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FLORIDA WATER RATES EVALUATION OF SINGLE-FAMILY HOMES

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Prepared for and funded by:

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South Florida Water Management District
Northwest Florida Water Management District

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Executive Summary

The general objective of this project is to examine and quantify the functional relationship between water consumption and water prices for single-family residential customers in Florida. The first law of economic theory states that as the price of a commodity increases, its quantity demanded decreases. This law is widely believed and well documented. Empirical research over the last 40 years has consistently shown this to be true for water. Although the direction of the relationship is well understood and accepted, the precise relationship is not.

In this project we have three specific objectives related to water pricing. The first objective is to better understand the multiple price signals sent to customers via block rate structures. This issue is of growing importance because many Florida water utilities have or are adopting increasing block rate structures in which water price increases with increasing increments of water use during a billing period. A theoretical argument used in support of block rates is that they increase the price signal sent to customers to conserve water. There is little or no research evidence, however, to gauge by how much and under what conditions.

Another specific objective is to assess how wealth and price sensitivity are related. Empirical data show water use generally goes up with increasing wealth—largely related to more landscape irrigation. But as water price increases, do wealthy customers reduce water in the same proportion as others? Because customer wealth can vary greatly by utility, this is an important issue in assessing how pricing can affect utilities differently.

Understanding and factoring in source substitution for irrigation is the third specific objective. Economic theory states price elasticity increases as more substitutes for a resource are available. With substitutes, customers have the ability to switch to cheaper sources of supply (e.g., irrigation wells) as utility water prices increase. Because of the relatively frequent availability of source substitution in Florida, price sensitivity would be expected to be higher than in other regions of the United States and world.

Besides these three research objectives, the study needs to generate results that are readily usable by practitioners to assist real-world decision-making concerning rate design, water use and revenue forecasting, resource planning, and customer support. The analysis and results need to be transparent to and readily understandable by the general public. In addition, the results need to be developed and presented to serve a wider audience than just the participating water utilities. An additional work product of this project includes a public outreach document that conveys the results and applicability of this study to a more general audience. The results are also integrated into a computer workbook (Waterate) that Florida utilities can obtain, free of charge from the water management districts, to simulate the impacts of different water and sewer rate structures on water use.

To address the primary research objectives, we collect and analyze data for a large number of single-family homes, the largest dataset ever collected for such a purpose. Our investigation includes both survey research (psychometrics) and empirical evaluation of actual water use (econometrics).

Our evaluation approach uses a nonrandomized sampling plan as follows:

1. Identify 16 participating Florida water utilities having a wide range of prices and rate structures. Figure ES-1 maps the 16 participating water utilities.
2. Identify four distinct home profiles based on characteristics such as property value and house size. Table ES-1 defines the profiles.
3. Over the 16 utilities and four profiles, select 7,200 homes that best match the home profile definitions.

Our sampling plan is to select and analyze water use of homes that have nearly identical characteristics, but face different types of rate structures and levels of water prices. We want to compare "apples to apples" so that we can focus on the rather complicated relationship between water prices and use. And although we still need to develop means to control for certain exogenous variables (e.g., weather), it becomes a simpler task.

Figure ES-1. Water Utility Participants Map

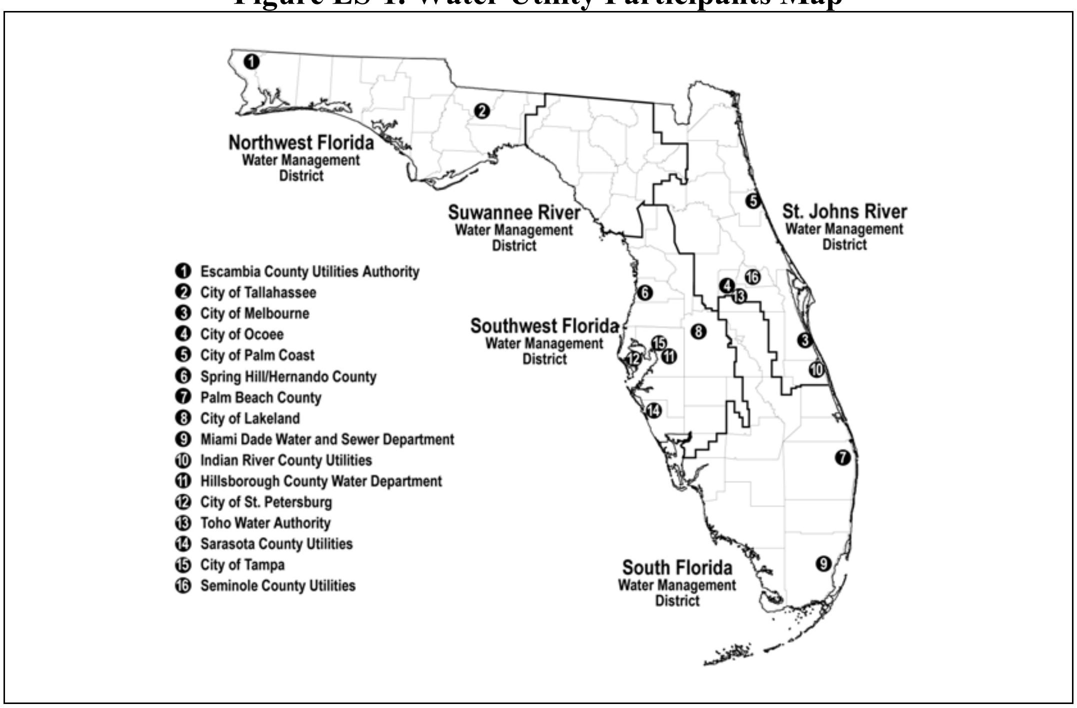


Table ES-1 Profile Definitions			
Profile	**Property Value Percentile**	**Assessed Property Value**	**House Size (Ft^2)**
1	25%	$57,890	1,350
2	50%	$84,330	1,727
3	75%	$126,932	2,197
4	90%	$197,400	2,841

Values derived from universe of 3,888,307 single-family homes in Florida for 2002 as defined in tax assessor records from all 67 counties. Property values include assessed value of land and buildings. Assessed property values are derived in a consistent fashion among all Florida counties. Market values for properties tend to be higher. House size values equal the median house size of all homes +/- 1% from the property value target. The profile 1 house size of 1,350 square feet, for example, is the median of the 77,766 homes between the 24th and 26th percentiles of property value.

We conduct a mail survey to serve two purposes. First, is to collect information about customers' concern, knowledge, sensitivity, and perceptions of water and sewer prices and uses. Second, is to gather household data used in our statistical modeling of water demand.

We mailed the survey in May and June of 2004. Our net response rate is 50.4%—greatly exceeding our expectations and industry norms for this type of survey. The following are key findings.

- **Concern of Water Costs**. Overall, 52% of customers report being strongly concerned about the cost of water and 80% report being either strongly or somewhat concerned. The level of concern tends to decrease with increasing wealth—62% of profile 1 and 43% of profile 4 customers are strongly concerned with water cost respectively. More customers are concerned about the cost of water used for outdoor irrigation than for indoor uses.

- **Knowledge of Water Rates**. A majority of customers are knowledgeable when it comes to the average dollar amount of the water bill and the type of water rate structure. However, far fewer are familiar with details regarding the number, size and prices of the blocks. Using a composite of responses, 20% of customers report being strongly knowledgeable, 41% report being somewhat knowledgeable, and 39% report being not knowledgeable of rates. Because only 5 of the 16 participating utilities print water prices on their bills, this lack of knowledge is not surprising. For utilities with increasing blocks, no utility shows the full set of prices, just those relevant to the calculation of that particular bill (if shown at all).

- **Cost Concerned but Not Knowledgeable**. 63% of homes are strongly or somewhat concerned, but not strongly knowledgeable about water rates. Hence, we conclude there is much room for customer education about rates.

- **Cost Calculations**. Only 3% of homes report they mathematically quantify the cost savings associated with water use decisions—a calculation that requires both knowledge of the rate structure and the water use associated with a particular activity. We define 32% of homes as "approximators" that focus on the total dollar amount of past water bills to guess the dollar change that might occur from a water use action. A majority of customers, 65%, admit they are "uncalculating" when it comes to water use decisions. These customers know their water bill will go down if they use less water, but do not make an active effort to estimate by how much.

- **Block Targeters**. We note 21% of customers with increasing block rates report they focus on reducing water use to stay below specific high priced rate blocks. These "block targeters" do not make explicit cost calculations, but are knowledgeable of the rate structure and use the block thresholds (e.g., 10,000 per month) as a not-to-exceed goal to avoid paying higher unit water prices.

Regarding the econometric water use analysis, below are the three primary findings corresponding to the primary research objectives of study.

1. **Price Elasticity and Wealth**. This study's empirical evidence firmly supports the conclusion that water use decreases as price increases. Figure ES-2 shows the negative slope of the estimated water demand curve for each of the four profiles. Water use increases with wealth. For water and sewer prices below $2 per thousand gallons, water use for profile 3 and profile 4 homes is about the same. As price increases, however, profile 3 water use decreases at a much faster rate.

   Price elasticity is a common metric of a customers' sensitivity to price. It can be viewed as the percentage change in quantity demanded resulting for a 1% change in price, all other factors held constant. Long-run elasticity ranges from –0.39 to –0.84 over the four wealth profiles. Price elasticity increases with wealth over profile 1 (–0.39), profile 2 (-0.51) and profile 3 (–0.84). Profile 4 breaks the trend by having a price elasticity of –0.56. This suggests homes at the top 10^{th} percentile of wealth (profile 4) are less sensitive to price than those at the 75^{th} percentile (profile 3), but still reduce water use as price increases.

   Figure ES-3 shows the same demand curves, but water use is converted to gallons per capita per day (GPCD)—a more common metric in Florida of gauging water use.

Figure ES-2. Florida Single-Family Home Water Demand Curves (GPHD)

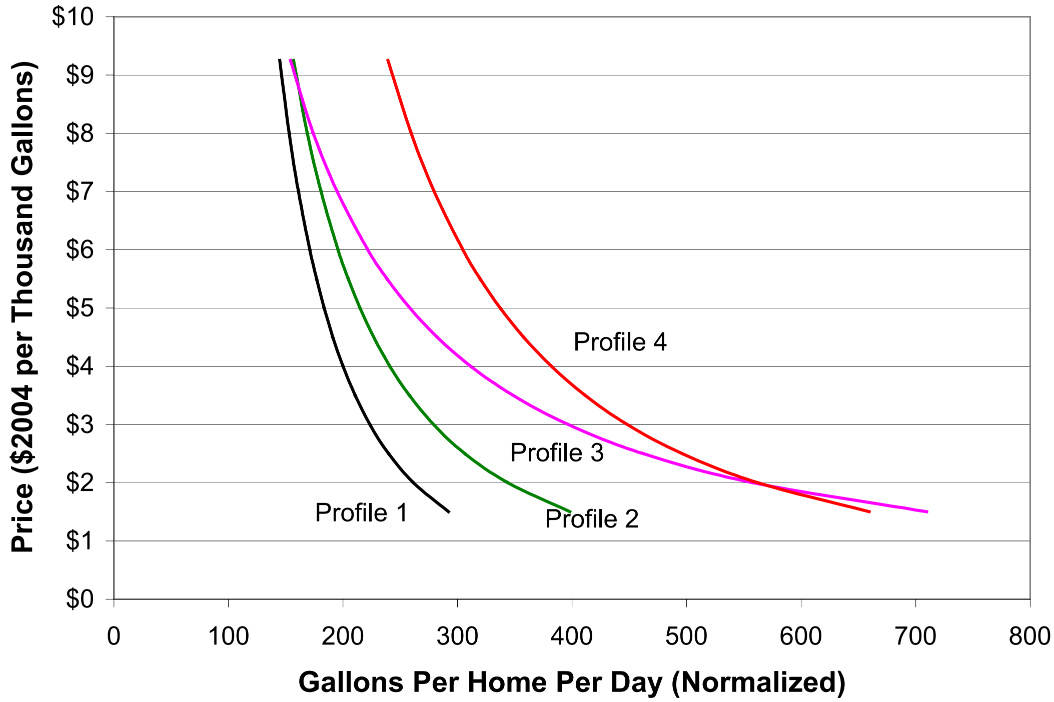
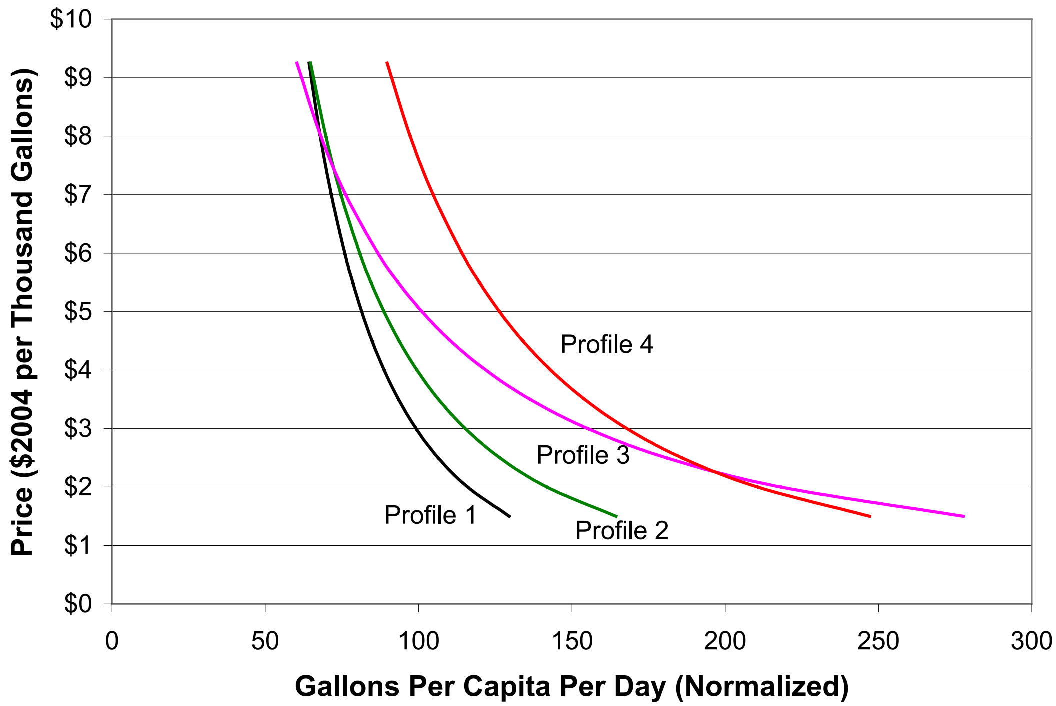


Figure ES-3. Florida Single-Family Home Water Demand Curves (GPCD)



2. **Efficacy of Block Rates**. Increasing block water rates reduce water use to the extent that they cause a positive differential between marginal and average price—the bigger the differential, the bigger the impact. For profiles 2 and 4, model results show the differential is equivalent to an increase in average price of that differential amount. For profiles 1 and 3, results indicate that the differential is about half as effective, but still significant.

   This has important policy implications. Water utilities can use increasing block rates to increase the price signal sent to customers without necessarily changing their average price. This can be done by decreasing the price for the first few units of water consumed and increasing the price on higher levels of marginal water use. 10 out of the 16 utilities participating in this study employed increasing block rates over the study period. Two others (Ocoee and Spring Hill) have recently converted from single price to increasing block water rates.

3. **Source Substitutes**. Results show price elasticity increases as more irrigation source substitutes are available. In our sample of homes, 36% report tapping into a water source other than utility water for irrigation. For utilities where customers cannot readily access substitutes, customers are less elastic. Lack of source substitutes reduces price elasticity by 28%, 14%, 23%, and 40% over the profiles, respectively.

In addition to these three primary findings, we also add a few key points regarding water prices and water use.

- **Fixed Charges**. Demand theory states that fixed monthly charges should have minimal impact on the economic decision of how much water to purchase. Our empirical results find fixed charges (independent of water use) have no correlation with water use. Hence, we conclude that customers can differentiate between fixed and variable charges on their water bills and in water use decisions. The upshot is that utilities can make revenue neutral changes in their rate structures, by decreasing fixed charges and increasing quantity charges—the higher quantity charges lowering total water consumption. The City of Tampa maximizes this strategy by collecting 0% from fixed charges and 100% from quantity charges.

- **Long-Run Elasticity**. The price elasticity estimates generated in this study are long run in nature. All of the utilities had relatively constant prices and rate structures over our 1998 through 2003 study period after adjusting for inflation. As a consequence, customers have had years to adjust their water using behavior, fixtures and landscaping to desired levels. Following the second law of demand in economic theory, short-run elasticities should be less elastic than the long-run elasticities reported here. It may take several years before the full impacts of water rate changes ripple completely through the customer base.

- **Price Range**. The price range in our study spans from about $1.00 to $9.50 per thousand gallons. In our demand models, we use and estimate a model specification that assumes that price elasticity is constant over the entire price range. This looks to be generally reasonable. We note, however, that price elasticity can change with price level. Of specific interest is price elasticity above about $6 per thousand gallons. As price exceeds $6, additional water savings become progressively harder to achieve as customers have cut back to core water uses (e.g., indoor water for toilets, showers, clothes washers, and cooking) or have accessed source substitutes. Customers' marginal utility or value from remaining utility water use is high, and hence they are less willing to make further water cuts in response to price increases. We would need additional data points in the high price range to better understand the degree that price elasticity might dampen with higher prices.

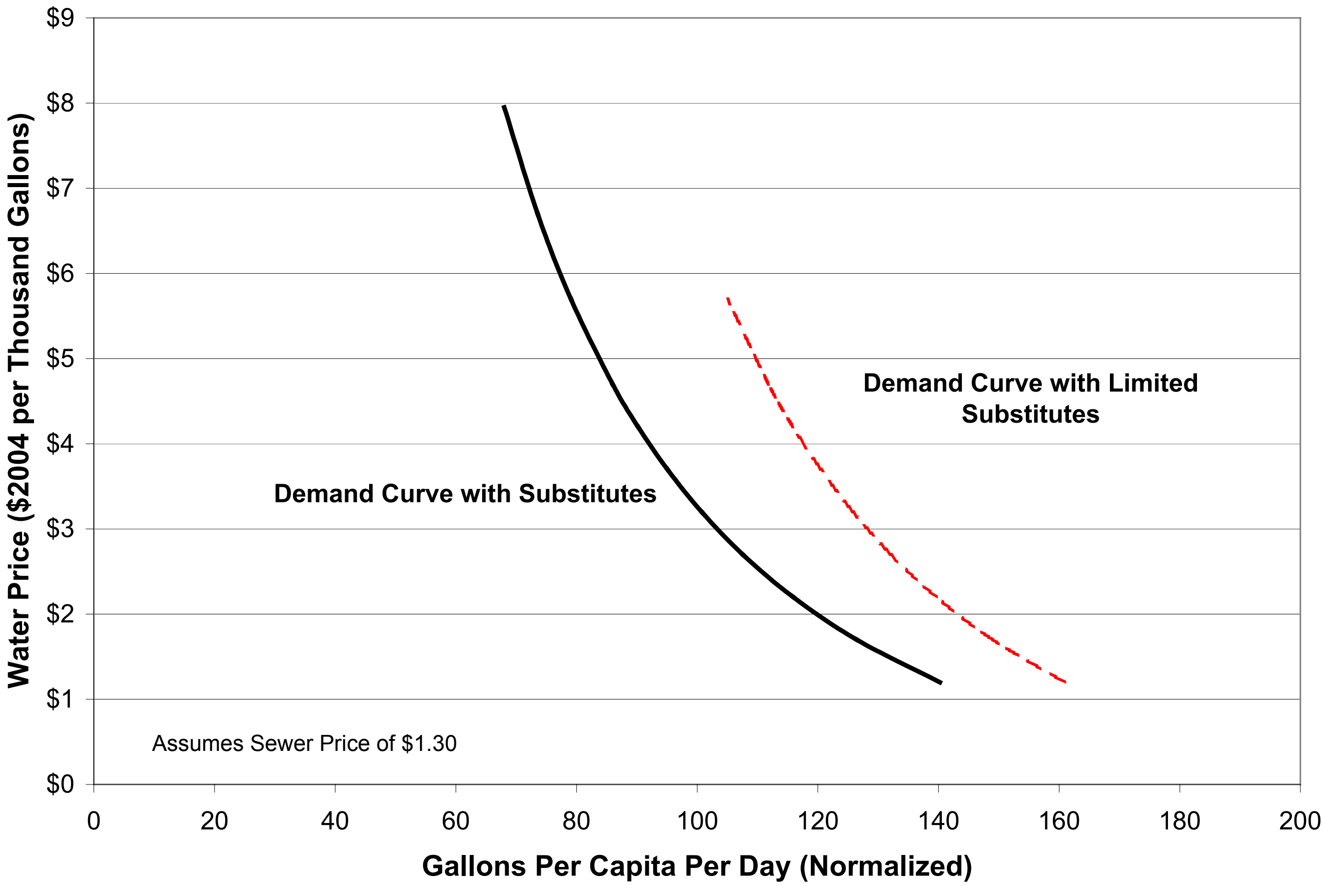
- **Sewer Prices.** All 16 participating utilities base their sewer charges on customer water use in some fashion. Our investigations show sewer prices are part of the price signal sent to customers, in combination with water prices. In the few cases where customers did not receive sewer service (on-site septic systems), the price signal is solely the water price. Inspection of these customers show that their actual water use falls along the statistically derived combined water/sewer price demand curves. This indicates that the response of water-only customers to price changes is similar to that of water and sewer customers and the results of the study apply to both.

- **Reclaimed Wastewater Customers**. This study focuses on the amount of potable water purchased by customers from a utility. Increasingly, reclaimed wastewater is being made available to customers in Florida for irrigation purposes. In this fashion, it is similar to irrigation wells as a potable source substitute. It has, however, a number of distinguishing differences related to its geographic availability and connection/pricing policies. For those customers in our dataset reporting being connected to a reclaimed wastewater system, we observe the amount of potable water purchased from the utilities equals what we would expect for indoor water use—about 50 to 70 GPCD. This is an obvious finding. What is not obvious is how reclaimed wastewater can impact the price elasticities of potable water use reported in this study. For customers already connected to reclaimed wastewater systems, changes in potable water/sewer prices can be expected to be muted as the price elasticities associated with indoor water use are known to be less than for outdoor use. For customers offered reclaimed wastewater in the future, potable water price elasticities can be significant as customers take advantage and substitute potable with reclaimed wastewater. The impact will depend on a number of specific conditions, such as the price differential between potable and reclaimed water and connection policies. This topic is worthy of additional research in the future.

- **Inference of Results to Specific Utilities**. Our approach focuses on four distinct customer profiles and whether customers have ready access to substitute sources for irrigation water. Utilities wanting to use the results of this study to evaluate how pricing can impact their water use will need to factor in their utility circumstances. Specifically, utilities need to weight the results from our four profiles to best fit the distribution of wealth of their customers. As part of this project, we developed a computer Excel model named Waterate to assist with this task. However, to give readers a general understanding of how water prices can impact per capita water use, we developed the illustration shown in Figure ES-4. This figure shows an example composite demand curve (based on all the utilities in this study) that includes separate demand curves for those with and without ready access to source substitutes. In this case, we only show water price on the vertical axis and assume the effective sewer price is $1.30 per thousand gallons—this is the average effective sewer marginal price over the study. The change in per capita use as price increases is caused only by the change is water price. This type of figure can assist decision makers in focusing on water price. However, the composite demand curves for each utility will change based on their associated weights of each profile and sewer prices.

In conclusion, water pricing can be an effective tool in managing scarce water resources. Results show that price is an undeniable and predicable indicator of water use. The relationship, however, is somewhat complicated. According to our survey results, people are generally ignorant of both the prices they pay for water and the water associated with a particular end use. The situation is unlike automotive gasoline purchases, for example, where pump prices and unit productivity (miles per gallon) are well known. Hence, there is somewhat of a paradox in that we find people behave in a rational, economically consistent fashion with respect to water consumption without having perfect information. This apparent paradox can perhaps be explained by the fact that our survey research also shows people are largely aware of and concerned by the total dollar amount of the water bill. They see that their bill goes up and down following their water use each period, and adapt their purchases accordingly.

Figure ES-4. Composite Single-Family Home Demand Curve Illustration (GPCD)



1. Project Design

This chapter has five sections describing the project objectives, challenges, approach, water utility selection, and the profiles of homes to be examined.

1.1 Objectives

The general objective of this project is to examine and quantify the functional relationship between water consumption and water prices for single-family residential customers in Florida. The first law of economic theory states that as the price of a commodity increases, its quantity demanded decreases. This law is widely believed and well documented. Empirical research over the last 40 years has consistently shown this to be true for water. Although the direction of the relationship is well understood and accepted, the precise relationship is not.

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Understanding and factoring in source substitution for irrigation is the third specific objective. Economic theory states price elasticity increases as more substitutes for a resource are available. With substitutes, customers have the ability to switch to cheaper sources of supply (e.g., irrigation wells) as utility water prices increase. Because of the relatively frequent availability of source substitution in Florida, price sensitivity would be expected to be higher than in other regions of the United States and world.

Besides these three research objectives, the study needs to generate results that are readily usable by practitioners to assist real-world decision-making concerning rate design, water use and revenue forecasting, resource planning, and customer support. The analysis and results need to be transparent, readily understandable, and believable to the general public. In addition, the results need to be developed and presented to serve a wider audience than just the participating water utilities.

1.2 Challenges

If water utilities sold water at a single price, the question of price signal would be an easy one — it would be the singular water price. When water is sold at multiple water prices, in contrast, we must identify the price or combination of prices to which customers respond. No consensus exists among researchers on specifying the price signal transmitted by block rates. Some believe that marginal price is the correct specification, while others argue for an average price specification.

Economic theory suggests that utility maximizing individuals with perfect information react to marginal price. In other words, for customers considering reducing their water consumption by one unit, marginal price equals the financial reward for doing so.

Some researchers, however, question the assumption that customers facing block rates react to perfect price information for the following reasons:[1]

- The cost of assimilating and understanding exact block pricing information is relatively high. Complicated block rate schedules, uninformative billing statements, and compounding sewer charges increase the costs and abilities needed to gather and process relevant price information. In addition, customers can only forecast probable marginal prices given uncertainties in how much total water will be used during a billing period. At the beginning of a billing period, some customers may have only a vague notion of how much water will be used during the period, and hence only a vague notion of the corresponding marginal water price.

- The cost of assimilating and understanding the quantity of water associated with specific end uses is relatively high. Water utilities record and bill customers for aggregate water use over a billing period spanning at least a month. Water use associated with specific end uses such as toilets, washing machines, and outdoor irrigation is not individually measured. Hence, customers have little direct feedback on the costs associated with particular water using activities. Because water use fluctuates over time (e.g., changes in number of occupants, guests, or weather related irrigation needs), it is often difficult to

[1] Some of these researchers include H.S. Foster and B.R. Beattie, "On the Specification of Price in Studies of Consumer Demand Under Block Rate Scheduling" *Land Economics* (57) 1981; and J.S. Shin, "Perception of Price When Price Information is Costly: Evidence from Residential Electricity Demand" *The Review of Economics and Statistics* (67) 1985.

isolate the water use impact associated with a specific action when looking at aggregated water use on billing statements.

- The water bill accounts for only a small percentage of disposable income, averaging 1.5% for the homes analyzed in this study.

