspiration.[3]

Dedicated irrigation meters may be required for all commercial and/or industrial accounts with automatic irrigation systems or for all accounts if the lot is above a minimum size. For municipalities with ordinance-making powers, this can be accomplished by ordinance. Otherwise, dedicated meters may be implemented in utility service rules as a new customer policy. This approach assists customers in evaluating their monthly water use outdoors. It also gives the utility immediate feedback on water use during peak demand periods for outdoor water use and the ability to direct messages regarding the actual amount of water needed to their customers. Cities with dedicated irrigation meters have found that historically, such customers have used peak water at rates higher than ET.[22]

4.3 Irrigation System Design

Two major elements of irrigation system design are readily apparent, and of importance to a utility, the use of hydrozones, and proper spacing of irrigation heads. A third element, pressure regulation, can also result in water waste if the system is not properly designed. Low water use landscape designs, when incorporating irrigation systems, must also make the proper use of hydrozones. Plants with similar water use needs should be on the same zone(s) in order to reduce water use wherever possible. Drip and Micro-irrigation can be used on zones with mulched beds and shrubs as appropriate. The use of non-irrigated zones is also recommended. Proper controllers must be used which can run separate zones for different times per run.

Texas' licensed irrigator requirement provides one way in which a local utility can ensure that only properly trained personnel are involved in irrigation system design. The utility should keep a list of licensed irrigators available for its customers, and work with new residential and commercial developers to ensure that only properly licensed individuals are involved in designing new irrigation systems. This can be accomplished as an educational effort, providing lists to customers, but can also be enforced using an ordinance or services rules by providing fines for those who do not used licensed irrigators to design irrigation systems. The EPA Water Sense program also offers certification for irrigation designers that have been certified by the IA. If the utility chooses the irrigation design approach, the utility should also provide information on climate-appropriate landscape design and efficient irrigation equipment and management for new customers and change-of-service customer accounts (See Section 3 for more detail).

To serve as a model, the utility should install demonstration landscapes, and use climate-appropriate, water-efficient landscaping at water agency facilities. Demonstration sites should be properly signed, and should include Smart Water Application Technology (SWAT) irrigation controllers, rain and/or soil sensors, drip, and micro-irrigation hydrozones to demonstrate efficient irrigation technology. Separate landscape meters on these demonstration landscapes will allow the utility to track water demand, and provide another potential educational tool. Utilities which require landscape irrigation meters can

[22] City of Waco Conservation Plan, 2003; SAWS (ask Dana) Outdoor Conservation (Stage IV)

require copies of properly sealed irrigation system designs as part of the meter application and approval process.

Irrigation system design and maintenance components and landscape design may be systematically upgraded through use of municipal ordinance-making powers or utility service rules. Minimum water efficient design features can be mandated for new construction, while existing systems or landscapes are offered incentives to upgrade. A "standards and upgrades" element of an irrigation system approach can include:

- Rain sensors
- Soil moisture sensors
- Irrigation controllers
- Pipe & meter specifications
- Dedicated irrigation meters
- Hydrozone specifications
  - Similar plant materials
  - Limits on total irrigated area
  - Limits on placement of heads to prevent watering hardscape
- Total turf grass areas
- Buffer zone plant material and irrigation system limits

4.4.1. Irrigation Systems

The Smart Water Application Technology (SWAT) [http://www.irrigation.org/SWAT/Industry/water-purveyors/] initiative is a nationwide effort by the irrigation industry and water utilities to promote improvements in landscape irrigation controllers. Known as Smart Controllers, the current set of controllers is an improvement over previous technology, but still not meeting all of the goals articulated by project participants. The SWAT Committee is working with utility and irrigation professionals to continually improve the specifications, so this initiative can be expected to elicit more improvements in irrigation technology over the next few years. As technology improves controllers can be expected to meet a number of goals:

- Ease of use
- Ability to change crop co-efficients
- Ability to define watering day
- Connections between soil water status and irrigation run times

Use of Geographical Information Systems (GIS) and databases of customer's use has indicated that a significant number of customers use less than ET in irrigation.[23] The same kinds of comparisons have assisted the City of Austin in identifying customers who irrigate in amounts greater than ET (see case study), and delivering water audits and water budgets to identified customers.

[23] SAWS and EPWU representatives, personal communication, 5/31/06

4.4.2. Rain Sensors

A rain sensor captures precipitation and prevents the automatic sprinkler system from operating during the rain. A high quality sensor will retain moisture based upon the quantity of rain, and interrupt sprinkler cycles after rainfall while the sensor is still moist. Sensors should:

- Automatically break the circuit to the sprinkler system when it has rained;
- Break the circuit when 1/4" of rain falls;
- Maintain the circuit break for an extended period of time to account for soil moisture replenished by rain;
- Be mounted in an unobstructed location, protected from splash, and according to the product's specifications.

4.4.3. Soil Moisture Sensors

Soil moisture sensors (SMS) use a variety of technologies to estimate the water content of soil. The most sophisticated and accurate, neutron probes, are not available for use in typical municipal utility situations due to cost and radioactivity concerns. Others include tensiometers, and various electromagnetic sensors. Tensiometers are traditionally considered to be the most accurate of these, but they require constant maintenance. Recent research in Florida [http://irrigation.ifas.ufl.edu/SMS/publications.htm] indicates some easier to use SMS are providing reasonably accurate feedback to irrigation systems. This technology has a great deal of promise in reducing water waste through over irrigation, but needs to be monitored by utilities for continued improvements in reliability.

4.4.4 Pipes and Meters

Pipe and meter specifications can be used to limit the size of irrigation system piping to 5/8" in order to restrict peak flow capacity of the system. Some cities have found that developments where 1" diameter or larger pipe and meters have been used in residential developments result in transient pressure problems as most residential customers tend to irrigate at the same time of day (evening, or early morning and on weekends).[24]

4.4.5 Hydrozones

[http://www.wspinners.com/centex/newsletter/grngrwg/hydrozn.htmlare] are important for plant health as well as water savings. By grouping plants with similar water needs together, the irrigation run times can be adjusted properly, and you will neither overwater nor underwater specific plants, which can lead to health problems.

4.4.6 Turfgrass

Turfgrass area limits are used to decrease the overall water budget of a landscape, and the limit the use of spray irrigation, since turfgrass landscapes do not do well with drip irrigation. An alternative approach to limiting the location and types of irrigation heads, the limit on turfgrass area can sometimes be applied to specific landscape areas such as, industrial, commercial, and institutional landscapes that are not likely to be used for

[24] Rick Garret, Manager City of Waco Water Utility, personal conversation, 2003.

recreation, or such limits may be applied to buffer areas or median strips. Areas which are not typically regulated in this fashion include common areas which could be used for recreation at schools, churches, playgrounds or apartment buildings, and residential back yards.

4.4.7 Buffers, Medians and Entrances

Buffer or median areas represent additional savings when all landscaped areas less than five feet in any dimension are restricted to drip or other surface or subsurface (non-spray) irrigation system or no irrigation system.

