HOME CONSUMER PERCEPTIONS ABOUT LANDSCAPE WATER CONSERVATION AND RELATIONSHIPS WITH HISTORICAL USAGE

A Thesis

by

WHITNEY FRANCES MILBERGER

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

May 2010

Major Subject: Agronomy

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Approved by:

Chair of Committee,	Richard White
Committee Members,	David Chalmers
	Gary Wingenbach
Head of Department	David D. Baltensperger

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ABSTRACT

Home Consumer Perceptions about Landscape Water Conservation and Relationships with Historical Usage. (May 2010)

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Chair of Advisory Committee: Dr. Richard White

Water is considered to be one of the most limited and precious resources on Earth. Due to this scarcity, water conservation has become essential in order to preserve water resources. Landscape plant material brings quality to urban and suburban lifestyles and increases value to home properties. Yet it has been shown that an excess amount of water is often applied to landscapes when the plant material does not in fact need the supplemental irrigation.

A researcher based survey, the Landscape Water Conservation Survey, was sent to 799 single family homes in the College Station, TX. Data collection occurred from November 2005 through August 2006 with a 27% return. The survey asked the recipients 14 questions on water use and home consumers' perceptions. Historical landscape water usage was compiled from 2000-2002 which included actual water use, taxable value, of the residence, heated area, and the water meter identification number for these selected households supplied by The City of College Station Water Utilities.

The survey indicates a strong disconnect between the amount of irrigation landscape plant materials need and the quantity of water that is actually applied.

Surveyed home consumer perceptions demonstrate excessive amounts of irrigation were normally applied to landscape plant material when no irrigation was needed due to rainfall. Many respondents to The Landscape Water Management Survey indicated that they believed to have efficient irrigation practices in place when in actuality they do not. Educational resources are needed to teach the public on the amounts of irrigation landscape plant materials actually need, how to apply measured home irrigation practices, the principles of water conservation, and meeting the water requirements of varied landscape plant material. If these could be established and implemented, there would be a higher rate of conserving water and providing plant material with the sufficient amount of irrigation required.

DEDICATION

To my grandfather, Francis Joseph (F.J.) Milberger

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I would like to thank my committee chair, Dr. Richard White, for all of the valuable insight and guidance he has given me over the years. I am grateful to my committee members, Dr. Chalmers and Dr. Wingenbach, for their support and encouragement.

I would also like to thank my friends, the staff, and faculty at Texas A&M University for all you have taught me and your guidance. The cooperation and data received from the City of College Station Utilities is appreciated. I would like to express sincere gratitude to my mother and father, who have always been supportive, and to my husband for his companionship.

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INTRODUCTION

Water is critical to our existence. Preserving potable water supplies continues to be a major issue in Texas, the nation, and world. Of all the earth's water, only 1% is actually available for human consumption. Population expansion and demand will increasingly tax a finite water supply (Water Right, 2003). The Texas Water Development Board states that by 2050, almost 900 cities will either have to reduce demand during drought either through conservation or develop more water sources. If there is a drought in 2050, approximately 43% of municipal water utilities will not have sufficient water available to meet demand (TWDB, 2002).

Water is considered to be one of the most limited and precious resources, yet in landscape management an excess amount of water is often applied with no regard to actual plant needs (Qian & Engelke, 1999) even in xeriscape landscape designs (Carrow, 2006). Although water use increases dramatically during summer months due to outdoor use for landscape irrigation (Kjelgren, Rupp, & Kilgren, 2000), little to no published information is available about the relationship of actual water used for landscape irrigation and amount of water needed to sustain landscape plant health and quality.

This thesis follows the style of *The Journal of Agrobiotechnology Management & Economics*.

Although municipal water utilities recognize that home consumer outdoor water consumption increases dramatically during summer, these agencies do not know whether the increased water used is necessary to sustain healthy landscapes (Nations, personal communications, 2004).

Thus, information that would elucidate the relationship between seasonal home consumer water consumption and estimates of water required to sustain healthy landscapes would aid municipal water agencies in targeting water conservation efforts.

Excess water consumption may be perpetuated by home consumers' misconceptions that plants need to be watered every other day. For proper irrigation management, established trees and shrubs should be irrigated after they show signs of stress (Knox, et al., 1991). Approaches to curb outdoor water consumption most often include conservation education, landscape design, landscape plant selection, specific or limited watering days, block or tiered pricing, and in severe situations, restrictions on outdoor water use. Michelsen, McGuckin, and Stumph (1999) determined that non-price conservation programs incorporating multiple approaches can significantly reduce residential water use. Yet, they also determined that such programs would only reduce demand by 1.1 to 4.0 percent.

Water conservation is both easy and difficult because of the lack of a quantitative relationship between the performance of landscape plants and the inputs of water. The diversity in landscape species within individual landscapes and their water use characteristics make whole mixed landscape irrigation management recommendations difficult (Kjelgren, Rupp, & Kilgren, 2000). Incorporating native vegetation, "low water

use plants," and even desert adapted species in the landscape may not always result in water conservation. Minimal research exists to document the impact of landscape design type and plant choice on water conservation; studies have indicated that these two factors alone do not result in reduced landscape water use.

Peterson, McDowell, and Martin (1999) provided compelling evidence that landscape water use was influenced more by irrigation management by Arizona municipal water consumers than by landscape design and plant type. They suggested factors such as plant density, total landscape foliage cover, plant size, and growth rate were greater determinants of water applied to landscapes than the presence or absence of low water requiring or desert adapted plant materials. The San Antonio Water System (SAWS) conducted a pilot study to determine the effects of converting existing residential landscapes to water conserving landscape designs that included native and low water use plants from a recommended plant list on monthly household water consumption (Finch, personal communication, 2003). According to Finch, the results of the SAWS study indicated that about 25% of the households that participated had lower monthly irrigation because of the change in landscape design and plant type. About 75% of the participants had equal or greater monthly irrigation after changing to the landscape design and plant materials recommended by SAWS. The failure of 75% of the participants to achieve water savings after converting to a "water efficient landscape" was associated with poor irrigation management practices.

Many water consumers lack the ability to manage landscape irrigation efficiently and therefore changing to landscape designs that include native, drought resistant, or

even plants adapted to desert environments will not guarantee municipal water savings. Evapotranspiration (ET) is the measured amount of total water a plant needs. Potential evapotranspiration of a grass reference crop (ETo) is the technical term that observes the potential ET assuming the crop is under well watered conditions and deep soils (Texas ET Network, 2010). Instruments from research plots have the ability to measure actual evapotranspiration (ETa) on a given day. Knowledge of actual water lost via ETo from landscapes is required to irrigate landscapes efficiently.

Havlak (2004) measured ETa in an irrigated Weslaco, Texas landscape comprised of turf and woody ornamentals using ETo as a reference. Havlak determined a landscape coefficient that could be used for irrigation scheduling. The landscape irrigation coefficient estimated from daily ratios of ETa:ETo was 0.65 for the period of February to September 2003.

Even when using a water efficient landscape, poor irrigation practices resulted in increased outdoor water consumption (Havlak, 2004). Good zoning, irrigation system design, and hardware reduce soil and landscape variability (Carrow, 2006). The real water management issue is finding out how consumers can learn to exploit water conservation strategies while sustaining economic viability (Carrow, 2006). As the need to conserve water has increased, so has water usage. City ordinances have started changing landscape water rights, making decisions as to qualifying turfgrass species that are allowed for planting, and in some cases outright banning the use of turf altogether (Water Right, 2003). In San Antonio, SAWS offered a rebate program to home consumers who applied xeriscape landscape design principles that included plants with a

low water requirement Yet, research has shown that xeriscape landscape designs can actually use more water annually (Martin, 2001, 2003). These programs being created may be appropriate for conserving water in locations where water is seasonally scarce.

