Control Number: 45283

Item Number: 53

Addendum StartPage: 0

LAW OFFICE OF RICHARD T. MILLER
414 E. Wallace Street
P.O. Box 99
San Saba, Texas 76877
325-372-4400 phone 325-372-3645 fax
Email: rtmiller@centex.net

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October 7, 2016

Via Express U.S. Mail
Public Utility Commission of Texas
Attention: Filing Clerk
1701 N. Congress Ave, Suite 8-100
P.O. Box 13326
Austin, TX 78711-3326

Re: PUC Docket No. 45283; SOAH Docket No. 473-16-1834.WS; *Ratepayers' Appeal of the Decision by North San Saba Water Supply Corporation to Change Rates*

Greetings,

Enclosed are one original copy and 13 disc copies of the Fourth Supplement to Roger Whatley's Rebuttal to PUC Staff's Testimony. Please file in the above-referenced matter.

Thanks,

Regina M. Morgan

Regina M. Morgan
rmmorgan@centex.net

Encl.

53

SOAH DOCKET NO. 473-16-1834.WS
PUC DOCKET NO. 45283

RATEPAYERS' APPEAL OF THE DECISION BY NORTH SAN SABA WATER SUPPLY CORPORATION TO CHANGE RATES	§ § § § § § §	**BEFORE THE STATE OFFICE** **OF** **ADMINISTRATIVE HEARINGS**

FOURTH SUPPLEMENT TO REBUTTAL TESTIMONY

OF

ROGER WHATLEY

ON BEHALF OF

NORTH SAN SABA WATER SUPPLY CORPORATION

October 7, 2016

INDEX TO THE THIRD SUPPLEMENT TO REBUTTAL TESTIMONY OF

ROGER WHATLEY, WITNESS FOR

NORTH SAN SABA WATER SUPPLY CORPORATION

LIST OF EXHIBITS

SUPPLEMENT TO REBUTTAL TESTIMONY OF ROGER WHATLEY

I. <u>REBUTTAL TO SCAFF DIRECT TESTIMONY</u>

Q. PLEASE STATE YOUR SUPPLEMENTAL REBUTTAL TESTIMONY IN RESPONSE TO DIRECT TESTIMONY BY PUC STAFF SEAN SCAFF.

A. In Mr. Bednarski's Direct Testimony (45283-35) much use is made of a reference source, the American Water Works Association M1 Manual entitled as "Principles of Water Rates, Fees, and Charges," also subtitled as "Manual of Water Supply Practices." On pages 26 to 38 of his testimony he shows, as Exhibit FB-3, the Foreword containing an overview of the content of the book. Mr. Bednarki's own analysis follows a subset of that M1 Manual methodologies and which he chose to apply in calculating the North San Saba Water Supply Corporation (NSSWSC) Revenue Requirement as might have been calculated in July2015 time frame using the base year of 2014.

The AWWA M1 Manual represents itself as authoritative on its subject & content of standard practices, and Mr. Bednarski (and by extension, PUC Staff) implicitly accepts its authority. I shall do no different here.

In my Third Rebuttal (45283-52) I addressed Mr. Bednarski's accounting errors in calculating an appropriate Base Rate based on his calculation of Fixed Revenue Requirement. I would now like to address Mr. Scaff's use of Mr. Bednarki's calculations and his own calculations to re-design NSSWSC's Conservation Rate structure.

Mr. Scaff's Direct Testimony (45283-36) contains the following Q&A (Scaff Testimony 5:5-9):

How did you analyze the water rate set by North San Saba?

"I used the number of connections at the end of the test year, the water production/billed worksheet provided by the utility, and the revenue requirement provided to me by Mr. Bednarski. I then determined the rate I would recommend based on Mr. Bednarski's cost of service…."

In others words, Mr. Scaff used the historical demand profile of the base year 2014, unadjusted, and he implicitly assumed, without ever explicitly addressing the question, that this is the demand profile that should be projected forward under the new Conservation Rates and thru the balance of 2015 and 2016 without ANY change or adjustment of demand in that revenue projection.

But what does the AWWA M1 Manual have to say about this? Plenty enough, it turns out. In Exhibit RW-27, there is a copy of pages 22, 23, 24, and 190 of the same AWWA M1 Manual, taken from an online source given on the first page of the exhibit. Under the heading of "Projecting Revenue" (page 22), and further subheading of "Projection Considerations" (page 23) is this passage:

> "…it is often necessary to normalize or adjust historical data to reflect abnormal conditions that may have caused unusual variations. Some of the most common areas for adjustment are discussed in the following sections."

Was 2014 an unusual weather year? I recall it as mighty droughty. One might expect water demand to be higher in a year with drought conditions, much less a historic and extended period of severe drought, as we were still experiencing in 2014.

The first two of the following sections under this subheading of "Projection Considerations" are un-interesting here. But the next three are of prime interest here:

"**Weather Normalization.** In many areas weather conditions can greatly affect water sales. Thus the utility should consider adjusting past sales when weather considerations have been abnormal." (emphasis added.)

"**Conservation.** Revenue projections may need to be adjusted for conservation measures installed in the past or to reflect conservation measures to be used in the future. These projections can be difficult to adjust. Past conservation measures may permanently reduce water sales, so comparing water sales before the conservation measures were installed could overstate future projections. The effects of future conservation measures can be difficult to quantify and support. However, a diligent attempt should be made to estimate the effect of conservation measures on revenues; otherwise actual revenues may differ significantly from projections." (emphasis added).

"**Price Elasticity.** Most water use is considered to be relatively insensitive to changes in the price of water (price inelastic). However, uses such as lawn watering and industrial sales may be somewhat more sensitive to the price of water. Many utilities have experienced water use reductions due, in at least some measure, to increases in the price of water. Major rate increases have, at times, reduced industrial water sales." (emphasis added).

Regarding Weather Normalization: Was Mr. Scaff wise in using unadjusted 2014 water sales, reflecting the demand profile of an unabashedly droughty year, as the basis of a forward projection from the July 2015 time frame into 2016? Was he following industry Standard Practice in his computation in using the demand profile of an unusually droughty year? Not as far as I can understand the AWWA M1 Manual.

Regarding Conservation: Was Mr. Scaff wise in using unadjusted 2014 water sales, reflecting the demand profile of a less aggressive conservation rate design, as the basis of a forward projection from the July2015 time frame when the NSSWSC Board chose to implement a more aggressive conservation rate design? Not as far as I can understand the AWWA M1 Manual.

Regarding Price Elasticity: Was Mr. Scaff wise to ignore the NSSWSC Board's intended policy choice of using stronger price signals to accomplish water conservation? Not as far as I can understand the AWWA M1 Manual, not to mention the express public policies of the State of Texas as expressed by TCEQ and TWDB. Why should the PUC be discouraging this? I explicitly considered demand changes as a result of the new conservation rates (Roger Whatley Direct Testimony, Docket #29, 6:17-20, 7:14-16, 8:17-18, and other places).

Regarding Weather and Conservation and Price Elasticity all taken together, Exhibit RW-18 in my Second Rebuttal (45283-44) clearly shows a drop in demand profile immediately after the new rate design was implemented, and as compared to the 2014 Base Year. Mr. Scaff's assumptions were, and are, unwise. The M1 Manual states "..., a diligent attempt should be made to estimate the effect of conservation measures on revenues; otherwise actual revenues may differ significantly from projections." Based on that AWWA M1 Manual claim, Mr. Scaff's analysis lacks "diligence."

In my Direct Testimony, filed April 8, 2016, on Page 7, Lines 12-16, I stated:

"Our previous rate structure, when applied to a hypothetical average month of demand in 2014, yielded an income of $27,146 – a deficit of about $1,854. The new rate structure applied to the same hypothetical average month in 2014, but **with some assumptions of demand drop in the higher volume tiers,** yielded a monthly income of $34,032. " (emphasis added).

Just to emphasize the point: In July 2015 I presented to the NSSWSC Board my spreadsheet calculations based on 2014 average demand, plus my assumptions of a demand drop due to new and higher conservation rates, and the projected water sales under these assumptions were $34,032 per month.

In Exhibit RW-29, a P&L for the recent month of July2016, the top-line water sales (base + conservation volume rates) are $33,903.06, very close to what I projected in July 2015. When the loan principal payments are subtracted from the Net Income at the bottom of the P&L, a net loss of $298.59 is noted.

Two salient points are illustrated here:

1) NSSWSC is NOT taking in too much money under the current rate structure and current demand.

2) The situation is pretty much as the Board projected in calculations and understood in fact in July 2015 - we do now have lower demand and consequently

more conservation in the higher volume-tiers and yet the lowest volume-tier remained unchanged from before, to the benefit of lower-income members.

Exhibit RW-28 is a 1999 Texas Water Development Board (TWDB) published paper on "Water Price Elasticities for Single Family Homes in Texas." This paper teaches a water price elasticity of approximately .2 can be expected. Thus, for every 10% rise in water prices, a 2% conservation drop in demand might be expected.

For the current NSSWSC conservation rates:

The top tier price was increased by 100%, for an expected conservation demand drop of 20% in current demand. I had actually assumed a 15% drop in July2015.

The next tier price was increased by 75%, for an expected conservation demand drop of 15%. I had actually assumed a 10% drop in July2015.

The next tier price was increased by 50%, for an expected conservation demand drop of 10%. I had actually assumed a 5% drop in July2015.

The lowest tier was unchanged, so as to not hurt the lower income members of our Coop.

Exhibit RW-30 is a copy from the City of Austin website of Austin's water rates including their conservation rates.

Exhibit RW-31 compares NSSWSC's conservation rates with the conservation rates currently being used by the City of Austin. At all points, the NSSWSC conservation rate price is lower than the City of Austin's conservation rate prices. Austin also has a lower rate for indigent customers termed as

"Community Assistance Program" (CAP) rates. NSSWSC's conservation rates are approximately equal or lower than Austin's CAP conservation rates.

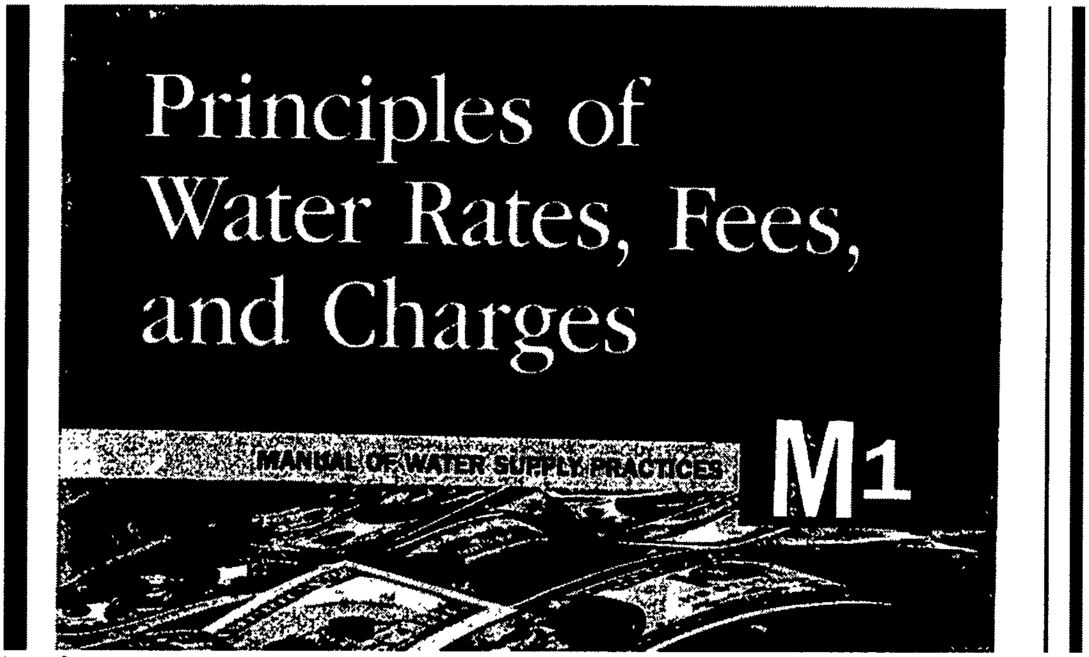
NSSWSC original founders organized the Corporation to serve and provide domestic water use to single-family homes in rural North San Saba County, Texas, and which otherwise had no safe and reliable source of water for their homes. The Corporation has now grown to the point that newer industrial users, such as sandstone and strip mining companies, have begun using the system as well, which has put an ever-increasing burden and pressure on NSSWSC's infrastructure, paid for by all. In Exhibit RW-2 (Roger Whatley Direct Testimony 45283-29) one of these stone companies, Cobra Stone, used an average of 160,666 gallons of water PER MONTH throughout the year 2014. The water is used to wash detritus from rock saws, as well as to cool the blade. Then this formerly potable water typically becomes a silt laden runoff into the riverine environs of the Colorado River. NSSWSC's graduated rate design is intended to protect low income members while requiring heavy commercial users to pay for the extreme amounts of water they use, thus encouraging conservation. NSSWSC should have the power to adopt conservation rates that will support the purpose for which it was formed, that being to provide domestic water use and encourage conservation. NSSWSC Board is quite happy with the conservation results we have achieved to date.

CONCLUSION

Q. DOES THIS CONCLUDE YOUR SUPPLEMENT TO YOUR REBUTTAL TESTIMONY?

A. Yes, although I reserve the right to add to or amend my testimony.

https://books.google.com/books?id=MMItmgkdbtgC&pg=PA290&lpg=PA290&dq=principles+of+water+rates+fees+and+charges+pdf&source=bl&ots=wKCiRaGWSh&sig=zNakoB2tsx9ArUElM9I0lSjRApk&hl=en&sa=X&ved=0ahUKEwij9r7YscHPAhUM64MKHSstA1w4HhDoAQgwMAM#v=onepage&q=principles%20of%20water%20rates%20fees%20and%20charges%20pdf&f=false



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PROJECTING REVENUE

In projecting revenue that may be available to the utility from the sources listed in Table II 2-1, the utility must first develop adequate historical data as a basis for projecting future revenues.

Historical Data

The amount of revenue that may be derived from water rates under any particular rate schedule can be appropriately projected based on historical data regarding customer billing. The amount and detail of needed data vary depending on the local situation. The most accurate projections result from separately summarizing and analyzing billing data for each customer classification.

For metered accounts, the utility may need to compile the number of bills rendered by customer class and meter size, and the water sales by rate block. This compilation usually includes adjustments for credits, additional billings, partial bills, final bills, and changes in the number of customers served. The compilation should include a verification procedure, such as a comparison with billed revenues. The verification procedure should also include a check on the days billed. A change in the billing cycle or in the makeup of the billing routes could result in test-year billings for more or less than 365 days. To properly analyze billed revenues, the utility must have billings for 365 days.

Flat-rate revenues and fire-service revenues can be annualized by establishing the average number of billing units for each rate level during the historical base year. Growth projections can be added if applicable.

In many situations, particularly for smaller utilities, detailed billing data are not available. In such cases, the utility must estimate a satisfactory basis for projection of anticipated revenues.

Projection Considerations

Reasonable projections of each revenue category listed in Table II.2-1 must be considered and made as appropriate. As previously noted, it is often necessary to normalize or adjust historical data to reflect abnormal conditions that may have caused unusual variations. Some of the most common areas for adjustment are discussed in the following sections.

Growth in number of customers. Growth in the number of customers served can be projected by recognizing historical growth patterns, growth restrictions and changes in economic conditions, and by awareness of proposed developments in the service area. Historical customer class average water use and/or revenues per customer normally are adequate to project revenues in growth situations. However, if the current rates have not been in effect for a sufficient period to establish valid average revenue per customer, historical average revenues need to be adjusted to reflect rate changes. Also, it often is necessary to perform special analyses of projected future revenues from existing or new industrial or other large-use customers.

The number of customers served at any particular point in time, such as historical year end, needs to be annualized so that projections ultimately reflect a full year's service. Often the trend in the average of beginning and end-of-year number of

The number of customers served at any particular point in time, such as historical year end, needs to be annualized so that projections ultimately reflect a full year's service. Often the trend in the average of beginning and end-of-year number of
customers of record provides a satisfactory method of projection. A factor that would require adjustments includes the effects of past annexation of new customers, an occurrence not likely to be repeated with regularity. Another factor that would necessitate an adjustment would be the effects of a major area-wide economic downturn or upturn that is not typical of a long-term trend.

Nonrecurring sales. Sales not expected to continue in the future should be eliminated from projections. This would include a large water user going off the system, abnormally high sales caused by an incorrect meter reading if not credited during the base year, leakage of customers' plumbing, and temporary purchases. Sufficient data must be accumulated to calculate the volume of nonrecurring sales and appropriate adjustment made to revenue projections.

Weather normalization. In many areas, weather conditions can greatly affect water sales. Thus, the utility should consider adjusting past sales when weather conditions have been abnormal. It is useful to follow a procedure that correlates average water use per customer over a period of years with temperature, rainfall, and other climatic conditions. These data are used together with normal climatic data to project water sales under normal weather conditions. Normal climatic conditions may be established using long-term averages as reported by the National Weather Service for the service area.

Care should be exercised when attempting to normalize water sales for weather. Other variables that affected the historical data may have more effect on the results than the weather normalization itself and, therefore, should be reflected in the revenue study.

Conservation. Revenue projections may need to be adjusted to reflect conservation measures installed in the past or to reflect conservation measures to be used in the future. These projections can be difficult to adjust. Past conservation measures may permanently reduce water sales, so comparing water sales before the conservation measures were installed could overstate future projections. The effects of future conservation measures can be difficult to quantify and support. However, a diligent attempt should be made to estimate the effect of conservation efforts on revenues; otherwise, actual revenues may differ significantly from projections.

Price elasticity. Most water use is considered to be relatively insensitive to changes in the price of water (price inelastic). However, uses such as outdoor lawn watering and industrial sales may be somewhat more sensitive to the price of water. Many utilities have experienced water-use reductions due, in at least some measure, to increases in the price of water. Major rate increases have, at times, reduced industrial water sales. The addition of billings for other utility services based on water usage, such as wastewater services, can also affect water use.

Water utilities are investigating and many have implemented pricing techniques intended to modify water demand. Some regulatory agencies are also considering this method to promote water conservation. Extreme care should be used in projecting revenues that reflect these pricing techniques because generalized water price-elasticity information may not apply to specific circumstances. See chapter V 7 for a more comprehensive discussion of this topic.

EXAMPLE

Tables II.2-2 and II.2-3 illustrate an example projection of utility revenues. These tables and additional tables presented in chapters II.3, II.4, and II.5 are intended to assist the reader in recognizing customer base, water use, revenues, O&M expenses, capital structure, and associated capital costs as part of the projection process. The information and methodology used in developing these tables apply equally to government-owned and investor-owned water utilities. The adequacy of projected five-year revenues according to existing rates is presented in a flow-of-funds analysis for the government-owned utility and an operating income statement for the investor-owned

revenues according to existing rates is presented in a flow-of-funds analysis for the government-owned utility and an operating income statement for the investor-owned
utility.

Revenue sources typically available to utilities have been discussed in this chapter. Included in the tables are water sales revenue from residential, commercial, industrial, and wholesale customer classes; revenue from charges for private and public fire protection; other miscellaneous operating revenues; and nonoperating income. Table II.2-2 summarizes a projection of the average number of customers served and the associated water use by customer class for each of the years in the example study period. As noted, the projections for the number of customers and water use are equally applicable to both government-owned and investor-owned utilities.

The number of customers and water use by customer class for the most recent historical year are presented in Table II.2-2 to serve as a reference point for the reader. As previously discussed, a review of historic changes in customer growth, use per customer, and variance in usage patterns caused by weather and other factors is necessary for sound projections. In Table II.2-2, these underlying factors are assumed to have been recognized in preparing the forecast. It may be noted that not all classes are expected to experience growth.

Table II.2-3 shows projected revenues under existing rates for a government-owned utility. In projecting revenues under existing rates, service charges or minimum bill charges and fire protection charges are applied to the projected number of customer bills, and average unit revenues applicable to water usage (volume charges)

SUMMARY

In designing rates, fixed charges are viewed as being desirable because they provide a measure of revenue stability to the utility. Another perspective is represented by those who seek to minimize fixed charges because of the importance of maintaining water affordability to low-income customers. At the same time, advocates of conservation believe that a rate structure must find a reasonable balance between fixed and variable charges that allows the variable charge to provide an adequate and reasonable price signal to the customer regarding their consumptive use. Another viewpoint is that recovering fixed costs through volumetric charges sends inaccurate price signals to customers because it incorrectly implies that fixed costs are being avoided by customers' reductions in usage. These differing views provide a clear example of how the goals and objectives of the utility, community, or city should be carefully considered and fully explained to the customer base in the design of rates in general, and specifically in the design of fixed and variable charges.

Water Price Elasticities

for Single-Family Homes in Texas

final report
August 1, 1999

EXHIBIT RW-28

Water Price Elasticities

for Single-Family Homes in Texas

final report
August 1, 1999

EXHIBIT RW-28

WATER PRICE ELASTICITIES FOR SINGLE-FAMILY HOMES IN TEXAS

Prepared for

Texas Water Development Board
City of Austin
City of Corpus Christi
San Antonio Water System

Prepared by

Stratus Consulting Inc.
P.O. Box 4059
Boulder, CO 80306 4059
(303) 381-8000

Contact

John Whitcomb

August 1, 1999

EXHIBIT RW-28

ACKNOWLEDGMENTS

This project was funded jointly by the Texas Water Development Board, City of Austin, City of Corpus Christi, and the San Antonio Water System. We gratefully acknowledge the contributions of the following individuals. In particular, we thank Tony Gregg for coordinating the project.

Texas Water Development Board
Butch Bloodworth
Joelle Labrosse

City of Austin
Tony Gregg
Dan Strub
David Anders
Steve Dietz
Chuck Grigsby

City of Corpus Christi
Steve Klepper
Yolanda Marruffo

San Antonio Water System
Chris Brown
Peggy McCray

Contents

Executive Summary

The general objective of this project performed by Stratus Consulting is to examine and quantify the functional relationship between water consumption and water price for single family residential customers in Texas. 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 30 years has consistently shown this to be true for water. Although the direction of the relationship is well understood and accepted, the precise relationship between water price and demand is not. Many previous price elasticity studies lack the sophistication in statistical design and appropriate databases required to produce reliable results. In addition, price elasticity estimates generated in one region are rarely applicable to other regions.

A specific objective of this project is to identify the overall price signal perceived by customers from the multiple prices associated with block rates. If water agencies 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. This question of price signal is of growing importance because many Texas water agencies are adopting increasing block rate structures in which water price increases with increasing increments of water use during a billing period. One of the principal arguments used in support of block rates is that they increase the price signal sent to customers to conserve water. This project investigates this hypothesis via both survey research (psychometrics) and empirical evaluation of water use patterns (econometrics). The impact of increasing block rates on peak season water use is of particular concern.

These challenging questions require both a strong research design and an extensive dataset to obtain accurate, statistically valid answers. To isolate and describe the impact of water price on water use, we must control for all the other factors affecting water use. Because of the inherent complexities in controlling for nonprice factors, we determined that the best course for this project was to use a highly focused segmentation plan. We identified 15 representative customer profiles and then selected sample homes that closely match the profile definitions over a cross-section of water agencies. In this way we obtained and analyzed water consumption of homes that are nearly identical in all ways, except for the critical fact that they face different water prices both over time and across water agencies. In short, we used a nonrandomized selection process to control for nonprice variables so that we could isolate the water price impact. We collected data from 3,276 homes served by the cities of Austin and Corpus Christi, and the San Antonio Water System (SAWS).

Conclusions on Pricing from Mail Survey

From the survey results, the major findings regarding pricing are as follows:

- Only 25% of customers report assessing the financial impacts of water use decisions quantitatively. Only 3% report using marginal price (the price paid for the last unit of water consumed) in their decisions.
- Customers concerned about their water bill focus on the total dollar amount. They are much less knowledgeable of the details of the water rate structure and its prices.
- Price sensitivity is greatest with respect to outdoor irrigation.
- The link between winter water use and the sewer bill is not well recognized by customers.

With respect to price signal perceived by customers facing increasing block rates, there is no single, perfect answer explaining how all people perceive block prices. However, it is clear that the assumption that customers know and respond to perfect information regarding water pricing is false.

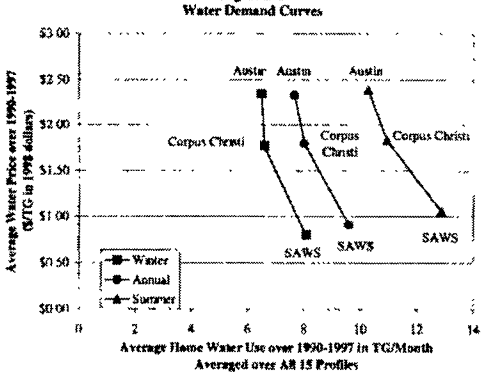
It is interesting to contrast water demand with gasoline demand. Gasoline has a measurement that is easily visualized (e.g., gallon), is frequently purchased for a single end use (e.g., car getting 20 miles per gallon), and is sold at a single, well-advertised price. Utility water is sold in hard-to-fathom units (e.g., thousand gallons), for consumption aggregated over many end uses over a month, and at multiple, often nonadvertised prices on a combined utility bill. As a consequence, it is logical that more respondents report being familiar with gasoline prices (83%) than water prices (24%).

Conclusions from Water Use Analysis

We compared profile water use among the homes from Austin, Corpus Christi, and SAWS over the period 1990 through 1997. Our analysis suggests the following conclusions:

- The quantity of water demanded clearly decreased with increasing water prices, as illustrated in Figure S-1.
- Average price is better than marginal price in explaining the quantity of water demanded. This conclusion is consistent with the general lack of awareness of block rates reported in the mail survey.
- In Austin's case, a switch from a single water price to increasing block rates in 1994 did not tend to lower water consumption for the 15 customer profiles studied. An explanation for this finding is that average water prices (inflation adjusted) dropped within all profiles after 1994, even for those profiles experiencing an increase in marginal water prices.

Figure S-1
Water Demand Curves



- Customers do not tend to factor in sewer prices into their water use decisions. This conclusion is also supported by the survey results showing that only 38% of customers correctly realize the link between water consumption and the sewer bill.
- The informational content of the water bill may affect customers' perceived price specification, but this hypothesis could not be tested in this study.
- Price elasticity is not correlated with house age or wealth, at least when household income is less than $100,000 per year.
- The weighted overall arc price elasticities for Austin, Corpus Christi, and SAWS are -0.17, -0.20, and -0.20, respectively. These should be interpreted as long run elasticities.
- The price elasticities reported in this study are relevant for water prices in the $1 to $3 per thousand gallon (TG) range.

- For increasing block rates to be effective in reducing water consumption, customers need to respond to marginal water prices, not average water prices.
- Water agencies can improve the effectiveness of increasing block rates to reduce water consumption by simplifying rates, educating customers about water end uses, and improving the informational content of the water bill.

Future Research

This study would have benefited by the inclusion of more water agencies with differing rate structures and rate levels. In particular, we could have made use of a water agency charging a single, nonblock water price in the $1 to $2/TG range to help us assess the impacts of increasing block rates (i.e., relative to SAWS or Corpus Christi). In addition, we would have liked to have another participating water agency with a water rate structure similar to SAWS, but that used a typical, uninformative water bill. Such a situation would allow us to measure the impact of SAWS' water bill, which provides detailed historical water use information. Future research could address these situations.

