SSU
Southern States Utilities

BEFORE THE

FLORIDA PUBLIC SERVICE COMMISSION

DOCKET NO. 950495 - WS

APPLICATION FOR A GENERAL RATE INCREASE

VOLUME I
BOOK 5 OF 22

MINIMUM FILING REQUIREMENTS
PREFILED DIRECT TESTIMONY

Containing

JOHN B. WHITCOMB, Ph.D.

DIRECT TESTIMONY OF JOHN B. WHITCOMB, PH.D.

BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

ON BEHALF OF

SOUTHERN STATES UTILITIES, INC.

DOCKET NO. 950495-WS

Q. WHAT IS YOUR NAME AND BUSINESS ADDRESS?

A. My name is John Whitcomb and my business address is 1375 Eaton Avenue, San Carlos, California 94070.

Q. BY WHOM ARE YOU EMPLOYED AND WHAT IS YOUR POSITION?

A. I am the principal of WATERTECH Software and Consulting located at the address indicated above.

Q. WHAT IS YOUR EDUCATIONAL BACKGROUND AND WORK EXPERIENCE?

A. I received my doctorate in Geography and Environmental Engineering from Johns Hopkins University in 1988 and a Bachelors degree in Economics and Geography from the University of California, Santa Barbara in 1984. I worked for Brown and Caldwell Consultants from 1989 to 1991 before starting WATERTECH Software and Consulting.

WATERTECH Software and Consulting provides consulting services and computer software to water agencies to assist in the planning, management, and pricing of water resources.

Included among my clients for water pricing studies are Redwood City, California (1995); Menlo Park, California (1995); San Jose, California (1994); Ashland, Oregon (1993); Sacramento, California (1992); West Sacramento, California (1991); Palo Alto, California (1991); Brookings, Oregon (1991); Fresno, California (1991); Northridge, California (1991); Grass Valley, California (1991); Tahoe City Public Utility District (1991); San Diego, California (1990); and Soquel Creek, California (1989).

The clients for whom I have performed empirical evaluations quantifying impacts on water use from factors such as weather, pricing, and various water conservation projects include The World Bank, Brazil (1995); Contra Costa Water District, California (1991, 1993 and 1994); Southwest Florida Water Management District (1993); Tampa, Florida (1992); Seattle, Washington (1990); South Florida Water Management District (1989); and San Jose, California.

I also have conducted assessments of the reliability and expected impact of water conservation programs on future water demand for the following clients: Santa Clara Valley Water District, California (1990 and 1995); Alameda County Water District, California (1992); Kentucky-American Water Company (1991); Sacramento, California (1991); Antioch, California (1990); Daly City, California (1990); Los Angeles Department of Water and Power, California (1987); Interstate Commission on the Potomac River Basin, Maryland (1987).

I have authored or co-authored nearly a dozen pieces regarding water use and water demand forecasting which have been presented in several fora and publications. A list of these pieces is included in Exhibit ___ (JBW-1).

Q. WHAT ARE YOUR PROFESSIONAL AFFILIATIONS?

A. I am a member of the American Water Resources Association, for which I also am a reviewer of AWRA Journal articles. I also am a member of the American Water Works Association and the California Urban Water Conservation Council.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. I will discuss the water conservation impact of the rate structure and the win/win aspects of the weather normalization clause being proposed by Southern States.

Q. COULD YOU IDENTIFY ANY PROFESSIONAL EXPERIENCE YOU MIGHT HAVE WHICH WOULD QUALIFY YOU AS AN EXPERT SPECIFICALLY IN WATER CONSERVING RATE STRUCTURES FOR FLORIDA UTILITIES?

A. From 1992 through 1994, I was sub-contracted by Brown and Caldwell to perform a series of studies of water conserving rate structures. Brown and Caldwell had been retained by the Southwest Florida Water Management District ("SWFWMD") to perform the studies. Mr. Jay W. Yingling was SWFWMD's senior economist with principal responsibility for the project management of the study. I was the person with primary responsibility for quantifying price elasticity and measuring rate structure impacts on water consumption.

The first study presented to SWFWMD was the study entitled

"Definition of Water Conservation Promoting Rates" which I will refer to as the "Conservation Rate Structure Study" which was completed in February, 1993. The intent of this study was to provide guidance to utilities in developing water conserving rate structures that would satisfy regulatory requirements and assist SWFWMD in the ability to quickly assess whether a rate structure would be effective in promoting water conservation. A copy of the Conservation Rate Structure Study is provided in Exhibit ____ (JBW-2).

Next, I continued my responsibilities as a subcontractor of Brown and Caldwell in the preparation of a large empirical study on residential and commercial water price elasticities for SWFWMD. Price elasticity measures the percentage change in demand resulting from a 1% change in price, all other factors held constant. This study culminated in the "Water Price Elasticity Study," which I will refer to simply as the "Elasticity Study," which was completed in August, 1993. A copy of the Elasticity Study is provided in Exhibit ____ (JBW-3).

Finally, I developed a PC/Windows software program known as WATERATE which simulates how changes in water and sewer prices impact water revenues and water demand. The program automates complex price elasticity calculations (as determined in the Elasticity Study) and provides a comprehensive, flexible framework from which to evaluate alternative rate structures. Features include single or multiblock rate structures that can vary by season, short- and long-run price elasticity adjustments specified by customer class, and detailed diagnostics as to the expected changes in the water use distribution over a three year planning horizon. SWFWMD has established a toll-free hot-line which utilities can call to obtain information on WATERATE including a free copy of the Program. At this time, there are over fifty (50) registered users of WATERATE, mostly in Florida. Exhibit ____ (JBW-4) contains a list of the registered users.

Subsequently, I was contracted by Southern States and requested to apply my knowledge and experience with the SWFWMD studies and programs to analyze the Company's existing rate structure and assist them in formulating an appropriate structure in this proceeding.

Q. ARE THE RESULTS FROM THE PRICE ELASTICITY STUDY APPLICABLE TO SOUTHERN STATES?

A. Yes. Florida has a unique mix of factors affecting price elasticity. (e.g., weather, type of soils, irrigation wells, vegetation, and tourism). For that reason, price elasticity results generated from other parts of the country can not be validly applied to Florida. To obtain local price elasticity estimates, SWFWMD undertook the Elasticity Study. The study was designed to quantify the relationship between water price and water demand for customers within the SWFWMD service area under a wide range of conditions. The Elasticity Study allowed price elasticity to vary with price level ($/ thousand gallons) and with property value. These steps were specifically taken to make the results more applicable to varying conditions. Given the geographic diversity of both the SWFWMD and Southern States' service areas and the diverse demographics and characteristics of the customers living in them, I believe it is reasonable to assume a similarity of Southern States' customer base and the customer base analyzed in the Elasticity Study. Therefore, I believe the price elasticities indicated in the Elasticity Study may properly be applied to Southern States.

I also point out that Southern States was one of the ten utilities which participated in the Elasticity Study. Specifically, Southern States provided data relating to the Company's facilities and customers in the Spring Hill service area in Hernando County. In addition, Southern States has 24 water service areas serving an estimated population of 125,000 within the SWFWMD jurisdiction.

Q. **DID YOU ANALYZE THE UNIFORM RATE STRUCTURE WHICH THE COMMISSION PREVIOUSLY AUTHORIZED SOUTHERN STATES TO CHARGE TO CUSTOMERS IN NINETY OF SOUTHERN STATES' SERVICE AREAS TO DETERMINE WHETHER THAT RATE STRUCTURE WAS PROPERLY DESIGNED TO RECOVER REVENUE REQUIREMENTS?**

A. Yes. I applied WATERATE to quantify expected changes in water consumption as a result of the application of the rate structure authorized in Docket No. 920199-WS. The principal factor which influenced the results of this analysis was the Commission's reduction of the portion of Southern States' revenue requirements which previously had been recovered through the base facility charge from approximately fifty-five percent (55%) to only thirty-three percent (33%) in the rate structure approved in Docket No. 920199-WS. The result of the analysis showed that the rate structure approved in Docket No. 920199-WS would be expected to cause a long-run water use reduction of 12.3 percent. The financial instability of revenues also increased; the 95% confidence interval around expected revenues increasing from 5.1 to 7.3 percent.

Since the Commission did not adjust the water consumption levels requested by Southern States in Docket No. 920199-WS when the uniform rate structure was established, Southern States requested that I quantify the revenue requirement impact which resulted when this water conserving rate structure was imposed without a corresponding reduction to the water consumption levels. All other factors held constant, my analysis revealed that the application of the uniform rate structure, without a recognition of the reduced consumption which flowed from it, resulted in an estimated reduction of 6.2, 9.2, and 10.8 percent of gallonage charge revenues in 1992, 1993, and 1994 respectively. In terms of total revenues, I calculated a reduction of 4.2, 6.2, and 7.2 percent in 1992, 1993, and 1994 respectively. In terms of dollars and with a $20,595,043 revenue requirement, the revenue deficiency for Southern States amounted to approximately $864,992, $1,276,893, and $1,482,843 for the years 1992, 1993, and 1994 as a result of the Commission's failure to recognize the inherent conservation impact of the rate structure approved in Docket No. 920199-WS.

Q. **DID THE UNIFORM RATE STRUCTURE APPROVED IN DOCKET NO. 920199-WS MEET THE CRITERIA FOR A WATER CONSERVING RATE STRUCTURE IDENTIFIED IN THE SWFWMD STUDIES?**

A. Yes. I applied the criteria set forth in the Conservation Rate Structure Study and confirmed that the rate structure established by the Commission in Docket No. 920199-WS and reconfirmed in Docket No. 930880-WS qualifies as a water conserving rate structure. The results in terms of consumption reductions from the application of the Elasticity Study through WATERATE confirm this fact. I note these facts as historical evidence of the validity of SSU's position that a straight base facility charge/gallonage charge structure, without inverted blocks, such as the structure being proposed by SSU in this proceeding, can indeed be classified as a water conserving rate structure.

Q. **COULD YOU BRIEFLY DESCRIBE THE RATE STRUCTURE PROPOSED BY SOUTHERN STATES IN THIS PROCEEDING?**

A. Southern States is requesting that the Commission continue to authorize the use of *uniform rate structures* -- one uniform rate for customers receiving service from conventional treatment facilities and one uniform rate for customers receiving service form reverse osmosis facilities. A base facility/gallonage charge structure with forty percent (40%) of the revenue requirement included in the base facility charge is being proposed.

Q. IS THE RATE STRUCTURE BEING PROPOSED BY SOUTHERN STATES' A WATER CONSERVING RATE STRUCTURE?

A. Based on criteria set forth in the Conservation Rate Structure Study, the rate structure proposed by Southern States is a water conserving rate structure. The Conservation Rate Structure Study defines several criteria which are weighted for relative assumed impacts on water consumption. These criteria include rate structure form, allocation of costs to fixed/variable charges, sources of utility revenues and communication on customer bills. As indicated in Chapter 7 of the Conservation Structure Rate Study, upon application of these criteria, a score of 3.2 qualifies as a water conserving rate structure. I applied these criteria to Southern States and arrived at a score of 3.2. My calculations are provided in Exhibit ____ (JBW-5). I also have been informed that Southern States is in the process of including historical billing information on customer bills. Once this information is provided, the rating would be a 3.3, further confirming the water conserving nature of the proposed structure.

I understand that some argue that only an inverted block rate structure can be a water conserving rate structure. There is no empirical support for such a position. I can design a single price (non-block) rate structure that sends a stronger water conservation price signal to customers than any of the block rate structures currently being used in Florida. This is achieved by an appropriate allocation of the revenue requirements for recovery through the gallonage charge.

Personally, I do not believe in a binary definition (yes or no) of a water conserving rate structure. Some rate structures are more conserving than others; it is matter of degree. A utility has to find a proper balance of competing objectives such as water conservation promotion and revenue stability.

Q. SOUTHERN STATES' EXISTING RATE STRUCTURE AUTHORIZED IN DOCKET NO. 920199-WS CONTAINS A 33%/67% BASE FACILITY/GALLONAGE CHARGE SPLIT. WHY IS THE COMPANY PROPOSING THAT A HIGHER PERCENTAGE OF ITS REVENUE REQUIREMENTS BE RECOVERED IN THE BASE FACILITY CHARGE?

A. First, as I have just confirmed, the proposed rate structure with a 40%/60% split qualifies as a water conserving rate structure. I have worked with Southern States to create a rate structure which fulfills the Company's desire to send the conservation message to its customers while also reducing Southern States' exposure to an inordinate level of business and financial risks.

This inordinate level of business and financial risk arises from the fact that SSU experiences a large variation in annual water use, largely caused by variations in weather. High year-round evapotranspiration levels combined with irregular rainfall patterns, makes outdoor water use in SSU, and Florida in general, both high and irregular relative to other parts of the country. I conducted a statistical analysis of SSU historic residential water consumption (1991-94) and weather (1949-1994). One finding is that the 95 percent confidence interval around average annual per account water use spans plus and minus 10.9 percent resulting from weather. This is likely the largest weather caused variability experienced in the United States (more than double my experience in California).

This large variation in water use translates into a relatively large variation in revenues. The precise magnitude of revenue deviation depends on rate structure. A rate structure that collects a large share of its revenues through a fixed monthly service charge, for example, tends to be more stable in generating revenues. A single water price tends to be more stable than a block rate structure, all other factors held constant. With a single non-block price, going from 33% to 40% collected via the base facility charge reduces the 95% confidence interval around total annual revenues from 7.3 to 6.6 percent. This is a lower, but still a significant amount of business and financial risk. It should also be noted that this is weather related risk only. Water use is also affected by other factors such as the economy and tourism which have not been factored into my analysis. Addition of these types of factors would lead to a higher total risk assessment.

Q. **HAS COMMISSION STAFF RECOGNIZED THE NEED TO COORDINATE A WATER CONSERVING RATE STRUCTURE WITH A UTILITY'S REVENUE STABILITY?**

A. Yes. In its white paper entitled, "Water Conservation Rate Structure Policy" dated December, 1993, Commission Staff made the following observations which I believe are consistent with the rate structure and revenue adjustment mechanism the Company is proposing in this proceeding. The Staff policy statement provides as follows:

> Another rate issue, regardless of the chosen rate structure, is a determination of the allocation of the revenue to be derived from either the base facility or gallonage charge and among the various classes of customers. Since the base charge is not affected by usage, its level will not impact on conservation. Therefore, conservation price signals are only given through the gallonage charge. Higher gallonage charges should be more effective in promoting conservation. However, with a given revenue requirement, increasing the

gallonage charge will lessen the base charge which may impact the revenue stability of the utility. Generally, fixed costs are included in the base facility charge and variable costs and return on investment are covered by the gallonage charge. Therefore, if fixed costs are shifted to the gallonage charge and the increased gallonage charge results in water conservation, a revenue deficiency could result. Obviously, a trade-off exists between revenue stability and conservation, which is yet another variable to be considered in changing rate level or rate structure.