Turfgrass is an exceptional landscape resource because of the enrichment it brings to life. Without turfgrass and trees to cool the soil surface, urban heat islands may develop (Jones et al., 1990; Oke, 1982). Turfgrass entraps organic pollutants, protects the loss of soil from erosion, enhances degradation of pesticides, reduces climatic temperature, provides fire protection by making a noncombustible green zone, gives a self-repairing living groundcover, aesthetic beauty, and most importantly to homeowners, enhances property and home values (Beard & Green, 1994). Research studies have confirmed that water conservation may be achieved to a point prior to the permanent decline in turfgrass quality. This implies the potential for a decrease in environmental contribution, recreational usage, and the economic value of the property (Carrow, 2006).

According to Hughey and others (2004), “While environmental and conservation-type surveys have been undertaken over the last decade (Heylen Research Centre, 1993; Petersen, et. al, 1997; Massey University, 2001) there have been few ongoing surveys of perceptions of the environment”. The Landscape Water Management Survey attempts to grasp home consumer’s perceptions on irrigation efficiency and methods. The word “landscape” may be first perceived as a picture idea (Titchener, 1899). When gazing at a landscape and turning eyes to different parts, it

cannot be said how many perceptions take in the scenery or where each perception ends (Spencer, 1872). Therefore, perception may be difficult to quantify.

Consumer awareness must be addressed for meaningful water conservation. Changing home consumers' landscape irrigation practices depends on a successful water conservation education program and a shift in their traditional practices (Aston & Whitney, 1993). A strong need exists to evaluate home consumers' perceptions about landscape water conservation and to use these perceptions to develop educational programs that effectively alter home consumers' water conservation management practices.

PURPOSE AND OBJECTIVES

The purpose of this study was to determine selected College Station home consumers' perceptions of landscape irrigation and water management. The objectives were to:

1. Assess home consumers' perceptions and methods of:
    a. efficient landscape water use
    b. landscape watering needs
    c. landscape watering practices
    d. sources of information for irrigation practices;
2. Determine historical landscape water use by home consumers;
3. Determine the magnitude of relationships between home consumers' perceptions of landscape water conservation and actual water consumption.

METHODS AND MATERIALS

Design

Descriptive survey methods with a correlational design were used to fulfill the purpose of this study. Online data collection methods were chosen for questionnaire delivery because of its ability to achieve fast response rates at minimal expense (Ladner, Wingenbach, & Raven, 2002). Data were collected after obtaining approval to conduct the study from the Texas A&M University Institutional Review Board (#2005-0485).

Population

Nine-hundred seventy-nine homes from three subdivisions of the College Station Water Utilities in College Station, Texas were targeted as the population of interest. Homes were chosen to represent landscapes of different maturities. One hundred eighty homes were eliminated in the survey due to unknown meter usage, vacant property, or due to a smaller or larger lot sizes than the targeted households.

Sample Size and Sampling Unit

Seven hundred ninety-nine family homes were selected that had valid water meter data on actual home water usage available. The sample population was taken from College Station, Texas from three subdivisions based on the age of the house. Houses in one subdivision were less than five years old with average valuations of $145,600. Houses in the second subdivision were six to ten years old (average valuations of $148,900), and houses from the third subdivision were between 15 to 20 years old with average valuations of $143,803.

Each single family home was identified by its water meter number and not a physical address so that home consumers remained anonymous. Properties of less than 93 and greater than 836 m^2 were excluded from the sample. Residencies for which water meters indicated less than 3,800 liters per month in any month were excluded. These sites were excluded because they were lots without houses or vacant homes.

The occupants of each residence were the target sampling unit to assess consumers' perceptions about landscape water conservation. Each of the 799 single family homes was mailed a survey instrument.

Instruments

Historical landscape water use for the selected College Station home consumers were collected with each residence's actual water use, taxable value, heated area, and the water meter identification number. Landscape size for each residence was estimated by:

Landscape area = lot size - heated area

This estimate of landscape area in square feet was used to ensure that landscape water use comparisons among households was based on square footage of landscape and for comparison of water use per square foot of landscape size with survey responses. Average in door water use was determined from measurements of usage for December, January, February, and March. Out-of-door water usage was estimated by subtracting the average use for December, January, February, and March from monthly water usage during other months that was provided by College Station Utilities.

An instrument, the Landscape Water Management Survey, validated by experts in the field of conservation, was used to collect survey data. The survey contained 14 questions on water use and home consumers' perceptions.

Three questions ranging from *not important* to *very important* (on a scale from 1-6; 6 = *very important*) measured respondents' perceptions of efficient landscape water use and landscape quality. The survey questions were:

1. How important is landscape irrigation to you?
2. How important is an attractive, healthy landscape to your quality of life? and
3. How important would an incentive be for you to operate your system more efficiently and use less water for landscape irrigation?

Respondents were asked how many times they irrigated their landscapes, ranging from 0-7 times weekly. Respondents recorded how much water was needed, on a scale of 1 = *A Little* to 6 = *A Lot*, to maintain plant health and quality for their (a) lawns, (b) trees, (c) shrubs, (d) flowers, (e) ground covers, (f) potted plants, and/or (g) vegetable gardens.

Respondents answered, using a scale of 1 = *Not at All* to 6 = *Always*, as to what factors influenced their irrigation practices from the choices (a) the condition of my plants, (b) frequency of rain, (c) temperature, (d) when my neighbor waters, (e) irrigation installer decides, (f) my landscaper decides, or (g) other (the respondent had the option to insert data).

Respondents were asked how they rated their landscape irrigation practices as *very efficient*, *somewhat efficient*, *inefficient*, or had the option of answering *no opinion*.

Respondents had the option of checking more than once on how they irrigated their landscape via *in-ground automatic system, in-ground manual system, hose & sprinkler, hand held hose,* or *I do not irrigate my landscape.*

Respondents checked the sources they used for more information about irrigating landscapes efficiently. Response choices included *television, radio, mail, newspapers, magazines, internet, county extension agent, homeowner's association, garden clubs, local water utilities office, retail garden centers,* or *neighbors*. The respondent could check multiple information sources.

To understand water use outdoors, respondents were asked what other ways they used water out of doors. They could reply with multiple choices, including (a) washing vehicles, (b) swimming pool, (c) spa/hot tub, (d) landscape water feature, (d) washing hardscape, (e) washing pets, (f) children's recreational activities other than a swimming pool, and/or (g) other uses.

Respondents were asked if they considered their water utility bill as abnormally high during the summer months. Answers could range from *yes, no,* or *undecided*. Also, respondents were asked if they knew (*yes* or *no*) how many liters of water they used to irrigate their landscape monthly.

Data Collection

Historical water use data from the target population was obtained from January through December for 2000 to 2002. Data collection for the survey ran from November 2005 to August of 2006. The first survey letter was sent out on November 7, 2005. The

database collected 207 out of the total 211 received surveys by January 18, 2006. This concludes that 98% of the completed surveys were entered in the winter of 2005.

Letters were sent to 799 homes for which their historical landscape water use was available. The letter provided instructions about participation in the survey via the internet (see attached instruction letter and survey instrument in Appendix A). Each household had a different password so home consumers could only respond one time. Passwords were water meter numbers. Confidentiality of participants was maintained by recording responses by water meter number only and by using a secure database.

A reminder letter along with an attached hard copy of the survey was mailed to home consumers who did not reply within four weeks. A reminder postcard was sent to the non-responders two weeks later, and a final notice with another hard copy of the survey was sent two weeks after the reminder postcard was mailed. Responses to completed paper surveys were entered using the password included on the returned survey. All postal mailing was conducted by Texas A&M University Copy Services.