As the cost of information increases, the incentive for the rational, utility-maximizing customer to gather and react to perfect information decreases. In fact, the rational decision may be to make a quick approximation of the situation and move on, especially when the financial impact is small. This creates “fuzziness” in the behavioral relationship between price and quantity demanded, making it more of a challenge to precisely identify.

Block rates also introduce complicated statistical modeling issues. In fact, the situation of estimating water demand curves is one of the most complicated applications in the field of econometrics. This occurs because of the two-way interaction between block prices and quantity demanded. As water use goes up, the unit price for water also goes up in step with increasing block prices. But as price increases, water demand tends to decrease. This two-way endogenous relationship is difficult to statistically adjust for in econometric models. If strict assumptions and conditions are not held, then resulting estimates of price sensitivity can be significantly biased.[2]

1.3 Approach

Given the objectives and challenges of this project, we designed an approach based on several analytical and data availability considerations. Our approach has two key directions.

The first direction is to conduct a mail survey to collect information on customers’ concern, knowledge, sensitivity, and perceptions of water and sewer prices and uses. We probe into the heart of the relationship between price and quantity demanded via questions associated with customers’ level of evaluation and introspection provided to water use decisions.

Of particular importance, we probe into how block rate structures impact their answers. Understanding the price signal perceived by customers from block rate structures is a major

[2] Previously researchers have used simultaneous equations models (two-stage least squares and other instrumental variables models) following labor supply and energy applications. More recently, discrete-continuous choice models have been used by Hewitt and Hanemann (“A Discrete/Continuous Choice Approach to Residential Water Demand under Block Rate Pricing”, Land Economics 71(2): 173-192, 1995) and by Cavanagh, Hanemann, and Stavins (“ Muted Price Signals: Household Water Demand Under Increasing-Block Prices”, ASSA Confernce, 2001).

objective of this study. Most assuredly there is not one single price specification that perfectly and universally explains all customers' behavior. Some well-informed customers may react to marginal prices. Others may approximate the situation and respond to some average of prices. Still, for others, water prices may be nearly irrelevant given current conditions. It is difficult to assess customers' perception of block rates on theoretical grounds. Hence, we devise a number of questions in the mail survey to guide us empirically in the area of price specification.

The second direction of our approach focuses not on what water users say, but on what they do. We analyze historical water use to measure the correlation between water use and water prices. In particular, we evaluate the effectiveness of different rate structures to impact water use.

Given the project objectives and practical considerations, we use a nonrandomized sampling plan as follows:

1. Identify 16 participating water utilities. Based on a Florida survey of water and sewer rates, select 16 water utilities having a wide range of prices and rate structures.
2. Identify four home profiles. Dissect the general population of Florida homes into four distinct profiles based on characteristics such as property value and house size.
3. Select 7,200 homes. Select target homes for each utility and profile that best match our home profile definitions.

Clinical Trial Parallel. Our approach is similar in nature to the clinical trials used by the FDA in testing and approving drugs. Researchers aim to setup clinical trials with people of similar characteristics (e.g., age, sex, weight, ethnicity, blood type) so that the efficacy of a drug can be measured under closely controlled circumstances. In a true experiment, you want to hold all factors but one constant, so that you can isolate the impact of that one factor.

Our sampling plan is to select and analyze water use of homes that have nearly identical characteristics, but face different types of rate structures and levels of water prices. We want to compare "apples to apples" so that we can focus on the rather complicated relationship between water prices and use. And although we still to need to develop means to control for certain exogenous variables (e.g., weather), it becomes a simpler task.

Although more data is always better to the statistician, we determined the number of utilities, profiles, and homes to be sufficient to address the research objectives. This is the largest and most extensive study of this type ever conducted.

The advantage of this sampling approach, in contrast to some randomized sample of homes, is that we control for key non-price variables via sampling instead of analytic methods (e.g. statistical regression analysis). Water use is a function of many variables, as summarized in

Table 1-1, that likely have nonlinear, interdependent, and complicated functional relationships.[3] To the degree that an analytic model does not capture the true functional relations among its explanatory variables, estimates of the price/quantity relationship can be biased. We deem the added difficulties of controlling for the other non-price factors as daunting and to be avoided if possible.[4]

The disadvantage of this sampling approach is that we focus all our resources on only four distinct customer profiles. One must be careful when making inferences of the results from these four profiles to general populations. The results need to be weighted to accommodate the characteristics of a given utility.

Table 1-1
General Factors Affecting Water Use

General Factor	Examples
Demographics	Number and age of occupants
Technology	Efficiency of toilets, showerheads, clothes washers, and irrigation systems
Irrigation potential	Lot size and weather
Tastes and preferences	Conservation ethic, landscape area, and plant selection
Substitutes	Irrigation wells, surface water, and reclaimed wastewater
Economic factors	Income and water/sewer prices

[3] Previously, water demand researchers analyzing data at the household level relied on developing a statistical demand equation representing a random, heterogeneous group of customers. Water use on the left side of the equation is specified to equal a mathematical function of explanatory variables on the right. Multiple regression is then used to estimate the coefficients in the relationship. The weakness of this approach is that it is almost impossible to know the specific mathematical function connecting the explanatory variables to water consumption. In the past, researchers have assumed specifications for computational convenience (linear or log-transformed linear specifications). In addition, compiling one model for a sample of heterogeneous users may mask important differences among market segments.

[4] Another advantage is that this approach avoids the endogeneity estimation issue associated with block rates.

1.4 Water Utility Selection

This project design is for 16 participating water utilities. The selection process consisted of first conducting a water and sewer rate survey of 100 Florida water utilities. We took these results and selected the 16 utilities to best help us address our research objectives. Specifically, we looked for utilities that would help us:

- Evaluate water/sewer prices over a wide price range. We want to identify water demand curves over a large range of prices ($1 to $9 per thousand gallons (TG)).
- Evaluate the efficacy of increasing block rate structures to reduce water consumption. We are looking to compare sets of utilities that collect the same general level of revenues from quantity charges, but with different rate structures.
- Evaluate the impact of the availability of source substitutes, such as irrigation wells.

We also gave preference to large water utilities so that we would have sufficiently large populations to draw our specific study homes. And, of course, we selected only water utilities that were both willing and able to provide us with water use billing records over a multiple year period.

Based on these factors, the research team and the Project Advisory Committee jointly selected the following 16 water utilities listed in Table 1-2 and mapped in Figure 1-1. The utility abbreviations shown in Table 1-2 are used throughout the report.[5]

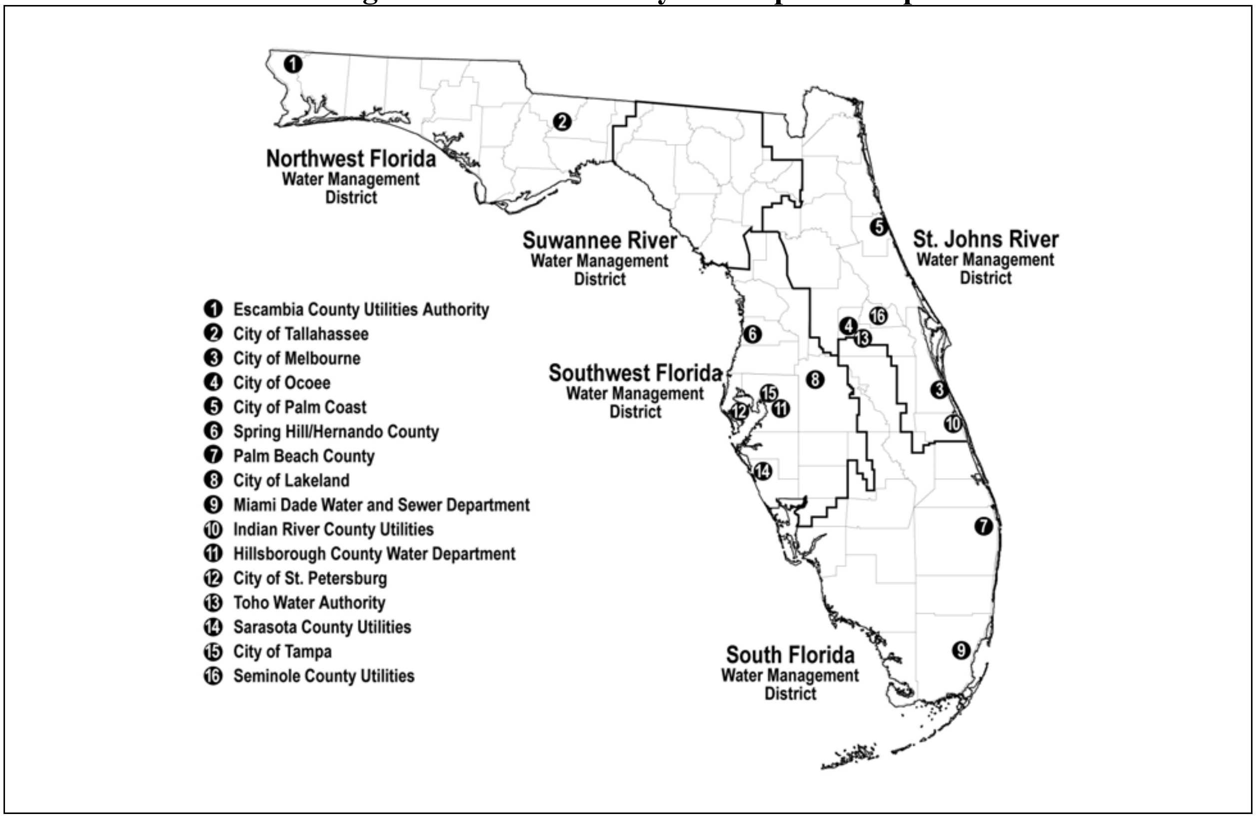
Water rates were relatively stable for these utilities over the study period 1998 to 2003 after adjusting for price inflation. The only significant change in rate structure occurred with Toho that changed from a uniform to an increasing block rate structure March 2002. As sewer rates are often a function of recorded water use, they also must be added as relevant.

[5] Florida Water Services (a private utility company) divested Spring Hill to Hernando County and Palm Coast to the City of Palm Coast near the end of our study period in 2003. Escambia County Utilities Authority is now called Emerald Coast Utilities Authority.

Table 1-2
Water Utility Participants

District	Utility	Utility Abbreviation	Water Rate Type 2003	# Rate Blocks
NWFWMD	Escambia County Utilities Authority	Escambia	Uniform	1
NWFWMD	City of Tallahassee	Tallahassee	Uniform	1
SJRWMD	City of Melbourne	Melbourne	Uniform	1
SJRWMD	City of Ocoee	Ocoee	Uniform	1
SJRWMD	City of Palm Coast	Palm Coast	Uniform	1
SWFWMD	Spring Hill / Hernando County	Spring Hill	Uniform	1
SFWMD	Palm Beach County	Palm Beach	Increasing	3
SWFWMD	City of Lakeland	Lakeland	Increasing	3
SFWMD	Miami Dade Water and Sewer Department	Miami Dade	Increasing	4
SJRWMD	Indian River County Utilities	Indian River	Increasing	4
SWFWMD	Hillsborough County Water Department	Hillsborough	Increasing	4
SWFWMD	City of St. Petersburg	St. Petersburg	Increasing	4
SFWMD	Toho Water Authority	Toho	Increasing	5
SWFWMD	Sarasota County Utilities	Sarasota	Increasing	5
SWFWMD	City of Tampa	Tampa	Increasing	5
SJRWMD	Seminole County Utilities	Seminole	Increasing	6

Figure 1-1. Water Utility Participants Map



1.5 Home Profiles

Our approach is based on finding and comparing similar type homes across all 16 water utilities. We identify four home profiles to study based on tax assessor information as defined in Table 1-3.

For each of the 16 participating water utilities and for each of the four profiles, we identify the homes closest to meeting the property value and house size specifications. The total target sample size of this project is 7,200. For 61 out of the 64 total utility/profile combinations, we identify sufficient homes for our purposes. Specifically, for 95 percent of selected homes, we are able to get within plus or minus 5 percent of the property and house size target values shown in Table 1-3. We are unable to find a sufficient number of matching homes with Toho profile 3, Toho profile 4, and Seminole profile 1. Chapter 2 provides more detail on the house characteristics for each utility and profile.

Table 1-3
Profile Definitions

Profile	Property Value Percentile	Assessed Property Value	House Size (Ft^2)
1	25%	$57,890	1,350
2	50%	$84,330	1,727
3	75%	$126,932	2,197
4	90%	$197,400	2,841

Values derived from universe of 3,888,307 single-family homes in Florida for 2002 as defined in tax assessor records from all 67 counties. Property values include assessed value of land and buildings. Assessed property values are derived in a consistent fashion among all Florida counties. Market values for properties tend to be higher. House size values equal the median house size of all homes +/- 1% from the property value target. The profile 1 house size of 1,350 square feet, for example, is the median of the 77,766 homes between the 24th and 26th percentiles of property value.

2. Data Collection

For each of the 16 water utilities participating in this study, we collected a variety of information including tax assessor records, water use billing records, water and sewer prices, weather, irrigation restrictions, source substitutes, and water conservation programs. This data collection process and results are described in this chapter.

2.1 Tax Assessor Records

We collected all 2002 tax assessor records for single-family homes for all 67 counties in Florida—this totaled 3,888,307 homes. Summary statistics for property value, house age, house size, and lot size are shown in Table 2-1.

Our approach consists of defining and analyzing four home profiles based on the 25th, 50th, 75th and 90th percentiles of property value at the statewide level. The 25th percentile of property value, for example, has 25% of the homes less than and 75% of the homes more than this value.

In selecting specific homes within each of the 16 water utilities, we also used house size as a targeting measure. We did not use lot size or house age in selecting homes. Unfortunately, over half of lot size field entries are missing (some counties do not populate this field). Given the differing times of development in each utility, we also found we could not successfully limit our sample to precise construction periods. As a consequence, we account for house age as a possible exogenous variable in the evaluation stage (Chapter 4).

Table 2-1
Tax Assessor Summary for State of Florida

Percentile	Property Value	Year Built	House Size (ft2)	Lot Size (ft2)
5%	$30,820	1947	930	5,040
10%	$40,194	1954	1,061	5,795
15%	$46,876	1957	1,160	6,200
20%	$52,563	1960	1,244	6,930
24%	$56,854	1963	1,309	7,405
25% Profile 1	**$57,890**	1963	1,325	7,500
26%	$58,912	1964	1,341	7,500
30%	$62,990	1968	1,406	7,668
35%	$68,092	1971	1,488	8,000
40%	$73,243	1974	1,572	8,581
45%	$78,574	1977	1,657	9,147
49%	$83,140	1979	1,728	9,750
50% Profile 2	**$84,330**	1979	1,747	9,931
51%	$85,540	1980	1,766	10,000
55%	$90,720	1982	1,842	10,000
60%	$97,900	1984	1,941	10,454
65%	$106,044	1986	2,051	11,300
70%	$115,500	1988	2,172	12,500
74%	$124,452	1990	2,285	14,000
75% Profile 3	**$126,932**	1990	2,316	14,500
76%	$129,547	1991	2,348	15,000
80%	$141,656	1993	2,491	17,480
85%	$162,592	1995	2,719	24,250
90% Profile 4	**$197,400**	1997	3,054	45,302
95%	$274,770	1999	3,691	101,930
Total Homes	3,888,307	3,871,908	3,878,455	1,852,377
	100%	99.6%	99.7%	47.6%

Values are for all single family homes (all 67 counties) in Florida for year 2002. Percentiles for each field are independent of other fields. Property value includes assessed value of land and buildings. Lot size tends to be either reported or not reported for each county.

Table 2-2 shows the count of homes by utility and profile in our final dataset. There are 3,538 homes for which we successfully collected tax assessor, water use, and mail survey data. Chapter 3 describes details of the mail survey. We obtained over 40 homes for each utility/profile except for in a few cases. We obtained relatively low counts for Miami Dade and Toho because of the relatively low mail survey response rates. For Seminole profile 1 and Toho profiles 3 and 4, we did not match sufficient houses via the tax records.

Table 2-2
Final Home Count

	Profile				
Utility	**1**	**2**	**3**	**4**	**Total**
Escambia	57	56	61	59	233
Hillsborough	50	47	60	65	222
Indian River	61	57	59	27	204
Lakeland	46	59	54	70	229
Melbourne	72	74	82	35	263
Miami Dade	33	32	35	45	145
Ocoee	53	55	70	72	250
Palm Beach	50	50	72	69	241
Palm Coast	61	70	79	81	291
Sarasota	57	67	73	66	263
Seminole	0	47	53	57	157
Spring Hill	53	67	69	33	222
St Petersburg	53	63	94	67	277
Tallahassee	55	64	63	38	220
Tampa	54	65	73	68	260
Toho	35	26	0	0	61
Total	790	899	997	852	3,538

The final homes selected tightly fit the targeted property values of each profile as shown in Table 2-3. For profiles 1, 2 and 3 the fits are especially tight, the averages being less than 2 percent from the targeted value in each case. We see a bit more spread with profile 4, resulting from the lack of homes that exactly meet our profile targets, but in no case deviating in average by more than 6 percent.

Table 2-3
Average Property Values

	Profile			
Utility	**1**	**2**	**3**	**4**
Escambia	$56,881	$84,034	$126,913	$193,415
Hillsborough	$57,586	$83,958	$126,229	$191,954
Indian River	$57,717	$84,436	$124,532	$202,900
Lakeland	$57,241	$84,059	$126,515	$200,267
Melbourne	$57,726	$84,500	$126,595	$195,542
Miami Dade	$58,127	$85,013	$126,323	$200,883
Ocoee	$58,925	$83,965	$126,206	$186,103
Palm Beach	$57,981	$84,326	$126,716	$197,088
Palm Coast	$58,275	$83,741	$126,428	$193,734
Sarasota	$58,272	$84,728	$129,046	$201,158
Seminole	NA	$84,673	$127,695	$189,369
Spring Hill	$57,570	$84,041	$125,340	$189,880
St Petersburg	$58,143	$84,089	$126,811	$191,940
Tallahassee	$57,918	$84,387	$126,587	$187,083
Tampa	$57,905	$84,562	$126,777	$197,010
Toho	$57,452	$85,014	NA	NA
Profile Target	**$57,890**	**$84,330**	**$126,932**	**$197,400**

NA = not applicable

Table 2-4 shows average house size by utility and profile. Again we obtained a tight fit with targeted values with the exception of Lakeland and Spring Hill. In these two areas, residents tend to get more house size for the same property value. Hence, in the evaluation stage we test and correct for any impact this might have.

Table 2-4
Average House Size (ft^2)

	Profile			
Utility	**1**	**2**	**3**	**4**
Escambia	1,370	1,834	2,465	3,175
Hillsborough	1,346	1,729	2,321	2,962
Indian River	1,388	1,777	2,153	2,596
Lakeland	1,682	2,413	3,334	4,027
Melbourne	1,345	1,724	2,116	2,681
Miami Dade	1,348	1,708	2,192	2,769
Ocoee	1,306	1,745	2,166	2,909
Palm Beach	1,343	1,727	2,209	2,832
Palm Coast	1,336	1,826	2,274	3,070
Sarasota	1,145	1,616	2,135	2,704
Seminole	NA	1,743	2,243	2,884
Spring Hill	1,668	2,238	2,725	4,056
St Petersburg	1,349	1,730	2,193	2,807
Tallahassee	1,357	1,716	2,226	3,024
Tampa	1,348	1,727	2,196	2,836
Toho	1,463	1,757	NA	NA
Profile Target	**1,350**	**1,727**	**2,197**	**2,841**

NA = not applicable

Lastly, Table 2-5 shows average year built by utility and profile. We see that profile 1 homes tend to be older than the other profiles. We also see that homes in Palm Coast and Spring Hill tend to be newer than homes from St. Petersburg and Miami Dade. Although in general the house ages are similar, we explicitly analyze and control for house age on water use in Chapter 4.

Table 2-5
Average Year Built

Utility	Profile 1	2	3	4	Total
Escambia	1970	1976	1987	1988	1980
Hillsborough	1979	1988	1990	1993	1988
Indian River	1984	1989	1995	1995	1991
Lakeland	1970	1971	1976	1983	1975
Melbourne	1970	1987	1993	1985	1984
Miami Dade	1949	1963	1957	1961	1958
Ocoee	1973	1987	1996	1995	1988
Palm Beach	1966	1981	1985	1995	1982
Palm Coast	1994	1994	1990	1992	1993
Sarasota	1966	1975	1987	1988	1979
Seminole	NA	1991	1993	1993	1992
Spring Hill	1990	1993	1997	1995	1994
St Petersburg	1956	1961	1964	1958	1960
Tallahassee	1960	1971	1971	1966	1967
Tampa	1978	1977	1983	1985	1981
Toho	1973	1989	NA	NA	1981
Total	1972	1981	1984	1985	1981

NA = not applicable

2.2 Water Use Billing Information

From each of the 16 participating water utilities, we requested water use billing records for all their homes over the six-year period spanning January 1998 through December 2003. Table 2-6 shows the results of what we obtained and the number of months in each billing cycle. Miami Dade reads its meters every 3 months. Tampa reads its meters every 2 months, but bills every month using an estimation process. The other 14 utilities read and bill on a monthly basis.

As part of the billing information, we collected information on mailing and service address, utilization of sewer service, presence of irrigation meter, and connection to reclaimed wastewater for irrigation.

Table 2-6 Water Billing History			
Utility	Water Start Date	Water End Date	Months per Billing Period
Escambia	Jan-98	Dec-03	1
Hillsborough	Jan-99	Dec-03	1
Indian River	Jan-98	Oct-03	1
Lakeland	Feb-00	Dec-03	1
Melbourne	Jan-01	Dec-03	1
Miami Dade	Jan-99	Dec-03	3
Ocoee	Jan-98	Dec-03	1
Palm Beach	Jan-98	Dec-03	1
Palm Coast	Jan-99	Dec-03	1
Sarasota	Jul-98	Dec-03	1
Seminole	Jan-98	Oct-03	1
Spring Hill	Jan-99	Dec-03	1
St Petersburg	Jan-99	Jul-03	1
Tallahassee	Jan-98	Dec-03	1
Tampa	Oct-98	Dec-03	2
Toho	Jan-98	Oct-03	1

In reviewing the water use records we deleted 2 records for being too high and 24 reads related to an adjustment showing negative water use. We deleted the negative reads plus previous reads that were over-billed. We are left with 200,102 useable water reads for our 3,538 study homes.

2.3 Water and Sewer Prices

We obtained a complete listing of all water and sewer rates over the study period for each utility, including associated taxes. Unless specified othewise, when we discuss price in this report we refer to all water and associated sewer prices. Using the U.S. consumer price index, we adjusted for inflation and converted all prices to 2004 adjusted dollars. Appendix E shows a listing of 2003 water and sewer rates for each utility.

We also collected a copy of the utility bill associated with water use as summarized in Table 2-7. Utility bill content and format can influence customers' perceptions and understandings about water pricing. Nine of the utilities put some form of historical water use on the bill (e.g., same calendar month in prior year).[6] Only five utilities print the associated unit water price on the bill.

Table 2-7
Water Bill Information

Utility	Current Water Use	Historical Water Use	Separate Fixed & Quantity	Water Prices	Sewer	Garbage	Storm-water	Electric
Escambia	Yes	No	No	No	Yes	Yes	No	No
Hillsborough	Yes	Yes	Yes	Yes	Yes	No	No	No
Indian River	Yes	No	Yes	No	Yes	No	No	No
Lakeland	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Melbourne	Yes	No	No	No	Yes	Yes	No	No
Miami Dade	Yes	Yes	No	No	Yes	No	Yes	No
Ocoee	Yes	No	No	No	Yes	Yes	Yes	No
Palm Beach	Yes	Yes	Yes	No	Yes	No	No	No
Palm Coast	Yes	Yes	Yes	Yes	Yes	No	No	No
Sarasota	Yes	No	Yes	Yes	Yes	No	No	No
Seminole	Yes	No	Yes	No	Yes	No	No	No
Spring Hill	Yes	Yes	Yes	Yes	Yes	No	No	No
St Petersburg	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Tallahassee	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Tampa	Yes	Yes	No Fixed	No	Yes	Yes	No	No
Toho	Yes	Yes	Yes	No	Yes	Yes	No	Yes

[6] None of the utilities print the average water use of the neighborhood or customer class on the bill.

2.4 Weather

We calculate four different measures of daily weather including:

- Maximum Temperature
- Evapotranspiration
- Effective Precipitation
- Net Irrigation Requirement

Searching databases maintained by the National Climatic Data Center (NCDC), we located at least one and in most cases two weather stations within or adjacent the service areas of each utility as shown in Table 2-8. For these stations, we collected daily temperature and rainfall over the study period. For utilities with more than one station, we calculate an average of the temperature and rainfall daily observations. In the rare case of missing values, we substitute values from nearby stations to get a complete string of observations.

We also collected potential evapotranspiration (ET) data from selected stations maintained by the Florida Automated Weather Network. ET is the depth of water evaporated and transpired from a reference crop (grass) when water supply is not limiting. ET is typically calculated for farmers to assist them with irrigation scheduling, but it also provides a good measure of the irrigation demands of homeowners. Although ET stations are far fewer than NCDC stations, and hence we often needed to stray beyond the utility service area to identify the closest one, ET has less spatial volatility than precipitation.

ET is based on the Penman-Montheith formula that includes wind speed, solar radiation, relative humidity, and temperature inputs. About 15 percent of total ET observations are missing for our study period, mainly because some of the ET stations are new. We fill in missing observations by using the Blaney-Criddle method (see Appendix A) that estimates ET as a function of temperature (taken from the local NCDC weather stations at each utility) and percent of daytime hours.

Table 2-8
Weather Stations

Utility	Weather Station 1	Weather Station 2	ET Station
Escambia	Pensacola Regional Airport	Pensacola Forest Sherman Nas	Marianna
Hillsborough	Dove Field Place	Dover ET	Dover
Indian River	Vero Beach 4 W	Vero Beach Municipal Arpt	Ft Pierce
Lakeland	Lakeland 2	Lakeland Public Works	Lake Alfred
Melbourne	Melbourne International Airport		Ft Pierce
Miami Dade	Perrine 4 W	Hialeah	Homestead
Ocoee	Clermont 7 S		Apopka
Palm Beach	Loxahatchee NWR	West Palm Beach Intl ARPT	Homestead
Palm Coast	Palm Coast 6 NE	St Augustine Lighthouse	Pierson
Sarasota	Oscar Scherer State Park	Venice	Bradenton
Seminole	Sanford		Apopka
Spring Hill	Weeki Wachee	Hunters Lake	Brooksville*
St Petersburg	St Petersburg Albert Whitted	Gulfport	Dover
Tallahassee	Tallahassee Regional Airport		Quincy
Tampa	Hills River at Sulphur Spgs	S-160 SWFWMD	Dover
Toho	Kissimme 2	Kissimmee SFWMD	Apopka

*We averaged the values of two ET stations in Brooksville (USDA Brooksville Subtropical Agricultural Station and the SWFWMD Headquarters Station).

Because precipitation can be both frequent and large in magnitude, not all can be stored and used by landscapes—some is lost as runoff or percolates past the root zone. Hence, we use a detailed daily soil moisture model to convert precipitation into effective precipitation. In doing this we find that only 39 percent of actual rainfall is effective at offsetting ET water requirements for a typical lawn. Appendix A contains details of the soil moisture model.

