Irrigation Literacy Evaluation

Water-Wise Irrigation Practices and Perceptions Survey

Final Report

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Executive Summary

The objectives of this study are to quantify outdoor water use practices and level of community knowledge of water conservation technologies and policy through a mail out survey questionnaire.

Methods. The research area was with in the Pinellas-Anclote River Basin under the jurisdiction of the Southwest Florida Water Management District (SWFWMD). The survey population includes a representative sample of homes that reflect this demographic data and which use both potable and alternative water sources (reclaimed and well water).

The instrument was developed by the University of Florida, in compliance with the UF-IRB protocol, and reviewed by the SWFWMD. The household questionnaire surveys the knowledge and attitudes about outdoor water use practices and perceptions as they relate to irrigation conservation. In efforts to attain information and opinions from a cross-section of water customers, the survey sample population was divided among three outdoor water sources: potable, reclaimed, and well-water. Address lists were developed from the Pinellas County Utilities customer database of customers that had documented requests of: potable variance exemption (a subset of potable customers), reclaimed cross-over inspection, or well installation permits or rebates. Additionally, households that were concurrently participating in an irrigation sensor technology study were sent the survey packet.

Approximately one thousand survey packets were mailed following the Multi-wave Method. To promote an increased response rate, the survey process included the following mailings: pre-survey letter, survey packet, and reminder postcard. The final response rate was 25%, yielding 272 completed and usable questionnaires, evenly distributed amongst the three water sources designations. Each respondent was offered an incentive, to be sent, of either an indoor or outdoor water conservation kit. Although the incentive was available to every respondent, only 13% requested the kits.

By analyzing the irrigation practices, the questionnaire can be utilized to determine an irrigation proficiency level. In terms of the measurability of pro-environmental competency, the inference of proficiency level can be attained by regression model and factor analysis. Questionnaire responses were evaluated using the SAS statistical Software package.

The independent variables include irrigation system type, outdoor water source, ownership and economic profile. Socio-demographic variables will include income, lot size, education, swimming pool, homeownership, level of water conservation technology, and automation of irrigation system. Latent attitudinal variables will be

lifestyle, recreation, landscape interest, conservation attitude, and social desirability towards conservation.

Demographic Characteristics. On average, the respondents have resided in the state for 26 years, with 78% having lived in the state for at least a decade. Eighty percent of the respondents are full time Florida residents. The average age of the respondents was 60 yrs. and overall, the age of respondents ranged from 23-89 yrs. The majority of the respondents were college educated with 64% having completed college or greater. Finally, 81% of the respondents provided household income. Additionally, economic level was determined by assessing the actual property value of the homes.

Watering practices and irrigation systems. In total, 91% of the respondents water their lawn/landscape utilizing an automatic irrigation system. Further, 84% were responsible themselves for the watering practices at the site, and in 3% of the cases a professional service was utilized for maintaining the watering schedule. Most often, the irrigation timer was located in the garage.

Overall the most desired water source was reclaimed water for irrigation purposes. Even though the responses were evenly distributed across the three sources (potable, well, and reclaimed). Of the potable source respondents, 65% would prefer the opportunity to use reclaimed water and 30% would prefer a well.

Upon asking a series of question regarding watering practices, 12% of potable customers and 24% of well water users reported irrigating more often than permitted according to Pinellas County Code 82-1. Only one percent of the reclaimed users reported irrigating more often than permitted, however it should be noted at the time of the data collection, reclaimed users were permitted up to four days of irrigation per week, following Resolution No. 01-329.

Overall, the reported average length of time set per irrigation cycle, for a single turfgrass zone was 69 min., ranging from 20 to 120 min. Although 55% reported that they adjust their watering schedule seasonally, 31% admitted that they do not adjust their irrigation run times based on seasonal plant water needs.

Thirty-six percent of the sites were reported to have rain shutoff devices, 66% of these were reported to be connected and functioning. All the rain shut-off devices reported were rain sensors, however, 4% were known to have soil moisture sensors attached to the system. This concurs with the notion that the term rain shut-off is not understood to include other bypass devices as well.

Attitudes and actions. Previous studies have found price to be a primary motivator for irrigation practices. However, for this sample set, price was only a factor for potable users. Seventy-five percent of all users responded that source was the major influence affecting their irrigation practices.

Three quarters of the respondents reported that their irrigation practices were water conservative, but admitted to room for improvement. And while 87% reported awareness of watering restrictions, 57% often observe their neighbors irrigating outside of watering restriction compliance.

The availability of local conservation programs were familiar to 66% of the respondents, 53% trust the reliability of a rain sensor, and 68% expressed interest in installing a soil moisture sensor. Further, 75% understand the importance of a rain shut-off device, finding them very important for water conservation. Regarding conservation attitudes, 78% report that their personal conservation practices affect the overall water supply, and 98% reported that everyone is responsible for water conservation jointly within the community.

Indexes were developed based on the Likert scale attitudinal questions. The Likert scale used was based on five options from strongly agree to strongly disagree. From these indexes, it was observed that there was a correlation between irrigation knowledge and education level. There was also a moderate correlation between the knowledge index and the statement that the "homeowner would like to consider changes but [does not] have the money." The strongest correlation, which was an inverse correlation, existed between the conservation attitudinal index and the statement that the homeowner would "prefer more lawn (turfgrass) and would like to increase the lawn area of [their] yard." A higher conservation attitude score by the respondents was associated with the understanding that larger turfgrass yards may require more water.

Based on the actual water use analysis, property value showed that the highest value range ($900,000-$1,500,000) used the most water even when normalized for irrigated area. Overall there was a trend of increased water application with increased property value. Conversely, the smaller the irrigated area, the more water was applied. A primary cause for the increased use in both homes of higher property value or smaller irrigated area is likely due to the minimal impact water cost has on excessive use.

Conclusions. The ultimate goal of this research was to determine a means to promote knowledge of water conservation related to residential irrigation by understanding why people over irrigate. The following significant barriers and benefits were identified:

- Misunderstanding of plant water needs; seasonal scheduling
- Terminology in reference to rain shut-off device
- Conservation relating to water source
- Reliability of rain shut-off device
- Expressed room for improvement and interest in learning
- Influence of property value or property size

Section 1: Introduction

The desire for a lush landscape often requires irrigation and fertilization. Further, many of Florida's residents are not well informed about proper application or the environmental impacts of over application of irrigation and fertilizer (Israel and Knox 2001). Research has shown that residential in-ground automatic irrigation systems can account for over 50% of the customer's total monthly water consumption and that residential customers in Florida tend to over-irrigate (Haley et al. 2007). Research has also shown that of homeowners and lawn care providers that apply fertilizer applied it more frequently than recommended and did not follow the manufacturer's instructions (Israel et al. 1995).

While Water Management Districts (WMDs) have implemented allotted irrigation days and times, as well as the requirement of rain shut-off devices for newer systems (Florida Statutes 2007), anecdotal evidence suggests that customers may not be following watering regulations and restrictions (Whitcomb 2005). It has also been seen that domestic irrigators do not understand plant water needs related to irrigation. Domestic irrigators rarely choose alternative, water conservative practices, because of the want for aesthetic desirability which does not allow for lawn heterogeneity (Bormann et al. 1993), time, effort, and perceived expense for individual households (Templeton et al. 1998).

Water use efficiency has become a growing concern on both the local and national level. The water used for residential irrigation can be separated into three unique water categories: potable (drinking) water, domestic well water, and reclaimed water. Reclaimed water as an irrigation source is a practical use for treated effluent, however this source requires available additional infrastructure. The most accessible water for the homeowner to use for outdoor purposes is the treated potable water line that is already supplying water to the residential property. This is a costly source with water rates steadily increasing due to the considerable amount of energy it takes to treat and deliver this water. Depending on the aquifer composition, groundwater from an on-site well may lead to some savings in energy costs, but not a decrease in the depletion of reservoirs and groundwater aquifers. A water table reduction due to over pumping can lead to saltwater intrusion, higher concentrations of natural contaminants (e.g. radon and arsenic), and human pollutants (e.g. fertilizers and pesticides). Over irrigation can specifically contribute to nonpoint source pollution by increasing runoff that can contain pollutants from the suburban landscape.

In 2000, Florida's population was nearly 16 million which ranked Florida as the fourth most populous state in the United States (USCB 2001). In Florida, 88% of the state's population received their potable water from the public supply. The public supply is that water which is withdrawn by either public or private suppliers and delivered to multiple users. In Florida, the public supply is made up of 90% ground

water (2nd highest in U.S.) and 10% surface water withdrawals. Over half, 53%, of the total public supply comes from the Floridan aquifer (Marella 1992). The public supply is usually treated ground or surface water, which is used for both domestic (indoor and outdoor) and public uses (e.g. firefighting and street washing). This sector of the water supply is critical when ensuring that the total water demand can be met.

The domestic self-supply refers to quantities of potable water withdrawn, via well or pumped from surface water, small enough that a permit is not required from the WMD. Although individual household wells fall under this definition, they are only included when water is used for both indoor and outdoor purposes. When the water is pumped solely for irrigation purposes it is not accounted for in this category (Marella 1999). Pinellas County Utilities (PCU) has initiated rebate programs for the installation of a shallow well for outdoor water use (PCU 2007a). The contemporary attitude is that the best way to decrease the need from irrigation water on the potable water demand is to encourage the use of alternative water sources. Florida's Legislature has allocated funds to the WMDs for the promotion of alternative water sources for irrigation water.

The overall objectives of this study are to quantify the outdoor water use practices and level of community knowledge of water conservation technologies and policy through a mail out survey questionnaire. It will be assumed that the survey respondents will fill out the questionnaire honestly. Since some of the questions will be asking about excessive outdoor water use practices or practices not incompliance with local policy, participants may be reluctant to disclose truthful information. A limitation of this study is that typically homeowners with more water conservative practices have a greater interest in participating.

Previous Work

Previous surveys within the jurisdiction of the Southwest Florida Water Management District (SWFWMD) have looked at homeowner concern relating to water cost (Whitcomb 2005) and participation in Cooperative Extension Service landscape programs (Israel and Hague 2002). Through previous residential irrigation cooperator studies, conducted by the University of Florida (UF) it was observed that the homeowners did not have a clear understanding of when and how much to irrigate (Haley et al. 2007) and that actual watering days do not necessarily follow local day of the week restrictions (Haley and Dukes 2009).

Residential irrigation research, in Florida, has indicated that the use of technology can decrease irrigation water use without causing plant/turfgrass stress or degradation of appearance (Haley et al. 2007). Anecdotally, is has been observed that there is reluctance on the part of the domestic irrigator to incorporate this new technology. One such device is an automatic rain shut-off sensor for irrigation systems. A rain sensor or shutoff device is required for homes with automatic in-ground irrigation systems installed since 1991 (Florida Statutes 2007). However, it is thought that rain sensor installation is not enforced or that these sensors are not

maintained. One study found that 50% of homes with automatic in-ground irrigation systems in the SWFWMD do not use rain sensors (Whitcomb 2005).