Statistical Analysis

Descriptive statistics were applied to each section and the instrument as a whole. Demographic data were analyzed using percentages and frequencies. The data were analyzed to provide descriptive statistics and correlations among questions on the Landscape Water Management Survey and correlations among the survey questions and actual home consumer landscape water use.

RESULTS AND DISCUSSION

Landscape Water Management Survey

The Landscape Water Management Survey was presented to 799 participants. From these 799, 26 surveys were thrown out due to flawed addresses. There was an outcome of 211 responses for a 27% return. These 799 single family homes were selected because valid water meter data on actual home water usage was available for the households. The survey included 14 questions on perceptions of their own landscape water use. The outcome of these questions provided insight into the perceptions of efficiency, information sources, environmental factors, methods, quality, and knowledge of landscape water use.

Objective 1.a. Assess home consumer's perceptions and methods of efficient landscape water use.

The survey initially wanted to establish how the respondent perceived their landscape. If the rating was low, then many of the questions would have little to no relevancy to the respondent. It was imperative to know how much the participant actually valued their landscape. When participants were asked how important an attractive, healthy landscape is to their quality of life, 182 (89.6%) of the respondents indicated above average importance and 21 (10.4%) indicated below average importance. On a scale of 1 (not important) to 6 (very important), there was a (M=4.76, SD=1.1). These data indicated that almost 90% of the respondents do have strong positive feelings about their landscape. The responses illustrate that the participants are interested in maintaining a vigorous landscape and probably desire to do so long-term.

The 30 year annual rainfall in College Station averages around 102cm, yet periods of droughts do occur (NOAA, 2010). The perceived value of the respondents landscape to their quality of life suggested why the respondent had strong feelings about the significance of landscape irrigation. When the participant was asked how important landscape irrigation is to them, 172 (84.7%) of respondents indicated that irrigation was above average in importance and 31 (15.2%) rated irrigation below average in importance. The response had a (M=4.66, SD=1.1). These results indicated that the majority of participants perceive that irrigation is important for an attractive, healthy landscape.

When asked if the participant considered their water utility bill to be abnormally high during the summer months, 98(46.9%) reported no, 77(36.8%) said yes, and 34 (16.3%) were undecided. Since more than 30% of the respondents considered their water utility bill to be high during the summer months, an opportunity exists to demonstrate how that bill can be lowered through conservation irrigation.

When asked if the survey participant knew how many liters of water he/she used each month, only 17 (8.1%) of the respondents answered yes. One hundred ninety-two (91.9%) of the respondents did not know how many liters of water they used each month.

To better understand how to get people to start conserving water, it was pertinent to find out what will make consumers turn off their irrigation systems or irrigate less. The survey asked how important would an incentive be to operate the respondent's system more efficiently and use less water for landscape irrigation (Table 1).

Table 1. *Importance of incentives to operate irrigation systems more efficiently to use less water for landscape irrigation.*

	Responses by Category					
Incentive Type	1	2	3	4	5	6
Lower utility bill due to reduced use	5	10	11	14	45	110
Better landscape quality	6	11	13	30	49	80
Healthier landscape plants	4	9	21	28	48	80
Rebates for efficient irrigation systems	17	11	15	24	42	76
Conserving water is enough incentive	3	12	29	32	53	67
Other	7	3	1	2	5	18

Note. Scale: 1 = Not Important…6 = Very Important.

Rating the responses below average (1-3) and above average (4-6), 169 of the respondents would like to have a lower utility bill due to reduced irrigation use. Sixty-seven of the respondents replied conserving water is enough of an incentive, but 192 of the respondents replied they don't even know how much they use. Demonstrating the relationship between efficient irrigation, better landscape quality, plant health, and a lower utility bill would result in a positive impact on water conservation. If they have better information on how to determine water usage then home consumers could, in actuality, conserve water, have a healthier and high quality landscape, and have a lower utility bill. In contrast to other cities, there have never been water restrictions in College Station, TX resulting in less incentive to become educated for water conservation (J. Nations, personal communication, May 4, 2004). This implies water consumers in this population have never actually been required to irrigate less.

Objective 1.b. Assess home consumer's perceptions and methods of landscape watering needs.

Irrigation water requirements of landscape plants differ for most landscape plants (Parsons et al., 1997). In order to develop effective landscape water management strategies it is important to understand home consumer perceptions about the amount of irrigation needed by various plant types. Participants were asked how much water they perceived lawns, trees, shrubs, flowers, ground covers, potted plants, and vegetables needed to maintain plant health and quality (Table 2).

Table 2. *Perceived amount of water needed by different landscape plant types.*

	Frequency by Plant Type					
Plant Type	1	2	3	4	5	6
Potted Plants	33	35	45	37	22	18
Lawns	5	22	57	60	48	16
Vegetables	26	16	46	35	36	15
Flowers	18	24	54	55	41	7
Trees	32	50	55	41	16	5
Shrubs	24	48	73	40	12	3
Groundcovers	44	47	64	26	5	3

Note. Scale: 1 = A Little…6 = A Lot.

Most of the respondents perceived that their lawn and flowers need about the same amount of water to maintain plant health and quality. Most of the respondents answered that trees, shrubs, ground covers, potted plants, and vegetables require the same amount of water. The survey did not attempt to establish the respondents' knowledge of the maturity of their landscape or experience with the plant types used. Yet, the responses illustrate that home consumers perceive that diverse plant types have

similar water needs. Their irrigation practices therefore would likely not be different for high and low water use plants.

In the previous question, the respondent had the option of choosing from a range of 1 “A Little” to 6 “A Lot”. In order to further characterize the responses pertaining to water requirements, the response for each plant type was summed. If the sum ranged from 7 to 14, the respondent had a positive perception on how much water plants actually need. If the sum ranged from 15 to 28, the respondent had a neutral perception on irrigation needs. If the sum of the responses to the amount of irrigation water needed for plant types ranged from 29 to 42, the respondent was labeled as having a negative perception on how much water plants need. Examples are shown in Table 3.

Table 3. *Example of the amount of water needed by plant type and the expression of a respondent’s perception as positive, neutral, or negative.*

Lawns	Trees	Shrubs	Flowers	Ground Covers	Potted Plants	Vegetables	Sum	Ranking
3	1	2	1	2	1	2	12	Positive
5	2	2	2	2	2	2	17	Neutral
6	4	3	6	3	6	5	33	Negative

Note. Responses ranged from 1 to 6; summation of all plant types helps differentiate respondents’ positive, neutral, or negative perceptions about water requirements per plant type.

Table 3 illustrates an example of a positive, a neutral, and a negative perception of plant water needs. A positive ranking indicated that the respondent had a reasonable

perception of the amount of water the plant type needed. The survey indicated that 44 respondents had a positive perception, because they answered in the low range of water needs for their landscape. There were 130 neutral perceptions and 31 negative perceptions. The 31 respondents with a negative perception, therefore, believed that a substantial amount of water is needed to sustain their landscape.

Objective 1.c. Assess home consumer's perceptions and methods of landscape watering practices.

Knowing how the respondents perceive their irrigation practices was important for comparing their perceptions to their knowledge of the amount of water they used for irrigation each month. Whether they perceived their irrigation practices as efficient or inefficient was also of interest for comparison with the historical amount of water they used for irrigation (Table 4).

Table 4. *Respondent perceptions of the efficiency of their irrigation practices.*

Efficiency Rating	*f*	%
Somewhat efficient	141	67.8
Very efficient	38	18.3
Inefficient	23	11.1
No opinion	6	2.9

One hundred seventy-nine of the respondents rated their irrigation practices somewhat to very efficient. The other 29 either had no opinion or rated their practices inefficient. The respondents who rated their irrigation practices inefficient or had no

opinion are suggested to have a negative perception about their irrigation practices. Respondents who rated their irrigation practices somewhat efficient are labeled as having a neutral perception, and the very efficient as having a positive perception about their irrigation practices. There was not a significant correlation (0.0251) between perceived landscape irrigation efficiency and perceptions about plant water requirement. Those that had a negative perception about plant water requirements did not consider themselves to irrigate any more efficiently or inefficiently relative to other respondents.