CHAPTER 1
RESEARCH OBJECTIVES AND APPROACH

This chapter provides a definition of price elasticity and the research objectives and approaches of this study.

1.1 DEFINITION OF PRICE ELASTICITY

A demand curve graphically shows the relationship between price (vertical axis) and quantity demanded (horizontal axis). In keeping with the first law of demand in economic theory, the curve is expected to be negatively sloped so that water price increases lead to water demand decreases.

Before proceeding, we need to introduce "price elasticity," which is a term commonly used by economists to measure the sensitivity of customers to price at a point on a demand curve. Price elasticity measures the percentage change in quantity demanded resulting from a 1% change in price, all other factors held constant. Price elasticity, denoted as ε, is mathematically defined as:

$$\varepsilon = \frac{\%\ \text{Change in Q}}{1\%\ \text{Change in P}} = \frac{\partial Q}{\partial P} \times \frac{P}{Q}, \qquad (1\text{-}1)$$

where Q is water use and P water price (∂ denotes partial derivative). For example, if a water price increase of 1% leads to a 0.2% reduction in water use, then price elasticity would be -0.2.

It is important to note that price elasticity represents the rate of change at a point on the demand curve. To measure price elasticity over a segment on a demand curve, economists commonly use what is referred to as an arc elasticity of demand, defined as:

$$\text{Arc } \varepsilon = \frac{Q_1 - Q_2}{(Q_1 + Q_2)/2} \div \frac{P_1 + P_2}{(P_1 + P_2)/2}, \qquad (1\text{-}2)$$

where Q_1 and P_1 are water demand and water price at one point on the demand curve and Q_2 and P_2 represent another point. Arc elasticity simply measures the average change in water use over the average change in price.

Lastly, when analyzing price elasticity, the distinction between the short run and the long run should be made. The second law of demand states that a customer will be less price elastic in the short run. This occurs because customers need time to make all desired adjustments to a price change, especially with respect to capital investments in water-using appliances, fixtures, and

landscapes. Once a customer makes a water-related capital investment, it becomes a sunk cost. It may take a long time before that investment needs replacing (e.g., toilet). Hence, while price increases may induce customers to act sooner, it may take some customers years to complete desired changes.

1.2 RESEARCH OBJECTIVES

The general objective of this project is to examine and quantify the functional relationship between water consumption and water price for single-family residential customers in Texas. 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 30 years has consistently shown this to be true for water. Although the direction of the relationship is well understood and accepted, the precise relationship between water price and demand is not. Many of the previous price elasticity studies lack the sophistication in statistical design and appropriate databases required to produce reliable results. In addition, price elasticity estimates generated in one region are rarely applicable to other regions.

A specific objective of this project is to identify the overall price signal perceived by customers from the multiple prices associated with block rates. This question is of growing importance because many Texas water agencies are adopting increasing block rate structures in which water price increases with increasing increments of water use during a billing period. One of the principal arguments used in support of block rates is that they increase the price signal sent to customers to conserve water. This project investigates this hypothesis via both survey research (psychometrics) and empirical evaluation of water use patterns (econometrics). The impact of increasing block rates on peak season water use is of particular concern.

Another specific objective of the study is 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 results need to be developed and presented to serve a wider audience than just the participating water agencies. We need to maximize the ability of water agencies with differing characteristics to customize findings to their situation.

These challenging questions require both a strong research design and an extensive dataset to obtain accurate, statistically valid answers.

1.3 RESEARCH DESIGN

Single-family home water use is influenced by many factors. These factors can be segmented into the general categories listed in Table 1-1.

Table 1-1 General Factors Affecting Water Use	
General Factor	**Examples**
Demographics	Number and age of occupants
Irrigation potential	Lot size and weather
Technological water efficiency	Toilets, showerheads, clothes washers, irrigation system performance
Tastes and preferences	Conservation ethic, landscape area, and plant selection
Economic factors	Income and water prices

Undoubtedly, the functional relationship between water use and its explanatory factors is a complicated one. Water consumption recorded at the meter is the summation of a multitude of individual decisions related to water fixture purchases, duration of showering, dish and clothes washing practices, quickness to detect and repair leaks, type of landscaping plants, and irrigation system equipment and scheduling, among many others. Water use decisions are also made by a diverse set of people. Some are quite water price sensitive. Others find water price irrelevant to their decisions. Sometimes these two types of people (water frugal and lavish) reside in the same house. The behavioral science of explaining peoples' actions with respect to consuming water has many challenges.

To isolate and describe the impact of water price on water use, we must control for all the other factors affecting water use. Because of the inherent complexities in controlling for nonprice factors, we determined that the best course for this project was to use a highly focused segmentation plan. The plan's basic concept is to identify 15 representative customer profiles and then select sample homes that closely match the profile definitions over a cross-section of water agencies. In this way we can obtain and analyze water consumption of homes that are nearly identical in all ways, except for the critical fact that they face different water prices both over time and across water agencies. In short, we use a nonrandomized selection process to control for nonprice variables so that we can isolate the water price impact. The advantage of this approach is that we do not have to assume (gamble) that we can analytically control (i.e., via regression analysis) for all of the other nonprice variables affecting water use which likely have

nonlinear, interdependent, and complicated functional relationships.[1] The disadvantage of this approach is that much effort must be put into home selection so that we indeed have nearly identical homes in each profile for which we can make "apples to apples" comparisons.

1.4 ANALYTIC APPROACHES

We studied the data obtained from the profiles, as described in Chapter 2, in three distinct ways. All three ways assist us in understanding the price/quantity relationship with water.

First, we analyzed mail survey results regarding customers' knowledge and sensitivity to water prices and uses. As part of this study, we conducted the most extensive survey ever on the subject, collecting responses from 3,276 Texas homes. Measuring water users' attitudes, opinions, and knowledge of water pricing issues can provide much useful information, as addressed in Chapter 3. In particular, this approach helps us to answer the question regarding the price signal perceived by customers from block rate structures (i.e., price specification).

The two other analytic approaches focus not on what water users say, but on what they do. Here we analyze historical water use to measure the correlation between water use and water price. In particular, we look at and judge the likeliness of alternative price specifications. In Chapter 4, we focus on the analysis of aggregate home water use by profile. In Chapter 5, we analyze individual home water use by profile.

We produced four appendices to elaborate on important issues. Appendix A presents the mail survey. Appendix B provides details on the weather variable employed in the analysis. Appendix C lists characteristics of the selected profiles, and Appendix D includes sample water bills for each agency. Appendix E describes the model used in Chapter 5.

1. 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), not logical reasoning. In addition, compiling one model for a sample of heterogeneous users may mask important differences among market segments. In contrast, using sampling to control for external differences is much more common in other research applications. For example, clinical trials in pharmaceutical studies often use very specific profiles of people (e.g., age, sex, ethnicity, blood type) in their analytical evaluations.

CHAPTER 2
DATA COLLECTION

This chapter describes the data collected for this study. Chapters 3, 4, and 5 describe the analyses that make use of these data.

2.1 WATER AGENCY PARTICIPANTS

The City of Austin, the City of Corpus Christi, and the San Antonio Water System (SAWS) are the participating water agencies in this study. They serve relatively large residential customer populations, as shown in Table 2-1.

Table 2-1 Number of Single Family Homes	
Water Agency	**Single Family Customers (1997 approximation)**
Austin	138,000
Corpus Christi	62,000
San Antonio Water System	260,000
Total	460,000

2.2 PROFILE DEFINITIONS

Our first data task was to define representative customer profiles. For all single family homes served by the participating agencies, we obtained house age, lot size, house size, and assessed property value via tax assessor records. We then used this information and the following procedure to define the profiles.

1. **House age.** We segmented homes into three house age groups as follows: pre-1960, 1960 to 1979, and 1980 to 1993. We did not include homes built after 1993 because they have limited historical billing records and may be in a period of transition regarding major water related investments such as landscaping. The 1980 threshold was used because that is when changes in plumbing fixtures started occurring in the United States

(e.g., to 3.5 gallon per flush toilets). The 1960 threshold was used because it roughly splits in half the number of homes in the pre-1960 and 1960-1979 groups.[1]

2. **Property value.** Within each house age group, we segmented homes into five 20% increments (quintiles) from lowest to highest property value. For example, the first quintile contains the 20% of homes with lowest property values.

3. **Lot size and house size.** For each of the 15 segments identified above (three house age groups each divided into five property value groups), we identified median property value, lot size, and house size. These values serve to define each profile as shown in Table 2-2. For example, homes in the eighth profile were built between 1960 and 1979 and have profile target values of $60,416 for property value, 8,276 ft^2 for lot size, and 1,348 ft^2 for house size.

Table 2-2
Profile Definitions

Profile	Home Age	Prop. Value Percentile	Profile Values: Prop. Value	Profile Values: Lot Size (ft^2)	Profile Values: House Size (ft^2)
1	Pre-1960	10th	$18,691	6,000	810
2	Pre-1960	30th	$29,431	6,970	1,000
3	Pre-1960	50th	$38,765	7,405	1,158
4	Pre-1960	70th	$52,486	7,910	1,304
5	Pre-1960	90th	$93,200	9,583	1,687
6	1960-1979	10th	$27,905	6,960	912
7	1960-1979	30th	$44,100	7,735	1,137
8	1960-1979	50th	$60,416	8,276	1,348
9	1960-1979	70th	$78,300	9,075	1,630
10	1960-1979	90th	$119,500	10,925	2,145
11	1980-1993	10th	$48,700	6,210	1,094
12	1980-1993	30th	$60,500	6,820	1,376
13	1980-1993	50th	$83,700	7,320	1,600
14	1950-1993	70th	$104,020	8,190	2,000
15	1980-1993	90th	$174,928	10,819	2,625

1. It should be noted that the house age field for Corpus Christi was null for homes built before 1976. As a consequence, for the pre-1960 and 1960-1979 categories we specified only that homes be built before 1960.

2.3 SAMPLE SELECTION

For each of the 15 profiles defined, we sought to identify homes that closely matched our profile definitions. The total sample size was limited to 7,500 homes because of project budget constraints related to the mail survey.

Given this constraint, we constructed selection rules to identify the 7,500 homes within the available universe of homes that would best serve the objectives of this study. The selection rules are as follows:

1. **Water agency equality.** Select an equal number of homes from each of the three water agencies
2. **Profile equality.** Select an equal number of homes for each of the 15 profiles.
3. **Best fit.** Select homes closest to the median property value, lot size, and house size values for each profile.[2]

Using these selection rules, we identified the best 7,500 homes — 2,500 homes from each of the three water agencies; 500 homes for each of the 15 profiles.

2.4 MAIL SURVEY

To collect more information on the 7,500 selected homes, we conducted a mail survey. The survey collected information in four broad areas related to measuring customers' perceptions, sensitivities, actions, and opinions associated with water prices and water uses:

1. **Knowledge and perceptions of water rates**
   a. Do customers know they have increasing block rates?
   b. Are customers familiar with the number, size, and price of blocks?
   c. Do customers know sewer charges are related to winter water consumption?
   d. Do customers compare current month's water use to previous use?
   e. Do customers know how many gallons they use?
   f. Are increasing block rates too complicated to understand?

2 Our definition of best fit is to pick the homes that have the minimum maximum percentage deviation from the targeted profile medians (minimax rule). For example, if we have two homes that are (2%, 2%, 2%) and (1%, 1%, 3%) +/- from the target medians of property value, lot size, and house size, respectively, then the first home would be ranked above the second home (2% is smaller than 3%).

2. **Importance of water rates**
   a. To what degree do water prices affect water use decisions?
   b. What water end uses are most sensitive to price?
   c. What is the price signal customers respond to?
3. **Policy opinions regarding water rates**
   a. Do customers want more rate information on water bill?
   b. Do customers want more information on ways to conserve water?
   c. Would customers prefer nonblock rates?
   d. Do customers believe the water agency provides water service at a reasonable cost?
4. **Sociodemographic information**
   a. Do occupants own or rent house?
   b. What type of irrigation system and grass exist?
   c. What type of water end uses (e.g., pool, type of toilets) exist?
   d. What are the number and age of occupants?
   e. What is household income?
   f. What is the age, gender, ethnicity, and education of respondent?

The survey content and wording evolved as part of a collaborative and iterative effort between the participating water agency staff and us. The survey instrument underwent informal pretesting before being finalized. Appendix A presents the survey questions and coded answers.

Survey implementation involved three contacts with water customers.

- **Advance letter.** This letter, printed on water agency letterhead and signed by utility personnel, was mailed one week before the survey mailing. This letter explained the purpose of the study, introduced the study sponsor, and asked for cooperation in completing the survey booklet they would receive in the mail. The advance letter was printed in both English and Spanish for those households identified as possibly being Hispanic. The advance letter was sent March 23, 1998.
- **Survey mailing.** The initial survey mailing contained a signed cover letter from the water agency, a survey booklet, and a business reply postage-paid return envelope. For those households identified as possibly being Hispanic, Spanish versions of the cover letter and the survey booklet were enclosed. The survey was sent March 30, 1998.
- **Thank you/reminder postcard.** One week after the survey mailing, all sampled customers received a postcard reminding them to complete and return the survey and thanking those who had already done so. The postcard was sent April 6, 1998.

We coded and entered responses from the returned surveys into a database and conducted a number of quality control steps. Table 2-3 shows the net response rates by profile sorted by response rate.

Table 2-3
Survey Response Rates

Profile	Number of Surveys Returned				Total Sent	Return %	Target Property Value
	Austin	Corpus	SAWS	Total			
1	51	49	31	131	500	26%	$18,608
11	43	51	49	143	500	29%	$48,835
6	57	58	51	166	500	33%	$28,079
2	48	57	67	172	500	34%	$29,748
7	54	74	71	199	500	40%	$44,120
3	56	65	82	203	500	41%	$38,734
12	53	74	79	206	500	41%	$70,508
13	71	75	63	209	500	42%	$84,000
14	73	90	78	241	500	48%	$104,126
8	77	87	90	254	500	51%	$60,830
4	82	90	85	257	500	51%	$52,765
15	86	88	87	261	500	52%	$174,280
9	85	87	94	266	500	53%	$77,941
5	102	83	95	280	500	56%	$92,097
10	97	86	105	288	500	58%	$118,573
Total Returned	1,035	1,114	1,127	3,276			
Total Sent	2,500	2,500	2,500	7,500			
% Returned	41%	45%	45%	44%			

Note: Profile definitions are shown in Table 2-2. An equal number of surveys were sent to each profile within each agency.

The overall 44% response rate is quite respectable for this type of survey.[3] The response rates are similar among the agencies, with Austin having a slightly lower response rate (41%) than Corpus Christi and San Antonio (45%). Additional analysis shows that the response rates do not vary much with house age. We do find, however, that the response rates decline significantly with the lower-valued homes. For homes with assessed property values less than $50,000, the response rate is 34%. For homes with assessed property values over $50,000, the response rate is 50%.

3. The gross response rate was 46%, but some surveys had the identification code removed or could not be linked with a specific customer account.

2.5 PROFILE HOMOGENEITY

The success and validity of our analytical approach are predicated on us being able to identify and collect information from a valid set of homes. Specifically, we made the following assumption. For homes within each profile, characteristics suspected to affect water consumption are balanced across all water agencies.

If this assumption holds, then the overall water use of the profile homes from each water agency would be the same, holding water/sewer prices and weather constant. This assumption serves as the backbone of our "apples to apples" comparison approach.

We analyzed the empirical evidence from the tax assessor records and the mail survey to gauge the validity of the assumption. The tables in Appendix C provide the statistics for each profile related to features of the house, sociodemographics, and general opinions on topics potentially affecting water consumption. We find a strong consistency among profiles from different agencies.

Regarding the tax assessor information, we find:

- little difference among average property values, lot sizes, and house sizes among the water agencies for each profile
- a tight distribution of property values, lot sizes, and house sizes around the profile targets.

The differences in the average values of property value, lot size, and house size from the associated profile targets never exceed +/- 2%. In 70% of the cases, deviations in the average from the profile targets are less than 1%. With respect to distribution, the average deviation between observed and profile target values over all individual homes is +/- 3.7%. In 97% of cases, the deviation is less than 10%. In no case does an individual home's property value, lot size, or house size exceed 15% of the targeted profile value.

The survey responses are summarized over all profiles in Table 2-4. In general, we find only minor differences in the survey responses among water agencies within profiles. The biggest overall difference among water agencies concerns occupants' ethnicity. Although the percentage of whites across agencies is nearly equivalent (averaging 65%), Austin has a higher black population and a lower Hispanic population (14%, 19%) than Corpus Christi (1%, 29%) and SAWS (5%, 29%). In this study, we do not specifically focus on ethnicity as a water use determinant, although ethnicity is correlated with other factors such as property value, which we do use and control for in our analysis.

Another notable difference occurs with type of grass. St. Augustine grass is reported as used by 66% of Corpus Christi homes, 56% of SAWS homes, and 51% of Austin homes. The lower use of St. Augustine grass in SAWS and Austin is equivalently offset with a higher percentage of reported "mixed grasses." The net impact on water use from this difference is unknown, but is likely to be minimal.

Table 2-4
Aggregate Profile Characteristics by Water Agency

Characteristic	Austin	Corpus	SAWS	Total	Maximum Deviation from Mean
Number of Homes Returning Surveys	1,022	1,079	1,103	3,204	
Tax Information:					
Property Value (1997 average)	$76,556	$73,020	$75,781	$75,068	2.8%
Lot Size (average ft²)	8,278	8,071	8,304	8,217	1.8%
House Size (average ft²)	1,518	1,510	1,536	1,521	0.9%
Year Home Built	1967	1969	1968	1968	
Fixtures and Landscape:					
Swimming Pool	5%	5%	8%	6%	2%
Ultra Low Flush Toilets	42%	32%	37%	37%	5%
Low Flow Showerheads	50%	[illegible]	46%	45%	2%
St. Augustine Grass	[illegible]	66%	57%	58%	9%
In-Ground Irrigation with Timer	10%	9%	15%	12%	4%
Hose-Based Irrigation System	86%	84%	79%	84%	5%
Socio-Demographics:					
Occupants per Home (average)	2.7[illegible]	2.83	2.74	2.76	2%
White	64%	67%	63%	65%	2%
Hispanic	19%	29%	29%	26%	7%
Black	17%	1%	5%	6%	7%
Annual Home Income (average)	$47,600	$52,277	$51,854	$50,284	5%
Occupants Own Home	87%	92%	93%	90%	4%
Occupants Pay Water Bill	97%	99%	98%	98%	1%
Penny Pincher Questions:					
I clip and use discount coupons for groceries	66%	69%	74%	70%	4%
I pay attention to changes in gasoline prices	83%	84%	83%	83%	1%
I have and use a monthly budget for utilities	46%	50%	53%	50%	2%
I try to keep my water bill as low as possible	77%	76%	82%	78%	4%

Table 2-4 (cont.)
Aggregate Profile Characteristics by Water Agency

Characteristic	Austin	Corpus	SAWS	Total	Maximum Deviation from Mean
Landscape Appearance Questions:					
I like my lawn and landscape to be among the best maintained in my neighborhood	48%	50%	49%	49%	1%
It is important to me for my lawn and landscape to look as good as possible	54%	54%	56%	54%	1%
Rugged Individual Questions:					
As long as I pay for it, I should have the right to use as much water as I think necessary	34%	34%	28%	32%	4%
I would rather take the chance of over-watering my lawn than not give it enough water	16%	14%	13%	14%	1%
Claims about Texas facing serious water shortages in the future are greatly exaggerated	27%	29%	37%	31%	6%
Even when there is very little rainfall, I water as much as I want	10%	8%	6%	8%	2%
Importance of Conservation Questions:					
Water conservation will help residents of this area to have a better overall quality of life	73%	73%	74%	73%	1%
Water conservation will ensure that there is enough water to meet my needs	72%	71%	72%	72%	1%
Unless people start learning how to conserve water, there is not going to be enough for everybody	69%	68%	66%	68%	2%
Water conservation will provide a better world for future generations	79%	79%	79%	79%	0%

Opinion responses include those that strongly or somewhat agree with statement.

Regarding customers' opinions, we find the biggest deviation occurs with the statement, "Claims about Texas facing serious water shortages in the future are greatly exaggerated." SAWS' customers are more likely to agree with this statement (37%) than customers in Austin (27%) or Corpus Christi (28%), although this difference is not great.

In summary, the evidence supports the assumption that characteristics are balanced across water agencies for each profile. The consistency of responses to the opinion questions, in particular, is surprising given the heterogeneity of peoples' thought processes. Although modest differences in customer characteristics do exist, we believe that this sampling approach has allowed us to control for nonprice water factors much more accurately than could be achieved through multivariate statistical modeling of a heterogeneous, random sample of homes.

2.6 WATER USE

From each of the participating water agencies, we collected monthly water use histories for each sample home. The water use observations come from water meter recordings made for billing purposes. The historical period spanned the eight years from January 1990 through December 1997. Water use is maintained in terms of thousand gallons (TG) per month.

After reviewing the water use data, we undertook three steps to "clean" the data. First, we removed billing periods that spanned less than 25 days, which occurs when there was a change in home ownership and a special final meter read was made. Second, we removed monthly observations when water consumption was zero (i.e., home vacant). Finally, we removed the highest 0.5% of water use observations from each water agency. These reads are attributed to extraordinary events (e.g., major leaks), which can unduly affect water use averages. Overall, fewer than 1% of observations were removed.

2.7 WEATHER

Weather can be an important factor affecting water use over time and among water agencies. Water use increases during hot, dry periods and decreases during cool, wet times. In particular, weather is believed to largely influence how much water is applied to landscapes such as turfgrass.

To control for weather in our analysis, we analyzed the statistical relationship between water use and maximum temperature, evapotranspiration (ET_o), and effective rainfall. ET_o is the sum of surface evaporation and plant transpiration of a reference crop (i.e., tall fescue grass) not constrained by water supply. Effective rainfall is the fraction of actual rainfall that is not lost to runoff or does not percolate past the root zone of irrigated vegetation. The effectiveness of rainfall to offset ET_o is dependent on soil infiltration rates, soil storage capacity, and the duration, frequency, and intensity of rainfall. In addition, irrigated landscape plant material, particularly turfgrass, is often grown under relatively high soil moisture levels. This implies that only a

portion of soil storage is available to absorb rain that occurs. To calculate effective rainfall we used a daily water balance simulation that considers daily rainfall, soil storage capacity, and daily ET_o as described in Appendix B. In general, effective rainfall is about a third of total rainfall.

We selected a representative weather station for each water agency, as shown in Table 2-5. For Austin and SAWS, the airports provided the only source of complete weather data we required. For Corpus Christi, several stations provided sufficient information, but we selected the Corpus Christi airport to be consistent with Austin and SAWS.

Table 2-5
Weather Stations

Water Agency	Coop Number	Coop Station Name
Austin	41-0428	Austin Airport
Corpus Christi	41-2015	Corpus Christi WSFO Airport
SAWS	41-7945	San Antonio International Airport

Averages of the weather parameters over the 1990-1997 period are shown in Table 2-6. They are close in value across agencies. Weather does vary, however, significantly over time and across agencies and needed to be controlled for in our analysis.

Table 2-6
Weather Averages 1990-97

Parameter	Austin	Corpus	SAWS	Average
Max Daily Temperature (°F)	79	81	80	80
ETo (inches/year)	52	51	53	52
Rain (inches/year)	34	31	30	32
Effective Rain (inches/year)	12	9	9	10

To control for impacts of weather on water use, we weather normalized the water use data using the following steps. First, for each water agency and for each profile we developed statistical models explaining water use as a function of the weather variables. The best model tested is

$$WATER_{a,p,t} = \beta_1 + \beta_2 * TEMP70_{a,t} + \beta_3 * TEMP90_{a,t} + \beta_4 * ERAIN_{a,t} \qquad (2\text{-}1)$$

where:

$WATER_{a,p,t}$	=	average TG for agency a for profile p in month t
$TEMP70_{a,t}$	=	°F over 70 up to 90 for agency a in month t
$TEMP90_{a,t}$	=	°F over 90 for agency a in month t
$ERAIN_{a,t}$	=	effective rainfall for agency a in month t
βs	=	ordinary least squares regression coefficients

The second step was to subtract out the impacts of nonnormal weather deviations from water use using the model results in the equation below.

$$NWATER_{a,p,t} = WATER_{a,p,t} - \beta_2 *(TEMP70_{a,t} - NTEMP70_t) - \beta_3 *(TEMP90_{a,t} - NTEMP90_t) - \beta_4 *(ERAIN_{a,t} - NERAIN_t) , \quad (2\text{-}2)$$

where:

$NWATER_{a,p,t}$	= weather normalized TG for agency a for profile p in month t
$NTEMP70_t$	= 1990-97 average TEMP70 over all agencies in calendar month t
$NTEMP90_t$	= 1990-97 average TEMP90 over all agencies in calendar month t
$NERAIN_t$	= 1990-97 average effective rain over all agencies in calendar month t

The net overall impact of this adjustment was to change average water use by 2.0%, 0.2%, and -2.1% in Austin, Corpus Christi, and SAWS, respectively. Although these changes are not great, the formula did have a greater impact on observations in particular months

2.8 WATER AND SEWER PRICES

We collected water and sewer price schedules for the three participating agencies. Below are summaries of the water and sewer rate structures used by the water agencies.

2.8.1 Austin Water Prices

In 1981, Austin moved from a declining block to a single price water rate structure.[4] The single price between November 1989 and April 1994 was $2.26/TG. In April 1994, a four-block increasing rate structure as shown in Table 2-7 was adopted

4 Actually, Austin had a zero price for the first 2 TG used each month, which technically makes it an inclining block rate structure. Because the 2 TG threshold is so low, however, we believe it is more accurate to characterize it as a single price rate structure.

Table 2-7
Austin's Water Rates

Block (TG/month)	Water Price ($/TG) Nov. 1994	Nov. 1996	Nov. 1997
0 to 2.9	$1.25	$1.25	$1.25
2.9 to 6.9	$2.00	$2.00	$2.00
6.9 to 14.9	$2.50	$2.60	$2.75
Over 14.9	$3.50	$3.80	$4.00

Over time, the prices in the first two blocks have been held constant. By the end of 1997, the price in the third block had increased to $2.75 and the price in the fourth block had increased to $4.00. Hence, Austin has moved to a fairly significant increasing block rate structure where the price in the fourth block is about 3 times the price of the first. A majority of water consumption, however, occurs in the second block where water price has decreased.

2.8.2 Corpus Christi Water Prices

Corpus Christi adopted a six-block increasing rate structure in 1984. The block thresholds have remained the same over time with the exception that the second and third blocks were consolidated in April 1997. The water rate structure is shown in Table 2-8.

Table 2-8
Corpus Christi's Water Rates

Block (TG/month)	Water Price ($/TG) Nov. 1990	Jan. 1994	Apr. 1997
0 to 2	$0.00	$0.000	$0.000
2 to 6	$1.41	$1.550	$1.569
6 to 15	$1.51	$1.663	$1.569
15 to 30	$1.90	$2.090	$2.211
30 to 50	$2.28	$2.505	$2.706
Over 50	$2.71	$2.989	$3.283

Note: Does not show rate changes effective 2/91, 8/92, 8/94, 8/95, 8/96, 1/97, or 8/97. Does not include raw water charge starting 1997

Given that it is rare that a single family home uses over 30 TG/month, the rate structure used by Corpus Christi was effectively similar in structure to Austin's four-block structure. The price differential between the second and third blocks, however, is minimal. The water prices charged by Corpus tend to be lower than those charged by Austin, especially in the third and fourth blocks.