There are two aspects that affect the functionality of the irrigation system: technology and user interaction. The technological components include: time clocks, weather-based controllers, soil moisture sensors, and rain sensors, which will electronically bypass unnecessary irrigation events. Local WMD regulations have an influence on the use of bypass technology as well as the time and day settings for the automatic irrigation timer.

Research has been conducted proving the effectiveness of technology in reduction of outdoor (lawn and garden) water use. However, these studies have been primarily conducted in controlled settings. When attempting to incorporate the recommendations of the research into the residential arena savings are not as significant (Campbell et al. 2004; Geller et al. 1983). In order to effectively change behavior, factors that contribute to perceived attitude must be considered.

Baumann (1990) established three factors which affect the intensity of water use by residential users. The first two are economically derived; the consumer's ability to pay for and the willingness to pay for water at a given price. The non-economic factor is the consumer's conservation behavior. This reflects the motivation to employ effort or technological innovations for water conservation. Weather plays a major role in conservation practices as well. During periods of drought, consumers are more willing to employ conservation techniques than during wet years (Baumann 1990). According to the *Florida Water Rates Evaluation of Single-Family Homes*, completed in 2005, the main concern of homeowners with respect to increased costs is outdoor use (Whitcomb 2005).

At the time of data collection for this study, the rate for potable water from Pinellas County Utilities was $4.16 per 1,000 gal (3,780 L) and as of October 2008, the rate increased to $4.28 (PCU 2007b).

Environmental Conditions

The monthly rainfall amounts for a two-year time period, which encompasses the survey data collection period, are presented in Figure 1.1. The rainfall was observed from local urban weather stations installed and maintained by UF. The stations stand approximately 8 ft (2.4 m) tall. The frame is buried 4 ft (1.2 m) in the ground and secured with concrete. Three of the four stations are on PCU owner property. The forth station is on private property, with permission granted by the owners. As common with most urban weather stations, the stations were surrounded by different obstacles and encountered different fetch distances. All practical efforts were made to minimize obstructions near the weather stations. In any case, the stations were representative of weather data in urban area.

In 2007 even though the cumulative precipitation, 40 in, was 19% less than the historical records, there were the same number of rainfall events, 34% of the days (NOAA 2003). During 2008, 33% of the days had rainfall events, resulting in 5 fewer rainfall events than a normal year; the total precipitation amount was 42 mm, 15% lower than normal.

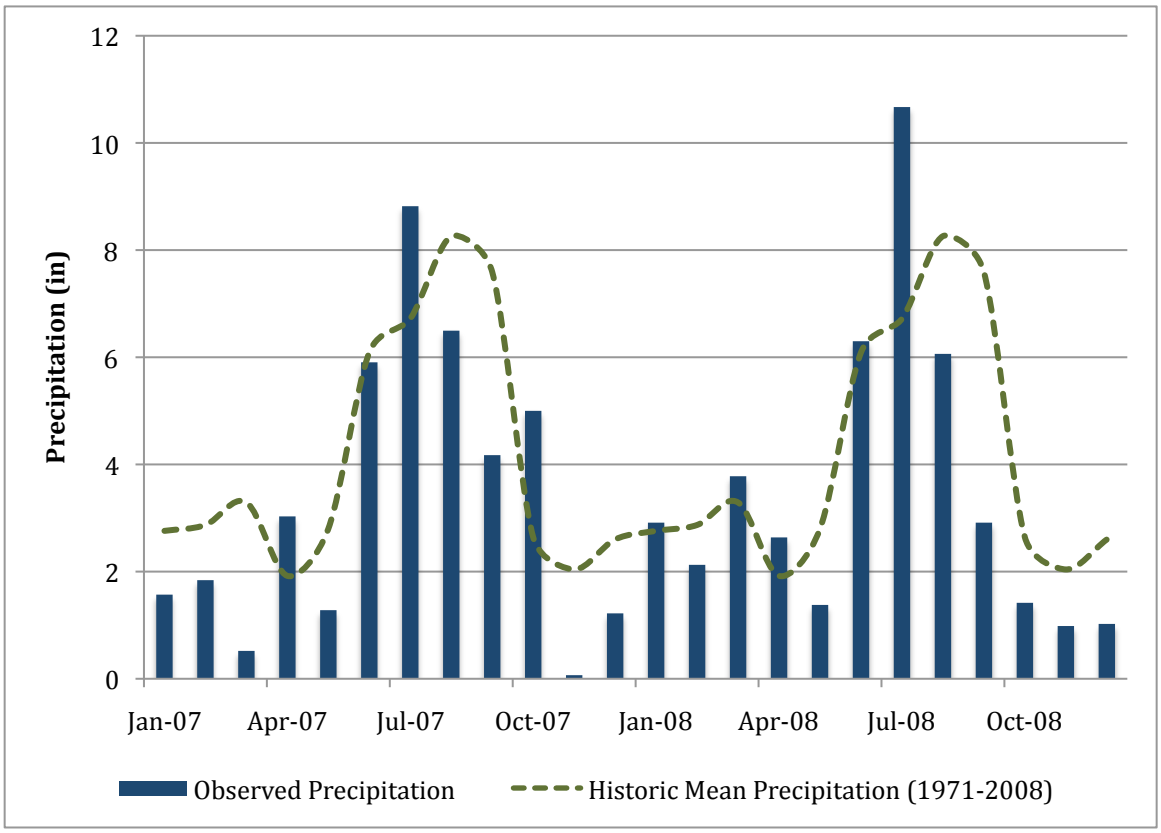

Figure 1.1. Observed monthly rainfall for 2007 and 2008 compared to historic rainfall (NOAA 2003).

Section 2: Study approach and methodology

The 2008 mail-out survey of residents in Pinellas County Florida utilized the instrument developed by the UF and incompliance with the UF-IRB protocol and reviewed by the SWFWMD communications department. The household questionnaire surveyed the knowledge and attitudes about outdoor water use practices and perceptions as they relate to irrigation conservation.

Target area

The project target area is within the Pinellas-Anclote River Basin within the SWFWMD. This area is located in the Southern Water Use Caution Area, meaning the expected water resources demand may be larger than the supply. According to the U. S. Census Bureau's 2006 estimates, Pinellas County has 924,413 residents. This population is 52.4% female and 47.6% male with an average age of 43 years (USCB 2001). The survey population includes a representative sample of homes that reflect this demographic data and which use both potable and alternative water sources (reclaimed and well water).

Sample design

In efforts to attain information and opinions from a cross-section of water customers, the survey sample population was divided among three outdoor water sources: potable, reclaimed, and well-water. Address lists were developed from the PCU customer database of customers that had documented requests of: potable variance exemption (a subset of potable customers), reclaimed cross-over inspection, or well installation rebates. Additionally households with participation in another UF and SWFWMD sensor based irrigation water conservation study were included in the sample population.

Once the address lists were compiled, the sample was selected randomly. The systemic sampling approach was employed, where every k^{th} customer was selected from the sampling frame.

$$\text{Sampling interval (k)} = \text{Population size (N)} / \text{Sample size (n)}$$

Mail-out survey

All participants received the same cover letter, household questionnaire, and incentive option. The initial mail-out package included a cover letter, questionnaire, and postage paid addressed return envelope. The survey packages were mailed in three waves and over a course of two months. Follow-up mailings were conducted on returned packages and to maintain a sufficient response rate.

The survey instrument

The household questionnaire was compiled into a four page 6.5 in by 8.5 in bi-fold booklet. Appendix A contains a copy of the actual survey instrument. The questionnaire was divided into six sections:

- Outdoor watering practices
- About your landscape
- Watering habits
- If you have an irrigation system
- Attitudes and actions
- Last bit (demographics)

In addition the direct questions asked, the participants were provided a boxed comment area. Each questionnaire was coded to respect the anonymity of the respondent.

Response rates

In three mailing waves, a total of 1090 PCU customers were sent survey packages; 396 potable, 282 well, and 412 reclaimed. Of the potable users, 45 respondents were also part of a concurrent irrigation technology study (refer to Section 6 for details of the technology study). The target response rate was at least 384 customers. So long as the response rate was greater than 267, additional mailings were not required by SWFWMD. The final response rate was 25%, yielding 272 completed and usable questionnaires, evenly distributed amongst the three water sources.

Table 2.1. Response rate of mail-out questionnaire.

	Mail-out	Response rate	
	(n)	(n)	(%)
Overall	1090	272	25
Potable	396	87	32
Reclaimed	282	94	35
Well	412	91	33

Survey incentive

As an incentive to complete the questionnaire, the all participants were offered either an indoor or outdoor water conservation kit. The indoor kit (Figure 1) included shower and sink water saving faucets as well as aerating nozzles, leak detection tables, and a hose nozzle. The outdoor kit (Figure 2) included a min-click rain sensor and water saving hose nozzle. Both kits included appropriate literature to reinforce the importance of these devices.

Table 2.2. Distribution of requested incentive packages.

	Overall	Package type (n)	
	(n)	Outdoor	Indoor
Overall	34	20	14
Potable	14	7	7
Reclaimed	15	12	3
Well	5	1	4

Figure 2.1. Indoor water conservation incentive kit.

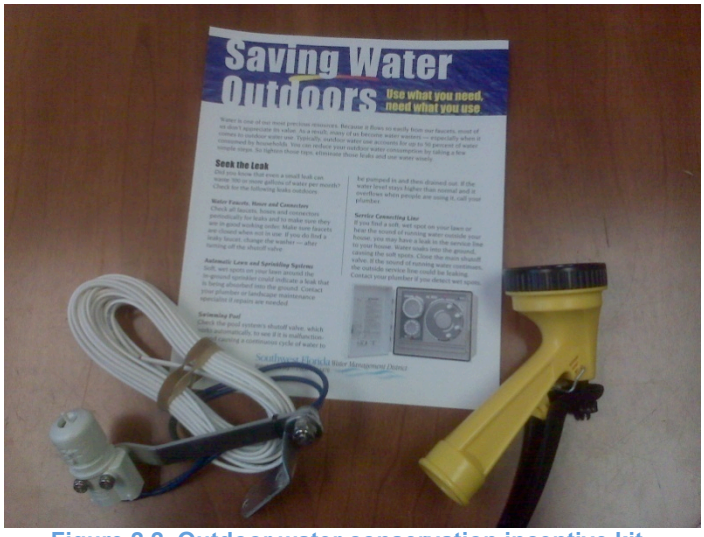

Figure 2.2. Outdoor water conservation incentive kit.

Variables of interest

This survey specifically targets lawn (turfgrass) and landscape (bedded areas) watering practices, knowledge of water conservation ordinances, motives for water conservation/overuse, and perception of community water conservation/overuse. Water conservation ordinances include watering days and percentage of allowable turfgrass. To investigate technological advances, such as the inclusion of a functioning rain shut-off device (e.g. rain sensor, soil moisture sensor, weather-based (ET) controller with rain bypass switch), it is assumed that an automatic time-based controller is part of the irrigation system. Socio-demographic variables include income, lot size, education, swimming pool, homeownership, level of water conservation technology, and automation of irrigation system. Latent attitudinal variables will be lifestyle, recreation, landscape interest, conservation attitude, and

social desirability towards conservation. The independent variables include irrigation system type, outdoor water source, home ownership and economic profile.