Q. **HAVE YOU USED THE ELASTICITY STUDY MODEL TO DETERMINE THE LEVEL OF REDUCTIONS IN WATER CONSUMPTION WHICH WOULD RESULT UNDER THE COMPANY'S PROPOSED RATE STRUCTURE?**

A. Yes. Applying the elasticity study model results in a consumption reduction of approximately 11% for the conventional and 2.7% for the reverse osmosis service classes on an annual basis. Exhibit ___ (JBW-6) provides further discussion of the application of the Elasticity Study, the assumptions used in the model and summarizes the results from the values inputted into the WATERATE model to derive this amount.

Q. **HAS SOUTHERN STATES ADJUSTED ITS PROJECTED 1996 ANNUAL CONSUMPTION TO REFLECT THIS LEVEL OF**

ELASTICITY?

A. Yes.

Q. DO YOU BELIEVE THAT SUCH AN ADJUSTMENT IS REASONABLE?

A. Not only do I believe that the adjustment is reasonable, I also believe that the adjustment must be made to provide Southern States the opportunity to obtain the revenue requirement to be established by the Commission including an opportunity to earn the authorized rate of return on the Company's investments in utility facilities.

Q. IS SOUTHERN STATES REQUESTING AUTHORITY TO IMPLEMENT A WEATHER NORMALIZATION CLAUSE TO ASSIST IN ACHIEVING SOME MEASURE OF REVENUE STABILITY?

A. Yes, in fact the Company has adjusted its requested return on equity downward to reflect the higher level of revenue stability which would result from the implementation of this clause.

Q. COULD YOU DESCRIBE THIS CLAUSE AND HOW IT WOULD WORK?

A. Yes. The weather normalization clause is being proposed to achieve the second goal which I established with the Company -- revenue stability. I will refer to the weather normalization clause as the "WNC." The WNC is designed to counteract the inordinate business and financial risk to which Southern States is exposed. The WNC provides for a monthly adjustment of the gallonage charge, up or down, to reflect deviations from projected monthly consumption levels per bill. To minimize volatility, the WNC recovers one twelfth (1/12) of the WNC outstanding balance in each month. Forrest L. Ludsen, SSU's Vice President - Finance and Administration, provides further discussion of the mechanics and merits of the WNC.

Q. **WHAT DO YOU BELIEVE ARE THE ADVANTAGES OF THE WNC?**

A. I strongly believe the WNC would provide significant advantages to SSU, the FPSC, SSU's customers, and the State of Florida. It is a win-win-win-win situation resulting from improved regulatory operation.

The advantage to SSU is revenue stability. SSU probably has one of the highest exposures to revenue fluctuations in the country, largely caused by weather. This exposure necessitates SSU to seek rate structures that are more stable in revenue generation. Unfortunately, changes in a rate structure to make revenues more stable come at the expense of the conservation price signal sent to customers. Revenue stability and water conservation pricing are competing objectives. Implementation of the WNC would mitigate SSU's revenue stability concerns as it would insure that SSU would meet its gallonage charge revenue requirement. SSU would be in the position to adopt more aggressive water conserving rate structures.

The FPSC would benefit from the WNC in at least two ways. First, the WNC would simplify the regulatory process. Having the WNC in operation would diminish the importance of the accuracy of water use projections made in the ratemaking process. Actual water use deviations from the projected consumption levels per bill would be trued up so that rates would be based on actual water use per bill not predicted water use. This would lead to less time and resources spent on contentious issues related to water use forecasts. The second advantage would be removing a major deterrent to both water conservation pricing and water conservation programs in general. Water utilities could adopt more aggressive water conserving rate structures without undue increases in business and financial risk. Water utilities could expand and pursue the most effective set of conservation programs (e.g., toilet retrofit programs) in an integrated resource planning framework, without penalty of reduced revenue from reduced water sales. Taking away these road blocks would dramatically increase water conservation activities. It is my understanding that one of the FPSC goals is to promote water conservation.

SSU's customers would also benefit in several ways. Simplifying the regulatory process would lead to lower rate hearing expenses. Increased revenue stability should allow SSU to borrow money at lower interest rates for its many planned capital projects. These savings are indirectly passed on to customers. In addition, customers obtain cost-of-service equity as they will pay SSU exactly the set gallonage revenue requirement -- no more or less. This obviates angry customers who see a utility generating exorbitant profits (periods of high water use) or financially strapped utilities from cutting back on necessary operations and improvements because of cash deficiencies (periods of low water use).

Another major benefactor of the WNC is the State of Florida. Increasing water demands together with limited and more expensive water supplies have increased the need for wise water management practices. Pricing is one of the most important tools available to water managers to restrict demand. Adoption of the WNC would lead to the improved financial viability of its regulated water purveyors by reducing risk, it would reduce regulatory administration and dramatically increase efforts to promote water conservation, and it would lower costs to customers and facilitate a proper level of revenue collection.

Q. WHAT ARE THE DISADVANTAGES OF THE WNC?

A. I do not see any disadvantages to SSU, the FPSC, or the State. Some of SSU's customers, however, may perceive a disadvantage from not having a constant price. A constant price makes it easier for customers to budget for their water bill.

To minimize this perceived disadvantage, the WNC was specifically designed to minimize its volatility from month to month. That was the reason that SSU decided to only collect one-twelfth of the WNC outstanding balance in each month. I believe that any perceived disadvantage is more than offset by its advantages as stated previously.

Q. **IS THERE PRECEDENT FOR THE WNC?**

A. The WNC concept originates from the fuel-cost adjustment charge (FCA), purchased gas adjustment (PGA) and weather normalization adjustment clause pass through mechanisms commonly used by electric and gas utilities. The objective is to make automatic adjustments to rates on a predetermined basis.

There are several criteria for conditions warranting an adjustment mechanism including (1) the need for rapid rate adjustments to avoid the time lag often inherent in the normal regulatory and rate-setting process, (2) the adjustment must be based on easily and separately identifiable factors, and (3) the factors upon which the adjustment is based must be significant, unpredictable, and outside the control of the utility. SSU's case meets these criteria. An adjustment mechanism seems ideal for this situation.

Q. **DOES THAT CONCLUDE YOUR TESTIMONY?**

A. Yes, it does.

"Publications"

"Turf Audit Water Savings," with Christopher Dundon, Northern California Turf & Landscape Council Expo 1995, January 1995.

"New Directions in Mapping Demand Curves," with Jay W. Yingling and Marvin Winer, submitted for publication in Water Resources Research.

"Residential Water Price Elasticities in Southwest Florida," with Jay W. Yingling and Marvin Winer, Proceedings of Conserv 93, December 1993.

The Water Conservation Manager's Guide to Residential Retrofit, contributor, American Water Works Association, 1993.

"Water Conserving Connection Fees," with John O. Nelson, unpublished 1992.

"Water Reductions From Residential Water Audits," Water Resources Bulletin 27(6), 1991.

"Water Use Reductions from Retrofitting Indoor Water Fixtures," Water Resources Bulletin 26(6):921-926, 1990.

"Generating Water Demand Curves for Single Family Homes," presented at the 26th Annual Conference of the American Water Resources Association, November 1990.

"Calculating the Water Use Reduction Resulting form Water Fixture Retrofitting of Single-Family Homes in Seattle," Proceedings of Conserv 90, August 1990.

A Daily Municipal Water-Use Model: Case Study Comparing West Los Angeles, California, and Fairfax County, Virginia, Ph.D. dissertation, Johns Hopkins University, 1988.

Multiobjective Reservoir Operations Using Forecasts of Water Supply and Water Use, with J.A. Smith, S. Schartz, and J.J. Boland, *U.S. Geological Survey Report*, 1987.

EXHIBIT (JBW-2)

PAGE 1 OF 91

Southwest Florida
Water Management District

DEFINITION OF WATER CONSERVATION PROMOTING RATES

FEBRUARY 1993

PREPARED BY

Brown and Caldwell
Consultants

Southwest Florida
Water Management District
2379 Broad Street (U.S. 41 South) Brooksville, Florida 34609-6899
Phone (904) 796-7211 or 1-800-423-1476 SUNCOM 628-4150
T.D.D. No. only: 1-800-231-6103

May 4, 1993

Dear Interested Person:

Per your request, please find the enclosed copy of "Definition of Water Conservation Promoting Rates" prepared for the Southwest Florida Water Management District (SWFWMD) by Brown and Caldwell Consultants. We feel that the consultant did an outstanding job and hope that you will find the resulting product useful.

The intent of this project was to provide guidance to utilities in developing water conserving rate structures that would satisfy regulatory requirements, and provide the District with the means of quickly assessing whether a rate structure would be effective in promoting water conservation. The criteria contained in the report are only recommendations made by the consultant.

To become effective and supplant the current "Interim Minimum Requirements for Water Conserving Rate Structures" (December 1991), would require approval by our Governing Board. There are no plans at this time to request approval. If you represent a public or private water utility in the SWFWMD, we would request that you complete the questionnaire in the report and tell us whether there are any problems with its format, and what, if any, problems your utility may have in complying with such criteria, if adopted.

Again, thank you for your interest. This is the first of three work products under our contract with the consultant. A report on residential and commercial water price elasticities in the SWFWMD, and a computer rate model for water conserving rate structures should be completed by July 1993. If you should have any questions about any of these, please call.

Sincerely,

Jay W. Yingling
Senior Economist
Planning Department

Excellence Through Quality Service

EXHIBIT (JBW-2)

PAGE 3 OF 91

ERRATA SHEET

Page 6-3, Table 6-2

The last sentence in item 1B. under Discussion should read "Seasonal rates (see 1C. below) would also promote more water conservation than nonseasonal uniform rates."

Appendix D

Please disregard Figure D-11. The WCRWSA Section 21 Wellfield can supply many utilities through an interconnected system. Therefore its pumping schedule is not representative of the demand for a single utility service area. This graphic was included in error.

EXHIBIT ___ (JBW-2)

PAGE 4 OF 91

Southwest Florida Water Management District

Project Management

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with assistance by
C. Don Rome, Economist, Technical Services Department

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EXHIBIT (JBW-2)

PAGE 16 OF 91

The Southwest Florida Water Management District (District) does not discriminate upon the basis of any individual's disability status. This non-discrimination policy involves every aspect of the District's functions including one's access to, participation, employment, or treatment in its programs or activities. Anyone requiring reasonable accommodation as provided for in the Americans With Disabilities Act should contact Ms. Patty McLeod at (904) 796-7211 or 1-800-423-1476, extension 4400; TDD ONLY 1-800-231-6103; FAX (904) 754-6874/Suncom 663-6874.

EXHIBIT (JPW-2)

PAGE 7 OF 91

CONTENTS

EXHIBIT (JBW-2)

PAGE 8 OF 91

CONTENTS (continued)

EXHIBIT (JBW-2)

PAGE 9 OF 91

LIST OF TABLES

EXHIBIT (JBW-2)

PAGE 10 OF 91

CHAPTER 1

INTRODUCTION

The water utilities within the Water Use Caution Areas of the Southwest Florida Water Management District (District) are required to adopt water conservation-promoting rates by January 1, 1993. To assist the water utilities in meeting this requirement the District hired Brown and Caldwell to perform the following tasks:

Task 1: Define Water Conservation-Promoting Rates.

Task 2: Develop a Customer Class Profile Data Base, Estimate Water Demand Models, and Estimate Price Elasticities.

Task 3: Develop a Computer Model Which Can be Used by the Utilities to Determine the Impacts of Alternative Conservation-Promoting Rate Structures on both water use and revenues from water sales.

This report documents the results of Task 1. The purpose of Task 1 and this report is to define conservation-promoting rates in a manner such that the water utilities and the District can easily determine if such rates have been adopted. This chapter summarizes the objectives of water rates in general, the criteria used to define conservation-promoting rates, and the methods used to measure whether a utility satisfies these criteria.

Chapters 2 through 5 of this report present the criteria and associated guidelines which define conservation-promoting rates. Chapter 6 summarizes the criteria and associated guidelines in a "Go/No Go" format which allows both the water utilities and the District to easily determine if the rates qualify as conservation promoting. Under the Go/No Go format, the guidelines associated with those criteria, which are the most effective in promoting water conservation must be satisfied by January 1, 1993 (unless the utility qualifies for a defined exemption) and within 2 years (January 1, 1995) all the guidelines must be satisfied (there will be no exemptions). A weighting system which can be used by the water utilities and the District as an alternative to the Go/No Go format is summarized in Chapter 7. Whether the Go/No Go format or the weighting system is used, a questionnaire to collect the necessary data from the utilities is presented in Appendix A. The review of the state and county regulations governing the adoption of water conservation-promoting rates is contained in Chapter 8.

Water Rates in General

Changes in the design of water utility rates may be undertaken for a variety of reasons. In order to discuss the possible effects of rate design changes and the criteria which define conservation-promoting rates, it is helpful to distinguish between rate structure form, cost allocation, and rate revenue level issues. Communication of rates and water use on the water bill is also an important, but often ignored, matter.

Rate Structure Form. Rate structure form refers to the fixed and variable charges used to collect revenues. The fixed charge is a set fee that each customer must pay per billing period regardless of the amount of water used. Typically, the fixed charge recovers the costs of meter reading, billing, meter maintenance, and other customer related expenses not directly related to water consumption. In addition, some utilities include all or a portion of fixed capacity-related costs in the fixed monthly charge. Customers with larger meters often pay a higher fixed charge. The variable charge, in contrast, is the price paid for a unit of water (e.g., 1,000 gallons). There are two general types of variable charges: uniform and block. A uniform rate sets the same price for all units of water sold. A block rate charges a customer a different price for increasing increments of water use during a billing period. Under a block rate structure, the price can either rise (inclining block rate) or fall (declining block rate) in successive blocks. Uniform rates can also be seasonal if the value of a unit of water varies by season. Time-dependent pricing is widely practiced in our economy--especially with capital intensive industries such as airlines, hotels, telecommunications, and energy.[-] Chapter 2 presents the water conserving guidelines associated with the rate structure form criterion.

Cost Allocation. Cost allocation concerns the apportionment of total costs (revenue requirements) to the fixed and variable charges. In one extreme, all costs could be collected through a fixed charge. On the other extreme, all the costs could be collected via a quantity charge. When considering the multiple objectives involved in developing water rates (to be discussed in the next section), water utilities strive to find the best combination of fixed and variable charges. Chapter 3 provides the water conservation guidelines associated with the allocation of costs to the fixed and variable charges criterion.