2.8.3 SAWS Water Prices

SAWS has had some form of increasing block water rate structure since at least 1980. It has had a four-block rate structure since 1988. Further, in 1988 SAWS adopted a seasonal differential where water prices are higher during the four month summer season (July 1 to October 31). The summer increases in prices, however, have been modest in magnitude and have tended to impact only the upper blocks. Table 2-9 shows water rates for SAWS.

Table 2-9
SAWS' Water Rates

Block (TG/month)	Water Price ($/TG) Dec. 1990 Off-Peak	Dec. 1990 Peak	Sep. 1994 Off-Peak	Sep. 1994 Peak
0 to 7.5	$0.594	$0.594	$0.661	$0.661
7.5 to 12.7	$0.729	$0.802	$0.950	$1.032
12.7 to 17.2	$0.816	$0.889	$1.178	$1.270
Over 17.2	$1.628	$1.707	$2.473	$3.193

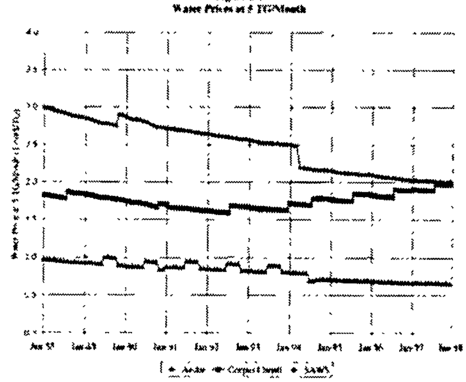
Note: The block points for the December 1990 rate structure are 3.7, 7.5, and 15.0. The peak season is July to October

2.8.4 Water Rate Comparison

Overall, relative water prices have been low in SAWS, intermediate in Corpus Christi, and relatively high in Austin. However, because rates differ at different water use levels and change over time, it is illustrative to view inflation-adjusted water prices at different consumption levels over time.

Figure 2-1 plots marginal water prices at 5 TG/month between 1988 and 1998, which is about the average water use of the lower income profiles. We see a clear decreasing trend in water price over time at this level in both Austin and SAWS. Austin's price is about 3 times that of SAWS. Corpus Christi's water price at 5 TG/month, in contrast, has been relatively steady over time.

Figure 2-1
Water Prices at 5 TG/Month



At the 10 TG/month level, typical of the average water use of the higher wealth profiles, we see inflation-adjusted prices are fairly constant over this period with all agencies, as shown in Figure 2-2. Austin's water price is about 2.5 to 3 times that of SAWS. Corpus Christi is in the midrange at about $2/TG

Lastly, Figure 2-3 shows marginal water prices over this period at the 20 TG/month level. This consumption level is typically exceeded only by homes in the higher wealth profiles during the summer months. Up until April 1994, real water prices were decreasing at all three agencies in a consistent and proportionate fashion. Austin's price was about 1.5 times SAWS' price and 1.25 times Corpus Christi's price. In April 1994, Austin adopted its increasing block rate structure, which increased water prices by about 50% for water use above 14.9 TG/month. In June 1994, SAWS also increased its water prices significantly for water use above 17.2 TG/month during both the peak and off-peak periods. This includes a brief two month period in 1996 (July 15 to September 15), when water price equaled $6.39/TG

2.8.5 Water Bill Comparison

Differences in water prices are not the only factor that can affect customers' sensitivity to water price. Another factor is the level and clarity of information provided on the water bill. When detailed information is provided in a clear, concise fashion, customers can be expected to act more rationally with respect to their water purchases. In effect, a well-designed water bill lowers the informational costs borne by customers with respect to analyzing the financial impacts of their water consumption decisions.

We collected water bills from each of the agencies (as presented in Appendix D) and make the following observations:

- All agencies charge for water service on a utility bill that includes other utility services. Austin includes water, wastewater, electric, solid waste, and storm water charges on its bill. Corpus Christi includes water, wastewater, natural gas, and solid waste charges on its bill. SAWS includes water, wastewater, and storm water charges.
- No agency shows the entire water rate structure on the monthly bill. Water prices are shown only for those rate blocks for which a customer is charged.
- SAWS' customer bills include a histogram showing water use for the previous 12 months for that account along with a personalized message regarding changes in water use patterns. For comparison purposes, it also includes the neighborhood and overall SAWS average residential water use for that month. In contrast, neither Austin nor Corpus Christi provides historical water use information on their bills.

The first observation is important as water typically accounts for only 20 to 30% of the total utility bill. Hence, for those customers looking at only the overall total utility bill, the water

Figure 2-2
Water Prices at 10 TG/Month

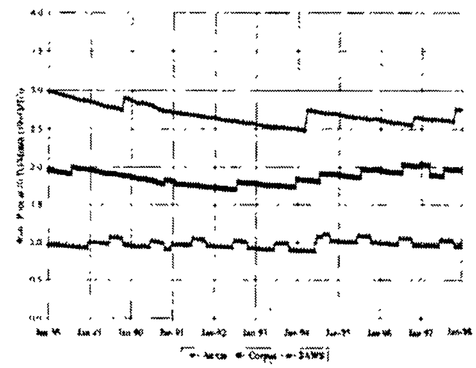
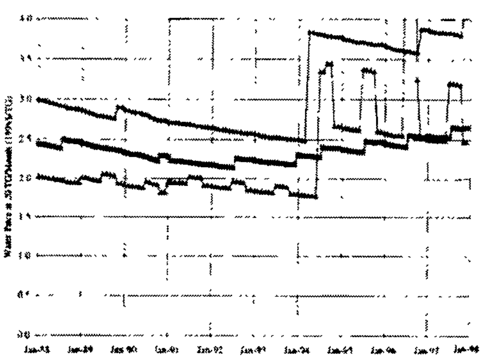


Figure 2-3
Water Prices at 20 TG/Month



charge may become "lost" among the other charges from some customers' perspective. The second important point is that the SAWS bill provides a much greater level of detail regarding historical water use

2.8.6 Sewer Prices

Homes within all three water agencies have their sewer (wastewater) charges based as a partial function of winter water consumption (3 months). Hence, the sewer charge can play a role in the economic price signal sent to customers to use water prudently

Figure 2-4 shows the sewer price per TG of winter water consumption in the three cities from 1988 to 1998.[5] We see that the sewer price per TG is much higher in Austin than in Corpus Christi and SAWS. If we are to include sewer prices as part of the overall water price signal, we need to multiply the sewer prices shown in Figure 2-4 by four. This is done to reflect the fact that saving a unit of water in the winter will reduce the sewer bill not only during the winter months but also for the other nine months of the year. Hence, for the three winter months the sewer price is quite high and for the other nine months the effective sewer price is zero.[6]

Some qualifications need to be made, however, with respect to sewer price. First, because of differences in the fixed monthly service charge, differences in the total sewer bill may not be large. For example, the total sewer bill for Corpus Christi customers is typically larger than that for Austin customers because Corpus Christi's current fixed charge of $10.75/month is much higher than Austin's fixed charge of $3.25/month. In addition, because of the complexity and time delay involved with the calculation of the sewer bill, it is not at all clear that customers understand and react to the sewer bill by altering winter water consumption. We look to the mail survey to help guide us in this area.

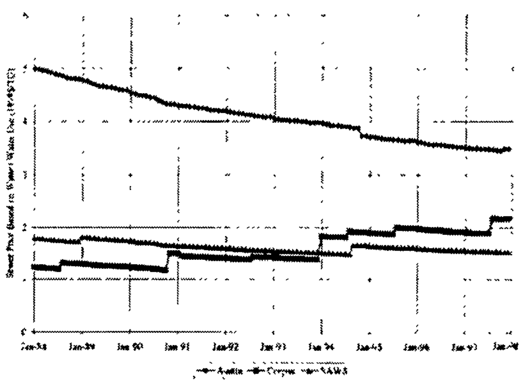
2.9 CONSERVATION PROGRAMS

Water agency-run conservation programs can potentially affect water use trends over time. Over the 1990-1997 period, Austin, Corpus Christi, and SAWS conducted a number of direct conservation programs aimed at single family homes, other than water conservation education, as described below

5. This sewer price is for water use over 2 TG/month except in Austin after April 1994, where it reflects water use over 2.9 TG/month

6. In Austin, sewer price is applied to water year round, but cannot exceed the winter water use level. Because water use in the nonwinter almost always exceeds winter consumption, the sewer price signal in the nonwinter months is effectively zero

Figure 2-4
Sewer Prices



Austin's programs consisted of providing financial incentives for installation of ultra-low flush toilets (ULFTs), providing free audits of indoor and outdoor water uses to customers requesting service, and a financial incentive program to install low watering using landscapes (xeriscape). Most of these programs' efforts, especially the ULFTs, took place during and after 1994.

SAWS' direct conservation programs consisted of financial incentives for ULFTs ("Kick the Can") and for installing low-water-using landscapes. These conservation programs also took place during and after 1994.

We believe that Corpus Christi's conservation programs are less extensive than Austin's, but Corpus Christi did not provide data on their programs.

The presence of these conservation programs needed to be factored into our evaluation of the impacts of water prices. We make the following three observations:

- There is a link between water pricing and customer interest in participating in water conservation programs. In the relatively high water priced Austin, for example, customers are more interested in and receive greater financial savings for water conservation activities (e.g., installing a ULFT). Hence, the efficacy of conservation programs may be largely a function of water price.
- Most of the conservation programs' efforts took place during and after 1994. Hence, over the 1990-1993 portion of our study period, water conservation program differences among agencies are not likely to have a large net impact.
- These direct conservation programs affected fewer than 10% of total homes in each agency over the 1990-1997 period. Hence, it is likely that the total water use impact may not exceed a few percent.

CHAPTER 3
ANALYSIS OF SURVEY RESULTS ON PRICE SIGNAL

What is the price signal perceived by water customers from increasing block rates and sewer charges? This chapter presents results from the mail survey addressing customers' knowledge, perception, sensitivity, and opinions concerning water pricing.

3.1 MULTIPLE PRICE SIGNALS: MARGINAL OR AVERAGE PRICE?

If water agencies 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. This issue is particularly relevant to this study because Austin, Corpus Christi, and SAWS all currently employ increasing block rate structures with four or more rate blocks.

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 consumer 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:

- The costs of assimilating and understanding exact block pricing information may be unacceptable to some customers. Complicated block rate schedules, uninformative billing statements, and compounding sewer charges increase the costs and abilities needed to process relevant information.
- Customers have limited knowledge regarding the quantity of water associated with specific end uses. Water agencies record and bill customers for aggregate water use over a billing period. The water use associated with specific end uses such as toilets, washing machines, and outdoor irrigation is not 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 isolate the water use impact associated with a specific action when looking at aggregated water use.

- Marginal water price is not known at the time water use decisions are made. At the beginning of billing period, customers may have only a vague notion of how much water will be used during the period given uncertainties regarding weather, occupants, and leaks among other factors.
- The water bill accounts for only a small percentage of disposable income, often less than 1%. If water prices increased so that water bills averaged $5,000 a year instead of $300, customers would be much more interested in finding ways to reduce water consumption.

As the cost of obtaining information increases (i.e., understanding the block rate structure, estimating water associated with end uses, forecasting probable marginal prices) and the benefit derived from the information is small (i.e., small relative financial impact), the incentive for the rational utility maximizing customer to obtain and react to perfect information decreases. In fact, the rational decision may be to make a quick estimate of the situation using average prices and uses.

Given the heterogeneity of customers and circumstances, most assuredly there is not one single price specification that perfectly and universally explains customers' water use demand. Some well-informed customers may react to marginal prices. Others may approximate the situation and respond to average of prices. Still, for others, water prices may be irrelevant given current conditions. It is difficult to assess customers' *perception* of block rates on theoretical grounds. Hence, we devised a number of questions in the mail survey to guide us in the area of price specification.

3.2 SURVEY RESULTS ON WATER PRICING

The survey instrument included a number of questions concerning customers' knowledge, perception, sensitivity, and opinions concerning water pricing. There are many interesting and useful observations resulting from the survey regarding many subjects. Here we focus and report on the results most relevant to price specification.

In general, we identified four clusters of customers, as shown in Table 3-1 and Figure 3-1.

Detailed listings of the responses to the water pricing questions are summarized by water agency in Tables 3-2 and 3-3, and discussed by topic in the following sections.

3.2.1 Price Knowledge

Customers are generally not knowledgeable regarding the specifics of their water and sewer rate structures. Only 36% knew the number of water rate blocks, and only 24% were familiar with the block water prices. Regarding sewer service, only 38% knew that water use was based on winter water consumption. Even when customers were presented with the water rate schedule, only

Table 3-1
General Types of Customers Regarding Water Pricing

Pricing Sensitivity and Knowledge	Description	Approximate % of Customers
Unconcerned and Unaware	Water cost not important, does not follow historical water use, not knowledgeable of water rate structure, unaware of water/sewer link	25%
Concerned but Unaware	Water cost important, follows historical water use, not knowledgeable of water rate structure, unaware of water/sewer link	50%
Concerned and Somewhat Aware	Water cost important, follows historical water use, somewhat knowledgeable of water rate structure and water/sewer link, not aware of average or marginal water price	18%
Concerned and Aware	Water cost important, follows historical water use, knowledgeable of water rate structure and water/sewer link aware of average or marginal water prices	7%

69% agreed that they could calculate their water bill at 8 TG. Very few (21%) find the rate block thresholds useful in targeting their water use.

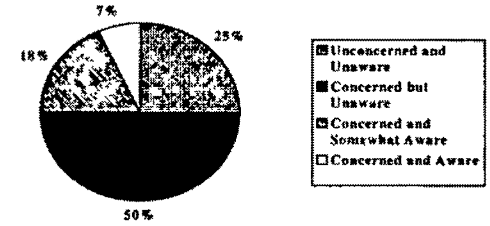
In general, Corpus Christi customers were less knowledgeable of their rate structure. Only 30% of Corpus Christi customers are aware of a raw water surcharge (unique to Corpus Christi). Overall, 56% of people responded that their water bill did a good job at explaining water rates. This rating was lower for Corpus Christi (42%) and significantly higher for SAWS (76%). It is interesting that only 23% agreed that the block water rates are too complicated to understand. Lack of knowledge of their water rate structures is apparently driven largely by indifference.

Although not knowledgeable of the specifics, most customers did report that they know water price increases with increasing use (68%). Customers are much more cognizant of the total dollar amount of the water bill (63%) than the volume of water used (38%) or the associated water prices (24%).

3.2.2 Price Sensitivity

Survey results show customers are only somewhat sensitive to water and sewer prices, 22% of homes report that water price rarely influences water use decisions. For most homes (53%), people report that they understand that if they use less water their water bill will go down, but do not take the time to estimate by how much. Hence, this implies that a combined 75% of people report that they do not incorporate the specifics of a water rate structure into their water use

Figure 3-1
General Types of Customers Regarding Water Pricing



decisions. Only 19% of homes report that they go the extra step to guess by how much their water bill may decrease by a specific water-related action. Only 4% report that they actually make mathematical calculations based on an approximated average water price, and 3% report that they make decisions based on marginal water price.

Water price sensitivity is seen to vary with type of end use. Only 56% of respondents agree that water price is important in decisions related to indoor use.[1] Similarly, only 50% and 62% of people agree water price is an important factor when selecting the area and types of plants in the landscape, respectively. When it comes to lawn irrigation, in contrast, 74% report water cost as important.

Regarding sewer prices, only 38% of customers correctly realized the link between water consumption and the sewer (wastewater) bill. A full 26% of people have no idea about the calculation of their sewer bill, and 34% misunderstand its calculation. These results are supported by responses to another question, where only 48% of customers report factoring in sewer prices when making water use decisions.

1. For the less wealthy people, however, 72% responded that they are sensitive to water price. This most likely is because the cost of water for indoor purposes comprises a relatively larger share of total disposable income.

Table 3-2
Survey Responses Concerning Water Bill and Rate Structure

Question	% Strongly or Somewhat Agree			
	Austin	Corpus Christi	SAWS	Average
Each month I look at the dollar amount of my bill, but not the details related to the water portion of the bill	38%	42%	36%	39%
Each month, I compare my current month's water consumption to past months	55%	62%	**78%**	65%
I (would) like my water bill to show my water use over the last 12 months	62%	65%	**75%**	67%
I (would) like my water bill to show the average water use of homes in my neighborhood	56%	54%	**74%**	61%
I would like to learn more about how to conserve water and reduce my water bill	72%	67%	71%	70%
I know the approximate dollar amount of my average monthly water bill in 1997	54%	61%	**75%**	63%
I know the approximate dollar amount of my highest monthly water bill in 1997	46%	51%	**65%**	54%
I know the approximate number of gallons of water my household used during an average month in 1997	29%	42%	42%	38%
I know the approximate number of gallons of water my household used during the highest-use month in 1997	25%	37%	37%	33%
Water cost is important to me when deciding how much water to use indoors (e.g., dish washing, clothes washing)	55%	56%	58%	56%
Water cost is important to me when deciding how large our lawn should be	49%	46%	54%	50%
Water cost is important to me when selecting the types of plants and grass to use in our landscape	62%	57%	67%	62%
Water cost is important to me when deciding how and when to water our lawn	72%	70%	78%	74%
I take into account the cost of wastewater (sewer) service when deciding how much water to use	49%	47%	48%	48%
Before today, I knew there were 4 (or 5) different prices for water depending on how much I use	41%	**27%**	42%	36%
Before today, I know that the price of water goes up as I use more water	71%	**57%**	77%	68%
Before today, I was familiar with the specific water prices shown below	28%	**18%**	27%	24%

Table 3-2 (cont.)
Survey Responses Concerning Water Bill and Rate Structure

Question	% Strongly or Somewhat Agree			
	Austin	Corpus Christi	SAWS	Average
Before today, I knew that the price of water tends to increase during the summer months			79%	79%
Before today, I knew there was a raw water charge between $0.25 to $0.35 per 1,000 gallons		30%		30%
I can calculate my water bill for 8,000 gallons using the table below	76%	65%	67%	69%
I use the gallons per month levels shown below to set goals about how much water to use	18%	21%	23%	21%
The information on my monthly bill does a good job of explaining my water rates/charges	51%	**42%**	**76%**	56%
I believe I should pay the same price for each gallon of water no matter how much I use	36%	36%	35%	35%
I believe my current water rates are too complicated and are difficult to understand	25%	26%	19%	23%
Note: Bolded numbers refer to significant differences				

3.2.3 Water Bill

Most people report (65%) that they compare their current month's water consumption to past months and that they want to see this information on the bill (67%). A majority also want to see how their water consumption compares to their neighborhood water use for the month (61%). SAWS customers are more likely (74%) to want this type of detailed information; coincidentally, they are the only ones currently receiving this information on their water bills. Hence, we conclude that once exposed to the concept, customers like receiving the additional water use information. In addition, we infer that the inclusion of past water consumption on the bill will cause about 20% more customers to analyze their water consumption each month.

It is clear that customers focus more on the dollar amount of the bill than the volume of water used. 63% of customers reported knowing the approximate dollar amount of their monthly water bill in 1997, and only 38% reported knowing the average number of gallons. Further, customers consistently reported knowing more about their average bill than their peak month bill. In comparing the agencies, SAWS customers knew more about the dollar amounts and gallons used. This is most likely a result of their more detailed water bill. A majority of customers (70%) want more information on ways to conserve water and reduce their water bills. This is consistent across all agencies and profiles.

Table 3-3 Survey Responses Concerning Water Price Signal				
Description	**Austin**	**Corpus Christi**	**SAWS**	**Average**
In the past, when you considered using less water to reduce your bill, which of the following statements comes closest to describing your thinking?				
Water price has rarely influenced my water use decisions	18%	26%	21%	22%
I knew that my water bill would go down if I used less water, but I did not take the time to estimate by how much.	56%	50%	52%	53%
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	19%	18%	20%	19%
I thought about how many gallons of water we would probably save, and calculated my water bill dollar savings using an average per gallon water price.	4%	4%	4%	4%
I thought about how many gallons of water we would probably save, and calculated my water bill dollar savings using exact per gallon water prices for different levels of water use.	3%	2%	3%	3%
Which of the following best describes your current understanding of how you are charged for your wastewater (sewer) service?				
It does not depend on how much water we use	7%	4%	8%	6%
It depends on how much water we use only during the winter months. (Austin response 3)	44%	40%	31%	38%
It depends on how much water we use each month (Austin response 2)	9%	39%	37%	28%
We have a septic system. We are not connected to a wastewater utility.	1%	0%	1%	1%
Don't know	39%	17%	23%	26%

3.3 CONCLUSIONS REGARDING PRICE SIGNAL

From the survey results, the major findings regarding price signal are as follows

- Only 25% of customers report assessing the financial impacts of water use decisions quantitatively. Only 3% report using marginal price in their decisions.
- Customers concerned about their water bill focus on the total dollar amount. They are much less knowledgeable of the details of the water rate structure and its prices.

- Price sensitivity is greatest with respect to outdoor irrigation.
- The link between winter water use and the sewer bill is not well recognized by customers.

With respect to price signal, there is no single, perfect answer explaining how all people perceive block prices. However, it seems that the assumption that customers know and respond to perfect information regarding water pricing and use is a stretch.

It is interesting to contrast water demand with gasoline demand. Gasoline has a measurement that is easily visualized (e.g., gallon), is frequently purchased for a single end use (e.g., car getting 20 miles per gallon), and is sold at a single, well-advertised price. Utility water is sold in hard-to-fathom units (e.g., thousand gallons), for consumption aggregated over many end uses over a month, and at multiple, often nonadvertised prices on a combined utility bill. As a consequence, it is logical that more respondents report being familiar with gasoline prices (83%) than water prices (24%).

3.4 PRICE SPECIFICATION ALTERNATIVES

Ultimately, the true price signal comprises all relevant water and sewer prices along with the information on the water bill. When comparing water consumption among agencies, all these circumstances are relevant. Identifying a "single price signal" is for the convenience of water agencies looking to draw inferences from this study to their situation. Because all price and presentation circumstances cannot be duplicated, practitioners need a simpler measure for comparisons. Hence, we attempt to identify the best price specification because the results from this study are intended for a wider audience.

In Chapter 4 we investigate the relative merits of marginal and average water prices in explaining observed profile water use differences. Marginal price has theoretical appeal and has been used in most previous water demand studies. The lack of price savvy expressed by customers via the survey, however, does not allow us to rule out average price as the superior choice. With respect to sewer prices, the survey lends suspicion of inclusion of sewer price in the overall price signal. Hence, our analysis is conducted with and without its presence. This results in four possible specifications, as shown in Table 3-4.

The participating water agencies at times charged a zero price for the first 2 TG/month. In these cases we assumed marginal price equaled the second block marginal price. Hence, our marginal price variable was never zero. We also defined average price to equal the simple average price paid for all units of water above 2 TG/month. Average price did not include the fixed charge portion of the water bill.

Table 3-4 Price Specification Alternatives		
Alternative	**Water Price Specification**	**Sewer Price**
1	Marginal price	Not included
2	Average price	Not included
3	Marginal price	Included
4	Average price	Included

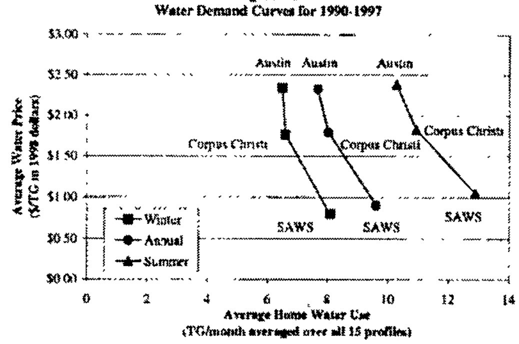
CHAPTER 4
ANALYSIS OF AVERAGE HOME WATER USE BY PROFILE

This chapter investigates a number of questions regarding how water use varies with water price. In this analysis, water use is averaged over all homes for a given profile, time period, and agency. This results in 4,320 water use observations (15 profiles x 8 years x 12 months x 3 agencies).

4.1 DOES WATER USE DECLINE WITH INCREASING PRICE?

Figure 4-1 plots the overall demand curves based on average home water use and average water price. Separate demand curves for winter consumption (January), annual consumption, and summer consumption (July, August, and September) are shown. All of the demand curves are downward sloping. This finding is consistent with the first law of demand. The demand curves derived using the other alternative price specifications in Table 3-4 also exhibit this result.

Figure 4-1
Water Demand Curves for 1990-1997



To quantify the sensitivity of customers to price, we calculate price elasticities of demand. Table 4-1 lists are price elasticities using the high price demand curve points from Austin and the low price demand curve points from SAWS as reference. Price elasticities are shown for all 15 profiles using four different price specifications and three different periods (winter, annual, and summer). We believe that these price elasticities should be interpreted as long run in nature because the cross-sectional differences in prices have been relatively constant over many years.

Table 4-1 results clearly show that the quantity of water demanded decreases with increasing price. The 15 profile composite price elasticity ranges from -0.21 to -0.36 depending on time of year and price specification. In looking at individual profiles, we find that 184 of the 192 price elasticity estimates calculated have the expected negative sign. The only exceptions occur in profiles 3 and 7 where winter price elasticities are zero. Zero price elasticities occur because average 1990-1997 winter water consumption in Austin and SAWS for these profiles was the same. In no case was a positive price elasticity found.[1]

Conclusion: The quantity of water demanded decreases with increasing water prices.

4.2 Is Average Price or Marginal Price the Best Specification?

One of the primary research objectives of this study is to judge whether customers tend to respond to average or marginal prices. The results of Table 4-1, unfortunately, do not shed much light on the subject. The price elasticities derived using the average price and marginal price assumptions are similar and within the reasonable range of expectation. If price elasticities were positive for one specification and negative with the other, for example, then we would favor the one exhibiting the expected negative elasticities. Or if price elasticities were exceptionally negative with one specification (e.g., more negative than -1), then we would favor the other. This latter case does occur with profile 15. Regarding summer water use in profile 15, the estimated marginal price elasticity is -1.78 and the average price elasticity is -0.54. For this profile, the average price specification is more plausible. No similar distinctions, however, can be made in looking at the other 14 profiles.

To further investigate distinctions between average and marginal prices, we sought situations where we could compare profile water use between two agencies where:

- marginal prices are the same and average prices are different
- marginal prices are different and average prices are the same.

1. We also calculated are price elasticities for water use and prices averaged over the 1990-1993 period. This period had minimal differences in direct conservation programs among the agencies. The resulting price elasticities are very similar to those shown in Table 4-1. The composite price elasticities using the average water price specification, for example, are -0.21, -0.22, and -0.29 for the winter, annual, and summer time frames, respectively.