Data analysis

Data analysis was performed using SAS software (SAS 2004). Univariate data analysis was used to describe the data set sample with mean, standard deviations, and percentages. The level of measurement was reported as frequency statistics from the survey responses. The bivariate analysis was used for the evaluation of the independent variables and the hypothesis testing between the independent and dependant variables.

Positive and negative correlations were based on Pearson's correlation coefficient. The multivariate analysis enables assessment of the direct and indirect effects for related variables. An analysis of variance was used to determine main effect differences through PROC GLM and means comparisons were performed with Duncan's Multiple Range Test at a 95% confidence level.

Section 3: Demographics

The demographic characteristics of the respondents are summarized below. Appendix A provides the exact wording for the demographic questions.

Housing

- Housing type - 100% of the respondents reside in single-family homes.
- Ownership
    - 99% of the respondents own their home.
    - 1% rent their home.
    - 5% of households did not reply to this question.

Residency

- Residency status – 80% of the respondents are primarily Florida residents, inhabiting the residence in question for 9 months or more during the year. Of the respondents that maintain dual residence during the year, 8% live in Florida from 3 months to 9 months of the year, and 12% have their primary residence out of the state, occupying the home for less than 3 months of the year.
- Length of time in Florida – 78% of the respondents have lived in Florida for more than a decade, with the average time being 26 years.
- Length of time at current residence – the average length of residence in the current house of the respondents is 13 years, with residence times ranging from 0 to 60 years.

Demographics

- Age – the average age of the respondents at the time of the survey dissemination was 60 yrs. The ages of respondents ranged from 23-89 yrs. Twenty-seven respondents did not disclose their age.
- Members of household – 69% of the households had from 1-4 member within the age range of 21-65 yrs. Thirty-seven percent had from 1-3 household residents over the age of 66. With 26% of the households including children; 10% with children under the age of 10 yrs. and 16% with teenagers ranging in age from 11-20 yrs.
- Education – The majority of the respondents were college educated, with 64% having completed college or beyond.
- Income – of the 81% of respondents who provided household income information, the income ranges were as follows:
    - Under $30,000 (7%)
    - $30,000 - $49,999 (15%)
    - $50,000 - $74,999 (19%)
    - $75,000 - $149,999 (39%)
    - Over $150,000 (20%)

Section 4: Watering practices and irrigation systems

Watering practices

All together, 91% of the respondents water their lawn/landscape utilizing an automatic irrigation system; which can be broken down to 74% who set to system to run automatically, and 16% who use the system manually. Five percent use a sprinkler head attached to a hose, 3% use a watering can, and 1% does not apply supplemental water to their lawn/landscape.

Of the respondents who irrigate, 84% control the watering practices themselves and in 9% of the households, another household member is in charge of the watering practices. Only 3% of the households relied on a lawn care service provider or irrigation maintenance professional.

Water Source

The respondents were evenly distributed amongst water source, with 32% using potable water, 35% reclaimed, and 33% well water users, (see Table 2.1). However, given the choice, 64% would rather irrigate with reclaimed water. The want for reclaimed water was almost exclusively from current potable users. Of the potable source respondents, 65% would prefer the opportunity to use reclaimed water and 30% would prefer well water.

Irrigation frequency

Pinellas County Utilities customers must comply with the SWFWMD and local watering restrictions. According to Pinellas County Code 82-1, homes using county water or wells, lakes, and ponds are allocated one day of irrigation a week for established lawns and landscaping. Irrigation using reclaimed water is on a voluntary schedule (Resolution No. 01-329) permitting up to 4 days of irrigation per week. It must be noted that theses irrigation frequency are self-reported.

Table 4.1. Distribution of reported irrigation frequency.

	Overall %	Potable %	Reclaimed %	Well %
Never/rarely	5	12	3	1
Once per week	56	75	16	75
Twice per week	27	10	46	23
Three to four times per week	13	1	34	1
Nearly every day	1	1	1	0

Actual irrigation frequency was determined for the homes that were concurrently participating in the irrigation sensor study. On these homes the irrigation systems on these homes were fitted with irrigation water meters and automatic meter recording devices. Table 4.2 presents the average monthly number of irrigation events by known technology type. On average the homes with soil moisture sensors

resulted in 2 events per month. Those with rain sensors plus educational materials, which included IFAS recommendations for irrigation run times, averaged 4 events per month. The homes with rain sensors (without educational materials) and the homes that were monitored only both had a mean of 5 events per month. Approximately 4 events per month would concur with the one-day per week watering code mentioned above, recall the study homes were all of the potable water source.

According to an irrigation requirement simulation determined by a soil water balance, on average 4 events per month are needed. However, when looking at the average number of events needed each month, based on this soil water balance, the turfgrass may actual require from 2 to 7 events per month. Although on average the study homes appeared to irrigate appropriately according to location watering day restrictions, when considering the range of irrigation event that occurred during a given month, vast over irrigation occurred.

Table 4.2. Number of irrigation events per month for the irrigation sensor study participants.

	Average #/month	Maximum %	Minimum %	Std Dev %
Soil Moisture Sensor Homes	2	11	0	3
Rain Sensor + Edu. Materials	4	20	0	4
Rain Senor	5	22	0	6
Monitor Only	5	29	0	7

An important step in outdoor water use conservation is proper irrigation scheduling. Most domestic irrigators are not familiar with this term, so the participants were asked a number of questions about their watering habits, presented in Table 4.3.

Table 4.3. Distribution of reported irrigation scheduling practices.

Characteristic	(%)
Do you adjust your watering schedule during year?	
Monthly	14%
Seasonally	55%
Not really	31%
Do you water your lawn (turfgrass) and landscape (bedded area) for different lengths of time?	
Yes	44%
No	53%
Don't know	3%

Based on the principles of irrigation scheduling, landscape and turfgrass should be irrigated differently. However, if a site has mostly one type of irrigated area

(predominately turfgrass vs. landscape) it might not make sense to have different watering practices. This would be evident if there was a correlation between responding "no" to watering the lawn and landscape for different lengths of time. However, upon closer observation of the data, there was not a correlation between the type or size of irrigated area and the watering practices of the irrigated area.

The average length of time set for a turfgrass zone during each irrigation cycle was reported as 69 minutes. The distribution of run time settings of the respondents can be seen in Figure 4.1 below. IFAS recommendations for irrigation run times were developed for twice weekly irrigation and vary depending on month of year and equipment type. According to these recommendations, for the Central Florida area, during the months April through November, turfgrass zones irrigated by gear driven rotary sprinklers should be set for an average of 57 min (ranging from 38 to 75 min depending on month) and fixed spray heads should be set for an average of 19 min (ranging from 13 to 25 min) per irrigation cycle. The run time recommendations given to the sensor study group were developed based on these IFAS recommendations, and tailored to the specific system of each participating home. For 1-day per week irrigation scheduling the rule of thumb is to increase the 2-day per week single cycle run time by 30%.

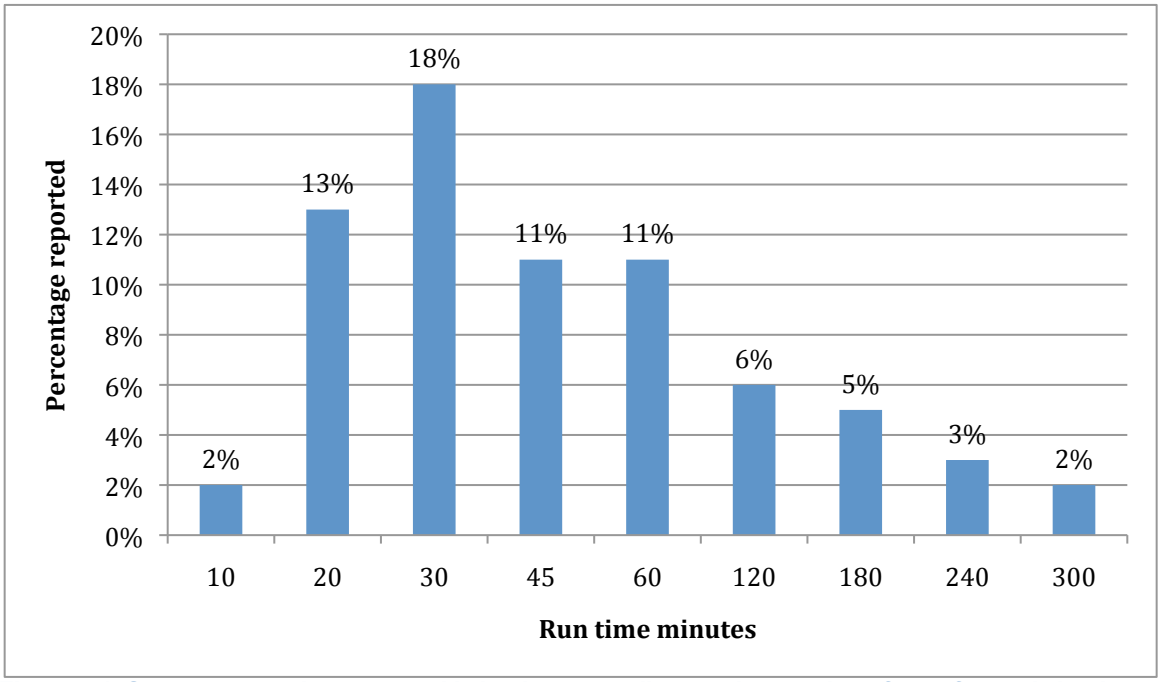

Figure 4.1. Survey respondent reported irrigation controller run time settings for turfgrass irrigation.

Landscape characteristics

A series of questions were asked to describe landscape characteristics of the property. A small diagram was provided for the respondent to illustrate the meanings of "lot", "turfgrass", and landscape bed".

Table 4.4. Distribution of reported landscape characteristics.

Characteristic	(%)
Percentage of lot that is lawn/landscape	
0-25%	10%
26-50%	38%
51-75%	36%
Over 75%	16%
Percentage of landscape that is turfgrass	
0-25%	21%
26-50%	37%
51-75%	31%
Over 75%	11%
Has a lawn maintenance service	
Yes	52%
No	48%
Has additional water features on property	
Yes	64%
Swimming pool	46%
No	36%

Irrigation system characteristics

A series of questions were developed to describe the irrigation system. Of the respondents reporting systems with rain-shut off devices, the questionnaire included three device type options: rain sensor, soil moisture sensor, and weather-based controller with a rain bypass switch. The only rain shut-off device reported was a rain sensor, corresponding to all 36% of the responses. It is however known that at least 4% of the respondents have soil moisture sensors connected to their system. Therefore the term "rain shut-off" may not be understood to include devices other than rain sensors that automatically bypass irrigation events.

Ninety one percent of the homes report having irrigation timers, and the time clocks were considered to be easily accessible. The primary locations for irrigation time clocks were "in the garage", which was reported by 72%, and "on an exterior wall of the house", which 15% of the participants checked. Further, the numbers of zones reported by the participants ranged from 5 to 8 (53%). The distribution of this system characteristic can be seen in Table 4.5.