Lastly, we create a net irrigation requirement (NIR) variable that equals ET minus effective precipitation. NIR provides us with an overall indicator of the theoretical water need of landscapes.

Table 2-9 shows the annual average weather statistics for the 16 utilities.[7] The northern utilities (Escambia, Tallahassee, and Palm Coast) tend to have lower ET and NIR than the other utilities.

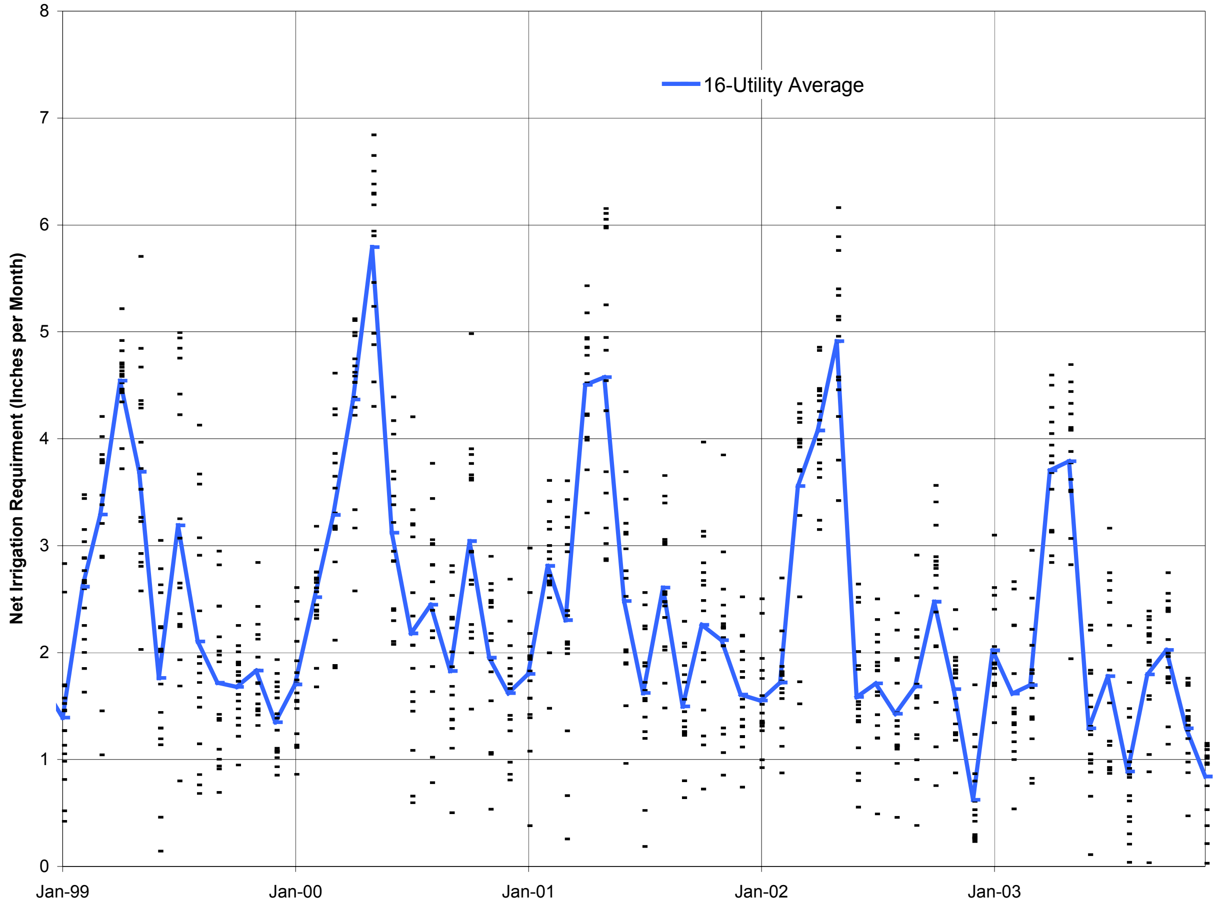
[7] We did not collect 1998 weather data for seven utilities as we did not have water use for that year. Hence we only show 1999 to 2003 averages to make comparisons over same time period.

Table 2-9
Average Annual Weather Statistics 1999-2003

Utility	Max Temperature F	ET Inches	Precipitation Inches	Effective Precipitation Inches	NIR Inches
Escambia	77.4	43.1	50.1	21.0	22.1
Hillsborough	81.9	48.5	45.6	20.2	28.3
Indian River	81.4	50.6	53.4	22.2	28.4
Lakeland	83.4	50.4	49.5	22.5	27.9
Melbourne	82.2	50.6	53.8	19.7	30.8
Miami Dade	84.1	52.0	72.9	25.7	26.3
Ocoee	83.5	52.7	53.6	20.2	32.5
Palm Beach	82.9	51.9	61.2	24.5	27.5
Palm Coast	78.7	45.0	50.1	21.1	23.9
Sarasota	84.1	51.3	54.4	20.7	30.7
Seminole	83.0	52.7	50.7	20.7	32.0
Spring Hill	82.5	48.4	53.2	20.0	28.4
St Petersburg	80.7	48.6	50.7	19.1	29.4
Tallahassee	79.8	45.6	55.9	21.4	24.2
Tampa	81.9	48.5	45.4	20.2	28.3
Toho	83.2	52.7	52.2	20.8	31.8

When looked at on a monthly basis, we see a large variation in weather values. Figure 2-1 shows the 16-utility average of NIR by month along with the individual utility deviations. The 16-utility average tends to peak each year around May and to a much lesser degree a second peak around October. Deviations tend to be significant, especially during the summer, largely a reflection of varying amounts of effective precipitation.

Figure 2-1. 16-Utility Average of NIR Compared to Individual Utility NIR



2.5 Irrigation Restrictions

The Florida water management districts and local utilities have at times mandated restrictions on when outdoor irrigation can occur as shown in Table 2-10.

Table 2-10 Irrigation Restrictions	
Utility	**Irrigation Restrictions**
Escambia	None
Hillsborough	Jan-98 to Mar-00: 2 days per week not between 9 a.m. and 5 p.m. Mar-00 to Nov-03: 1 day per week not between 8 a.m. and 6 p.m. Nov-03 to Dec-03: 2 days per week not between 8 a.m. and 6 p.m.
Indian River	Jan-98 to Dec-03: not between 10 a.m. and 4 p.m.
Lakeland	Jan-98 to May-00: 2 days per week not between 10 a.m. and 4 p.m. May-00 to Nov-01: 1 day per week not between 10 a.m. and 4 p.m. Nov-01 to Dec-03: 2 days per week not between 10 a.m. and 4 p.m.
Melbourne	Jan-98 to Dec-03: not between 10 a.m. and 4 p.m.
Miami Dade	Jan-98 to Mar-01: not between 9 a.m. and 5 p.m. Dec-00 to Jan-01: 3 days per week not between 9 a.m. and 5 p.m. Feb-01 to Oct-01: 2 days per week not between 8 a.m. and 4 a.m. Nov-01 to Dec-03: not between 9 a.m. and 5 p.m.
Ocoee	Jan-98 to Dec-00: not between 10 a.m. and 4 p.m. Jan-01 to Dec-03: 2 days per week not between 10 a.m. and 4 p.m.
Palm Beach	Jan-98 to Mar-01: not between 9 a.m. and 5 p.m. Dec-00 to Jan-01: 3 days per week not between 9 a.m. and 5 p.m. Feb-01 to Oct-01: 2 days per week not between 8 a.m. and 4 a.m. Nov-01 to Dec-03: not between 9 a.m. and 5 p.m.
Palm Coast	Jan-98 to Dec-03: not between 10 a.m. and 4 p.m.
Sarasota	Jan-98 to May-00: 2 days per week not between 10 a.m. and 4 p.m. May-00 to Dec-03: 1 day per week not between 10 a.m. and 4 p.m.
Seminole	Jan-98 to Dec-00: not between 10 a.m. and 4 p.m. Jan-01 to Dec-03: 2 days per week not between 10 a.m. and 4 p.m.
Spring Hill	Jan-98 to May-00: 2 days per week not between 10 a.m. and 4 p.m. May-00 to Nov-01: 1 day per week not between 10 a.m. and 4 p.m. Nov-01 to Feb-03: 2 days per week not between 10 a.m. and 4 p.m. Mar-03 to Jun-03: 1 day per week not between 10 a.m. and 4 p.m. Jul-03 to Dec-03: 2 days per week not between 10 a.m. and 4 p.m.
St Petersburg	Jan-98 to Apr-00: 2 days per week between 5-9 a.m. and 7-11 p.m. Apr-00 to Oct-03: 1 day per week between 5-9 a.m. and 7-11 p.m. Oct-03 to Dec-03: 2 days per week between 5-9 a.m. and 7-11 p.m.
Tallahassee	None
Tampa	Jan-98 to Mar-00: 2 days per week not between 9 a.m. and 5 p.m. Mar-00 to Nov-03: 1 day per week not between 8 a.m. and 6 p.m. Nov-03 to Dec-03: 2 days per week not between 8 a.m. and 6 p.m.
Toho	Jan-98 to Dec-03: not between 10 a.m. and 4 p.m.

All restrictions prohibit irrigation during the mid-day hours (e.g., between 10 a.m. and 4 p.m.) when a greater percentage of irrigation spray is lost through evaporation. The key difference between the restrictions is the number of days-per-week that irrigation can occur—the number varies between 1 and 3 days depending on the utility and the period.

Another related factor is enforcement. Anecdotal evidence suggests that the restrictions were enforced to different degrees in different utilities, but were in general more stringently enforced relative to similar restrictions prior to our study period.

2.6 Source Substitutes

In most areas, homeowners can drill and maintain groundwater wells for their own water supplies. As part of our selection process, all the homes included in this study purchase potable water from their local utility for drinking and indoor water uses. Some homes, however, have their own irrigation wells used exclusively for landscape irrigation. As the cost of purchasing utility water increases, the cost-effectiveness of installing a personal irrigation well improves. This source substitution can significantly impact the price responsiveness of customers to utility water.

A complicating factor to this study is that in some areas groundwater is readily available in the sandy surface aquifer by 30 to 80 foot deep wells.[8] These surficial aquifer wells are generally about 2 inches in diameter, use a screen to restrain sand, and use above-ground or submersible pumps. They are also relatively inexpensive, costing between $500 and $1,000 to install. In contrast, wells deeper than 100 feet (generally going into the Floridian aquifer) are generally 4 inches in diameter, use submersible pumps, and cost two to three times as much.

We contacted hydrogeologists at the water management districts to discuss the potential of surficial wells in each utility service area. Customers have ready access to surficial irrigation wells in most utilities, the exceptions being Escambia, Hillsborough, Tallahassee, and Tampa. We factor this finding in our evaluation described in Chapter 4.

Another source substitute is recycled wastewater for outdoor irrigation—an increasingly available alternative source of supply provided by Florida water/wastewater utilities. In this study, we included a relatively small group of customers connected to recycled water systems in St. Petersburg and Toho. Because the water use of these customers tends to only reflect indoor water use, we did not expand or focus attention on these customers as part of this study.

[8] *Water Supply Needs and Sources Assessment*, Special Publication SJ98-SP2, prepared for the St. Johns River Water Management District by Post, Buckley, Schuh & Jerrigan, Inc., 1998.

Within Palm Beach, many customers (32% of our sample) access surface water (ponds and lakes) as a source substitute.

2.7 Water Conservation Programs

We interviewed water utility staff regarding their water conservation programs over the study period. Although water conservation programs can have significant impact on individual customers, our assessment is that aggregate coverage of programs was so limited as to not materially impact the results of this study, other than the irrigation restrictions.

3. Mail Survey

Our mail survey has two purposes. First, it collects information about customers' concern, knowledge, sensitivity, and perceptions of water and sewer prices and uses. Second, it gathers household data used in our statistical modeling of water demand. This chapter describes the survey process, response rates, and results. Tabulations of the responses for each question are in Appendix B.

3.1 Survey Process

The University of Florida Survey Research Center (UFSRC) managed the mail survey of 7,236 single-family water customers distributed across the 16 water utilities and 4 home profiles using the following three-phase approach.

1. PRE-SURVEY LETTER

Selected homes received a pre-survey letter describing the project and notifying them that they would receive a survey from the University of Florida. Letters were printed on utility letterhead, mailed in a utility business envelope, and signed by a utility representative.

With the exception of Miami-Dade, all pre-survey letters contained a line at the bottom of the letter written in Spanish which instructed respondents to call the UFSRC's toll free number should they need information in Spanish. Respondents in Miami-Dade received a pre-survey letter with the full letter text printed on the reverse side in Spanish.

2. SURVEY PACKET

About a week after sending the pre-survey letter, each home received a packet containing a letter from the utility, the survey booklet, a business reply envelope, and in some cases a $1 bill incentive.

A total of 1,500 homes received a $1 incentive with the survey. We used the incentive to selectively increase the response rate of homes that best fit our profile definitions. The incentive spanned all utilities except St. Petersburg that did not want this type of incentive used with their customers.

Survey letters included assurance of the confidentiality of individual answers and the importance of each respondent returning a completed survey. With the exception of Miami-Dade, all survey letters contained a line at the bottom of the letter written in Spanish instructing respondents to call a toll free number should they need information in Spanish or want to complete the survey verbally via telephone. Respondents in Miami-Dade received the survey letter in English with the full letter text printed on the reverse side in Spanish. Respondents in Miami-Dade also received both English and Spanish surveys.

All survey packets were mailed first class with return service requested. For response rate purposes, undelivered survey packets were returned to the UFSRC.

3. POST CARD

The last phase included a reminder post card. The card thanked respondents who returned a completed survey and reminded others of the importance of completing and returning the survey. Respondents whose survey packet was logged as undelivered were not sent a post card.

3.2 Survey Response Rates

Of the 7,236 surveys mailed in May and June of 2004, we received 211 surveys back as undeliverable. From our net total of 7,025 surveys sent, we received 3,538 back by July 2, 2004 for a response rate of 50.4%.

Response rates vary by utility, profile and incentive. Table 3-1 shows response rates by utility and profile.

By utility, response rates range from 28% to 62%. We are unclear of the cause of the low response rate of 28% for Toho other than we only surveyed the low and median property value groups (profiles 1 and 2). The low response rate for Miami Dade is expected as survey researchers find this region to be one of the hardest to survey in the nation. Our extra effort of sending the survey in Spanish helped, but the response rate is still low at 30%. For the other 14 utilities, response rates are all over 43%. Melbourne generated an impressive 62% response rate.

Overall, the higher property value homes (profiles 3 and 4) had a response rate about 10% over the lower property value homes (profiles 1 and 2).

Our targeting of select groups with the inclusion of a $1 bill in the survey packet proved effective. This step increased the response rate for this group by 12%, a result generally consistent across all utilities and profiles.

For those returning the survey, almost all answered every question presented. Our lowest response occurred with the household income questions where only 91% provided an answer.

Table 3-1
Survey Response Rates

Utility	Profile 1	2	3	4	Total
Melbourne	58%	59%	66%	70%	62%
Palm Coast	49%	56%	67%	66%	59%
Escambia	58%	57%	62%	60%	59%
Indian River	58%	56%	56%	52%	56%
Sarasota	48%	54%	61%	55%	54%
Spring Hill	43%	54%	56%	67%	53%
Tallahassee	46%	53%	56%	58%	53%
Tampa	44%	52%	59%	54%	53%
St. Petersburg	43%	51%	55%	55%	51%
Lakeland	41%	53%	48%	63%	51%
Ocoee	43%	44%	56%	58%	50%
Palm Beach	40%	40%	59%	55%	49%
Hillsborough	41%	39%	50%	52%	46%
Seminole	NA	39%	43%	47%	43%
Miami Dade	28%	26%	28%	36%	30%
Toho	32%	23%	NA	NA	28%
Total	45%	47%	55%	56%	50%

3.3 Survey Results: Home Characteristics

This section describes basic characteristics of the homes surveyed.

- **Home Type**. 94% of our sample of single-family homes is owner-occupied, directly pays a water bill, and reports being a full-time resident—this is our base unit of analysis. We find 96% of homes are owner-occupied and directly pay a water bill. This high percentage is not surprising given our targeting and matching process of homes via the tax records. Miami Dade, however, is a notable deviation with only 68%. In reviewing this situation, we find 31% of homes have occupant renters (the percentages are especially high in the lower property value groups). In our selection process we sought to bypass renters, but for unexplained reasons a high number of water bills go directly to the landlord/owner at the service address, although the owner does not live there.

  We also find 98% of all homes report they typically occupy their house year round. This seems high given the general, seasonal nature of residence in Florida. The cause might be related to our focused selection of owner-occupied homes via tax records, from year-round residents being more likely to respond to our survey that occurred in May and June of 2004 (most seasonal residents are already gone), or from some type of response bias to our question. Only in Indian River did year-round residents drop to 90% of the total.

- **Irrigation Source**. All the homes in this study use utility water for indoor potable uses. We find, however, that only 64% of customers use utility water for outdoor irrigation. Irrigation wells, surface water, and reclaimed water serve as utility water substitutes for irrigation. Although we do not have measured volumes of these substitutes, it is important to the evaluation to know that they exist. Source of irrigation supply varies largely by utility, but not profile.

  28% of homes use irrigation wells—these are typically shallow, relatively inexpensive wells located on the property and connected to an in-ground irrigation system. In certain areas with easy access to groundwater and relatively high potable water prices, such as Melbourne, St Petersburg, and Indian River, about two-thirds of homes have irrigation wells. In other areas without easy access or with relatively low potable water prices, such as Lakeland, Ocoee, Tallahassee, Escambia, Hillsborough, Seminole, and Tampa, less than 15% of homes have irrigation wells or other source substitutes. Local surface water (e.g., ponds, lakes, and canals) is a less frequent substitute used by 4% of our total sample. In Palm Beach, however, surface water is prevalent, used by 32% of homes. We included small groups of homes using reclaimed water in St Petersburg and Toho, as well as a few homes in other areas.

- **Irrigation System**. About half of homes have an in-ground irrigation system with automatic timer. Higher wealth homes are much more likely to have them. For example, 20% of profile 1 homes and 78% of profile 4 homes report having in-ground irrigation systems with timers. In-ground irrigation systems with manually controlled values makeup 13% of the sample—there is little variation among profiles. Hose-based watering systems are used by 25% of homes. This system is more common with the lower value homes, accounting for 47% of profile 1 homes. The lower value homes also more frequently report that they do not irrigate outdoor landscaping.

  For homes with in-ground irrigation systems with timers, 25% and 1% of homes respectively reported having rain-sensor and soil-moisture sensor shutoff devices.

  Irrigation system results are generally consistent across utilities. Tallahassee is an exception where hose-based systems (78%) are much more common than in-ground systems with timers (7%). Miami-Dade also has this trait, to a lesser degree.

- **Water Features**. Pools, water softeners, and hot tubs/spas are found in 37%, 11%, and 15% of homes respectively and are highly correlated with wealth. Known faucet leaks, toilet leaks, and broken sprinklers are reported in less than 5% of homes.

- **Number of Occupants.** The average number of occupants is 2.51 over the total sample. There tend to be more occupants in the higher value homes. Miami-Dade is an outlier having the highest average occupants per home at 3.18.

- **Household Income**. About 9% of the respondents refused to answer the income question. For those that did answer, we find income highly correlated with home value as expected.

3.4 Survey Results: Concern of Water Rates

We presented respondents with statements and asked them to select from a five option scale ranging from strongly agree, somewhat agree, neither agree or disagree, somewhat disagree, or strongly disagree. This is a common scaling used in market research.

The survey has two questions measuring the importance of water cost to customers when deciding how much water to use indoor and outdoors. To facilitate comparisons, we categorize customers into three groups using a composite of responses to the two concern questions.[9] The first group tends to be concerned, strongly agreeing that they are concerned about the cost of either indoor or outdoor water use. The second group tends to be somewhat concerned about either indoor or outdoor water use. The third group reports having little or no concern with water cost. Although the precise borders differentiating these groups are arguable, it provides us with a general categorization to show linkages among other factors.

Table 3-2 shows the results. Overall, 52% of customers report being strongly concerned about the cost of water and 80% report being either strongly or somewhat concerned. The level of concern tends to decrease with increasing wealth—62% of profile 1 and 43% of profile 4 customers are strongly concerned with water cost respectively. More customers are concerned about the cost of water used for outdoor irrigation than for indoor uses.

Further analysis shows that water cost concern is related to the total water bill. As the total bill increases, so does concern for water costs—a logical finding. Interestingly, we also find that cost concern is correlated with environmental concern. Of the customers strongly agreeing that they conserve water mainly for environmental reasons (33% of total sample), 65% strongly agree that water cost is important. Of the customers not concerned about water cost, only 15% strongly

[9] The composite is based on questions B3 and B4 in Appendix B.

agree that they conserve water for environmental reasons. Hence, "green" and cost conscious concepts are highly linked.

Table 3-2 Concern with Water Costs			
Profile	**Strongly Concerned**	**Somewhat Concerned**	**Not Concerned**
Escambia	43%	40%	16%
Hillsborough	60%	33%	8%
Indian River	57%	24%	19%
Lakeland	43%	32%	25%
Melbourne	52%	24%	23%
Miami Dade	52%	32%	17%
Ocoee	55%	28%	16%
Palm Beach	51%	25%	25%
Palm Coast	66%	17%	17%
Sarasota	64%	18%	17%
Seminole	51%	32%	17%
Spring Hill	58%	25%	17%
St Petersburg	49%	30%	21%
Tallahassee	35%	36%	29%
Tampa	40%	34%	26%
Toho	55%	26%	19%
Profile 1	62%	23%	14%
Profile 2	55%	26%	18%
Profile 3	49%	30%	21%
Profile 4	43%	33%	24%
Total	52%	28%	20%

3.5 Survey Results: Knowledge of Water Rates

The survey included a series of five-scale questions (same format as concern questions) to determine customers' existing knowledge of water rates. Below are key findings.[10]

[10] Throughout this chapter we define "agreement" with a statement to include customers that strongly or somewhat agree with a statement and make distinctions when relevant. Appendix B contains full spectrum of results.

- **Dollars More Recognized than Gallons**. 78% of homes agree that they knew the approximate dollar amount of their average water bill. Only 38% of homes agree they knew the approximate number of gallons.
- **Rate Structure Recognition**. Of the homes facing an increasing block water rate structure, 64% agree they knew this fact.
- **Number of Rate Blocks**. Of the homes facing an increasing block water rate structure, 35% agree they knew the number of rate blocks.
- **Size of Blocks**. Of the homes facing an increasing block water rate structure, 19% agree they knew the gallons associated with the blocks.
- **Price of Blocks**. Of the homes facing an increasing block water rate structure, 19% agree they knew the prices associated with the blocks.

Hence, a majority of customers are knowledgeable when it comes to the average dollar amount of the water bill and the type of water rate structure. However, far fewer are familiar with details regarding the number, size and prices of the blocks.

The information contained on the utility bill can obviously impact customers' knowledge of water rates. For the three utilities with block rates that show actual water rates on the bill (Hillsborough, Sarasota, and St. Petersburg), we see a jump in the level of knowledge of rates. These utilities tend to have higher prices, however, that might be a partial reflection of this fact.

To facilitate comparisons, we categorize customers into three groups using a composite of responses to the knowledge questions.[11] The first group tends to be knowledgeable of rates, either strongly or somewhat agreeing to the knowledge questions. The second group is somewhat knowledgeable, providing a mix of agreement and disagreement to the knowledge questions. The third group is not knowledgeable, somewhat or strongly disagreeing they had prior knowledge of water rates.

Table 3-3 shows the results by utility and profile. Overall, 20% of customers report being strongly knowledgeable about rates and 61% report being either strongly or somewhat knowledgeable. The level of knowledge tends to decrease with increasing wealth, but only slightly.

[11] The composite is based on six questions (B7, B8, B10, B11, B12) for customers with block rates and three questions (B7, B8, B11) for those facing a single water price.

Table 3-3
Knowledge of Water Rates

Group	Strongly Knowledgeable	Somewhat Knowledgeable	Not Knowledgeable
Escambia	11%	38%	51%
Hillsborough	18%	54%	28%
Indian River	16%	42%	42%
Lakeland	14%	37%	50%
Melbourne	24%	44%	31%
Miami Dade	10%	30%	60%
Ocoee	22%	40%	38%
Palm Beach	15%	39%	46%
Palm Coast	29%	40%	31%
Sarasota	34%	41%	26%
Seminole	19%	32%	49%
Spring Hill	39%	41%	20%
St Petersburg	22%	43%	35%
Tallahassee	11%	32%	56%
Tampa	10%	46%	44%
Toho	20%	41%	39%
Profile 1	22%	44%	34%
Profile 2	23%	41%	37%
Profile 3	19%	41%	40%
Profile 4	18%	37%	45%
Total	20%	41%	39%

Spring Hill has the highest percentage (39%) of strongly knowledgeable customers; the changing from a private (Florida Water Services) to a public utility (Hernando County) in 2003 might have elevated customers' interest in water rates. Spring Hill also publishes its water prices on its water bill. Sarasota, with a detailed utility bill and relatively high rates, has the second highest percentage of strongly knowledgeable customers (34%).

3.6 Survey Results: Cost Calculations

The survey also asked customers about the level of rigor used in making cost-effectiveness calculations regarding water use as summarized in Table 3-4.

Only 3% of homes report they mathematically quantify the cost savings associated with water use decisions—a calculation that requires both knowledge of the rate structure and the water use associated with a particular activity. Only 4% of homes facing a single price and 2% of homes facing block prices report being "quantifiers." It is logical to see a higher percentage with the single price because it is simpler for customers to calculate, but neither percentage is large.

Table 3-4
Water Cost Evaluation Level

Group	Quantifier	Approximator	Uncalculating
Escambia	3%	28%	70%
Hillsborough	2%	44%	55%
Indian River	2%	32%	66%
Lakeland	0%	31%	69%
Melbourne	3%	25%	71%
Miami Dade	2%	32%	65%
Ocoee	3%	40%	56%
Palm Beach	1%	34%	64%
Palm Coast	6%	26%	68%
Sarasota	3%	45%	52%
Seminole	1%	39%	60%
Spring Hill	8%	25%	67%
St Petersburg	2%	35%	62%
Tallahassee	1%	14%	85%
Tampa	1%	32%	67%
Toho	4%	28%	68%
Profile 1	3%	32%	66%
Profile 2	3%	32%	65%
Profile 3	3%	31%	65%
Profile 4	2%	32%	66%
Total	3%	32%	65%

The next level of sophistication includes the "approximators." These customers tend to focus on the total dollar amount of past water bills to guess the dollar change that might occur from a given water use action. Specific water prices and water use changes are only indirectly factored into their assessments. We find 32% of customers fall into this category.

65% of customers admit they are "uncalculating" when it comes to water use decisions. These customers know their water bill will go down if they use less water, but do not make the effort to estimate by how much.

Given our research objective of better understand block rates, we note that 21% of customers with increasing block rates report they focus on reducing water use to stay below specific high priced rate blocks. These “block targeters” do not make cost calculations, but are knowledgeable of the rate structure and use the block thresholds (e.g., 10,000 per month) as a not-to-exceed goal to avoid paying higher unit water prices. This is potentially a key group—providing a distinctive difference compared to the single price rate structure.

3.7 Concern, Knowledge, and Cost Calculation

Looking at the intersections of concern, knowledge, and cost calculation provides a clearer big picture view.