Table 4-1
Price Elasticity of Annual Water Demand by Profile

	Alternative Price Specifications											
	Marginal Water Price			Average Water Price			Marginal Water Price and Sewer Price			Average Water Price and Sewer Price		
Profile	Winter	Annual	Summer	Winter	Annual	Summer	Winter	Annual	Summer	Winter	Annual	Summer
1	-0.29	-0.24	-0.23	-0.27	-0.22	-0.20	-0.31	-0.25	-0.23	-0.31	-0.24	-0.20
2	-0.19	-0.36	-0.44	-0.35	-0.39	-0.44	-0.20	-0.33	-0.51	-0.23	-0.3	-0.44
3	0.00	-0.03	-0.07	-0.01	-0.02	-0.06	0.00	-0.02	-0.07	0.00	-0.02	-0.06
4	-0.31	-0.31	-0.3	-0.28	-0.26	-0.26	-0.33	-0.31	-0.32	-0.32	-0.28	-0.26
5	-0.32	-0.18	-0.10	-0.29	-0.14	-0.06	-0.34	-0.17	-0.10	-0.34	-0.15	-0.06
6	-0.38	-0.37	-0.46	-0.33	-0.31	-0.34	-0.37	-0.34	-0.45	-0.37	-0.32	-0.34
7	0.00	-0.07	-0.19	0.00	-0.06	-0.14	0.00	-0.07	-0.19	0.00	-0.06	-0.14
8	-0.21	-0.17	-0.22	-0.21	-0.14	-0.16	-0.23	-0.17	-0.22	-0.23	-0.16	-0.16
9	-0.21	-0.17	-0.18	-0.14	-0.13	-0.12	-0.22	-0.16	-0.16	-0.22	-0.14	-0.13
10	-0.30	-0.28	-0.43	-0.25	-0.19	-0.20	-0.30	-0.23	-0.45	-0.30	-0.20	-0.20
11	-0.07	-0.11	-0.14	-0.06	-0.10	-0.12	-0.08	-0.11	-0.14	-0.07	-0.10	-0.12
12	-0.21	-0.17	-0.18	-0.21	-0.15	-0.13	-0.23	-0.17	-0.18	-0.23	-0.16	-0.13
13	-0.28	-0.46	-0.77	-0.28	-0.36	-0.46	-0.30	-0.40	-0.77	-0.30	-0.36	-0.46
14	-0.13	-0.23	-0.31	-0.12	-0.19	-0.21	-0.14	-0.21	-0.31	-0.14	-0.19	-0.21
15	-1.52	-0.84	-1.78	-0.41	-0.48	-0.54	-0.47	-0.59	-1.78	-0.46	-0.46	-0.54
Composite	-0.21	-0.26	-0.36	-0.21	-0.21	-0.21	-0.24	-0.26	-0.36	-0.24	-0.22	-0.23

Note: Shown are elasticities of water demand between low price SAWS and high price Austin. Water use and prices are averaged over 1990-1997 and water use is weather adjusted. Winter includes January and summer includes July, August and September.

Either of these situations would allow us to focus on the price specification question. Unfortunately, this type of situation does not exist over the profiles, study period, and agencies participating in this study.

We can, however, make use of the fact that Austin used a single (nonblock) water price until April 1994, when it switched to an increasing four block rate structure. A useful circumstance with a single water price is that both average and marginal prices are the same. With the introduction of block rates, marginal and average prices diverge. Water use changes after the introduction of block rates can be analyzed to see if they are better explained by changes in average or marginal price. Water use, average price, and marginal price during the summer season for Austin are shown in Figures 4-2, 4-3, and 4-4 respectively.

Figure 4-2
Austin Summer Water Use over Time: 15 Profiles

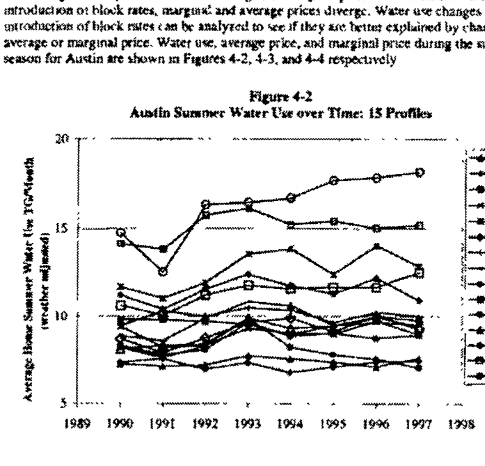


Table 4-2 shows the results from our pre/post block rate structure evaluation for Austin. We focus on situations where average price and marginal price changed in different directions with the inception of block rates. This occurred in the higher water using profiles, where marginal water price increased (tended to enter the fourth rate block) and average price decreased. In all other profiles, both average and marginal prices (inflation adjusted) decreased, prohibiting such distinctions.

Figure 4-3
Average Summer Water Price over Time: Austin by Profile

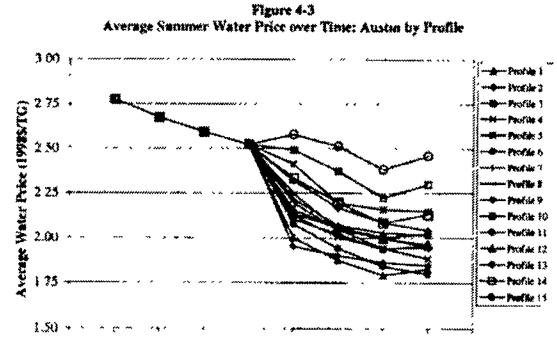


Figure 4-4
Summer Marginal Water Price over Time: Austin by Profile

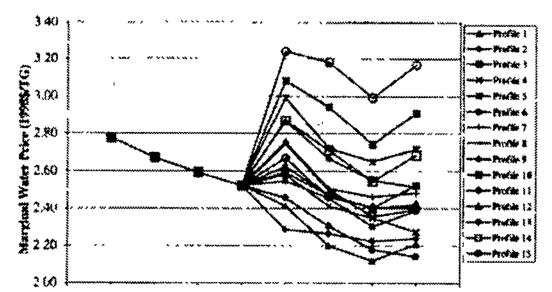


Table 4-2
Austin Water and Price Changes from Inception of Block Rates

Profile	Time of Year	% Change between 1990-1993 and 1995-1997		
		Water Use	Marginal Price	Average Price
5	Peak	8.3%	2.1%	-19.7%
10	Peak	1.7%	8.2%	-13.9%
14	Peak	9.1%	0.3%	-21.1%
15	Peak	17.5%	16.4%	-7.4%
15	Annual	7.1%	5.7%	16.0%

Note: Water and price observations for 1994 were not used because 1994 was the year of the rate structure change.

The results of Table 4-2 show that in all profiles where marginal price increased, water use also increased — this is inconsistent with expectations. We do see, however, that average price decreased in each one of these cases. Decreasing average prices are consistent with the observed increases in water use. Hence, this evidence supports the hypothesis that average price is the better price signal. Apparently, customers that are presented with higher marginal prices but a lower total water bill are not inclined to reduce water consumption. In fact, the lower total bill appears to have encouraged them to increase consumption.[2]

It should be noted that for the highest water using customers in Austin, the inception of block rates caused average price to increase significantly. Although this customer group was not analyzed as part of this study (not likely to be part of an identified profile), it is expected that their water use declined after 1994.

Conclusion: Average price is better than marginal price in explaining the quantity of water demanded by a single family home. This conclusion is consistent with the general lack of awareness of block rates reported in the mail survey.

Conclusion: In Austin's case, a switch from a single water price to block rates in 1994 did not tend to lower water consumption for the 15 customer profiles studied. An explanation for this finding is that average water prices (inflation adjusted) dropped within all profiles after 1994, even for those profiles experiencing an increase in marginal water prices.

2. Because Austin accelerated its direct conservation programs after 1994 (ULFT rebate programs), the finding that water used increased after the 1994 rate structure change with these profiles is even more striking.

4.3 IS SEWER PRICE PART OF THE PRICE SIGNAL?

Table 4-1 shows the price elasticity estimates for the average and marginal price specifications both with and without the sewer charge included as part of the price signal. Price elasticities do not vary much with sewer charge inclusion/exclusion. This results largely from the fact that sewer price differences across the agencies are similar in proportion to the water price differences (e.g., Austin has the highest water prices and the highest sewer prices). Hence, we cannot make a determination about the effects of sewer prices from this evidence.

To further investigate the impact of sewer prices, we sought situations where we could compare profile water use between two agencies where

- average water prices are the same and the combined average water and sewer prices are different
- average water prices are different and the combined average water and sewer prices are the same

The latter situation occurs between Corpus Christi and SAWS over the 1990-1993 period when the combined average winter water and sewer prices are nearly identical, but the average winter water price in Corpus Christi is about 70% higher.[3] If sewer price is part of the total price signal that customers respond to, then we would expect winter water use differences between Corpus and SAWS to be minimal.

Table 4-3 shows that winter water use is much lower in Corpus Christi than in SAWS in each of the 15 profiles, with the composite difference over all profiles being -22%. Hence, we reject the specification of combined average water prices and sewer prices. The average water price specification (without sewer), however, does a good job of explaining the water use differences. In fact, the implied price elasticity using the average price specification is -0.31. This is not far from the -0.21 composite price elasticity estimate shown in Table 4-1.

We explored this finding in more detail by alternatively hypothesizing that winter water use within a profile is impacted not by just winter prices, but by some average of prices throughout the year. The reasoning behind this is that for customers installing water-conserving technology (e.g., ultra-low flush toilets) to reduce winter (indoor) water use, the financial savings would accrue not only in winter, but for all months of the year. Based on this hypothesis, we compared winter water use differences to annual price differences. The results in Table 4-3 show that

3. In addition, the 1990-1993 period has minimal direct conservation program differences as described in Section 2.9.

annual average water price without sewer is better in explaining the difference in water use between Corpus Christi and SAWS.[4]

Conclusion: Customers do not tend to factor in sewer prices into their water use decisions. This conclusion is also supported by the survey results showing that only 38% of customers correctly realize the link between water consumption and the sewer bill.

Table 4-3
Sewer Price Signal Comparison: % Difference in Corpus Christi Relative to SAWS, 1990-1993

Profile	Winter Water Use	Winter Average Water Price Plus Sewer Price	Winter Average Water Price	Annual Average Water Price Plus Sewer Price	Annual Average Water Price
1	-32%	-5%	70%	6%	66%
2	14%	-3%	71%	18%	65%
3	-17%	-4%	72%	16%	64%
4	-20%	-3%	70%	15%	63%
5	-26%	-4%	70%	13%	60%
6	-36%	-5%	67%	13%	61%
7	-36%	-4%	68%	13%	62%
8	22%	3%	70%	18%	62%
9	-12%	-2%	70%	18%	61%
10	-31%	-3%	66%	17%	53%
11	-14%	-2%	70%	13%	66%
12	-6%	-2%	70%	16%	64%
13	-16%	-2%	70%	21%	60%
14	-3%	-2%	71%	24%	59%
15	-32%	-3%	60%	16%	45%
Composite	-22%	-3%	69%	16%	61%

Note: The composite arc price elasticity using the winter average water price specification is -0.31 (-22%/69%), which is only slightly more than the -0.21 composite price elasticity estimated in Table 4-1. The arc price elasticity using the winter average water price plus sewer price specification is 6.9 (-22%/-3%), which is unrealistic.
If winter use is posed as a function of annual prices, alternatively, the composite arc price elasticity using annual average water price is -0.35 (-22%/61%) and using annual average water price plus sewer price is -1.38 (-22%/16%). In both cases, evidence suggests customers' winter water use is best explained by average water price alone, without the inclusion of sewer prices.

4. The finding that sewer prices do not help explain winter water use differences does not depend on selection of average or marginal water price. Winter average water prices and winter marginal water prices are almost identical (customers on lower rate blocks) in this case, leading to the same results and conclusion.

4.4 DOES THE CONTENT OF THE WATER BILL IMPACT RESULTS?

SAWS' water bills contain detailed water use information, including a histogram of home water use over the previous 12 months. In contrast, neither Austin nor Corpus Christi provides historical water use information.

One could postulate that the enhanced information on the SAWS water bills increases the awareness and understanding of its customers regarding water pricing and use by making it more convenient (lowering the costs) to study the price-quantity relationship. If this is true, one could further postulate that SAWS' informed customers are more likely to respond to marginal water prices than to average water prices. Informed customers are more likely to assess the financial impacts of water use decisions in terms of marginal prices.

To investigate the impact of water bill content, we sought situations where we could compare water use between two agencies for profiles where:

- water prices are the same and the water bill content differs.

Unfortunately, SAWS' water prices (both average and marginal) are much lower than those of either Corpus Christi or Austin. Hence, we could not analyze this situation in this study.

Conclusion: The informational content of the water bill may affect customers' perceived price specification, but this hypothesis could not be tested in this study.

4.5 DOES PRICE ELASTICITY VARY WITH HOUSE AGE OR HOUSEHOLD INCOME?

Understanding the relationship between price elasticity and factors such as house age and household income can potentially assist water managers in assessing the expected impacts from alternative block rate structures in their service areas. In our analysis of house age, we find that price elasticity is independent of house age. Table 4-4 shows the aggregate price elasticities for the three groupings of house age used in this study.

Table 4-4
Price Elasticity and House Age

House Age	Aggregate Price Elasticity
Pre-1960 (Profiles 1-5)	-0.19
1960 to 1979 (Profiles 6-10)	-0.17
1980 to 1993 (Profiles 11-14)	-0.20

Note: Price elasticity of annual water use based on the average water price specification. Profile 15 is not included.

Ignoring profile 15, we also found no correlation between price elasticity and wealth using ordinary least squares regression techniques. Profile 15, however, does offer evidence that price elasticity may be higher with the most wealthy customers. Profile 15 price elasticity is -0.48, as shown in Table 4-5, which is much higher than the composite profile average of -0.21. The puzzling aspect to this is that the price elasticities for the next highest wealthy profiles are both -0.19. One could conclude that the profile 15 result is some random or specific outcome unique to profile 15. Or, one could conclude that price elasticity takes a step jump when household income exceeds approximately $100,000 per year. More evidence is needed to make a determination.

Table 4-5
Price Elasticity and Wealth

Profile	Price Elasticity	Average Reported Annual Household Income	Average Tax Assessed Property Value
1	-0.22	$22,145	$18,608
2	-0.30	$24,300	$29,748
6	-0.31	$26,493	$28,079
3	-0.02	$27,255	$38,734
7	-0.06	$33,241	$44,120
4	-0.26	$35,915	$52,765
11	0.10	$38,159	$48,880
8	-0.14	$40,803	$60,830
12	-0.15	$48,934	$70,390
9	-0.13	$51,123	$77,941
5	-0.14	$53,715	$91,583
13	-0.35	$57,027	$84,001
10	0.19	$72,975	$118,573
14	-0.19	$74,434	$104,126
15	-0.48	$110,958	$174,427
Composite	-0.21	$47,832	$69,547

Note: Price elasticities based on annual water use and the average water price specification. Ordinary least squares regressions explaining price elasticity (profile 15 not included) as a function of either income or property value resulted in F-statistics of 0.005 and 0.009 which indicate there is no linear correlation.

Conclusion: Price elasticity is not correlated with house age or wealth, at least when household income is less than $100,000 per year.

4.6 WHAT IS THE OVERALL WEIGHTED PRICE ELASTICITY FOR EACH AGENCY?

Because price elasticity varies with profile, a water agency needs to assess the degree that each profile is representative to the mix of housing in its service area. For the three participating agencies, we calculated the percentage of homes falling into each one of the profile definitions (based on house age and tax assessed property value). Multiplying each profile percentage by the derived price elasticity provides an overall weighted price elasticity as shown in Table 4-6. The overall weighted price elasticities for Austin, Corpus Christi, and SAWS are -0.17, -0.20, and -0.20, respectively. The results indicate that profile weighting does not significantly change the overall price elasticities among agencies. This is a reasonable and predictable result given the lack of correlation between price elasticity and house age or property value. Given these results, it is unlikely that the weighted price elasticities for other similar water agencies will be much different.

Table 4-6
Price Elasticity Weighted by Water Agency

Profile	Price Elasticity	% of Total Homes within Each Profile		
		Austin	Corpus Christi	SAWS
1	-0.22	3.9%	6.7%	9.9%
2	-0.30	1.8%	6.4%	11.1%
3	-0.02	6.1%	8.2%	8.2%
4	-0.26	2.7%	8.2%	3.8%
5	-0.14	3.3%	7.0%	5.4%
6	-0.31	2.1%	15.0%	10.0%
7	-0.06	16.5%	10.3%	3.9%
8	-0.14	9.0%	6.8%	7.2%
9	-0.13	16.9%	5.1%	6.0%
10	-0.19	5.5%	3.9%	4.8%
11	-0.10	5.8%	5.6%	6.9%
12	-0.15	11.4%	5.5%	7.0%
13	-0.36	4.4%	4.1%	4.9%
14	-0.19	5.2%	3.7%	5.0%
15	-0.48	7.4%	3.5%	4.0%
Composite Elasticity	-0.21	-0.17	-0.20	-0.20

Note: Price elasticities based on annual water use and average water price specification. The composite elasticities of the agencies do not average to -0.21 because of weighting differences.

Conclusion: The weighted overall price elasticities for Austin, Corpus Christi, and SAWS are -0.17, -0.20, and -0.20, respectively. These should be interpreted as long-run elasticities.

4.7 DOES PRICE ELASTICITY VARY WITH PRICE LEVEL?

The sensitivity of customers to water price may change with price level. In this study, average water prices vary between approximately $1/TG and $3/TG. Because this range is relatively narrow and because we do not have multiple intermediary price points (which would require more water agencies), distinctions of price elasticity within this price range cannot be made effectively.

Further, readers should note that price elasticities estimated in this study are representative of average water prices only in the $1/TG to $3/TG range. For agencies with water prices outside this range, price elasticities may be different.

Conclusion: The price elasticities reported in this study are relevant for water prices in the $1/TG to $3/TG range.

4.8 ARE INCREASING BLOCK RATES EFFECTIVE IN REDUCING WATER CONSUMPTION?

Increasing block rates can increase the overall marginal water prices paid by customers without changing the overall average price. This is done by lowering prices below average price in the lower blocks (which tend to be nonmarginal) and increasing prices above average price in the higher blocks (which tend to be marginal). Hence, if customers respond to marginal prices, then increasing block rates can be an effective, revenue-neutral, water conserving rate structure.

If customers respond to average prices, not marginal prices, however, then the efficacy of increasing block rates to reduce water demand is greatly diminished. Average price does not change with changes in rate structure, given the total costs to be recovered via commodity rates do not change (i.e., revenue requirements constant). Increasing block rates can increase the average price paid by certain customers (i.e., high water use customers), but they decrease the average price paid by other customers (i.e., low water use customers). If price elasticity does not change significantly with level of water use (which is highly correlated with wealth), then the net impact on total water use is likely to be minimal. The results in Table 4-6 show price elasticity is not correlated with wealth, at least for homes with 1997 household incomes below approximately $100,000.

Conclusion: For increasing block rates to be effective in reducing water consumption, customers need to respond to marginal water prices, not average water prices.

4.9 HOW CAN WATER AGENCIES IMPROVE THE EFFECTIVENESS OF INCREASING BLOCK RATES?

The short answer is to get customers to respond to marginal water prices. Specific steps could include the following:

- ***Simplify the rate structure.*** Fewer than 25% of customers report understanding and considering the specific prices of the four to six block water rate structures employed by the agencies over the study period. In fact, 31% of customers report that they could not calculate their water bill for 8,000 gallons even when provided block thresholds and prices. More customers might focus on marginal prices if the rate structures were simplified. A two-block rate structure with significant block price differences would be easier for more customers to understand. Further, the second block water use threshold should be set low enough so that a majority of customers are impacted by the second block price (e.g., 8 TG/month) at some time during the year (e.g., summer).

- ***Promote knowledge of end-use water consumption.*** To make block rates more effective, customers also need to know more about the volume of water used with specific end uses. Ideally, perfect information would consist of customers knowing the gallons saved and marginal prices associated specific water use decisions (e.g., installing a ULFT or reducing sprinkler run times) so they could calculate dollar impacts. Although this information can be very difficult and expensive to develop for individual homes, water agencies can provide customers with typical end-use water use information from research studies. Such information, for example, can be occasionally provided with the water bill.

- ***Improve water bill information.*** The water bill is an important educational and informational source for customers regarding both prices and water consumption. Including the entire rate structure on each bill, not just the rate blocks factored into the bill, is one step. In addition, including historical water over at least the last 12 months may help some customers better understand their water use patterns and end uses. Specifically, it may help them assess the change in water use resulting from specific actions such as better operation of the landscape irrigation system. SAWS does provides such information on its current bill.

There is no doubt that much effort would be involved in getting customers to make water use decisions based on perfect information. The survey reports that only 3% of customers attempt to make water use decisions using marginal analysis. However, customers need to better understand pricing for it to have an effective impact.

Conclusion: Water agencies can improve the effectiveness of increasing block rates to reduce water consumption by simplifying rates, educating customers about water end uses, and improving the informational content of the water bill.

Chapter 5
Analysis of Individual Home Water Use by Profile

In the last chapter we analyzed water use data aggregated over all homes within a profile from each agency. Another approach is to analyze the water use of individual homes (disaggregated data). Analyzing the water use of individual homes has the potential advantage of allowing for a more focused and precise evaluation. It does, however, cause a number of complicated statistical problems.

The primary problem regards the two-way (endogenous) relationship between water use and price. Based on the first law of demand, quantity of water demanded diminishes with increases in price. With block rates, however, water price also changes with water use. This endogenous relationship tends to cause estimation problems known as simultaneity bias for researchers comparing different individuals over the same block rate structure.

This chapter describes our efforts to analyze individual home water use using a sophisticated modeling approach recommended in a recent academic journal.[1] We found, unfortunately, that the modeling approach produced unrealistic results. We postulate a number of reasons why this occurred. Readers should note that is much more difficult to explain exactly why something did not work, than to just show the results of something that is believed to have worked.

Nevertheless, the finding that the modeling approach did not work in this case is an important finding to others investigating water price elasticity. We feel fortunate and validated that our research design did not rely exclusively on analyzing individual home water use observations from a heterogeneous random sample. Our analysis of aggregated water use, as described in Chapter 4, is not subject to these types of statistical problems. Hence, the water price elasticity results and conclusions derived from this project come from Chapter 4.

5.1 Discrete/Continuous Choice Model

A research article published in *Land Economics* in May 1995 described the use of a discrete/continuous choice model to estimate price elasticity for the residential demand for water under block rate pricing.[2] The discrete/continuous choice model is consistent with economic

1. The lead researcher on this segment of the project was Donald M. Waldman, Professor of Economics at the University of Colorado, Boulder.

2. Hewitt, J.A. and W.M. Hanemann. 1995. "A Discrete/Continuous Choice Approach to Residential Water Demand Under Block Rate Pricing." *Land Economics* 71(2), pp. 173-192.

theory and has been used since 1978 in applications related to labor supply, welfare programs, and charitable contributions.[3] The *Land Economics* article was the first to illustrate how the discrete/continuous choice model could be applied to residential water consumption. The article presented case study results from a small sample of homes (121 homes) from Denton, Texas which showed a water price elasticity of -1.5 over the summer months (based on marginal prices).

The discrete/continuous model is algebraically complicated, and difficult to estimate. Unlike the analysis in Chapter 4, estimation must be accomplished by searching over the set of possible parameter values (elasticities and other marginal effects) to find the values that maximize a likelihood function. This search procedure is time-intensive even for the fastest microcomputers, and is not guaranteed to produce results (due to algorithm failure). Since the model produces a nonlinear likelihood, convergence of the algorithm is not necessarily at the global optimum, so repeated attempts from different starting values of the parameters must be tried, and the resulting stopping points examined to determine whether the true maximum has been found.

To maximize the likelihood we use the Gauss programming language. The likelihood function is shown in Appendix E.

5.2 Results of the Discrete/Continuous Choice Model

Table 5-1 shows the price elasticity estimates derived from the discrete/continuous choice model for each of the 15 profiles identified in Chapter 2. We find that in most profiles the price elasticity estimate is positive, not negative as expected. This, of course, makes no sense economically, and in the next section we speculate on the reason for this outcome.

5.3 Problems with the Discrete/Continuous Choice Model

It is difficult to pinpoint why the discrete/continuous choice model estimated unrealistic price elasticities. We suspect the following causes:

- ***Marginal price and perfect information assumptions.*** The discrete/continuous choice model is consistent with the assumption that water customers are knowledgeable about block prices and volumes, and react to marginal prices. As the survey research shows (Chapter 3), however, customers report having very little knowledge of their block rate structures or volumes of water used. The discrete/continuous choice model is also consistent with the assumption that water customers, even if they do not know the price structure and/or are unable to work out the consequences of that structure for their own

3. Burtless, G., and J.A. Hausman. 1978. "The Effect of Taxation on Labor Supply: Evaluating the Gary Income Maintenance Experiment." *Journal of Political Economy* 86, pp. 1103-1130.

Table 5-1
Price Elasticity Results using Discrete/Continuous Choice Model

Profile	Price Elasticity Coefficient	T-Statistic
1	-0.0969	1.70
2	0.0703	2.14
3	0.0746	3.09
4	0.086	3.17
5	No Convergence	
6	0.058	1.88
7	0.3447	9.16
8	No Convergence	
9	0.115	4.83
10	0.4769	12.11
11	0.1827	5.74
12	0.0597	2.33
13	0.1193	4.88
14	-0.0524	1.64
15	-0.1887	15.36

Note: Price elasticity coefficients are statistically different from zero with 95% confidence when T-Ratio is greater than 1.96. Hence, for 10 profiles we obtain positive price elasticities that are statistically significant which is unrealistic. For profiles 5 and 8 the likelihood function never converged.

behavior, act *as if* they knew. This assumption is also not supported by the other analysis of this report.

- ***Temporal independence.*** The discrete/continuous choice model assumes water prices in one billing period do not affect water consumption in other periods. In reality, however, prices in one period may indeed affect water use in other periods. A closely related possibility is that consumers may be optimizing a function of water use over time. This would imply that their month-to-month consumption is not determined by the model under consideration.

- ***Exogenous variables.*** Missing variables or errors in the measurement of variables used in modeling can cause distortions in results. Problems with the exogenous variables that explain water use may be a partial reason for unrealistic results. Since there is but a single household survey, it had to be assumed that demographic variables remained unchanged over the period of water use.

- ***Stochastic specification.*** The discrete/continuous model starts with the economic theory of the rational consumer, which assumes knowledge of prices, and proceeds to a specification of hypothetical errors in judgment and optimization that produce the observed data on water consumption. Few if any economists would argue with the plausibility of the economic theory, but the specification of random influences, while consistent with the economic theory, is only one modeling alternative. Hence there is the possibility of misspecification in this step.

We conclude that our analysis on individual home water use did not provide valid results for one or more of the above reasons. The ability to use a regression model to minimize simultaneity bias is very difficult, especially when customers face multiple rate blocks as they do in this case (four to six). We feel fortunate that our selected research design did not exclusively rely on this analysis method.

APPENDIX A
SURVEY QUESTIONS AND CODES

NOTE:
1. NA means the question was not applicable
2. Response categories with an asterisk are coded responses to open end questions.

CASEID	Unique case identification number	
CITY	1	Austin
	2	San Antonio
	3	Corpus Christi
VERSION	1	English
	2	Spanish

(For San Antonio only)
The San Antonio Water System (SAWS) is interested in what its water customers think about water use and the water billing system. This survey is intended to help us provide the best and billing service possible to customers. Please remember that all your responses will be kept confidential.

(For Austin only)
The City of Austin is interested in what its water customers think about water use and the water billing system. This survey is intended to help us provide the best and billing service possible to customers. Please remember that all your responses will be kept confidential.

(For Corpus Christi only)
The City of Corpus Christi is interested in what its water customers think about water use and the water billing system. This survey is intended to help us provide the best and billing service possible to customers. Please remember that all your responses will be kept confidential.