4.5 Implementation of Irrigation BMP

The irrigation conservation BMP is applicable for utilities with automated irrigation systems, or who serve customers that use automated irrigation systems. Since not all customers fall into this category, utilities implementing irrigation surveys will need to identify their high water use customers as a first step in determining their target audience. It is worth noting that many customers irrigate some during the summer to keep their landscapes alive, but do not irrigate excessively. Proper identification of high water use customers is essential to developing the most cost-effective program. If choosing to implement this BMP through ordinance, the requirement that all irrigation systems have backflow preventers, which need to be inspected, can be used as a point at which irrigation system design documents and standards can be checked as well.

The various program approaches listed in Sections 4.0 - 4.4 can be implemented as separate programs, or in an integrated fashion. The implementation options discussed herein include education, incentives, and ordinance or rules approach to reducing water waste and promoting water efficiency in landscape irrigation.

4.5.1. Programmatic Approaches

After determining the target audience, a programmatic approach focuses on educating customers. The Green Industry, professional irrigators, irrigation supply stores, nurseries, and home improvement stores can all be recruited as allies in this effort. Cooperative Extension offices and Master Gardeners also often have resources for training residents about drip irrigation and proper irrigation practices. Training can be offered to professionals and education programs can be offered to homeowners. Water budgets and irrigation systems maintenance are topics well-suited to educational programs.

Local media outlets can also assist in educating the public. Often the local newspaper will have a gardening editor or a radio talk-show host who will share water-saving tips with their audience or promote the utility's programs. TV weather reporters also have an interest in water efficiency as it relates to changes in the seasons. The San Antonio Express-News [http://www.mysanantonio.com] publishes a regular weekly notice with recommended irrigation quantities for different local turf grasses. By co-sponsoring workshops and training sessions with local Cooperative Extension offices and gardening clubs, a utility can achieve additional targeted outreach.

The utility should consider offering the following services:

1) Training in efficiency-focused landscape maintenance and irrigation system design;
2) Notices at the start and end of the irrigation season alerting customers to check irrigation systems and to make repairs and adjustments as necessary;
3) On-site education through irrigation audits and development of water budgets.

Training Customers and Irrigators

Utility educational programs targeted to customers can focus on general topics such as water budgets, irrigation systems design and maintenance which can be offered in workshops or public programs, or they can focus on delivering information to customers on a one-to-one basis through the irrigation system survey and site specific water budgets. The individual approach is more likely to result in measurable water savings, but the need to marshal technical and staffing resources typically limits the individual approach to large utilities with a dedicated water conservation staff.

Whichever approach is used, landscape irrigation education programs for the general public should include the following topics:

- Rain sensor – How they work and how to install
- ET controllers – How they work and How to use
- Drip irrigation system – How to install and maintain
- Hydrozoning principles

Training for Professional Irrigators

A municipal utility can work with local professionals, its own staff, or preexisting training programs to offer or sponsor professional irrigator training within its service area. The Irrigation Association (IA) has education programs, certifications for irrigation auditors and golf course irrigation auditors. A utility can organize educational programs with the IA or with Texas A & M Irrigation Technology Center [http://itc.tamu.edu/]. The IA certification adoption by the New EPA Water Sense Labeling program provides irrigators with a valuable marketing advantage when working with the IA [http://www.irrigation.org/certification/default.aspx?pg=default.htm&id=18].

Licensed irrigators in Texas are required to have 8 CEUs per year. By hosting a seminar which promote the utility's irrigation conservation program and uses speakers by Texas Cooperative Extension, or a professional presenter, a utility can attract licensed irrigators to their presentation. Utilities interested in offering or sponsoring training with continuing education credits for licensed irrigators should go to the TCEQ website [http://www.tceq.state.tx.us/comm_exec/forms_pubs/pubs/rg/rg-373.html] with links to necessary forms for accredited training sessions. The City of Austin has offered irrigators professional training for a number of years and has determined certain principles in presenting a successful workshop:[25]

[25] Stewart, K, WWIP,AWWA ACE 06

- Limit fee, but do not offer for free – people believe they get what they pay for. The city of Austin charges $50 for its irrigation training.
- Provide refreshments such as a morning snack or coffee and pastry, lunch, and an afternoon snack. Good nutrition help keep the audience alert.
- Schedule during the winter when irrigators have more time. Classes should be designed with required CEUs in mind, and can be either 4 hours or a full 8-hour class.
- Potential speakers include backflow inspectors, water conservation specialists, and plumbing inspectors from city staff.
- Classes are held at city facilities, parks and recreation facilities, or a local botanical or garden center.

Individual Water Budgets, and On-site Irrigation Surveys

To create a cost-effective and successful program, the utility will need to identify high summertime peak water users among its customer base using customer-billing data. Those customers can be offered educational programs, free audits, or be encouraged to avail themselves of professional irrigation audit services in order to reduce their summertime water bill. Utilities with GIS capabilities and access to aerial photos may consider more sophisticated program targeting methods (See Austin Case Study).

Due to the differences in rainfall and growing seasons across the state, a utility will need to review its historic demand curve to determine when to offer pre-irrigation water surveys. Choosing the month at which water demand has historically first exceeded the monthly average water use for the water system is a good starting point for rolling out annual irrigation surveys. This can be anytime from early spring to early summer in Texas.

Utility conservation programs often avoid the term “audit” to describe irrigation system evaluations due to the negative connotation of the term. Some alternative terms to consider are:

- Irrigation system survey
- Irrigation consultation
- Irrigation evaluation
- Irrigation system review

In order to maintain water savings achieved through landscape irrigation BMP, regular maintenance and evaluation of irrigation systems are required. To be successful, such programs must include pre-irrigation season checks for leaks and irrigation uniformity. (Even if a full distribution uniformity is not run every year, irrigation heads and valves can become stuck or blocked by detritus when not used for a while.) Irrigation timers should be adjusted monthly or run manually. ET controllers need to be checked to ensure that they are operating correctly. If the utility chooses to promote irrigation audits performed by landscape contractors, a copy of an inspection report for the customer should become an expectation that the utility promotes. In its evaluation report to the customer, the utility may also include the following information:

1) A list of landscape areas, measurements, plant types, irrigation system hydrozones, and controller(s);
2) A list of existing irrigation policies or procedures including maintenance and irrigation schedules;
3) A distribution uniformity analysis on irrigated turf areas;

4) A review of water bills with attention to the ratio of summer to winter use; and
5) An initial report summarizing the results of the evaluation.