Table 3-5 shows the intersection between concern and knowledge of water rates. It is interesting to note that those strongly concerned about water costs have a mix of knowledge about water rates. In fact for those strongly concerned, 31% report being not knowledgeable and 43% only somewhat knowledgeable about rates. This suggests that customers are not getting the information they need to be knowledgeable, even though they want it. Looking at all customers, 63% that are strongly or somewhat concerned could be brought up to strongly knowledgeable. Hence, we conclude there is much room for customer education on water rates.[12]

Table 3-5
Concern versus Knowledge

Concerned	Strongly Knowledgeable	Somewhat Knowledgeable	Not Knowledgeable	Total
Strongly	14%	22%	16%	52%
Somewhat	4%	11%	14%	28%
Not	2%	8%	10%	20%
Total	20%	41%	39%	100%

Further evaluation finds a clear link between knowledge and the type of cost calculations made. Looking at customers that are strongly or somewhat concerned with water costs, Table 3-6 shows that increases in knowledge make them more quantitative. In fact if customers are strongly knowledgeable, they are much more likely to be quantifiers (10%) or approximators (49%) than otherwise. Going from not knowledgeable to somewhat knowledgeable also greatly increases the level of quantification.

[12] For example, only 5 of the 16 utilities put water price on the bill.

Table 3-6 Knowledge versus Cost Calculations			
Cost Calculator	**Strongly Knowledgeable**	**Somewhat Knowledgeable**	**Not Knowledgeable**
Quantifier	10%	1%	1%
Approximator	49%	40%	24%
Uncalculating	41%	59%	75%
Total	100%	100%	100%
Universe: strongly or somewhat concerned customers.			

3.8 Survey Results: Perceptions of Water Rates

We also asked a series of questions regarding customers' perceptions of water rates. Our findings are listed below.

- We asked a question probing if their water pricing system is perceived as effective in getting them to conserve water. 49% of customers facing a block rate system agreed it is effective. In comparison, only 37% of customers with a single price agreed.

- For customers facing block prices, 45% would prefer a single price and 38% prefer the block prices (17% neutral with no opinion). For customers facing a single price, 48% prefer the single price and 30% would prefer block prices (21% neutral with no opinion). Hence, there appears to be a preference among customers to pay the same unit price for each gallon of water no matter how much they used, but the preference is not large.

- When asked if their water rates are too complicated, only 18% of single price and 25% of block price customers agreed. The small percentage difference between the two indicates that block rates are not generally perceived as complicated. Another observation is that the percentages are not large given the high percentage of customers that are uncalculating and unaware of existing rates. This evidence suggests that it is not necessarily the pricing of water that is preventing a more through analysis, but the communication of pricing information.

- 30% of single price and 24% of block price customers strongly agree that their monthly bill does a good job of explaining water rates and charges. For most utilities the primary objective of the water bill is to collect revenue. Other educational aspects such as showing the rate structure and historical water use are often absent.

4. Water Use Analysis

This project investigates both statements made and actions taken by water customers regarding water pricing. In the last chapter, we analyze statements made by customers via the mail survey. In this chapter we investigate the link between actual water use decisions and prices.

Our approach is to compare water use across all the utilities for each of the four customer profiles; we ascribe differences in water use to differences in pricing. This approach relies on controlling for non-price factors so that we can bring focus to the demand relationships.

The rigor of our sampling process provides us with a relatively large, homogeneous set of homes to work with in each profile across utilities. We can still, however, sharpen focus by controlling for other known determinants impacting water use. Such non-price determinants include weather, irrigation restrictions, and additional home characteristics collected via the mail survey. The first two sections of this chapter address the steps taken to further normalize water use. The first section estimates non-price regression models. The second section uses the non-price models to adjust water use for deviations in non-price variables from profile norms—a process we define as normalizing water use.

The remaining sections of this chapter address the specification and estimation of water demand models—the mathematical relationship between normalized water use and water related prices. This is the crescendo of all our work. We investigate a variety of price variables to the measure the impacts of block rates including average price, marginal price, and a combination of these prices. We also develop variables addressing how irrigation source substitutes, fixed charges, and water bill information might impact water use as part of the overall pricing signal.

4.1 Non-Price Models

As a first step, we model water use as a function of non-price variables. The non-price variables include weather, irrigation restrictions, and selected variables derived from responses to the mail survey. Because we do not yet address prices, we calculate separate models for each utility and profile. The price information experienced by customers within a utility is identical, so we can estimate non-price models without explicitly factoring in price. Our large sample size makes dissecting customers in this fashion feasible. We estimate 55 different utility/profile models; we exclude Miami-Dade, Toho, and profile 1 homes from Seminole County because of insufficient observations.[13]

[13] 13 utilities x 4 profiles + 3 Seminole profiles = 55

We explored a variety of non-price model specifications. We judge equation (1) to best fit our purposes of controlling for non-price variables.

$$WATER_{i,t} = a + b*PERSONS_i + c*POOL_i + d*NIR_{i,t}*SUB_i + e*IR_t*SUB_i + f*HOSE_i*SUB_i + g*MANUAL_i*SUB_i + h*SUB_i \quad (1)$$

where,

$WATER_{i,t}$ = gallons per day for home i in month t (t spans 1998 to 2003)

$PERSONS_i$ = number of persons in home i as reported from mail survey

$POOL_i$ = 1 if home has a pool; 0 otherwise

$NIR_{i,t}$ = net irrigation requirement (inches/day) exactly matching billing period for home I in month t

IR_t = 1 if most stringent irrigation restriction for billing period t; 0 otherwise

$HOSE_i$ = 1 if home uses a hose-based irrigation system; 0 otherwise

$MANUAL_i$ = 1 if home uses a manual in-ground irrigation system; 0 otherwise

SUB_i = 1 if home uses a source substitute other than utility water to irrigate; 0 otherwise

a, b, c, d, e, f , h = coefficients estimated using ordinary least squares regression

Hence equation (1) models water use as a function of two variables that change over time (NIR and IR) and five variables that change across homes (PERSONS, POOL, HOSE, MANUAL, SUB). We estimate the model for all 55 profile/utility combinations using ordinary least squares regression and adjust the error term for first order serial correlation to improve the properties of the estimates.

Appendix C shows the model regression results by utility and profile. In general, the model coefficients do a good job explaining time and cross-sectional differences in water use; the amount of variance in water use explained by the models varies from 30% to 47% by utility. We did include other variables in the model, but they do not prove to correlate consistently with water use. The other variables include deviations in property value and house size from the profile targets, house age, presence of a water softener, use of a rain or soil-moisture sensor shutoff device, and household income.[14]

NIR strongly correlates with water use.[15] The NIR coefficient always takes on the correct sign (positive)—as NIR increases water use increases and as NIR decreases water use decreases. In calculating NIR, we exactly match and sum daily NIR with each home's billing cycle. This extra programming effort obviates potential time-blurring problems associated with revolving meter reads that can occur on any day of the month.

Irrigation restrictions correlate with reductions in water use. The model uses an irrigation restriction variable based on the number of days per week irrigation is allowed.[16] Table 4-1 shows the percentage reduction in average water use associated with two circumstances.

The first circumstance occurs when irrigation is restricted from 2-days to 1-day per week. Utilities within the Southwest Florida Water Management District experienced this circumstance during a drought period starting March to May 2000 and continuing for different lengths of time at each utility. When the 1-day restriction was not in effect, a 2-day restriction was in effect over the study period for all these utilities. Average water reductions associated with going from 2-days to 1-day restrictions ranged from 9% to 20%, tending to be higher for the profile 3 and 4 customers. Lakeland experienced less of a reduction than other utilities—profile 2 actually shows a 10% increase in water use.

[14] The fact that deviations in property value and house size from profile averages do not correlate with water use is not surprising given the small deviations to work with; the sample selection process provides us with homes that are nearly identical with respect to these two variables. Anecdotal evidence suggests rain sensors are often improperly installed. Installed rain sensors may also be correlated at homes with larger irrigated turf areas, making the net impact from rain sensors difficult to measure from billing data. Only a few percent of homes report having soil moisture sensors; the small sample size and again the fact that soil sensors may be correlated with large landscape sites makes quantifying their impact from this data difficult. We do not have size and type of irrigated landscape in our database.

[15] As an alternative, we modeled water use as a function of maximum temperature and effective rainfall. NIR, however, provides a much better correlation with water use.

[16] All restrictions included time-of-day restrictions preventing watering during the middle of the day. Because these time-of-day restrictions at a given utility did not change much, if it all, during the study period they were not specifically addressed. They are, however, an important part of the intervention.

Table 4-1 Irrigation Restriction Reductions					
		Profile			
Utility	**Days per Week Irrigation**	**1**	**2**	**3**	**4**
Hillsborough	2 to 1	-7%	-4%	-17%	-19%
Lakeland	2 to 1	-6%	10%	-8%	-2%*
Sarasota	2 to 1	-1%*	-5%	-16%	-23%
Spring Hill	2 to 1	-2%*	-29%	-21%	-23%
St. Petersburg	2 to 1	-24%	-15%	-5%	-33%
Tampa	2 to 1	-14%	-13%	-23%	-21%
Average	2 to 1	-9%	-9%	-15%	-20%
Ocoee	7 to 2	-14%	-5%	-10%	-13%
Palm Beach	7 to 2	-23%	-20%	-21%	-19%
Seminole	7 to 2	NA	-8%	-16%	-23%
Average	7 to 2	-19%	-11%	-16%	-18%

Results applicable to homes without irrigation source substitution. In Lakeland, administrative difficulties during restriction period may have limited enforcement.
* denotes estimates not statistically different from zero (95% confidence).
NA = not applicable as no homes for this utility/profile.

The second circumstance has three utilities (Ocoee, Palm Beach, and Seminole) going from no restrictions to 2-days per week restrictions. The restrictions started in the beginning of 2001 and extended for varying lengths of time. Model results show the intervention of going to 2-days per week restrictions correlates with an average 11% to 19% reduction in water use.[17]

[17] We note that three previous studies showed significantly less water savings associated with irrigation restrictions in Florida. These studies evaluated restrictions in earlier years, at different places, under different implementation and enforcement circumstances, and using different evaluation techniques. The studies include: 1) *Water Price Elasticity Study*, August 1993 revised August 1999, Report prepared for the SWFWMD by Brown and Caldwell Consultants in association with John B. Whitcomb, PhD; 2) *Assessment of the Effects of Drought-Related Water Use Restrictions*, August 2001, Report prepared for the SJRWMD by Barnes, Ferland and Associates, Inc. and R.W. Beck; and 3) *Water Supply Needs and Sources Assessment Alternative Water Supply Strategies Investigation Effects of Water Use Restrictions on Actual Water Use SJ97-SP12*, 1997, Report prepared for the SJRWMD by Post, Buckley, Schuh and Jernigan, Inc.

The SUB variable denotes homes using irrigation source substitutes, such as irrigation wells. We multiplied the weather, irrigation restriction, and irrigation system variables by SUB. Homes using a source substitute are not impacted by these factors.

If both HOSE and MANUAL are zero, then the home has an in-ground irrigation system with automatic timer. The coefficients for HOSE and MANUAL tend to be negative, as homes that irrigate with these systems tend to use less water.[18]

4.2 Normalized Water Use

We normalize water use for differences in the non-price variables from mean values using the following procedures. The total net changes in GPD are shown in Appendix D.

For NIR, we calculate the NIR norm for each calendar day in a year. The norm is based on our daily NIR values over the study period over all utilities. We then, for each home water use observation described by $WATER_{i,t}$, calculate the difference between $NIR_{i,t}$ and the NIR norm for the billing period. If the difference is negative, then NIR at the utility was less than average. If the difference is positive, then NIR was over the average. We multiply the NIR coefficient from the non-price models by the NIR difference—this product is subtracted from water use to weather normalize water use. This is the water use we would expect if no deviations from the NIR norm occurred.

The biggest change resulting from weather normalization occurs with Escambia. Escambia experienced significantly less evapotranspiration than the other utilities participating in this study. Escambia also proves relatively sensitive to NIR in the models. This combination translates into a 7 to 16% increase in GPD over the four profiles after making the weather normalization correction. Tallahassee, the other northern Florida in this study, also got a boost in water use ranging from 7 to 11% from the normalization. For all the other utilities and profiles, the percentage changes are less than +/- 7%.

The irrigation restriction normalization follows in a similar manner. For each utility/profile combination, we add to GPD the product of the IR coefficient and the percentage of the study period that the most restrictive irrigation restrictions were in effect. Hence, we normalize to the least restrictive state. For the six Southwest Florida Water Management District utilities, this meant normalizing to 2-days per week restrictions. For Ocoee, Palm Beach, and Seminole, this

[18] This does not imply homes that use hoses and manual in-ground irrigation systems are more efficient. Instead, the negative coefficients likely reflect that homes with these systems tend to have less irrigated area and require more effort. Because we do not have irrigated area measurements, we cannot say anything about irrigation efficiency in this study. Collecting irrigated area measurements would be an interesting extension.

meant normalizing to no day of week restrictions. For Escambia, Indian River, Melbourne, Palm Coast, and Tallahassee no action is taken as no irrigation restrictions were in effect during the study period.

A case could be made that we should further normalize the Southwest Florida Water Management District utilities to no days per week restrictions—then all utilities would be on the same footing. We have no evidence to suggest what such an adjustment would be, however, so we made no such changes. The efficacy of irrigation restrictions depends on a variety of factors such as the publication, enforcement, and perceived need by customers of the restrictions. Each situation is somewhat different.

Regarding the mail survey data, we normalize persons and pools to profile averages over all utilities. Normalizing for number of persons (occupants) leads to only minor adjustments in GPD values. For profile 1 in Tallahassee we increase water use by 13% as its average persons of 1.91 is lower than the profile 1 norm of 2.25. Similarly, we boost Indian River profile 4 water use by 10% as its average persons of 2.36 is lower than the norm of 2.67. All other adjustments are less than +/- 10%.

For pools, the only changes amounting to more than 10% occurred with profile 1 with Spring Hill and profile 4 with Tallahassee. In the Spring Hill case, a large percentage (69%) of homes have pools relative to the norm of 15%. The opposite occurs with Tallahassee where only 18% have pools, and the norm is 63%.

We elect not to normalize for HOSE, MANUAL and SUB as these variables are correlated with water prices. Hence, it would be wrong to control for them. This is mainly true for SUB. As water prices increase, customers are much more likely to tap into source substitutes when available, thus reducing their utility water consumption. Controlling for SUB would mask the price responsiveness and so normalization in this fashion is not done.

4.3 Base Demand Model

A water demand model provides a mathematical description of how water use is correlated with price. In looking at graphical plots of normalized water use and price, we select a general set of models with a constant elasticity functional form. This type of model is widely used by economists in many research areas.

The standard constant elasticity model is shown below:

$$\text{WATER} = a * \text{PRICE}^{b} \tag{2}$$

where a and b are constants to be estimated.

Price elasticity is a common metric of customers' sensitivity to price. It can be viewed as the percentage change in quantity demanded resulting for a 1% change in price, all other factors held constant. For example, if a water price increase of 1% leads to a 0.5% reduction in water use, then price elasticity would be –0.5.

Using calculus, price elasticity is mathematically defined as:

$$\text{Price Elasticity} = \frac{\partial \text{WATER}}{\partial \text{PRICE}} \times \frac{\text{PRICE}}{\text{WATER}} \tag{3}$$

Using this price elasticity calculation on demand equation (2) produces the simple result of b. Hence, price elasticity equals the constant b over the entire demand curve.[19]

Demand theory states that price sensitivity increases when more substitutes are available. Hence, we extend demand equation (2) by adding a variable identifying utilities where source substitutes are not generally available or used. These utilities include Escambia, Hillsborough, Tampa, and Tallahassee.

$$\text{WATER}_u = a * \text{PRICE}_u^{\,(b + c^* \text{NOSUB}_u)} \tag{4}$$

where a, b and c are constants to be estimated separately for each profile and

NOSUB_u = 1 if source substitutes generally not available for utility u; 0 otherwise.

The appeal of this equation is that price elasticity is put into easily understandable terms, and that hypotheses of alternative factors impacting price elasticity can be checked. Taking equation (4) and calculating price elasticity leaves us with (5).

$$\text{Price Elasticity}_u = b + c^*\text{NOSUB}_u \tag{5}$$

Inclusion of the NOSUB variable allows us to measure the incremental change in price elasticity when no readily available substitutes to utility water are available for irrigation. Theoretically, we expect coefficient c to be positive. This implies customers are more price inelastic when substitutes are not readily available.

PRICE is not specifically defined in (4). If water utilities sold water at a single price, the question of price signal would be an easy one — it would be the singular water price. When

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[19] We considered and rejected using a linear functional form. Price elasticity for linear equations equals b*(PRICE/WATER). Because the PRICE/WATER ratio increases with increasing price, price elasticity is forced to increase with price—an unrealistic result to assume.

water is sold at multiple water prices, in contrast, we must identify the price or combination of prices to which customers respond. No consensus exists among researchers on specifying the price signal transmitted by block rates. In the next sections, we develop several price variables and model variations to get at this issue. We also explore how fixed charges and bill information might impact water use.

4.4 Average Price Models

Following the mail survey results suggesting customers' lack of pricing knowledge, we start with average price as the base price signal.

$AP_{u,p}$ = average price of water for utility u and profile p over the study period.

Calculating average price takes several steps. First, all prices are converted into 2004 dollars using the U.S. Bureau of Labor Statistics CPI index. Second, we tabulate the water use distribution in thousand gallons per month for each profile over all utilities. Figure 4-1 shows the composite distribution for the 14 utilities included in this analysis. The higher profiles tend to have higher water use values as expressed through their longer tails to the right. Next, for each profile/utility, we calculate average water prices in each billing period given the rate structure and the corresponding composite water use distribution.[20] Lastly, we average the results over the study period resulting in a price that exactly matches the water use observations in time. As part of this process we factor in water, sewer[21], and irrigation meter prices. We do not include fixed charges—only quantity charges. We do include associated taxes shown on the bill.

Using AP as the price variable in (4), we estimate the model coefficients for each profile using a numerical optimization algorithm.[22]

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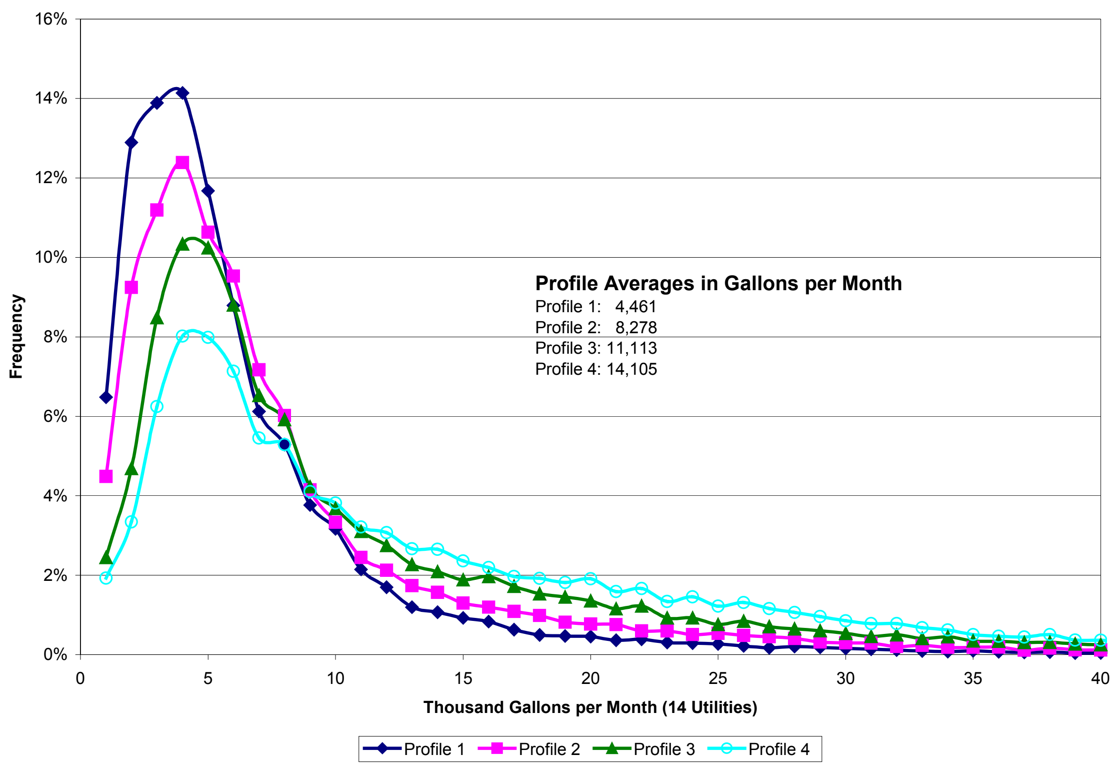
[20] We note that the price variables defined in this fashion avoid the complicated econometric issues associated with the endogenous relationship between block prices and water use. It also follows the quasi-experimental design philosophy of our approach. Namely, we have a group of homogeneous users with similar water use distributions, and we measure the water us change resulting from differing rate structures.

[21] For all 16 participating utilities, sewer customers have their sewer charges based on water use in some fashion.

[22] We use the variable metric method described by Judge, G., Griffiths, W., Hill, R., Lutkepohl, H., and Lee, T., *The Theory and Practice of Econometrics*, Second Edition, Wiley, pp. 958-960, 1985. We use the Shazam econometric software program for the estimation. As a check, we also take logarithms of both sides of the demand equation and estimate via ordinary least squares. Results did not materially differ.

Table 4-2 shows the results. We see a strong correlation between water use and average price. Price elasticity increases over profile 1 (–0.39), profile 2 (-0.54), and profile 3 (–1.00). Profile 4 breaks the trend by having a price elasticity of –0.73. This suggests homes at the top 10th percentile of wealth (profile 4) are less sensitive to price than those at the 75th percentile.

Figure 4-1. Composite Water Use Distribution



The lack of source substitutes significantly decreases price elasticity. Using equation (5), price elasticity drops to –0.26, -0.38, -0.73, and –0.43 for each profile respectively after adding the NOSUB coefficient. The model explains 75%, 80%, 82%, and 75% of the water use variation respectively, as denoted by the R^2 values.

Table 4-2 Average Price Model Estimates					
		AP Specification		AP Specification with BLOCK	
Profile	**Parameter**	**Estimate**	**T-Ratio**	**Estimate**	**T-Ratio**
1	a: Constant	337.25	14.641	335.03	15.870
	b: Price	-0.38945	-5.8191	-0.3282	-4.9833
	c: NOSUB	0.13173	2.1074	0.12864	2.3986
	d: BLOCK			-0.09373	-1.7722
	Model R^2	0.7486		0.7967	
2	a: Constant	490.32	14.416	490.50	14.266
	b: Price	-0.5358	-7.2873	-0.54514	-5.6947
	c: NOSUB	0.16044	2.0962	0.16246	2.0802
	d: BLOCK			0.01274	0.1567
	Model R^2	0.8027		0.8030	
3	a: Constant	1248	6.6662	1202.4	6.5389
	b: Price	-0.99996	-6.6299	-0.9301	-5.4000
	c: NOSUB	0.27132	2.9929	0.25474	2.8122
	d: BLOCK			-0.0587	-0.6972
	Model R^2	0.8236		0.8293	
4	a: Constant	1088.5	7.1639	1029.1	6.8623
	b: Price	-0.73464	-5.6294	-0.6349	-3.9937
	c: NOSUB	0.30284	3.641	0.28415	3.5076
	d: BLOCK			-0.0803	-0.92186
	Model R^2	0.7509		0.7654	

Given the objectives of this project, we vary equation (4) to test if the existence of an increasing block rate structure causes a decrease in water use. The average price specification does not address this issue. Two utilities can have the same average prices, but entirely different rate structures.

The test consists of a simple binary variable identifying utilities with increasing block water rates. The BLOCK variable is added to equation (4) in the same manner as the NOSUB variable.

$$WATER_u = a * PRICE_u^{(b + c^* NOSUB_u + d^*BLOCK_u)} \quad (6)$$

where d is an additional coefficient to estimate and

$BLOCK_u$ = 1 if utility u uses an increasing block water rate; 0 otherwise.

The BLOCK coefficient measures the change in price elasticity resulting from increasing block rates. Table 4-2 shows the results of the binary existence of increasing block rates (occurring at 8 utilities). For profile 1, the BLOCK coefficient is –0.09 and is significantly different from zero. For the other profiles, however, the BLOCK coefficient is not different from zero and takes on the wrong sign (positive) in profile 2. We conclude the mere existence of block rates does little to impact water use.

4.5 Models Measuring Efficacy of Block Pricing

Given the unconvincing results associated with the BLOCK variable, we deepen the analysis by assessing increasing block rates not as a binary variable, but in how block rates can create separation between average price and marginal price. Because of revenue constraints, utilities are limited in changing their average price. But through increasing block rates, utilities can maintain the same average price and increase marginal prices.

The inclusion of a variable measuring the difference between marginal and average prices is shown in equation (7).

$$WATER_u = a * (AP_u + \alpha * DIFF_u)^{(b + c * NOSUB_u)} \quad (7)$$

where,

$DIFF_{u,p}$ = $MP_{u,p} - AP_{u,p}$

$MP_{u,p}$ = weighted marginal price of water for utility u and profile p over the study period.[23]

The appeal of this model is that it can empirically test if average price, marginal price, or some combination of these two prices best explains observed water use.[24] The α coefficient determines

[23] We calculate weighted marginal price in a similar fashion as average price using the composite bill distribution for each utility. We take each water use observation, multiply it by its marginal water and, if applicable, sewer price, and then divide by total water use for that profile/utility. We exclude fixed charges.

[24] The concept of a MP-AP difference variable is discussed by J.J. Opaluch, "Urban Residential Demand for Water in the United States: Further Discussion." *Land Economics* (58) 1982; J. Shin, "Perception of Price When Information is Costly: Evidence from Residential Electricity Demand", *Review of Econometrics and Statistics* (67) 1985; D.L. Chicoine and G. Ramamurthy, "Evidence on the Specification of Price in the Study

the outcome. If α is zero, then equation (7) reduces to the AP model as the DIFF variable is not relevant. The upshot of this result is that increasing block rates are ineffective in changing the price signal—the differential does not matter. As α increases from 0 to 1, the DIFF variable becomes progressively important. At α equals 1, the separation between MP and AP is fully equivalent to an equal change in AP. It also means that MP is the only determining price factor. Lastly, it is possible for α to increase beyond 1. The interpretation of this event is that the DIFF variable creates a bonus reaction. This could be caused, for example, by "block targeters" (identified in Chapter 3) who give psychological meaning to block rates beyond the economic price signals involved.

Figure 4-2 shows the ability of equation 7 to fit the data (using R^2 as a measure) with α ranging from 0 to 2. The best fitting α for profiles 1 through 4 are 0.5, 1.1, 0.5 and 1.2, respectively. The α estimates are all statistically different from zero. Hence, we clearly reject the hypothesis that block rates have no impact on water use (α equals zero).

Rather, block rates are effective in reducing water use to the extent they create a positive differential between MP and AP. It is not the mere existence of block rates, but the differential that matters.