Section A. How Your Household Uses Water

Q1 Do you own or rent your home? *(check one)*

1 Own
2 Rent or other
9 Missing

Q2 When was your home built? *(check one)*

1 Before 1960
2 Between 1960 and 1979
3 1980 or later
4 Don't know
9 Missing

Q3 Does your home have the following? *(check all that apply)*

For Q3A to Q3E:
0 Not checked
1 Checked

Q3A Swimming pool
Q3B Jacuzzi or hot tub
Q3C Outdoor water fountain or pond
Q3D Ultra low flush toilets (1.6 gallons per flush)
Q3E Low flow showerheads

Q4 What type of grass makes up *most* of your lawn? *(check one)*

1 No lawn
2 Bermuda
3 St. Augustine
4 Buffalo
5 Zoysia
6 Mixed/Combination
7 Other
8 Don't know
9 Missing

Q5 How do you water your lawn? *(check one)*

1 In-ground system with automatic timer
2 Hose-based or other system
3 In-ground system that is manually operated
4 Do not have a lawn or water lawn
9 Missing

Section B. Buying Habits and Attitudes

Q6 Below are statements people might make about water conservation, the environment, and water usage. Using the scale below, please tell us how strongly you agree or disagree with each of these statements. *(Circle your answer in the space to the right of each statement.)*

Strongly Agree	Somewhat Agree	Neither Agree or Disagree	Somewhat Disagree	Strongly Disagree	Missing
1	2	3	4	5	9

		Circle Number
Q6A	As long as I can pay for it, I should have the right to use as much water as I think necessary.	1 2 3 4 5 9
Q6B	I like my lawn and landscape to be among the best maintained in my neighborhood.	1 2 3 4 5 9
Q6C	I would rather take the chance of over-watering my lawn than not give it enough water	1 2 3 4 5 9
Q6D	Water conservation will help residents of this area to have a better overall quality of life	1 2 3 4 5 9
Q6E	Claims about Texas facing serious water shortages in the future are greatly exaggerated	1 2 3 4 5 9
Q6F	Water conservation will ensure that there is enough water to meet my needs	1 2 3 4 5 9
Q6G	Even when there is very little rainfall, I water as much as I want.	1 2 3 4 5 9
Q6H	Unless people start learning how to conserve water, there is not going to be enough for everybody.	1 2 3 4 5 9
Q6I	Water conservation will provide a better world for future generations	1 2 3 4 5 9
Q6J	It is important to me for my lawn and landscape to look as good as possible.	1 2 3 4 5 9

Q7 Buying habits may be related to water use. Using the scale below, please tell us how strongly you agree or disagree with each of the following statements about buying habits. *(Circle your answer in the space to the right of each statement.)*

Strongly Agree	Somewhat Agree	Neither Agree or Disagree	Somewhat Disagree	Strongly Disagree	Missing
1	2	3	4	5	9

	Statement	Circle Number
Q7A	I clip and use discount coupons for groceries	1 2 3 4 5 9
Q7B	I pay attention to changes in gasoline prices	1 2 3 4 5 9
Q7C	I have and use a monthly budget for utility expenses (water, electricity, and/or gas)	1 2 3 4 5 9
Q7D	I try to keep my water bill as low as possible	1 2 3 4 5 9

Section C. Your Water Bill

Q8 Who is responsible for paying the water bill for your home? *(check one box)*

1 Occupant
2 Landlord
3 Homeowner's Association
9 Missing

If you marked occupant above, proceed to Question 9. Otherwise, skip to Section E.

9 *Please answer the following questions __without__ looking at past water/utility bills.* Below are some statements people have made about their water bill. Using the scale below, please tell us how strongly you agree or disagree with each statement. *(Circle your answer in the space to the right of each statement.)*

Strongly Agree	Somewhat Agree	Neither Agree or Disagree	Somewhat Disagree	Strongly Disagree	Missing	NA
1	2	3	4	5	9	☐

	Statement	Circle Number
Q9A	**(For San Antonio only)** Each month I look at the dollar amount of my total SAWS bill, but not the details related to the water portion of the bill. **(For Austin and Corpus Christi only)** Each month I look at the dollar amount of my total utility bill, but not the details related to the water portion of the bill	1 2 3 4 5 9 ☐
Q9B	Each month I compare my current month's water consumption to past months	1 2 3 4 5 9 ☐
Q9C	**(For San Antonio only)** I like my monthly water bill to show my water use over the last 12 months. **(For Austin and Corpus Christi only)** I would like my monthly water bill to show my water use over the last 12 months.	1 2 3 4 5 9 ☐
Q9D	**(For San Antonio only)** I like my monthly water bill to show the average (typical) water use of homes in my neighborhood. **(For Austin and Corpus Christi only)** I would like my monthly water bill to show the average (typical) water use of homes in my neighborhood	1 2 3 4 5 9 ☐
Q9E	I would like to learn more about how to conserve water and reduce my water bill	1 2 3 4 5 9 ☐
Q9F	I know the approximate *dollar amount* of my average (typical) monthly water bill in 1997	1 2 3 4 5 9 ☐
Q9G	I know the approximate *dollar amount* of my highest monthly water bill in 1997	1 2 3 4 5 9 ☐
Q9H	I know the approximate number of *gallons of water* my household used during an average (typical) month in 1997	1 2 3 4 5 9 ☐
Q9I	I know the approximate number of *gallons of water* my household used during the highest-use month of 1997	1 2 3 4 5 9 ☐

Section D. Water Prices

10 Using the scale below, please tell us how strongly you agree or disagree with each of the following statements about the importance of water cost to your household. *(Circle your answer in the space to the right of each statement.)*

Strongly Agree	Somewhat Agree	Neither Agree or Disagree	Somewhat Disagree	Strongly Disagree	Missing	NA
1	2	3	4	5	9	☐

	Statement	Circle Number
Q10A	Water cost is important to me when deciding how much water to use indoors (e.g., dish washing, clothes washing, showering/bathing, toilets).	1 2 3 4 5 9 ☐
Q10B	Water cost is important to me when deciding how large our lawn should be	1 2 3 4 5 9 ☐
Q10C	Water cost is important to me when selecting the types of plants and grass to use in our landscape	1 2 3 4 5 9 ☐
Q10D	Water cost is important to me when deciding how and when to water our lawn	1 2 3 4 5 9 ☐
Q10E	I take into account the cost of wastewater (sewer) service when deciding how much water to use	1 2 3 4 5 9 ☐

For the following questions, refer to the Water Price Table below:

	Statement	Circle Number
Q10F	**(For San Antonio and Austin only)** Before today, I knew there were 4 different prices for water depending on how much I use. **(For Corpus Christi only)** Before today, I knew there were 5 different prices for water depending on how much I use	1 2 3 4 5 9 ☐
Q10G	Before today, I knew that the price of water goes up as I use more water	1 2 3 4 5 9 ☐
Q10H	Before today, I was familiar with the specific water prices shown below	1 2 3 4 5 9 ☐
Q10I	**(For San Antonio only)** Before today, I knew that the price of water tends to increase during the summer months. **(For Corpus Christi only)** Before today, I knew there was a raw water charge between $0.25 to $0.35 per 1,000 gallons	1 2 3 4 5 9 ☐
Q10J	I can calculate my water bill for 8,000 gallons using the table below	1 2 3 4 5 9 ☐
Q10K	I use the gallons per month levels shown below to set goals about how much water to use	1 2 3 4 5 9 ☐
Q10L	The information on my monthly bill does a good job of explaining my water rates/charges	1 2 3 4 5 9 ☐
Q10M	I believe I should pay the same price for *each gallon* of water no matter how much I use	1 2 3 4 5 9 ☐
Q10N	I believe my current water rates are too complicated and are difficult to understand	1 2 3 4 5 9 ☐

(For San Antonio only)

WATER PRICE TABLE

Currently, the price you pay for water increases as your water use increases as follows*:

Number of Gallons Used Per Month:	Cost per 100 Gallons: Standard	Seasonal**
First 7,481 gallons	$0.0661	$0.0661
Next 5,236 gallons	$0.0950	$0.1032
Next 4,488 gallons	$0.1178	$0.1178
Over 17,205 gallons	$0.2473	$0.3193

*Plus a fixed monthly meter charge of $5.13 per month for a basic meter (higher for larger meters)
**Seasonal water prices are effective from July 1 to October 31

(For Austin only)

WATER PRICE TABLE

Currently, the price you pay for water increases as your water use increases as follows*:

Number of Gallons Used Per Month:	Cost per 1,000 Gallons:
0 to 2,900 gallons	$1.25
2,901 to 6,900 gallons	$2.00
6,901 to 14,900 gallons	$2.75
Over 14,900 gallons	$4.00

*Plus a fixed monthly meter charge of $3.90 per month for a basic meter (higher for larger meters)

(For Corpus Christi only)

WATER PRICE TABLE

Currently, the price you pay for water increases as your water use increases as follows*:

Number of Gallons Used Per Month:	Cost per 1,000 Gallons:
First 2,000 gallons	$0.000 (no charge)
Next 13,000 gallons	$1.063
Next 15,000 gallons	$2.344
Next 20,000 gallons	$2.868
Over 50,000 gallons	$3.480

* A minimum fixed meter charge of $4.80 per month is added, plus a raw water charge varying between $0.25 and $0.35 per 1,000 gallons depending upon system water sales and total costs to acquire water

Q11 In the past, when you considered using less water to reduce your bill, which of the following statements comes closest to describing your thinking? *(check one box)*

1 Water price has *rarely* influenced my water use decisions
2 I knew that 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 thought about how many gallons of water we would probably save, and calculated my water bill dollar savings using an average per gallon water price.
5 I thought about how many gallons of water we would probably save, and calculated my water bill dollar savings using exact per gallon water prices for different levels of water use.
9 Missing
• NA

(For San Antonio and Corpus Christi only)
Q12 Which of the following best describes your current understanding of how you are charged for your wastewater (sewer) service? *(check one box)*

1 It does not depend on how much water we use
2 It depends on how much water we use *only* during the winter months
3 It depends on how much water we use each month.
4 We have a septic system. We are not connected to a wastewater utility.
5 Don't know
9 Missing
• NA

(For Austin only)
Which of the following best describes your current understanding of how you are charged for your wastewater (sewer) service? *(check one box)*

1 It does not depend on how much water we use.
2 It depends on how much water we use *only* during the summer months
3 It depends on how much water we use each month but cannot exceed our average (typical) winter water use.
4 We have a septic system. We are not connected to a wastewater utility
5 Don't know
9 Missing
• NA

Section E. General Information

These last few questions ask a little more about your household. Your answers will help us better understand how people use water. All your responses will be kept strictly confidential.

Q13 Including yourself, how many people live full-time in your home now, and how many lived in your home full-time in July 1997? **(Write the number of people** ***in each age group. Print "0" for none*** **)**

For Q13_1A to Q13_1C and Q13_2A to Q13_2C:
99 Missing

Number in home now

Q13_1A ____Adults *(18 years or more)*
Q13_1B ____Teenagers *(13 to 17)*
Q13_1C ____Children *(under 13)*

Number in home July 1997

Q13_2A ____Adults *(18 years or more)*
Q13_2B ____Teenagers *(13 to 17)*
Q13_2C ____Children *(under 13)*

Q14 What is your age?

1 18-25
2 26-30
3 31-40
4 41-50
5 51-64
6 65 or older
9 Missing

Q15 Are you . . .?

1 Male
2 Female
9 Missing

Q16 Which of the following best describes your ethnic background? *(check one box)*

1 American Indian
2 Asian
3 Black
4 Hispanic
5 White
*7 Hispanic/Italian
*8 White/Hispanic
9 Missing
*10 German
*11 Italian
*12 Jewish
*13 Anglo
*14 Scottish
*15 Anglo/Asian

Q17 Which of the following best describes your total household income in 1997? *(check one)*

1 Under $15,000
2 $15,000 to $29,999
3 $30,000 to $49,999
4 $50,000 to $74,999
5 $75,000 to $99,999
6 Over $100,000
9 Missing

(For San Antonio only)
Please list one or two things that SAWS could do to help you to better understand the water billing process.

(For Austin only)
Please list one or two things that we could do to help you to better understand Austin's water billing process.

(For Corpus Christi only)
Please list one or two things that the water department could do to help you to better understand Corpus Christi's water billing process.

Q18_A First Response
Q18_B Second Response
Q18_C Third Response

*0 No other response(s)
*1 Round gallon figures for each level of water usage
*2 Don't estimate bill one month and raise bill next month
*3 Water price table should be printed on bill and how to calculate
*4 Explanation of why sewer cost is higher than water usage cost
*5 Nothing; billing format fine, understand the way it is
*6 Breakdown of charges, detail billing
*7 Comparison of water usage during summer, winter months
*8 Identify neighborhood in comparisons, city and neighborhood averages
*9 Show amount of past water usage
*10 Explain various ways I can save/cost efficient measures
*11 Explain how to read meter
*12 Prefer old index postcard for billing, less paper in small envelope
*13 Use more graphics, makes it easier to understand
*14 Print drought watering rule information on bill, when water should be used less
*15 Don't have so many rates, difficult to understand
*16 Make simpler, easier to understand, simple language
*17 Informational advertising on TV or radio or mail/video
*18 Hold seminars, have speakers at homeowner's association, civic groups
*19 Explain necessity for continuing monthly charge for basic meter
*20 Increase size of print, too small
*21 Explanation of services/what is water level
*22 Want meter read accurately
*23 Have better educated and pleasant employees handle billing
*24 Send out a printout in Spanish/bilingual
*25 Put information on Internet
*26 Include a copy of billing process with each bill or every few months
99 No comment at all

ACCOUNT Water account number

(NOTE: In all correspondence with the water utility customers, respondents were told their information would be kept confidential. Since the data file contains personal account information, extreme care should be taken to protect the confidentiality of respondents. We would strongly recommend removing account information from the data file where possible.)

ZIP Zip code of respondent

APPENDIX B
WEATHER VARIABLE

The net irrigation requirement (NIR) was estimated using evapotranspiration (ET_o) calculated by the Blaney-Criddle method — which employs temperature and sunshine data — and effective precipitation. Daily values for daily temperature maximum and minimum with 24-hour precipitation totals were obtained from the Southern Regional Climate Center's Unified Climate Access Network (http://www.srcc.lsu.edu/ucan.net/listers.html). Six sites had relatively complete data series (Table B-1). Additional general climatological information was obtained from U.S. Department of Agriculture (1941).

Table B-1
Weather Stations

Co-op Number	County	Co-op Station Name
41-7945	Bexar	San Antonio International Airport
41-1651	Nueces	Chapman Ranch
41-2015	Nueces	Corpus Christi Wsfo Airport
41-7170	Nueces	Port Arkansas
41-7677	Nueces	Robstown
41-0428	Travis	Austin Airport

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 (Doorenbos and Pruitt, 1977). These refinements add considerably to the accuracy of Blaney-Criddle estimates (Jensen et al., 1990).

The basic 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 = $a_0 + a_1 RH_{min} + a_2 n/N + a_3 Ud + a_4 RH_{min}\ n/N + a_5 RH_{min}\ Ud$
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 °C
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.

Daily precipitation was evaluated under the following series of conditions:

IF *Precipitation* (P) > ET_O AND P > 2.5 mm, THEN Soil Storage (SS) = ($P - ET_O$) + $SS_{current}$ WHILE SS <= 15 mm.

Target soil was a loam of 150 mm depth. Maximum storage was considered to be 15 mm.

NIR was evaluated under the following conditions:

IF $SS - ET_O < 0$ THEN $NIR = SS - ET_O$.
IF $SS - ET_O >= 0$ THEN $NIR = 0$.

This method produces a daily NIR that accounts for ET_O and precipitation. When water is available from precipitation or soil storage, the NIR is effectively nil. When it is not, the portion of ET_O not compensated for accumulates in the running total NIR.

References

Doorenbos, 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.

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

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APPENDIX C
PROFILE STATISTICS

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Table C-1
Profile Characteristics by Water Agency: Profile 1

Characteristic	Austin	Corpus	SAWS	Total	Maximum Absolute Deviation In Means	H0: Means Equal
Number of Homes in Sample	51	39	31	[illegible]		
Tax Information						
Property Value (1997 average)	$18,[illegible]	$18,[illegible]	$18,[illegible]	$18,[illegible]	0.5%	
Lot Size (average ft2)	6,100	6,053	[illegible]	6,057	1.0%	
Home Size (average ft2)	778	790	803	791	1.7%	
Year Home Built	1941	1950	1942	1944		
Fixtures and Landscape						
Swimming Pool	0%	1%	3%	1%	2%	Accept
Ultra Low Flush Toilets	55%	42%	61%	52%	10%	Accept
Low Flow Showerheads	31%	64%	48%	48%	17%	Reject
St. Augustine Grass	27%	12%	9%	19%	10%	Accept
In-ground Irrigation with timer	0%	0%	0%	0%	0%	Accept
Hose-based irrigation system	100%	97%	100%	99%	2%	Accept
Demographics						
Occupants per Home (average)	3.5	2.92	3.46	3.12	11%	Accept
White	[illegible]	26%	13%	33%	[illegible]	Accept
Hispanic	52%	76%	66%	65%	12%	Accept
Black	10%	0%	19%	22%	11%	Reject
Annual House Income (average)	$25,[illegible]	$33,[illegible]	$19,839	$22,125	10%	Accept
Occupants Own Home	64%	[illegible]	[illegible]	[illegible]	10%	Accept
Occupants Pay Water Bill	76%	76%	97%	96%	1%	Accept
Penny Pincher Questions						
"I clip and use discount coupons for groceries"	77%	47%	46%	74%	7%	Accept
"I pay attention to changes in gasoline prices"	81%	82%	72%	80%	6%	Accept
"I have and use a monthly budget for utilities"	63%	72%	86%	53%	13%	Accept
"I try to keep my water bill as low as possible"	34%	85%	97%	87%	9%	Accept
Appearance Questions						
"It is important to me for my lawn and landscape to look as good as possible"	44%	49%	45%	48%	3%	Accept
"I like my lawn and landscape to be among the best maintained in my neighborhood"	56%	51%	48%	50%	12%	Accept
Rugged Individual Questions						
"As long as I pay for it, I should have the right to use as much water as I think necessary"	32%	36%	47%	45%	9%	Accept
"I would rather take the chance of over-watering my lawn than not give it enough water"	23%	25%	14%	18%	6%	Accept
"Even when there is very little rainfall, I water as much as I want"	5%	[illegible]	4%	11%	7%	Accept
"Claims about Texas facing serious water shortages in the future are greatly exaggerated"	36%	28%	41%	33%	4%	Accept
Importance of Conservation Questions						
"Water conservation will ensure that there is enough water to meet my needs"	71%	83%	46%	80%	7%	Accept
"Unless people start learning how to conserve water, there is not going to be enough for everybody"	62%	71%	73%	69%	3%	Accept
"Water conservation will provide a better world for future generations"	77%	88%	77%	80%	7%	Accept
"Water conservation will help residents of this area to have a better overall quality of life"	64%	73%	67%	68%	6%	Accept

Attitudinal results include strongly agree and somewhat agree responses.

H0 refers to the "null hypothesis" to be statistically tested. In this instance, the null hypothesis is that mean proportions over all 3 agencies are equal. We used Chi Squared test using 0.05 level of significance.

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Table C-2
Profile Characteristics by Water Agency: Profile 2

Characteristic	Austin	Corpus	SAWS	Total	Maximum Absolute Deviation In Means	H0: Means Equal
Number of Homes in Sample	48	57	67	172		
Tax Information						
Property Value (1997 average)	$30,119	$29,619	$29,394	$29,748	1.2%	
Lot Size (average ft2)	[illegible]	[illegible]	5,035	[illegible]	3.4%	
Home Size (average ft2)	977	1,000	997	992	1.6%	
Year Home Built	1960	1950	1944	1963		
Fixtures and Landscape						
Swimming Pool	[illegible]	0%	1%	3%	5%	Accept
Ultra Low Flush Toilets	52%	45%	40%	46%	6%	Accept
Low Flow Showerheads	46%	62%	43%	50%	12%	Accept
St. Augustine Grass	29%	15%	25%	21%	6%	Accept
In-ground Irrigation with timer	0%	0%	3%	1%	2%	Accept
Hose-based irrigation system	97%	100%	95%	97%	3%	Accept
Demographics						
Occupants per Home (average)	[illegible]	3.04	2.78	2.86	6%	Accept
White	[illegible]	36%	26%	27%	11%	Accept
Hispanic	45%	60%	58%	56%	9%	Accept
Black	36%	2%	12%	15%	19%	Reject
Annual House Income (average)	$24,[illegible]	$20,[illegible]	$22,376	$23,[illegible]	[illegible]	Accept
Occupants Own Home	[illegible]	79%	88%	81%	7%	Accept
Occupants Pay Water Bill	92%	96%	97%	95%	5%	Accept
Penny Pincher Questions						
"I clip and use discount coupons for groceries"	62%	70%	78%	74%	12%	Accept
"I pay attention to changes in gasoline prices"	95%	93%	85%	[illegible]	4%	Accept
"I have and use a monthly budget for utilities"	35%	75%	75%	69%	14%	Reject
"I try to keep my water bill as low as possible"	89%	92%	92%	92%	3%	Accept
Appearance Questions						
"It is important to me for my lawn and landscape to look as good as possible"	[illegible]	45%	56%	53%	7%	Accept
"I like my lawn and landscape to be among the best maintained in my neighborhood"	34%	52%	49%	44%	12%	Accept
Rugged Individual Questions						
"As long as I pay for it, I should have the right to use as much water as I think necessary"	36%	35%	22%	27%	7%	Accept
"I would rather take the chance of over-watering my lawn than not give it enough water"	25%	15%	13%	14%	9%	Accept
"Even when there is very little rainfall, I water as much as I want"	12%	9%	11%	11%	1%	Accept
"Claims about Texas facing serious water shortages in the future are greatly exaggerated"	19%	35%	31%	29%	10%	Accept
Importance of Conservation Questions						
"Water conservation will ensure that there is enough water to meet my needs"	79%	87%	79%	81%	5%	Accept
"Unless people start learning how to conserve water, there is not going to be enough for everybody"	76%	74%	66%	71%	2%	Accept
"Water conservation will provide a better world for future generations"	[illegible]	89%	81%	85%	6%	Accept
"Water conservation will help residents of this area to have a better overall quality of life"	69%	78%	79%	75%	6%	Accept

Attitudinal results include strongly agree and somewhat agree responses.

H0 refers to the "null hypothesis" to be statistically tested. In this instance, the null hypothesis is that mean proportions over all 3 agencies are equal. We used Chi Squared test using 0.05 level of significance.

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Table C-3
Profile Characteristics by Water Agency: Profile 3

Characteristic	Austin	Corpus	SAWS	Total	Maximum Absolute Deviation In Means	H0: Means Equal
Number of Homes in Sample	[illegible]	65	82	[illegible]		
Tax Information						
Property Value (1997 average)	$38,376	$39,[illegible]	$38,849	$38,[illegible]	[illegible]	
Lot Size (average ft2)	7,224	7,229	7,497	7,298	1.4%	
Home Size (average ft2)	[illegible]	1,135	1,167	1,150	1.9%	
Year Home Built	1964	1955	[illegible]	1966		
Fixtures and Landscape						
Swimming Pool	0%	0%	0%	0%	0%	Accept
Ultra Low Flush Toilets	[illegible]	30%	37%	40%	15%	Reject
Low Flow Showerheads	54%	40%	40%	46%	9%	Accept
St. Augustine Grass	30%	44%	40%	36%	17%	Reject
In-ground Irrigation with timer	0%	0%	0%	0%	0%	Accept
Hose-based irrigation system	100%	95%	94%	95%	5%	Accept
Demographics						
Occupants per Home (average)	2.72	2.93	2.65	2.75	6%	Accept
White	30%	43%	42%	41%	11%	Accept
Hispanic	45%	50%	49%	[illegible]	3%	Accept
Black	17%	2%	7%	8%	9%	Reject
Annual House Income (average)	$26,234	$30,[illegible]	$31,[illegible]	[illegible]	15%	Accept
Occupants Own Home	89%	83%	90%	88%	5%	Accept
Occupants Pay Water Bill	93%	93%	94%	99%	5%	Accept
Penny Pincher Questions						
"I clip and use discount coupons for groceries"	78%	76%	77%	73%	1%	Accept
"I pay attention to changes in gasoline prices"	83%	82%	85%	83%	1%	Accept
"I have and use a monthly budget for utilities"	34%	50%	62%	61%	13%	Reject
"I try to keep my water bill as low as possible"	79%	74%	83%	84%	5%	Accept
Appearance Questions						
"It is important to me for my lawn and landscape to look as good as possible"	63%	43%	57%	55%	12%	Reject
"I like my lawn and landscape to be among the best maintained in my neighborhood"	43%	49%	31%	33%	2%	Accept
Rugged Individual Questions						
"As long as I pay for it, I should have the right to use as much water as I think necessary"	40%	35%	34%	36%	4%	Accept
"I would rather take the chance of over-watering my lawn than not give it enough water"	15%	14%	15%	15%	0%	Accept
"Even when there is very little rainfall, I water as much as I want"	23%	11%	14%	15%	9%	Accept
"Claims about Texas facing serious water shortages in the future are greatly exaggerated"	36%	38%	39%	[illegible]	2%	Accept
Importance of Conservation Questions						
"Water conservation will ensure that there is enough water to meet my needs"	74%	67%	76%	72%	3%	Accept
"Unless people start learning how to conserve water, there is not going to be enough for everybody"	80%	64%	72%	72%	7%	Accept
"Water conservation will provide a better world for future generations"	83%	73%	85%	80%	3%	Accept
"Water conservation will help residents of this area to have a better overall quality of life"	75%	72%	76%	72%	2%	Accept

Attitudinal results include strongly agree and somewhat agree responses.

H0 refers to the "null hypothesis" to be statistically tested. In this instance, the null hypothesis is that mean proportions over all 3 agencies are equal. We used Chi Squared test using 0.05 level of significance.