Table 4.5. Distribution of reported irrigation system characteristics.

Characteristic	(%)
Has mixed zones (spray and rotor)	
Yes	58%
No	38%
Don't Know	5%
Number of zones	
0-4	37%
5-8	53%
9 or more	6%
Don't know	4%
Use of low volume irrigation	
Yes	19%
Micro-irrigation	*38%*
Drip tubing	*40%*
Bubblers	*21%*
No	66%
Don't Know	7%
Use of rain shut-off device	
Yes	36%
Connected and functioning	*66%*
Not connected or functioning	*21%*
Don't know	*12%*
No – turns off system manually	31%
No	22%

Section 5: Attitudes and Actions

Many of the attitudinal questions were presented with Likert scale response options. The Likert scale asks the respondent to rate his/her agreement to statements based on an interval scale. In this questionnaire the scale ranged from "strongly agree" to "strongly disagree" in five even intervals with an additional "don't know" option.

Attitudes regarding watering practices

Overall water price was not the primary motivator for irrigation practices. Cost only became a contributing factor for the potable users, likely due to the volumetric usage pricing associated with this source. When asked if water source influences water use practices, 75% agreed.

Of the respondents with irrigation systems, 77% did not consider their irrigation practices to be water conserving. Contrarily, the poor functionality of their own irrigation system did not diminish their desire to use the system. This was determined by asking the respondent directly "Because my irrigation system functions poorly, I don't irrigate."

The respondents did however, express room for improvement, with 66% aware of the availability of local conservation programs, 53% trusting the reliability of a rain sensor, and 68% expressing interest in installing a soil moisture sensor. Further, 75% understand the importance of a rain shut-off device, finding them very important for water conservation.

Eighty-seven percent of the participants are aware of watering restrictions in their area. Concurrently, 57% often observe their neighbors over-irrigating.

With regards to irrigation scheduling, although 5% stated no understanding of plant water needs at all, 77% did report familiarity with seasonal water needs of their lawn and landscape plants. Further, 70% reported that they decrease their irrigation in the winter months.

Attitudes regarding landscapes

The participants were asked to rate the top three statements which best describe their attitude toward their present landscape, the results were, in order of priority:

- I am reasonably content with my present landscape and am not considering any changes.
- I would like to learn more about landscape water use before deciding what, if any, actions to take.
- I would like to consider changes but don't have the money.

The results showed no trend in reaction to the water needs of native plants. When looking at the correlation of the Likert scale questions, the responses were evenly distributed across the Likert scale. Further, the respondents did not have a negative

impression of the appearance of native plants in the landscape beds. Seventy-seven percent reported that the neighborhood or association has lawn appearance requirements and 92% of the respondents are very concerned personally about the appearance of their yard.

Attitudes regarding conservation

Only 25% of the respondents have previously participated in an outdoor water use conservation program. Ninety percent reported having appliances or devices that are intended for water savings inside the home, while a mere 3% reported having water saving devices outside the home, and 7% reported having no water saving devices at all. Similarly, 92% reported having appliances or devices intended for energy savings versus the 8% that reported having no such devices, but 91% of the respondents were aware of the interaction between water use and energy use.

Seventy-eight percent feel that their personal conservation practices affect the overall water supply, and 98% reported that everyone is responsible for water conservation jointly within the community. However, when asked directly, the respondents did not state that environmental concern had any effect on irrigation practices.

As previously stated, 75% responded that water source affected their watering practices. Further, 70% reported that when watering with reclaimed water, outdoor water conservation is not necessary; and 86% reported that conservation is not necessary when using well water. Finally, the participants were asked to rate their opinion of the effectiveness of water conservation ordinances, practices, and programs. The results are illustrated in Figure 5.1 below.

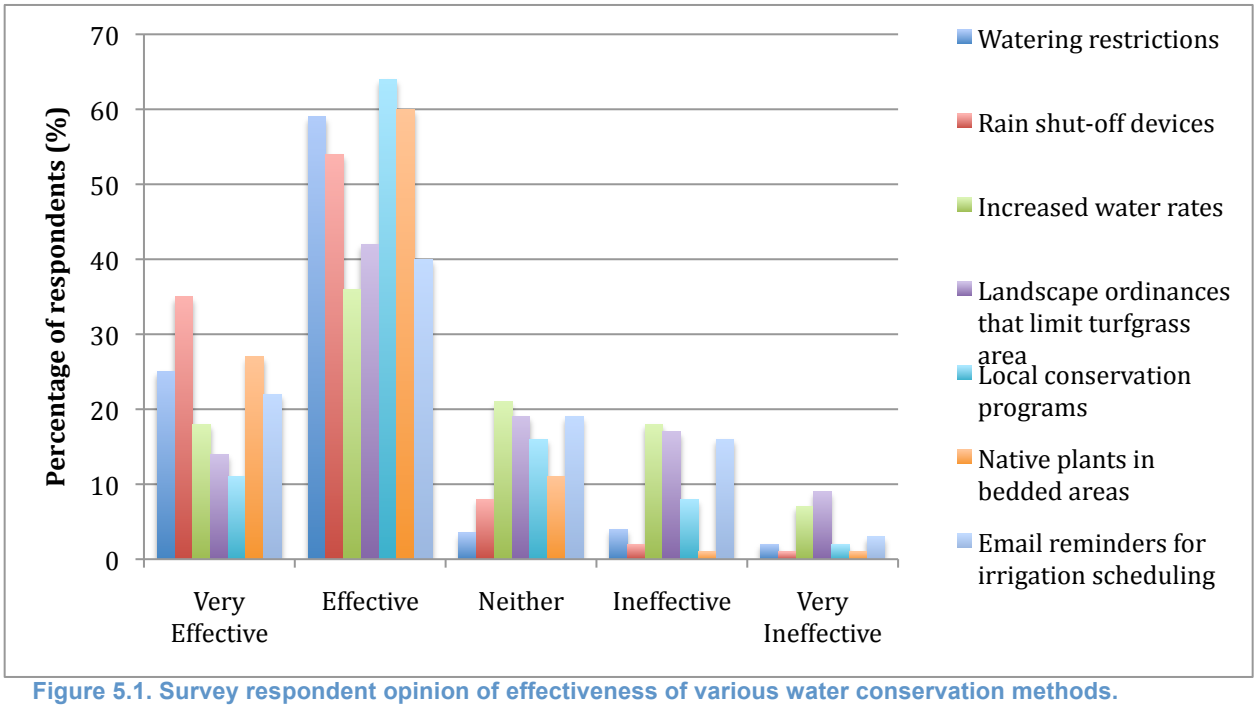

Figure 5.1. Survey respondent opinion of effectiveness of various water conservation methods.

Index development

Indexes were developed statistically based on Eigen value criteria. Indexes serve as a means to group strongly related questions together resulting in a numeric score than can be used for statistical analysis.

Three indexes were developed from Likert scale attitudinal questions:

- Index of conservation attitude:
  - When watering with reclaimed water, outdoor water use conservation is not necessary.
  - When watering with well water, outdoor water use conservation is not necessary.
  - We are all responsible for water conservation in out community.

- Index of conservation knowledge:
  - I am not aware of watering restrictions in my area.
  - I am aware of lawn appearance requirements in my neighborhood.
  - New irrigation systems are required to have shutoff devices.

- Index of personal lawn/landscape interaction:
  - I spend a lot of time outside in my lawn/landscape.
  - I am very concerned about the appearance of my yard.
  - I am familiar with seasonal water needs of my lawn/landscape plants.

The index for knowledge has a correlation with education level, having a Pearson correlation coefficient of 0.60. There was also a moderate correlation between the knowledge index and the statement that the "homeowner would like to consider changes but [does not] have the money." The strongest correlation (-0.87) existed between the conservation attitudinal index and the statement that the homeowner would "prefer more lawn (turfgrass) and would like to increase the lawn area of [their] yard." This means that a higher conservation attitude score by the respondent would be associated with the understanding that a larger turfgrass yards may require more water. Further, there were only weak correlations between the personal lawn/landscape interaction and the attitudinal preferences about the present landscape and the desire to make changes.

Section 6: Actual Water Use

Sample size

In addition to the survey instrument, actual water use data was obtained for 142 homes in the study area. All of these homes irrigate with water from the public supply. As part of the total sample, all of the homes participating in the sensor technology irrigation conservation study were included.

The irrigation study investigated the affects of sensor based irrigation on residential in-ground irrigation water application (Haley and Dukes, 2009). Experimental treatments evaluated were (1) automatic time based irrigation set and operated by the cooperator, (2) an automatic timer with the integration of a soil moisture sensor, (3) an automatic timer with a rain sensor, and (4) an automatic timer with a rain sensor along with educational materials including a run time schedule, based on IFAS recommendations, given to the cooperator.

Property information

Property information was gathered from the Pinellas County property appraisal public records (www.pcpao.org) for each home included in the analysis. These records included information on the comparable sales (which denotes property value), the property size, total gross living area (i.e. gross structural footprint), and residential extras (e.g. pool, enclosure, patio, shed, etc.). A calculated irrigated area was determined by subtracting the gross structural area and residential extras from the property size. From the Pinellas County public GIS records (www.gis.pinellas.org), the residential parcels are outlined and an aerial layer from Jan/Feb 2006 was overlaid (Figure 6.1.). Using the GIS layers, the irrigated areas were outlined with a polygon tool (note the red polygons in Figure 6.1) and GIS to determine the aerial estimated irrigated area calculated the area of each polygon. Actual irrigation area from site visits to homes participating in the irrigation sensor study was used to verify assumptions in the aerial estimated irrigation area methodology. The aerial estimated irrigated area was then compared to the calculated irrigated area from the property appraisal information.

The GIS aerial images proved to be more accurate estimations of actual irrigated areas than the property appraisal data. To determine the accuracy of the GIS measurement method, the true irrigated area was measured on-site at homes in the participant group, with the average error within 5%, with no over or under-estimation greater than 10%. Although 35% of the calculated irrigated areas where also within 5% of the aerial estimated areas, the error ranged from 49% under-estimation to 180% over-estimation. Sources of error can be found for both methods of determining irrigation area. The property appraisal information may include enclosures, patios, and pools. However, it is not clearly defined whether the pool/patio is housed within the enclosure or additional area. Additionally, the property appraisal information rarely includes driveways, child playgrounds, and

sheds. When looking at the property size, from the public records, the parcel may consist of two lots or a fenced portion, were there are obviously non-irrigated areas. The parcel lines can also cause discrepancy; within GIS the boundaries do not always coincide with the actual parcel size, sometimes including lakes or natural areas adjacent to the property. Possible irrigated areas beyond the total property size and not included in the recorded parcel area are easements, walkways, and buffer zones. These areas, which are irrigated and considered part of the actual irrigated area, were included in the aerial estimated irrigated calculations.

Figure 6.1. Aerial view of residential parcels with red polygons denoting irrigated area and black polygons denoting parcel boundaries.

Monthly water use

Monthly water data was obtained from Tampa Bay Water Authority for a period of five years for each residence. The data provided was total, indoor plus outdoor, household water consumption.