Rate Revenue Level. Rate revenue level is defined as the total revenue derived from user charges. In most cases a water utility operates on a financially independent basis--all revenue requirements are derived from user charges or other defendable fees (e.g., connection fees, penalties, deposits, interest earned, etc.). Utilities could, however, derive revenues from external sources such as transfers from the general fund, the improper use of connection fee receipts, etc. In some states, a portion of water utility revenue requirements (debt service) are sometimes met via property taxes. Because external revenues can significantly lower the water conserving price signal transmitted to customers through water price, guidelines limiting external sources of revenue are presented in Chapter 4 (sources of revenues criterion).

Communication. Communication of rate information and water use on the water bill is also a very important issue. If the customers are informed about the price of water and how much they have used, they are more likely to respond to the pricing signal and use the resource efficiently. On the other hand, if the utility has not communicated the rate structure and water use to its customers in a timely manner, water conservation may not be maximized. Chapter 5 provides the water conservation guidelines associated with the rate structure and water use communication criterion.

Objectives of Water Rates

Selection of rate structure form, cost allocation basis, and rate revenue level are the three primary decisions that a utility has to make when developing water rates. Each can have significant ramifications from the perspective of the utility and its customers. As a means of comparing different alternatives, it is important to keep in mind the principal objectives of water rate development as listed below:

1. **Revenue Sufficiency:** Rates are set so that a utility recovers the costs incurred in providing water service. This includes ongoing operation and maintenance expenses, capital costs, as well as the costs necessary to comply with the District's permit conditions (i.e., required per capita reductions, improved water use classification accounting systems to meet reporting requirements, reductions in unaccounted for water, and investigation of reuse and desalination as appropriate). Because prices must be set in advance of actual costs and actual water usage, an element of uncertainty in revenue sufficiency arises as future costs and water use are not known exactly. Any rate structure can be set so as to achieve the required rate revenue level for revenue sufficiency if both costs and water use are known. However, different rate structures vary in their ability to be revenue sufficient when assumed conditions change. Weather and economic activity are examples of factors that can dramatically affect water use levels and consequently revenue sufficiency.

2. **Revenue Stability:** A companion objective to revenue sufficiency is revenue stability. The form of the rate structure determines how stable revenues will be with respect to water use, and thus with respect to changes in weather, price, and economic activity which affect water use. A flat monthly fixed charge obviously provides for the most stable revenue stream. For example, under such a rate structure, very wet or very dry conditions (although impacting water use) will have no impact on revenues. Such rates, of course, do not encourage conservation and are not equitable in that those who use small amounts of water subsidize those who use large amounts of water. Conversely, seasonal rates (rates employing a relatively small fixed monthly charge together with both off-peak-period and peak-

period quantity charges) with the peak-period quantity charge significantly exceeding the off-peak-period quantity charge can introduce uncertainty in the revenue stream. For example, an unusually wet peak season can result in a significant reduction in water use, and thus a significant decrease in revenues. Alternatively, an unusually dry peak season (without accompanying water use restriction) can result in both increased water use and revenues. Seasonal rates, however, are better at encouraging conservation and are more equitable in that they not only recover cost in proportion to use, but also in accordance to when the use occurs (peak or off-peak).

3. **Economic Efficiency:** Water price has an impact on the economic efficiency with which customers use water. Price relays the scarcity value of water so that water consumption is encouraged when benefits exceed costs and discouraged when costs exceed benefits. While the rate revenue level has some influence on this, it is primarily rate structure form and cost allocation basis which create incentives for customers to use more or less water, or to use water more sparingly in some periods than in others. Carefully designed incentives can alter load patterns in a way that significantly reduces the cost of supplying water.

4. *Equity:* With respect to water rates, equity is defined as cost-of-service equity. Achieving cost-of-service equity requires the development of rates which are cost-causative. That is, equity is maximized when each customer's water bill equals, as closely as possible, the cost borne by the purveyor in providing that service. The principal is nondiscriminating in that it only considers the customer's water use characteristics (often meter size and water consumption) in calculating water bills. This objective is determined by rate structure form and cost allocation basis. Proportional sharing of costs among customers is unaffected by the rate revenue level.

5. *Acceptance:* It is important that water rates are readily understood and accepted by water customers. Although the rate revenue level has some impact on this, experience shows that it is principally rate structure form and cost allocation basis which cause customers to conclude whether or not rates are fair and equitable, or that the way in which they are be billed is or is not comprehensible.

Rate structure form and cost allocation basis are the primary factors in four out of the five water rate objectives. Only revenue sufficiency is accomplished primarily through changes in the rate revenue level. The other four objectives are important to virtually all water utilities, yet changes in rate structure to accomplish these ends are rarely contemplated. Rate structure form and cost allocation basis are powerful management tools, often ignored in the interest of continuity and a mistaken reliance on the importance of precedent.

As is obvious from the above discussion of rate objectives, these objectives are often conflicting. Although we recognize that all these objectives are important, the reader should keep in mind that the purpose of this particular study is to define conservation-promoting rates. This does not mean that we feel that the objective of revenue stability, for example, is not important. It is important. However, conservation-promoting rates can be implemented together with the establishment of a reserve fund and the proper level of working capital so that the risk of revenue insufficiency is minimized even for seasonal rates with large price differences between seasons.

Conservation-Promoting Rates

One additional objective of water rates is the promotion of water conservation. Not everyone, however, has the same definition of water conservation. Since the term first became widely used more than a decade ago, the title "water conservation" has been applied to activities as diverse as building dams, cloud seeding, xeriscape landscaping, retrofitting homes with water-efficient toilets and showerheads, and even advice on tooth brushing habits. To understand the concept of water conserving rate structures, it is necessary to clarify the meaning of water conservation.

One widely used definition was adopted by several Federal agencies in the late 1970's (Baumann, 1984). It simply states that water conservation is brought about when (1) a reduction in the use or loss of water occurs, and (2) the reduction must be, on balance, beneficial. For a reduction to be beneficial requires that benefits (which may accrue to customers, the utility, or the community as a whole) must outweigh the costs (which include loss of use and inconvenience). This is synonymous with the economic efficiency objective. A reduction in water use which is not beneficial fails the test because it is inconsistent with the principal of conservation of all scarce resources.

Definition of Conservation-Promoting Rates. Changes in rate structure form, provided they are not accomplished by increases in the rate revenue level (total revenue derived from user charges), have the virtue of avoiding the possibility of nonbeneficial changes in water use. In this situation, the total amount paid by *all* customers does not change if their water use patterns do not change. If some customers reduce use as a result of incentives provided in the rate structure, it is because it is beneficial for them to do so. In comparison, the water rates resulting from the mere doubling of the prior rate revenue level does not constitute a conservation-promoting event. Although water use will very likely decrease, the total amount recovered from all customers will very likely increase.

Therefore, a conservation-promoting rate structure is one which results in a net reduction of water use solely due to the economic incentives contained therein, when compared to other rate structure alternatives. Such a rate structure can only benefit water users taken as a whole.

The utility should be indifferent to this reallocation, provided that it continues to set its revenue requirements in the same way. To determine whether a conservation-promoting rates are in effect, a set of subjective criteria must be established. The criteria selected to define conservation-promoting rates are presented in the next section.

Criteria

Four criteria were selected to define conservation-promoting rates based on our rate development and water conservation experience. These four criteria are listed in the following table.

Table 1-1 Criteria for Conservation-Promoting Rates

Criteria	Description
1--Rate Structure Form	Type of rate structure (i.e., uniform quantity charge, inclining block quantity charge, seasonal quantity charge).
2--Allocation of Costs to Fixed and Variable Charges	The portion of the net revenue requirements allocated to the fixed and variable components of the rate structure (e.g., service charge v. quantity charge). Net revenue requirements are the operation and maintenance expenses and capital costs to be recovered from rates.
3--Sources of Utility Revenues	The portion of the total revenue requirements recovered from rates as compared to other sources of revenue (e.g., tax receipts, turn-on fees, and impact fees).
4--Communication of Rates and Water Use	Communication to the customers about the rates and their water use.

Methods Used to Measure if the Criteria are Satisfied. In Chapters 2 through 5 of this report, specific guidelines are developed for each of these criteria. The guidelines are used to define the conservation-promoting components of each criterion. Supporting discussions are provided for each of the guidelines as well as exemptions (when warranted). For example, a guideline for rate structure communication (Criterion 4) would be the use of monthly or bimonthly billing in which the amount of water consumed, (compared to the same period in the previous year and/or the average for the previous year), and the rates charged are clearly presented. Monthly or bimonthly billing is necessary to provide the customer with timely information on their water use and water rates. An exemption for this guideline might be the fact that the utility is required by a prior agreement to bill in a different manner or less frequently.

fact that the utility is required by a prior agreement to bill in a different manner or less frequently.

Chapter 6 provides a summary of all the criteria and the associated guidelines that will be used to determine if a utility's rates are conservation promoting under a Go/No Go format. That is, the guidelines are either satisfied or they are not. Initially we recommend that only those guidelines which are the most effective in promoting water conservation need to be satisfied in order for rates to be defined as conservation promoting. However, within 2 years all of the guidelines need to be satisfied. For example, a utility may have what we have defined as a water conservation-promoting rate structure form (Criterion 1), but if an insignificant portion of the costs are allocated to, and thus recovered from the variable charge (Criterion 2), there will be little or no conservation. Therefore, the guidelines for Criterion 1 and 2 would initially have to be satisfied for the rates to be defined as conservation promoting. The guidelines which should initially be satisfied under this Go/No Go format are identified in Chapter 6.

Chapter 7 provides a weighting system for the criteria and guidelines which can be used as an alternative to the Go/No Go format summarized in Chapter 6. The weighting system is subjective, but as discussed in Chapter 7 a weighting system may provide a better indication as to whether a rate structure is conservation promoting under certain conditions. Whether the Go/No Go format or the weighting system is used, certain data must be obtained in order to determine if the criteria are being met. A questionnaire is presented in Appendix A to identify the necessary data to be collected from the utilities.

For each of the criteria, guidelines are also presented for sewer utilities to acknowledge the relationship between water use (indoor use) and wastewater discharge. <u>However, the determination of whether a water utility's rate structure is conservation promoting will not be dependent on the guidelines for sewer utilities.</u>

CHAPTER 2

RATE STRUCTURE FORM--CRITERION 1

The form of the rate structure is an important parameter in establishing water conserving rates. A rate structure consists of two general components: a fixed service charge and a quantity charge. The fixed charge is collected each billing period and does not depend on the amount of water used. Typically, the fixed charge varies with meter size. On the other hand, the quantity charge represents the price paid for each unit (e.g., Ccf or 1,000 gallons) of water consumed. If a customer has both an irrigation and domestic or commercial meter the quantity charge would be levied on the sum of the water use from each meter. Water utilities generally employ two types of quantity charges; uniform or block. There are a number of variations of these two types of quantity charges. This chapter describes the guidelines related to both water and sewer quantity charges. The level of the fixed charge is covered in Chapter 3.

Water Utility Guidelines

The first guideline prohibits declining block water rates. Declining block rates cause a customer to pay a lower water price with increasing blocks (increments) of water use during a given billing period. Alternatively, water agencies must employ either uniform or increasing block rates. Uniform rates consist of a single price ($/1,000 gallons) applied to all users for all water use. Uniform rates can be seasonal. Increasing block rates have the effect of charging higher prices for higher blocks of water use.

The usual rationale for declining block rates is that large commercial and industrial water users usually have favorable load-factors (the ratio of peak use to average use is low relative to other customer classes) and hence should be charged less. The use of declining block rates are one means of accomplishing this objective. A major disadvantage of declining block rates, however, is that they perform poorly in sending a price signal that encourages customers to use water efficiently. Another disadvantage is that some large customers may have a strong seasonal water use pattern (large ratio of peak to average use), and therefore, do not deserve a lower price. If customer rate equity (as determined by a customer's contribution to use during the peak period) is a major concern to a water utility, a uniform quantity charge which varies by season would be superior in addressing this concern. It would not only provide a more equitable means of providing rate relief to large nonseasonal customers, but would also provide a better price signal to encourage water conservation.

Inclining block rates have become more popular in recent years and are commonly promoted as water conserving rate structures. With inclining block rates, three issues need to be addressed for each class of customers: the number of blocks, the size of blocks, and the price of each block. Unfortunately, there is often little objective bases for making these decisions. Moreover, water is used by a diversity of customers for a diversity of uses which change over time. This greatly complicates identifying homogeneous block rate classes (especially nonresidential customers) or establishing blocks based on historical usage. As a result, block rates are somewhat arbitrary and could be subject to challenge. From a pricing standpoint, inclining block rates penalize customers for using a unit of water in a higher block, but they do not correspondingly reward customers in lower blocks for saving a unit of water. For example, a reduction of one unit of water use in the second block may save $3, while a customer saving a unit in the first block may save only $1. For these reasons, inclining block rates may not necessarily be superior to uniform rates, but are acceptable under this guideline.

The second guideline requires seasonal rates for utilities with highly seasonal water use unless they meet the District's water use reduction requirements via inclining block rates or nonseasonal uniform rates. However, if average daily water production in the peak season exceeds that in the off-peak season by more than 50 percent, a seasonal quantity charge should be adopted. The peak season is defined as the four continuous months with the largest water production levels based on the last 3 years of water use records. The off-peak season includes the remaining 8 calendar months of the year. The differential in water price between the two seasons shall be based on standard practices articulated in (AWWA Water Rates Manual, 1991). If meter recording for billing purposes is currently completed at time intervals greater than once every two months (e.g. quarterly), seasonal rates do not have to be implemented initially. However, within 2 years the utilities are required to implement monthly or bimonthly billing (see Chapter 5) and thus seasonal rates would have to be implemented at that time.

The superiority of seasonal quantity charges over nonseasonal uniform or inclining block quantity charges stems from that fact that most water agencies incur a significantly higher cost in supplying a unit of water during the peak season. This results from the fact that when water demands are distinctly seasonal the water system facilities have to be sized to meet this peak seasonal demand. As a result, costs related to facility size (capital costs such as debt service and certain size related operation and maintenance expenses such as maintenance and replacement expenses or depreciation) can be traced directly to the need to have peak season capacity, and should be recovered in the peak season quantity charge. However, during the off-peak season, a portion of the capacity dictated by and provided for peak season use is used and thus a portion of these capacity (size) related costs could be included in the off-peak season quantity charge. The variable costs (power, chemicals and purchased water, if appropriate) would be recovered throughout the year and thus included in both the off-peak and peak season quantity charges. Because the capacity related costs to meet peak demand are usually higher than the capacity related costs to meet average or off-peak demand, the unit cost of water (the quantity charge) in the peak season is usually higher than the unit cost in the off-peak season. As a consequence, customers will pay a lower quantity charge during the defined 8 month off-peak period and a higher quantity charge during the defined 4 month peak period.