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Table C-4
Profile Characteristics by Water Agency: Profile 4

Characteristic	Austin	Corpus	SAWS	Total	Maximum Absolute Deviation In Means	H_0: Means Equal
Number of Homes in Sample	82	90	85	257		
Tax Information:						
Property Value (1997 average)	$53,[illegible]	$52,475	$52,242	$52,[illegible]	1.6%	
Lot Size (average ft2)	7,466	7,773	7,884	7,844	9.8%	
Home Size (average ft2)	1,299	1,300	1,307	1,302	0.4%	
Year Home Built	1954	1950	1951	1953		
Fixtures and Landscape:						
Swimming Pool	1%	1%	1%	2%	1%	Accept
Ultra Low Flush Toilets	49%	35%	33%	39%	10%	Accept
Low Flow Showerheads	69%	53%	45%	57%	10%	Accept
St. Augustine Grass	57%	73%	55%	62%	15%	Reject
In-ground Irrigation with timer	3%	1%	4%	3%	3%	Accept
Hose-based irrigation system	90%	88%	83%	51%	7%	Accept
Demographics:						
Occupants per Home (average)	2.44	2.49	2.30	2.41	4%	Accept
White	79%	72%	76%	77%	3%	Accept
Hispanic	17%	21%	27%	24%	6%	Accept
Black	7%	2%	4%	4%	3%	Accept
Annual House Income (average)	$35,868	$46,467	$53,122	$35,915	13%	Accept
Occupants Own Home	97%	92%	92%	89%	7%	Accept
Occupants Pay Water Bill	96%	96%	99%	98%	2%	Accept
Penny Pincher Questions						
"I clip and use discount coupons for groceries"	63%	67%	75%	[illegible]	8%	Accept
"I pay attention to changes in gasoline prices"	79%	57%	81%	81%	4%	Accept
"I have and use a monthly budget for utilities"	[illegible]	63%	51%	59%	3%	Accept
"I try to keep my water bill as low as possible"	10%	[illegible]	86%	89%	3%	Accept
Appearance Questions						
"It is important to me for my lawn and landscape to look as good as possible"	57%	62%	48%	51%	8%	Accept
"I like my lawn and landscape to be among the best maintained in my neighborhood"	48%	57%	41%	47%	6%	Accept
Rugged Individual Questions						
"As long as I pay for it, I should have the right to use as much water as I think necessary"	39%	36%	20%	34%	10%	Accept
"I would rather take the chance of over watering my lawn than not give it enough water"	15%	13%	24%	14%	1%	Accept
"Even when there is very little rainfall I water as much as I want"	10%	5%	7%	7%	3%	Accept
"Claims about Texas facing serious water shortages in the future are greatly exaggerated"	31%	35%	30%	26%	7%	Accept
Importance of Conservation Questions						
"Water conservation will ensure that there is enough water to meet my needs"	74%	76%	79%	75%	3%	Accept
"Unless people start learning how to conserve water, there is not going to be enough for everybody"	71%	67%	73%	71%	5%	Accept
"Water conservation will provide a better world for future generations"	85%	78%	88%	83%	6%	Accept
"Water conservation will help residents of this area to have a better overall quality of life"	74%	72%	82%	75%	6%	Accept

Attitudinal results include strongly agree and somewhat agree responses.

H_0 refers to the "null hypothesis" to be statistically tested. In this instance, the null hypothesis is that mean proportions over all 3 agencies are equal. We used Chi Squared test using 0.05 level of significance.

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Table C-5
Profile Characteristics by Water Agency: Profile 5

Characteristic	Austin	Corpus	SAWS	Total	Maximum Absolute Deviation In Means	H_0: Means Equal
Number of Homes in Sample	62	71	85	218		
Tax Information:						
Property Value (1997 average)	$92,303	$90,308	$93,707	$92,[illegible]	1.7%	
Lot Size (average ft2)	9,562	9,475	9,421	9,468	0.5%	
Home Size (average ft2)	1,662	1,704	1,654	1,671	2.0%	
Year Home Built	1954	1952	1950	1952		
Fixtures and Landscape:						
Swimming Pool	4%	7%	6%	5%	2%	Accept
Ultra Low Flush Toilets	41%	35%	39%	37%	6%	Accept
Low Flow Showerheads	57%	51%	42%	53%	4%	Accept
St. Augustine Grass	56%	74%	63%	65%	13%	Reject
In-ground Irrigation with timer	15%	15%	16%	15%	1%	Accept
Hose-based irrigation system	81%	85%	80%	82%	3%	Accept
Demographics:						
Occupants per Home (average)	2.73	2.34	2.35	2.37	7%	Accept
White	92%	92%	95%	96%	4%	Accept
Hispanic	6%	14%	11%	10%	4%	Accept
Black	0%	0%	0%	0%	0%	Accept
Annual House Income (average)	$46,681	$63,896	$53,436	$53,775	19%	Accept
Occupants Own Home	98%	98%	95%	97%	3%	Accept
Occupants Pay Water Bill	99%	100%	100%	100%	1%	Accept
Penny Pincher Questions						
"I clip and use discount coupons for groceries"	75%	68%	68%	70%	5%	Accept
"I pay attention to changes in gasoline prices"	82%	79%	82%	81%	2%	Accept
"I have and use a monthly budget for utilities"	34%	30%	38%	37%	5%	Accept
"I try to keep my water bill as low as possible"	79%	73%	74%	74%	5%	Accept
Appearance Questions						
"It is important to me for my lawn and landscape to look as good as possible"	53%	61%	57%	56%	4%	Accept
"I like my lawn and landscape to be among the best maintained in my neighborhood"	42%	58%	54%	49%	8%	Accept
Rugged Individual Questions						
"As long as I pay for it, I should have the right to use as much water as I think necessary"	35%	19%	29%	25%	5%	Accept
"I would rather take the chance of over watering my lawn than not give it enough water"	15%	10%	18%	14%	5%	Accept
"Even when there is very little rainfall I water as much as I want"	9%	4%	4%	6%	1%	Accept
"Claims about Texas facing serious water shortages in the future are greatly exaggerated"	28%	25%	43%	32%	12%	Reject
Importance of Conservation Questions						
"Water conservation will ensure that there is enough water to meet my needs"	44%	44%	73%	68%	6%	Accept
"Unless people start learning how to conserve water, there is not going to be enough for everybody"	57%	75%	67%	66%	9%	Accept
"Water conservation will provide a better world for future generations"	70%	84%	80%	78%	5%	Accept
"Water conservation will help residents of this area to have a better overall quality of life"	67%	74%	83%	75%	8%	Accept

Attitudinal results include strongly agree and somewhat agree responses.

H_0 refers to the "null hypothesis" to be statistically tested. In this instance, the null hypothesis is that mean proportions over all 3 agencies are equal. We used Chi Squared test using 0.05 level of significance.

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Table C-6
Profile Characteristics by Water Agency: Profile 6

Characteristic	Austin	Corpus	SAWS	Total	Maximum Absolute Deviation In Means	H_0: Means Equal
Number of Homes in Sample	57	58	51	166		
Tax Information:						
Property Value (1997 average)	$29,137	$28,057	$27,417	$28,079	3.9%	
Lot Size (average ft2)	5,998	6,947	5,965	6,404	1.4%	
Home Size (average ft2)	919	900	919	913	1.5%	
Year Home Built	1968	1970	1966	1969		
Fixtures and Landscape:						
Swimming Pool	2%	0%	0%	2%	1%	Accept
Ultra Low Flush Toilets	53%	35%	43%	45%	26%	Reject
Low Flow Showerheads	58%	57%	57%	56%	3%	Accept
St. Augustine Grass	19%	35%	25%	24%	6%	Accept
In-ground Irrigation with timer	0%	0%	0%	0%	0%	Accept
Hose-based irrigation system	99%	100%	94%	27%	4%	Accept
Demographics:						
Occupants per Home (average)	3.03	3.15	3.57	3.24	10%	Accept
White	4%	46%	20%	24%	24%	Reject
Hispanic	67%	48%	76%	58%	32%	Reject
Black	36%	4%	2%	20%	34%	Reject
Annual House Income (average)	$26,403	$25,2[illegible]	$27,[illegible]	$26,493	6%	Accept
Occupants Own Home	65%	69%	84%	76%	15%	Accept
Occupants Pay Water Bill	87%	100%	56%	84%	8%	Reject
Penny Pincher Questions						
"I clip and use discount coupons for groceries"	74%	79%	75%	76%	5%	Accept
"I pay attention to changes in gasoline prices"	85%	89%	69%	96%	1%	Accept
"I have and use a monthly budget for utilities"	74%	73%	68%	72%	4%	Accept
"I try to keep my water bill as low as possible"	89%	85%	86%	85%	3%	Accept
Appearance Questions						
"It is important to me for my lawn and landscape to look as good as possible"	64%	49%	40%	55%	15%	Accept
"I like my lawn and landscape to be among the best maintained in my neighborhood"	58%	51%	52%	46%	16%	Reject
Rugged Individual Questions						
"As long as I pay for it, I should have the right to use as much water as I think necessary"	51%	72%	35%	38%	15%	Reject
"I would rather take the chance of over watering my lawn than not give it enough water"	25%	4%	9%	14%	9%	Reject
"Even when there is very little rainfall I water as much as I want"	16%	4%	12%	11%	7%	Accept
"Claims about Texas facing serious water shortages in the future are greatly exaggerated"	48%	34%	40%	41%	7%	Reject
Importance of Conservation Questions						
"Water conservation will ensure that there is enough water to meet my needs"	79%	59%	63%	73%	5%	Accept
"Unless people start learning how to conserve water, there is not going to be enough for everybody"	45%	84%	47%	54%	19%	Reject
"Water conservation will provide a better world for future generations"	70%	88%	54%	60%	11%	Accept
"Water conservation will help residents of this area to have a better overall quality of life"	75%	82%	68%	73%	7%	Accept

Attitudinal results include strongly agree and somewhat agree responses.

H_0 refers to the "null hypothesis" to be statistically tested. In this instance, the null hypothesis is that mean proportions over all 3 agencies are equal. We used Chi Squared test using 0.05 level of significance.

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Table C-7
Profile Characteristics by Water Agency: Profile 7

Characteristic	Austin	Corpus	SAWS	Total	Maximum Absolute Deviation In Means	H_0: Means Equal
Number of Homes in Sample	64	74	71	194		
Tax Information:						
Property Value (1997 average)	$44,960	$44,[illegible]	$44,121	$44,120	0.8%	
Lot Size (average ft2)	7,836	7,558	7,318	7,645	1.2%	
Home Size (average ft2)	1,127	1,100	1,141	1,122	1.9%	
Year Home Built	1960	1970	1965	1960		
Fixtures and Landscape:						
Swimming Pool	2%	0%	4%	2%	2%	Accept
Ultra Low Flush Toilets	50%	44%	41%	49%	5%	Accept
Low Flow Showerheads	46%	52%	45%	50%	3%	Accept
St. Augustine Grass	55%	52%	41%	42%	13%	Accept
In-ground Irrigation with timer	2%	0%	7%	7%	6%	Reject
Hose-based irrigation system	94%	96%	99%	94%	3%	Accept
Demographics:						
Occupants per Home (average)	3.32	2.79	3.02	3.01	15%	Accept
White	37%	65%	35%	45%	16%	Reject
Hispanic	34%	33%	49%	37%	12%	Reject
Black	27%	1%	12%	13%	19%	Reject
Annual House Income (average)	$30,294	$37,815	$30,425	$33,341	14%	Reject
Occupants Own Home	80%	95%	77%	85%	9%	Reject
Occupants Pay Water Bill	94%	92%	94%	96%	2%	Accept
Penny Pincher Questions						
"I clip and use discount coupons for groceries"	62%	71%	57%	75%	12%	Reject
"I pay attention to changes in gasoline prices"	75%	69%	62%	85%	7%	Accept
"I have and use a monthly budget for utilities"	61%	59%	72%	64%	7%	Accept
"I try to keep my water bill as low as possible"	90%	85%	84%	87%	4%	Accept
Appearance Questions						
"It is important to me for my lawn and landscape to look as good as possible"	54%	52%	53%	44%	7%	Accept
"I like my lawn and landscape to be among the best maintained in my neighborhood"	46%	39%	41%	42%	4%	Accept
Rugged Individual Questions						
"As long as I pay for it, I should have the right to use as much water as I think necessary"	41%	48%	35%	36%	5%	Accept
"I would rather take the chance of over watering my lawn than not give it enough water"	10%	14%	11%	[illegible]	1%	Accept
"Even when there is very little rainfall I water as much as I want"	14%	8%	9%	9%	9%	Accept
"Claims about Texas facing serious water shortages in the future are greatly exaggerated"	39%	27%	37%	34%	7%	Accept
Importance of Conservation Questions						
"Water conservation will ensure that there is enough water to meet my needs"	87%	74%	73%	75%	9%	Accept
"Unless people start learning how to conserve water, there is not going to be enough for everybody"	71%	71%	61%	64%	5%	Accept
"Water conservation will provide a better world for future generations"	83%	83%	74%	79%	5%	Accept
"Water conservation will help residents of this area to have a better overall quality of life"	74%	79%	68%	74%	6%	Accept

Attitudinal results include strongly agree and somewhat agree responses.

H_0 refers to the "null hypothesis" to be statistically tested. In this instance, the null hypothesis is that mean proportions over all 3 agencies are equal. We used Chi Squared test using 0.05 level of significance.

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Table C-8
Profile Characteristics by Water Agency: Profile 8

Characteristic	Austin	Corpus	SAWS	Total	Maximum Absolute Deviation In Means	H_o: Means Equal
Number of Houses in Sample	77	87	90	254		
Tax Information						
Property Value (1997 average)	$60,915	$60,832	$58,869	$60,833	0.3%	
Lot Size (average ft2)	8,207	8,153	8,303	8,239	1%	
House Size (average ft2)	1,334	1,346	1,387	1,363	0.4%	
Year Home Built	1968	1971	1971	1970		
Fixtures and Landscape						
Swimming Pool	8%	1%	1%	3%	5%	Reject
Ultra Low Flush Toilets	44%	31%	32%	36%	9%	Accept
Low Flow Showerheads	51%	52%	53%	52%	4%	Accept
St. Augustine Grass	57%	65%	59%	60%	5%	Accept
In-ground Irrigation with timer	5%	0%	5%	3%	3%	Accept
Hose based irrigation system	91%	98%	89%	93%	4%	Reject
Demographics						
Occupants per Home (average)	2.58	2.56	2.64	2.62	2%	Accept
White	71%	69%	79%	74%	5%	Accept
Hispanic	9%	29%	16%	19%	11%	Reject
Black	19%	2%	2%	4%	10%	Reject
Annual House Income (average)	$43,[illegible]	$37,911	$41,2[illegible]	$42,805	7%	Accept
Occupants Own Home	96%	94%	89%	90%	4%	Accept
Occupants Pay Water Bill	99%	98%	100%	99%	3%	Reject
Penny Pincher Questions						
"I clip and use discount coupons for groceries"	67%	76%	79%	73%	13%	Reject
"I pay attention to changes in gasoline prices"	86%	86%	83%	85%	6%	Accept
"I have and use a monthly budget for utilities"	31%	40%	51%	39%	12%	Reject
"I try to keep my water bill as low as possible"	75%	87%	84%	83%	9%	Accept
Appearance Questions						
"It is important to me for my lawn and landscape to look as good as possible"	56%	58%	59%	57%	4%	Accept
"I like my lawn and landscape to be among the best manicured in my neighborhood"	57%	47%	41%	44%	1%	Accept
Rugged Individual Questions						
"As long as I pay for it, I should have the right to use as much water as I think necessary"	30%	28%	26%	27%	5%	Accept
"I would rather take the chance of over watering my lawn than not give it enough water"	17%	14%	9%	13%	3%	Accept
"Even when there is very little rainfall, I water as much as I want"	4%	6%	4%	7%	1%	Accept
"Claims about Texas facing serious water shortages in the future are greatly exaggerated"	31%	27%	34%	31%	5%	Accept
Importance of Conservation Questions						
"Water conservation will ensure that there is enough water to meet my needs"	76%	65%	71%	72%	5%	Accept
"Unless people start learning how to conserve water, there is not going to be enough for everybody"	71%	65%	64%	68%	6%	Accept
"Water conservation will provide a better world for future generations"	61%	79%	79%	81%	2%	Accept
"Water conservation will help residents of this area to have a better overall quality of life"	73%	67%	73%	64%	3%	Accept

Attitudinal results include strongly agree and somewhat agree responses.

H_o refers to the "null hypothesis" to be statistically tested. In this instance, the null hypothesis is that mean proportions over all 3 agencies are equal. We used Chi Squared test using 0.05 level of significance.

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Table C-9
Profile Characteristics by Water Agency: Profile 9

Characteristic	Austin	Corpus	SAWS	Total	Maximum Absolute Deviation In Means	H_o: Means Equal
Number of Houses in Sample	[illegible]	[illegible]	[illegible]	266		
Tax Information						
Property Value (1997 average)	$78,518	$76,728	$78,541	$77,941	1.4%	
Lot Size (average ft2)	8,952	9,068	9,075	8,899	0.5%	
House Size (average ft2)	1,618	1,659	1,628	1,635	1.5%	
Year Home Built	1970	1971	1972	1971		
Fixtures and Landscape						
Swimming Pool	4%	2%	2%	2%	5%	Accept
Ultra Low Flush Toilets	49%	30%	36%	37%	11%	Reject
Low Flow Showerheads	65%	47%	49%	53%	9%	Accept
St. Augustine Grass	66%	83%	62%	70%	13%	Reject
In-ground Irrigation with timer	5%	12%	13%	10%	5%	Accept
Hose based irrigation system	89%	80%	84%	83%	3%	Accept
Demographics						
Occupants per Home (average)	2.37	2.82	2.34	2.47	14%	Accept
White	83%	82%	72%	79%	5%	Accept
Hispanic	6%	15%	30%	15%	9%	Reject
Black	17%	0%	2%	4%	7%	Reject
Annual House Income (average)	$48,617	$52,527	$50,444	$51,121	5%	Accept
Occupants Own Home	93%	94%	97%	95%	2%	Accept
Occupants Pay Water Bill	98%	99%	100%	99%	1%	Accept
Penny Pincher Questions						
"I clip and use discount coupons for groceries"	68%	72%	73%	70%	5%	Accept
"I pay attention to changes in gasoline prices"	80%	85%	87%	82%	4%	Accept
"I have and use a monthly budget for utilities"	39%	35%	43%	40%	8%	Accept
"I try to keep my water bill as low as possible"	69%	79%	85%	75%	10%	Reject
Appearance Questions						
"It is important to me for my lawn and landscape to look as good as possible"	50%	57%	62%	58%	5%	Accept
"I like my lawn and landscape to be among the best manicured in my neighborhood"	[illegible]	50%	54%	[illegible]	9%	Accept
Rugged Individual Questions						
"As long as I pay for it, I should have the right to use as much water as I think necessary"	32%	28%	30%	30%	2%	Accept
"I would rather take the chance of over watering my lawn than not give it enough water"	14%	15%	12%	13%	2%	Accept
"Even when there is very little rainfall, I water as much as I want"	6%	19%	2%	3%	6%	Reject
"Claims about Texas facing serious water shortages in the future are greatly exaggerated"	22%	33%	34%	30%	10%	Reject
Importance of Conservation Questions						
"Water conservation will ensure that there is enough water to meet my needs"	64%	60%	70%	67%	4%	Accept
"Unless people start learning how to conserve water, there is not going to be enough for everybody"	62%	64%	62%	64%	4%	Accept
"Water conservation will provide a better world for future generations"	71%	76%	72%	73%	5%	Accept
"Water conservation will help residents of this area to have a better overall quality of life"	75%	75%	72%	72%	3%	Accept

Attitudinal results include strongly agree and somewhat agree responses.

H_o refers to the "null hypothesis" to be statistically tested. In this instance, the null hypothesis is that mean proportions over all 3 agencies are equal. We used Chi Squared test using 0.05 level of significance.

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Table C-10
Profile Characteristics by Water Agency: Profile 10

Characteristic	Austin	Corpus	SAWS	Total	Maximum Absolute Deviation In Means	H_o: Means Equal
Number of Houses in Sample	92	86	105	283		
Tax Information						
Property Value (1997 average)	$118,734	$118,637	$118,109	$118,573	1.6%	
Lot Size (average ft2)	12,765	10,745	19,936	10,755	0.6%	
House Size (average ft2)	2,096	2,129	2,142	2,127	1.2%	
Year Home Built	1972	1971	1974	1972		
Fixtures and Landscape						
Swimming Pool	18%	6%	24%	16%	10%	Reject
Ultra Low Flush Toilets	34%	22%	34%	32%	9%	Accept
Low Flow Showerheads	39%	49%	43%	40%	2%	Accept
St. Augustine Grass	47%	86%	61%	76%	12%	Reject
In-ground Irrigation with timer	25%	18%	34%	26%	8%	Reject
Hose based irrigation system	38%	74%	73%	66%	9%	Reject
Demographics						
Occupants per Home (average)	3.41	2.46	2.59	2.48	4%	Accept
White	93%	88%	96%	90%	3%	Accept
Hispanic	5%	11%	8%	8%	7%	Accept
Black	1%	0%	0%	0%	5%	Accept
Annual House Income (average)	$65,219	$73,788	$79,890	$72,514	11%	Reject
Occupants Own Home	93%	99%	99%	97%	4%	Reject
Occupants Pay Water Bill	99%	99%	100%	99%	3%	Accept
Penny Pincher Questions						
"I clip and use discount coupons for groceries"	60%	68%	72%	69%	4%	Accept
"I pay attention to changes in gasoline prices"	75%	79%	[illegible]	83%	3%	Accept
"I have and use a monthly budget for utilities"	42%	31%	34%	34%	6%	Accept
"I try to keep my water bill as low as possible"	80%	69%	[illegible]	76%	13%	Reject
Appearance Questions						
"It is important to me for my lawn and landscape to look as good as possible"	40%	49%	61%	59%	11%	Reject
"I like my lawn and landscape to be among the best manicured in my neighborhood"	35%	62%	48%	59%	12%	Reject
Rugged Individual Questions						
"As long as I pay for it, I should have the right to use as much water as I think necessary"	22%	33%	24%	23%	9%	Accept
"I would rather take the chance of over watering my lawn than not give it enough water"	10%	23%	16%	19%	4%	Accept
"Even when there is very little rainfall, I water as much as I want"	10%	12%	3%	8%	5%	Accept
"Claims about Texas facing serious water shortages in the future are greatly exaggerated"	29%	35%	44%	34%	9%	Reject
Importance of Conservation Questions						
"Water conservation will ensure that there is enough water to meet my needs"	66%	67%	61%	67%	1%	Accept
"Unless people start learning how to conserve water, there is not going to be enough for everybody"	68%	69%	69%	66%	4%	Accept
"Water conservation will provide a better world for future generations"	79%	79%	78%	79%	1%	Accept
"Water conservation will help residents of this area to have a better overall quality of life"	64%	55%	66%	72%	9%	Accept

Attitudinal results include strongly agree and somewhat agree responses.

H_o refers to the "null hypothesis" to be statistically tested. In this instance, the null hypothesis is that mean proportions over all 3 agencies are equal. We used Chi Squared test using 0.05 level of significance.

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Table C-11
Profile Characteristics by Water Agency: Profile 11

Characteristic	Austin	Corpus	SAWS	Total	Maximum Absolute Deviation In Means	H_o: Means Equal
Number of Homes in Sample	43	41	44	128		
Tax Information						
Property Value (1997 average)	$49,4[illegible]	$48,806	$48,296	$48,8[illegible]	1.4%	
Lot Size (average ft2)	6,07[illegible]	5,971	6,121	6,080	1.9%	
House Size (average ft2)	1,072	1,088	1,071	1,075	0.9%	
Year Home Built	1962	1963	1964	1963		
Fixtures and Landscape						
Swimming Pool	2%	0%	7%	3%	4%	Accept
Ultra Low Flush Toilets	39%	22%	41%	35%	13%	Accept
Low Flow Showerheads	39%	44%	41%	43%	6%	Accept
St. Augustine Grass	22%	47%	26%	31%	15%	Accept
In-ground Irrigation with timer	0%	0%	0%	0%	0%	Accept
Hose based irrigation system	100%	99%	100%	100%	0%	Accept
Demographics						
Occupants per Home (average)	3.20	3.20	3.20	3.20	0%	Accept
White	39%	44%	50%	38%	6%	Accept
Hispanic	17%	38%	51%	42%	4%	Accept
Black	22%	3%	14%	17%	10%	Reject
Annual House Income (average)	$34,605	$44,813	$35,135	$38,150	12%	Accept
Occupants Own Home	88%	86%	90%	88%	1%	Accept
Occupants Pay Water Bill	91%	100%	91%	97%	4%	Accept
Penny Pincher Questions						
"I clip and use discount coupons for groceries"	46%	56%	65%	57%	11%	Accept
"I pay attention to changes in gasoline prices"	83%	79%	91%	85%	7%	Accept
"I have and use a monthly budget for utilities"	44%	44%	72%	54%	18%	Reject
"I try to keep my water bill as low as possible"	73%	63%	82%	75%	11%	Accept
Appearance Questions						
"It is important to me for my lawn and landscape to look as good as possible"	29%	17%	56%	40%	16%	Reject
"I like my lawn and landscape to be among the best manicured in my neighborhood"	24%	41%	58%	43%	15%	Reject
Rugged Individual Questions						
"As long as I pay for it, I should have the right to use as much water as I think necessary"	30%	40%	26%	34%	9%	Accept
"I would rather take the chance of over watering my lawn than not give it enough water"	10%	10%	7%	9%	2%	Accept
"Even when there is very little rainfall, I water as much as I want"	5%	5%	2%	3%	2%	Accept
"Claims about Texas facing serious water shortages in the future are greatly exaggerated"	29%	32%	29%	26%	5%	Accept
Importance of Conservation Questions						
"Water conservation will ensure that there is enough water to meet my needs"	73%	66%	79%	71%	7%	Accept
"Unless people start learning how to conserve water, there is not going to be enough for everybody"	76%	61%	79%	72%	11%	Accept
"Water conservation will provide a better world for future generations"	67%	70%	79%	76%	6%	Accept
"Water conservation will help residents of this area to have a better overall quality of life"	73%	63%	56%	66%	4%	Accept

Attitudinal results include strongly agree and somewhat agree responses.

H_o refers to the "null hypothesis" to be statistically tested. In this instance, the null hypothesis is that mean proportions over all 3 agencies are equal. We used Chi Squared test using 0.05 level of significance.

Table C-12
Profile Characteristics by Water Agency: Profile 12

[illegible]	Austin	Corpus	SAWS	Total	Maximum Absolute Deviation In Means	H_0 Means Equal
Number of Homes in Sample	32	36	76	146		
Tax Information						
Property Value (1997 average)	$71,914	$70,552	$64,891	$73,540	2.0%	
Lot Size (average ft2)	6,459	6,756	6,817	6,787	0.9%	
House Size (average ft2)	1,535	1,362	1,380	1,363	1.9%	
Year Home Built	1982	1983	1984	1983		
Fixtures and Landscape						
Swimming Pool	6%	4%	0%	2%	4%	Accept
Ultra Low Flush Toilets	12%	20%	35%	27%	10%	Accept
Low Flow Showerheads	44%	54%	39%	42%	8%	Accept
St. Augustine Grass	56%	72%	66%	65%	9%	Accept
In-ground Irrigation with timer	3%	4%	1%	3%	2%	Accept
Hose based irrigation system	95%	90%	90%	91%	4%	Accept
Demographics						
Occupants per Home (average)	2.57	3.01	2.85	2.81	9%	Accept
White	75%	70%	64%	66%	7%	Accept
Hispanic	6%	25%	24%	19%	5%	Reject
Black	13%	3%	6%	6%	4%	Accept
Annual House Income (average)	$40,150	$47,277	$49,341	$49,934	3%	Accept
Occupants Own Home	90%	93%	88%	91%	2%	Accept
Occupants Pay Water Bill	92%	99%	99%	98%	0%	Accept
Penny Pincher Questions						
"I clip and use discount coupons for groceries"	59%	60%	77%	69%	8%	Accept
"I pay attention to changes in gasoline prices"	87%	86%	74%	82%	4%	Accept
"I have and use a monthly budget for utilities"	52%	50%	54%	51%	2%	Accept
"I try to keep my water bill as low as possible"	89%	74%	80%	79%	6%	Accept
Appearance Questions						
"It is important to me for my lawn and landscape to look as good as possible"	65%	35%	42%	54%	11%	Accept
"I like my lawn and landscape to be among the best maintained in my neighborhood"	62%	55%	41%	53%	9%	Accept
Rugged Individual Questions						
"As long as I pay for it, I should have the right to use as much water as I think necessary"	31%	37%	27%	31%	5%	Accept
"I would rather take the chance of over watering my lawn than not give it enough water"	12%	13%	12%	13%	2%	Accept
"Even when there is very little rainfall, I water as much as I want"	8%	10%	7%	8%	1%	Accept
"Claims about Texas facing serious water shortages in the future are greatly exaggerated"	29%	35%	27%	30%	9%	Accept
Importance of Conservation Questions						
"Water conservation will ensure that there is enough water to meet my needs"	75%	64%	74%	71%	6%	Accept
"Unless people start learning how to conserve water, there is not going to be enough for everybody"	76%	73%	71%	74%	3%	Accept
"Water conservation will provide a better world for future generations"	84%	82%	87%	87%	1%	Accept
"Water conservation will help residents of this area to have a better overall quality of life"	74%	68%	75%	73%	5%	Accept

Attitudinal results include strongly agree and somewhat agree responses.