To calculate the monthly outdoor water use, the winter (December, January, and February) water use was analyzed for each parcel to determine the winter minimum usage. The minimum winter water use was assumed to be only indoor use; therefore, any use greater than the winter minimum was assumed to be

outdoor use. If a monthly use was less than the winter minimum, the outdoor use was estimated as zero for that month. The homes participating in the sensor based irrigation study have sub-meters for their irrigation water use, which were used to verify the winter minimum method.

Irrigation use (depth) was estimated based on the monthly volume of water used outside normalized for the aerial estimated irrigated area. For the five years of utility data obtained, winter average, low quartile (lowest 25%), and minimum use were compared. The calculated outdoor use by winter average, low quartile, and minimum for the billing period was compared to the actual irrigation water use from the participating homes that had sub-meters for irrigation water consumption. The average actual monthly average use for the time period was 2.0 in/month. Using the average winter use, the monthly average consumption resulted in 0.91 in/month, a 54% error. The low quartile outcome was 1.5 in/month, which is a 25% difference form the actual value. The minimum winter water use over the billing period resulted in 2.2 in/month average use which was the lowest error at 9%.

Irrigation water use analysis

From the correlation analysis, there were associations between irrigation application depths with property value, house size, presence of a pool, and aerial estimated irrigated area. Overall, there was a positive correlation between property value and irrigation application depth ($r = 0.66$) and a negative correlation between irrigated area and water application depth ($r = 0.85$); note Figures 6.2 and 6.3 respectively. This trend is most evident when looking at the homes without pools (Table 6.1). There was a significant difference ($p<0.001$) between the water use in homes with and without a pool on the property.

The homes with pools used on average over 0.5 inches more water per month. Upon further investigation, the presence of a pool can be considered a conditional relationship, where the impact is greater for one group than for another when other factors are included. This could be caused by a combination of two factors. First, the pool may consume a notable fraction of the average monthly consumption, and the monthly use should be offset accordingly. Additionally, external factors may need to be considered. For example, people who reside in homes with pools may tend to spend more time outdoors, consequently having a stronger motivation for increased landscape aesthetics.

Property values were categorized in to five profiles: $100,000 to $300,000, $300,000 to $500,000, $500,000 to $700,000, $700,000 to $900,000, and $900,000 to $1,500,000 (Table 6.1). The interaction of a having pool can also be seen here, nearly all homes valued above $500,000 have a pool. The positive correlation between property value and irrigation application depth suggests socioeconomic level affects conservation behavior, likely because cost is less of a primary motivation. From the analysis of property value and outdoor water application, it can also be observed that the homes ranging from $900,000 to $1,500,000 used the largest amount of water for outdoor use ($p<0.001$). This trend concurs with the

literature, suggesting that sensitivity to water cost results in reduction of use (Whitcomb 2005). For homes participating in the sensor based technology program, the trend between increased water applications with increased property value is most apparent. For the total sample, the same trend exists, aside from the $700,000 to $900,000 range, which has the lowest calculated outdoor water application depth.

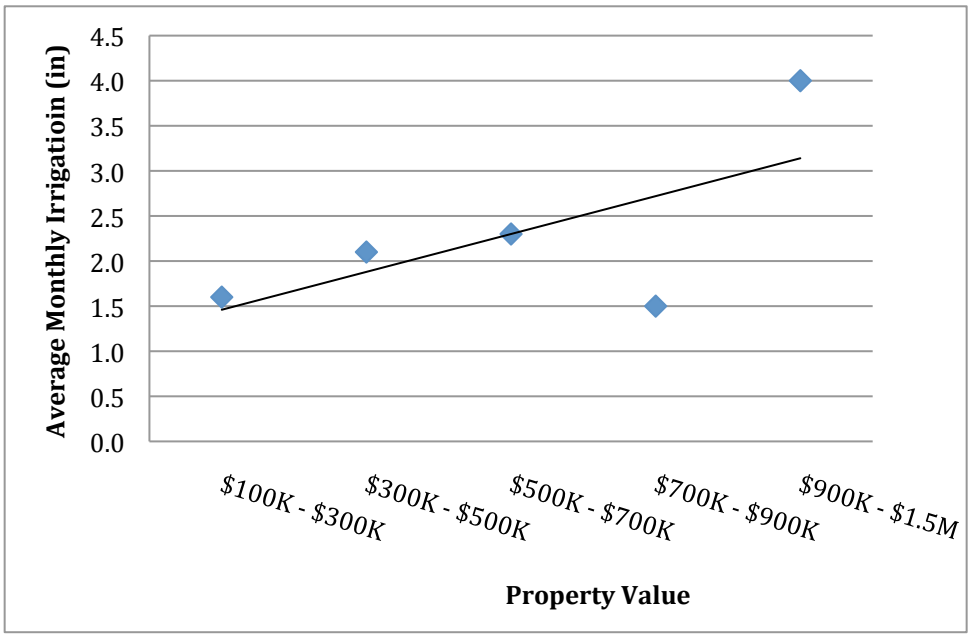

Figure 6.2. Effect of property value on average monthly irrigation for all homes.

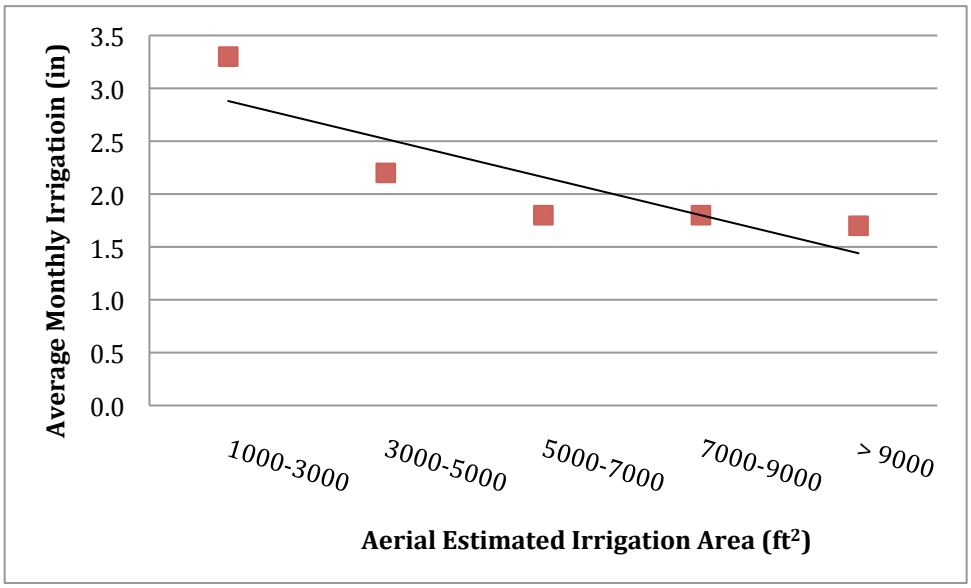

Figure 6.3. Correlation between irrigated area and monthly irrigation for all homes included in analysis.

Conversely, the smaller the property, the more water was applied, described by the negative correlation in Figure 6.3. It is also interesting to note that the homes with

smaller irrigated areas all have property values ranging from $100,000 to $500,000. The increase in negative correlation between irrigated area and water application could be due to a misunderstanding of irrigation scheduling principles and the over-design of irrigation systems (e.g. too many heads per hydrozone). Moreover, high consumption of outdoor water use is typically flagged by excessive volume use, not taking area into consideration. Therefore, over irrigation in smaller irrigated areas are rarely flagged by local purveyors or felt as an excessive economic stress.

Of the 142 homes included in this analysis, 56 have been part of an irrigation conservation study since 2006. In Table 6.1, it can be observed that the homes associated with the irrigation study applied more irrigation on average, 2.2 inches per month, versus 1.7 inches per month for the non-participant group ($p<0.001$). The increased outdoor water use for participating homes might be attributed to consistent use of an automatic irrigation system, as it was one of the criteria for participation in the sensor based irrigation water conservation program. However, since the commencement of that study there has been a significant ($p<0.001$) reduction, from 2.5 to 2.1 inches per month of average outdoor water application for participating homes due to treatment effects in that study.

Table 6.1. Average outdoor water application depth per month for the time period of 2002-2007.

Category		Overall		With Pool		Without Pool		Participants	
		Use_{avg} (in)	No.	Use_{avg} (in)	No.	Use_{avg} (in)	No.	Use_{avg} (in)	No.
Property Value Range	$100K - $300K	1.6 c*	66	2.1 b	32	1.2 b	34	2.0 c	25
	$300K - $500K	2.1 b	54	2.2 b	43	1.5 a	11	2.0 c	21
	$500K - $700K	2.3 b	7	2.3 b	7	-	0	2.1 c	4
	$700K - $900K	1.5 c	8	1.5 c	7	-	1	3.2 b	3
	$900K - $1.5M	4.0 a	7	4.0 a	6	-	1	4.7 a	3
Aerial Est. Irr. Area Range (ft^2)	1000-3000	3.3 a	7	3.7 a	5	2.3 a	2	5.4 a	3
	3000-5000	2.2 b	31	2.6 b	19	1.5 b	12	2.0 bc	13
	5000-7000	1.8 c	60	2.1 c	38	1.2 bc	22	1.9 c	22
	7000-9000	1.8 c	31	2.2 c	21	0.9 c	10	2.1 bc	10
	> 9000	1.7 c	13	1.8 d	12	0.3 d	1	2.2 b	8
	Average	*1.9*		*2.3¤*		*1.3¤*		*2.2*	
	Total		*142*		*95*		*47*		*56*

* Lower case letters denote significant differences at the 95% confidence level based on Duncan's Multiple Range Test.

¤ Means comparisons between homes with and without pools show these averages to be significantly different.

Section 7: Conclusions

This report presents the analysis of the outdoor water use practices and perceptions survey, distributed summer 2008. From the reported irrigation system attributes, approximately one-fifth of the homes use some form of microirrigation to water their landscape and a third of the homes have rain-shutoff devices. Further, according to the respondents the majority of these devices were reported as connected and functioning. These percentages of conservation technology and equipment incorporated into the system were slightly higher than expected for the area based on previous studies. However, the percentage of homes with mixed head types within the zones was 58%, which concurs with visual inspection of similar homes in the County.

A significant result observed was the misunderstanding of terminology or bypass devices. When asked about rain shut-off devices, 36% respondents reported having a rain shut-off device. All of these were reported to be rain sensors. However, it known, from actual observation that at least 4% of the respondents have functioning soil moisture sensors attached to their system. This concurs with the notion that the term "rain shut-off" is confusing to domestic irrigators. Further, Florida Stature 373.62, which requires irrigation systems to have "rain senor devices", is even more misleading.

The significant difference between water source and how often the respondent admits to watering their lawn/landscapes agrees with the watering day restrictions within Pinellas County. According to Pinellas County Code 82-1, homes using county water or wells, lakes, and ponds are allocated one day of irrigation a week for established lawns and landscaping. The homes surveyed using well/surface or potable water fell within the once per week categorical level. However, it should be noted that although the respondents reported once per week irrigation, previous research in the target area has observed greater irrigation frequencies for some potable users. Irrigation using reclaimed water is on a voluntary schedule (Resolution No. 01-329) permitting up to 4 days of irrigation per week. The mean response for homes receiving reclaimed water was 3.1 times per week.