As an example of the possible impact of such a rate structure, consider the case of alternative cost-of-service based rate structures recently developed by Brown and Caldwell. Two quantity charge rates structure alternatives were developed (the fixed monthly service charges were the same under both alternatives). One alternative was a nonseasonal uniform quantity charge of $0.38/Ccf. The second alternative was an off-peak season quantity of $0.26/Ccf combined with a peak season quantity charge of $0.46/Ccf. Consider the impact of this seasonal rate structure on three residential customers: (1) the average customer who uses 10 Ccf/month during the 8-month off-peak season and 26 Ccf/month during the 4-month peak season; (2) the customer who uses 12 Ccf/month during the 8-month off-peak season and 36 Ccf/month during the 4-month peak season; and (3) the customer who uses 12 Ccf/month during the 8-month off-peak season and 48 Ccf/month during the 4-month peak season. The impacts are summarized in Table 2-1.

As shown in this table the average residential customer (whose peak season monthly use is 2.6 times off-peak season monthly use) actually receives an 1.8 percent reduction in the quantity charge portion of the bill under the seasonal rate structure alternative. The annual cost of water remains the same for the high peak season user (peak use is 3 times off-peak use) and increases by 3.5 percent for the very high peak season user (peak use is 4 times off-peak use). The rates were designed to be revenue neutral over all users giving consideration to use reductions during the peak period resulting from the price increases associated with the seasonal rate structure alternative.

Most nonseasonal users would pay less under the above seasonal rate alternative. Charging customers the seasonal unit cost will likely promote water conservation.

The implementation of seasonal rates will mean that the water bill will significantly increase during the peak season (February through May for most utilities) and decrease during the off-peak season. If seasonal rates are adopted, this should be communicated to the utility's customers. In addition, the utility will have to adjust its working capital requirements to correspond to the changes in cash flow resulting from the adoption of seasonal rates and may have to establish a reserve fund in order to be prepared for unanticipated fluctuations in water use.

Obviously, the design of both inclining block rates and seasonal rates require the definition of block thresholds and block rate levels (in the case of inclining block rates) and seasonal prices (in the case of seasonal rates). As we will elaborate on in Chapter 7, block rates will differ little from nonseasonal uniform rates if the first block threshold is set so high such that very few customers and thus, very little water use is assessed the higher price in the second block. For example, if the average monthly single-family water use in a community is 10 units (e.g., 1,000 gallons) and the block threshold for the second (next) block is defined as 50 units, very little single-family customer water use will be assessed the second block price. As a consequence, even if the price increase between blocks is large, the impact on use will be small.

Table 2-1 Impact of Seasonal Rate Structure

Description	Nonseasonal uniform quantity charge			Seasonal quantity charge			Difference	
	Off-peak revenues, dollars	Peak revenues, dollars	Total annual revenues, dollars	Off-peak revenues, dollars	Peak revenues, dollars	Total annual revenues, dollars	Dollars	Percent
Average user	30.40	39.52	69.92	20.80	47.84	68.64	<1.28>	<1.8>
High peak season user	36.48	54.72	91.20	24.96	66.24	91.20	--	--
Very high peak season user	36.48	72.96	109.44	24.96	88.32	113.28	3.84	3.5

EXHIBIT (JPM-2)
PAGE 20 OF 91

Similarly, if the price level of the second block is only slightly higher than that of the first block, regardless of the block size, there will be little impact on water use. For example, if in the same community as sited in the above example, the block threshold is established at 10 units (rather than 50 units), but the price increase between blocks is only 5 percent (say $1/unit in the first block and $1.05/unit in the second block) the impact on use will be negligible. As a consequence, we offer the following guidelines with respect to designing inclining block and seasonal rates:

Inclining Block Rates:

1. There should be different block thresholds for each customer classification (single-family residential, commercial, industrial, irrigation, etc.)

2. The threshold between the first and second blocks for a given customer classification should be equal to or less than 125 percent of the average water usage for that customer classification. Although inclining block rates can be comprised of more than two blocks (although it is rarely necessary), guidelines are established based on only the first two blocks.

3. The size of the second block should be at least equal to the size of the first block.

4. The price of the second block should be at least 125 percent of the price of the first block.

Seasonal Rates:

1. The seasonal rates (quantity charges) should be applied during the 4-month period of highest water use (for the utility as a whole).

2. The price of water during the peak season should be at least 125 percent of the price of the price of water during the off-peak season.

A variation of the more traditional inclining block rate structure is an inclining block rate structure in which the second block is only levied on water use during the peak water use season. This type of rate structure is typically called a seasonal surcharge rate structure and is usually assessed on some percent of water use over average use. This type of structure is merely an inclining block structure applied only during the peak season. As with the more traditional inclining block rate structures, a definition of block thresholds and block rate levels is required. The guidelines for the development of a seasonal surcharge rate structure would include both the guidelines for inclining block rates and seasonal rates as presented above. This includes the requirement that the block threshold between blocks be equal to or less than 125 percent of the average use for the customer classification rather than equal to or less than 125 percent of the average use for individual customers. This will prevent users with high average use (who may waste water year-round) from having a significant portion of their peak season use escaping the surcharge.

Seasonal Water Use

In the Southwest Florida Water Management District service area, it is clear that peak usage occurs in May. An analysis of total pumpage data for the District indicates that there is a large peak in usage in May, which is clearly weather related (because it corresponds to a peak in net irrigation requirements). In addition, there is a minor peak (clearly less than the major peak in May) in October. This minor peak also corresponds to an increase in net irrigation requirements. As a consequence, this minor peak is also, at least partially, a result of weather conditions. In some service areas, it is our understanding that there is a large influx of part-time residents in the late fall and early winter ("snowbirds"). These part-time residents may also contribute to the minor peak. As a consequence, in order to equitably recover the cost of service form these part-time residents, water utilities with population increases during the late fall/early winter of 20 percent or more may employee seasonal rates during this peak or during both the fall and spring peaks. A detailed discussion of seasonal fluctuations in gross water pumpage is presented in Appendix D.

Sewer Utility Guidelines

The guideline regarding sewer rate structure form requires the quantity charge to be uniform. This uniform rate can vary by customer class because of differences in the quality of the discharge. Restaurants, for example, have been found to have much higher biochemical oxygen demand and suspended solids loadings per gallon of discharge than residential customers, and hence, should pay a higher price to reflect the higher costs of treatment. Furthermore, since wastewater discharge is not as seasonal as water use, the need for block or seasonal type rates is minimal.

Because sewer customers rarely have their wastewater discharge metered, utilities usually base the sewer charge on water use. A problem arises, however, as some water uses, such as irrigation, do not return water to the sewer. For customers with significant irrigation, a utility can limit the amount of water assessed the sewer charge based on what can reasonably be expected to be used for indoor purposes. Many utilities limit single family customers to around 10,000 gallons/month. Most commercial, industrial, or institutional customers with large irrigation requirements are often given the opportunity to install irrigation meters whose water use is not assessed a sewer charge.

The guidelines established to determine whether the utility's rate structure form is conservation promoting, are presented in the Tables 2-2 and 2-3. The guidelines for water utilities are presented first followed by the guidelines for sewer utilities.

Under the Go/No Go format discussed in Chapter 1, the water utilities have to initially satisfy those guidelines which are the most effective in promoting water conservation (unless they qualify for stated exemptions) in order for their water rates to be defined as conservation promoting. The guidelines which have to initially be satisfied are indicated above. Within 2 years all of the guidelines for water utilities will have to be satisfied. The guidelines for the sewer utilities do not have to be satisfied for a water utility's rates to be defined as water conservation promoting.

The water utility guidelines presented above will be summarized in Chapter 6 to determine whether a water utility's rates are conservation promoting under the four criteria when measured using the Go/No Go format. A weighting system is also presented in Chapter 7 as an alternative to the Go/No Go format. The data to be collected by the utilities, to identify the rate structure form, are specified in the questionnaire in Appendix A.

EXHIBIT (JBW-2)

PAGE 24 OF 91

Table 2-2 Water Utility Guidelines
Rate Structure Form—Criterion 1

Satisfy	Guideline	Exemption	Discussion
Yes ( ) No ( ) Initially Required	1A. Water agencies with either flat rates (do not vary with water use) or declining block rates shall adopt either uniform (nonseasonal or seasonal) or inclining block rates.	1A. None.	1A. Declining block rates do not encourage customers to use water efficiently. Although inclining block rates are commonly promoted as water conserving rate structures they are not necessarily superior to uniform rates and thus both are accepted for this guideline.
Yes ( ) No ( ) Initially Required	1B. Water utilities with nonseasonal uniform quantity charges shall adopt either inclining blocks or seasonal rates (see 1C. below). Inclining block thresholds and quantity charges shall be different for each customer classification. There shall be at least two blocks and the threshold between the first and second blocks for a given customer class shall be equal to or less than the 125 percent of the average usage for that class. The size of the second block shall be equal to or greater than the size of the first block, and the price of the second block shall be at least 125 percent of the price of the second block.	1B. If the use of nonseasonal uniform quantity charges meets the District's water use reduction requirements and the average daily water production in the peak season exceeds that of the off-peak season by 50 percent or less (see 1C. guidelines below).	1B. If developed in accordance with the parameters defined in the "1B." guideline, inclining block rates are more conservation promoting than nonseasonal uniform rates. Seasonal rates (see 1C. below) would also promote more water conservation than nonseasonal uniform rates.

Table 2-2 Water Utility Guidelines
Rate Structure Form—Criterion 1 (continued)

Satisfy	Guideline	Exemption	Discussion
Yes ( ) No ( ) Required within 2 years	1C. If average daily water production (mgd) in the peak season exceeds that of off-peak season by more than 50 percent, a seasonal quantity charge should be adopted. The quantity charge in the peak season shall exceed the quantity charge in the off-peak season by at least 25 percent.	1C. If meter reading for billing purposes is completed at time intervals greater than once every two months (e.g., quarterly). This meter reading exemption is only valid for 2 years. If utility has a population increase of greater than 20 percent in the fall/winter season, it may assess peak rates during this fall peak and/or the spring peak.	1C. Most water agencies incur a significantly higher cost in supplying a unit of water during the peak season. Passing on the seasonal unit cost to customers can significantly improve the water conserving practices of customers.

Table 2-3 Sewer Utility Guidelines
Rate Structure Form--Criterion 1

Satisfy	Guideline	Exemption	Discussion
Yes ( ) No ( )	1A. Sewer agencies are required to have uniform quantity rates.	1A. The amount of water assessed the sewer quantity charge may be limited.	1A. A limit is warranted when significant amounts of water are not returned to sewer (e.g., irrigation).

CHAPTER 3

ALLOCATION OF COSTS TO FIXED AND VARIABLE CHARGES--CRITERION 2

A water utility may have in effect a rate structure form which is conservation promoting, as defined in Chapter 2, but this rate structure will not promote water conservation if the costs allocated to and thus recovered from the variable charge (e.g., quantity charge) are insignificant. In this chapter, guidelines are established to determine the portion of the costs that should be allocated to and thus recovered from the quantity charge component of the rate structure. The underlying economic principal for this criteria is that the price of water should equal the true cost of supplying water. Guidelines are developed for both water and sewer utilities to acknowledge the relationship between water use (indoor use) and wastewater discharge.

Water Utility Guidelines

These guidelines are based on the results of Brown and Caldwell's cost-of-service based rate studies (see Appendix B) and are intended to represent averages for cost-of-service based rate studies in which one of the principal objectives was to promote the efficient use of water. The preponderance of the utilities included in Appendix B, are California utilities. They are not included because they are California utilities, but rather because one of their major rate objectives was to promote conservation.

The rates developed in Brown and Caldwell's cost-of-service based rate studies are designed to meet the rate objectives presented in Chapter 1 (i.e., revenue sufficiency and stability, economic efficiency, equity, and acceptance). As part of the cost-of-service based rate development, the costs (revenue requirements) to be recovered from rates are separated into those which are water use dependent and those which are independent of water use. The revenue requirements to be recovered from rates are more appropriately termed net revenue requirements because the revenue from other sources (e.g., impact fees, interest income, penalties, turn-on/turn-off fees, hook-up fees, etc.) have been subtracted from the total costs. Impact fees (sometimes called connection fees, system development fees, capacity fees, etc.) are fees assessed new development to recover the cost of providing capacity to serve new connections and hook-up fees recover the direct costs of connecting a new customer (e.g., the labor and materials for meter and service line installation). These fees are designed to recover the incremental capital costs allocable to new applicants for service. Water rates, on the other hand, are designed to recover the costs (both O&M expenses and capital costs) allocable to existing customers.

Cost-of-service water rate studies typically allocate the net revenue requirements to be recovered from rates to the following parameters: fire protection, customer, base water use, and peak water use. Fire protection costs are the capital and O&M costs directly (hydrants) and indirectly (storage and distribution system capacity) allocable to fire protection. Customer costs include the capital and O&M costs associated with billing, meters, and service lines. Base and peak water use costs include the capital and O&M costs associated with providing water during average and peak periods of demand. The fire protection and customer costs are independent of use and should be recovered via the fixed monthly (or bimonthly) portion of the rates. The remaining net revenue requirements should be recovered via the quantity charge portion of the rates. Water rate structures which have a fixed charge, that includes a minimum amount of water (minimum charge), usually result from the fact that costs that should be recovered from the quantity charge have been shifted to the fixed charge portion of the rate structure.

Sewer Utility Guidelines

Cost-of-service sewer rate studies typically allocate the net revenue requirements to be recovered from rates to the following parameters: flow, biochemical oxygen demand (BOD), suspended solids (SS), infiltration/inflow (I/I), and customer. I/I costs are the capital and O&M costs allocable to I/I based on its proportion of the total influent to the wastewater treatment plant. I/I costs are usually recovered over the number of customers or flow depending on the customer mix. Customer costs include the capital and O&M costs associated with billing and service lines (laterals). Flow, BOD, and SS costs include the capital and O&M costs associated with the collection, treatment, and disposal of wastewater. For a sewer utility, the customer costs are independent of use and should be collected via the fixed monthly (or bimonthly) portion of the rates and the remaining net revenue requirements should be recovered via the quantity charge portion of the rates. I/I costs can either be recovered via the fixed or variable component of the rate structure depending on the homogeneity of the customers. If the customers are relatively homogenous then I/I costs can either be recovered via the fixed charge or via the quantity charge. If the customers are not homogeneous (with respect to the amount of discharge) I/I costs should be recovered via the fixed portion of the rate structure.

The guidelines established to determine whether the utility's allocation of costs to the fixed and variable charges is conservation promoting, are presented in Tables 3-1 and 3-2. The guidelines for water utilities are presented first followed by the guidelines for sewer utilities. Lifeline rates for qualifying customers (e.g., low income, elderly, and/or disabled) would be exempt from the guidelines.

Under the Go/No Go format discussed in Chapter 1, the water utilities will initially have to satisfy those guidelines which are the most effective in promoting water conservation (unless they qualify for the stated exemptions) in order for their water rates to be defined as conservation promoting. All of the water utility guidelines for this criterion have to initially be satisfied. The guidelines for sewer utilities do not have to be satisfied for a water utility's rates to be defined as water conservation promoting.