Targeting High Water Users in Austin:
Residential Irrigation System Evaluations

The City of Austin has adopted a unique water conservation program promoting irrigation system evaluations, an outreach effort aimed at its highest-end users. In the irrigation evaluation program, the licensed city irrigators look at the water use records of the highest water-using residential customers. Then, using aerial photographs and GIS software, they calculate the potential water budget for the landscape using historical ET. Once the water budget has been calculated, it is compared with the actual water use of the customer. A certain amount of the water is allocated for that customer to account for indoor water use and the utility sends a letter to the customer indicating what the outdoor water use for their landscape could be using the water budget. The letter also compares the water use and the amount of money a customer could expect to save over a year, should the customer reduce their water use to the amount suggested by the water budget. Finally, the letter offers the customer a free irrigation inspection. This is a way of targeting an irrigation system evaluation, which is a time consuming practice, to those homeowners who are most likely to benefit from them and where the water savings will be maximized.

More than 350 irrigation evaluations were performed in 2005-2006 for an estimated savings of more than 35,000 gpd. Performing landscape irrigation audits can usually only be cost effective for very large landscapes due to the time required to set up the data collection from the irrigation zones, collect the data, and then analyze it. As a result the City of Austin has a more abbreviated irrigation system examination process in which the licensed irrigator runs each zone, measuring gallons of water per minute for each zone through the water meter, and observes for the following problems:

- Broken, leaking, low, misaligned, obstructed, or tilted heads;
- Broken, and clogged nozzles;
- High or low pressure, and misting;
- Overspray, wrong pattern or trajectory, or poor coverage; and
- Pipe leaks

The free irrigation evaluation is available to all residential customers that use over 25,000 gallons per month. However, many of the participants in the program are new customers or those that have suffered from unusually high water bills.

Approximately one year after conducting an irrigation audit, the utility should consider conducting a customer-satisfaction survey. The objective of the customer-satisfaction survey is to determine the implementation rate of recommended modifications and to gauge customer satisfaction with the program. The utility should consider implementing a notification program to remind customers of the need for maintenance and adjustments in irrigation schedules as the seasons change.

More aggressive irrigation programs can offer free irrigation system audits by trained utility conservation staff as well as offering their multi-level or licensed irrigation survey programs with incentives. A description of how to perform an irrigation audit can be found at: [http://www.bugwood.org/container/Scholtes.html] in addition to the values recommended for determining a coefficient of uniformity (CU). A Distribution Uniformity (DU) value can be calculated by dividing the lowest 25% of values by the average of all values collected from your cups. The Irrigation Association also includes a description of uniformity analysis in its BMP [http://www.irrigation.org/gov/pdf/IA_LISWM_MARCH_2005.pdf] and a description for performing the audit in the workbook, *Certified Landscape Irrigation Auditor*. (Irrigation Association, August 2001).

A professional irrigation firm could offer advantages in delivering irrigation audits including a greater level of detail in the survey, and additional services, such as irrigation head replacement. City attorneys often instruct utility staff not to touch customer irrigation equipment due to concerns about liability.

4.5.2. Incentive Approach

Incentives for irrigation audits and systems upgrades can include rebates, recognition for water-efficient landscapes (through signage and award programs), and certification of irrigation professionals and volunteer representatives who can promote the Program. The simplest types of incentive programs include rebates for rain sensors, SWAT controllers [http://www.mwdoc.com/SmarTimer/index.html], or rain barrels [http://www.cityofallen.org/commservices/Rebate/FY06%20Application%20Rain%20Barrel.pdf], [http://www.ci.austin.tx.us/watercon/downloads/rbrebateapp.pdf]. Numerous Texas examples [http://www.ci.austin.tx.us/watercon/irrigation.htm] of these programs with rebates for different water saving irrigation measures.

Another approach to financial incentives is to offer rebates for part of the cost of having irrigation system audits performed by professionals. This can take the form of rebates for specific equipment retrofitted – as in new irrigation heads or a pressure regulator – which helps fix problems found during an audit. It could also include partial costs of the audit itself, especially if the customer shows evidence of implementing audit recommendations through reduced water use.[26] It is also possible to combine an irrigation system standard with a water saving landscape rebate.

[26] Brown, C., *Landscape Water Survey Program,* Green Industry Alliance, San Antonio, TX, July 2000

As a requirement for landscape rebates, (see Section 3.8) SAWS requires customers to obtain an irrigation system check up by a SAWS conservation technician. [http://www.saws.org]. Less detailed than a distribution uniformity analysis, the check up includes:

- A review of hydrozones;
- General maintenance overview;
- A backflow preventer which has been inspected properly;
- Visible evidence that the irrigation system does not overspray onto hardscape or non-plant areas, excessive pooling, or evidence of lack of complete coverage.

Some regional water authorities like Orange County MWD [http://www.mwdoc.com/] have successfully used incentive programs to encourage third-party professionals to offer audit services to their customers.

Recognition Incentives

A utility can recognize irrigators who have been certified by the IA Water Sense or TAMU. Performance tracking of water use after each irrigation services can reward the irrigation professional by grading the performance. Recognition can include listing certified irrigators on a utility website, in the local newspaper, or in a flyer/brochure published by the utility and distributed to utility customers at events, on city counters, by the licensed irrigators themselves, or in bill stuffers.

Recognition programs have the benefit of professional irrigators assisting in promotion of the program at no additional cost to the utility, other than administering the program. The certification program provides an incentive to the professional irrigation company to promote conservation as a part of their firm's marketing efforts.

Utilities which are prepared to offer customers' information online, can integrate their program and assist customers in tracking their water use. Municipal Water District of Orange County, CA [http://waterprograms.com/wb/] has a program which combines customer water budgets with irrigator certification, and Web-based resources for the customer and irrigator to track the relationship between water use and the budget. If an irrigator's customer repeatedly fails to meet their budget, the irrigator can lose their certification.

Another incentive which could be implemented is a performance based incentive, similar to those offered by utility management firms to large commercial and multi-family customers. The principle underlying such incentives is that the reduced costs of water savings are shared between to customer and the contractor. A utility could assist in promoting such performance-based contracting by helping identify target water savings based on 80% of ET. Recognized or certified contractors could guarantee their clients (the utility customers) to meet such water budgets. The customer could use the anticipated water savings from the budget to determine their financial capacity to purchase the water savings measures offered by the irrigation contractor. Like the Orange County example above, the utility can promote success by removing contractor certification if they fail to achieve the projected savings.

Incentive programs are also useful for municipally-owned utilities wishing to provide a transition period in anticipation of new ordinance requirements. Rain sensor rebates have been combined with ordinances so that customers were given a limited time opportunity to voluntarily retrofit their sprinkler system with an approved rain sensor prior to an ordinance requiring rain sensors taking effect. Utilities like SAWS and Dallas Water Utility have offered these temporary rebates for rain sensors.

4.6. Ordinances and Rules for Implementing Irrigation BMP

As with many types of water saving equipment, many utilities have found that rules or ordinances are effective means of increasing water efficiency standard. This directive approach assures the utility that all new customers are using a certain minimum approach which ensures that water is used effectively. Conservation rules or ordinances for new customers are typically less expensive to implement than incentive or education programs, but can be and often are implemented in concert with incentive or education programs. Some education always needs to be a part of any ordinance process, as the affected parties must be informed about the new rules, the expectations for compliance, and enforcement procedures.

