

Impact of Irrigation Devices on Water Consumption

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Executive Summary

It is in the interest of Seattle Public Utilities (SPU) to encourage water conservation among our customers. In the summer of 2002, SPU conducted a research study to explore if irrigation devices are effective water savers. We studied single family residential customers that were already using automatic in-ground irrigation systems.

Customers selected to participate in the study had a history of higher use in the summer, generally a good indication that they are irrigating a lot. A control group was carefully chosen to match the consumption patterns of participants.

Study participants received devices that changed their automated watering schedule according to historical weather patterns in the region; according to rainfall; or some combination of the two. Rather than a device, some participants were given a customized schedule to adjust consumption throughout the season.

The model compares the customers' historical (1998-2001) summer consumption to 2002 in addition to the participant/control comparison. This historical analysis give the most recent data context, but also brings in the factors of seasonal weathers changes and drought that must be considered.

The regression results show that a device called *Aqua Conserve With Rain Sensor* demonstrated a savings of 190 gallons per day for a group that would typically use 650 gallons a day. At \$4.08/CCF, this would translate to a savings of \$136 in a summer. (When we get the program costs back from Community Services, the division that implemented the study, we'll know whether or not that's a good

deal.) This is the only measure that combined the rain sensor with adjustments based on historical weather patterns.

The other measures studied had no statistically significant savings. The model guesses *that Aqua Conserve Without Rain Sensor* saves 117 and *Irrigation Scheduling* saves 46 gallons per day, but the error is high. It appears that the *Mini Clicks* devices don't do much at all.

The Whole Story

The business of supplying municipal water is unlike many markets in that it is in the interest of the supplier for demand to stay steady, as opposed to always increasing. The vast majority of the costs of providing water are in a large fixed investment for system infrastructure. If, as demand increases, a municipality "taps" the entirety of their water supply and needs to invest in an additional source, this can be very expensive.

In efforts to avoid a costly additional supply, SPU has decided to encourage conservation among its customers. In the summer of 2002, SPU launched a research study to explore conservation possibilities for single-family residential customers that use a large amount of water during the peak season, May 15 – September 15. The peak season is targeted because, in the Northwest, we typically have a steady supply of water October through April, and it is the summer months when supply gets low. Furthermore, demand for water is high during these months, much of which is used for irrigation.

The study provided select water-hogging customers with devices to be installed on existing in-ground automatic irrigation systems that customers have been using for the past four years. The reason for selecting customers that have high use is that they potentially have a lot of room for improvement. Typically, they are watering a large area, so even if they save a small amount of water per square foot, it can add up to a significant savings. There are a couple of reasons we are targeting customers with automatic irrigation systems. First, we suspect some set their system for the amount of water needed at the peak of the summer and leave it at that level for the entire season, therefore watering more than necessary in the cooler and wetter months of the irrigation season.. Also, even if the system is set to water a reasonable amount for a particular month, it will still run during and after it has rained. Finally,

these devices are designed to be no-brainers for the customers. Potentially, it is a way to get a water savings from large customers while making minimum demand on the customer.

If the measures save enough water to be cost effective to install, SPU may decide to establish a program that would encourage implementation among appropriate customers.

Customer Selection

Customers were selected with the help of SPU's WaterBIRD database, which tracks customer account and billing information. First, we estimated outdoor water consumption by subtracting average daily winter¹ use from average daily peak season use and selected customers who had fairly consistent high outdoor water consumption for the previous four years.

This gave us a list of about 1,000 customers. We invited half of these customers to participate in the study. To qualify customers were required to have an automatic in-ground irrigation system. Factors that would disqualify a customer included manual use of the irrigation system, homes with swimming pools, fountain or other water features, and a change in the number of residents living in the home over the last 4 years or during the summer of 2002.

We selected a group of control customers from the other half of the list. Each qualified participant was matched with three controls using similar attributes. These included quantity of peak season consumption, lot size, and geographical proximity. Using the same criterion to qualify the participants, one control was assigned to each participant.

Devices and Services Provided

Each participant was assigned one of four measures. The measures were implemented or installed by a professional irrigation contractor who assessed their landscape needs. 25 received the *Aqua Conserve Without Rain Sensor* (AWO), an irrigation controller which automatically adjusts the base watering schedule according to historical weather information for the Puget Sound area. 21 received the *Aqua Conserve With Rain Sensor* (AW), which combines the controller with a rain sensor. 51 customer received the *MiniClicks* (MC) rain sensor, which interrupts the irrigation schedule when it has rained a

¹ November 15 – March 15

preset amount. Finally, rather than a device, 26 customers were given a customized irrigation schedule with monthly scheduling changes from the irrigation contractor (IS).