Table 3-1 Water Utility Guidelines
Allocation of Costs to Fixed and Variable Charges--Criterion 2

Satisfy	Guideline	Exemption	Discussion
Yes ( ) No ( ) Initially Required	2A. 75 percent or more of the net revenue requirements are recovered from the variable portion of the rate structure (quantity charge).	2A1. Actual meter, service line, and billing costs (fixed costs) are greater than 25 percent of the net revenue requirements. 2A2. Part-time residential population increase in excess of 20 percent so that a major shift from fixed charge cost recovery to variable charge cost recovery may result in an inequity in the recovery of costs for residential customers who only reside part time in Southwest Florida. In such cases, only 65 percent or more of the net revenue requirements need be recovered from the variable portion of the rate structure (quantity charge). 2A3. Lifeline rates for qualifying customers.	2A. This guideline is based on a review of cost-of-service water rate studies. The more net revenue that is recovered from the variable component of the rate structure the more conservation promoting.
Yes ( ) No ( ) Initially Required	2B. No minimum charge. A minimum charge is a fixed charge which includes some water use.	2B. Lifeline rates for qualifying customers.	2B. Minimum charges shift the recovery of a portion of the variable costs to the fixed component of the rate structure. This shift reduces the portion of the rate structure which is dependent on water use and thus reduces the ability to promote conservation.

EXHIBIT (JBW-2)

PAGE 29 OF 91

Table 3-2 Sewer Utility Guidelines
Allocation of Costs to Fixed and Variable Charges--Criterion 2

Satisfy	Guideline	Exemption	Discussion
Yes ( ) No ( )	2C. 75 percent or more of the net revenue requirements are recovered from the variable portion of rate structure (quantity charge).	2C1. Actual billing, service lines (laterals) and I/I costs are greater than 25 percent. 2C2. Residential rates are fixed but were initially based on average indoor water use. 2C3. Quantity charges are assessed large dischargers (commercial and industrial users discharging more than 30,000 gallons per month) and are based on water use. 2C4. Lifeline rates for qualifying customers.	2C. This guideline is based on a review of cost-of-service sewer rate studies. The more net revenue that is recovered through the variable portion of the rate structure the more conservation promoting.

Utilities that have historically recovered a significant portion of their costs from fixed charges, and are now recovering more from variable charges, should establish a revenue stabilization fund or reserve fund. A revenue stabilization fund will provide the required revenue when water use is lower than expected, thus allowing the utilities to achieve revenue stability while at the same time having water conservation-promoting rates.

The water utility guidelines presented above will be summarized in Chapter 6 to determine whether the water utility's rates are conservation promoting under the four criteria when measured using the Go/No Go format. A weighting system is presented in Chapter 7 as an alternative to the Go/No Go format in Chapter 6. The data to be collected by the utilities, to identify the allocation of costs to the fixed and variable charges, are specified in the questionnaire in Appendix A.

CHAPTER 4

SOURCES OF UTILITY REVENUES--CRITERION 3

Whether we are discussing rate structure form (Chapter 2) or the allocation of costs to fixed and variable charges (Chapter 3), the underlying economic principal upon which these water conservation rate criteria are based is that the price of water should equal the true cost of supplying the water. Whether or not the true cost of supplying water is conveyed to the customer is also dependent on the rate revenue level or the utility's use of other sources of revenues. That is, if the rates which derive the utility costs are subsidized (by transfers from the general fund, the improper use of impact fee receipts [to offset revenues to be collected via rates rather than to fund new facilities for expansion], and/or taxes) they will not provide a true pricing signal to the customer. In this chapter, guidelines are established to define the portion of the utility revenues that should be recovered from rates, other defendable fees (e.g., impact fees, turn-on fees, and hook-up fees), and interest income. As discussed in Chapter 3, impact fees are fees assessed new development to recover the cost of providing capacity to serve new connections and hook-up fees recover the direct cost of connecting a new customer (e.g., the labor and materials for meter and service line installation). Guidelines are developed for both water and sewer utilities to acknowledge the relationship between water use (indoor use) and wastewater discharge.

The guidelines are based on a review of the budgets and financial statements for utilities for which Brown and Caldwell has conducted rate studies (see Appendix C) and are intended to represent industry averages. The sources of revenue were categorized as operating or nonoperating revenues. Operating revenues are the revenues from rates, impact fees, other fees, and miscellaneous operating revenue as specified in the financial statements. Nonoperating revenues are interest earnings, taxes, transfers from other funds, and other miscellaneous nonoperating revenues. Assuming that the operating revenues recover the costs associated with providing the respective services (e.g., rates--existing services, impact fees--expansion facilities, and other fees--turn-on services and connection services) then the revenues from these sources are consistent with the true costs of supplying water. Using the interest earned on the operating revenues and/or reserves provided by the operating revenues, to offset the cost of providing these services, is also consistent with the true cost of supplying water. In contrast, utilities with rates that reflect the subsidizes provided by taxes and transfers from other funds (e.g., general fund) are not providing the true pricing signal to their customers.

The guidelines established to determine whether a utility's sources of revenues are consistent with the true cost of supplying water or providing wastewater service, and thus conservation promoting, are presented in the following tables. The guidelines for water utilities are presented first followed by the guidelines for sewer utilities.

EXHIBIT ___ (JBW-2)

PAGE 32 OF 91

Table 4-1 Water Utility Guidelines
Sources of Utility Revenues–Criterion 3

Satisfy	Guideline	Exemption	Discussion
Yes ( ) No ( ) Required within 2 years	3A. At least 90 percent of the water utility's total revenue is recovered from the water rates, impact fees, other fees, and interest income, or at least 75 percent recovered from water rates.	3A1. Water assessment districts fund expansion projects. Classify assessment district revenue as impact fee revenue to meet 90 percent guideline. 3A2. The other sources of revenues are grants. 3A3. General fund and tax subsidies will only continue for 2 more years.	3A. This guideline is based on a review of the financial statements and budgets of the water utilities for which Brown and Caldwell has conducted rate studies. The justification for this guideline is that the price of selling water should equal the true cost of supplying water. In other words, the true cost of supplying water should not be masked by subsidies.

Table 4-2 Sewer Utility Guidelines
Sources of Utility Revenues--Criterion 3

Satisfy	Guideline	Exemption	Discussion
Yes ( ) No ( )	3A. At least 90 percent of the sewer utility's total revenue is recovered from the sewer rates, impact fees, other fees, and interest income, or at least 75 percent recovered from sewer rates.	3A1. Sewer assessment districts fund expansion projects. Classify assessment district revenue as impact fee revenue to meet 90 percent guideline. 3A2. The other sources of revenues are grants. 3A3. General fund and tax subsidies will only continue for 2 more years.	3A. This guideline is based on a review of the financial statements and budgets of the sewer utilities for which Brown and Caldwell has conducted rate studies. The justification for this guideline is that the price of wastewater services should equal the true cost of providing wastewater services. In other words, the true cost of providing wastewater services should not be masked by subsidies.

Under the Go/No Go format discussed in Chapter 1, the water utilities have to initially satisfy those guidelines which are the most effective in promoting water conservation (unless they qualify for stated exemptions) in order for their water rates to be defined as conservation promoting. As shown in the tables, none of the guidelines for sources of utility revenues have to be satisfied initially, but within 2 years all of the guidelines for water utilities will have to be satisfied. The guidelines for the sewer utilities do not have to be satisfied for a water utility's rates to be defined as water conservation promoting.

Utilities that have historically received subsidizes should correct this procedure by incorporating the costs that have traditionally been funded from subsidies into the costs to be recovered from rates and other charges.

The water utility guidelines presented above will be summarized in Chapter 6 to determine whether the water utility's rates are conservation promoting under the four criteria when measured using the Go/No Go format. A weighting system is also presented in Chapter 7 as an alternative to the Go/No Go format. The data to be collected by the utilities for identifying the sources of revenue are specified in the questionnaire in Appendix A.

CHAPTER 5

WATER RATE AND WATER USE COMMUNICATION--CRITERION 4

Water conservation will be maximized if a utility has a rate structure which is consistent with the underlying economic principal that the price of water equals the true costs of supplying water (satisfying Criterion 1 through 3) and the utility has communicated this rate to its customers. In other words, if the customers are informed about the price of water and how much they have used they are more likely to respond to the pricing signal and use the resource efficiently. On the other hand, if the utility has not communicated the rate and water use to its customers, water conservation may not be maximized. In this chapter, guidelines are established for the utility's communication of the rates and water use to its customers. Guidelines are developed for both water and sewer utilities to acknowledge the relationship between water use (indoor use) and wastewater discharge.

The guidelines established to determine if a utility is effectively communicating the rates to its customers are presented in the following tables. These guidelines are based on our rate development and water conservation experience. The guidelines for water utilities are presented first followed by the guidelines for sewer utilities.

Under the Go/No Go format discussed in Chapter 1, the water utilities will initially have to satisfy those guidelines which are the most effective in promoting water conservation (unless they qualify for stated exemptions) for their water rates to be defined as conservation promoting. The guidelines which have to initially be satisfied are identified in Table 5-1. Within 2 years all of the guidelines for water utilities will have to be satisfied. The guidelines for sewer utilities do not have to be satisfied for a water utility's rates to be defined as water conservation promoting.

The water utility guidelines presented above will be summarized in Chapter 6 to determine whether the water utility's rates are conservation promoting under the four criteria when measured using the Go/No Go format. A weighting system is presented in Chapter 7 as an alternative to the Go/No Go format. The data to be collected by the utilities, for determining whether or not the utility is communicating the rates and water use to its customers, are specified in the questionnaire in Appendix A.

Table 5-1 Water Utility Guidelines
Water Rate and Water Use Communication--Criterion 4

Satisfy	Guideline	Exemption	Discussion
Yes ( ) No ( ) Initially Required	4A. Water rates clearly documented on water bill.	4A. None.	4A. For a customer to respond to the water rates and use the resource efficiently they have to know the price (rate).
Yes ( ) No ( ) Required within 2 years	4B. Historic (from the same period in the previous year and/or average for the previous year) and current water use are documented on the water bill. Water use should be presented in gallons per day.	4B. Flat water rates are used. This exemption is only valid for 2 years.	4B. Customers respond to the price of water by changing their water use. Therefore, the customer has to be provided with information on their water use.
Yes ( ) No ( ) Required – within 2 years	4C. Monthly or bimonthly billing.	4C1. The Utility is required by a prior agreement to bill on the tax rolls. 4C2. Flat water rates (not dependent on water use) are used. This exemption is only valid for 2 years.	4C. Monthly or bimonthly billing is required to provide the customer with timely information on their water use and water rates.

Table 5-2 Sewer Utility Guidelines
Sewer Rate and Water Use Communication--Criterion 4

Satisfy	Guideline	Exemption	Discussion
Yes ( ) No ( )	4A. Sewer rates clearly documented on sewer bill.	4A. None.	4A. If sewer rates are based on water use and the customers have been informed of the sewer rates, they will respond by using the resource (water) efficiently.
Yes ( ) No ( )	4B. Historic (from the same period in the previous year and/or average for the previous year) and current water use are documented on the sewer bill. Water use should be presented in gallons per day. If a percent of water use or a limit on the amount of water use is used to calculate the sewer bill, that should be documented.	4B1. If the water and sewer utilities are separate entities and this information cannot be provided in a timely manner. 4B2. Flat sewer rates are used.	4B. If sewer rates are based on water use, then a customer responds to the sewer rates by changing their water use. Therefore, the customer has to be provided with information on their water use.
Yes ( ) No ( )	4C. Monthly or bimonthly billing.	4C1. The utility is required by a prior agreement to bill on the tax rolls. 4C2. Flat sewer rates are used.	4C. If sewer rates are based on water use, monthly or bimonthly billing is required to provide the customer with timely information on their sewer rates and water use.

CHAPTER 6

SUMMARY OF CRITERIA--GO/NO GO FORMAT

The four criteria and associated guidelines used to define conservation promoting rate structures were presented in Chapters 2 through 5. These criteria were selected based on our rate development and water conservation experience and are listed in the following table.

Table 6-1 Criteria for Conservation-Promoting Rates

Criteria	Description
1--Rate Structure Form	Types of rate structure form (i.e., uniform quantity charge, inclining block quantity charge, seasonal quantity charge).
2--Allocation of Costs to Fixed and Variable Charges	The portion of the net revenue requirements allocated to the fixed and variable components of the rate structure (i.e., service charge v. quantity charge). Net revenue requirements are the operation and maintenance expenses and capital costs to be recovered from rates.
3--Sources of Utility Revenues	The portion of the total revenue requirements recovered from rates as compared to other sources of revenue (e.g., tax receipts, turn-on fees, and impact fees).
4--Communication of Rates and Water Use	Communication to the customers about the rates and their water use.

In Chapters 2 through 5, specific guidelines were developed for each of these criteria. The guidelines were used to define the conservation promoting components for each criteria. Initially we recommend that only those guidelines which are the most effective in promoting water conservation need to be satisfied in order for the rates to be defined as conservation promoting. However, within 2 years all of the guidelines need to be satisfied. Under this format all the guidelines must be satisfied by the utility. For example, a utility may have what we have defined as a water conservation promoting rate structure form (Criterion 1), but if an insignificant portion of the costs are allocated and thus recovered from the variable charge (Criterion 2), there will be little or no conservation. Therefore, the guidelines for Criterion 1 and 2 would initially have to be satisfied for the rate structure to be defined as conservation promoting.

Chapter 7 provides a weighting system for the criteria and guidelines which can be used as an alternative to the Go/No Go format summarized in this chapter. The weighting system is subjective, but as discussed in Chapter 7 a weighting system may, under certain conditions, provide a better indication as to whether rates are water conservation promoting.

EXHIBIT (JDW-2)

PAGE 38 OF 41

For each of the criteria, guidelines are also presented for sewer utilities to acknowledge the relationship between water use (indoor use) and wastewater discharge. However, the determination of whether a water utility's rates are conservation promoting will not be dependent on the guidelines for sewer utilities.

The following tables summarize the guidelines presented in Chapters 2 through 5 for water and sewer utilities, respectively. The guidelines that have to initially be satisfied for the water utility's rates to be classified as conservation promoting are identified. A questionnaire is presented in Appendix A to identify the necessary data to be collected from the utilities.

Under this Go/No Go format, the water utilities have to initially satisfy the five guidelines (1A, 1B, 2A, 2B, 4A) which are the most effective in promoting water conservation (unless they qualify for stated exemptions) in order for their water rates to be defined as conservation promoting. Within 2 years all of the guidelines for the water utilities will have to be satisfied (unless they qualify for stated exemptions). The guidelines for the sewer utilities do not have to be satisfied for a water utility's rates to be defined as water conservation promoting.