4.6.1 Irrigation System Design & Installation

The State of Texas Licensed Irrigator rules give utilities concerned with irrigation system design an excellent starting point in developing a good set of utility service rules or ordinances. At a minimum, irrigation systems in Texas should be designed by a licensed irrigator, and local cities may enforce this by passing ordinances requiring new connections to show a plan sealed by a licensed irrigator. This is enforceable at the time that a customer applies for a certificate of occupancy, or a meter connection fee in association with the backflow prevention valve required for irrigation systems by state health code.

Irrigation system standards which have been passed by rule or ordinance include requirements for installation of rain sensors or soil moisture sensors, use of ET controllers, and/or location of irrigation heads in relationship to hardscapes (distance from curb or walls [http://www.saws.org/conservation/Ordinance/IrrigationAudit/]). By rule, irrigation standards have also been implemented directly related to the size of median strips and buffers [Denver Water].

Cities may wish to take further steps to require irrigation systems to have certain types of heads based upon total area irrigated, require specific hydrozoning measures, limit the placement of irrigation heads near curbs and other hardscape, require rain sensors, SWAT irrigation controllers, or eliminate water wasting irrigation systems in small medians, buffer zones and entrances altogether. Appendix A.1 includes landscape and irrigation standards, published by the Lower Colorado River Authority (LCRA) which have been used as templates for city ordinances and by homeowners associations for deed restrictions and covenants. The State of California designed a model landscaping ordinance structure for use by municipalities [http://www.owue.water.ca.gov/docs/WaterOrdIndex.cfm]. A sample landscape design checklist produced by the City of Colorado Springs Colorado

[www.springsgov.com/units/planning/AppForms/Forms/landscapechklst.doc] can help utilities work with city planners to ensure that proper principles of hydrozoning and irrigation design are followed.

Concerns about the ability to enforce irrigation standards on the residential sector, with new construction including everything from single homes to planned unit developments, leads some utilities to focus on commercial customers. Municipalities with ordinance-making powers should consider adopting ordinances that require all new apartment complexes and commercial buildings to install a water conserving landscape. This can often be accomplished by amending an existing commercial landscape ordinance.

The utility should ensure that landscape irrigation system specifications are coordinated with local building codes and zoning ordinances. A careful review of both of these sections of local government code is necessary to determine if preexisting requirements may be inconsistent with desired water conservation elements. Often introducing water-conserving elements into local code by amendment involves removing or revising existing language. If changes are desired to sections of the code involving zoning, it is important to plan for appropriate review and approval by planning or zoning boards and/or commissions. Utility staff must be prepared to present the information about proposed changes and potential water savings to audiences which are not familiar with conservation or water utility issues. Existing zoning and building codes also may be organized in a way that requires major changes to a number of different sections of the code. Working with city attorneys, the water utility staff should keep in mind that careful review is necessary to prevent a result which has contradictory or conflicting requirements between different sections of code. Sufficient time and background information should be allowed as part of an ordinance process.

It is a very good idea to work with stakeholders from the local construction, landscape, and development industries so that they can understand the reasons for and the extent of each ordinance proposal. These public involvement and input efforts in developing new rules can both help the utility to make minor modifications which address concerns of the affected parties, and also avoid opposition which may stem from customers who misunderstand the provisions or potential impact of proposed provisions. A stakeholder advisory group is recommended as a crucial element for ordinance-making success.

Ordinance or rulemaking processes can be used both for equipment standards and for behavior changes. Although most often used during drought, irrigation scheduling ordinances can be used in wet years as well as dry to manage water lost to evaporation by requiring irrigation systems to be run at night or in the early morning [http://www.ci.austin.tx.us/watercon/summer.htm}, penalizing customers who allow their irrigation system to water the street [http://www.saws.org/conservation/watering/index.shtml], and/or setting irrigation days by street address to help reduce peak demand on the system [http://www.epwu.org/conservation/ordinance.html] (if only ½ or less of customers can water on a given day, the overall peak pumping volume is reduced).

4.6.2 Compliance Activities: Education & Enforcement

Water conservation staff can be involved in ensuring compliance with ordinances, as they are in a number of Texas cities (Austin, El Paso, and San Antonio). However, for provisions which involve plan reviews, the utility may need to work directly with city planners. For provisions which require inspections at the time of construction, the utility may need to work with plumbing or building inspectors.

Determining who will be responsible for ensuring compliance with rules is an important consideration in choosing ordinance provisions. The availability of staff to ensure compliance with provisions is crucial, as is the education of the staff. Utility conservation staff or outside experts must be available to educate the staff that will be directly responsible for reviewing plans, or performing inspections on irrigation systems. Since backflow prevention devices are required for installation of automatic irrigation systems, backflow device inspectors are potential compliance officers for irrigation system design and installation ordinances, but only if they are properly trained and have the funding for the additional inspection activity.

The San Antonio Water System [http://www.saws.org/ conservation/ordinance/] has used its ordinance powers to ensure that annual checkups of irrigation systems for large turf areas are required. These can be performed by licensed irrigators, an employee, a volunteer (for schools or other nonprofits) or the owner of the property.

Failure to comply with outdoor irrigation regulations by time-of-day or day-of-week is often defined as a water waste, and enforcement is handled as part of the city code for misdemeanor violations of ordinance. The City of El Paso uses peace officers to enforce time-of-day and day-of-week irrigation ordinances during times of drought and non-drought periods as well. Notices of violations (NOV) are often preceded by warnings, and the number of warnings prior to enforcement activity varies around the country. In order to process potential violations observed by customers, utilities with time-of-day or day-of-week programs operate a “Hotline” telephone number, or Website [http://www.saws.org/conservation/waterwaste/] which needs to be publicized if the public is to be aware and use the service. When a call or Web alert is received, the utility can issue a work order to its enforcement personnel who can then proceed to the site and issue a warning or NOV as the situation requires.

At each stage of an ordinance process, from drafting, through passage and during enforcement, education is necessary. In order to gain public support for the ordinances, the public needs to understand the importance of water conservation. If rules are to be enforceable and supported by the affected customers, customers must feel the rules are fair, that they are able to understand the rules and how to comply. The general public also needs to know how to notify the utility about alleged violations, enforcement measures, whether enforcement includes warnings, and how large a fine will be assessed.

5.0 Implementation

The Best Management Practices Guide has specific recommendations for program implementation and tracking. Those concepts are not repeated in this section. Rather, this includes some information, gathered from input of landscape conservation professionals from different utilities, about potential program elements to consider based upon the size of a utility. Utilities should be considered as small if less than 3,300 to 49,999 connections, as medium with 50,000 to 99,999 connections, and as large with 100,000 connections or more. Some very small utilities, those with less than 3,300 connections, have implemented educational programs using educational brochures and bill stuffers.