There were also significant differences observed between the number of irrigation events per week and automation of the system. Homes that allow the rain shutoff device to bypass irrigation following rain events reported less weekly irrigation events occurring. A homeowner may attempt to be more conservative by manually operating the time clock schedule in response to rainy weather; however, these homes also seem to have their timers set to higher frequencies. Additionally, homes without irrigation time clocks irrigate less often than those homes with automatic systems, this concurs with previous findings about residential end use by the AWWA.

The average length of time set per irrigation cycle for a single turfgrass zone was 69 min., ranging from 20 to 120 min. Although 55% reported that they adjust their watering schedule seasonally, 31% do not adjust their irrigation run times based on seasonal plant water needs. In cases where the turfgrass zone is a large area, the irrigation design may likely utilize rotor head for irrigation. Rotor heads have larger radiuses and therefore less heads and spray heads will be needed to cover the area. Rotor heads have lover application rates than spray heads, and although in the spring /summer months approximately 60 min would be more than adequate for a rotor zone. The majority of the sites were not designed properly, with 58% of the sites reported having mixed zones, with presumably non-matched application rates. The application rates requiring approximately 25 min in the spring/summer months. Therefore, turfgrass zones that include spray heads are significantly over irrigated with the reported average run times.

A higher water use knowledge level was positively correlated with the educational level of the respondent. Furthermore, an increased knowledge index score correlates with the attitudinal factor of money affecting the desire to change the landscape. Thus, homeowners are aware of the expected costs for changes to the lawn/landscape when adding or removing turfgrass or conservation technology devices. Interestingly, an increased conservation attitude was positively correlated with increased turfgrass area. Recall, the questions that make up this index were contrary, meaning the questions were negative resulting in a reverse code. What this result could imply is that the homeowners' attitude toward alternative water sources is that they do not require irrigation conservation practices and in turn provide the additional water needed for an increased turfgrass lawn area.

Unexpectedly, there were no obvious correlations between the personal lawn/landscape interaction, which is the index that attempts to quantify the level of time spent in the lawn/landscape, and any of the attitudinal choices about the present landscape, which express the homeowner's satisfaction or desire to make changes. It would have been expected for this index to have a more defined opinion clearly observable.

To properly evaluate irrigation water based on utility data, outdoor and indoor water consumption must be separated. Three methods for calculating outdoor water use as a fraction of total water use were compared: winter average, low quartile (lowest 25%), and minimum use. The winter water use was assumed to only be indoor use, and subtracting the winter use provided the estimated monthly outdoor use. The minimum winter water use over the billing period was calculated as 2.2 in/month (6,700 gal) on average. The minimum winter method yielded the lowest error, 9%, compared to the actual irrigation water use collected from participating homes. To determine actual irrigation application amounts, the usage in gallons was then converted into inches, based on irrigated area. To estimate these areas, a combination of both property appraisal information and measured areas from GIS aerial images was used. The property appraisal information alone may vastly over and under estimate the actual property size, which will in turn

cause substantial error when calculating the irrigated area. For this sample, to verify the accuracy of the areal estimated irrigated area, the true irrigated areas were measured on homes in the participant group.

A pro-environmental behavior such as water conservation can stem from reluctance to over-use irrigation water based on cost. Two barriers to this conservation behavior, observed based on the actual water use analysis in this study were economic level, displayed in the form of property value, and irrigated area. The property value analysis showed that the highest value range ($900,000-$1,500,000) used the most water even when normalized for irrigated area. Overall there was a trend of increased water application with increased property value. Conversely, the smaller the irrigated area, the more water was applied. A primary cause for the increased use in both homes of higher property value or smaller irrigated area is likely due to minimal impact water cost for excessive use. The homes with pools used on average over 0.5 inches more water per month. This increase irrigation water use could be due to the pool or some other factor not considered in this analysis but correlated to the presence of a pool.

The following significant barriers and benefits were identified:

- Misunderstanding of plant water needs; seasonal scheduling
- Terminology in reference to rain shut-off device
- Conservation relating to water source
- Reliability of rain shut-off device
- Expressed room for improvement and interest in learning
- Influence of property value or property size

The ultimate goal of this research is to determine a means to promote knowledge of water conservation related to residential irrigation by understanding why people over irrigate. The next step is to create a cognitive model with the survey responses and the acquired actual water use data to develop a structural equation model that can be used to best determine the avenues to promote behavioral change leading to measured water conservation in landscape irrigation.

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Appendix A: Copy of survey instrument

UF UNIVERSITY of FLORIDA

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Dear Sir or Madam,

In recent years, the University of Florida has been conducting research on outdoor water use. It has become evident that focusing on the real practices of outdoor water use by households is very important. Enclosed you will find a questionnaire regarding your experiences with using water outside of the home. Your answers will assist us in determining ways we may better tailor future water use research. Furthermore, this study will serve to optimize the management of water and water-related resources through a better understanding of actual residential water use practices.

As an incentive for participation we would like to offer the first 50 respondents either a general water conservation kit (indoor) or irrigation system rain shut-off kit (including a rain sensor). If you would like to receive either of these, just note which one you prefer in the comment box on the back of your completed survey.

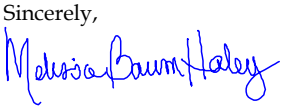
Your participation is voluntary and we sincerely hope that you will help us with this project. All responses will be kept confidential. As a participant you are at NO risk of penalty or fines, due to participation in this survey, if irrigation practices indicated are outside of the watering restrictions of your area. Please note that the identification number on the questionnaire will only be used for clerical purposes and that the information will be compiled anonymously. This is a good opportunity for you to help shape research and programs developed for your benefit by the University of Florida.

If you have any questions about the research study or the survey, please contact me by telephone (352-392-1864 ext 263) or email (mhaley@ifas.ufl.edu). If you have any questions about your rights as a research participant in the study feel free to contact the IRB02 Office, at PO Box 112250, University of Florida, Gainesville, FL 32611-2250; phone 392-0433.

We have provided a postage paid envelope for your convenience in returning your completed questionnaire back to us.

Thank you very much for your participation.

Sincerely,



Melissa Baum Haley, M.E. E.I.
Irrigation Research Coordinator
Agricultural & Biological Engineering

Outdoor Water Use Practices & Perceptions

Household Questionnaire

UF | UNIVERSITY of FLORIDA

Please use a **ball point pen** to complete this survey regarding your outdoor water use practices and perceptions. Upon completion, please return in the preaddressed, stamped envelope provided. Thanks!

Outdoor watering practices

1. How do you water your lawn/landscape?
   - □ Automatic irrigation system, which is set
   - □ Automatic irrigation system, used manually
   - □ Sprinkler head with hose attachment, which is moved around yard
   - □ Hose or watering can
   - □ I do not apply water to my lawn/landscape

2. On average, how often is your lawn/landscape watered?
   - □ Only when it rains
   - □ Never/Rarely
   - □ Once per week
   - □ Twice per week
   - □ Three to four times per week
   - □ Nearly every day

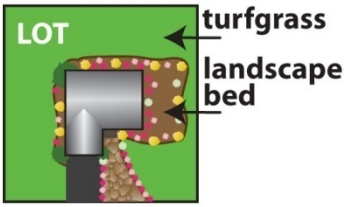
3. Who is in charge of watering your lawn/landscape?
   - □ I am
   - □ Other member of household
   - □ Lawn care service provider
   - □ Irrigation maintenance professional
   - □ Other: _____

4. Where does the water used in your lawn/landscape come from?
   - □ Rainwater only
   - □ Municipal/City/County water (not reclaimed)
   - □ Reclaimed water
   - □ Well or surface water
   - □ Rain barrels
   - □ Don't know
   - □ Other: _____

5. Given the choice, which water source would you prefer for outdoor water use?
   - □ Municipal water
   - □ Reclaimed water
   - □ Well or Surface water
   - □ Don't care

About your landscape

1. About what percentage of your **lot** is turfgrass and landscape?
   - ☐ 0% – 25%
   - ☐ 26% – 50%
   - ☐ 51% – 75%
   - ☐ Over 75%



2. About what percentage of your **landscape** is turfgrass?
   - ☐ 0% - 25%
   - ☐ 26% - 50%
   - ☐ 51% - 75%
   - ☐ 76% - 100%

3. Do you pay a company to maintain your lawn/landscape?
   - ☐ Yes ☐ No

4. Does your home have outdoor water features?
   - ☐ No
   - Yes
     - ☐ Swimming pool
     - ☐ Hot tub
     - ☐ Fountain
     - ☐ Pond

     Other: _____

Watering habits

1. Do you adjust your watering schedule throughout the year?
   - ☐ Monthly ☐ Seasonally ☐ Not really
2. Does your system have ***both*** spray and rotary sprinkler heads within the same zone?
   - ☐ Yes ☐ No ☐ Don't know
3. Do you water your lawn (turfgrass) and landscape (bedded area) for different lengths of time?
   - ☐ Yes ☐ No ☐ Don't know
4. How long do you typically water your lawn (turfgrass) each time you water?
   - ☐ _____ hours ☐ _____ minutes ☐ Don't know

If you have an irrigation system *(If not, proceed to next section.)*

1. Do you use any of the following low-volume irrigation equipment?

   Yes
   - ☐ Micro-irrigation
   - ☐ Drip tubing
   - ☐ Bubblers

   Other: _____

   - ☐ No
   - ☐ Don't know

2. If you have an irrigation timer, where is it located?
   - ☐ Attached to hose bib or faucet
   - ☐ In the garage
   - ☐ Inside of house
   - ☐ Exterior wall of house
   - ☐ Don't know where it is
   - ☐ Don't have one

3. If you have an irrigation timer, is it easily accessible?
   - ☐ Yes
   - ☐ Somewhat
   - ☐ No
   - ☐ Don't know

4. Do you have a rain shut-off device attached to your watering system?

   Yes
   - ☐ Rain sensor
   - ☐ Soil moisture sensor
   - ☐ Weather-based controller (with a rain bypass switch)
   - ☐ Other: _____

   - ☐ No
   - ☐ No, but I turn the irrigation timer off manually when it rains
   - ☐ Don't know

5. If you have a rain shutoff device, is it connected and functioning?
   - ☐ Yes
   - ☐ No
   - ☐ Don't know

6. How many zones does your system have?
   - ☐ 0–4
   - ☐ 5–8
   - ☐ 9 or more
   - ☐ Don't know

Please rate your agreement to the following statements:

	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree	Don't Know
7. Water costs don't affect my irrigation practices.	☐	☐	☐	☐	☐	☐
8. I would install a soil moisture sensor on an irrigation system.	☐	☐	☐	☐	☐	☐
9. I consider my irrigation practices to be very water conserving.	☐	☐	☐	☐	☐	☐
10. Local conservation programs are readily available.	☐	☐	☐	☐	☐	☐
11. Rain sensors are reliable.	☐	☐	☐	☐	☐	☐