EXHIBIT (JBW-2)

PAGE 39 OF 91

Table 6-2 Water Utility Guidelines

Satisfy	Guideline	Exemption	Discussion
Criterion 1--Rate Structure Form:			
Yes ( ) No ( ) Initially Required	1A. Water agencies with either flat rates (do not vary with water use) or declining block rates shall adopt either uniform (nonseasonal or seasonal) or inclining block rates.	1A. None.	1A. Declining block rates do not encourage customers to use water efficiently. Although inclining block rates are commonly promoted as water conserving rate structures they are not necessarily superior to uniform rates and thus both are accepted for this guideline.
Yes ( ) No ( ) Initially Required	1B. Water utilities with nonseasonal uniform quantity charges shall adopt either inclining blocks or seasonal rates (see 1C. below). Inclining block thresholds and quantity charges shall be different for each customer classification. There shall be at least two blocks and the threshold between the first and second blocks for a given customer class shall be equal to or less than the 125 percent of the average usage for that class. The size of the second block shall be equal to or greater than the size of the first block, and the price of the second block shall be at least 125 percent of the price of the second block.	1B. If the use of nonseasonal uniform quantity charges meets the District's water use reduction requirements <u>and</u> the average daily water production in the peak season exceeds that of the off-peak season by 50 percent or less (see 1C guideline).	1B. If developed in accordance with the parameters defined in the "1B." guideline, inclining block rates are more conservation promoting than nonseasonal uniform rates. Seasonal nonseasonal rates (see 1C. below) would also promote more water conservation.

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EXHIBIT JBW-2

PAGE 40 OF 91

Table 6-2 Water Utility Guidelines (continued)

Satisfy	Guideline	Exemption	Discussion
Criterion 1–Rate Structure Form (continued):			
Yes ( ) No ( ) Required within 2 years	1C. If average daily water production (mgd) in the peak season exceeds that of off-peak season by more than 50 percent, a seasonal quantity charge should be adopted. The quantity charge in the peak season shall exceed the quantity charge in the off-peak season by at least 25 percent.	1C. If meter reading for billing purposes is completed at time intervals greater than once every two months (e.g., quarterly). This meter reading exemption is only valid for 2 years. If utility has a population increase of greater than 20 percent in the fall/winter season, it may assess peak rates during this fall peak and/or spring peak.	1C. Most water agencies incur a significantly higher cost in supplying a unit of water during the peak season. Passing on the seasonal unit cost to customers can significantly improve the water conserving practices of customers.
Criterion 2–Allocation of costs to Fixed and Variable Charges:			
Yes ( ) No ( ) Initially Required	2A. 75 percent or more of the net revenue requirements are recovered from the variable portion of the rate structure (quantity charge).	2A1. Actual meter, service lines, and billing costs (fixed costs) greater than 25 percent of net revenue requirements. 2A2. A part-time residential population increase in excess of 20 percent so that a major shift from fixed charge cost recovery to variable charge cost recovery may result in an inequity in the recovery of costs for residential customers who only reside part-time in Southwest Florida. In such cases, only 65 percent or more of the net revenue requirements need to be recovered from the variable portion of the rate structure (quantity charge). 2A3. Lifeline rates for qualifying customers.	2A. This guideline is based on a review of cost-of-service water rate studies. The more net revenue that is recovered from the variable component of the rate structure the more conservation promoting.

EXHIBIT JBW-2

PAGE 41 OF 91

Table 6-2 Water Utility Guidelines (continued)

Satisfy	Guideline	Exemption	Discussion
Criterion 2—Allocation of costs to Fixed and Variable Charges (continued)			
Yes ( ) No ( ) Initially Required	2B. No minimum charge. A minimum charge is a fixed charge which includes some water use.	2B. Lifeline rates for qualifying customers.	2B. Minimum charges shift the recovery of a portion of the variable costs to the fixed component of the rate structure. This shift reduces the portion of the rate structure which is dependent on water use and thus reduces the ability to promote conservation.
Criterion 3—Sources of Utility Revenues:			
Yes ( ) No ( ) Required within 2 years	3A. At least 90 percent of the water utility's total revenue is recovered from the water rates, impact fees, other fees, and interest income, or at least 75 percent recovered from water rates.	3A1. Water assessment districts fund expansion projects. Classify assessment district revenue as impact fee revenue to meet 90 percent guideline. 3A2. The other sources of revenues are grants. 3A3. General fund and tax subsidies will only continue for 2 more years.	3A. This guideline is based on a review of the financial statements and budgets of the water utilities for which Brown and Caldwell has conducted rate studies. The justification for this guideline is that the price of selling water should equal the true cost of supplying water. In other words, the true cost of supplying water should not be masked by subsidies.

Table 6-2 Water Utility Guidelines (continued)

Satisfy	Guideline	Exemption	Discussion
Criterion 4—Water Rate and Water Use Communication:			
Yes ( ) No ( ) Initially Required	4A. Water rates clearly documented on water bill.	4A. None.	4A. For a customer to respond to the water rate structure and use the resource efficiently they have to know the price (rate).
Yes ( ) No ( ) Required within 2 years	4B. Historic (from the same period in the previous year and/or average for the previous year) and current water use are documented on the water bill. Water use should be presented in gallons per day.	4B. Flat water rates (not dependent on water use) are used. This exemption is only valid for 2 years.	4B. Customers respond to the price of water by changing their water use. Therefore, the customer has to be provided with information on their water use.
Yes ( ) No ( ) Required within 2 years	4C. Monthly or bimonthly billing.	4C1. The utility is required by a prior agreement to bill the on tax rolls. 4C2. Flat water rates are used. This exemption is only valid for 2 years.	4C. Monthly or bimonthly billing is required to provide the customer with timely information on their water use and water rates.

Table 6-3 Sewer Utility Guidelines

Satisfy	Guideline	Exemption	Discussion
Criterion 1–Rate Structure Form:			
Yes ( ) No ( )	1A. Sewer agencies are required to have uniform quantity rates.	1A. The amount of water assessed the sewer quantity charge may be limited.	1A. The more revenue that is recovered via a quantity charge the more conservation promoting. A limit is warranted when significant amounts of water are not returned to sewer (i.e. irrigation).
Criterion 2–Allocation of Costs to Fixed and Variable Charges:			
Yes ( ) No ( )	2C. 75 percent or more of the net revenue requirements are recovered from the variable portion of rate structure (quantity charge).	2C1. Actual billing, service lines (laterals), and I/I costs are greater than 25 percent. 2C2. Residential rates are fixed but were initially based on average indoor water use. 2C3. Quantity charges are assessed large dischargers (commercial and industrial users discharging more than 30,000 gallons per month) and are based on water use. 2C4. Lifeline rates for qualifying customers.	2C. This guideline is based on a review of cost-of-service sewer rate studies. The more net revenue that is recovered through the variable portion of the sewer rate structure the more conservation promoting.

EXHIBIT (JPW-2)

PAGE 44 OF 91

Table 6-3 Sewer Utility Guidelines (continued)

Satisfy	Guideline	Exemption	Discussion
Criterion 3—Sources of Utility Revenues:			
Yes ( ) No ( )	3A. At least 90 percent of the sewer utility's total revenue is recovered from the sewer rates, impact fees, other fees, and interest income, or at least 75 percent recovered from sewer rates.	3A1. Sewer assessment districts fund expansion projects. Classify assessment district revenue as impact fee revenue to meet 90 percent guideline. 3A2. The other sources of revenues are grants. 3A3. General fund and tax subsidies will only continue for 2 more years.	3A. This guideline is based on a review of the financial statements and budgets of the sewer utilities for which Brown and Caldwell has conducted rate studies. The justification for this guideline is that the price of wastewater services should be equal the true cost of providing wastewater services. In other words, the true cost of providing wastewater services should not be masked by subsidies.
Criteria 4—Sewer Rate and Water Use Communication:			
Yes ( ) No ( )	4A. Sewer rates clearly documented on sewer bill.	4A. None.	4A. If sewer rates are based on water use and the customers have been informed of the sewer rate structure, they will respond by using the resource (water) efficiently.
Yes ( ) No ( )	4B. Historic (from the same period in the previous year and/or average for the previous year) and current water use are documented on the sewer bill. Water use should be presented in gallons per day. If a percent of water use or a limit on the amount of water use is used to calculate the sewer bill, that should be documented.	4B1. If the water and sewer utilities are separate entities and this information cannot be provided in a timely manner. 4B2. Flat sewer rates are used.	4B. If sewer rates are based on water use, then a customers responds to the sewer rates by changing their water use. Therefore, the customer has to be provided with information on their water use.

EXHIBIT ______ (JDK-2)

PAGE 45 OF 91

Table 6-3 Sewer Utility Guidelines (continued)

Satisfy	Guideline	Exemption	Discussion
Yes ( ) No ( )	4C. Monthly or bimonthly billing.	4C1. The utility is required by prior agreement to bill on the tax rolls. 4C2. Flat sewer rates are used.	4C. If sewer rates are based on water use, monthly or bimonthly billing is required to provide the customer with timely information on their sewer rates and water use.

EXHIBIT (JPL-2)

PAGE 46 OF 91

CHAPTER 7

WEIGHTING SYSTEM FOR CRITERIA

The previous chapter (Chapter 6) summarizes the guidelines developed in Chapters 2 through 5. As specified in Chapter 6, the utilities have to initially satisfy those guidelines which are the most effective in promoting water conservation (unless they qualify for the stated exemptions) and within 2 years satisfy all the guidelines. That is, the guidelines are presented in a Go/No Go format. The short coming of this Go/No Go format is that a water utility may satisfy 3 of the 4 criteria (by a wide margin in the cases of Criterion 1 and 2) but still not have rates that are defined as a water conservation promoting because of not meeting one of the criterion.

For example, a utility may meet the two relatively qualitative criteria (Criterion 1 and 4) and recover 100 percent of the utilities total revenue requirements via rates (as compared to the 75 percent requirement set forth in Criterion 3), but only recover 70 percent of the net revenue requirements via the quantity charge (as compared to the 75 percent required by Criterion 2). Clearly this utility (which fails via the requirement that all four criteria be satisfied) actually collects more of its total annual revenue requirements via the quantity charge (70 percent [1.0 x 0.70]) than does the utility which passes all four criteria (56.2 percent [0.75 x 0.75]). In an attempt to avoid these types of anomalies, we have also developed a weighting system for determining whether or not a utility has adopted a water conservation promoting rate structure. This weighting system can be used by the District as an alternative to the Go/No Go system summarized in Chapter 6.

Weighting System

In order to develop a weighting system, it is first necessary to establish a rank (via weighting factor) for each of the four criteria. These weighting factors are presented in the table below.

Table 7-1 Weighting Factors

Criteria	Weighting Factor, percent
1. Rate Structure Form	20
2. Allocation of Costs to Fixed/Variable Charges	40
3. Sources of Utility Revenues	30
4. Communication on Bill	10
Total	100

Obviously the weighting factors shown above are subjective. This is the way Brown and Caldwell weights the four criteria. Others might weight these criteria differently.

Having established overall weighting factors for each of the four criteria it is necessary to develop a scoring system for each criteria. The scoring system is presented in the following sections.

Rate Structure Form (Criterion 1). For the reasons indicated in Chapter 2, seasonal quantity charges are the most equitable and efficient in recovering the cost of service and in promoting conservation for service areas that exhibit seasonal use. In our weighting system (see Table 7-2), the seasonal rate quantity charge received a higher score than either the nonseasonal uniform quantity charge or the inclining block quantity charge, the peak-season charge must exceed the off-peak season charge by 25 percent. Inclining block quantity charges, although difficult to design based on sound economic principles, can also be effective in promoting conservation. Depending on the ratio of the price of the tail block to the price of the first block, the block thresholds, and the size of the blocks, this type of structure maybe more conservation promoting than a nonseasonal uniform quantity charge. As we indicated in Chapter 2, the size of the first block should not exceed 125 percent of average monthly usage. Declining block and flat rate structures are never conservation promoting and thus have been assigned the lowest score. The weighting factors for Criterion 1 are presented below.

Table 7-2 Weighting Factors for Criterion 1

Quantity Charge Form	Score
Seasonal	
1. Ratio of peak season to off-peak season charge is greater than 1.5.	5
2. Ratio of peak season to off-peak season charge is less than or equal to 1.5, but greater than 1.25.	4
3. Ratio of peak season to off-peak season charge is less than or equal to 1.25.	2.5
Inclining Blocks	
1. Ratio of tail block charge to first block charge > 1.5 and the first block threshold is less than or equal to 125 percent of average monthly use for class.	3.5
2. Ratio of tail block charge to first block charge is less than or equal to 1.5 and/or first block threshold is greater than 125 percent of average monthly use for class.	2
Nonseasonal Uniform Quantity Charge	2.5
Declining Blocks	1
Flat Rates	0

Allocation of Costs to Fixed and Variable Charges (Criterion 2). Obviously the more costs (net revenue requirements) that are allocated to and thus recovered from the quantity charge portion of the rate structure, the more conservation promoting. A subjective scoring system for this criterion is set forth below.

Table 7-3 Weighting Factors for Criterion 2

Percentage of Net Revenue Requirements Recovered via the Quantity Charge	Score
90 - 100	5
80 - 89	4
70 - 79	3
60 - 69	2
50 - 59	1

Sources of Utility Revenues (Criterion 3). As indicated in Chapter 4, the greater the amount of total revenues recovered via rates (as opposed to taxes, transfers from the general fund, or other subventions) the more effective the pricing signal. The proposed scoring system for this criterion is presented below.

Table 7-4 Weighting Factors for Criterion 3

The Percentage of Total Utility Revenue Collected via Rates	Score
90 - 100	5
80 - 89	4
70 - 79	3
60 - 69	2
50 - 59	1

Rate Structure and Water Use Communication (Criterion 4). As indicated in Chapter 5, the more information a customer is given about the rates and their water usage, the more likely they are to respond to a pricing signal. A scoring system for this criterion is presented below.

Table 7-5 Weighting Factors for Criterion 4

Communication on Bill	Score
Rates, water use in current billing period, and water use in similar period of prior year and/or average from prior year	5
Rates and water use in current billing period	4
Rates only	3
Water use in current billing period	3
Monthly or bimonthly billing	2
No information on rates or usage	1

Given the weighting of the criteria and the individual scoring of each criterion, the highest score possible is a 5. In order for utility water rates to be defined as conservation promoting using the weighting and scoring system it must have a score of at least 3.2.

Example

To illustrate the use of the weighting system, we have provided a sample calculation for a water utility with a nonseasonal uniform quantity charge, 70 to 79 percent of its net revenue requirements recovered from quantity charges, 80 to 89 percent of its total revenues collected via rates, and only the water rates (not usage) are communicated on the bill. The results calculation are presented in Table 7-6 below:

Table 7-6 Example Utility Scoring

	Criteria	Weighting factor, percent	Score	Total*
1.	Rate structure form	20	2.5	0.5
2.	Allocation of costs to fixed/variable charges	40	3	1.2
3.	Sources of utility revenues	30	4	1.2
4.	Communication on bill	10	3	0.3
	Total	100	--	3.2

*Weighting factor times score.