5.1 Staffing and Resources

Program / Size of Utility	Small	Medium	Large
Staffing			
Staff with training in irrigation auditing; master gardening; master naturalist or similar class work at a university or college level	✓	✓	✓
Close working relationships with cooperative extension; local green industry with IA or Water Sense training		✓	✓
One or more staff with academic degree in horticulture, agronomy, landscape architecture			✓
Staff given continuing education in irrigation auditing, and/or horticulture, including master gardening, master naturalist or Cooperative Extension classes		✓	✓
Staff perform irrigation system evaluations for customers			✓
Performing or contracting for irrigation audits for municipal facilities		✓	✓
Education			
Brochures	✓	✓	✓
Bill Stuffers	✓	✓	✓
Books, CD-ROMs, or Manuals			✓
Co-sponsoring workshops with Master Gardeners, Cooperative extension, other nearby utilities	✓	✓	✓
Sponsoring workshops		✓	✓
Training for landscape professionals			✓
Presentations to schools, neighborhood associations, gardening clubs, and civic groups		✓	✓
Awards programs	✓	✓	✓
Booths at Home and Garden shows and other community events	✓	✓	✓
Producing brochures, media alerts, and information with bio-region-specific tips on using ET curve to irrigate appropriate to the season		✓	✓

5.1 Staffing and Resources

Program / Size of Utility	Small	Medium	Large
Demonstration Gardens			
Sponsoring a Xeriscape Demonstration Garden		✓	✓
WaterWise landscaping at utility facilities	✓	✓	✓
Agency funds extra services/studies by Cooperative Extension Master Gardeners, etc…		✓	✓
Agency provides funding for studies in plant water use and irrigation control and management			✓
Incentives			
Rain Sensors	✓	✓	✓
Irrigation Controllers		✓	✓
Irrigation system evaluations		✓	✓
Landscape Conversions			✓
Irrigation Professional Certification			✓
Ordinance Provisions*			
Time of Day and/or Day of Week ordinances	✓	✓	✓
Seasonal water rates	✓	✓	✓
Irrigation system design and installation provisions	✓	✓	✓
Limits on types of irrigation system in medians, buffers and entrances	✓	✓	✓
Irrigation plan by licensed irrigator	✓	✓	✓

* Ordinances or service rules can be implemented by any water utility regardless of size. Actual wording of provision may vary with regard to legal status of entity (municipality, water service company, district, etc…).

5.2 Cost Effectiveness Considerations

Using the cost-effectiveness model presented with the Best Management Practices Guide (p.122-126), the utility will need to obtain certain data and make some assumptions about its goals for the program.

Customer billing data can give a clue to the number of customers that have a pattern of large increases in water use in summer months. These indicate a high potential for irrigated landscapes, although some commercial customers may be using large quantities of cooling water in the summer months.

The number of probable customers irrigating their landscapes should be determined and an amount of water savings in gallons per customer per day per measure must be estimated. The model in the Guide indicates a savings rate of 50 qpd for irrigation

surveys for customers and 470 qpd for commercial customers. Values for landscape conversion programs show in the range of 100 qpd for El Paso, although other programs have not been as consistent. Water savings estimates for landscape education programs are not available.

A program penetration goal needs to be determined, which is multiplied times the total estimated customers who irrigate to determine both the number of surveys or conversions the program will strive to perform, and is used to estimate the cost and potential water savings of the program. The length of the proposed program will need to be entered, and the estimated life of the measure.

The irrigation survey program has a natural replacement rate of zero because experience and discussions with professionals have determined that few, if any, customers seek out irrigation surveys without a utility sponsored program. However, it includes a 1% free ridership value to account for some customers who will access the program to help them fix a problem of which they are already aware.

Net program costs for the irrigation survey in 2004 are estimated at $51 per residential survey and $202 per commercial survey. These values should be increased for inflation and can be adjusted in the model to reflect a utility's actual costs. Such costs could be based upon the value of utility staff time to perform an irrigation system evaluation or the cost of a rebate to provide an incentive for customers to use a landscape professional to perform the service.

Based upon the values entered, the model calculates the cost of water per acre foot (AF) AF saved, the total cost of the program, the net present value of water saved per AF, and the estimated water saved over the life of the measure. The values of these variables can be used to determine the value of the proposed program, how large or for how long a program should be designed and operated. The final values will be dependent both upon customer data, and upon the assumptions the planner uses in the model which can be adjusted.

Appendix A

Lower Colorado River Authority
Suggested Conservation and Landscape Guidelines
With Rationale and Talking Points

A. Landscape irrigation systems shall not be mandatory.

(Many HOA's and POA's currently require irrigation systems. Studies have shown a substantial increase in water use associated with automatic irrigation systems, including a 1999 City of Austin study demonstrating a 83% in water consumption in home with in-ground irrigation systems over homes without.)

B. Landscape irrigation systems, if installed, will be required to include the following water conservation features:

1. **Rain and/or moisture sensors**

   (According to Rain Bird, rain sensors can result in at least 15-20% in water savings.)
2. **Backflow prevention device installed in accordance with applicable state laws**
3. **Pressure reducing valve and/or remote control valves for each station with flow control**

   (Over-pressurized systems cause fogging which can result in up to 25% of water being lost to wind and evaporation)
4. **Pressure reducing valve, for which pressure reducing valve installed in-line at the meter and serving house as well as irrigation system, is acceptable.**
5. **Zoning of irrigation system based on plant water requirements.**

   (Mixing different plant types (such as turf with shrubs) in the same irrigation zone results in over or under-watering some of the plants. Because most people water for the "dry-spot," mixed zones most often result in over-watering)
6. **Multiple cycle controllers with an irrigation water budget feature.**

   (These controllers allow system to "cycle and soak" which decreases runoff. They also allow the system to be easily rescheduled to more closely match seasonal water needs, cutting back on water by 50% in spring and fall relative to summer application.)
7. **Minimization of overspray onto hardscapes by design, maintenance and scheduling practices. Due to overspray, subsurface drip irrigation is encouraged but not required.**
8. **Low volume irrigation shall be installed in areas less than 10 feet wide, such as median strips, and parking islands.**

   (Narrow areas are extremely difficult to water without overspray (and runoff) using pop-up spray heads. In addition, sprinkler heads adjacent to sidewalks and driveways are often broken or damaged by vehicle and foot traffic. Broken heads eliminate the potential for the area to be watered efficiently.)

C. Contractors installing irrigation systems must provide system design plans to the homeowner. And scheduling recommendations shall be posted in or near the irrigation controller box.

(Without basic information about the irrigation system, a new homeowner would have to do an extensive audit of the system to manage it efficiently. Once the pipes are covered in the ground, it becomes very difficult to understand the layout of the system without a design plan.)

D. Irrigation systems in common areas will be monitored once a month, and any repairs shall be made in a timely manner

(Sprinkler heads are commonly broken by mowers, pedestrians and other traffic. A system with broken heads cannot operate efficiently, and can result in thousands of gallons of runoff every time the system operates.)

E. Spray irrigation for each home/business shall be limited to 2.5 times the foundation footprint, with a 12,000 sq foot maximum. The footprint may include both the house and the garage, but not the driveway or patio.