A series of questions pertained to irrigation practices, water requirements, and specific plant needs. Knowing the amount of irrigations per week provides a perspective on typical landscape irrigation frequencies. Participant's responses indicated irrigation from 0 to 7 times each week (Table 5).

Table 5. *Number of weekly landscape irrigations reported by respondents.*

Irrigations/Week	*f*	%
3	76	37.6
2	64	31.7
1	37	18.3
4	9	4.5
0	8	4.0
5	5	2.5
6	2	1.0
7	1	0.5

The questions in the Landscape Water Management Survey were not adjusted for seasonal influences. However, according to Pittenger and Gooding (1971), "*A person*

behaves in terms of what is real to him or her and what is related to his or her self at the moment of action" (Knowles, Holton, and Swanson, 2005). This implies the respondent was answering upon the time the survey was received. The survey was first sent to home owners on November 7, 2005. Most respondents (140) irrigated two to three times per week whereas, 17 of respondents irrigated from 4 to 7 times each week with a (M=2.34, SD=1.1). These responses indicated that 17 (8.5%) of the respondents irrigate their landscape more than 3 times each week and 185 (91.6%) of respondents irrigate their landscape 3 times each week or less.

Matching irrigation water application amounts with water consumed by plants is critical to efficient irrigation and water conservation. The survey indicated a disconnect between the perceived irrigation efficiency of respondents and their knowledge of water applied to their landscape. Landscape water conservation strategies should include scrutiny about how to determine actual amount of irrigation water used. It is difficult to understand how so few participants knew how many liters of water they use each month yet such a high frequency believe they have somewhat to very efficient irrigation practices.

Not all water used out-of-doors goes towards landscape irrigation. Where water is being used is important for establishing and achieving overall water conservation goals (Table 6).

Table 6. *Alternate or additional uses of water out-of-doors.*

Use	*f*	%
Washing vehicles	112	38.4
Washing hardscape (patio, deck, driveway, sidewalks)	55	18.8
Washing pets	42	14.4
Children's recreational activities other than a swimming pool	39	13.4
Swimming Pool	16	5.5
Other	10	3.4
Spa/Hot tub	9	3.1
Landscape water feature (wall fountain, fountain, etc.)	9	3.1

The respondents had the option of replying more than once to this question. One hundred twelve of the respondents indicated they use water out-of-doors to wash their vehicles. This water may not be wasted if they wash these vehicles on the lawn with bio-degradable soap instead of allowing the water to flow off-site. An additional large percentage of respondents also indicated that they use water for washing hardscapes. Alternative methods of cleaning hardscapes should be encouraged to reduce water consumed.

Objective 1.d. Assess home consumer's perceptions and methods of sources of information for irrigation practices.

It is good to know of the source or action that determines when one will irrigate landscapes. This could be a way of educating people on water conservation and irrigation water needed by various plant species (Table 7).

Table 7. *Factors affecting respondent decisions about when to irrigate landscapes.*

	Percent of Responses by Response Category					
	1	2	3	4	5	6
Frequency of rain	4	4	5	16	54	122
Temperature	3	4	10	35	77	74
Condition of my plants	3	12	19	36	61	73
Other	36	1	1	3	5	10
My landscaper decides	155	9	13	4	7	7
Irrigation installer decides	162	13	11	3	4	3
When my neighbor waters	162	13	14	2	3	2

Note. Scale: 1 = Not at All…6 = Always.

A high number of respondents indicated that when their neighbor waters, irrigation installer decides, or their landscaper decides has no affect on when they irrigate. Most of the respondents do have neighbors and this question is understandable. Many people don't want to admit they depend on neighbors. Yet, it is difficult to understand why irrigation installers and landscapers do not affect when the respondents irrigate. It might be that the respondent does not have contact with either but if they do, the irrigation installer and landscaper could be the educator on teaching the respondent the amount of water each plant type needs. The irrigation installer could then teach a respondent with an automatic sprinkler which zones need more or less water. These data would indicate an opportunity for landscape and irrigation professionals to have a greater influence on landscape irrigation water conservation. The majority of the respondents reported that the condition of their plants, the frequency of rain, and the temperature always affect when they irrigate. This is good to know because if there is an

abundance of rainfall or perhaps a freeze they would likely reduce landscape irrigation for a period.

Irrigation methods help one understand why people might be overwatering or under-watering. If there is a drought, then one would have to be more attentive to irrigating their landscape if they don't have an automatic programmed system (Table 8).

Table 8. *Frequency and percentage of types of methods used to irrigate landscapes.*

Irrigation Methods	*f*	%
In-ground automatic system	150	44.1
Hand held hose	90	26.5
Hose and sprinkler	64	18.8
In-ground manual system	35	10.3
I do not irrigate my landscape	1	0.3

The participants were able to answer more than once to the method of irrigation used. Almost half of the respondents use a hand held hose in conjunction with another method. Two hundred and forty of the respondents irrigate their landscape with an in-ground system. One hundred fifty have automatic systems. If the respondent is not aware of plant water needs and the amount of water that is being applied to the plant material, they may be wasting water, money, and potentially reducing plant health and landscape quality. In-ground systems are an easy way to irrigate but there were no efforts to ascertain if these systems were monitored by the respondent.

The survey asked if in the respondent's opinion, is there enough information available about how to irrigate Texas landscapes efficiently. Eighty-seven reported no, 55 reported yes, and 55 were undecided. The participants were asked what sources they use to get more information about irrigating landscapes more efficiently (Table 9).

Table 9. *Sources of information about irrigating landscapes more efficiently used by respondents.*

Source	*f*	%
Internet	108	16.7
Newspaper	70	10.9
Water utilities office	62	9.6
Retail garden center	61	9.5
TV	59	9.1
County extension agent	54	8.4
Home owners association	52	8.1
Magazines	49	7.6
Mail	46	7.1
Radio	35	5.4
Neighbor	33	5.1
Garden club	16	2.5

The participants could answer multiple times to this survey question about sources of information that they use. It is important to remind the reader that this is College Station, TX specific. Within this sample of the population, 35 of the respondents depend on the radio for information about irrigation. Many respondents do not depend on a garden club or their neighbor for information about irrigating. However, 108 of the respondents reported that the internet is the source they would use to obtain information about irrigating landscapes more efficiently. Internet based information appears to be the most efficient way to deliver information to this population. There is an opportunity here for the water utilities office and the retail garden centers to become more pro-active in reaching out to home consumers with landscape water management information.

Historical Outdoor Water Usage

Figures 1, 3, and 5 present the outdoor water usage between respondents and non-respondents for 2000, 2001, and 2002. Figures 2, 4, and 6 present the precipitation, maximum temperature, and minimum temperature for the same three years.