Attitudes and actions

1. Please mark the top three statements that best describe your attitude toward your home's present landscape (in order of priority, 1 through 3).
   - ___ I am reasonably content with my present landscape and am not considering any changes.
   - ___ I prefer less lawn (turfgrass) and would like to remove some of it.
   - ___ I prefer more lawn (turfgrass) and would like to increase the lawn area of my yard.
   - ___ I would like to learn more about landscape water use before deciding what, if any, actions I take.
   - ___ I don't think my neighbors (and/or Homeowners Association) would accept the changes I would like to make.
   - ___ I would like to consider changes but don't have the ***time***.
   - ___ I would like to consider changes but don't have the ***money***.
   - ___ Other: _____

2. Have you ever participated in an outdoor water use conservation program?
   ☐ Yes ☐ No ☐ Don't know

3. Does your house have any of the following appliances or devices that are intended for water savings?
   ☐ No

   Yes (check all that apply)

Already there	I/we installed		Already there	I/we installed	
☐	☐	Low-flow faucet or showerhead	☐	☐	Micro-irrigation
☐	☐	Low-flow toilet	☐	☐	Drip irrigation
☐	☐	Water-efficient dishwasher	☐	☐	Rain sensor
☐	☐	Water-efficient washing machine	☐	☐	Soil moisture sensor
☐	☐	Tankless water heater	☐	☐	Weather-based (ET) controller
☐	☐	Rain Barrel	☐	☐	Other:_____

4. Does your house have any appliances or devices intended for energy savings?
   ☐ No

   Yes (check all that apply)

Already there	I/we installed	
☐	☐	Compact fluorescent light bulbs
☐	☐	Energy-saving power strips
☐	☐	High-efficiency clothes dryer
☐	☐	High-efficiency air conditioner
☐	☐	Tankless water heater
☐	☐	Solar water heater
☐	☐	Solar panels
☐	☐	Other:

Please rate your agreement to the following statements:	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree	Don't Know
5. Native plants don't need to be watered once established.	☐	☐	☐	☐	☐	☐
6. I do not feel my conservation of water affects the overall supply.	☐	☐	☐	☐	☐	☐
7. Because my irrigation system functions poorly, I don't irrigate.	☐	☐	☐	☐	☐	☐
8. I don't irrigate because of environmental concern.	☐	☐	☐	☐	☐	☐
9. My water source influences my outdoor water use practices.	☐	☐	☐	☐	☐	☐
10. When watering with reclaimed water, outdoor water use conservation is not necessary.	☐	☐	☐	☐	☐	☐
11. I spend a lot of time outside in my lawn/landscape.	☐	☐	☐	☐	☐	☐
12. I am very concerned about the appearance of my yard.	☐	☐	☐	☐	☐	☐
13. I am familiar with seasonal water needs of my lawn/landscape plants.	☐	☐	☐	☐	☐	☐
14. I am not aware of watering restrictions in my area.	☐	☐	☐	☐	☐	☐
15. I am aware of lawn appearance requirements in my neighborhood.	☐	☐	☐	☐	☐	☐
16. I think a rain shut-off device is very important.	☐	☐	☐	☐	☐	☐
17. Conservative outdoor water-use practices save money on my water bill.	☐	☐	☐	☐	☐	☐
18. I often observe my neighbors overirrigating.	☐	☐	☐	☐	☐	☐
19. When watering with well water, outdoor water use conservation is not necessary.	☐	☐	☐	☐	☐	☐
20. When it does not rain regularly, I tend to water my lawn a little extra.	☐	☐	☐	☐	☐	☐
21. I water less in the winter months.	☐	☐	☐	☐	☐	☐
22. Native plants in the landscape tend to look un-maintained.	☐	☐	☐	☐	☐	☐
23. New irrigation systems are required to have rain shutoff devices.	☐	☐	☐	☐	☐	☐
24. Water conservation is a contribution to energy savings.	☐	☐	☐	☐	☐	☐
25. We are all responsible for water conservation in our community.	☐	☐	☐	☐	☐	☐

In your opinion, how effective are (or would be) each of the following to increase water conservation:	Very Effective	Effective	Neither	Ineffective	Very Ineffective	Don't Know
26. Watering restrictions	☐	☐	☐	☐	☐	☐
27. Rain shut-off devices	☐	☐	☐	☐	☐	☐
28. Increased water rates	☐	☐	☐	☐	☐	☐
29. Landscape ordinances that limit turfgrass area	☐	☐	☐	☐	☐	☐
30. Local conservation programs	☐	☐	☐	☐	☐	☐
31. Irrigation scheduling based on water needs of plants	☐	☐	☐	☐	☐	☐
32. Using native plants in the bedded areas	☐	☐	☐	☐	☐	☐
33. Email reminders of when to change the irrigation timer and suggested run times would help increase irrigation efficiency	☐	☐	☐	☐	☐	☐

Last bit…

1. Do you own or rent your home?

   ☐Own ☐ Rent

2. How many years have you lived in your current home?

   _____ years

3. How many years have you lived in Florida?

   _____ years

4. How many months out of the year are you in Florida?

   _____ months

5. Including yourself, how many members in your household are in each age group?

   _____ under 10
   _____ 11 – 20
   _____ 21 – 65
   _____ 66 or older

6. What is your age?____ years

7. What is the highest level of education you have completed?

   ☐ Some high school
   ☐ Complete high school
   ☐ Some college
   ☐ Completed college
   ☐ Advanced degree

8. Please indicate the income range that most closely approximates your total household income.

   ☐ Under $30,000
   ☐ $30,000 – $49,999
   ☐ $50,000 – $74,999
   ☐ $75,000– $149,999
   ☐ Over $150,000

Is there anything we have overlooked? Please enter your comments in the space provided below.

Thank you very much for your time!

We really appreciate your completion of this questionnaire.
Please send the survey back
as soon as possible.

If you have misplaced the preaddressed, stamped envelope, please send it to the address below.

Agricultural & Biological Engineering

Attn. Melissa B. Haley
Frazier Rogers Hall
P.O. Box 110570
Gainesville, FL 32611-0570

Phone (352) 392-1864 ext 263
Fax (352) 392-4092

Survey No._____

UF UNIVERSITY of FLORIDA

Institute of Food and Agricultural Sciences
Agricultural and Biological Engineering Department

Frazier Rogers Hall
PO Box110570
Gainesville, FL 32611-0570
352-392-1864
352-262-1172
E-mail: mbhaley@ufl.edu

Dear Questionnaire Respondent,

Thank you very much for your participation in our research study by responding to and returning the *Outdoor Water Use Practices & Perceptions* household questionnaire. Your answers will assist us in determining ways we may better tailor future water use research. Furthermore, this study will serve to optimize the management of water and water-related resources through a better understanding of actual residential water use practices.

As an incentive for participation we offered 50 of the respondents either a general water conservation kit (indoor) or an irrigation system rain shut-off kit (including a rain sensor). Enclosed is the in conservation kit you marked as your preference in the comment box on the back of your completed survey.

If you have any questions about the research study or the survey, please contact me by telephone (352-392-1864 ext 263) or email (mbhaley@ufl.edu). If you have any questions about your rights as a research participant in the study feel free to contact the IRB02 Office, at PO Box 112250, University of Florida, Gainesville, FL 32611-2250; phone 392-0433.

Again, thank you very much for your participation.

Sincerely,

Melissa Baum Haley, M.E. E.I.
Irrigation Research Coordinator
Agricultural & Biological Engineering

Appendix B: Copy of progress reports

Irrigation Literacy Evaluation
Water-Wise Irrigation Perceptions and Practices Survey
Progress Report 1

Submitted to

Ms. Dorian Morgan
Project Manager
Communications Department
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34604-6899

by

Michael D. Dukes, Melissa B. Haley
Agricultural and Biological Engineering
Institute of Food and Agricultural Sciences
University of Florida
mddukes@ufl.edu, mbhaley@ufl.edu

December 21, 2007

Background

The purpose of this progress report is to document the status of the project entitled "Irrigation Literacy Evaluation, Water-Wise Irrigation Perceptions and Practices Survey" with SWFWMD University of Florida project numbers to be determined. This project was officially started in November 2007 as a cooperative agreement for the 2008 fiscal year.

Project Status

The scope of work has been submitted to the District for review and the purchase order is being sent to the University. Task 1, the design of the advertising program, is in the initial planning stages and work will begin officially when the contract is received by the University. The survey area will be within Pinellas County. The project includes the distribution of survey packets with a target of at least 384 customer responses. The response population will include a representative sample of homes which use both potable and alternative water sources. The design of the advertising program to encourage residents to complete the survey will also include the determining the best method for questionnaire distributions including mixed mode methods (inclusion of telephone and internet).

Methodology will be agreed upon between the District and the ABE Department at UF prior to survey dissemination. A required application will be submitted to the University Internal Review Board (IRB). A copy of IRB application including survey dissemination plan will be provided to the District for invoicing upon completion of the task. Task status and timeline attached.

Task Timeline and Status

Table 1. The following tasks are associated with this project and have been completed as follows:

Task	Percent complete
Task 1 – Development of surveys	15%
Task 2 – Deployment of surveys	0%
Task 3 – Obtain demographic and utility data	0%
Task 4 – Preliminary survey response update	0%
Task 5 – Final survey response report	0%
Task 6 – Final report	0%

Table 2. Timeline as outlined in project scope of work, FY 2008.

Description	O	N	D	J	F	M	A	M	J	J	A	S
Design advertising program	X	X	X									
Outline survey questionnaire		X	X	X								
Submit questionnaire for review to District				X	X							
Identify qualifying customers with Utilities				X	X							
First survey mailing						X						
Second survey mailing							X					
Third survey mailing								X				
Preliminary survey response update									X			
Additional mailings if necessary									X			
Obtain billing data from Utilities										X		
Draft survey response report											X	
Final survey response report											X	
Draft final report												X
Final report												X
Final invoice to District												X
Project closeout												X

Irrigation Literacy Evaluation
Water-Wise Irrigation Perceptions and Practices Survey
Progress Report 2

Submitted to

Ms. Dorian Morgan
Project Manager
Communications Department
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34604-6899

by

Michael D. Dukes, Melissa B. Haley
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February 22, 2008

Background

The purpose of this progress report is to document the status of the project entitled "Irrigation Literacy Evaluation, Water-Wise Irrigation Perceptions and Practices Survey" with SWFWMD University of Florida project numbers to be determined. This project was officially started in November 2007 as a cooperative agreement for the 2008 fiscal year.

Project Status

The scope of work has been submitted to the District for review and the purchase order was sent to the University. Task 1, the design of the advertising program, is underway. The survey area will be within Pinellas County and the identification of qualifying customers will be completed with the aid of the local water purveyor and using the County GIS records.

The required application has been submitted to the University Internal Review Board (IRB). A copy of IRB application is included. The next deliverable to the District will be the survey dissemination plan. This will be provided to the District along with the IRB "approval" letter for invoicing upon completion of the task. Additionally, task status and timeline attached.