CHAPTER 8

REGULATORY REVIEW

The review of policies, rules, and regulations governing the development of water rates includes:

* Florida Public Service Commission (FPSC) requirements for investor owned utilities,

* County requirements for investor owned utilities under County regulatory control, and

* Government owned, operated, or managed water and wastewater utilities.

The review concentrates primarily on those regulations as they pertain to the adoption of water conservation-promoting rates.

Florida Public Service Commission

Counties may elect to have private utilities within their boundaries regulated by the FPSC pursuant to FS 367.171 (1). There are currently 34 such counties within the state that elect to do so. Once a county makes this election, these utilities are to remain under FPSC rules and regulations for a period of at least 10 years. In 10 of the District's 16 counties, investor owned (private) utilities are regulated by the FPSC. Florida Statutes (FS), Chapter 367 describes the powers, duty, and authority of the FPSC. Section 367.081 specifies the procedure for fixing and changing rates. These rates must be "just, reasonable, compensatory, and not unfairly discriminatory" as stated in FS 367.081 (2). There are no statutory limitations which would preclude the adoption of conservation-promoting rates.

To determine the level and pervasiveness of conservation-promoting rates currently being used or under consideration, we talked with the FPSC. Conservation-promoting rates, such as surcharge programs and the use of seasonal rates, have not been requested by utilities for adoption. However, there is a high level of interest from utilities desiring to implement inclining block rate structures to promote conservation. There is only one utility under FPSC regulation that has had inclining block rates approved, Hobe Sound Water Company (HSWC). HSWC is located within the South Florida Water Management District.

The inclining rates adopted by HSWC have been in effect for approximately six months and were approved with special requirements. The utility must report to the FPSC quarterly on consumption and revenue to monitor the programs' effectiveness at promoting conservation and desired levels of revenue. The quarterly reports will be filed for a period of eighteen months at which time the program will be analyzed. FPSC staff indicated that there was no particular difficulty during the approved process other than deciding on an elasticity value. A conservative elasticity of -0.1 was assumed by the FPSC based on their review of professional literature. This conservative approach, taken by the FPSC in approving HSWC's inclining rates, reinforces the importance of setting rates to assure that revenues will not be derived in excess of the allowed rate of return of the utility's rate base.

With the inclusion of uniform rate structure also promoting the economic efficiency and equitability among individual users (and across user groups), the expanding rate approval process currently used by the FPSC to promote use of conservation-promoting rates does not appear to conflict with the guidelines proposed. As long as any proposed rate structure assures that rates are just and reasonable and will not produce revenues greater than those allowed for that rate base, the use of conservation-promoting rates should be allowed.

County-Regulated Private Utilities. Of the 16 counties that comprise the Southwest Florida Water Management District, six have elected to regulate the private utilities within their boundaries. These counties, Hillsborough, Manatee, Sarasota, Charlotte, Hardee, and Polk are given regulatory authority under FS 367.171. Under this authority, the requirements of the rate setting as set forth in FS 367.081 (1), (2), (3), and (6) again state that only rates must be just, reasonable, compensatory, and not unfairly discriminatory. There is nothing within the statutes that would prohibit conservation-promoting rates as long as the four criteria of the statute are met.

County-Owned Public Utilities. FS Section 153.11 (1) (b) allows the county commission to set rates, fees, and other charges without "supervision or regulation by any other commission, board, bureau or agency of the county or of the state, or of any sanitary district or other political subdivision of the State." FS Section 153.11 (1) (c) requires that "rates, fees, and charges shall be just and equitable." The only restrictions to rate setting for county-owned public utilities are that they are fair and reasonable. Section 153.11 (1) (d) addresses water use that imposes an "unreasonable burden" upon the water supply system. In such cases, "an additional charge may be made thereof or the county commission may if it deems advisable compel the owners or occupants of such building or premisses to reduce the amount of water consumed."

Other Government-Owned Public Utilities. FS Section 367.022 (2) specifically exempts other government owned, operated, managed or controlled utiltities from regulation under that chapter of the statutes, including regulation of rates and charges.

Conclusions

Based on our review of the policy and rules and regulations governing the development of rate structures, for both publicly and privately owned utilities, there are no restrictions against the use of conservation-promoting rates. The only requirements are that the rates be just and reasonable across users and user groups, and provide reasonable assurance that the revenue generated from the rate base equal the utility's revenue requirements.

EXHIBIT (JBW-2)

PAGE 54 OF 91

APPENDIX A

QUESTIONNAIRE

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

WATER AND SEWER UTILITY QUESTIONNAIRE

IDENTIFICATION

Date:__________

Name and Address of Utility:

____
____
____
____
____

Name and Title of Person Responsible for Questionnaire:

____

Phone Number: ____________

INSTRUCTIONS

Please refer to the respective Chapters 2 through 5 of this report for additional information on the data requested in the following water and sewer utility questionnaires. If your utility provides both water and sewer service please complete both the water and sewer utility questionnaires. If you have any questions call Southwest Florida Water Management District.

WATER UTILITY QUESTIONNAIRE

Criterion 1--Rate Structure Form (See Chapter 2)

Data Source: Water Rate Ordinance (please include a copy of the water rate ordinance)

1. In the following table indicate (with a check) the water utility's quantity charge structure by customer class.

Quantity Charge Structure	Single Family	Multiple Family	Commercial	Industrial	Other
Declining Block					
Uniform					
Inclining Block*					
Seasonal*					

*If seasonal surcharge structure, check with inclining block and seasonal.

2. Fill in the current quantity charges by customer class (dollars/unit). What are the units used (e.g., dollars/gallon, dollars/cubic feet (cf), dollars/hundred cubic feet (Ccf)) ________ ?

Quantity Charge	Single Family	Multiple Family	Commercial	Industrial	Other
Declining Block First Block Second Block					
Uniform Rate					
Inclining Block* First Block Second Block Ratio (Second/First)					
Seasonal* Off-Peak Peak Ratio (Peak/Off-Peak)					

*If seasonal surcharge structure, fill in both inclining block and seasonal.

3. If you checked declining block or inclining block charges in Number 1, fill in the water use block thresholds (using applicable units) associated with the quantity charges by customer class. What are the units used (e.g., gallons, cubic feet (cf), hundred cubic feet (Ccf), __________? If you checked seasonal quantity charges in Number 1, fill in the period (months) associated with the quantity charges by customer class.

Quantity Charge	Single Family	Multiple Family	Commercial	Industrial	Other
Declining Block					
First Block					
Second Block					
Ratio of first and second block threshold to average use by class					
Size of second block equal size of first (yes/no)					
Inclining Block[a]					
First Block					
Second Block					
Ratio of first and second block threshold to average use by class					
Size of second block equal size of first (yes/no)					
Seasonal Periods, months[a]					
Off-Peak Period					
Peak Period					

[a]If seasonal surcharge structure, fill in both inclining block and seasonal.

4. Fill in the monthly water production for the last three years in the following table. What are the units used (e.g., gallons, million gallons (mg), cubic feet (cf), hundred cubic feet (Ccf), acre feet (ac ft)) ________?

Month	Year ______	Year ______	Year ______
January			
February			
March			
April			
May			
June			
July			
August			
September			
October			
November			
December			
Total			
Peak Season (a) Production Percent of Total			
Off-Peak Season (b) Production Percent of Total			

(a)Production during 4 continuous months with largest water production (e.g., February through May).
(b)Production during remaining 8 months of calendar year (e.g., June through January).

5. Indicate the water utility's meter reading cycle by customer class in the following table.

Meter Reading Cycle	Single Family	Multiple Family	Commercial	Industrial	Other
Monthly					
Bimonthly					
Greater than Bimonthly					

Criterion 2--Allocation of Costs to Fixed and Variable Charges (See Chapter 3)

Data Sources: Water Utility Budget - Year end summary of expenses and revenues; Water Rate Ordinance.

6. In the following table fill in the fixed and variable water utility user charge revenues by customer class.

User Charge Revenues, Year ______	Single Family	Multiple Family	Commercial	Industrial	Other	Total	Percent of Total
Quantity Charge *(Variable)*							
Fixed Charge							
Total							

7. What expenses are funded by the water utility's fixed charge? Fill in the dollar amounts in the following table.

Fixed Charge Expenses	Year ______
Meter maintenance	
Service line maintenance	
Billing/Customer Service	
Meter Reading	
Other costs (e.g., capital costs, minimum water use costs): Specify	
Total Fixed Charge Expenses (should match fixed charge total in number 6)	

8. If the fixed charge includes some water use (minimum charge) fill in the amount of water use by customer class. What are the units used (e.g., gallons, cubic feet (cf), hundred cubic feet (Ccf)) _________ ?

If Fixed Charge Includes Some Water Use	Single Family	Multiple Family	Commercial	Industrial	Other
Amount of Water					

Criterion 3--Sources of Utility Revenues (See Chapter 4)

Data Sources: Water Utility Financial Statement; Water Utility Budget - Year end summary of revenues.

9. In the following table fill in the requested water utility sources of revenue.

Sources of Revenue	Year _________
Water Rates	
Impact Fees	
Other Service Charges (e.g., turn-on fees, hook-up fees)	
Other Operating Revenues	
Interest Income	
Subtotal	
Percent of Total	
Taxes	
Transfers from Other Funds	
Other Nonoperating Revenues	
Subtotal	
Percent of Total	
Total	

Criterion 4--Water Rate and Water Use Communication (See Chapter 5)

Data Source: - Example Water Bill

10. Are the water rates documented on the water bill ?
Yes ______ No ______

11. Is the water use documented on the water bill ?
Yes ______ No ______

12. Is the historic water use for a similar period in the prior year and/or average from the prior year documented on the water bill ?
Yes ______ No ______

13. If yes to numbers 11 or 12, is the water use presented in gallons per day on the water bill ?
Yes ______ No ______

14. In the following table indicate the water utility's billing cycle by customer class.

Billing Cycle	Single Family	Multiple Family	Commercial	Industrial	Other
Monthly					
Bimonthly					
Greater than Bimonthly					

EXHIBIT (UTW-2)

PAGE 162 OF 91

SEWER UTILITY QUESTIONNAIRE

Criterion 1--Rate Structure Form (See Chapter 2)

Data Source: Sewer Rate Ordinance (please include a copy of the sewer rate ordinance)

1. In the following table indicate (with a check) the sewer utility's quantity charge structure by customer class.

Quantity Charge Structure	Single Family	Multiple Family	Commercial	Industrial	Other
Flat					
Declining Block					
Uniform					
Inclining Block					
Seasonal					

Criterion 2--Allocation of Costs to Fixed and Variable Charges (See Chapter 3)

Data Sources: Sewer Utility Budget - Year end summary of expenses and revenues

2. In the following table fill in the fixed and variable sewer utility user charge revenues by customer class.

User Charge Revenues, Year ______	Single Family	Multiple Family	Commercial	Industrial	Other	Total	Percent of Total
Quantity Charge (Variable)							
Fixed Charge							
Total							

3. What expenses are funded by the sewer utility's fixed charge ? Fill in the dollar amounts in the following table.

Fixed Charge Expenses	Year ______
Infiltration/Inflow	
Service line maintenance	
Billing/Customer Service	
Other costs (e.g., capital costs, minimum discharge): Specify	
Total Fixed Charge Expenses (should match fixed charge total in number 2)	

Criterion 3--Sources of Utility Revenues (See Chapter 4)

Data Sources: Sewer Utility Financial Statement; Sewer Utility Budget - Year end summary of revenues.

4. In the following table fill in the requested sewer utility sources of revenue.

Sources of Revenue	Year ______
Sewer Rates	
Impact Fees	
Other Service Charges (e.g., turn-on fees, hook-up fees)	
Other Operating Revenues	
Interest Income	
Subtotal	
Percent of Total	
Taxes	
Transfers from Other Funds	
Other Nonoperating Revenues	
Subtotal	
Percent of Total	
Total	

Criterion 4--Sewer Rate and Water Use Communication (See Chapter 5)

Data Source: - Example Sewer Bill

5. Are the sewer rates documented on the sewer bill ?
   Yes ______ No ______

6. Is the water use documented on the sewer bill ?
   Yes ______ No ______

7. Is the historic water use for a similar period in the prior year and/or the average from the prior year documented on the sewer bill ?
   Yes ______ No ______

8. If yes to numbers 6 or 7, is the water use presented in gallons per day on the sewer bill?
   Yes ______ No ______

9. If a percent of water use or a limit on water use is used to calculated the sewer bill is this documented on the sewer bill ?
   Yes ______ No ______

10. In the following table indicate the sewer utility's billing cycle by customer class.

Billing Cycle	Single Family	Multiple Family	Commercial	Industrial	Other
Monthly					
Bimonthly					
Greater than Bimonthly					

APPENDIX B

REVIEW OF COST-OF-SERVICE ALLOCATIONS

File: WRALLO.WK1
Date: 02/05/93
Job #: 6825-02

Table 2 Net Revenue Requirements Allocation for Water Utilities in OTHER STATES

Utility (a)	Study Date	Accounts	Revenue Requirements, million $	Year	Allocation, percent Fire Protection	Facility(b)	Customer	Total
1. City of Pittsburg, CA	May-92	13,500	$7.01	1992/93	4.1	85.7	10.2	100.0
2. City of Salt Lake City, UT	Jan-92	73,000	$18.01	1989/90	1.4	76.7	21.9	100.0
3. City of West Sacramento, CA (residenital not metered)	Feb-92	8,000	$4.88	1992/93	10.4	87.1	2.5	100.0
4. Northridge Water Uisctrict, CA (residenital not metered)	Dec-91	21,000	$2.99	1992/93	1.3	70.5	28.2	100.0
5. Paradise Irrigation District, CA	Nov-91	10,000	$2.22	1992/93	18.5	62.6	18.8	100.0
6. City of Fresno, CA (residenital not metered)	Jul-91	94,000	$21.46	1991/92	4.7	75.6	19.7	100.0
7. City of Grass Valley, CA	Sep-90	2,000	$0.82	1990/91	23.8	69.3	6.9	100.0
8. Soquel Creek Water Disctrict, CA	Jun-90	13,000	$3.19	1990/91	6.4	77.2	16.4	100.0
9. City of San Diego, CA	Mar-90	350,000	$117.19	1989/90	2.8	82.1	15.1	100.0
10.City of Corvallis, OR	Feb-88	11,000	$2.36	1987/88	15.9	69.2	15.0	100.0
11.City of Martinez, CA	Jun-88	9,000	$3.42	1988/89	7.8	78.0	14.1	100.0
12.City of Watsonville, CA	Nov-87	11,000	$2.50	1987/88	12.0	71.4	16.6	100.0
13.City of Oklahoma City, OK	Jan-87	150,000	$23.94	1986/87	4.4	77.8	17.8	100.0
14.City of Antioch, CA	Dec-86	15,000	$2.03	1984/85	12.8	79.9	7.3	100.0
15.City of Santa Cruz, CA	Feb-85	21,000	$4.20	1984/85	8.2	67.3	24.5	100.0
Average		53,433	$14.41		9.0	75.4	15.7	100.0

(a)Source:Cost-of-service rate studies conducted by Brown and Caldwell's Pleasant Hill, CA office.
(b)Includes base and extra capacity cost allocation as well as variable cost allocation.