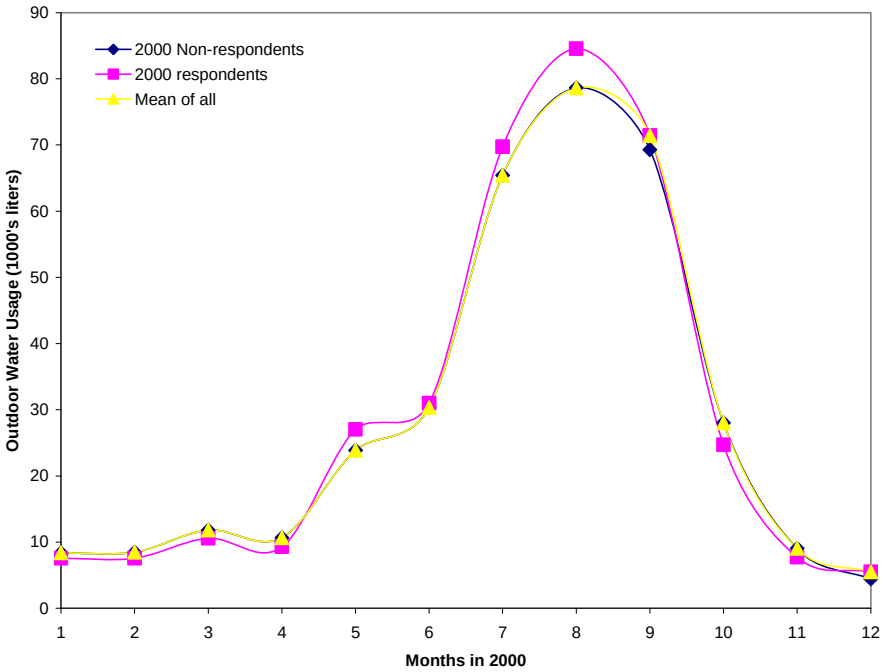

Figure 1. Average historical outdoor water usage by respondents versus non-respondents in 2000.

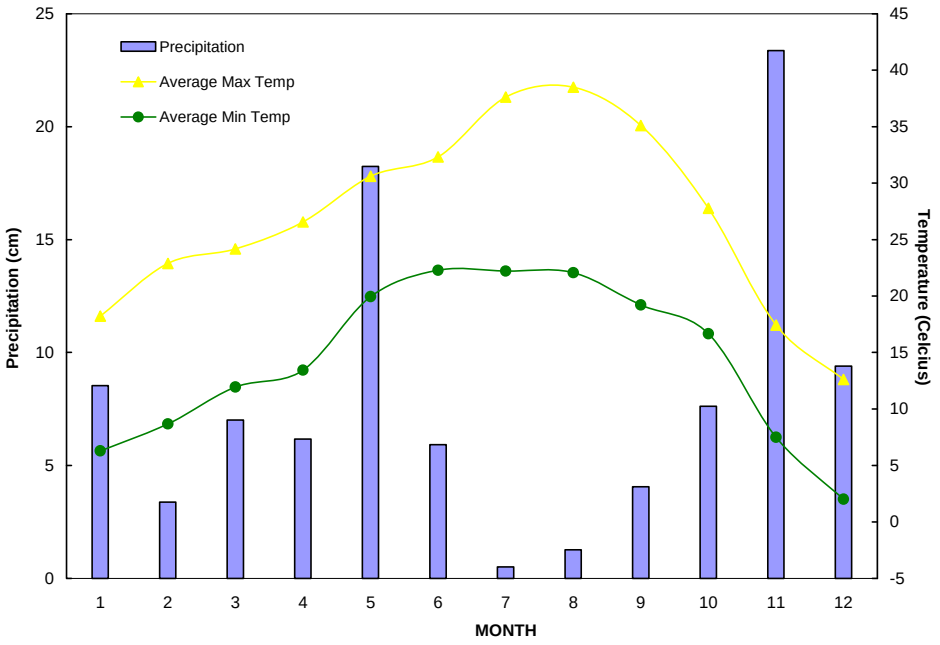

Figure 2. Maximum and minimum temperature and precipitation by month in 2000.

The trend in outdoor water usage among non-respondents and respondents in 2000 was similar (Figure 1). In 2000, the increase in outdoor water usage began in April with peak usage in July, August, and September. Peak outdoor water usage in July, August, and September corresponded to relatively low rainfall during those months (Figure 2). Outdoor water usage began to decrease into late-summer and fall. However, more than 30cm of precipitation were recorded in October and November and although there was a trend of a steady decrease in outdoor potable usage, no landscape irrigation would have been required during October and November based on previous estimates by White et al. (2004).

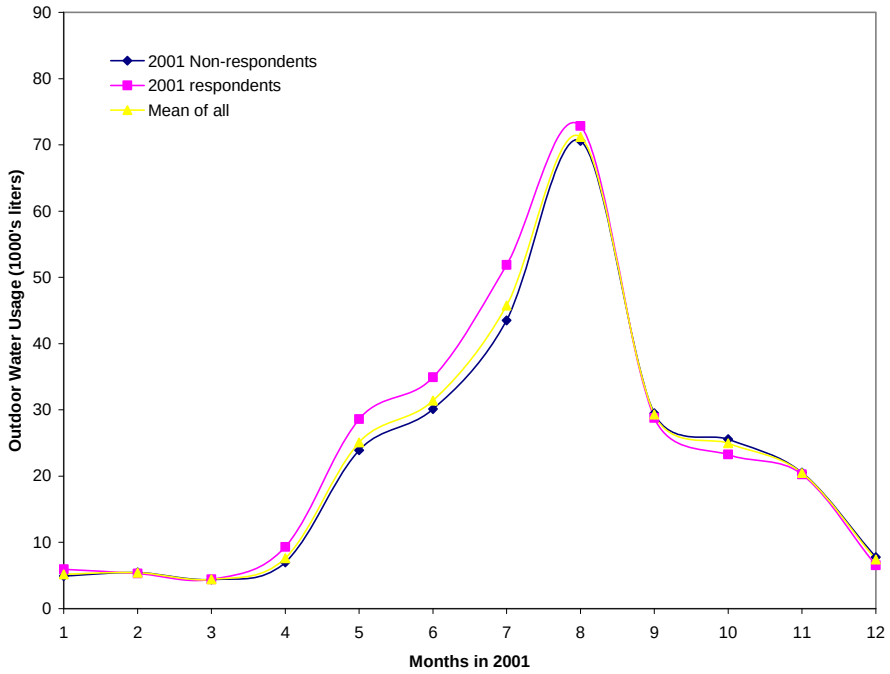

Figure 3. Average historical outdoor water usage by respondents versus non-respondents in 2001.

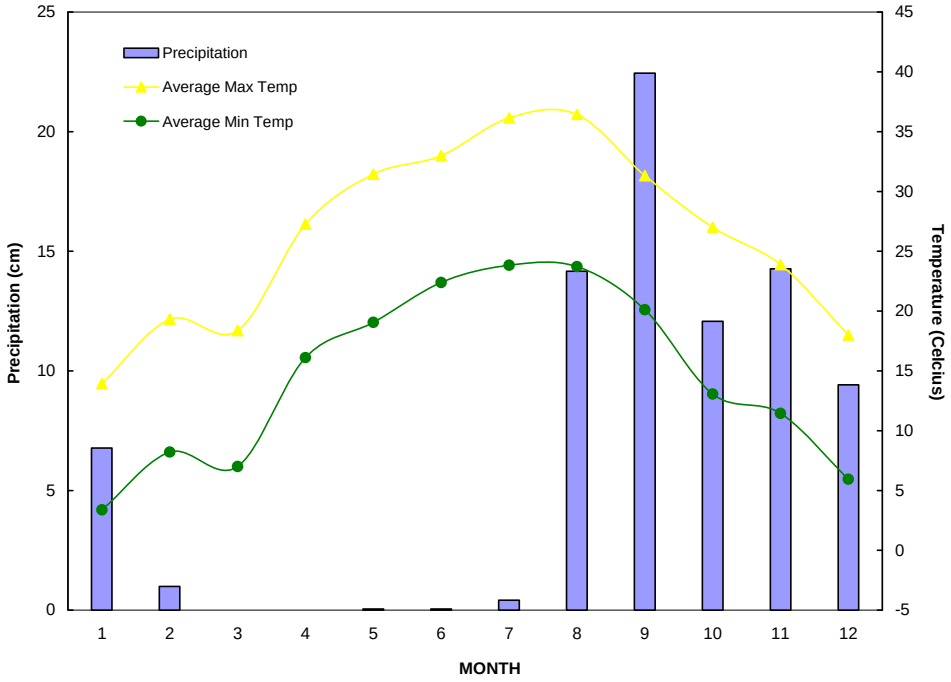

Figure 4. Maximum and minimum temperature and precipitation by month in 2001.