(For every 1000 square feet that receives one inch of water (the weekly recommended amount during the summer months), about 600 gallons of water is used. That means that a 12,000 sq foot irrigated area will receive about 7200 gallons of water per week during the summer following the recommended watering schedule. Limiting the area of irrigated landscape to 2.5 times the footprint of the home allows for a more intensively landscaped area around the home without having vast irrigated areas.)

F. Irrigated ornamental common areas at entryways and intersections shall follow the guidelines outlined below (unless irrigation of reclaimed water is necessary to meet regulatory requirements)

1. **Irrigated landscaped area shall be limited:**
   - i. **Subdivision entryway landscaping shall not exceed 6000 square feet.**
   - ii. **Landscaping at intersections within the subdivision shall not exceed 3000 square feet.**

(This allows for irrigated landscape focal points in the subdivision without vast irrigated common areas)

G. Irrigation of common areas shall occur between the hours of 7:00 PM and 10:00 AM. There shall be NO WATERING between the hours of 10:00 AM and 7:00 PM unless irrigation of reclaimed water during the day is necessary to meet regulatory requirements.

(Watering between dusk and dawn reduces loss to evaporation which can be as high as 40% during the heat of summer.)

H. All irrigated and newly planted turf areas will have a minimum soil depth of 6 to 8 inches. Builders and owners will import soil if needed to achieve sufficient soil depth. Soil in these areas may be either native soil from the site or imported, improved soil. Improved soil will be a mix of no less than twenty percent compost blended with sand and loam. Caliche shall not be considered as soil.

(In the turf type used in central Texas, the majority of roots grow in the top 4-6 inches of soil. A recent study conducted by TAMU and SAWS tested the drought tolerance of the main turf types during 60 days without water on 4 inches of soil and on unlimited soil depth. All of the turf planted on 4 inches of soil died during the 60 days without water. On deep soil, all of the turf rebounded except some varieties of St. Augustine, demonstrating the importance of soil depth on turf survival and health. Additionally, according to the Irrigation Association, up to a 50% water savings can be achieved by increasing soil depth for a turf area from four inches to eight inches.
Compost increases the water holding capacity of soil by about 16,000 gallons per acre foot for each 1% organic matter. This decreases runoff and improves plant health.)

I. Native soil shall be stockpiled and reused on site.

J. Topsoil that is added to the site shall be incorporated in a 2 to 3 inch scarified transition layer to improve drainage.

K. In new homes, no more than fifty percent of the landscape may be planted in turf.

(Turf is the most watered component of the landscape. Limiting turf area reduces outdoor water use.)

L. All new turfgrass installed shall have summer dormancy capabilities.

(Turf with summer dormancy capabilities insures that landscapes will survive under mandatory water restrictions.)

M. Shrubs and flowers should be selected from native and adapted plant list approved by the LCRA or _____ County/City.

(Using native and well adapted plants in the landscape reduces the need for supplemental water and chemicals.)

N. Invasive plants listed in this document shall not be used.

("Problems caused by invasive plants cost billions to the global economy every year, mainly from loss of grazing land and reduced crop productivity due to non-native weeds. The cost to the United States alone is an estimated $137 billion a year in management and missed economic gain. Ecologically, they can disrupt ecosystem services and disrupt communities by being space-dominant or through impacts on keystone native species. At their worst, invasive plants have the ability to degrade whole ecosystems, both terrestrial and aquatic." Source: Wikipedia)

O. Landscape companies providing maintenance on all common areas and individual landscapes must only use integrated pest management (IPM) to minimize exposure of storm water runoff to chemicals (fertilizers, herbicides and pesticides). IPM prohibits routine and "preventive" broadcast application of broad-sprectrum chemical pesticides in the absence of evidence of active pests. IPM techniques include the following:

1. **Accurately identify pest or disease problem before considering treatment**
2. **Explore cultural or mechanical controls (i.e. modification of irrigation, pruning, etc)**
3. **Look for biological control options (i.e. predatory insects for pest control, Bt for caterpillar control, etc)**
4. **Consider chemical control only if other options fail**
5. **Utilize least-toxic and targeted chemical controls**
6. **Baits are preferable to broad-spectrum chemical application**
7. **Follow instructions on chemical labels exactly**
8. **Perform periodic monitoring for early detection of potential problems**

P. Landscape companies providing maintenance on all common areas and individual landscapes must only use the following fertilizer practices:

1. **Fertilization of turf areas shall not be required**
2. **In turf areas that are to be fertilized, natural or certified organic fertilizers with less than 4% phosphorus shall be used.**
3. **Fertilizer shall be applied at a rate of ½ pound of nitrogen per 1000 square feet, not to exceed a total of one pound of nitrogen per 1000 square feet per year.**

(Phosphorus accumulates in alkaline Central Texas soils, and there is generally not a need to add large amounts of phosphorus in the form of fertilizer. Nitrogen is limited in Central Texas soils and does not accumulate. Although adding small amounts of nitrogen can be beneficial to plants, excess soluble nitrogen runs off or leaches through the soil as a potential pollutant to ground and surface water.)

Q. Builders or property managers must present guidelines for IPM plans and fertilizer practices meeting the deed restriction requirements to home buyers at the time of closing.

(These guidelines are contained in Grow Green fact sheets available from LCRA)

R. As passed by HB 645 in the 2003 Texas Legislative session, the homeowners or property owners association documents (including declaration of covenants, articles of incorporation, bylaws, or any other document of the association which binds members of the association) shall not restrict the property owner from:

1. **implementing measures promoting solid-waste composting of vegetation, including grass clippings, leaves or brush, or leaving grass clippings uncollected on grass;**
2. **installing rain barrels or a rainwater harvesting system; or**
3. **implementing efficient irrigation systems, including underground drip or other drip systems.**

S. The homeowners or property owners association documents (including declaration of covenants, articles of incorporation, bylaws, or any other document of the association which binds members of the association) shall not require:

1. **a defined irrigation schedule specified by the association except if that defined irrigation schedule is mandated by the association's water supplier in order to curtail outdoor water use.**
2. **maintenance of the landscape to a specified level that requires the property owner to irrigate his or her landscape.**
3. **installation or maintenance any specific variety or limited choice of varieties of turf grass.**
4. **the homeowner to install a minimum percentage of turf in the landscape.**

(Homeowner association rules should not be in conflict with water conservation measures)

T. A minimum of two inches of mulch shall be maintained in all shrub and bed areas.

(Mulch helps retain soil moisture, moderated soil temperatures, and helps prevent soil erosion)

U. Encourage rainwater gutters sized appropriately to catch rainwater from the rooftop.

V. Encourages galvanized metal roofs to facilitate rainwater storage.

W. Encourage installation of water efficient toilets, dishwashers and clothes washers.

X. **Encourage incorporation of treated effluent/rain water/storm water systems to meet certain irrigation water needs, including common areas.**

Appendix B

Potential Drought Provisions Affecting Landscape Water Use

Based upon City of San Antonio Ordinance, Chapter 34.