For profiles 1 and 3, α of 0.5 implies the best price specification is a simple average of AP and MP. It also implies half the MP-AP differential is added to AP to determine the price impact. For example, a utility with a single price of $2.00 adopts an increasing block rate structure that keeps AP at $2.00 but increases weighted MP to $3.00. Half of the MP-AP differential is $0.50. Hence, going to block rates is equivalent to increasing the single price from $2.00 to $2.50. In this example, the utility keeps the same average price but significantly increases the effective price signal sent via block rates.

For profiles 2 and 4, α of 1.1 and 1.2 imply customers are even more sensitive to the MP-AP differential. When α is 1, equation 7 reduces to a simple marginal price model. When α is greater than 1, the MP-AP differential receives a bonus effect beyond marginal price. We find, however, the 1.1 and 1.2 α estimates to not be significantly different from 1. Hence, we can accept the hypothesis that MP is the best price signal (α equals 1).

Extending our illustration where α equals 1, a utility with a single price of $2.00 adopts an increasing block rate structure that keeps AP at $2.00 but increases MP to $3.00. The MP-AP differential is $1.00. Hence, going to block rates is equivalent to increasing the single price from

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of Domestic Water Demand", *Land Economics* (62) 1986; and M.L. Nieswiadomy and D.L. Molina, "A Note on Price Perception in Water Demand Models", *Land Economics* (67) 1991.

$2.00 to $3.00. In this example, block rates are even more effective at increasing the price signal relative to profiles 1 and 3.

Figure 4-2. Model Fit and the DIFF Coefficient Alpha

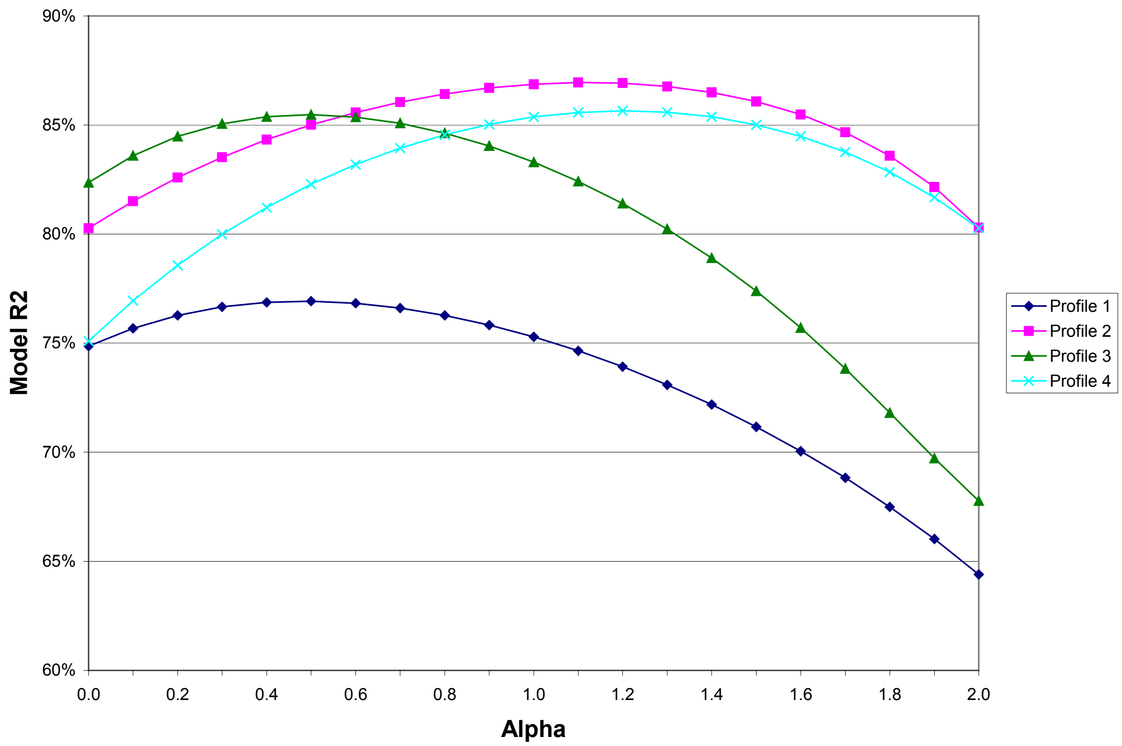

Table 4-3 shows the model results for α equal to 0.5, 1.0, 0.5 and 1.0 for the profiles respectively. For profiles 2 and 4 we use the 1.0 estimate as we accept the marginal price hypothesis.

Price elasticity ranges from –0.39 to –0.84 over the profiles. Price elasticity increases over profile 1 (–0.39), profile 2 (-0.51), and profile 3 (–0.84). Profile 4 breaks the trend by having a price elasticity of –0.56; homes at the top 10th percentile of wealth (profile 4) are less sensitive to price than those at the 75th percentile.

The availability of source substitutes plays a significant role in the price elastic response. With substitutes, customers have the ability to switch to cheaper sources of supply (e.g., irrigation wells) as water prices increase. For profile 1 and 2 customers, lack of source substitutes reduces price elasticity by a moderate 0.11 and 0.07 respectively. For profile 3 and 4 customers, lack of substitutes reduces price elasticity by 0.19 and 0.22 respectively.

Table 4-3 DIFF Price Model Estimates			
Profile	**Parameter**	**Estimate**	**T-Ratio**
1	a: Constant	341.48	14.809
	b: Price	-0.38566	-6.4207
	c: NOSUB	0.10708	1.8807
	α	0.5	
	Model R^2	0.7692	
2	a: Constant	490.06	18.361
	b: Price	-0.51210	-9.4511
	c: NOSUB	0.07312	1.0816
	α	1.0	
	Model R^2	0.8687	
3	a: Constant	997.35	9.8380
	b: Price	-0.83927	-7.8376
	c: NOSUB	0.19282	2.3941
	α	0.5	
	Model R^2	0.8547	
4	a: Constant	826.58	14.702
	b: Price	-0.55699	-8.0102
	c: NOSUB	0.22322	2.9738
	α	1.0	
	Model R^2	0.8537	

4.6 Fixed Charges and Bill Information

In contrast to the quantity charges that depend on how much water is used, utilities also use fixed charges to collect revenues from customers (all but Tampa do this). Demand theory states that fixed monthly charges should have minimal impact on the economic decision of how much water to purchase.[25] We, however, develop a fixed charge variable to investigate this point. Table 4-4 shows the average fixed charges over the study period.

$FIXED_{u,p}$ = average monthly fixed charge for all study homes in utility u and profile p over the study period. Includes water and, when applicable, sewer fixed charges.

As part of this project, we also explore if the information contained on the water/utility bill has any bearing on water use. We calculate a simple point system where more informative bills that focus only on water and sewer services get more points. We give a point for each of the following items shown on the bill as summarized in Table 4-4.

- historical water use
- separate fixed and quantity charges
- water prices
- absence of garbage and electrical charges

$BILLINFO_{u,p}$ = 0 to 4 depending on points awarded for more informative bills

We append the fixed price and bill information variables to model (7) to glean their potential impact using the following demand equations and the α shown in Table 4-4.

$$WATER_u = a * (AP_u + \alpha*DIFF_u)^{(b + c* NOSUB_u)} + d*FIXED_u \quad (8)$$

$$WATER_u = a * (AP_u + \alpha*DIFF_u)^{(b + c* NOSUB_u)} + e*BILLINFO_u \quad (9)$$

Coefficient d in the fixed charge model is nearly zero and not significantly different from zero in all cases. Clearly, fixed charges do not explain any of the variance in water use. This finding is consistent with prior expectations.

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[25] We note economic theory states that fixed charges can impact the level of disposable income available to customers to purchase their "basket" of goods. Hence, high fixed fees can mean a lower budget to purchase other goods, such as water. This income effect, however, is very minor in this circumstance. Even smaller is the income effect associated with the infra-marginal differences caused by rate structure differences as discussed be Nordin in "A Proposed Modification on Taylor's Demand Analysis: Comment", *The Bell Journal of Economics* (7) 1976. Hence, we did not include such a modification in this study.

Coefficient e in the bill information model is also near zero and not statistically significant in any case. This does not mean bill information could not be important, but for the utilities considered the information presented did not correlate with a change in water use.[26]

Table 4-4
Fixed Charges and Bill Information

Utility	$/Month	BILLINFO Score
Escambia	$15.83	0
Hillsborough	$20.80	4
Indian River	$17.25	2
Lakeland	$13.15	1
Melbourne	$10.20	0
Ocoee	$18.17	0
Palm Beach	$15.09	3
Palm Coast	$24.00	4
Sarasota	$28.47	3
Seminole	$19.45	2
Spring Hill	$8.38	4
St Petersburg	$12.71	2
Tallahassee	$19.81	1
Tampa	$0.00	2

Fixed charges averaged over study period and include a mix of meter sizes relevant to the utility/profile sample. They also include a mix of water and sewer charges as relevant.

4.7 Demand Models Using Other Price Specifications

So far, we restrict our analysis to average and marginal prices, and their combination. Other price specifications are also possible. The question becomes how to weight the array of prices across the spectrum of prices in a manner that best matches consumer behavior. We also look at a class of weighting systems providing heavier weight to prices at higher water use levels—this weighting system follows a lognormal distribution.

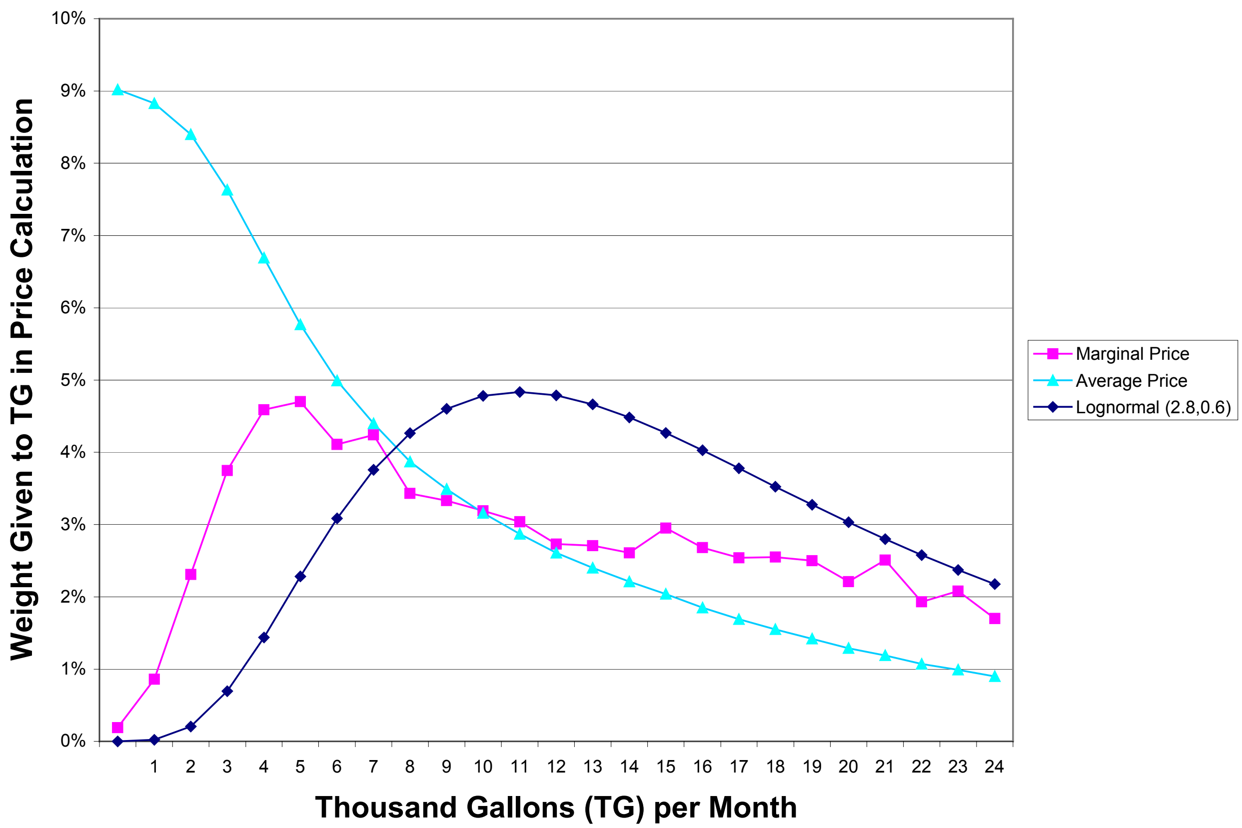
[26] The price information is very limited on the utility bills considered. Also the consumption information shown on the bill is limited—no utility shows average benchmark water use or other relative measures for comparison.

For example, the weights associated with the average, marginal, and lognormal-weighted prices for profile 3 are shown in Figure 4-3. The figure limits its view to weights associated with water use up to 25 thousand gallons per month, but continues on beyond what is shown. The three price options provide significantly different weighting schemes. Average price gives the most weight to the first few thousands of gallons consumed per month—51% of the total weight comes from prices equal to or below 6 thousand gallons per month. In comparison, the total weight associated with marginal price is 21% and with the lognormal weighting of price is 8% over the same water use range.

Our exploration did not lead to models that outperform the DIFF models at any profile level.

There is a point to be made from this analysis. The mail survey results show, in general, that customers are neither knowledgeable about rate structure details nor sophisticated in the level of cost analysis afforded water use decisions. We clearly see in the last section, however, that at least customers can distinguish between fixed and quantity charges—fixed charges having no measurable influence on customer water use. We also see, by the rejection of the AP price specification hypothesis, that customers are not strongly influenced by prices at low water use levels. Figure 4-3 highlights this point by the gap between the weights afforded MP and AP with the first few TG per month. Hence, customers are giving more weight to the higher, marginal units of water consumption. The lognormal weighting results show us that the weights provided to higher levels of consumption have limits. It is the weighting derived from the MP that appropriately fits real world behavior with profiles 2 and 4. For profiles 1 and 3, a hybrid between the MP and AP weighing distributions works best.

Figure 4-3. Composite Water Use Distribution



4.8 Price Elasticity and Price Level

The demand models assume price elasticity is constant over the entire price range—the range spans from about $1.00 to $9.50 per thousand gallons. In this section we investigate the appropriateness of this assumption.

Figures 4-4 through 4-7 plot the estimated demand curves for each profile; the individual utility points are also shown as a reference. Visual inspection suggests customers are less sensitive to prices when they exceed about $6 per thousand gallons. As price exceeds $6, additional water savings become progressively harder to achieve as customers have cut back to core water uses (e.g., indoor water for toilets, showers, clothes washers, and cooking). Customers' marginal utility from remaining water use is high, and hence they are less willing to make further water cuts in response to price increases.

To quantify this observation, we calculate price elasticity between points on the demand curve above $6. To measure price elasticity in such a way, economists commonly use what is referred to as an arc elasticity of demand, defined as:

$$\text{Arc Price Elasticity} = \frac{\text{WATER}_1 - \text{WATER}_2}{(\text{WATER}_1 + \text{WATER}_2)/2} \div \frac{\text{PRICE}_1 + \text{PRICE}_2}{(\text{PRICE}_1 + \text{PRICE}_2)/2} \quad (10)$$

Where WATER_1 and PRICE_1 are water demand and water price for one utility observation and WATER_2 and PRICE_2 represent another utility. Arc elasticity simply measures the average change in water use over the average change in price.

Of particular interest, we compare high price Sarasota (about $9 per thousand gallons) with a composite of Indian River, Melbourne, St Petersburg—utilities with average prices above $6 per thousand gallons. The resulting arc elasticities are shown in Table 4-5. Results find the arc elasticities to be lower than those estimated via the equation (7). In fact, for profile 3 the arc elasticity is positive.

Based on this data we suspect that price elasticities over about $6 per thousand gallons may be less elastic than reported by our regression models. Unfortunately, we do not have or does exist additional data observations on the very high price end of the spectrum to assist us in more rigorously testing this hypothesis.

Table 4-5
Arc Elasticity Comparison

	Profile			
	1	**2**	**3**	**4**
Arc Elasticity over $6	-0.34	-0.24	0.28	-0.42
Equation (7) Elasticity	-0.39	-0.51	-0.84	-0.56

4.9 Demand Model Conclusions

The demand models estimated in this chapter clearly show that water use decreases with increasing price, block rates impact water use, price elasticity increases with source substitutes, and fixed charges do not impact water use. Information on the utility bills considered, limited as it is, do not impact water use. Price elasticity appears to be less elastic over about $6 per TG, but we do not have enough information to make a definitive estimate.

Figure 4-4. Water Demand Curves: Profile 1 (GPHD)

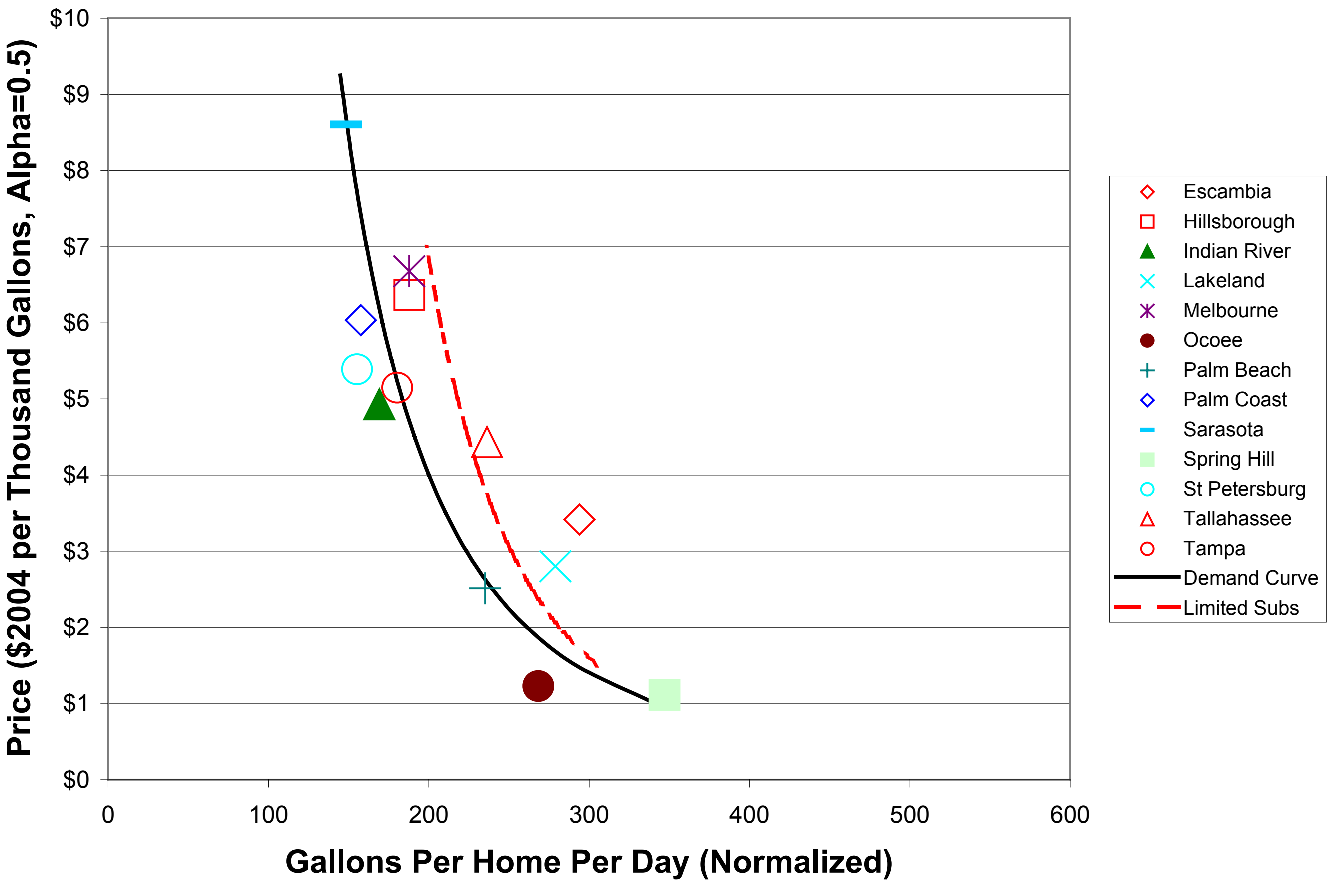


Figure 4-5. Water Demand Curves: Profile 2 (GPHD)

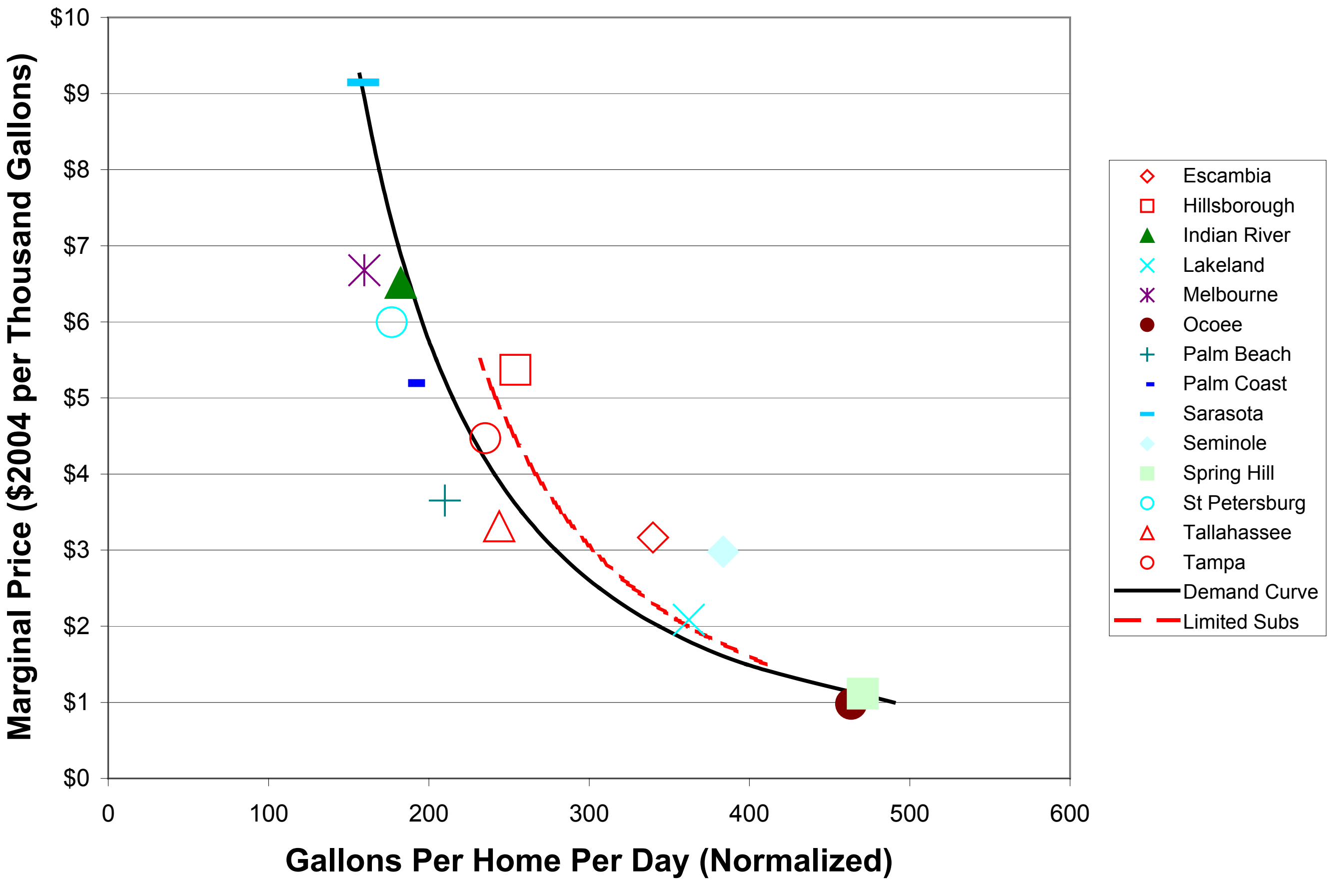


Figure 4-6. Water Demand Curves: Profile 3 (GPHD)