H_0 refers to the "null hypothesis" to be statistically tested. In this instance, the null hypothesis is that mean proportions across all 3 agencies are equal. We used Chi Squared test using 0.05 level of significance.

EXHIBIT RW-28

Table C-13
Profile Characteristics by Water Agency: Profile 13

Characteristic	Austin	Corpus	SAWS	Total	Maximum Absolute Deviation In Means	H_0 Means Equal
Number of Homes in Sample	71	45	83	200		
Tax Information						
Property Value (1997 average)	$86,410	$84,131	$81,583	$84,300	3.7%	
Lot Size (average ft2)	7,349	7,095	7,277	7,260	0.2%	
House Size (average ft2)	1,595	1,605	1,598	1,600	0.4%	
Year Home Built	1982	1984	1985	1984		
Fixtures and Landscape						
Swimming Pool	0%	5%	10%	5%	6%	Reject
Ultra Low Flush Toilets	39%	27%	29%	30%	5%	Accept
Low Flow Showerheads	51%	42%	49%	48%	8%	Accept
St. Augustine Grass	12%	29%	66%	64%	13%	Reject
In-ground Irrigation with timer	1%	1%	7%	6%	1%	Accept
Hose based irrigation system	57%	40%	49%	51%	2%	Accept
Demographics						
Occupants per Home (average)	2.75	3.18	2.61	2.97	7%	Accept
White	75%	68%	74%	74%	4%	Accept
Hispanic	19%	28%	23%	22%	5%	Accept
Black	3%	1%	2%	2%	1%	Accept
Annual House Income (average)	$43,997	$47,546	$53,000	$51,621	16%	Accept
Occupants Own Home	88%	99%	95%	93%	7%	Reject
Occupants Pay Water Bill	99%	100%	100%	100%	1%	Accept
Penny Pincher Questions						
"I clip and use discount coupons for groceries"	63%	77%	70%	69%	6%	Accept
"I pay attention to changes in gasoline prices"	50%	55%	61%	60%	6%	Accept
"I have and use a monthly budget for utilities"	47%	45%	50%	49%	7%	Accept
"I try to keep my water bill as low as possible"	73%	65%	76%	71%	5%	Accept
Appearance Questions						
"It is important to me for my lawn and landscape to look as good as possible"	55%	42%	57%	50%	10%	Accept
"I like my lawn and landscape to be among the best maintained in my neighborhood"	50%	46%	56%	50%	7%	Accept
Rugged Individual Questions						
"As long as I pay for it, I should have the right to use as much water as I think necessary"	19%	15%	29%	16%	6%	Accept
"I would rather take the chance of over watering my lawn than not give it enough water"	13%	6%	14%	14%	2%	Accept
"Even when there is very little rainfall, I water as much as I want"	5%	9%	6%	8%	2%	Accept
"Claims about Texas facing serious water shortages in the future are greatly exaggerated"	27%	16%	12%	21%	9%	Accept
Importance of Conservation Questions						
"Water conservation will ensure that there is enough water to meet my needs"	73%	71%	73%	70%	9%	Accept
"Unless people start learning how to conserve water, there is not going to be enough for everybody"	68%	66%	64%	67%	3%	Accept
"Water conservation will provide a better world for future generations"	85%	72%	76%	79%	6%	Accept
"Water conservation will help residents of this area to have a better overall quality of life"	72%	62%	78%	73%	9%	Accept

Attitudinal results include strongly agree and somewhat agree responses.

H_0 refers to the "null hypothesis" to be statistically tested. In this instance, the null hypothesis is that mean proportions across all 3 agencies are equal. We used Chi Squared test using 0.05 level of significance.

EXHIBIT RW-28

Table C-14
Profile Characteristics by Water Agency: Profile 14

Characteristic	Austin	Corpus	SAWS	Total	Maximum Absolute Deviation In Means	H_0 Means Equal
Number of Homes in Sample	73	40	73	241		
Tax Information						
Property Value (1997 average)	$104,817	$103,266	$136,540	$124,126	0.9%	
Lot Size (average ft2)	8,317	8,000	8,216	8,125	1.2%	
House Size (average ft2)	1,993	1,879	1,995	1,989	0.4%	
Year Home Built	1983	1985	1983	1986		
Fixtures and Landscape						
Swimming Pool	5%	4%	6%	5%	2%	Accept
Ultra Low Flush Toilets	23%	22%	35%	26%	4%	Accept
Low Flow Showerheads	41%	41%	46%	43%	3%	Accept
St. Augustine Grass	57%	80%	62%	67%	13%	Reject
In-ground Irrigation with timer	7%	15%	21%	15%	8%	Reject
Hose based irrigation system	56%	82%	45%	59%	15%	Reject
Demographics						
Occupants per Home (average)	2.65	2.96	2.76	2.83	1%	Accept
White	61%	76%	81%	81%	5%	Accept
Hispanic	7%	16%	15%	12%	9%	Accept
Black	3%	3%	0%	2%	2%	Accept
Annual House Income (average)	$66,324	$80,525	$75,000	$74,434	11%	Reject
Occupants Own Home	93%	99%	95%	94%	4%	Reject
Occupants Pay Water Bill	97%	99%	99%	98%	1%	Accept
Penny Pincher Questions						
"I clip and use discount coupons for groceries"	62%	59%	69%	65%	4%	Accept
"I pay attention to changes in gasoline prices"	83%	85%	79%	82%	3%	Accept
"I have and use a monthly budget for utilities"	47%	40%	42%	41%	4%	Accept
"I try to keep my water bill as low as possible"	64%	77%	78%	74%	9%	Accept
Appearance Questions						
"It is important to me for my lawn and landscape to look as good as possible"	62%	61%	54%	59%	5%	Accept
"I like my lawn and landscape to be among the best maintained in my neighborhood"	43%	53%	41%	49%	6%	Accept
Rugged Individual Questions						
"As long as I pay for it, I should have the right to use as much water as I think necessary"	21%	34%	29%	25%	7%	Accept
"I would rather take the chance of over watering my lawn than not give it enough water"	15%	11%	19%	15%	0%	Accept
"Even when there is very little rainfall, I water as much as I want"	11%	7%	0%	6%	0%	Reject
"Claims about Texas facing serious water shortages in the future are greatly exaggerated"	42%	27%	40%	27%	14%	Reject
Importance of Conservation Questions						
"Water conservation will ensure that there is enough water to meet my needs"	66%	71%	65%	67%	4%	Accept
"Unless people start learning how to conserve water, there is not going to be enough for everybody"	26%	57%	42%	45%	13%	Reject
"Water conservation will provide a better world for future generations"	78%	77%	75%	76%	2%	Accept
"Water conservation will help residents of this area to have a better overall quality of life"	77%	75%	74%	75%	1%	Accept

Attitudinal results include strongly agree and somewhat agree responses.

H_0 refers to the "null hypothesis" to be statistically tested. In this instance, the null hypothesis is that mean proportions across all 3 agencies are equal. We used Chi Squared test using 0.05 level of significance.

EXHIBIT RW-28

Table C-15
Profile Characteristics by Water Agency: Profile 15

Characteristic	Austin	Corpus	SAWS	Total	Maximum Absolute Deviation In Means	H_0 Means Equal
Number of Homes in Sample	76	75	87	238		
Tax Information						
Property Value (1997 average)	[illegible]	$120,954	$178,126	$114,290	2.0%	
Lot Size (average ft2)	10,814	10,431	10,823	10,434	1.9%	
House Size (average ft2)	2,371	2,665	2,825	2,620	1.9%	
Year Home Built	1987	1989	1988	1990		
Fixtures and Landscape						
Swimming Pool	8%	18%	22%	22%	9%	Accept
Ultra Low Flush Toilets	36%	42%	34%	38%	4%	Accept
Low Flow Showerheads	45%	44%	49%	47%	3%	Accept
St. Augustine Grass	72%	47%	77%	77%	5%	Accept
In-ground Irrigation with timer	49%	50%	70%	57%	11%	Reject
Hose based irrigation system	47%	38%	17%	32%	14%	Reject
Demographics						
Occupants per Home (average)	3.03	3.06	3.02	3.04	3%	Accept
White	85%	92%	93%	90%	2%	Accept
Hispanic	3%	9%	5%	6%	5%	Accept
Black	3%	0%	0%	1%	2%	Accept
Annual House Income (average)	$112,581	$110,159	$110,233	$113,958	1%	Accept
Occupants Own Home	96%	99%	97%	96%	2%	Accept
Occupants Pay Water Bill	100%	100%	100%	100%	0%	Accept
Penny Pincher Questions						
"I clip and use discount coupons for groceries"	41%	47%	67%	45%	7%	Accept
"I pay attention to changes in gasoline prices"	30%	24%	42%	32%	2%	Accept
"I have and use a monthly budget for utilities"	40%	35%	23%	34%	6%	Accept
"I try to keep my water bill as low as possible"	53%	59%	60%	51%	8%	Accept
Appearance Questions						
"It is important to me for my lawn and landscape to look as good as possible"	55%	45%	62%	60%	7%	Accept
"I like my lawn and landscape to be among the best maintained in my neighborhood"	42%	34%	60%	36%	12%	Reject
Rugged Individual Questions						
"As long as I pay for it, I should have the right to use as much water as I think necessary"	32%	43%	32%	36%	9%	Accept
"I would rather take the chance of over watering my lawn than not give it enough water"	14%	24%	17%	19%	6%	Accept
"Even when there is very little rainfall, I water as much as I want"	9%	0%	5%	4%	4%	Accept
"Claims about Texas facing serious water shortages in the future are greatly exaggerated"	20%	33%	33%	24%	6%	Accept
Importance of Conservation Questions						
"Water conservation will ensure that there is enough water to meet my needs"	48%	53%	60%	58%	2%	Accept
"Unless people start learning how to conserve water, there is not going to be enough for everybody"	64%	49%	61%	63%	3%	Accept
"Water conservation will provide a better world for future generations"	75%	72%	77%	74%	7%	Accept
"Water conservation will help residents of this area to have a better overall quality of life"	73%	75%	68%	76%	4%	Accept

Attitudinal results include strongly agree and somewhat agree responses.

H_0 refers to the "null hypothesis" to be statistically tested. In this instance, the null hypothesis is that mean proportions across all 3 agencies are equal. We used Chi Squared test using 0.05 level of significance.

EXHIBIT RW-28

Table C-16. Austin Profile Characteristics

[illegible]

EXHIBIT RW-28

Table C-17. Corpus Christi Profile Characteristics

[illegible]

EXHIBIT RW-28

Table C-18. [illegible] Profile Characteristics

[illegible]

EXHIBIT RW-28

APPENDIX D
SAMPLE WATER BILLS

EXHIBIT RW-28

UTILITY STATEMENT

City of Austin

REPRINTED 10/27/97

ACCOUNT NUMBER	CUSTOMER NAME
0654-500305-04	[redacted] TONY S

FOR SERVICES AT
[redacted] HERON COVE

FROM 08/17/97 TO 10/16/97

FOR A LIMITED TIME, YOUR ACCOUNT IS BEING GIVEN SPECIAL ATTENTION EACH MONTH TO VERIFY ACCURACY AND TO ASSURE THAT YOUR CONTRACT TERMS ARE BEING MET. THIS MAY SOMETIMES CAUSE A DELAY IN BILLING. [illegible] QUESTIONS [illegible] PLEASE CALL 476-7721.

NEXT SCHEDULED METER READING DATE 11/18/97

FOR ACCOUNT INFORMATION, CALL 476-7721

BALANCE ON 09/22/97	[illegible]
PLUS ADJUSTMENTS	[illegible]
LESS PAYMENTS RECEIVED THROUGH 10/27/97	0.00
CONTRIBUTIONS RECEIVED	
PLUS LATE PAYMENT PENALTY	[illegible]
REMAINING BALANCE	$ [illegible]
MISCELLANEOUS	82.41

ELECTRIC

YOUR CHARGE FOR 1,200 KWH IS	$84.33	
SALES TAX	$.84	
TOTAL COST FOR ELECTRIC SERVICE:		85.16

WATER

YOUR CHARGE FOR 14,100 GALLONS IS	$34.75	
TOTAL COST FOR WATER SERVICE:		34.75

WASTEWATER

YOUR CHARGE FOR 9,800 GALLONS IS	$34.34	
TOTAL COST FOR WASTEWATER SERVICE:		34.34

OTHER SERVICES

YOUR CHARGE FOR SOLID WASTE SERVICE IS	$16.95	
SALES TAX	$1.2[illegible]	
YOUR CHARGE FOR DRAINAGE/STREET SERVICES IS	$5.06	
TOTAL COST FOR OTHER SERVICES:		23.42

*PAYMENT MUST BE POSTED ON OR BEFORE 11/16/97 OR A 5% PENALTY IS ASSESSED ON THE CURRENT ELECTRIC, WATER, AND WASTEWATER CHARGES UNPAID

TOTAL PAYMENT DUE UPON RECEIPT* > > > > > $	892.37
PENALTY ON CURRENT SERVICES	8.17
BALANCE DUE AFTER 11/16/97 $	900.54

[illegible] DETACH AND RETURN THE STUB WITH YOUR PAYMENT [illegible]

City of Austin

TO CONTRIBUTE, ENTER AMOUNT TO THE RIGHT OF [illegible] HELPS AND INCLUDE IN TOTAL PAID
TO CONTRIBUTE, ENTER AMOUNT TO THE RIGHT OF TREE AND INCLUDE IN TOTAL PAID
PLEASE MAKE CHECK PAYABLE TO CITY OF AUSTIN UTILITIES

HELPS	$
PLANTING PROGRAM	$
TOTAL DUE ON OR BEFORE 11/16/97	892.37
PENALTY	8.17
TOTAL DUE AFTER 11/16/97	900.54
PLEASE ENTER TOTAL PAID	$

PO BOX 630063
DALLAS TX 75263-0063

0654-500305-04
[redacted] TONY S
[redacted] HERON COVE
AUSTIN TX 78759

1 50030504 000000 00000089237 A

EXHIBIT RW-28

City of Austin

PAGE 2

ACCOUNT# 0654-500305-04

ELECTRIC 322-6300

IN 29 DAYS YOU USED 1,200 KWH

READ DATE	METER # 08304730
10/16/97	47500
08/17/97	46300
DIFFERENCE	1200

RATE CALCULATION:
RESIDENTIAL SERVICE RATE, MULTI-FUEL

CUSTOMER CHARGE			$6.00
ENERGY	500 KWH AT	$.03550/KWH	17.75
	700 KWH AT	$.07820/KWH	54.74
FUEL	1200 KWH AT	$.01311/KWH	15.73
SUBTOTAL ELECTRIC CHARGES			$84.22
SALES TAX			.84
TOTAL COST FOR ELECTRIC SERVICE			$85.16

FOR THIS 29 DAY PERIOD, YOUR AVERAGE DAILY COST FOR ELECTRIC SERVICE WAS $2.28

GET A SUPER DEAL ON SUPER TOILETS! CITY OFFERS UP TO A $80 REBATE IF YOU REPLACE OLD TOILET WITH LOW-FLUSH MODEL. HURRY OFFER ENDS SOON! FOR MORE INFO, CALL 499-2199

WATER/WASTEWATER 322-2820

BASED ON A 5/8 INCH METER
AT THE URBAN RESIDENTIAL WATER RATE

READ DATE	METER # 00138000
10/16/97	854300
08/17/97	840100
DIFFERENCE	14100

WATER SERVICE CALCULATION
BASED ON CONSUMPTION OF 14,100 GALLONS

CUSTOMER CHARGE IS			$4.4[illegible]
CHARGE FOR	2,900 @	1.25/1000G	3.6[illegible]
NEXT	4,000 @	2.00/1000G	8.0[illegible]
NEXT	7,200 @	2.60/1000G	18.7[illegible]
TOTAL WATER CHARGES FOR 58 DAYS			$34.7[illegible]

WASTEWATER SERVICE CALCULATION
BASED ON WASTEWATER AVERAGE OF 9,800 GALLONS

CUSTOMER CHARGE IS			$3.9
CHARGE FOR	2,000 @	1.65/1000G	3.3
NEXT	7,800 @	3.48/1000G	27.1
TOTAL WASTEWATER CHARGES FOR 29 DAYS			$34.3

A NEW WASTEWATER AVERAGE WILL BE CALCULATED FOR THIS ACCOUNT BASED UPON WATER USAGE FROM 11/15/97 TO 03/13/98

ADJUSTMENTS / FEES

FOR QUESTIONS CALL 476-7721

WW-BILLING	882.41
FEE TOTAL	882.41

SOLID WASTE 499-2111

GARBAGE COLLECTION	$14.50
SALES TAX	1.21
ANTI-LITTER/HOME CHEMICAL COLLECTION	2.05
TOTAL COST FOR SOLID WASTE SERVICES	$17.76

AUSTIN RECYCLES AT CURB! YOU CAN RECYCLE JUNK MAIL & ALL # 1 & # 2 PLASTIC BOTTLES. PUT JUNK MAIL WITH NEWSPAPERS AND CATALOGS. PLASTIC BOTTLES GO IN YOUR BIN. CALL 499-2111

DRAINAGE / STREETS 476-7721

TRANSPORTATION USER FEE	$2.18
COMPREHENSIVE DRAINAGE FEE	3.87
TOTAL COST FOR DRAINAGE/STREET SERVICES	$6.06

IF YOU ARE AT LEAST 65 YEARS OF DO NOT DRIVE/OWN A VEHICLE OR THIS PROPERTY IS VACANT - YOU MAY QUALIFY FOR AN EXEMPTION TO THE TRANSPORTATION USER FEE. CALL 476-7721 FOR MORE INFORMATION.

AUTHORIZED PAYSTATIONS:

PAYMENTS ARE ACCEPTED AT MOST AUSTIN-AREA HEB AND RANDALL STORES, AS WELL AS:
[redacted] GUADALUPE STREET
[redacted] IH 35 SERVICE ROAD

DROP BOX: 701 WEST FIFTH STREET

FOR BILLING QUESTIONS, CALL 476-7721

SE HABLA ESPANOL

HEARING IMPAIRED TDD: 477-3083

DO NOT INCLUDE CORRESPONDENCE WITH THIS BILL. SEND CORRESPONDENCE TO:
[illegible]

EXHIBIT RW-28

City of Corpus Christi
P.O. Box 9097
Corpus Christi, Texas 78469-9097

Account Number	Due Date
1012-1740-6	10/30/97

Service Address: [redacted] MILO ST

Service Period From	To
09/07/97	10/08/97

Service Days	Issue Date
31	10/15/97

[redacted] MILO ST
CORPUS CHRISTI TX 78415-2113

WHEN MAKING PAYMENT IN PERSON, PLEASE BRING ENTIRE STATEMENT.

Service	Meter Readings Previous	Present	Consumption in Thousands	Itemized Cost Of Service	Total Cost of Service
PREPAID AMOUNT					60.00CR
1 WATER - BASIC SERVICE RAW WATER @ $.276 PER 1,000	323	329	6.000	11.45 1.66	13.11
1 GAS - BASIC SERVICE FUEL COST @ $2.70/MCF 1.00% SALES TAX-CITY ONLY	38	39	1.000	6.24 2.70 .09	9.03
1 WASTEWATER	WINTER AVERAGE				19.83
1 SOLID WASTE COLLECTION STATE FEE SURCHARGE STATE/FED MANDATES 7.75% SALES TAX	CURBSIDE			11.81 .23 .48 .93	13.15

WATER IS PRECIOUS, PLEASE CONSERVE! Total Amount Due: 8.40CR

RETAIN TOP PORTION FOR YOUR RECORDS. DETACH AND RETURN STUB WITH PAYMENT
PLEASE DO NOT STAPLE OR CLIP PAYMENT TO STUB.

☐ Indicate new address below

ACCOUNT NUMBER	DUE DATE	TOTAL AMOUNT DUE
1012-1740-6	10/30/97	8.40CR

City of Corpus Christi

[redacted] MILO ST
CORPUS CHRISTI TX 78415-2113

Make checks payable to: City of Corpus Christi
Remit to: Central Cashiering
P.O. Box 9097
Corpus Christi, Texas 78469-9097

Your prompt payment is greatly appreciated.

000000001012174065

TOTAL P.02

San Antonio Water System

P.O. Box 2990
San Antonio, Texas 78299-2990
(210) 225-8222

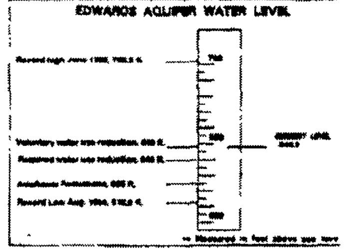
CURRENT BILL SUMMARY

[redacted] KING ROGER
ACCOUNT # 20 8000 098791 8

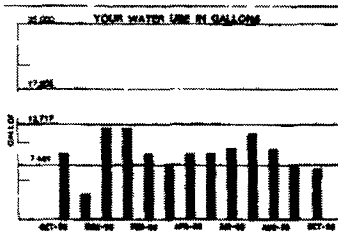
WATER	8.88
SEWER	18.60
FEDERAL STORMWATER FEE	1.90
AMOUNT DUE NOW	30.48
5% LATE FEE AFTER NOV 18 98	1.45
TOTAL WITH LATE FEE	31.93

(Detailed bill calculation on back)

EDWARDS AQUIFER WATER LEVEL



YOUR WATER USE IN GALLONS



YOUR WATER USE WAS 5,[illegible] GALLONS

YOUR NEIGHBORHOOD AVERAGE WATER USE WAS 7,401 GALLONS

SAWS RESIDENTIAL AVERAGE WATER USE WAS 7,401 GALLONS

PERSONALIZED MESSAGE

YOUR SUMMARY MONTH USAGE IS LESS THAN THE SAME TIME LAST YEAR.

YOUR WINTER AVERAGE IS [illegible] GALLONS. THIS AVERAGE, BASED ON YOUR USAGE BETWEEN NOVEMBER 15 AND MARCH 15, GENERALLY REPRESENTS INDOOR WATER USE. WATER USE IN EXCESS OF THIS AVERAGE MAY BE ATTRIBUTED TO OUTDOOR APPLICATION. THIS MONTH YOUR WATER USE IS [illegible] GALLONS BELOW YOUR WINTER AVERAGE.

DETACH HERE — PLEASE PRESENT BOTH PORTIONS IF PAYING IN PERSON — DETACH HERE

RETURN BOTTOM PORTION WITH PAYMENT

ACCT# 20 8000 098791 8
00186

VOID

AMOUNT DUE NOW	$30.48
AMOUNT DUE AFTER NOV 18 98 INCLUDES 5% LATE CHARGE	$31.93

[redacted] KING ROGERS
SAN ANTONIO TX 78204-2348

408600039791000003193000030481

If you have any question about your bill please call (210) 225-5222 or write to: SAWS Customer Service, P.O. Box 2449, San Antonio Texas 78298-2449. SAWS appreciates the opportunity to serve you.

CURRENT BILL CALCULATION

SERVICE DATES FOR THIS STATEMENT	SEP 27-OCT 24 1996
RESIDENTIAL/CITY SERVICE ACCOUNT	[illegible]
TOTAL DAYS OF SERVICE	27
METER READING ON SEP 27 96	[illegible]
METER READING ON OCT 24 96	[illegible]
METER WATER USE (GALLONS)	6,732

WATER

(3/4) INCH METER CHARGE (MINIMUM BILL)	[illegible]
6,732 GALS [illegible] CENTS PER 100 GALS.	[illegible]
SUBTOTAL FOR WATER	[illegible]

SEWER

YOUR WINTER AVERAGE IN GALLONS	[illegible]
YOUR SEWER CHARGES ARE	[illegible]
SUBTOTAL FOR SEWER	16.40

FEDERAL STORMWATER FEE

RESIDENTIAL LOT LESS THAN [illegible] SQ/FT	[illegible]
SUBTOTAL FOR STORMWATER	[illegible]
TOTAL CURRENT CHARGES	[illegible]

HOW TO READ YOUR METER

0	0	7	0	8	X

YOUR METER HAS A NUMBER DISPLAY SIMILAR TO THE ONE PICTURED ABOVE. READ THE METER FROM LEFT TO RIGHT. NUMBERS WITH A BLACK BACKGROUND ARE NOT USED IN THE CALCULATION OF YOUR MONTHLY WATER CONSUMPTION AND SHOULD BE DISREGARDED. SUBTRACT THE PREVIOUS METER READING (PROVIDED IN YOUR STATEMENT) FROM YOUR CURRENT OBSERVATION. THE RESULT WILL INDICATE THE AMOUNT OF WATER USED (IN HUNDREDS OF CUBIC FEET) SINCE THE LAST METER READING. TO CONVERT THIS USAGE TO GALLONS MULTIPLY THIS AMOUNT BY 748.1.

EXAMPLE

[illegible]

SUMMERTIME HEROES

NOW THAT SUMMER IS COMING TO A CLOSE ITS TIME TO VENTURE INTO THE YARD AND ASSESS THE RESULTS OF ONE OF THE DRIEST, HOTTEST SUMMERS ON RECORD.

FIRST, LOOK AROUND YOUR YARD AND MAKE A NOTE OF WHAT PLANTS LOOK GOOD AND PLANT MORE. AREAS OF GRASS THAT SUCCUMBED TO SUNSTROKE MAY BE CANDIDATES FOR CONVERSION TO MULCHED FLOWER BEDS, GROUNDCOVER OR A MORE DROUGHT RESISTANT GRASS.

AS WE MOVE INTO WINTER, BEGIN TO THINK ABOUT WINTERIZING YOUR YARD. ADD MULCH IN BEDS AND AROUND SHRUBS AND TREES. BEGIN FURTHER REDUCTIONS IN IRRIGATION AND REDUCE MOWING.

THE IDEA BEHIND WINTERIZING IS TO GET PLANTS TO STOP PUTTING ON TOP GROWTH AND BEGIN BUILDING ROOT GROWTH. A PLANT THAT IS PUTTING ON TOP GROWTH WILL NOT FAIR WELL IN A FREEZE.

BEGIN TO PLAN AND INSTALL YOUR WATERSAVER LANDSCAPE AND RECEIVE FROM 100 TO [illegible] DOLLARS FOR AN APPROVED LANDSCAPE. CALL 704-7384 FOR AN APPLICATION.