Stage 1:
Water waste is prohibited at all times. Water waste includes allowing water to run off into a gutter, ditch, street, or drain; or failing to repair a controllable leak.

You should reduce water consumption by any means available.

Hand watering with a hand-held hose, soaker hose, drip irrigation, bucket or watering is permitted any time and any day.

Operators of golf courses, athletic fields and parks must submit a conservation plan to SAWS. Golf courses, athletic fields and parks may not irrigate between the hours of 10 a.m. and 8 p.m.

Landscape areas on golf courses not directly "in play" are required to follow one-day-per-week watering based on address unless otherwise instructed by SAWS.

Use of fountains, waterfalls, or other aesthetic water features outdoors or indoors is prohibited.

Landscape watering with an irrigation system or sprinkler is allowed only once a week before 10 a.m. or after 8 p.m. on your designated watering day as determined by your address.

Last Digit of Street Address	Watering Day
0 or 1	Monday
2 or 3	Tuesday
4 or 5	Wednesday
6 or 7	Thursday
8 or 9	Friday

No watering on weekends

Newly planted landscapes may qualify for a three-week exemption from the one-day-per-week watering rules. Property owners must mail, fax or e-mail their request to SAWS along with their name, address of the landscape, and date of installation. You may also apply for a variance online. If your request is approved, you will receive a confirmation letter stating the duration of the permit. Over-seeding existing turf or other landscape is not considered new landscape and will not be given an exemption.

Stage 2:
All restrictions from Stage 1 are included.

Watering with a hand-held hose or drip irrigation permitted during the hours of 3 a.m. to 8 a.m. and 8 p.m. to 10 p.m. any day.

Watering with an irrigation system or sprinkler, permitted only once a week on the designated watering day during the hours of 3 a.m. to 8 a.m. and 8 p.m. to 10 p.m.

Last Digit of Street Address	Watering Day
0 or 1	Monday
2 or 3	Tuesday
4 or 5	Wednesday
6 or 7	Thursday
8 or 9	Friday

No watering on weekends

Conforming golf courses shall effect a 20% reduction of ET rate. Non-conforming golf courses shall use no more than 1.6 times their base usage. Accompanied by reduced irrigation times.

Athletic fields shall reduce water use by an additional 5% from Stage 1 and have on with SAWS an approved conservation plan.

Stage 3:
All restrictions from Stage 2 are included.

Aesthetic fountains prohibited, unless treated wastewater is used.

Irrigation with a soaker hose, hose-end sprinkler or in-ground irrigation system is allowed every other week beginning on the second Monday after the Stage III has been declared, 3:00 a.m. to 8:00 a.m. and 8:00 p.m. to 10:00 p.m. Hand-held hose, drip irrigation system or 5 gallon bucket Tuesdays, Thursdays, Saturdays during Stage III hours.

Watering newly planted landscapes permitted only with a variance from the SAWS Conservation Department.

Conforming golf courses shall effect a 10% reduction of ET rate. Non-conforming golf courses shall use no more than 1.8 times their base usage.

Athletic fields shall reduce water use by an additional 5% from Stage 1 and have on with SAWS an approved conservation plan.

SOURCES

A Creation Steward's Handbook: Practical Resource Conservation in the Parish Self-Assessment Guidelines. Environmental Stewardship Committee, Episcopal Diocese of West Texas,
http://www.episcopal-dwtx.org/

About Mulch, www.aboutmulch.com/aboutmulch.asp

BMP 5 Handbook: A Guide to Implementing Large Landscape Conservation Programs as Specified in Best Management Practice 5. The California Urban Water Conservation Council, April 1, 1999.

Bormann, H., Balmori, D., and. Geballe, G. T., *Redesigning the American Lawn, A Search for Environmental Harmony: Second Editio*n, Yale University Press, 2001

Brown, C., *Landscape Water Survey Program*. Green Industry Alliance, San Antonio, TX, July 2000

Call, C., *What is Xeriscape,* Colorado Water Wise Council, www.xeriscape.org/maintainarticle.html

Carrow, Robert N. "Can We Maintain Turf to Customer's Satisfaction with Less Water?" *Agricultural Water Management*, Volume 80, Issues 1-3, 24 February 2006, Pages 117-131.

City of Dallas, *Water Conservation Five-Year Strategic Plan,* 2005

City of San Antonio Ordinance, Chapter 34, 2005

County Extension Agent Turf News, Vol. 1, No. 1, April 2006.

Cox, Dr. David M. "Developing a Water-Efficient Landscape." University of Nevada Cooperative Extension, Fact Sheet 91-54.

"Designing a Water-Wise Landscape," Water-Wise Gardening Information Sheet No. 3, Jordan Valley Water Conservancy District.

Dewees, A., and Woods, J. "Improving Landscape Irrigation Efficiency with ET Calculations, Aerial Photography, and On-site Evaluations." Austin Water Utility Water Conservation Department, 2007.

Draft Irrigation Standards Ordinance and Procedures for the Tucson Metropolitan Area. Executive Summary, May 16, 2003.

Drought Management Handbook. American Water Works Association, 2002.

Dukes, Michael PhD. “Irrigation System Technologies and Trends.” AWWA Water Conservation Workshop, Savannah, Georgia, January 29, 2007

ET and Weather Based Controllers CUWCC Web Page, http://www.cuwcc.org/Irrigation_Controllers.lasso

Evaluation of the Landscape Performance Certification Program. A & N Technical Services, Inc., January 2004.

Fundamentals of Xeriscaping and Water-Wise Landscape, WD-WSEB-26-4 2001, http://www.des.state.nh.us/factsheets/ws/ws-26-4.htm

Garden/Garden: A Comparison of Native and Traditional Gardens in Santa Monica. Environmental Programs Division, City of Santa Monica, California, http://www.smgov.net/epd/residents/Water/pdf/GG_Project_Description2006.pdf

Goldhill, J., “Why Smart Water Application Technology Makes Sense!” March 2004.

Guidelines for Developing Tree Ordinances, International Society for Arborists, http://www.isa-arbor.com/publications/ordinance.aspx

International Irrigation Show, Partnered by Green Industries of Colorado and Colorado WaterWise Council, San Antonio, Texas, November 7, 2006.

Introduction to Dillo Dirt™, http://www.ci.austin.tx.us/water/dillo.htm

Irrigation for a Growing World. Rain Bird Corporation, 2004, http://www.rainbird.com/pdf/iuow/iuow_whitepapers.pdf

Jury, William A., Gardner, W. R., Gardner, W. H. *Soil Physics, Fifth Edition.* John Wiley & Sons, New York, 1991.

Koeller, John. “Sustainability and ‘Green Building’ Forces Driving Market Changes.” AWWA Water Conservation Workshop, Savannah, Georgia, January 29, 2007.

Kopp, K., Johnson, P., and Cox, L. “Water-Wise Landscaping: Practical Turfgrass Areas.” *Horticulture/Yards*, Utah State University Extension, January 2006.