In 2001, outdoor water usage started to increase in the middle of March (Figure 3). Zero inches of precipitation were recorded in March and April and only 0.10 cm of precipitation were recorded in May and June (Figure 4). A marked decrease in outdoor water use occurred between August and September although landscape water requirement for the months of September, October, November, and December were estimated to be near zero (White et al., 2004) The outdoor water consumed by non-respondents and respondents was similar in 2001.

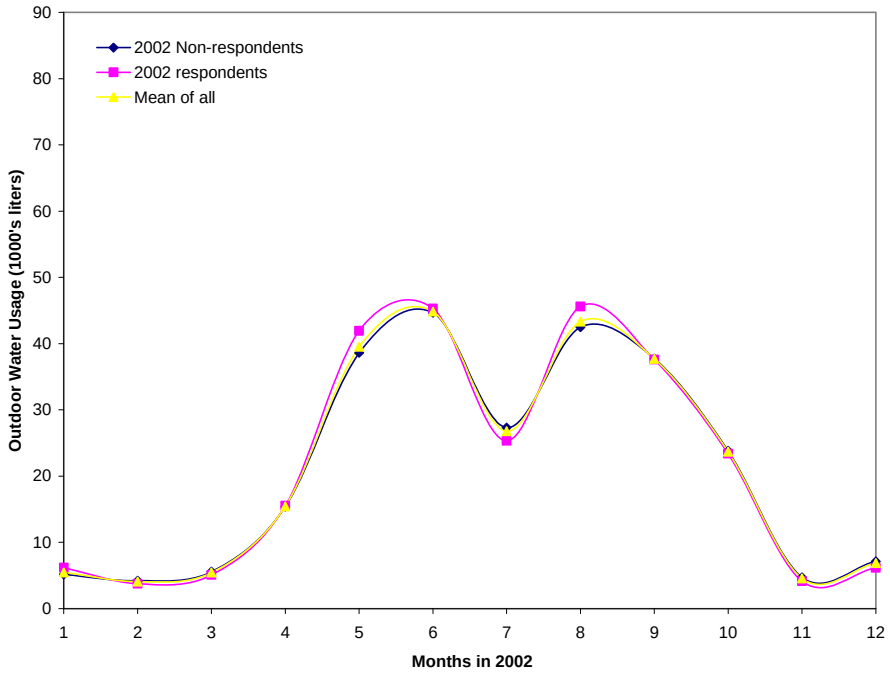

Figure 5. Average historical outdoor water usage by respondents versus non-respondents in 2002.

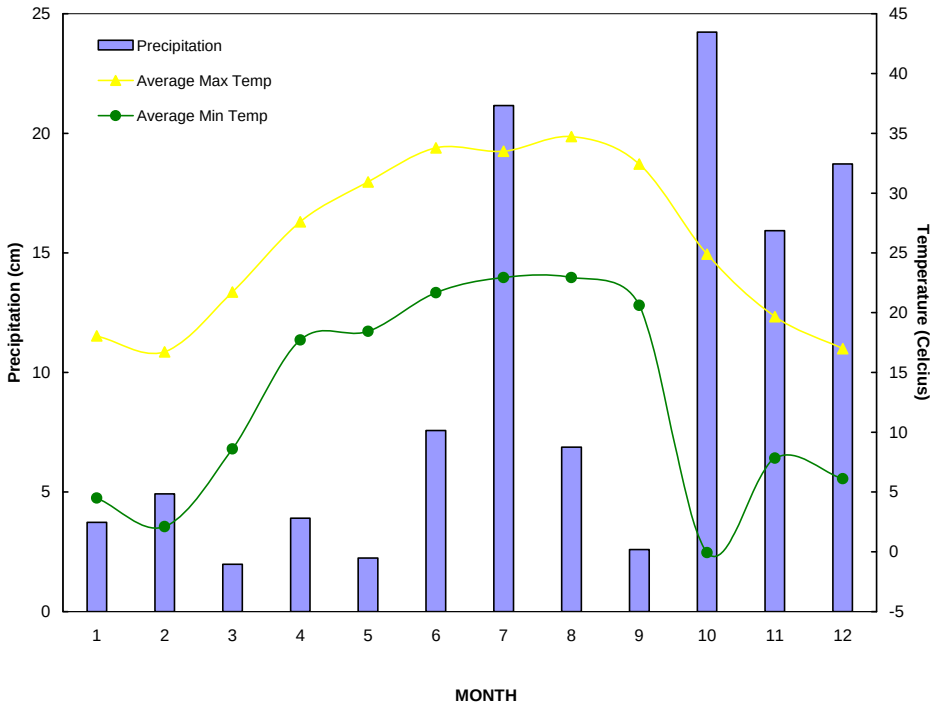

Figure 6. Maximum and minimum temperature and precipitation by month in 2002.

In 2002, there was a typical increase in outdoor water usage in April through June (Figure 5). A substantial reduction in average outdoor water usage in July coincided with over 21cm of precipitation during that month (Figure 6). However, average outdoor usage peaked in August for a second time in 2002 even though substantial precipitation was recorded. Precipitation amounts during July, August, September, and October should have precluded the need for supplemental landscape irrigation to maintain plant health and quality (White et al., 2004) yet substantial

amounts of irrigation were applied to landscapes based on average outdoor water usage during July through October.

In the Landscape Water Management Survey, 112 of the respondents reported that the frequency of rain always affects their irrigation practices. This is not reflected in the historical outdoor water usage reported for respondents during 2000 and 2001.

Historical Outdoor Water Usage in Relation to Participant Responses

A gradual increase in the average water used and estimated water used out-of-doors was observed from May through August across all 3 years (Table 10). Although total water used increased about 16,300 liters from May through August, water used out-of-doors increased over 12,500 liters during the same period. During June through September, out of door water use accounted for more than 62% of the total water consumed. During August, almost 56% of all water consumed was used out-of-doors.

The mean outdoor water usage during 2000, 2001, and 2002 was compared to the participants rating of their irrigation efficiency (Figure 7).

Table 10. *Average total water usage, water used out-of-doors, and percentage of total water used out-of-doors by survey respondents in College Station, Texas from January through December for 2000, 2001, and 2002.*

	Average total water used	Average water used out-of-doors	Percentage of total water used out-of-doors
Month	----------1,000's of liters ----------		%
1	27.3	0	0
2	25.4	0	0
3	26.9	0	0
4	34.1	0	0
5	59.1	7.4	12
6	63.1	11.5	18
7	72.1	20.5	28
8	91.8	39.7	43
9	69.5	17.7	25
10	48.4	0	0
11	31.8	0	0
12	26.5	0	0