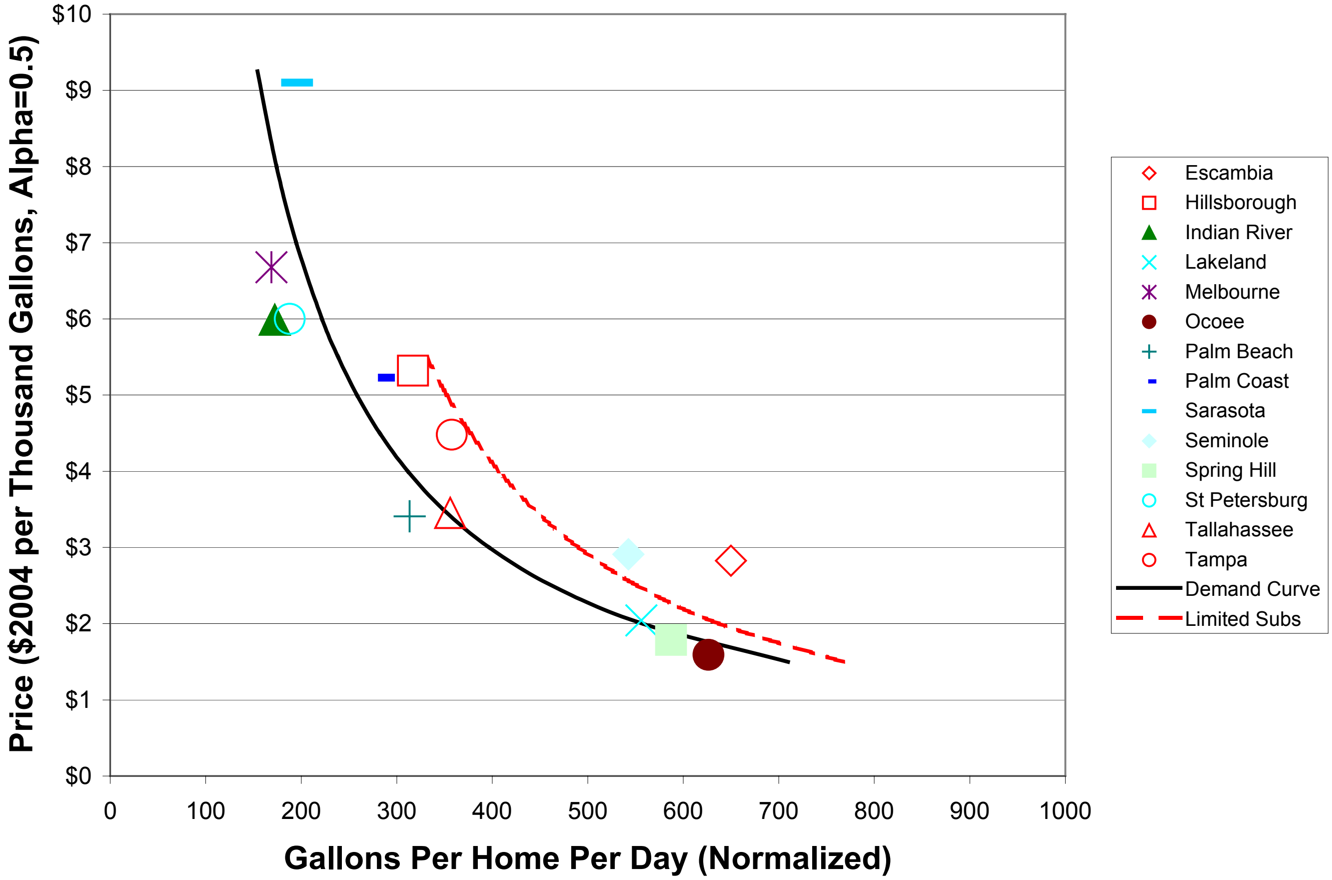
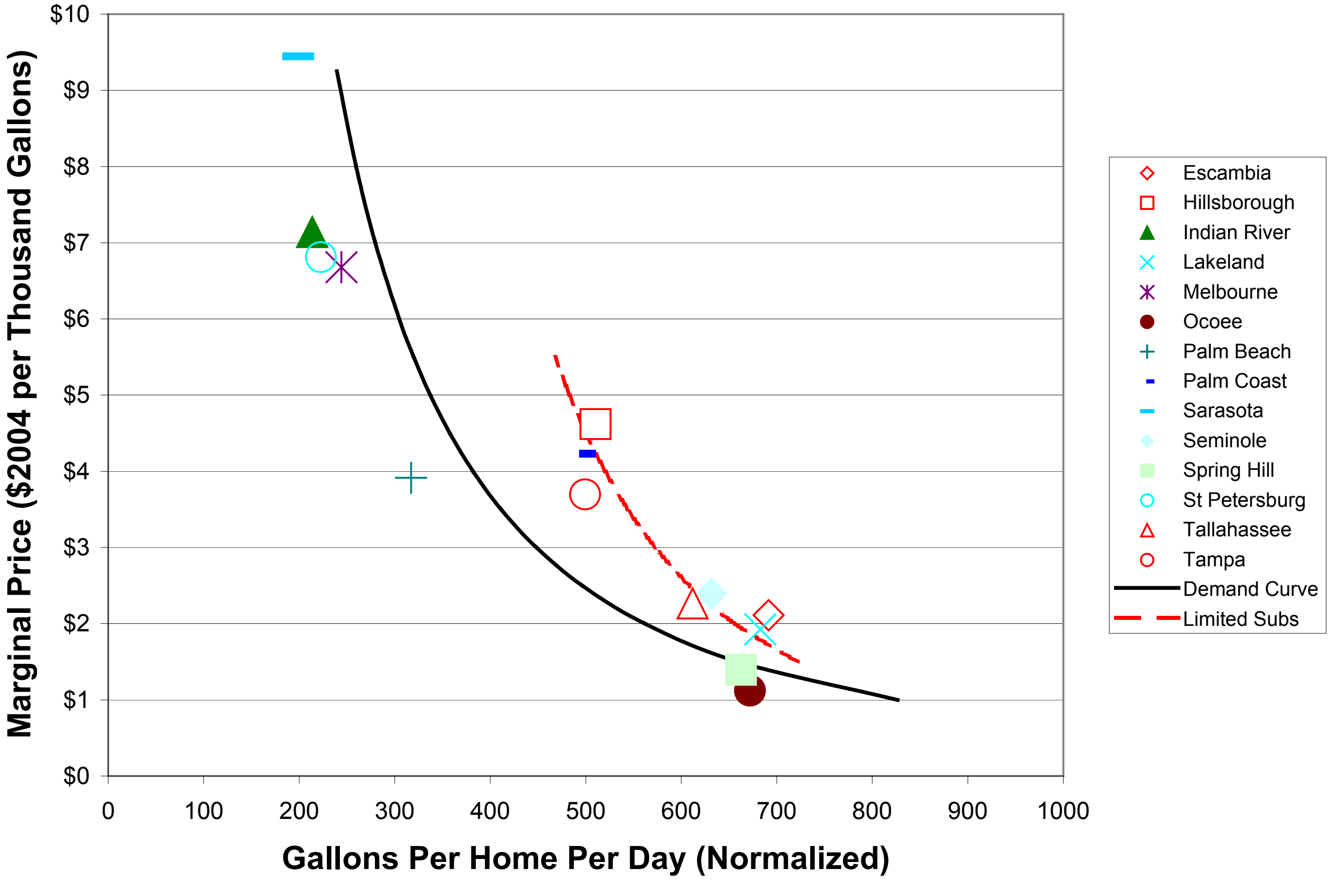


Figure 4-7. Water Demand Curves: Profile 4 (GPHD)



5. Conclusions and Comments

This chapter provides a summary of conclusions and comments associated with the mail survey and the water use analysis.

1. **Price Elasticity and Wealth**. This study's empirical evidence firmly supports the conclusion that water use decreases as price increases. Figure 5-1 shows the negative slope of the estimated water demand curve for each of the four profiles. Water use increases with wealth. For prices below \$2, water use for profile 3 and profile 4 homes is about the same. As price increases, however, profile 3 water use decreases at a much faster rate.

   Long-run elasticity ranges from –0.39 to –0.84 over the four wealth profiles. Price elasticity increases with wealth over profile 1 (–0.39), profile 2 (-0.51) and profile 3 (–0.84). Profile 4 breaks the trend by having a price elasticity of –0.56. This suggests homes at the top 10^{th} percentile of wealth (profile 4) are less sensitive to price than those at the 75^{th} percentile (profile 3).

Figure 5-1. Florida Water Demand Curves (GPHD)

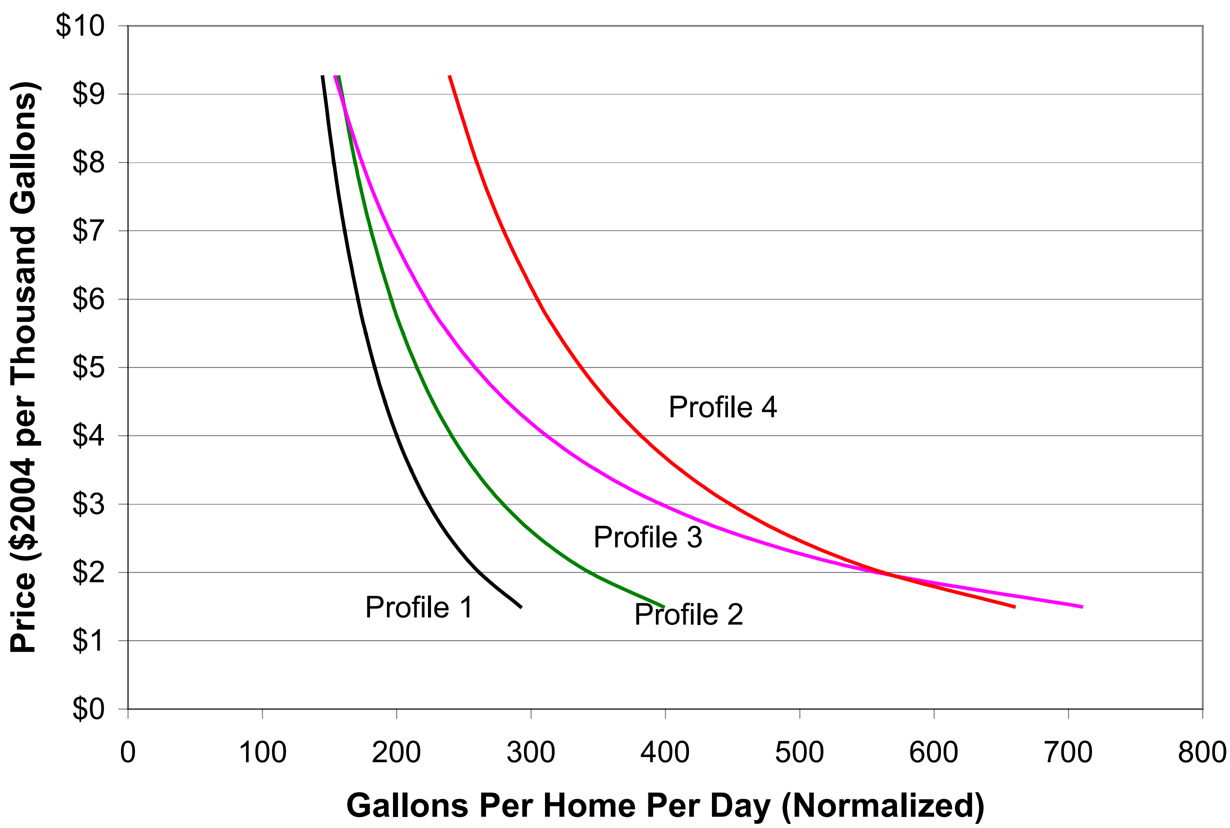
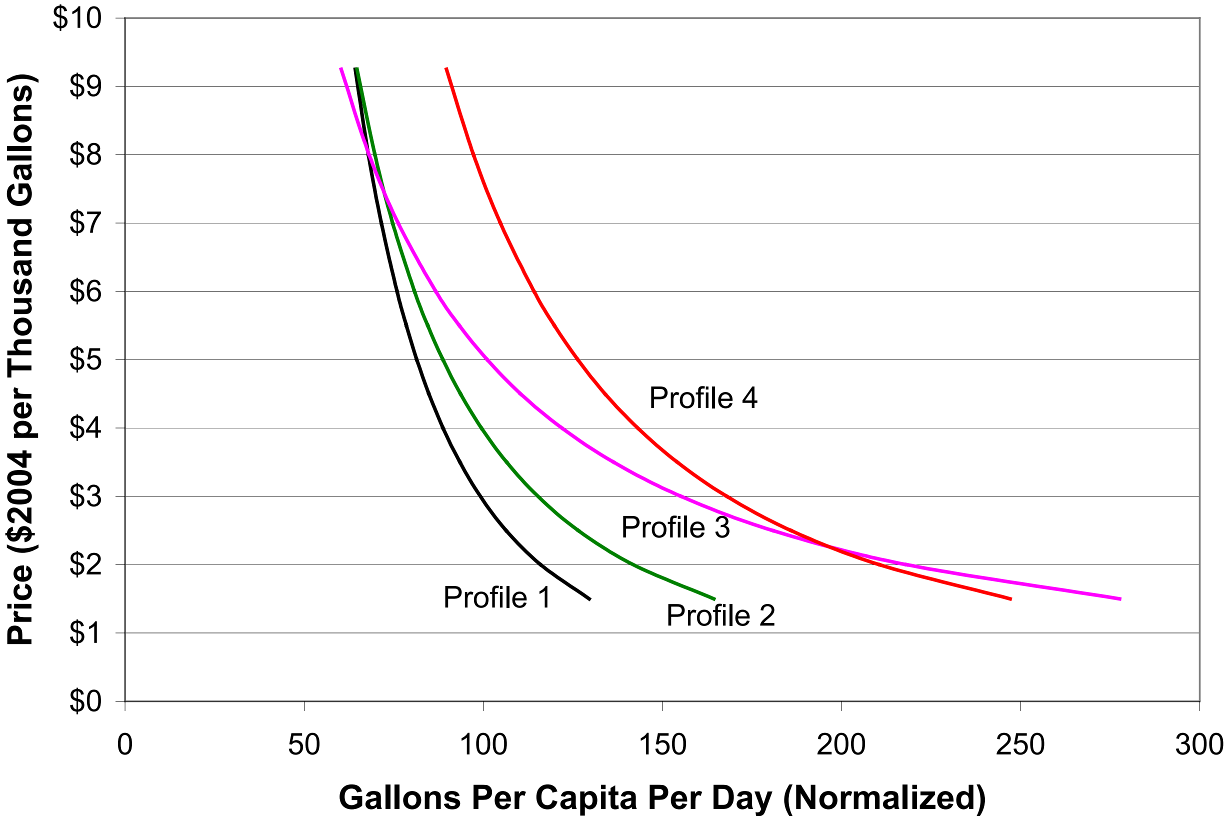


Figure 5-2 shows the same demand curves, but water use is converted to gallons per capita per day (GPCD)—a more common metric in Florida of gauging water use.

Figure 5-2. Florida Water Demand Curves (GPCD)



2. **Efficacy of Block Rates**. Increasing block water rates can reduce water use to the extent that they cause a positive differential between marginal and average price—the bigger the differential, the bigger the impact. 10 out of the 16 utilities participating in this study employed increasing block rates over the study period. Two others (Ocoee and Spring Hill) have recently converted from single price to increasing block water rates. The upshot to utilities is that they can use increasing block rates to increase the price signal sent to customers without necessarily changing their average price. This could be done by decreasing the price for the first few units of water consumed and increasing the price on higher levels of marginal water use.

3. **Source Substitutes**. Economic theory states price elasticity increases as more substitutes for a resource are available. Our results support this theory. With substitutes, customers have the ability to switch to cheaper sources of supply (e.g., irrigation wells) as utility water prices increase. Because of the frequent availability of source substitution, price elasticity tends to be higher in Florida than in other regions of the United States and world. In our sample of homes, 36% report tapping into a water source other than utility water for irrigation. For utilities where customers cannot readily access substitutes, customers are more inelastic. Lack of source substitutes reduces price elasticity by 28%, 14%, 23%, and 40% over the profiles respectively.

4. **Fixed Charges.** Empirical results show that fixed monthly service charges (independent of water use) have no correlation with water use. Hence, we conclude that customers can differentiate between fixed and variable charges on their water bills and in water use decisions. The upshot is that utilities can make revenue neutral changes in their rate structures, by decreasing fixed charges and increasing quantity charges, so as to increase the price signal and correspondingly lower total water consumption. The City of Tampa maximizes this strategy by collecting 0% from fixed charges and 100% from quantity charges.

5. **Long-Run Elasticity**. The price elasticity estimates generated in this study are long run in nature. All of the utilities had relatively constant prices and rate structures over our 1998 through 2003 study period after adjusting for inflation.[27] As a consequence, customers have had years to adjust their water using behavior, fixtures and landscaping to desired levels. Following the second law of demand in economic theory, short-run elasticities should be less elastic than the long-run elasticities reported here. It may take several years before the full impacts of water rate changes ripple completely through the customer base.

6. **Price Range**. The price range in our study spans from about $1.00 to $9.50 per thousand gallons. In our demand models, we use and estimate a model specification that assumes that price elasticity is constant over the entire price range. This looks to be a reasonable assumption given the data. We note, however, that price elasticity can change with price level. Of specific interest is price elasticity above about $6 per thousand gallons. As price exceeds $6, additional water savings become progressively harder to achieve as customers have cut back to core water uses (e.g., indoor water for toilets, showers, clothes washers, and cooking) or have accessed source substitutes. Customers' marginal utility from remaining utility water use is high, and hence they are less willing to make further water cuts in response to price increases. We would need additional data points in the high price range to better understand the degree that price elasticity might dampen with higher prices.

[27] We note that Toho that did change rate structures during the period is not included in the water use analysis because of lack of observations.

7. **Bill Information**. We use a simple point system to see if more informative bills (i.e., historical water use, separate fixed and quantity charges, water prices, absence of garbage and electrical charges) reduce water use. Our water use analysis is inconclusive on this matter. The mail survey results, however, show that including more information correlates with more informed customers, which in turn, correlates with greater quantitative introspection regarding water use.

8. **Irrigation System**. About half of homes have an in-ground irrigation system with automatic timer. Higher wealth homes are much more likely to have them. For example, 20% of profile 1 homes and 78% of profile 4 homes report having in-ground irrigation systems with timers.

9. **Concern of Water Costs**. Overall, 52% of customers report being strongly concerned about the cost of water and 80% report being either strongly or somewhat concerned. The level of concern tends to decrease with increasing wealth—62% of profile 1 and 43% of profile 4 customers are strongly concerned with water cost respectively. More customers are concerned about the cost of water used for outdoor irrigation than for indoor uses.

10. **Knowledge of Water Rates**. A majority of customers are knowledgeable when it comes to the average dollar amount of the water bill and the type of water rate structure. However, far fewer are familiar with details regarding the number, size and prices of the blocks. Using a composite of responses, 20% of customers report being strongly knowledgeable, 41% report being somewhat knowledgeable, and 39% report being not knowledgeable of rates.

11. **Cost Concerned but Not Knowledgeable**. 63% of homes are strongly or somewhat concerned, but not strongly knowledgeable about water rates. Hence, we conclude there is much room for customer education in this area.

12. **Cost Calculations**. Only 3% of homes report they mathematically quantify the cost savings associated with water use decisions—a calculation that requires both knowledge of the rate structure and the water use associated with a particular activity. We define 32% of homes as "approximators" that focus on the total dollar amount of past water bills to guess the dollar change that might occur from a given water use action. A majority of customers, 65%, admit they are "uncalculating" when it comes to water use decisions. These customers know their water bill will go down if they use less water, but do not make an active effort to estimate by how much.

13. **Block Targeters**. Given our research objective of better understand block rates, we note that 21% of customers with increasing block rates report they focus on reducing water use to stay below specific high priced rate blocks. These "block targeters" do not make explicit cost calculations, but are knowledgeable of the rate structure and use the block thresholds (e.g., 10,000 per month) as a not-to-exceed goal to avoid paying higher unit water prices. In the water use analysis, we see the possible impact of this group with profiles 2 and 4. Results

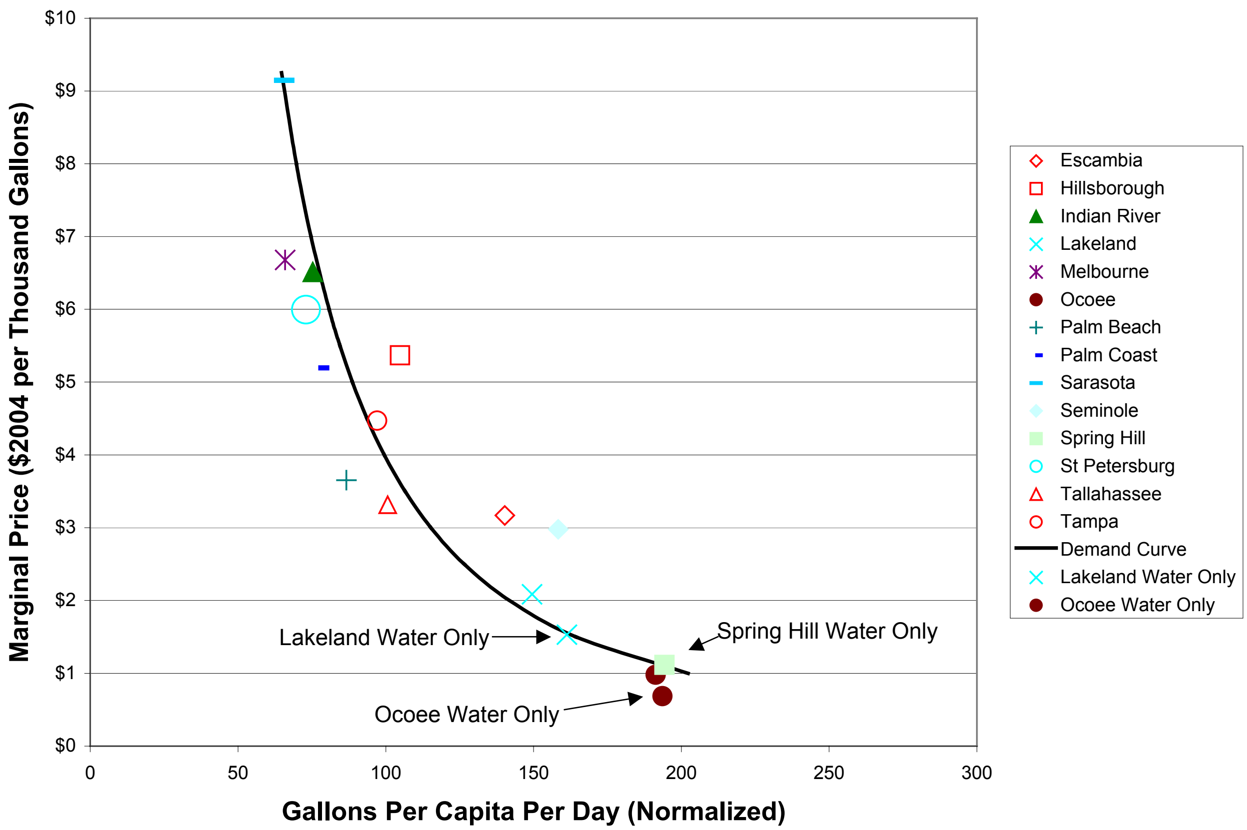
show that customers are more reactive to block rates beyond the economic price signals involved. Results for profile 1 and 3 homes, however, do not support this finding.

14. **Irrigation Restrictions**. For the SWFWMD utilities, average water reductions associated with going from 2-days to 1-day restrictions ranged from 9% to 20%, tending to be higher for the profile 3 and 4 customers that use more water for outside landscaping. Model results for Ocoee, Palm Beach, and Seminole show the intervention of going from no to 2-days per week restrictions is correlated with an average 11% to 19% reduction in water use.

15. **Water Only Customers**. In most metropolitan areas, the homes defined by the profiles we consider receive both water and sewer service. In some cases, homes have their own septic systems. We see this occurring to some degree for selected profiles in Hillsborough, Indian River, Lakeland, Spring Hill, and Ocoee. Inspection of water only customers show that they generally fall on the demand curve derived from the water and sewer customers. This is the expected result. Figure 5-3 shows water only customers for profile 2 (Lakeland, Ocoee, and Spring Hill) relative to the other water and sewer customers. We see no need (or do we have the data) to develop separate water only and water/sewer demand curves.

16. **Reclaimed Wastewater Customers**. This study focuses on the amount of potable water purchased by customers from a utility. Increasingly, reclaimed wastewater is being made available to customers in Florida for irrigation purposes. In this fashion, it is similar to irrigation wells as a potable source substitute. It has, however, a number of distinguishing differences related to its geographic availability and connection/pricing policies. For those customers in our dataset reporting being connected to a reclaimed wastewater system, we observe the amount of potable water purchased from the utilities equals what we would expect for indoor water use—about 50 to 70 GPCD. This is an obvious finding. What is not obvious is how reclaimed wastewater can impact the price elasticities of potable water use reported in this study. For customers already connected to reclaimed wastewater systems, changes in potable water/sewer prices can be expected to be muted as the price elasticities associated with indoor water use are known to be less than for outdoor use. For customers offered reclaimed wastewater in the future, potable water price elasticities can be significant as customers take advantage and substitute potable with reclaimed wastewater. The impact will depend on a number of specific conditions, such as the price differential between potable and reclaimed water and connection policies. This topic is worthy of additional research in the future.

Figure 5-3. Profile 2 Demand Curve with Water Only Observations (GPCD)



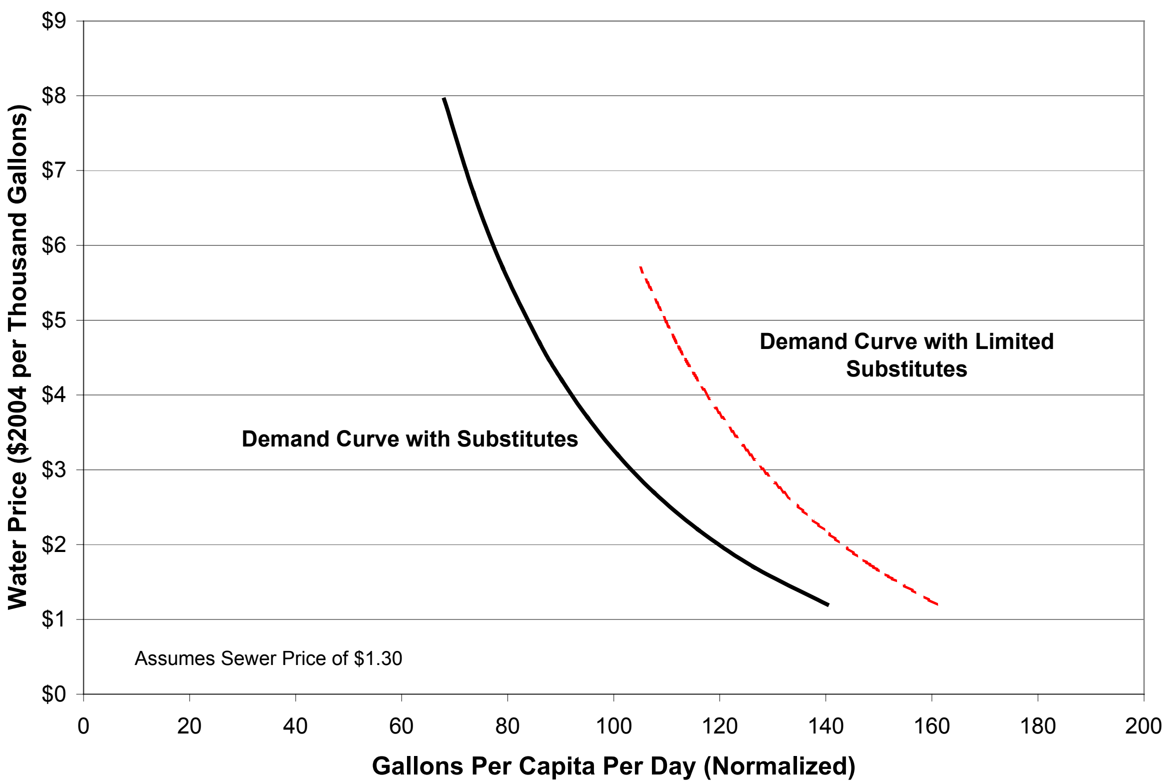
17. **Composite Water Demand Curve**. We develop demand curves for four distinct customer profiles—this approach serves the research purposes of this study. Undoubtedly, others will want to use this information to predict price impacts on specific utility circumstances. In doing this, one needs to combine and extrapolate the specific results from this study to the overall customer base. This will require weighting the results from our four profiles to best fit the distribution of customers served by a given utility. Table 5-1 shows an illustration of one calculation to this effect based on hypothetical circumstances.

Table 5-1
Composite Price Elasticity Illustration

Profile	**1**	**2**	**3**	**4**
Price Elasticity	-0.39	-0.51	-0.84	-0.56
Profile Weight	37.5%	25.0%	20.0%	17.5%
Composite Elasticity	-0.54			

Figure 5-4 shows a composite demand curve derived from Table 5-1. In this case, we only show water price on the vertical axis and assume the effective sewer price is $1.30 per thousand gallons—this is the effective average sewer marginal price over the study. This type of figure can assist decision makers in focusing on water price.

Figure 5-4. Composite Demand Curve Illustration (GPCD)



18. **Comparison with SWFWMD 1993 Report**.[28] The Southwest Florida Water Management District funded a water price elasticity study based on the analysis of water use from 1,200 homes from 10 water utilities over period 1988 to 1992. Because the analytic methods and base of customers analyzed are quite different, however, it is difficult to directly compare the results of that study with this study. Nevertheless, some of general findings are quite similar.

    The main similarity is in the general level of estimated price elasticity. Aggregate long-run price elasticities from the SWFWMD study range from –0.24 to –0.69. In this study, we estimate elasticities of –0.39, -0.51, –0.84, and –0.56 for each of our four profiles respectively.[29] Hence, the elasticities are not notably different.

19. **Comparison with Gibbs 1978 Report**.[30] This study examined water use of 355 homes in metropolitan Miami in 1973. Using a log-transformed model, price elasticity is estimated to be –0.51 and –0.62 using marginal and average price specifications respectively. Although the modeling approach and customer base for this study is completely different than that used in our study, the price elasticity results are similar.

20. **Comparison with Danielson 1979 Report**.[31] This study examined water use of 261 homes in Raleigh, North Carolina for the period 1969 to 1974. Using a log-transformed model, price elasticity is estimated to be –0.31 for indoor use and –1.38 for outdoor use using a marginal price specification. In aggregate, the results do not materially differ from the general price elasicities estimated here.