Landscape Irrigation Licensing, TECQ, http://www.tceq.state.tx.us/compliance/compliance_support/licensing/landscape_lic.html

Landscape Irrigation Scheduling and Water Management, Water Management Committee of the Irrigation Association, September 2003. http://www.irrigation.org/PDF/IA_LIS_AND_WM_SEPT_2003_DRAFT.pdf

McAfee, J., Chalmers, D., Havlak, R., County Extension Agent Turf News – Spring 2006, by Department of Soil and Crop Science, Vol. 1, No. 1 April 2006

Mead, Richard. *Soil Moisture Instrumentation: Sensors & Strategies for the 21st Century*, in Irrigation Journal, Sept/Oct 1998.

"National and Regional Green Building Programs." AWWA Water Conservation, January 28, 2007.

Native and Adaptive Landscape Plants: An Earthwise Guide for Central Texas. Texas Cooperative Extension, City of Austin, July 2005, http://www.growgreen.org

North Plains areas of Texas may find local historical data on potential evapotranspiration at: http://amarillo2.tamu.edu/nppet/whatpet.htm

"QuickQual Level 1 Home." *Build San Antonio Green*, June 30, 2006.

Residential End Use Study, 1999 data / WCITF Report to Legislature, 2004

Rick Garret, Manager City of Waco Water Utility, personal conversation, 2003.

San Antonio City Ordinance Chapter 34-316, as amended, September 14, 2000.

San Antonio Landscape Care Guide. San Antonio Water System, 2005, http://saws.org/conservation/Landscape/index.shtml

San Antonio Water System Conservation Program, http://www.saws.org/conservation/

Saving Water Partnership, Seattle Public Utilities, 2003

SAWS and EPWU, (Think Tank) personal communication, 5/31/06

Smart Water Application Technologies Report, 2006.

Smart Water Technology Initiative Web Page, http://www.irrigation.org/swat1.asp

Stewart, K, WWIP, AWWA, ACE 06

SMARTscapes: Save Money And Resources Today (S.M.A.R.T.) by Creating a Truly Central Texas Landscape. City of Austin Water Conservation Program and Xeriscape Advisory Board to the City of Austin, http://www.smartscapes.org/smartscapes_brochure.pdf

Tanner, S, *Every Drop Counts,* Irrigation Association Annual Conference, San Antonio, TX, 2006.

Texas Evapotranspiration Network (http://texaset.tamu.edu/)

Texas Hill Country Landscape Option Specifications. Lower Colorado River Authority, June 2005, http://www.lcra.org/docs/water_conservation_HCLOContractorSpecifications.pdf

Texas Water Development Board Report 362: Water Conservation Best Management Practices Guide. Texas Water Development Board, November 2004.

Turf and Landscape Irrigation Best Management Practices, Water Management Committee of the Irrigation Association, September 2003. http://www.irrigation.org/PDF/IA_BMP_SEPT_2003_DRAFT.pdf

Turf and Landscape Irrigation Best Management Practices, Irrigation Association, April 2005

Vickers, Amy. *Handbook of Water Use and Conservation*, Waterplow Press, May, 2001.

Waco Conservation Plan, 2003; SAWS (ask Dana) Outdoor Conservation (Stage IV)

Waste Not, Want Not: The Potential for Urban Water Conservation in California, Pacific Institute, November 2003. http://www.pacinst.org/reports/urban_usage/waste_not_want_not_full_report.pdf

Water Conservation Plan Rules for Water Sale Contracts. Lower Colorado River Authority, April 2005.

Water Efficient Landscaping: Preventing Pollution and Using Resources Wisely. U.S. Environmental Protection Agency, 2006, http://www.epa.gov/watersense/docs/water-efficient_landscaping_508.pdf

WaterWise Council of Texas, http://www.waterwisetexas.org/

Wilcutt, Eddie. "Utilizing Multiple Resources for Landscape Irrigation." Irrigation Association Annual International Irrigation Show, November 5, 2006.

Working Together to Promote Landscape Water Conservation. Prepared for the Green Industries of Colorado by Wright Water Engineers, May 2004.

Xeriscape: A Guide to Developing a Water-Wise Landscape. The University of Georgia College of Agricultural and Environmental Sciences Cooperation Extension Service.

WEBSITES

http://amarillo2.tamu.edu/nppet/whatpet.htm
http://floriculture.tamu.edu:7998/urbanlandscapeguide/zipcode.html
http://itc.tamu.edu/
http://texaset.tamu.edu/
http://waterprograms.com/wb/
http://www.austinenergy.com/Energy%20Efficiency/Programs/Green%20Building/index.htm
http://www.bugwood.org/container/Scholtes.html
http://www.buildsagreen.org/
http://www.ci.austin.tx.us/watercon/downloads/rbrebateapp.pdf
http://www.ci.austin.tx.us/watercon/irrigation.htm
http://www.ci.austin.tx.us/watercon/landscape.htm
http://www.ci.austin.tx.us/watercon/soilbuilders.htm
http://www.ci.austin.tx.us/watercon/soilrebate.htm
http://www.ci.austin.tx.us/watercon/summer.htm
http://www.cityofallen.org/commservices/Rebate/FY06%20Application%20Rain%20Barrel.pdf
http://www.epa.gov/watersense/
http://www.epwu.org/conservation/ordinance.html
http://www.epwu.org/conservation/plants.html
http://www.epwu.org/conservation/turf_rebate.html
http://www.epwu.org/conservation/turf_rebate.html#commercial
http://www.floridawaterstar.com/
http://www.irrigation.org/gov/pdf/IA_LISWM_MARCH_2005.pdf
http://www.irrigation.org/SWAT/Industry/water-purveyors/
http://www.irwd.com/AboutIRWD/rates_residential.php
http://www.kimberly.uidaho.edu/water/asceewri/ASCE_Standardized_Ref_ET_Eqn_Phoenix2000.pdf.
http://www.ladwp.com/ladwp/cms/ladwp001068.jsp
http://www.lcra.org/water/hillcountrylandscapes.html
http://www.mwdoc.com/
http://www.mwdoc.com/SmarTimer/index.html
http://www.mysanantonio.com
http://www.owue.water.ca.gov/docs/WaterOrdIndex.cfm
http://www.saws.org
http://www.saws.org/conservation/h2ome/landscape/
http://www.saws.org/ conservation/ordinance/
http://www.saws.org/conservation/Ordinance/IrrigationAudit/
http://www.saws.org/conservation/watering/index.shtml
http://www.saws.org/conservation/waterwaste/
http://www.snwa.com/html/cons_wshome.html
http://www.springsgov.com/units/planning/AppForms/Forms/landscapechklst.doc

http://www.tceq.state.tx.us/comm_exec/forms_pubs/pubs/rg/rg-373.html
http://www.tceq.state.tx.us/compliance/compliance_support/licensing/li_basic_train.html
http://www.usgbc.org/
http://www.wspinners.com/centex/newsletter/grngrwg/hydrozn.htmlare