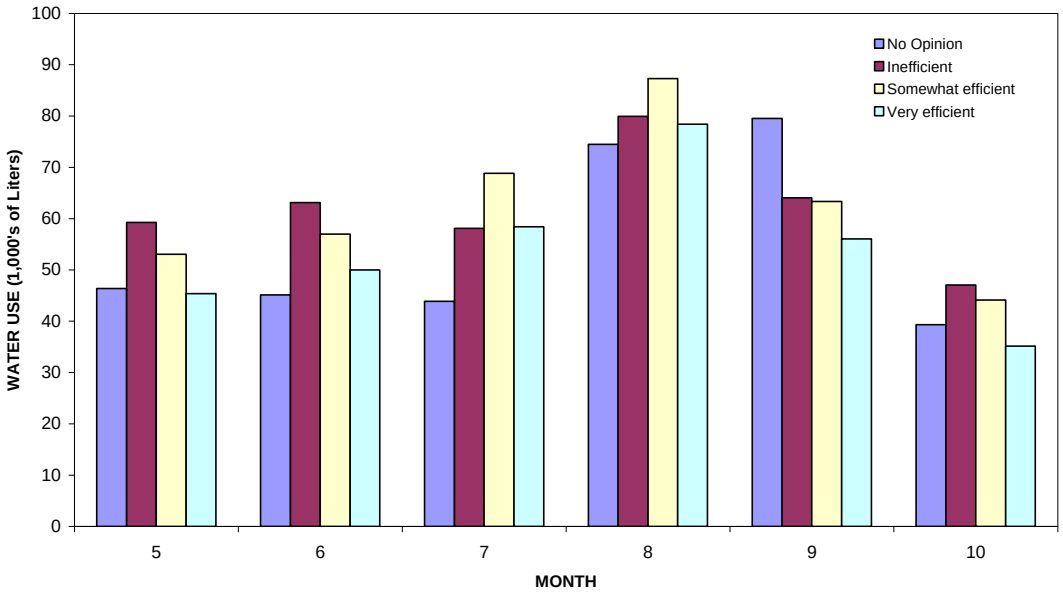

Figure 7. Outdoor water used by month in comparison to participants' rating of their irrigation practices.

In May, respondents who rated their practices to be very efficient used slightly more than an average of 45,300 liters out-of-doors per month and the respondents who gave no opinion on their efficiency rating were the second lowest water users averaging 46,400 liters. The highest water users in May averaging over 59,200 liters of water use out-of-doors were the respondents who rated their irrigation practices to be inefficient. In June, respondents who rated their practices to be inefficient were the highest out-of-door water users and consumed more than 63,100 liters of water out-of-doors on average.

The respondents who believed they had very efficient irrigation practices used on average 50,000 liters of water out-of-doors in June. In July, the respondents who had no

opinion about their outdoor water usage efficiency used on average 1,240 liters less than the month before. Also, the respondents who rated their irrigation practices inefficient used more than 3,800 liters less in July than in June. The respondents who rated their systems somewhat efficient to very efficient had almost 20% greater outdoor water usage in July compared with June.

August was the peak month for water use out-of-doors with the respondents who rated their irrigation practices somewhat efficient using more than 87,300 liters of water. Those that rated their irrigation practices as inefficient used slightly more than 80,000 liters. The respondents who gave no opinion on their irrigation efficiency used more than 79,900 liters of water out-of-doors in September. The respondents who rated their practices to be very efficient used slightly over 56,000 liters of water in September.

In October all of the outdoor water usage decreased compared to usage in August and September. The respondents who rated their practices inefficient used about 17,000 liters less in October than September. The respondents who rated their practices to be somewhat efficient used slightly approximate to 19,200 liters less and the respondents who rated their practices to be very efficient used over 20,800 liters less in October than in September.

In May and June the participants that perceived their irrigation practices as inefficient used 11% more water out-of-doors on average than those participants that perceived their irrigation practices as somewhat efficient. Yet in July and August, the participants that perceived their irrigation practices as somewhat efficient used 12% more water on average than those participants that perceived their irrigation practices as

inefficient. In September and October the participants that perceived their irrigation practices to be inefficient used 18% more water than the participants who perceived their irrigation practices to be very efficient. During 2000, 2001, and 2002 respondents did not use water for landscape irrigation in amounts consistent with their perceived irrigation efficiency.

Respondents used the most water out-of-doors in August for 2000, 2001, and 2002. There was not a significant correlation between historical outdoor water usage in August and perceptions about plant water requirement (Table 11).

Table 11. *Linear dependence between historical outdoor water usage and perceptions about plant water requirements.*

Year	2000	2001	2002
Correlation	0.02	0.05	0.07

In addition, there was not a significant correlation (-0.0603) between respondents' perceptions of irrigation efficiency and perceptions of plant water needs. Those that had a positive perception about plant water requirements did not necessarily irrigate less than other respondents.

SUMMARY AND CONCLUSIONS

The Texas Water Development Board stated that if there is a drought in 2050, approximately 43% of municipal water utilities will not have sufficient water available to meet demand (TWDB, 2005). Researchers have already suggested that changing home consumers' landscape irrigation practices depends on a successful water conservation education program and a shift in their traditional practices (Aston & Whitney, 1993). The Landscape Water Management Survey and the outdoor historical water usage data presented in this paper support this conclusion.

I was very satisfied with the 27% response from The Landscape Water Management Survey. It is clear that about 90% of the respondents do believe that having a healthy and attractive landscape does add to their quality of life. This indicates that it is important to reach out to the community and help it understand the importance of measured irrigation practices. The Survey did not address participants to consider seasons of the year. Therefore, the number of times the respondent irrigated their landscape might change throughout the year. The results of the study indicated that more than 91% of the respondents irrigate their landscapes 0-3 times per week in the summer months when there is minimal rainfall. The results also indicated that respondents irrigated 0-3 times per week even when there is substantial rainfall.

When the respondent was asked how much water is needed by plant type, flowers and turfgrass were rated the highest. Annual flowers generally do require more water than other landscape plant types and if already established and rainfall is adequate, turfgrasses may only require moderate supplemental irrigation. The responses show that

diverse plants were perceived to have the same watering requirements. The Survey also showed that there were 130 neutral perceptions and 31 negative perceptions among participants about the plant water requirements. There is a demonstrated need to educate the public about seasonal plant water needs. Again, there have never been water restrictions in College Station, TX that imposed incentive to become educated for water conservation (J. Nations, personal communication, May 4, 2004).

The Survey showed that about 86% of the respondents rated their irrigation practices to be somewhat to very efficient. Yet only 8.5% of the respondents reported knowing how many liters of water they used out-of-doors each month. This indicates that most of the home consumers do not know how many liters of irrigation water they use each month. Knowing the volume of irrigation water applied is crucial to estimating the efficiency of an irrigation system. Once one can determine the plant material's water need only then can an irrigation schedule be efficient and the number of liters used per month may be adjusted or understood.

Irrigation installers and landscapers have the opportunity and responsibility to teach home consumers how and when to irrigate landscapes. A very small percentage of the respondents indicated that their irrigation installer or landscaper influence their decision on irrigation schedules. Over 70% of the respondents indicated that they have an in-ground automatic system. There could be a possibility that an automatic irrigation system was installed prior to purchasing the home and the homeowner did not know the installer. Landscapes may have already been established when respondents moved into their homes or respondents might landscape themselves. If the home consumer does

have a landscaper, the landscaper also could assist the homeowner as to irrigation requirements. It is very rewarding to know that over 58% of the respondents said that the frequency of rain affected when they would irrigate. This shows awareness to precipitation and a link to home consumers that when it rains, there is no need to irrigate.

Over 40% of the Survey respondents responded that there is not enough information available about how to irrigate Texas landscapes efficiently. The internet was the highest source respondents utilized to get more information about irrigating landscapes more efficiently. This gives experienced individuals in landscape water management, such as the county extension agent, water utilities office, and the retail garden center, an opportunity to educate the public on water conservation and plant water needs. Over half of the respondents indicated that a lower utility bill due to reduced use would encourage them to use less water for landscape irrigation. This reinforces the need for greater educational opportunities for home consumers about water conservation.

The historical outdoor water usage for 2000, 2001, and 2002 all had similar trends in that there was irrigation applied to landscapes when no irrigation was required in particular months. Again, over 58% of the respondents in the Landscape Water Management Survey suggested that the frequency of rain influences their irrigation practices. This is not reflected in the historical outdoor water usage for all three years.