CUSTOMER SERVICE LOCATIONS AND HOURS

—[illegible] Castroville Road(Las Palmas)	8:00 am - 5:30 pm
—[illegible] E. Houston Street	7:45 am - 4:30 pm
—1001 E. Market Street	7:45 am - 4:30 pm

—Monday - Friday
—All Customer Service transactions

SAWS PHONE NUMBERS

—Customer Service/	225-6822
—Water Emergencies/	227-4143
—Sewer Emergencies/	704-1295
—Business Office/	704-SAWS

Para recibir su estado de cuenta en español favor de llamar 225-5322

San Antonio Water System

To receive your statement in Spanish please call 225-5222

TOTAL P.03

APPENDIX E
DETAILS OF THE DISCRETE/CONTINUOUS CHOICE MODEL

The Likelihood for the General Discrete/Continuous Choice Model of Water Demand Under Increasing Block-Rate Pricing

Hewitt and Hanemann (HH, 1995) present the theory of utility maximization with kinked budget constraints and analyze a model of discrete/continuous choice for the demand for water. Although their analysis is for multiple block pricing, their likelihood is written for the case of exactly two blocks, and cannot be easily generalized given the specificity of their notation. This note contains the likelihood for the general case of K blocks, where, in addition, K may vary over households. The likelihood below is presented for the use of interested applied economists--little analysis is given--see HH for the economic and econometric derivations.

Suppose the demand for water is

$$x = s'\delta + \alpha p + \mu y + \epsilon + \eta \tag{1}$$

where

x = water demand;
s = demographic and other exogenous characteristics;
p = price;
y = income;
ϵ = heterogeneity error, assumed to be distributed $N(0,\sigma_\epsilon^2)$;
η = measurement, optimization, or perception error, assumed to be $N(0,\sigma_\eta^2)$ and independent of ϵ;
α, μ = price and income coefficients, respectively; and
δ = parameters of the utility function.

Demand, price, and income could be specified as their natural logs in which case α and μ would be elasticities. Let p_k be the price of water in block k, and define FC as fixed costs. Let x_k^*, $k = 1, \ldots, K-1$ be the kink points between blocks k and $k+1$. Define

$$x(p_k, d_k) = s'\delta + \alpha p_k + \mu(y + d_k), \tag{2}$$

where d_k is a kind of virtual income due to the block rate pricing, given by

$$d_k = -FC - \sum_{j=1}^{k-1}(p_j - p_{j+1})x_j^*, \text{ for } k = 2, \ldots, K, \tag{3}$$

and $d_1 = -FC$. The behavioral assumption is that a household's water demand is given

EXHIBIT RW-28

The Likelihood for the General Discrete/Continuous Choice Model of Water Demand Under Increasing Block-Rate Pricing

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and $d_1 = -FC$. The behavioral assumption is that a household's water demand is given

by

$$x = \begin{cases} x(p_1,d_1)+\epsilon+\eta & -\infty < \epsilon \le x_1^* - x(p_1,d_1) \\ x_1^*+\eta & x_1^* - x(p_1,d_1) < \epsilon < x_1^* - x(p_2,d_2) \\ x(p_2,d_2)+\epsilon+\eta & x_1^* - x(p_2,d_2) < \epsilon \le x_2^* - x(p_2,d_2) \\ x_2^*+\eta & x_2^* - x(p_2,d_2) < \epsilon \le x_2^* - x(p_3,d_3) \\ \vdots & \vdots \\ x(p_K,d_K)+\epsilon+\eta & x_K^* - x(p_K,d_K) < \epsilon < \infty \end{cases} \tag{4}$$

This is the general form of HH equation 21. The likelihood is complicated because households could locate on either of the K segments or the $K-1$ kink points separating the segments. The likelihood is:

$$L(x|z,p_1,\dots,p_K,x_1^*,\dots,x_K^*;\mu,\alpha,\delta,\sigma_\epsilon,\sigma_\eta) = \tag{5}$$

$$\prod\Big[\frac{1}{\sigma_\eta}\sum_{k=1}^{K-1}\exp(-u_k^2/2)[\Phi(a_k)-\Phi(b_k)] + \frac{1}{\sigma_\nu}\sum_{k=1}^{K}\exp(-w_k^2/2)[\Phi(b_k')-\Phi(a_{k-1}')]\Big]$$

where the product is over all observations, and for $k=1,\dots,K$

$w_k = [x - z'\delta - \mu(y+d_k) - \alpha p_k]/\sigma_\nu$,

$\sigma_\nu = \sqrt{\sigma_\epsilon^2+\sigma_\eta^2}$

$u_k = [x - x_k^*]/\sigma_\eta$;

$b_k = [x_k^* - z'\delta - \mu(y+d_k) - \alpha p_k]/\sigma_\epsilon$;

$b_k' = (b_k - \rho w_k)/\sqrt{1-\rho^2}$;

$\rho = \sigma_\epsilon/\sigma_\nu$,

and for $k=1,\dots,K-1$

$a_k = [x_k^* - z'\delta - \mu(y+d_{k+1}) - \alpha p_{k+1}]/\sigma_\epsilon$,

$a_k' = (a_k - \rho w_k)/\sqrt{1-\rho^2}$.

Here Φ is the standard normal cumulative distribution function. Consistent with our definition of kink points we have $x_K^* = \infty$ which implies $b_K = \infty$, and we set $a_0 = -\infty$. The first summation (with $K-1$ terms) in equation 5 is for desired demand on the $K-1$ kink points, and is omitted for $K=1$. The second summation (with K terms) is for demand on the K segments. Each term is multiplied by its respective probability.

Reference

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and $d_1 = -FC$. The behavioral assumption is that a household's water demand is given

by

$$x = \begin{cases} x(p_1,d_1)+\epsilon+\eta & -\infty < \epsilon \le x_1^* - x(p_1,d_1) \\ x_1^*+\eta & x_1^* - x(p_1,d_1) < \epsilon \le x_1^* - x(p_2,d_2) \\ x(p_2,d_2)+\epsilon+\eta & x_1^* - x(p_2,d_2) < \epsilon \le x_2^* - x(p_2,d_2) \\ x_2^*+\eta & x_2^* - x(p_2,d_2) < \epsilon \le x_2^* - x(p_3,d_3) \\ \vdots & \vdots \\ x(p_K,d_K)+\epsilon+\eta & x_K^* - x(p_K,d_K) < \epsilon < \infty \end{cases} \tag{4}$$

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$$\prod\Big[\frac{1}{\sigma_\eta}\sum_{k=1}^{K-1}\exp(-u_k^2/2)[\Phi(a_k)-\Phi(b_k)] + \frac{1}{\sigma_\nu}\sum_{k=1}^{K}\exp(-w_k^2/2)[\Phi(b_k')-\Phi(a_{k-1}')]\Big]$$

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$\rho = \sigma_\epsilon/\sigma_\nu$,

and for $k=1,\dots,K-1$

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EXHIBIT RW-29

8:05 AM
08/05/16
Accrual Basis

North San Saba Water Supply Corp.
Profit & Loss
July 2016

		Jul 16
Income		
Capital fee		300.00
Exp. Rebate		100.00
Interest		3.61
Water Sales		33,903.06
Total Income		34,306.67
Expense		
Contract labor		7,500 00
Interest-		3,506.43
Office Expense		400.03
Office Supplies		108 55
Payroll Expenses		1,324.20
Payroll Tax Expense		308 60
Postage		277.00
Rental		
Office Rental	400.00	
Total Rental		400.00
Repairs		1,393.18
Returned Check		70 00
Supplies		
Parts	1,894 38	
Supplies - Other	245.91	
Total Supplies		2,140.29
Taxes		
Unemployment	16.20	
Total Taxes		16.20
Utilites		
Electricity	1,332.03	
Telephone	146.62	
Water	8,485.09	
Total Utilites		9,963 74
Water Testing		376.59
Total Expense		27,784.81
Net Income		**6,521.86**
		- 6820.45
		-298.59

Principal Payments

TWDB 310	2480.40
TWDB 335	500.00
Nelson Lewis	1920.78
FmHA	1919.27
	6820.45

EXHIBIT RW-29

8:06 AM

08/05/16

Accrual Basis

North San Saba Water Supply Corp.
Transaction Detail By Account
July 2016

Type	Date	Num	Name	Memo	Clr	Split	Amount
Contract labor							
Check	07/29/2016	8330	Broyles, Will			Arrowhead Bank	7,500.00
Total Contract labor							7,500.00
Interest-							
Check	07/12/2016	8325	Texas Water Develo			Arrowhead Bank	741.68
Check	07/12/2016	8326	Nelson Lewis, Inc			Arrowhead Bank	145.90
Check	07/12/2016	8327	Texas Water Develo			Arrowhead Bank	1,398.12
Check	07/23/2016		FMHA			Arrowhead Bank	1,220.73
Total Interest-							3,506.43
Office Expense							
Check	07/12/2016	8315	San Saba Printing			Arrowhead Bank	400.03
Total Office Expense							400.03
Office Supplies							
Check	07/12/2016	8323	QUILL			Arrowhead Bank	108.55
Total Office Supplies							108.55
Payroll Expenses							
Paycheck	07/29/2016	8331	Cindy Hibler			Arrowhead Bank	1,200.00
Paycheck	07/29/2016	8331	Cindy Hibler			Arrowhead Bank	74.40
Paycheck	07/29/2016	8331	Cindy Hibler			Arrowhead Bank	17.40
Paycheck	07/29/2016	8331	Cindy Hibler			Arrowhead Bank	0.00
Paycheck	07/29/2016	8331	Cindy Hibler			Arrowhead Bank	32.40
Total Payroll Expenses							1,324.20
Payroll Tax Expense							
Check	07/15/2016		United States Treas	940		Arrowhead Bank	308.60
Total Payroll Tax Expense							308.60
Postage							
Check	07/26/2016	8329	Postmaster			Arrowhead Bank	277 00
Total Postage							277.00
Rental							
Office Rental							
Check	07/12/2016	8328	Mark Martin			Arrowhead Bank	400.00
Total Office Rental							400.00
Total Rental							400.00
Repairs							
Check	07/12/2016	8321	Smith Pump Co.			Arrowhead Bank	1,393 18
Total Repairs							1,393.18
Returned Check							
Check	07/22/2016					Arrowhead Bank	70 00
Total Returned Check							70.00
Supplies							
Parts							
Check	07/12/2016	8313	Johnson Lab & Supply			Arrowhead Bank	1,581.89
Check	07/12/2016	8316	Pecan Valley Hardw...			Arrowhead Bank	312.49
Total Parts							1,894.38

EXHIBIT RW-29

North San Saba Water Supply Corp.
Transaction Detail By Account
July 2016

Type	Date	Num	Name	Memo	Clr	Split	Amount
Supplies - Other							
Check	07/12/2016	8317	RVS SOFTWARE	water bills		Arrowhead Bank	182.01
Check	07/12/2016	8318	San Saba Produce			Arrowhead Bank	63.90
Total Supplies - Other							245.91
Total Supplies							2,140.29
Taxes							
Unemployment							
Check	07/31/2016		Texas Workforce Co...			Arrowhead Bank	16 20
Total Unemployment							16.20
Total Taxes							16.20
Utilites							
Electricity							
Check	07/12/2016	8310	Hamilton Co. Electric			Arrowhead Bank	16.02
Check	07/12/2016	8311	Reliant			Arrowhead Bank	1,316.01
Total Electricity							1,332.03
Telephone							
Check	07/12/2016	8319	Central Texas Telep			Arrowhead Bank	146 62
Total Telephone							146.62
Water							
Check	07/12/2016	8314	City of San Saba	4434900 gals		Arrowhead Bank	8,485.09
Total Water							8,485 09
Total Utilites							9,963.74
Water Testing							
Check	07/12/2016	8312	Department Of Stat.	Radium, Alph...		Arrowhead Bank	322.59
Check	07/12/2016	8320	BIO CHEM LAB	2nd qtr analysis		Arrowhead Bank	54.00
Total Water Testing							376.59
TOTAL							**27,784.81**

EXHIBIT RW-29

8:08 AM
08/05/16
Accrual Basis

North San Saba Water Supply Corp.
Profit & Loss YTD Comparison
July 2016

	Jul 16	Jan - Jul 16
Income		
"Line Extension	0.00	5,043.00
Capital fee	300.00	6,600 00
Exp. Rebate	100.00	2,227.06
Interest	3.61	21.80
Membership fee	0.00	2,400.00
Reconnects	0.00	50.00
Water Sales	33,903.06	218,449.60
Total Income	34,306 67	234,791.46
Expense		
Contract labor	7,500 00	52,500.00
Deposit	0.00	200.00
Fuel	0.00	361.81
Insurance	0.00	4,248.00
Interest-	3,506.43	25,101.47
Membership Dues	0 00	368 75
New Software	0.00	2,091.21
Office Expense	400.03	674.02
Office Supplies	108.55	714 31
Payroll Expenses	1,324 20	10,854.40
Payroll Tax Expense	308.60	617.20
Postage		
Certified mail	0.00	6 74
Postage - Other	277.00	1,475.00
Total Postage	277.00	1,481.74
Professional Services		
Childers Case	0 00	7,293.41
Rate Appeal	0.00	4,456.95
Sealy Case	0.00	2,896.80
Professional Services - Other	0 00	5,100 00
Total Professional Services	0.00	19,747.16
Rental		
Chlorine Cyclinder	0.00	432 00
Civic Center	0.00	225 00
Office Rental	400.00	2,800.00
Total Rental	400 00	3,457 00
Repairs	1,393.18	5,527.58
Returned Check	70 00	165.15
State Water Fees	0 00	1,815.89
Supplies		
Parts	1,894 38	5,988 46
Supplies - Other	245.91	642 92
Total Supplies	2,140.29	6,631 38
Taxes		
Unemployment	16 20	54 00
Total Taxes	16.20	54.00
Utilites		
Electricity	1,332.03	10,756.98
Telephone	146 62	1,102.04
Water	8,485.09	44,178.21
Total Utilites	9,963.74	56,037.23

8:08 AM
08/05/16
Accrual Basis

North San Saba Water Supply Corp.
Profit & Loss YTD Comparison
July 2016

	Jul 16	Jan - Jul 16
Water Line Extension	0 00	4,820.00
Water Testing	376.59	1,407 28
Total Expense	27,784.81	198,875.58
Net Income	**6,521.86**	**35,915.88**

EXHIBIT RW-29

8:08 AM
08/05/16
Accrual Basis

North San Saba Water Supply Corp.
Profit & Loss Prev Year Comparison
January through July 2016

	Jan - Jul 16	Jan - Jul 15	$ Change	% Change
Income				
"Line Extension	5,043.00	0.00	5,043.00	100.0%
Capital fee	6,600.00	0.00	6,600.00	100.0%
Exp. Rebate	2,227 06	100.00	2,127.06	2,127.1%
Income Adjustment	0.00	996.61	-996.61	-100.0%
Interest	21.80	20 66	1.14	5.5%
Loan Income	0 00	256,884.23	-256,884.23	-100.0%
Membership fee	2,400.00	100.00	2,300.00	2,300.0%
Reconnects	50.00	0.00	50.00	100.0%
Water Sales	218,449.60	185,703.54	32,746.06	17.6%
Total Income	234,791.46	443,805.04	-209,013 58	-47.1%
Expense				
Advertising	0.00	217.50	-217.50	-100.0%
Construction Project	0.00	256,884.23	-256,884.23	-100.0%
Contract labor	52,500.00	38,500.00	14,000.00	36.4%
Deposit	200.00	100 00	100 00	100.0%
Fuel	361.81	0 00	361.81	100.0%
Insurance	4,248 00	3,925.00	323.00	8.2%
Interest-	25,101.47	25,915.48	-814.01	-3 1%
Labor	0.00	1,275 00	-1,275.00	-100.0%
Membership Dues	368.75	385.00	-16.25	-4.2%
New Software	2,091.21	0.00	2,091 21	100.0%
Office Expense	674 02	260.24	413 78	159.0%
Office Supplies	714.31	996.69	-282.38	-28.3%
Payroll Expenses	10,854 40	11,589.44	-735.04	-6 3%
Payroll Tax Expense	617 20	0.00	617.20	100.0%
Penalty	0 00	4,095.00	-4,095.00	-100 0%
Postage				
Certified mail	6.74	0.00	6.74	100.0%
Postage - Other	1,475.00	1,564 00	-89.00	-5 7%
Total Postage	1,481.74	1 564.00	-82.26	-5.3%
Professional Services				
Childers Case	7,293.41	0.00	7,293.41	100 0%
Rate Appeal	4,456 95	0.00	4,456.95	100 0%
Sealy Case	2,896.80	0 00	2,896.80	100.0%
Professional Services - Other	5,100.00	155.00	4,945 00	3,190 3%
Total Professional Services	19,747 16	155 00	19,592 16	12,640.1%
Reconciliation Discrepancies	0.00	24 60	-24.60	-100.0%
Refund	0 00	248.30	-248.30	-100.0%
Rental				
Chlorine Cyclinder	432.00	228 00	204.00	89.5%
Civic Center	225.00	62 50	162 50	260.0%
Office Rental	2,800.00	2,800 00	0.00	0.0%
Total Rental	3,457.00	3,090 50	366.50	11.9%
Repairs	5,527.58	645 00	4,882.58	757.0%
Returned Check	165.15	575.28	-410.13	-71.3%
State Water Fees	1,815.89	1,737.44	78.45	4 5%
Supplies				
Chlorine	0.00	207.00	-207 00	-100.0%
Parts	5,988.46	9,328.84	-3,340.38	-35.8%
Supplies - Other	642.92	235.00	407 92	173 6%
Total Supplies	6,631.38	9,770.84	-3,139.46	-32.1%
Taxes				
Unemployment	54.00	0 00	54.00	100 0%
Total Taxes	54 00	0.00	54.00	100 0%
Truck & Equipment Allowance	0.00	6,000.00	-6,000.00	-100.0%

EXHIBIT RW-29

North San Saba Water Supply Corp.
Profit & Loss Prev Year Comparison
January through July 2016

	Jan - Jul 16	Jan - Jul 15	$ Change	% Change
Utilites				
Electricity	10,756.98	11,517.01	-760.03	-6.6%
Telephone	1,102.04	1,126.40	-24.36	-2 2%
Water	44,178.21	39,909 56	4,268.65	10 7%
Total Utilites	56 037.23	52,552.97	3,484.26	6 6%
Water Analyzer	0 00	481 24	-481.24	-100.0%
Water Line Extension	4,820.00	8,107 00	-3,287 00	-40.6%
Water Testing	1,407.28	1,931.18	-523.90	-27.1%
Total Expense	198,875.58	431 026 93	-232,151.35	-53.9%
Net Income	**35,915.88**	**12,778.11**	**23,137.77**	**181.1%**

EXHIBIT RW-29

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Accrual Basis

North San Saba Water Supply Corp.
Balance Sheet
As of July 31, 2016

	Jul 31, 16
ASSETS	
Current Assets	
Checking/Savings	
Arrowhead Bank	51,507.35
Total Checking/Savings	51,507 35
Accounts Receivable	
Accounts Receivable TWDB	222,881 04
Total Accounts Receivable	222,881 04
Other Current Assets	
Reserve 310	38,235.69
Reserve 335	10,546 35
Reserve Savings	39,565.95
Total Other Current Assets	88,347.99
Total Current Assets	362,736.38
Fixed Assets	
Buildings	1,021.00
Equipment	31,052.15
Land	6,637 00
Office equipment	36,809.00
Pipeline system	3,751,373.37
Stand piprs	427,319.00
Wells and pumps	548,605.32
x-Acccumulated depreciation	-1,214,353.57
Total Fixed Assets	3,588,463.27
TOTAL ASSETS	**3,951,199.65**
LIABILITIES & EQUITY	
Liabilities	
Current Liabilities	
Accounts Payable	
Accounts Payable	17,175 60
Total Accounts Payable	17,175.60
Other Current Liabilities	
Payroll Liabilities	6,767.80
TCEQ Payable	5,355 18
TWDB Project Payable	356,884 23
Total Other Current Liabilities	369,007 21
Total Current Liabilities	386,182 81
Long Term Liabilities	
FMHA LOAN	295,125 10
Nelson Lewis Loan	41,848.77
Texas Water Development Board	180,542.78
TWDB #2 335k	319,000 00
Total Long Term Liabilities	836,516 65
Total Liabilities	1 222,699.46
Equity	
Temp. Restricted Net Assets	80,425.94
Unrestricted Net Assets	2,612,158.37
Net Income	35,915.88
Total Equity	2,728,500.19
TOTAL LIABILITIES & EQUITY	**3,951,199.65**

Austin WATER

EXHIBIT RW-30

2015-2016

Water & Wastewater Rates

Residential Water Customers – Monthly water charges include: billing, metering, collections, customer service, and servicing / monitoring of fire hydrants.

Meter Size	Customer Charge	Meter Charge	Fire Protection Charge	TOTAL
5/8*	$4.83	$1.79	$0.48	**$7.10**
¾	$4.83	$5.68	$2.49	**$13.00**
1	$4.83	$5.83	$4.34	**$15.00**
1¼	$4.83	$7.66	$4.51	**$17.00**
1½	$4.83	$14.15	$6.02	**$25.00**
2	$4.83	$19.97	$16.20	**$41.00**
3	$4.83	$39.79	$23.38	**$68.00**
4	$4.83	$74.14	$60.03	**$139.00**
6	$4.83	$151.78	$126.39	**$283.00**
8	$4.83	$296.93	$744.24	**$1,046.00**
10	$4.83	$416.57	$814.60	**$1,236.00**
12	$4.83	$538.35	$922.82	**$1,466.00**

*5/8 is the average residential customer meter size

Five-Tier Fixed Charge – Based on total billed water consumption for the billing period.

Gallons of Water	Fixed Charge
0 - 2,000 Gallons	$1.20
2,001 - 6,000 Gallons	$3.45
6,001 - 11,000 Gallons	$8.75
11,001 - 20,000 Gallons	$27.35
20,001 - over Gallons	$27.35

Five-Tier Volume Charge – Rate is charged per 1,000 gallons of total billed water consumption for the billing period. Customers must meet qualifications for Community Assistance Program (CAP) rates.

Gallons of Water	Non-CAP	CAP
0 - 2,000 Gallons	$3.16	$2.47
2,001 - 6,000 Gallons	$4.84	$3.89
6,001 - 11,000 Gallons	$7.88	$5.76
11,001 - 20,000 Gallons	$11.90	$9.90
20,001 - over Gallons	$14.16	$14.16

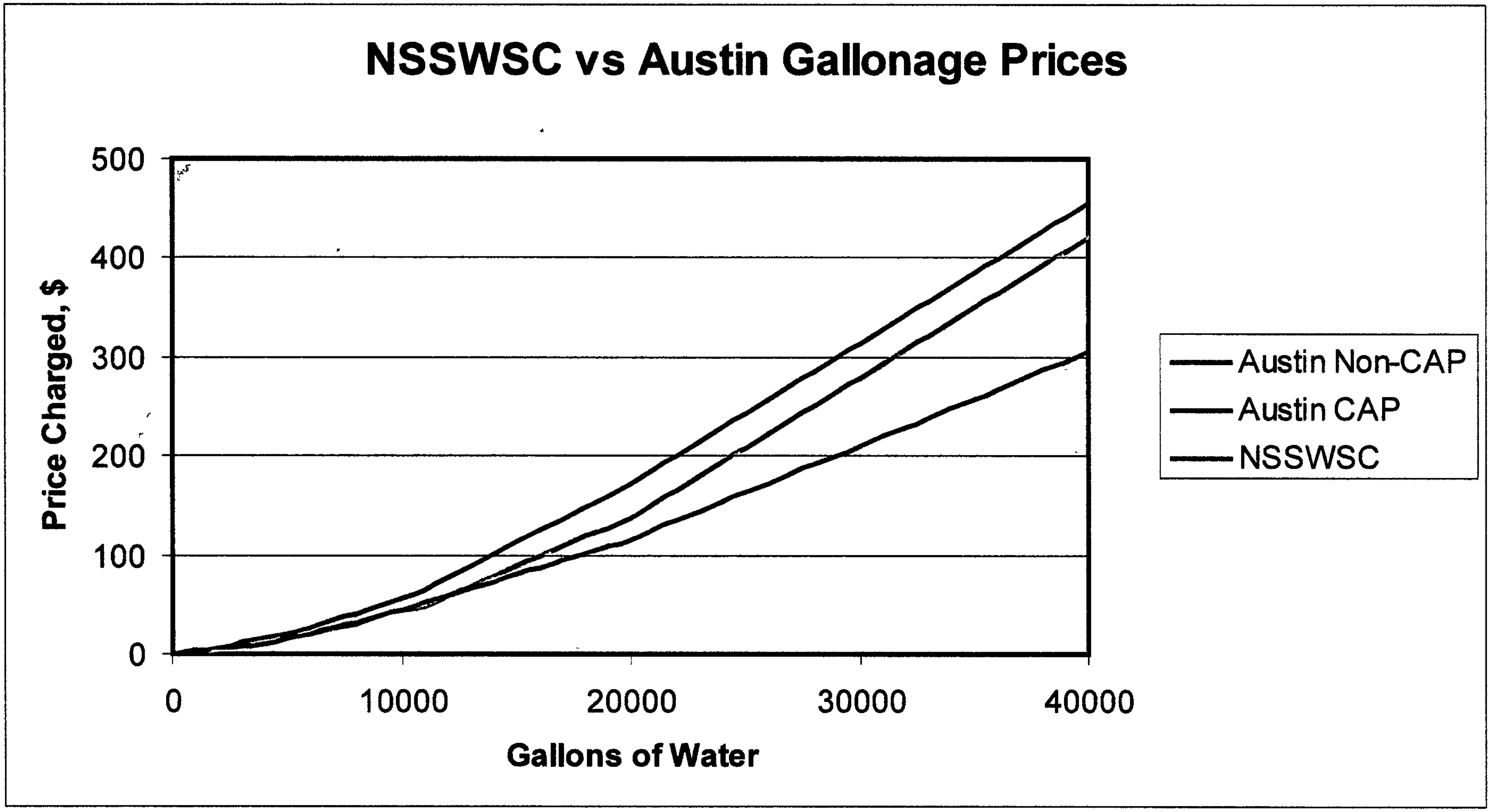
Reserve Fund Surcharge – fee goes into a restricted reserve fund to offset water service revenue shortfalls that may impact operations and services. This **$0.19** surcharge is per 1,000 gallons billed.

Residential Wastewater Customers – A monthly wastewater charge of **$10.30** includes the costs of billing, collections, customer service and other account management services.

Two-Tier Volume Charge – Rate is charged per 1,000 gallons of wastewater billed during the billing period. The amount of wastewater billed is based upon water usage during the Wastewater Averaging period, or monthly water consumption, whichever is lower.

Gallons of Water	Volume Charge
0 - 2,000 Gallons	$4.90
2,001 – or more Gallons	$9.94

EXHIBIT RW-31



Note: "CAP" refers to Austin's "Community Assistance Program."

STATE OF TEXAS §
§
COUNTY OF SAN SABA §

AFFIDAVIT OF ROGER WHATLEY

BEFORE ME, the undersigned authority, on this day personally appeared Roger Whatley, who, having been placed under oath by me, did depose as follows:

1. "My name is Roger Whatley. I am of sound mind and capable of making this affidavit. The facts stated herein are true and correct based upon my personal knowledge.

2. The foregoing Fourth Supplement to Rebuttal Testimony of Roger Whatley on Behalf of North San Saba Water Supply Corporation and the attached exhibits have been prepared by me, under my direct supervision, or are co-sponsored by me and are true and correct to the best of my knowledge."

Further affiant sayeth not.

Roger Whatley

SUBSCRIBED AND SWORN TO BEFORE ME by the said Roger Whatley this 7th day of October, 2016.

CHERIE RINGO
Notary Public, State of Texas
Comm. Expires 09-29-2018
Notary ID 1136759-4

Notary Public, State of Texas