[28] *Water Price Elasticity Study*, August 1993 revised August 1999, Report prepared by Brown and Caldwell Consultants in association with John B. Whitcomb, PhD.

[29] This is for homes in utilities identified to have easy access to source substitutes—elasticities are less for the homes without ready access to substitutes. Also the price specifications used in the models are different. These points illustrate the difficulties in directly comparing the results.

[30] Gibbs. K.C., “Price Variable in Residential Water Demand Models”, *Water Resources Research,* 14(1), 15-18, 1978.

[31] Danielson, L.E., “An Analysis of Residential Demand for Water Using Micro Time-Series Data”, *Water Resources Research*, (15)4, 763-767, 1979.

Appendix A. Weather Formulas

We use the FOA-24 Blaney-Criddle method for estimating missing values of ET. This step gives us a complete set of daily ET values over the study period.

The Blaney-Criddle method in its original form used the mean air temperature and the monthly percentage of daylight hours. In the variation utilized in this study (FAO-24), the ET_O estimates are further refined by including average daytime wind speed, minimum relative humidity, and the ratio of possible to actual sunshine hours (Doorehbos and Pruitt, 1977). These refinements add considerably to the accuracy of Blaney-Criddle estimates (Jensen et al., 1990).

The FAO-24 Blaney-Criddle equation is as follows:

$$ET_o = a + bf,$$

where:

ET_o	= grass reference ET in mm d^{-1}
a	$= 0.0043\, RH_{\min} - n/N - 1.41$
b	$= a_o + a_1 RH_{\min} + a_2 n/N + a_3 Ud + a_4 RH_{\min}\, n/N + a_5 RH_{\min}\, Ud$
f	$= p(0.46T + 8.13)$
Rh_{min}	= minimum relative humidity in percentage
n/N	= ratio of possible to actual sunshine hours
T	= mean daily air temperature in EC
p	= the mean daily percent of annual daytime hours
Ud	= daytime wind speed at 2 m height in m s^{-1}.

The regression coefficients for *a0* through *a5* are:

$a0 =$	0.82
$a1 =$	-0.0041
$a2 =$	1.07
$a3 =$	0.066
$a4 =$	-0.006
$a5 =$	-0.0006.

We substituted the mean daily percent of annual daytime hours with mean daily percent of solar radiation as suggested by Shih (1981) for Florida. When comparing the two Blaney-Criddle results with the Penman-Montheith ET results where we had direct daily comparisons (24,862 observations), we found both Blaney-Criddle results were significantly greater than the Penman-

Montheith results. This difference can be related to underlying assumptions in crop coefficients and possibly because the Blaney-Criddle temperature observations come from the utility stations while the Penman-Montheith observations come from the FAWN stations. To minimize potential bias, we multiplied the Blaney-Criddle substitited ET values by the following correction matrix.

Table A-1
Blaney-Criddle to Penman-Montheith Correction Matrix

Utility	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Escambia	103%	93%	87%	86%	72%	62%	61%	61%	63%	61%	76%	87%
Hillsborough	75%	86%	86%	90%	83%	69%	70%	68%	66%	67%	63%	62%
Indian River	89%	97%	95%	97%	87%	70%	72%	74%	70%	73%	72%	71%
Lakeland	77%	90%	91%	94%	88%	74%	73%	72%	68%	73%	68%	67%
Melbourne	85%	93%	95%	96%	86%	69%	70%	73%	69%	72%	73%	73%
Miami Dade	83%	91%	94%	93%	80%	66%	70%	69%	69%	72%	71%	70%
Ocoee	89%	101%	99%	101%	95%	77%	77%	78%	72%	74%	72%	73%
Palm Beach	83%	91%	96%	95%	82%	67%	70%	70%	69%	73%	73%	71%
Palm Coast	79%	87%	90%	118%	75%	59%	59%	61%	58%	64%	62%	63%
Sarasota	80%	92%	92%	95%	89%	74%	68%	72%	70%	74%	69%	69%
Seminole	88%	98%	100%	100%	94%	76%	76%	76%	71%	73%	70%	72%
Spring Hill	142%	118%	105%	102%	90%	70%	67%	70%	73%	85%	97%	108%
St Petersburg	74%	86%	85%	89%	83%	69%	69%	68%	66%	67%	63%	61%
Tallahassee	169%	119%	87%	90%	74%	61%	60%	61%	65%	62%	82%	99%
Tampa	75%	86%	86%	90%	83%	69%	70%	68%	66%	67%	63%	62%
Toho	87%	97%	100%	101%	95%	77%	77%	77%	71%	73%	71%	71%

Daily precipitation was converted into daily effective precipitation using a soil moisture equation. In the equation the maximum amount of daily precipitation allowed to be effective equaled 0.32 inches (8.25 mm) plus ET for that day. The 0.315 inches maximum is based on a 6 inch root zone (150 mm), a 11% water available content (sand to sandy loam), and a 50% management allowed deficit (see Jensen et al., 1990, pp 21-24).

References

Doorehbos, J. and Pruitt, W.O. 1977. Guidelines for Predicting Crop Water Requirements. *FAO Irrig. and Drain. Paper No. 24, 2nd ed*. FAO Rome, Italy. 156 pp.

Jensen, M.E., Burman, R.D., and Allen, R.G. eds. 1990. "Evapotranspiration and Irrigation Water Requirements." *ASCE Manuals and Reports on Engineering Practice No. 70*, American Society of Civil Engineers, New York. 332 pp.

Shih, S.F., Allen, L.H., Jr., Hammond, L.C., Jones, J.W., Rogers, J.S., Smajstrala, A.G., 1981. "Comparison of Methods of Evapotranspiration Estimates." American Society of Agricultural Engineers Summer meeting, Orlando June 21-24 1981, Paper Number is 81-2015.

U.S. Department of Agriculture. (1941). "Climate and Man." *Yearbook of Agriculture 1941,* Washington, D.C. 1,248 pp.

Appendix B. Mail Survey Results

Mail survey responses based on 3,538 completed surveys from single-family homes served by 16 water utilities. These responses come only from homes matching our profile criteria within each profile/utility. Hence, they are not representative of the whole utility population.

Table B-1
House Characteristics by Utility and Profile

Group	Owner-Occupied Water Bill Payer	Year-Round Owner-Occupied Water Bill Payer
Lakeland	98%	96%
Melbourne	99%	97%
Ocoee	96%	96%
St. Petersburg	99%	97%
Tallahassee	98%	97%
Tampa	98%	97%
Escambia	96%	95%
Hillsborough	100%	99%
Indian River	97%	87%
Miami Dade	68%	68%
Palm Beach	96%	95%
Palm Coast	94%	91%
Sarasota	97%	93%
Seminole	98%	97%
Spring Hill	96%	91%
Toho	90%	90%
Profile 1	93%	92%
Profile 2	95%	94%
Profile 3	97%	95%
Profile 4	98%	95%
Total	96%	94%

Universe: 3,538 homes.

Table B-2
Irrigation Source by Utility and Profile

Group	Utility	Well	Surface	Reclaimed	Other
Lakeland	94%	2%	3%	0%	0%
Melbourne	21%	74%	3%	2%	0%
Ocoee	96%	2%	0%	0%	0%
St. Petersburg	21%	66%	1%	12%	0%
Tallahassee	100%	0%	0%	0%	0%
Tampa	87%	10%	0%	2%	1%
Escambia	91%	8%	0%	0%	0%
Hillsborough	94%	4%	0%	1%	1%
Indian River	24%	61%	9%	3%	3%
Miami Dade	72%	27%	0%	1%	0%
Palm Beach	43%	20%	32%	5%	0%
Palm Coast	50%	46%	2%	1%	2%
Sarasota	48%	42%	8%	1%	1%
Seminole	85%	6%	0%	4%	5%
Spring Hill	60%	32%	0%	3%	5%
Toho	61%	13%	2%	11%	13%
Profile 1	73%	24%	1%	1%	1%
Profile 2	65%	29%	4%	1%	1%
Profile 3	59%	30%	6%	5%	1%
Profile 4	62%	28%	6%	4%	1%
Total	64%	28%	4%	3%	1%

Universe: 3,521 homes (99.5%). Homes responding they do little or no irrigation put in utility category.

Table B-3
Type of Irrigation System by Utility and Profile

Group	In-Ground with Timer	In-Ground Manual	Hose	Do Not Irrigate	Rain Sensor	Soil Sensor
Lakeland	46%	26%	20%	7%	22%	0%
Melbourne	62%	13%	16%	9%	24%	0%
Ocoee	62%	14%	16%	7%	47%	2%
St. Petersburg	61%	15%	14%	10%	11%	0%
Tallahassee	7%	3%	78%	12%	3%	0%
Tampa	39%	18%	32%	10%	15%	1%
Escambia	60%	14%	20%	6%	15%	1%
Hillsborough	52%	10%	28%	10%	25%	2%
Indian River	62%	9%	19%	11%	30%	2%
Miami Dade	13%	13%	55%	19%	2%	0%
Palm Beach	64%	14%	18%	4%	16%	1%
Palm Coast	63%	12%	16%	9%	40%	1%
Sarasota	46%	8%	26%	20%	32%	0%
Seminole	68%	15%	14%	4%	41%	1%
Spring Hill	78%	4%	12%	6%	54%	1%
Toho	20%	11%	48%	21%	7%	2%
Profile 1	20%	14%	47%	20%	9%	0%
Profile 2	43%	13%	32%	12%	19%	1%
Profile 3	67%	12%	15%	5%	35%	1%
Profile 4	78%	11%	9%	3%	35%	1%
Total	53%	13%	25%	10%	25%	1%

Rain and soil sensor percentages calculated over homes with in-ground irrigation systems with timers.

Table B-4
Home Features by Utility and Profile

Group	Pool	Softener	Hot Tub	Faucet Leak	Toilet Leak	Sprinkler Broken
Lakeland	22%	11%	15%	8%	4%	5%
Melbourne	45%	9%	17%	6%	3%	2%
Ocoee	37%	14%	16%	4%	2%	2%
St. Petersburg	40%	10%	18%	5%	4%	2%
Tallahassee	11%	2%	10%	14%	6%	1%
Tampa	28%	13%	13%	5%	6%	3%
Escambia	23%	1%	15%	6%	7%	3%
Hillsborough	52%	24%	19%	5%	2%	4%
Indian River	40%	11%	15%	4%	3%	1%
Miami Dade	19%	7%	9%	6%	5%	1%
Palm Beach	35%	5%	16%	5%	4%	3%
Palm Coast	55%	12%	20%	2%	3%	1%
Sarasota	41%	10%	13%	3%	2%	1%
Seminole	49%	19%	16%	3%	1%	5%
Spring Hill	54%	21%	19%	4%	2%	2%
Toho	15%	6%	9%	6%	8%	2%
Profile 1	14%	7%	7%	8%	6%	2%
Profile 2	30%	11%	11%	6%	4%	2%
Profile 3	43%	11%	17%	4%	3%	3%
Profile 4	60%	15%	26%	3%	3%	3%
Total	37%	11%	15%	5%	4%	3%

Table B-5
Average Occupants per Home per Utility and Profile

Group	Persons	Kids	Adults	Seniors
Lakeland	2.49	0.48	1.42	0.59
Melbourne	2.62	0.52	1.49	0.61
Ocoee	2.75	0.74	1.76	0.26
St. Petersburg	2.47	0.50	1.51	0.46
Tallahassee	2.35	0.45	1.35	0.54
Tampa	2.62	0.62	1.58	0.42
Escambia	2.25	0.47	1.45	0.33
Hillsborough	2.71	0.64	1.81	0.25
Indian River	2.24	0.34	1.09	0.81
Miami Dade	3.18	0.50	1.98	0.71
Palm Beach	2.55	0.53	1.38	0.64
Palm Coast	2.11	0.26	0.96	0.90
Sarasota	2.41	0.37	1.16	0.88
Seminole	2.90	0.88	1.80	0.22
Spring Hill	2.31	0.37	1.29	0.65
Toho	1.99	0.35	1.32	0.32
Profile 1	2.30	0.41	1.36	0.54
Profile 2	2.45	0.48	1.45	0.52
Profile 3	2.63	0.55	1.51	0.57
Profile 4	2.68	0.58	1.52	0.58
Total	2.51	0.50	1.46	0.55

Universe: 3,410 homes (96%).

Table B-6
Annual Household Income per Utility and Profile

Group	<$15k	$15-30k	$30-45k	$50-75k	$75-100k	>$100k
Lakeland	2%	11%	15%	25%	12%	34%
Melbourne	5%	16%	23%	22%	17%	17%
Ocoee	5%	14%	21%	26%	17%	17%
St. Petersburg	4%	15%	21%	20%	13%	26%
Tallahassee	3%	13%	20%	22%	20%	23%
Tampa	4%	14%	20%	22%	13%	28%
Escambia	3%	10%	23%	25%	19%	19%
Hillsborough	1%	15%	15%	28%	22%	20%
Indian River	6%	19%	27%	26%	9%	13%
Miami Dade	19%	23%	20%	15%	5%	18%
Palm Beach	8%	14%	25%	25%	13%	15%
Palm Coast	7%	22%	25%	27%	9%	9%
Sarasota	5%	25%	27%	23%	11%	9%
Seminole	3%	8%	18%	27%	21%	23%
Spring Hill	9%	19%	30%	25%	10%	7%
Toho	15%	21%	36%	22%	4%	3%
Profile 1	14%	31%	27%	21%	5%	2%
Profile 2	5%	21%	31%	25%	12%	6%
Profile 3	3%	10%	21%	29%	17%	21%
Profile 4	1%	4%	11%	21%	20%	43%
Total	6%	16%	23%	24%	14%	18%

Universe: 3,221 homes (91%).

Table B-7
Without looking at past bills, I know the approximate dollar amount of my average (typical) monthly water bill in 2003.

Group	Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
Lakeland	25%	34%	9%	17%	15%
Melbourne	59%	29%	6%	4%	3%
Ocoee	55%	28%	9%	6%	4%
St. Petersburg	53%	34%	5%	4%	4%
Tallahassee	18%	33%	13%	16%	21%
Tampa	46%	38%	6%	5%	5%
Escambia	34%	42%	11%	9%	4%
Hillsborough	48%	42%	4%	3%	4%
Indian River	56%	26%	6%	6%	5%
Miami Dade	27%	41%	15%	10%	10%
Palm Beach	61%	29%	3%	3%	4%
Palm Coast	48%	35%	8%	6%	4%
Sarasota	54%	35%	5%	7%	3%
Seminole	48%	34%	9%	7%	4%
Spring Hill	50%	32%	11%	8%	4%
Toho	32%	41%	5%	8%	13%
Profile 1	44%	35%	9%	7%	7%
Profile 2	44%	34%	8%	7%	7%
Profile 3	46%	34%	8%	8%	5%
Profile 4	45%	35%	6%	9%	7%
Total	45%	34%	8%	8%	7%

Universe: 3,492 (99%) homes for utilities with increasing block water rates.

Table B-8
Without looking at past bills, I know the approximate number of gallons of water my household used during an average (typical) month in 2003.

Group	Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
Lakeland	11%	22%	14%	15%	37%
Melbourne	21%	17%	17%	16%	28%
Ocoee	16%	19%	17%	17%	30%
St. Petersburg	12%	29%	16%	15%	27%
Tallahassee	7%	24%	13%	22%	33%
Tampa	10%	23%	22%	18%	27%
Escambia	7%	18%	16%	16%	43%
Hillsborough	11%	35%	13%	22%	19%
Indian River	16%	21%	19%	14%	30%
Miami Dade	8%	20%	17%	12%	44%
Palm Beach	22%	21%	14%	12%	31%
Palm Coast	15%	19%	18%	18%	30%
Sarasota	23%	25%	18%	15%	19%
Seminole	9%	23%	10%	24%	34%
Spring Hill	16%	29%	17%	17%	20%
Toho	38%	22%	9%	13%	18%
Profile 1	19%	26%	19%	13%	23%
Profile 2	16%	25%	18%	16%	25%
Profile 3	13%	21%	16%	18%	33%
Profile 4	10%	20%	12%	19%	38%
Total	15%	23%	16%	17%	30%

Universe: 3,482 (98%) homes for utilities with increasing block water rates.

Table B-9
Before today, I knew that the unit price of water goes up as I use more water.

Group	Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
Lakeland	41%	15%	8%	8%	29%
Ocoee	56%	12%	4%	9%	18%
St. Petersburg	59%	15%	4%	6%	17%
Tampa	49%	20%	6%	11%	15%
Hillsborough	57%	16%	4%	8%	14%
Indian River	45%	12%	8%	8%	27%
Miami Dade	32%	20%	8%	9%	31%
Palm Beach	39%	13%	8%	6%	34%
Sarasota	68%	15%	3%	3%	10%
Seminole	44%	19%	8%	10%	19%
Toho	49%	6%	12%	9%	24%
Profile 1	54%	16%	8%	7%	15%
Profile 2	46%	17%	6%	9%	21%
Profile 3	46%	15%	6%	8%	25%
Profile 4	50%	12%	5%	7%	26%
Total	49%	15%	6%	8%	22%

Universe: 2,272 (64%) homes for utilities with increasing block water rates.

Table B-10
Before today, I knew that there are (x) different prices for water depending on how much I use.

Group	Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
Lakeland	19%	16%	12%	14%	39%
Ocoee	22%	17%	12%	14%	34%
St. Petersburg	22%	19%	17%	12%	31%
Tampa	9%	14%	20%	21%	35%
Hillsborough	23%	24%	12%	17%	25%
Indian River	16%	14%	15%	15%	39%
Miami Dade	8%	10%	14%	20%	47%
Palm Beach	19%	8%	18%	13%	43%
Sarasota	31%	19%	16%	11%	23%
Seminole	10%	17%	18%	16%	38%
Toho	25%	9%	19%	10%	36%
Profile 1	21%	14%	20%	15%	31%
Profile 2	17%	18%	14%	16%	35%
Profile 3	18%	15%	14%	16%	36%
Profile 4	19%	15%	14%	13%	40%
Total	19%	16%	15%	15%	35%

Universe: 2,266 (64%) homes for utilities with increasing block water rates.

Table B-11
Before today, I knew the specific water price(s) shown in the water-rate table.

Group	Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
Lakeland	5%	10%	15%	16%	55%
Melbourne	7%	14%	16%	17%	46%
Ocoee	7%	11%	16%	19%	46%
St. Petersburg	9%	13%	15%	14%	48%
Tallahassee	4%	9%	9%	15%	64%
Tampa	4%	6%	15%	22%	53%
Escambia	6%	7%	11%	19%	57%
Hillsborough	6%	10%	16%	23%	44%
Indian River	7%	11%	13%	15%	55%
Miami Dade	5%	10%	14%	20%	51%
Palm Beach	9%	7%	15%	12%	57%
Palm Coast	15%	19%	18%	15%	32%
Sarasota	13%	18%	20%	14%	36%
Seminole	6%	12%	17%	16%	49%
Spring Hill	28%	18%	20%	10%	24%
Toho	14%	9%	23%	10%	43%
Profile 1	12%	14%	17%	16%	41%
Profile 2	9%	13%	16%	15%	47%
Profile 3	9%	10%	15%	18%	48%
Profile 4	7%	10%	14%	15%	54%
Uniform Rates	12%	14%	15%	15%	45%
Increasing Block Rates	8%	11%	16%	16%	49%
Total	9%	12%	16%	16%	48%

Universe: 3,463 (98%) homes.

Table B-12
Before today, I knew the gallons associated with each unit water price.

Group	Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
Lakeland	9%	8%	14%	15%	54%
Ocoee	5%	13%	19%	18%	45%
St. Petersburg	8%	10%	18%	15%	48%
Tampa	5%	8%	16%	21%	49%
Hillsborough	7%	17%	16%	21%	41%
Indian River	7%	8%	13%	16%	56%
Miami Dade	6%	13%	14%	17%	50%
Palm Beach	11%	5%	16%	15%	53%
Sarasota	14%	16%	21%	13%	36%
Seminole	8%	11%	16%	15%	50%
Toho	11%	10%	29%	13%	36%
Profile 1	12%	12%	20%	18%	38%
Profile 2	8%	13%	18%	17%	45%
Profile 3	8%	9%	14%	17%	52%
Profile 4	6%	9%	15%	15%	55%
Total	8%	11%	17%	17%	47%

Universe: 2,254 (64%) homes for utilities with increasing block water rates.

Table B-13
I take into account the cost of wastewater(sewer) service when deciding how much water to use.

Group	Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
Lakeland	19%	21%	21%	14%	25%
Melbourne	29%	23%	22%	9%	17%
Ocoee	27%	22%	24%	16%	11%
St. Petersburg	21%	26%	24%	15%	14%
Tallahassee	16%	23%	21%	19%	20%
Tampa	17%	26%	27%	13%	17%
Escambia	25%	30%	24%	12%	9%
Hillsborough	19%	23%	28%	18%	13%
Indian River	32%	20%	20%	17%	12%
Miami Dade	46%	15%	20%	10%	9%
Palm Beach	21%	15%	33%	10%	21%
Palm Coast	29%	26%	20%	12%	12%
Sarasota	38%	24%	23%	7%	8%
Seminole	26%	25%	26%	12%	11%
Spring Hill	23%	22%	22%	12%	20%
Toho	42%	22%	19%	9%	8%
Profile 1	33%	22%	26%	8%	11%
Profile 2	28%	25%	21%	13%	13%
Profile 3	24%	23%	24%	15%	14%
Profile 4	21%	21%	24%	17%	18%
Total	27%	23%	24%	13%	14%

Universe: 2,759 (78%) homes with sewer service.

Table B-14
Water cost is important to me when deciding how much water to use indoors (e.g., dish washing, clothes washing, showering/bathing, toilets).

Group	Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
Lakeland	24%	32%	22%	10%	12%
Melbourne	35%	27%	20%	9%	9%
Ocoee	41%	24%	18%	10%	7%
St. Petersburg	36%	33%	13%	12%	7%
Tallahassee	21%	26%	18%	19%	16%
Tampa	29%	30%	21%	9%	10%
Escambia	27%	35%	18%	9%	10%
Hillsborough	36%	35%	16%	7%	6%
Indian River	35%	26%	21%	10%	8%
Miami Dade	47%	29%	12%	8%	5%
Palm Beach	33%	24%	20%	13%	10%
Palm Coast	51%	23%	15%	7%	3%
Sarasota	46%	26%	15%	7%	6%
Seminole	31%	29%	21%	12%	7%
Spring Hill	44%	26%	17%	7%	6%
Toho	38%	35%	16%	6%	5%
Profile 1	44%	28%	15%	6%	7%
Profile 2	39%	29%	17%	9%	7%
Profile 3	33%	30%	19%	10%	9%
Profile 4	28%	27%	20%	14%	11%
Total	36%	29%	18%	10%	8%

Universe: 3,506 (99%) homes.

Table B-15
Water cost is important to me when deciding how much water to use outdoors to irrigate our lawn/landscape.

Group	Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
Lakeland	40%	29%	14%	8%	9%
Melbourne	39%	17%	18%	9%	17%
Ocoee	51%	29%	10%	4%	6%
St. Petersburg	44%	22%	13%	6%	14%
Tallahassee	31%	37%	10%	13%	10%
Tampa	35%	34%	17%	6%	9%
Escambia	42%	38%	11%	4%	4%
Hillsborough	58%	30%	6%	4%	2%
Indian River	46%	14%	16%	9%	15%
Miami Dade	50%	27%	12%	5%	7%
Palm Beach	46%	20%	15%	3%	16%
Palm Coast	59%	17%	9%	6%	8%
Sarasota	55%	12%	15%	6%	12%
Seminole	49%	29%	12%	6%	4%
Spring Hill	51%	20%	19%	4%	6%
Toho	51%	28%	13%	5%	3%
Profile 1	56%	22%	11%	3%	8%
Profile 2	51%	22%	12%	6%	8%
Profile 3	44%	26%	14%	7%	9%
Profile 4	35%	29%	15%	8%	12%
Total	47%	25%	13%	6%	9%

Universe: 3,420 (97%) homes.

Table B-16
In past situations where water price influenced you to use less water, which one of the following best describes your thinking?

Group	1	2	3	4	5	6
Lakeland	25%	44%	21%	10%	0%	0%
Ocoee	15%	41%	22%	18%	1%	2%
St. Petersburg	17%	45%	21%	15%	0%	2%
Tampa	20%	47%	18%	14%	0%	0%
Hillsborough	10%	45%	28%	16%	0%	1%
Indian River	23%	41%	13%	21%	1%	1%
Miami Dade	14%	54%	13%	16%	3%	0%
Palm Beach	26%	39%	19%	15%	1%	0%
Sarasota	12%	42%	25%	19%	2%	1%
Seminole	18%	42%	20%	19%	1%	1%
Toho	23%	44%	22%	7%	2%	2%
Profile 1	16%	47%	20%	15%	1%	1%
Profile 2	19%	40%	19%	20%	2%	0%
Profile 3	17%	47%	21%	13%	1%	2%
Profile 4	21%	43%	20%	15%	1%	1%
Total	18%	44%	20%	16%	1%	1%

Universe: 2,064 homes from utilities with increasing block water rates.
Response Key:

1. Not applicable/I have never really thought about water prices.
2. I knew my water bill would go down if I used less water, but I did not take the time to estimate by how much.
3. I knew I could avoid paying the higher unit water prices if I used less water, but I did not take the time to estimate the $ savings of such actions.
4. I thought about the total dollar amount of my past water bills to guess how much my water bill might change if I used less water.
5. I estimated about how many gallons of water I would probably save, and calculated my water bill dollar savings using an average water price.
6. I estimated about how many gallons of water I would probably save, and calculated my water bill dollar savings using the unit prices for different levels of water use.

Table B-17
In past situations where water price influenced you to use less water, which one of the following best describes your thinking?

Group	1	2	3	4
Melbourne	18%	54%	25%	3%
Tallahassee	29%	56%	14%	1%
Escambia	15%	56%	27%	3%
Palm Coast	12%	56%	26%	6%
Spring Hill	19%	48%	25%	8%
Profile 1	16%	56%	23%	4%
Profile 2	24%	53%	19%	4%
Profile 3	16%	54%	25%	5%
Profile 4	18%	53%	25%	3%
Total	19%	54%	23%	4%

Universe: 1,193 homes from utilities with single price water rates.
Response Key:

1. Not applicable/I have never really thought about water prices.
2. I knew my water bill would go down if I used less water, but I did not take the time to estimate by how much.
3. I thought about the total dollar amount of my past water bills to guess how much my water bill might change if I used less water.
4. I estimated about how many gallons of water I would probably save, and calculated my water bill savings using the water price.

Table B-18
I have taken specific actions to lower my water use to avoid paying the higher water prices.

Group	Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
Lakeland	20%	26%	23%	12%	19%
Ocoee	28%	35%	19%	8%	11%
St. Petersburg	30%	28%	20%	11%	12%
Tampa	20%	30%	28%	9%	12%
Hillsborough	30%	32%	20%	10%	8%
Indian River	26%	24%	24%	12%	14%
Miami Dade	35%	31%	17%	8%	9%
Palm Beach	28%	23%	21%	9%	19%
Sarasota	39%	29%	20%	6%	6%
Seminole	21%	27%	25%	12%	14%
Toho	34%	31%	14%	5%	17%
Profile 1	32%	31%	20%	7%	10%
Profile 2	31%	29%	20%	7%	12%
Profile 3	26%	26%	23%	10%	14%
Profile 4	23%	29%	21%	12%	16%
Total	28%	29%	21%	9%	13%

Universe: 2,267 homes from utilities with increasing block water rates.