Texas water usage patterns during May through October for the three years (Table 10) and how participants rated their irrigation practices by month (Figure 7) details interesting contrasts. In the month of May, the respondents who rated their

systems to be inefficient used the most liters of water out-of-doors. This is a good indicator that the respondent is aware there are problems in their irrigation practices. The same indicator is reflected in the month of June. The highest out-of-doors water users were the respondents who rated their irrigation practices to be inefficient, using again 11,355 more liters of water than respondents who rated their irrigation practices to be very efficient.

Yet in July and August there was a shift in who used the most water out-of-doors. In July, the respondents who rated their irrigation practices as somewhat efficient to very efficient used more water out-of-doors than participants who rated their irrigation practices inefficient or had no opinion. In August, the respondents who rated their irrigation practices as inefficient used 1514 liters less than the respondents who rated their irrigation practices to be very efficient. There is a misperception by the respondents who rated their irrigation practices to be very efficient for the month of August. If one rates a practice to be somewhat to very efficient, less irrigation water would be used.

In September, the respondents who rated their irrigation practices to be very efficient used 22,700 liters less water out-of-doors than the respondents who gave no opinion. This is a similar trend as in May and June. In October, the out-of-doors water usage decreased significantly by all respondents. This response was well received because the month of October usually ends the growing season for most warm season plants.

The data presented from The Landscape Water Management Survey in relationship to the historical outdoor water use gives a clear understanding that there is a

misperception between how home consumers view irrigation practices and the actual amount of irrigation is used on landscapes. Based on the results of this research, there is a strong need for educational programs to promote and achieve internet accessible programs and information on water conservation. This method would be the most relevant for this population since 108 respondents said this is their main source of information about irrigating landscapes more efficiently.

According the Knowles, Holton, & Swanson (2005), "Learning occurs as a result of a change in cognitive structures produced by changes in two types of forces: (1) Change in the structure of the cognitive field itself or (2) change in the internal needs or motivation of the individual". If educators can help home consumer's start thinking more about irrigation water usage, water as a precious resource, and the need to preserve water, irrigation practices and beliefs may change also. When the price of water on utility bills increases, this will likely cause the motivation to start irrigating properly. However, the need to teach *how* to irrigate properly is indisputable.

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APPENDIX A

Landscape Water Management
Soil & Crop Sciences Department
Texas A&M University
College Station, TX 77843-2474

College Station Utilities
Reliable, Affordable, Community Owned

Water Consumer
«Street»
«City», «State» «Zip»

Dear Water Consumer:

We recently mailed you a Landscape Water Management Survey. If you have already completed the survey, we appreciate your time and willingness to help. If you have not responded, please:

- Go to http://www.ag-communicators.org/surveys/LWMSIntro.htm
- Login using this password: «PassWord»

Or, if you do not have internet access, please:

- Complete the attached survey
- Place the completed survey in the enclosed, pre-addressed, stamped envelop and mail

Your participation will help College Station Utilities and Texas A&M University personnel understand your perceptions about outdoor water use. Your responses will be used to develop information that will help water consumers irrigate more efficiently, enhance landscape quality, and reduce their landscape maintenance costs. Your participation is important. You were chosen to represent about 200 other local water consumers. You may send questions or comments concerning this survey to rh-white@tamu.edu.

With Best Regards,

J. D. Nations
Water Resource Coordinator
College Station Utilities

R. H. White
Professor
Texas AES

D. R. Chalmers
State Extension Specialist
Texas Cooperative Extension

R. D. Havlak
Extension Program Specialist
Texas Cooperative Extension

Texas Cooperative EXTENSION
The Texas A&M University System

Texas Agricultural Experiment Station
THE TEXAS A&M UNIVERSITY SYSTEM

Landscape Water Management Survey

(Only complete this survey and return it by mail if you did not complete the online survey)

INSTRUCTIONS: How to respond? If you think your response to a question would be "above average importance", but not "very important", mark the response as shown below.

Not Important ☐ ☐ ☐ ☐ ☐ ☐ Very Important

How important is landscape irrigation to you?

Not Important ☐ ☐ ☐ ☐ ☐ ☐ Very Important

How important is an attractive, healthy landscape to your quality of life?

Not Important ☐ ☐ ☐ ☐ ☐ ☐ Very Important

How many times each week do you irrigate your landscape?

0	1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐	☐

How much water is needed for the following areas to maintain plant health and quality?

	A little					A lot
Lawn	☐	☐	☐	☐	☐	☐
Trees	☐	☐	☐	☐	☐	☐
Shrubs	☐	☐	☐	☐	☐	☐
Flowers	☐	☐	☐	☐	☐	☐
Ground covers	☐	☐	☐	☐	☐	☐
Potted Plants	☐	☐	☐	☐	☐	☐
Vegetable Garden	☐	☐	☐	☐	☐	☐

How would you rate your landscape irrigation practices?

☐ Very efficient ☐ Somewhat efficient ☐ Inefficient ☐ No opinion

How do the following affect when you irrigate?

	Not at all					Always
The condition of my plants	☐	☐	☐	☐	☐	☐
Frequency of rain	☐	☐	☐	☐	☐	☐
Temperature	☐	☐	☐	☐	☐	☐
When my neighbor waters	☐	☐	☐	☐	☐	☐
Irrigation installer decides	☐	☐	☐	☐	☐	☐
My landscaper decides	☐	☐	☐	☐	☐	☐
Other (please comment)	☐	☐	☐	☐	☐	☐

_____

_____

How do you irrigate your landscape? (Check all that apply)

☐ In-ground automatic system
☐ In-ground manual system
☐ Hose & Sprinkler
☐ Hand held hose
☐ I do not irrigate my landscape

In your opinion, is there enough information available about how to irrigate Texas landscapes efficiently?

☐ Yes ☐ No ☐ Undecided

What sources would you use to get more information about irrigating landscapes more efficiently? (Check all that apply)

☐ TV	☐ Mail	☐ Magazine
☐ County Extension Agent	☐ Retail Garden Center	☐ Radio
☐ Garden Club	☐ Newspaper	☐ Internet
☐ Home owner's Association	☐ Water Utility Offices	☐ Neighbor

What other ways do you use water out of doors? (Check all that apply)

☐ Washing vehicles
☐ Swimming pool
☐ Spa/Hot tub
☐ Landscape water feature (water fall, fountain, etc.)
☐ Washing hardscape (patio, deck, driveway, sidewalks)
☐ Washing pets
☐ Children's recreational activities other than a swimming pool
☐ Other (please comment)

_____
_____

How important would an incentive be for you to operate your system more efficiently and use less water for landscape irrigation? (Check all that apply)

	Not Important					Very Important
Lower utility bill due to reduced use	☐	☐	☐	☐	☐	☐
Rebates for efficient irrigation systems	☐	☐	☐	☐	☐	☐
Better landscape quality	☐	☐	☐	☐	☐	☐
Healthier landscape plants	☐	☐	☐	☐	☐	☐
Conserving water is enough incentive	☐	☐	☐	☐	☐	☐
Other (please comment)	☐	☐	☐	☐	☐	☐

_____
_____

Do you consider your water utility bill to be abnormally high during the summer months?

☐ Yes ☐ No ☐ Undecided

Do you know how many gallons of water you use to irrigate your landscape each month?

☐ Yes ☐ No

Would you be willing to participate in a "Using Water Wisely" workshop about landscape irrigation and landscape maintenance?

☐ Yes. Send me more information
☐ No. But I would like to receive an informative CD
☐ No.

If you checked "Yes. Send me more information" or "No, but I would like to receive an informative CD", please provide us with your name and address so that we can send you more information.

Name _____

Street_____

City_____

State_____

Zip code_____

Thank you for taking time to complete the survey.

Mail completed survey to:
Landscape Water Management Survey
Soil & Crop Sciences Department
Texas A&M University
College Station, TX 77843-2474

VITA

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