To reduce costs, measures were assigned to customers depending on the number of irrigation zones they had.

Data

The dependent variable analyzed in this evaluation is average daily water consumption during the summer season (CCFDAY). The 2002 summer consumption data was collected by special meter reads taken specifically for this study. The period analyzed for the 2002 consumption is slightly different from the May 15 – September peak season. The first reads were taken around June 8 (see [Figure 1](#) for details) and the final reads were taken October 18.

We also include historical consumption of participants and controls between 1998 and 2001 taken from the WaterBIRD database. This number was calculated by prorating consumption for June 8 – October 18 using the billing data available. Single family residential accounts are typically billed (and therefore their meters are read) every two months. The prorated consumption calculation, consequently, is influenced by consumption on the shoulders of this period.

Using a combination of seasonal temperature and rainfall for the region a weather index was developed (by Tim Skeel, SPU) to account for demand shifts due to weather.

Dummy variables were created for each study measure, applied to all years for both participants and control customers. These measure dummies were applied to the control customers based on the measure applied to their matched participant. The purpose of these dummies is to distinguish differences between the groups that were selected for each measure. Measure implementation dummy variables were applied to participants for the year 2002 (AW02, AWO02, MC02, IS02). A dummy was created for control customers to distinguish any inherent differences between them and the participants.

Finally, dummy variables were created for the years 2001 (Y01) and 2002 (Y02). The primary reason these variables are necessary is to account for the effect of the 2001 drought. SPU's water saving

campaign significantly dropped overall consumption in 2001 and the effect appears to have carried over to 2002.

Another dummy variable was created for control customers in 2002 (CONT02), to check the interaction between the control group and the year 2002.

Hypothesis

Of course we hope to find that these measures save immense quantities of water and never kill anybody's plants due to lack of water. In order to test this, I ran an ordinary least squares regression that compares the control group to the participants in 2002 and picks out inherent consumption differences among measure groups. The formula for this analysis was:

$$\text{CCFDAY} = \beta_2(\text{AW02}) + \beta_3(\text{AWO02}) + \beta_4(\text{IS02}) + \beta_5(\text{MC02}) + \beta_6(\text{INDEX}) + \beta_7(\text{AW}) + \beta_8(\text{AWO}) + \beta_9(\text{IS}) + \beta_{10}(\text{MC}) + \beta_{11}(\text{Y01}) + \beta_{12}(\text{Y02})$$

The primary hypothesis for this formula is that β_2 through β_5 are 0, which would indicate that, in 2002 the measure participants used as much water as the control group.

Results

The regression results can be found in [Figure 2](#).

Let's start by noting the inherent differences in consumption of the measure groups. While the coefficients of these variables are not particularly interesting to analyze, it is clear that they play a vital role in this regression. Because some participants were assigned a measure based on the number of irrigation zones, we have reason to believe some measures groups will generally have distinct consumption patterns.

Next we'll consider the inherent difference in water consumption for the control group as compared to the participants. The coefficient for the control variable is very small with essentially no statistical significance. This is a good indication that the control group was well selected and historically there hasn't been a difference between them and the participants.

The 2002 and 2001 variables should measure the drought effect for those years. The only other variable we have in this study that can count for changes in consumption from year to year is the weather

index. If the index was perfect and weather was the only influence on consumption, the coefficients for these variables would be 0. As indicated in the regression results, the 2002 effect is -0.181 (-0.285, -0.076). This is over four standard deviations (about 17%) less than typical consumption established by the measure group coefficients.

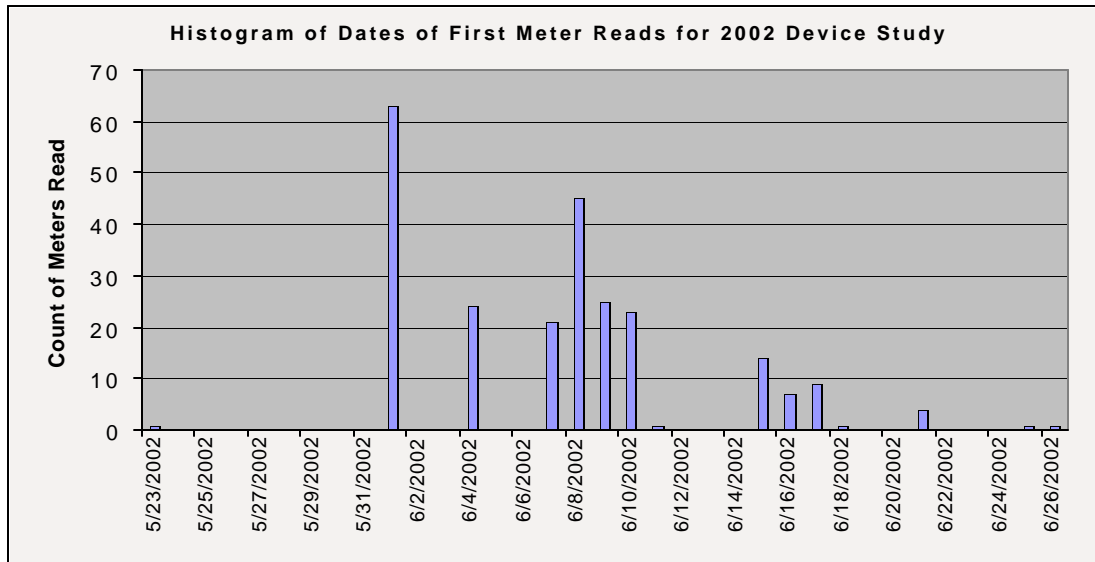
Now we can look at the effectiveness of the devices. Here we are testing the hypothesis that the coefficients for the study measures in 2002 are 0.