Table B-19
The water pricing system in the water-rate table is effective in getting me to conserve water.

Group	Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
Lakeland	15%	28%	30%	15%	12%
Melbourne	14%	23%	42%	10%	11%
Ocoee	24%	26%	31%	9%	10%
St. Petersburg	17%	31%	28%	15%	8%
Tallahassee	9%	18%	44%	15%	14%
Tampa	11%	26%	40%	12%	12%
Escambia	10%	23%	43%	13%	11%
Hillsborough	16%	39%	24%	11%	9%
Indian River	21%	28%	33%	11%	8%
Miami Dade	19%	27%	34%	10%	10%
Palm Beach	22%	23%	31%	10%	14%
Palm Coast	20%	24%	37%	11%	8%
Sarasota	25%	29%	29%	8%	9%
Seminole	15%	32%	31%	14%	8%
Spring Hill	19%	26%	37%	11%	7%
Toho	31%	28%	19%	12%	10%
Profile 1	21%	29%	35%	7%	9%
Profile 2	21%	26%	31%	12%	10%
Profile 3	15%	26%	36%	13%	10%
Profile 4	14%	28%	33%	14%	12%
Uniform Rates	14%	23%	41%	12%	10%
Increasing Block Rates	20%	29%	30%	12%	10%
Total	18%	27%	34%	12%	10%

Universe: 3,464 homes (98%).

Table B-20
I believe I should pay the same unit price for each gallon of water no matter how much I use.

Group	Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
Lakeland	26%	11%	16%	18%	30%
Melbourne	33%	20%	21%	15%	11%
Ocoee	32%	16%	16%	17%	19%
St. Petersburg	22%	9%	21%	16%	33%
Tallahassee	25%	24%	20%	15%	16%
Tampa	27%	16%	18%	18%	22%
Escambia	28%	15%	30%	14%	13%
Hillsborough	21%	22%	18%	16%	23%
Indian River	32%	15%	18%	17%	19%
Miami Dade	36%	22%	14%	13%	15%
Palm Beach	42%	10%	17%	14%	18%
Palm Coast	31%	16%	17%	13%	23%
Sarasota	34%	14%	16%	12%	24%
Seminole	26%	16%	12%	19%	26%
Spring Hill	26%	25%	19%	19%	12%
Toho	30%	18%	23%	17%	12%
Profile 1	35%	17%	19%	12%	18%
Profile 2	28%	18%	18%	16%	20%
Profile 3	29%	17%	17%	17%	20%
Profile 4	26%	15%	19%	18%	22%
Uniform Rates	28%	20%	21%	15%	15%
Increasing Block Rates	30%	15%	17%	16%	22%
Total	29%	17%	18%	16%	20%

Universe: 3,456 homes (98%).

Table B-21
The information on my monthly bill does a good job of explaining my water rates and charges.

Group	Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
Lakeland	20%	28%	33%	11%	8%
Melbourne	29%	32%	26%	9%	4%
Ocoee	22%	32%	26%	9%	12%
St. Petersburg	25%	35%	25%	10%	6%
Tallahassee	26%	35%	25%	11%	3%
Tampa	17%	26%	31%	16%	11%
Escambia	21%	32%	32%	11%	5%
Hillsborough	33%	32%	23%	9%	3%
Indian River	26%	23%	30%	13%	8%
Miami Dade	20%	34%	28%	8%	10%
Palm Beach	25%	28%	28%	8%	11%
Palm Coast	39%	32%	20%	6%	3%
Sarasota	37%	31%	24%	4%	4%
Seminole	15%	33%	35%	10%	7%
Spring Hill	35%	34%	23%	5%	2%
Toho	27%	35%	23%	3%	11%
Profile 1	30%	29%	25%	9%	6%
Profile 2	27%	33%	24%	9%	7%
Profile 3	26%	32%	28%	8%	6%
Profile 4	20%	31%	31%	11%	7%
Uniform Rates	30%	33%	25%	8%	4%
Increasing Block Rates	24%	31%	28%	9%	8%
Total	26%	31%	27%	9%	7%

Universe: 3,470 homes (98%).

Table B-22
I believe my current water rates are too complicated.

Group	Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
Lakeland	10%	11%	45%	19%	15%
Melbourne	5%	14%	43%	19%	19%
Ocoee	11%	16%	37%	23%	13%
St. Petersburg	7%	12%	41%	20%	19%
Tallahassee	4%	10%	36%	29%	21%
Tampa	11%	18%	38%	22%	10%
Escambia	8%	14%	45%	20%	13%
Hillsborough	8%	14%	38%	22%	19%
Indian River	8%	11%	48%	14%	19%
Miami Dade	14%	22%	41%	8%	14%
Palm Beach	12%	9%	38%	18%	22%
Palm Coast	6%	12%	39%	21%	23%
Sarasota	12%	19%	32%	18%	19%
Seminole	6%	16%	46%	21%	12%
Spring Hill	7%	11%	39%	23%	21%
Toho	7%	15%	41%	21%	17%
Profile 1	10%	15%	41%	18%	17%
Profile 2	7%	13%	41%	20%	18%
Profile 3	10%	12%	39%	22%	17%
Profile 4	7%	15%	41%	19%	17%
Uniform Rates	6%	12%	40%	22%	19%
Increasing Block Rates	10%	15%	40%	19%	16%
Total	9%	14%	40%	20%	17%

Universe: 3,459 homes (98%).

Table B-23
I conserve water mainly for environmental reasons.

Group	Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
Lakeland	28%	38%	22%	4%	9%
Melbourne	30%	36%	24%	5%	5%
Ocoee	29%	32%	28%	6%	4%
St. Petersburg	41%	33%	19%	4%	3%
Tallahassee	28%	37%	22%	8%	5%
Tampa	32%	33%	23%	6%	5%
Escambia	23%	32%	32%	8%	6%
Hillsborough	35%	32%	22%	7%	4%
Indian River	33%	34%	21%	5%	7%
Miami Dade	41%	29%	17%	6%	7%
Palm Beach	39%	30%	20%	4%	6%
Palm Coast	37%	29%	22%	7%	5%
Sarasota	39%	34%	21%	4%	3%
Seminole	28%	40%	21%	6%	5%
Spring Hill	40%	32%	21%	5%	2%
Toho	39%	37%	15%	6%	4%
Profile 1	36%	30%	23%	5%	6%
Profile 2	33%	35%	21%	6%	5%
Profile 3	32%	34%	23%	5%	4%
Profile 4	33%	33%	21%	7%	5%
Total	34%	33%	22%	6%	5%

Universe: 3,477 homes (98%).

Table B-24
Water Cost Evaluation Level

Group	1	2	3	4	5	6
Lakeland	0%	4%	1%	3%	9%	84%
Melbourne	3%	NA	6%	8%	10%	73%
Ocoee	4%	4%	6%	5%	11%	70%
St. Petersburg	2%	7%	3%	6%	7%	74%
Tallahassee	1%	NA	4%	2%	9%	85%
Tampa	1%	3%	2%	6%	8%	80%
Escambia	3%	NA	3%	7%	17%	71%
Hillsborough	2%	9%	7%	6%	8%	68%
Indian River	2%	3%	5%	4%	14%	72%
Miami Dade	3%	1%	3%	6%	9%	79%
Palm Beach	2%	4%	2%	4%	12%	77%
Palm Coast	6%	NA	5%	8%	12%	68%
Sarasota	3%	12%	6%	10%	6%	63%
Seminole	1%	5%	4%	6%	13%	71%
Spring Hill	9%	NA	9%	7%	7%	68%
Toho	4%	12%	2%	0%	6%	76%
Profile 1	3%	5%	4%	6%	9%	73%
Profile 2	3%	4%	4%	7%	11%	71%
Profile 3	4%	3%	5%	5%	9%	75%
Profile 4	2%	3%	5%	5%	10%	75%
Single Price	4%	NA	5%	6%	11%	73%
Block Rates	2%	6%	4%	5%	9%	74%
Total	3%	4%	4%	6%	10%	74%

Universe: 3,242 homes (92%).
Response Key:
1. Quantifier
2. Block Targeter
3. Approximator – Knowledgeable
4. Approximator – Somewhat Knowledgeable
5. Approximator – Not Knowledgeable
6. Uncalculating

NA. Not applicable to utilities with single price rates.

Appendix C. Non-Price Regressions

		Profile 1		Profile 2		Profile 3		Profile 4	
Utility	VARIABLE	ESTIMATE	T-RATIO	ESTIMATE	T-RATIO	ESTIMATE	T-RATIO	ESTIMATE	T-RATIO
Escambia	CONSTANT	40	2.40	200	13.82	97	4.31	143	5.11
Escambia	HOSE	-61	-5.49	-162	-12.14	39	0.85	-395	-9.60
Escambia	MANUAL	-86	-4.00	-82	-4.17	-53	-2.45	-91	-3.34
Escambia	NIRPD	1488	16.78	2600	22.82	4863	29.96	5626	28.52
Escambia	PERSONS	77	10.01	13	3.03	53	7.41	56	7.50
Escambia	POOL	129	6.05	-13	-0.74	82	4.50	109	5.68
Escambia	SUB			-77	-4.07			-124	-4.06
Escambia	RHO	1	51.96	0	34.57	0	31.57	0	31.44
Escambia	R-SQUARE	0.49		0.39		0.35		0.42	
Escambia	OBSERVATIONS	3791		3882		4281		4272	
Hillsborough	CONSTANT	56	5.44	71	5.12	126	6.04	304	12.13
Hillsborough	HOSE	-17	-2.75	-33	-3.31	-154	-8.97		
Hillsborough	IR1	-13	-2.41	-10	-1.24	-55	-4.93	-95	-8.16
Hillsborough	MANUAL	-69	-3.11	-7	-0.46	-19	-1.11	-73	-3.27
Hillsborough	NIRPD	443	9.78	978	15.23	2010	20.89	2766	24.85
Hillsborough	PERSONS	49	15.96	42	12.61	34	7.57	6	0.99
Hillsborough	POOL	48	6.27	75	6.76	68	5.30	80	4.64
Hillsborough	SUB					-83	-3.66		
Hillsborough	RHO	0	30.35	1	36.52	0	29.20	0	25.25
Hillsborough	R-SQUARE	0.39		0.46		0.35		0.27	
Hillsborough	OBSERVATIONS	3061		2820		3550		3910	
Indian River	CONSTANT	-1	-0.08	99	4.95	127	6.63	0	0.02
Indian River	HOSE	66	8.28	19	1.12	-133	-7.79		
Indian River	MANUAL	166	8.64	-58	-2.35			-41	-2.03
Indian River	NIRPD	542	8.49	450	3.48	1457	8.21	262	2.32
Indian River	PERSONS	34	15.26	18	4.25	36	10.93	77	14.17
Indian River	POOL	34	3.62	14	2.08	40	5.87	-16	-1.45
Indian River	RHO	0	28.61	1	34.02	0	19.56	0	5.49
Indian River	R-SQUARE	0.33		0.33		0.28		0.26	
Indian River	SUB	88	9.80	40	2.49	-80	-4.17		
Indian River	OBSERVATIONS	3216		2700		2751		981	
Lakeland	CONSTANT	-2	-0.12	325	12.82	483	16.05	446	13.09
Lakeland	HOSE	12	0.72	-94	-4.87	-235	-6.16	-433	-4.79
Lakeland	IR1	-16	-1.53	36	2.88	-47	-2.85	-13	-0.71
Lakeland	MANUAL	88	5.24	-46	-2.09	-221	-9.31	-139	-5.09
Lakeland	NIRPD	1751	17.76	2070	18.90	3413	21.84	4034	23.78
Lakeland	PERSONS	56	12.23	-30	-4.74	-4	-0.52	-7	-0.58
Lakeland	POOL	-77	-1.79	-50	-1.99	-58	-2.72	-54	-2.37
Lakeland	SUB					-237	-6.73		
Lakeland	RHO	0	25.45	1	34.14	1	33.00	0	31.44
Lakeland	R-SQUARE	0.38		0.40		0.45		0.37	
Lakeland	OBSERVATIONS	2117		2434		2482		3039	
Melbourne	CONSTANT	65	2.21	0	-0.04	-4	-0.16	288	7.68
Melbourne	HOSE	6	0.24	33	3.66	68	3.13	-188	-6.77
Melbourne	NIRPD	-130	-0.44	610	7.27	756	3.29	635	2.33
Melbourne	PERSONS	46	8.75	39	23.22	38	12.56	43	7.07
Melbourne	POOL	-9	-0.48	40	8.29	56	7.54	-80	-5.13
Melbourne	RHO	0	1.80	0	15.41	0	16.28	1	17.71
Melbourne	R-SQUARE	0.05		0.47		0.31		0.47	
Melbourne	SUB	6	0.22	46	4.48	48	2.02	-132	-4.14
Melbourne	OBSERVATIONS	1682		1717		1894		756	

		Profile 1		Profile 2		Profile 3		Profile 4	
Utility	**VARIABLE**	**ESTIMATE**	**T-RATIO**	**ESTIMATE**	**T-RATIO**	**ESTIMATE**	**T-RATIO**	**ESTIMATE**	**T-RATIO**
Ocoee	CONSTANT	39	2.12	238	8.56	296	10.66	448	11.69
Ocoee	HOSE	-51	-3.95	-177	-8.85	-450	-6.62	-309	-3.81
Ocoee	IR2	-38	-4.14	-23	-1.79	-63	-4.98	-90	-5.92
Ocoee	MANUAL	97	6.56	49	2.39	-80	-2.53	-2	-0.06
Ocoee	NIRPD	1419	18.05	2671	24.80	2529	23.17	3295	25.16
Ocoee	PERSONS	63	12.78	21	2.96	47	6.10	-35	-4.35
Ocoee	POOL	-19	-1.20	27	1.43	127	5.47	158	6.46
Ocoee	RHO	0	32.96	1	38.06	1	40.80	1	46.16
Ocoee	R-SQUARE	0.40		0.42		0.35		0.40	
Ocoee	OBSERVATIONS	3573		3854		4636		4931	
Palm Beach	CONSTANT	17	1.34	244	16.60	258	18.04	396	18.53
Palm Beach	HOSE	37	3.05	-117	-10.93	-149	-10.27	93	2.30
Palm Beach	IR2	-54	-4.78	-42	-3.22	-65	-4.60	-61	-2.64
Palm Beach	MANUAL	192	13.02	-74	-4.24	-108	-5.97	31	0.63
Palm Beach	NIRPD	594	6.91	395	4.09	1007	8.45	1410	7.81
Palm Beach	PERSONS	56	21.40	35	9.78	41	11.41	18	3.46
Palm Beach	POOL	75	7.01	8	1.12	20	2.47	84	6.98
Palm Beach	RHO	0	15.64	0	14.61	0	17.17	0	28.76
Palm Beach	R-SQUARE	0.39		0.31		0.31		0.48	
Palm Beach	SUB	48	3.59	-173	-14.37	-171	-13.84	-283	-15.50
Palm Beach	OBSERVATIONS	2874		2870		3833		3698	
Palm Coast	CONSTANT	7	1.09	156	7.56	198	8.92	252	6.99
Palm Coast	HOSE	8	1.45	-180	-11.22			-460	-7.69
Palm Coast	MANUAL	49	4.83	-159	-4.19	-125	-3.36	-164	-5.69
Palm Coast	NIRPD	568	12.68	1745	15.19	1867	14.33	3624	20.85
Palm Coast	PERSONS	38	17.30	19	3.09	18	2.46	42	3.51
Palm Coast	POOL	110	11.07	89	8.81	-13	-1.14	61	2.75
Palm Coast	RHO	0	25.39	0	35.70	0	34.83	1	41.65
Palm Coast	R-SQUARE	0.42		0.43		0.32		0.44	
Palm Coast	SUB	38	5.87	-103	-7.67	-12	-0.78	-121	-5.55
Palm Coast	OBSERVATIONS	3118		3886		4057		4402	
Sarasota	CONSTANT	68	9.98	13	1.95	160	16.93	155	9.77
Sarasota	HOSE	38	8.34	36	7.68	-36	-5.44	-68	-5.70
Sarasota	IR1	-1	-0.26	-9	-2.22	-31	-6.07	-46	-4.30
Sarasota	MANUAL	122	7.19	84	8.65	-1	-0.16	-97	-4.65
Sarasota	NIRPD	125	4.09	240	6.87	578	12.22	917	9.18
Sarasota	PERSONS	19	7.99	33	20.41	15	7.62	38	15.12
Sarasota	POOL	61	4.69	72	18.51	24	5.60	34	5.58
Sarasota	RHO	1	43.30	0	32.52	0	32.18	0	22.57
Sarasota	R-SQUARE	0.51		0.43		0.32		0.39	
Sarasota	SUB	30	5.30	46	7.89	-40	-5.34	-98	-6.84
Sarasota	OBSERVATIONS	3395		3915		4555		3787	
Seminole	CONSTANT			155	7.65	395	15.57	455	12.15
Seminole	HOSE			-148	-8.98	-192	-7.86		
Seminole	IR2			-32	-2.91	-89	-6.44	-143	-9.23
Seminole	MANUAL			16	0.67	-55	-2.44	-85	-3.16
Seminole	NIRPD			1306	14.17	2335	19.65	3270	24.79
Seminole	PERSONS			60	10.32	-1	-0.26	18	2.59
Seminole	POOL			113	3.37	136	8.15	-26	-0.97
Seminole	RHO			1	34.95	0	31.77	0	28.25
Seminole	R-SQUARE			0.41		0.36		0.34	
Seminole	SUB			7	0.26	-125	-5.21	43	1.46
Seminole	OBSERVATIONS			3147		3510		3636	

		Profile 1		Profile 2		Profile 3		Profile 4	
Utility	VARIABLE	ESTIMATE	T-RATIO	ESTIMATE	T-RATIO	ESTIMATE	T-RATIO	ESTIMATE	T-RATIO
Spring Hill	CONSTANT	164	5.05	419	13.15	477	12.45	606	11.44
Spring Hill	HOSE	-314	-13.84	-137	-4.04	-327	-6.26	-510	-5.57
Spring Hill	IR1	-7	-0.49	-135	-8.45	-120	-5.53	-124	-3.82
Spring Hill	MANUAL	-63	-1.79	28	0.65	-850	-8.81		
Spring Hill	NIRPD	1786	12.35	3221	21.00	2974	13.67	4045	12.68
Spring Hill	PERSONS	56	7.80	-7	-0.97	38	2.51	61	5.13
Spring Hill	POOL	105	4.28	42	1.83	280	10.47	-140	-4.01
Spring Hill	RHO	1	32.10	0	32.25	0	27.66	1	25.94
Spring Hill	R-SQUARE	0.39		0.46		0.48		0.57	
Spring Hill	SUB			-307	-12.43	-581	-17.79	-386	-9.27
Spring Hill	OBSERVATIONS	2698		3474		3117		1554	
St Petersburg	CONSTANT	39	4.82	-33	-2.85	67	7.41	127	7.84
St Petersburg	HOSE			117	11.75	5	0.38	-47	-2.23
St Petersburg	IR1	-37	-6.48	-26	-3.33	-9	-1.97	-73	-5.97
St Petersburg	MANUAL			40	2.82	17	2.88	-72	-3.10
St Petersburg	NIRPD	467	9.77	489	7.65	228	5.87	1057	9.86
St Petersburg	PERSONS	55	28.48	59	26.67	35	14.95	42	18.01
St Petersburg	POOL	22	4.00	27	5.81	20	3.92	44	7.84
St Petersburg	RHO	0	28.21	1	39.66	0	26.25	0	30.82
St Petersburg	R-SQUARE	0.54		0.55		0.27		0.38	
St Petersburg	SUB	-26	-3.78	52	5.07	8	1.14	-54	-3.63
St Petersburg	OBSERVATIONS	2911		3297		3622		3514	
Tallahassee	CONSTANT	-30	-1.93	21	1.82	102	5.92	150	4.40
Tallahassee	HOSE	32	2.85	26	3.22	-28	-2.03	-160	-7.06
Tallahassee	MANUAL							-108	-2.78
Tallahassee	NIRPD	1143	18.07	1384	20.46	2916	26.38	3517	19.97
Tallahassee	PERSONS	71	14.89	38	11.47	11	2.62	38	3.94
Tallahassee	POOL	-70	-3.40	13	1.20	60	3.51	331	11.30
Tallahassee	RHO	1	42.91	0	34.56	0	27.31	0	27.58
Tallahassee	R-SQUARE	0.44		0.33		0.27		0.41	
Tallahassee	OBSERVATIONS	3781		4436		4310		2650	
Tampa	CONSTANT	66	6.16	166	9.14	260	11.08	239	6.29
Tampa	HOSE	5	0.65	-54	-4.80	-166	-8.19	-180	-2.68
Tampa	IR1	-25	-4.26	-30	-3.11	-81	-6.01	-104	-4.96
Tampa	MANUAL	83	5.46	5	0.27	-97	-4.86	5	0.15
Tampa	NIRPD	564	10.16	920	10.16	1471	10.65	2851	13.29
Tampa	PERSONS	32	12.82	13	3.14	38	6.85	34	3.55
Tampa	POOL	66	5.84	48	4.26	72	4.25	87	3.49
Tampa	RHO	0	22.81	0	23.77	1	28.85	1	26.20
Tampa	R-SQUARE	0.42		0.32		0.39		0.32	
Tampa	SUB			-9	-0.53	-122	-5.12	44	1.07
Tampa	OBSERVATIONS	1584		1803		2107		1992	

Appendix D. Normalization Adjustments

Profile	Utility	Average GPD	NIR Change	Pool Change	Persons Change	Normalized GPD	% Change
1	Escambia	250	18	9	17	294	18%
1	Hillsborough	196	0	-3	-6	188	-4%
1	Indian River	167	0	2	0	169	1%
1	Lakeland	292	3	-10	-7	279	-5%
1	Melbourne	193	0	0	-5	188	-3%
1	Ocoee	299	-15	0	-16	268	-10%
1	Palm Beach	232	1	2	0	235	1%
1	Palm Coast	137	5	10	6	158	15%
1	Sarasota	143	-1	5	1	148	4%
1	Spring Hill	417	-1	-58	-11	347	-17%
1	St Petersburg	156	-1	0	0	155	-1%
1	Tallahassee	203	14	-8	27	236	16%
1	Tampa	184	0	2	-6	180	-2%
2	Escambia	295	41	-3	6	340	15%
2	Hillsborough	269	1	1	-17	254	-6%
2	Indian River	181	0	-2	4	182	1%
2	Lakeland	364	4	-11	6	362	0%
2	Melbourne	152	0	6	2	160	5%
2	Ocoee	498	-29	-1	-5	463	-7%
2	Palm Beach	210	1	1	-2	210	0%
2	Palm Coast	215	8	-39	4	188	-13%
2	Sarasota	152	-1	5	3	159	5%
2	Seminole	373	-11	34	-12	384	3%
2	Spring Hill	492	-2	-19	0	471	-4%
2	St Petersburg	172	0	-3	8	177	3%
2	Tallahassee	225	17	3	-1	244	8%
2	Tampa	234	0	3	-2	235	0%
3	Escambia	546	88	13	3	650	19%
3	Hillsborough	343	1	-16	-11	317	-8%
3	Indian River	176	0	-5	1	172	-2%
3	Lakeland	555	6	-5	0	556	0%
3	Melbourne	188	0	-17	-2	169	-10%
3	Ocoee	620	-26	38	-4	626	1%
3	Palm Beach	317	2	-2	-3	314	-1%
3	Palm Coast	260	11	2	8	281	8%
3	Sarasota	199	-2	-3	1	196	-2%
3	Seminole	575	-20	-13	1	543	-6%
3	Spring Hill	564	-2	7	18	587	4%
3	St Petersburg	191	-1	0	-2	188	-1%
3	Tallahassee	302	34	21	0	356	18%
3	Tampa	341	0	17	0	358	5%
4	Escambia	585	89	20	-2	691	18%
4	Hillsborough	527	2	-18	0	510	-3%
4	Indian River	192	0	2	20	214	11%
4	Lakeland	688	8	-11	-2	683	-1%
4	Melbourne	260	0	3	-19	244	-6%
4	Ocoee	719	-33	-28	14	672	-7%
4	Palm Beach	305	1	10	1	317	4%
4	Palm Coast	452	28	-11	24	494	9%
4	Sarasota	203	-1	-4	1	199	-2%
4	Seminole	658	-28	7	-6	631	-4%
4	Spring Hill	531	-2	14	-15	528	0%
4	St Petersburg	220	-1	7	-3	223	1%
4	Tallahassee	418	41	144	9	612	46%
4	Tampa	489	1	13	-4	499	2%

Appendix E. 2003 Water and Sewer Prices

Listed water and sewer prices for single-family homes are inside-city limits, do not include associated taxes, and were effective at some point in 2003.

Utility	Water Price $/TG	Sewer Price $/TG
Escambia	$1.34	$4.05 (winter use cap)
Tallahassee	$1.22	$2.68 (winter use cap)
Melbourne	$2.27	$4.47
Ocoee	$0.57	$1.65 (cap at 12 TG)
Palm Coast	$3.33	$2.79 (cap at 8 TG)
Spring Hill	$1.00	$2.64 (cap at 6 TG)
Palm Beach	0 to 4 TG: $0.75 5 to 10 TG: $1.60 over 10 TG: $3.80	0 to 4 TG: $1.00 $2.20 (cap at 10 TG)
Lakeland	0 to 10 TG: $1.28 11 to 15 TG: $1.57 over 15 TG: $1.96	$1.92 (cap at 12 TG)
Miami Dade	0 to 3.750 TG: $0.50 3.751 to 7.500: $1.60 7.501 to 12.750: $2.20 over 12.751: $3.05	0 to 3.750 TG: $1.85 3.751 to 12.750: $2.90 over 12.751: $3.60
Indian River	0 to 3 TG: $2.20 4 to 7 TG: $2.42 8 to 13 TG: $3.85 over 13 TG: $7.70	$2.86 (cap at 12 TG)
Hillsborough	0 to 5 TG: $2.43 6 to 15 TG: $3.58 16 to 30 TG: $4.78 over 30 TG: $6.28	$4.10 (cap at 8 TG)
St. Petersburg	0 to 5.6 TG: $2.44 5.7 to 8 TG: $3.05 9 to 15 TG: $4.14	$3.19

Utility	**Water Price $/TG**	**Sewer Price $/TG**
	over 15 TG: $5.16	
Toho	0 to 2 TG: $0.50 3 to 6 TG: $1.00 7 to 15 TG: $1.10 16 to 25 TG: $1.50 over 26 TG: $2.50	$3.32
Sarasota	0 to 4 TG: $1.84 or $2.66 5 to 8 TG: $2.66 9 to 12 TG: $4.48 13 to 18 TG: $7.22 over 18 TG: $10.31	$6.61 (cap at 10 TG)
Tampa	0 to 3.7 TG: $1.39 3.7 to 9.7 TG: $1.60 9.8 to 19.4 TG: $2.70 19.5 to 33.7 TG: $3.61 over 33.7 TG: $4.17	$4.28 (cap varies)
Seminole	0 to 10 TG: $0.65 11 to 15 TG: $0.95 16 to 20 TG: $1.25 21 to 30 TG: $1.50 over 30 TG: $1.75	$2.59 (cap at 15 TG)