Task Timeline and Status

Table 1. The following tasks are associated with this project and have been completed as follows:

Task	Percent complete
Task 1 – Development of surveys	30%
Task 2 – Deployment of surveys	0%
Task 3 – Obtain demographic and utility data	0%
Task 4 – Preliminary survey response update	0%
Task 5 – Final survey response report	0%
Task 6 – Final report	0%

Table 2. Timeline as outlined in project scope of work, FY 2008.

Description	O	N	D	J	F	M	A	M	J	J	A	S
Design advertising program	X	X	X									
Outline survey questionnaire		X	X	X								
Submit questionnaire for review to District				X	X							
Identify qualifying customers with Utilities				X	X							
First survey mailing						X						
Second survey mailing							X					
Third survey mailing								X				
Preliminary survey response update									X			
Additional mailings if necessary									X			
Obtain billing data from Utilities										X		
Draft survey response report											X	
Final survey response report											X	
Draft final report												X
Final report												X
Final invoice to District												X
Project closeout												X

Irrigation Literacy Evaluation
Water-Wise Irrigation Perceptions and Practices Survey
Progress Report 3

Submitted to

Ms. Dorian Morgan
Project Manager
Communications Department
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34604-6899

by

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April 18, 2008

Background

The purpose of this progress report is to document the status of the project entitled "Irrigation Literacy Evaluation, Water-Wise Irrigation Perceptions and Practices Survey" with SWFWMD University of Florida project numbers to be determined. This project was officially started in November 2007 as a cooperative agreement for the 2008 fiscal year.

Project Status

The scope of work has been submitted to the District for review and the purchase order was sent to the University. The required application has been submitted to the University Internal Review Board (IRB) and approved. The IRB "approval" letter was provided to the District for invoicing.

The survey area will be within Pinellas County and the identification of qualifying customers will be completed with the aid of the local water purveyor and using the County GIS records. Pinellas County Utilities is currently working on developing a list of single family residence customers for instrument deployment. The list will include water source information (potable, reclaimed, or well).

The question bank has been set up for efficient data analysis and index development. The survey instrument has been formatted into an 8 ½" by 11" bi-fold

booklet. The booklet and cover page are provided along with this update for review by the District prior to printing and deployment. Each booklet will be coded with an identification number for data analysis purposes.

Additionally, task status and timeline attached.

Task Timeline and Status

Table 1. The following tasks are associated with this project and have been completed as follows:

Task	Percent complete
Task 1 – Development of surveys	90%
Task 2 – Deployment of surveys	0%
Task 3 – Obtain demographic and utility data	5%
Task 4 – Preliminary survey response update	0%
Task 5 – Final survey response report	0%
Task 6 – Final report	0%

Table 2. Timeline as outlined in project scope of work, FY 2008.

Description	O	N	D	J	F	M	A	M	J	J	A	S
Design advertising program	X	X	X									
Outline survey questionnaire		X	X	X								
Submit questionnaire for review to District				X	X							
Identify qualifying customers with Utilities				X	X							
First survey mailing						X						
Second survey mailing							X					
Third survey mailing								X				
Preliminary survey response update									X			
Additional mailings if necessary									X			
Obtain billing data from Utilities										X		
Draft survey response report											X	
Final survey response report											X	
Draft final report												X
Final report												X
Final invoice to District												X
Project closeout												X

Irrigation Literacy Evaluation
Water-Wise Irrigation Perceptions and Practices Survey
Progress Report 4

Submitted to

Ms. Dorian Morgan
Project Manager
Communications Department
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34604-6899

by

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June 18, 2008

Background

The purpose of this progress report is to document the status of the project entitled "Irrigation Literacy Evaluation, Water-Wise Irrigation Perceptions and Practices Survey" with SWFWMD University of Florida project numbers to be determined. This project work started in November 2007 as a cooperative agreement for the 2008 fiscal year.

Project Status

To resolve an administrative error, and permit the University to properly process the purchase order, scope of work and time line has been resubmitted to the District. At this time the University is awaiting the amended purchase order from the District. The amended task status and timeline are below (Tables 1 and 2).

The required application has been submitted to the University Internal Review Board (IRB) and approved in February 2008. The IRB "approval" letter was previously provided to the District for invoicing.

The survey area will be within Pinellas County and the identification of qualifying customers have been compiled by Pinellas County Utilities Alternative Water Sources. The list includes customers in single family residences. The list includes water source information (potable, reclaimed, or well).

The survey instrument has been formatted into an 8 ½" by 11" bi-fold booklet. The booklet and cover page have been provided for review by the District prior to printing and deployment. Each booklet will be coded with an identification number for data analysis purposes. Printing of the booklet will include both color and black and white pages. Immediately following the receipt of the purchase order and instrument review from the District, the first mail out will commence.

Task Timeline and Status

Table 1. The following tasks are associated with this project and have been completed as follows:

Task	Percent complete
Task 1 – Development of surveys	100%
Task 2 – Deployment of surveys	5%
Task 3 – Obtain demographic and utility data	50%
Task 4 – Preliminary survey response update	0%
Task 5 – Final survey response report	0%
Task 6 – Final report	0%

Table 2. Timeline as outlined in amended project scope of work, FY 2008.

Description	D	J	F	M	A	M	J	J	A	S	O	N
Design advertising program	X	X	X									
Outline survey questionnaire		X	X	X								
Submit questionnaire for review to District				X	X	X						
Identify qualifying customers with Utilities					X	X						
First survey mailing							X					
Second survey mailing								X				
Third survey mailing									X			
Additional mailings if necessary									X			
Preliminary survey response update										X		
Obtain billing data from Utilities										X		
Draft survey response report											X	
Final survey response report											X	
Draft final report												X
Final report												X
Final invoice to District												X
Project closeout												X

Irrigation Literacy Evaluation
Water-Wise Irrigation Perceptions and Practices Survey
Progress Report 5

Submitted to

Ms. Dorian Morgan
Project Manager
Communications Department
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34604-6899

by

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August 14, 2008

Background

The purpose of this progress report is to document the status of the project entitled "Irrigation Literacy Evaluation, Water-Wise Irrigation Perceptions and Practices Survey" with SWFWMD University of Florida. This project work started in November 2007 as a cooperative agreement for the 2008 fiscal year.

Project Status

Prior to Progress Report 4, the scope of work and time line were resubmitted to the District and the University. After reprocessing the purchase order, the University has issued an internal project number of 00075634. The revised task status and timeline are below in Tables 1 and 2.

From the lists of potable, reclaimed, and well customers compiled by the Pinellas County Utilities Alternative Water Sources department, qualified customers were randomly selected. All customers chosen have a U.S. postal address and are noted within the PCU customer service database to have in-ground irrigation system.

The survey instrument has been formatted into an 8 ½" by 11" bi-fold booklet. The booklet and cover page were reviewed by the District prior to printing and deployment. Each booklet has been coded with a customer identification number for data analysis purposes. Printing of all 1500 booklets was completed with colored

pages. The mail-out survey package includes: the questionnaire booklet, customer cover letter, and pre-stamped return envelope.

In three mailing waves a total of 1090 PCU customers received survey packages; 396 potable, 282 well, and 412 reclaimed. The target response rate is at least 384 customers. If the response rate is less than 267, additional mailings will continue.

Task Timeline and Status

Table 1. The following tasks are associated with this project and have been completed as follows:

Task	Percent complete
Task 1 – Development of surveys	100%
Task 2 – Deployment of surveys	75%
Task 3 – Obtain demographic and utility data	50%
Task 4 – Preliminary survey response update	10%
Task 5 – Final survey response report	0%
Task 6 – Final report	0%

Table 2. Timeline as outlined in amended project scope of work, FY 2008.

Description	D	J	F	M	A	M	J	J	A	S	O	N
Design advertising program	X	X	X									
Outline survey questionnaire		X	X	X								
Submit questionnaire for review to District				X	X	X						
Identify qualifying customers with Utilities					X	X						
First survey mailing							X					
Second survey mailing								X				
Third survey mailing									X			
Additional mailings if necessary									X			
Preliminary survey response update										X		
Obtain billing data from Utilities										X		
Draft survey response report											X	
Final survey response report											X	
Draft final report												X
Final report												X
Final invoice to District												X
Project closeout												X

Irrigation Literacy Evaluation
Water-Wise Irrigation Perceptions and Practices Survey
Progress Report 6

Submitted to

Ms. Dorian Morgan
Project Manager
Communications Department
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34604-6899

by

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mddukes@ufl.edu, mbhaley@ufl.edu

December 23, 2008

Background

The purpose of this progress report is to document the status of the project entitled "Irrigation Literacy Evaluation, Water-Wise Irrigation Perceptions and Practices Survey" with SWFWMD University of Florida project number 00075634. This project work started in November 2007 as a cooperative agreement for the 2008 fiscal year and the account was closed as of 30 November 2008. The task status and timeline are below in Tables 1 and 2.

Project Status

Following the forth mailing of follow up with non-respondents and returned survey packets due to resident/address errors, an additional 20 surveys were received. The final response rate was 26%, yielding 275 completed questionnaires, which continues to satisfy the minimum response criteria required by the District.

As part of the questionnaire response incentive, the participants were offered either an indoor or outdoor water conservation kits. Twelve percent of the respondents requested one of the free conservation kits. The indoor kit (Figure 1) included shower and sink water saving faucets as well as aerating nozzles, leak detection tables, and a hose nozzle. The outdoor kit (Figure 2) included a min-click rain sensor and water saving hose nozzle. Both kits included appropriate literature to reinforce the importance of these devices.

Currently the final survey response report and subsequent final report are being prepared to submit for review by the District.

Task Timeline and Status

Table 1. The following tasks are associated with this project and have been completed as follows:

Task	Percent complete
Task 1 – Development of surveys	100%
Task 2 – Deployment of surveys	100%
Task 3 – Obtain demographic and utility data	100%
Task 4 – Preliminary survey response update	100%
Task 5 – Final survey response report	50%
Task 6 – Final report	50%

Table 2. Timeline as outlined in amended project scope of work, FY 2008.

Description	D	J	F	M	A	M	J	J	A	S	O	N
Design advertising program	X	X	X									
Outline survey questionnaire		X	X	X								
Submit questionnaire for review to District				X	X	X						
Identify qualifying customers with Utilities					X	X						
First survey mailing							X					
Second survey mailing								X				
Third survey mailing									X			
Additional mailings if necessary									X			
Preliminary survey response update										X		
Obtain billing data from Utilities										X		
Draft survey response report											X	
Final survey response report											X	
Draft final report												X
Final report												X
Final invoice to District												X
Project closeout												X

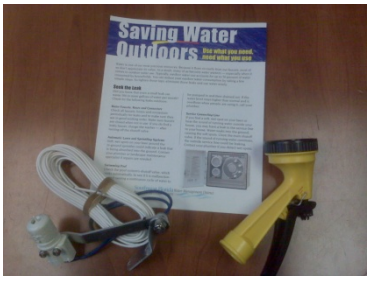

Figure 1. Indoor water conservation incentive kit (left).
Figure 2. Outdoor water conservation incentive kit (right).