	2002 Consumption Effects Measured in CCF/Day				% change from measure implementation		
	Historical Coefficients for Measure Groups	2002 "Drought Effect"	2002 Weather Effect	2002 Measure Coefficients (Effect from Implementation)	best estimate	95% confidence	
						Low	high
AW	1.0153	-0.1807	0.0349	-0.2528	-29%	-58%	0%
AWO	1.0037	-0.1807	0.0349	-0.1577	-18%	-50%	14%
IS	1.2098	-0.1807	0.0349	-0.0618	-6%	-34%	20%
MC	1.0635	-0.1807	0.0349	0.0053	1%	-21%	22%

The only measure that we can say has a statistically significant effect on consumption is the *Aqua Conserve With Rain Sensor*. The table above indicates that customers who used this device used 29% less water than the control group they were matched with. That's a savings of 190 gallons per day. While the other measures may also be moderately effective in saving water, the data does not reflect this conclusively. The model guesses that *Aqua Conserve Without Rain Sensor* saves 117 and *Irrigation Scheduling* saves 46 gallons per day, but the error is high. It appears that the *Mini Clicks* devices don't do much at all.

SPU currently values peak season water at \$4.08/CCF. According to the model results, implementation of the *Aqua Conserve With Rain Sensor* could save 33 CCF/year or \$136.

Figure 1



Count of reads before June 8: 109
 Count of June 8 reads: 45
 Count of reads after June 8: 86

Figure 2

Dependent Variable: CCFDAY
 Method: Least Squares
 Date: 12/10/02 Time: 20:20
 Sample(adjusted): 2 1216

Included observations: 1215 after adjusting endpoints					95% Confidence Interval	
Variable	Coefficient	Std. Error	t-Statistic	Prob.	Low	High
AW02	-0.252754	0.130241	-1.940658	0.0525	-0.508	0.003
AWO02	-0.157675	0.143288	-1.100408	0.2714	-0.439	0.123
IS02	-0.061805	0.120810	-0.511593	0.6090	-0.299	0.175
MC02	0.005305	0.095799	0.055381	0.9558	-0.182	0.193
INDEX	0.001599	0.001086	1.472856	0.1411	-0.001	0.004
AW	1.015313	0.041558	24.43112	0.0000	0.934	1.097
AWO	1.003743	0.045430	22.09440	0.0000	0.915	1.093
IS	1.209826	0.038698	31.26340	0.0000	1.134	1.286
MC	1.063482	0.031608	33.64627	0.0000	1.002	1.125
Y01	-0.307144	0.050980	-6.024754	0.0000	-0.407	-0.207
Y02	-0.180731	0.053439	-3.382024	0.0007	-0.285	-0.076
CONTROL	-0.002029	0.032632	-0.062167	0.9504	-0.066	0.062
R-squared	0.101258	Mean dependent var	0.977140			
Adjusted R-squared	0.093040	S.D. dependent var	0.533456			
S.E. of regression	0.508034	Akaike info criterion	1.493292			
Sum squared resid	310.4930	Schwarz criterion	1.543687			
Log likelihood	-895.1749	Durbin-Watson stat	0.601939			

If you double-click on spreadsheet object, you can choose individual measures from the pivot table and check the data fit. Fun!

MEASURE (All)

	Control	Data		
	Control		Participant	
Year	Average of Predicted	Average of Actual	Average of Predicted	Average of Actual
1998	1.113253007	1.112993815	1.113588564	1.118933178
1999	1.048490157	1.046832199	1.048825714	1.052444872
2000	1.097646737	1.09826971	1.097982294	1.090613272
2001	0.728424041	0.726073204	0.728759598	0.731632148
2002	0.930208822	0.930213249	0.849600722	0.849050019

60 gallons per day savings