ALLOCATION SUMMARY:

Average Fixed and Variable Allocation - OTHER STATES

Fixed (Fire Protection + Customer) =	25%
Variable (Facility) =	75%

EXHIBIT [illegible]
PAGE [illegible] OF 91

File: WRALLO.WK1
Date: 02/05/93
Job #: 6825-02

Table 2a Net Revenue Requirements Allocation for FLORIDA Water Utilities

Utility (a)	Study Date	Accounts	Revenue Requirements, million $	Year	Allocation, percent Readiness to Serve (b)	Usage (c)	Customer(d)	Total
1. City of Winter Park, FL	Jan-92	21,155	$4.79	1992	17.4	63.8	18.8	100.0
2. Collier County, FL (e)	Aug-91	17,500	$13.15	1992	41.4	51.5	7.1	100.0
3. City of St. Cloud, FL	Feb-91	7,000	$0.73	1991	17.0	69.0	14.0	100.0
Average		15,218	$6.22		25.3	61.4	13.3	100.0

(a)Source:Rate studies conducted by Brown and Caldwell's Orlando, FL office.
(b)Readiness to serve costs are peak capacity costs (O&M and capital) recovered over number of equivalent meters.
(c)Usage costs are base capacity costs and variable costs recovered over water use.
(d)Customer costs are customer accounting and billing costs and meter-related costs recovered over number of customers.
(e)For Collier County more costs were allcoated to readiness to serve category because existing debt was only allocated to the readiness to serve category. The fire protection allocation of 3.6 percent was included in customer.

ALLOCATION SUMMARY:

Average Fixed and Variable Allocation - FLORIDA

Fixed (Readiness to Serve + Customer) = 39%
Variable (Usage) = 61%

Average Fixed and Variable Allocation - FLORIDA AND OTHER STATES (see Table 2)

Fixed (Fire Protection or Readiness to Serve + Customer) 27%
Variable (Facility or Usage) = 73%

EXHIBIT (JBL-2)
PAGE 67 OF 91

File: SWRALLO.WK1
Date: 02/05/93
Job #: 6825-02

Table 3 Net Revenue Requirements Allocation for Wastewater Utilities in OTHER STATES

Utility (a)	Study Date	Accounts	Revenue Requirements, million $	Year	Allocation, percent Flow	BOD	SS	Customer	I/I	TP	Pre-treatment	Septage	Total
1. City of West Sacramento, CA	Feb-92	7,500	$2.74	1992/93	57.4	15.7	15.7	0.0	11.2	0.0	0.0	0.0	100.0
2. City of Hercules, CA	Jun-91	5,000	$1.19	1991/92	92.1	4.0	4.0	0.0	0.0	0.0	0.0	0.0	100.0
3. City of Brookings, CA	Mar-91	2,000	$0.66	1990/91	61.9	23.0	6.0	9.1	0.0	0.0	0.0	0.0	100.0
4. City of Grass Valley, CA (b)	Jan-91	3,000	$2.35	1991/92	35.1	13.8	9.4	4.0	37.7	0.0	0.0	0.0	100.0
5. City of San Diego, CA (c)	Mar-90	249,000	$104.38	1990/91	65.2	0.0	26.9	0.9	7.0	0.0	0.0	0.0	100.0
6. City of Rochester, MN	Mar-88	21,000	$5.31	1988/89	39.5	27.0	14.5	2.4	9.5	6.4	0.7	0.0	100.0
7. City of Corvallis, OR	Feb-88	10,500	$2.51	1987/88	33.9	16.1	4.9	5.9	39.1	0.0	0.0	0.0	100.0
8. City of Santa Cruz, CA	May-87	13,500	$2.72	1986/87	33.3	11.9	14.6	3.1	35.3	0.0	1.8	0.0	100.0
9. City of Ft.Collins, CA	Feb-87	33,000	$5.40	1986/87	54.7	12.5	17.7	1.3	12.5	0.0	1.3	0.0	100.0
10.East Bay MUD, CA (c)	Aug-86	169,000	$27.76	1985/86	24.1	22.7	36.8	2.9	13.5	0.0	0.0	0.0	100.0
11.Monterey Regional Water Pollution Control Agency	Draft Jun-92	170,000	$12.60	1992/93	54.7	26.3	13.4	1.7	0.0	0.0	2.2	1.7	100.0
Average		62,136	$15.24		50.2	15.7	14.9	2.8	15.1	0.6	0.5	0.2	100.0

(a)Source:Cost-of-service rate studies conducted by Brown and Caldwell's Pleasant Hill, CA office.
(b)I/I includes unused capacity.
(c)The measurement for BOD is actually for COD.

ALLOCATION SUMMARY:

Average Fixed and Variable Allocation - OTHER STATES

Fixed (Customer + I/I) = 18%
Variable (Flow,BOD,SS,TP,other) = 82%

EXHIBIT (JBW-2)
PAGE 68 OF 91

File: SWRALLO.WK1
Date: 02/05/93
Job #: 6825-02

Table 3a — Wet Revenue Requirements Allocation for FLORIDA Wastewater Utilities

Utility (a)	Study Date	Accounts	Revenue Requirements, million $	Year	Usage (b)	BOD	SS	Customer (c)	Readiness to Serve (d)	TP	Pre-treatment	Septage	Tota
1. City of Winter Park, FL	Jan-92	13,925	$8.76	1992	80.1	0.0	0.0	6.0	13.9	0.0	0.0	0.0	100
2. Collier County, FL (e)	Aug-91	22,654	$10.35	1992	34.6	0.0	0.0	10.9	54.5	0.0	0.0	0.0	100
3. City of St. Cloud, FL	Feb-91	5,800	$1.99	1991	56.3	0.0	0.0	6.0	37.7	0.0	0.0	0.0	100
Average		14,126	$7.03		57.0	0.0	0.0	7.6	35.4	0.0	0.0	0.0	100

(a)Source:Rate studies conducted by Brown and Caldwell's Orlando, FL office.
(b)Usage costs are base capacity costs and variable costs recovered over water use.
(c)Customer costs are customer accounting and billing costs recovered over number of customers.
(d)Readiness to serve costs are peak capacity costs (O&M and capital) recovered over number of equivalent billing units.
(e)For Collier County more costs were allcoated to readiness to serve category because of future debt service only allocated to the readiness to serve category.

ALLOCATION SUMMARY:

Average Fixed and Variable Allocation - FLORIDA

Fixed (Readiness to Serve + Customer) =	43%
Variable (Usage) =	57%

Average Fixed and Variable Allocation - FLORIDA AND OTHER STATES

Fixed (I/I or Readiness to Serve + Customer) =	23%
Variable (Flow and Strength or Usage) =	77%

EXHIBIT (JPM-2)
PAGE 69 OF 91

APPENDIX C

REVIEW OF THE SOURCES OF UTILITY REVENUES

File: WRALLO.WK1
Date: 03/04/93
Job #: 6825-02

Table 4 Review of Sources of Revenue for Water Utilities

Utility (a)	Study Date	Accounts	Revenue Year	Operating Revenues: Water Rates	Operating Revenues: Impact Fees	Operating Revenues: Other Service Charges	Operating Revenues: Other	Nonoperating Revenues: Interest Earnings	Nonoperating Revenues: Taxes	Nonoperating Revenues: Transfer From Other Funds	Nonoperating Revenues: Other	Total
1. City of Pittsburg, CA	May-92	13,500	1989/90									
Dollars (b)				3,354,176	53,419	18,188	0	0	802,059	500,000	90	4,727,931
Percent of Total				71%	1%	0%	0%	0%	17%	11%	0%	100%
2. City of West Sacramento, CA (c)	Feb-92	8,000	1989/90									
Dollars (d)				3,857,250	557,231	81,459	79,953	211,058	0	507,054	0	5,294,005
Percent of Total				73%	11%	2%	2%	4%	0%	10%	0%	100%
3. Northridge Water District, CA (c)	Dec-91	21,000	1989/90									
Dollars (e)				2,208,046	250,055	354,773	0	215,451	394,097	371,997	111,510	3,985,929
Percent of Total				57%	6%	9%	0%	5%	10%	9%	3%	100%
4. Paradise Irrigation District, CA	Nov-91	10,000	1989/90									
Dollars (f)				1,424,274	138,114	11,706	45,130	79,441	517,083	0	57,439	2,273,187
Percent of Total				63%	6%	1%	2%	3%	23%	0%	3%	100%
5. Soquel Creek Water District, CA	Jun-90	13,000	1988/89									
Dollars (g)				2,658,212	1,035,332	99,046	7,822	329,322			445,660	4,575,394
Percent of Total				58%	23%	2%	0%	7%	0%	0%	10%	100%
6. City of Martinez, CA	Jun-88	9,000	1988/89									
Dollars (h)				3,332,833	269,240	25,922	0	323,957	0	27,190	19,386	3,998,528
Percent of Total				83%	7%	1%	0%	8%	0%	1%	0%	100%
7. City of Antioch, CA	Dec-86	15,000	1984/85									
Dollars (i)				2,176,038	1,216,475	100,718	25,593	25,732	0	0	0	3,544,556
Percent of Total				61%	34%	3%	1%	1%	0%	0%	0%	100%
Average		12,786		2,727,261	502,838	98,830	22,643	169,280	244,748	200,892	90,584	4,057,076
Percent of Total				67%	12%	2%	1%	4%	6%	5%	2%	100%

(a)Utilities for whom cost-of-service rate studies were conducted by Brown and Caldwell's Pleasant Hill, CA office.
(b)Source: City of Pittsburg 1989/90 Summary of Revenues and 6/30/90 Enterprise Fund Statement. Additional Funding from Assessment Districts.
Transfers from other funds from general fund. Taxes to pay redevelopment bonds for treatment plant.
(c)Residential customers not metered.
(d)Source: City of West Sacramento 1991/92 Budget and 6/30/90 Financial Statement. Transfers from other funds from redevelopment agency.
(e)Source: Northridge Water 1989/90 Actuals and 6/30/90 Financial Statement. Transfers from other funds from CIP and Surface Water funds.
Taxes include assessment district payments.
(f)Source: Paradise Irrigation District 1989/90 Actuals and 6/30/90 Financial Statement. Taxes to pay debt service.
(g)Source: Soquel Creek Water 6/30/89 Financial Statement. Other nonoperating includes PERS surplus.
(h)Source: City of Martinez 6/30/89 Financial Statement used for water rate study update. Transfer from other funds is prior year adjustment.
(i)Source: City of Antioch 6/30/85 Financial Statement.

REVENUE SUMMARY:

Water Rates	67%
Operating revenue	83%

EXHIBIT (JBW-2)
PAGE 71 OF 91

File: SWRALLO.WK1
Date: 03/04/93
Job #: 6825-02

Table 5 Review of Sources of Revenue For Wastewater Utilities

Utility (a)	Study Date	Accounts	Revenue Year	Operating Revenues: Wastewater Rates	Operating Revenues: Impact Fees	Operating Revenues: Other Service Charges	Operating Revenues: Other	Nonoperating Revenues: Interest Earnings	Nonoperating Revenues: Taxes	Nonoperating Revenues: Transfer From Other Funds	Nonoperating Revenues: Other	Total
1. City of West Sacramento, CA (c)	Feb-92	7,500										
Dollars (b)			1989/90	1,943,710	669,367	40,202	93,736	583,894	0	0	0	3,330,909
Percent of Total				58%	20%	1%	3%	18%	0%	0%	0%	100%
2. City of Hercules, CA	Jun-91	5,000	1989/90									
Dollars (d)				701,172	83,300	4,125	29,035	0	0	0	0	817,632
Percent of Total				86%	10%	1%	4%	0%	0%	0%	0%	100%
3. City of Rochester, MN	Mar-88	21,000	1984/95									
Dollars (e)				3,552,425	4,939	14,520	0	24,756	60,921	15,278	2,984	3,675,823
Percent of Total				97%	0%	0%	0%	1%	2%	0%	0%	100%
4. Monterey Regional Water Pollution Control Agency, CA	Draft Jun-92	170,000	1989/90									
Dollars (f)				9,365,300	0	316,365	0	280,000	0	0	301,808	10,263,473
Percent of Total				91%	0%	3%	0%	3%	0%	0%	3%	100%
Average		50,875		3,890,652	189,402	93,803	30,693	222,163	15,230	3,820	76,198	4,521,959
Percent of Total				86%	4%	2%	1%	5%	0%	0%	2%	100%

(a)Utilities for whom cost-of-service rate studies were conducted by Brown and Caldwell's Pleasant Hill, CA office.
(b)Source: City of West Sacramento 1991/92 Budget and 6/30/90 Financial Statement.
(c)Residential customers not metered.
(d)Source: City of Hercules 6/30/90 Financial Statement and Sewer Enterprise Revenues Summary 1989/90.
(e)Source: City of Rochester 6/30/85 Financial Statement and 1987 Annual Budget.
(f)Source: MRWPCA 6/30/90 Financial Statement and 1991-92 Budget.

REVENUE SUMMARY:

Wastewater Rates =	86%
Operating Revenues =	93%
Operating Revenues + Interest Income	98%

EXHIBIT (JBW-2)
PAGE 12 OF 91

APPENDIX D

SEASONALITY OF WATER USE IN THE SWFWMD SERVICE AREA AND ITS IMPLICATIONS WITH RESPECT TO SEASONAL RATES

APPENDIX D

SEASONALITY OF WATER USE IN THE SWFWMD SERVICE AREA AND ITS IMPLICATIONS WITH RESPECT TO SEASONAL RATES

In order to better understand the impact that seasonal rates and/or any general shift in the recovery of annual revenue requirements from fixed charges (the fixed monthly service charge) to variable charges (the quantity charges) will have on cash flow and/or rate equity, we have analyzed certain pumpage data for 1988 through mid-1992. Based on our analysis, we have the following conclusions:

1. In analyzing the total pumpage data for the entire Southwest Florida Water Management District (District) service area, it is clear that there is a peak in about May for all 5 years (1988 through 1992) for which we had data (see the attached Figures D-1 through D-5 for total pumpage for all utilities). In 1988, there appears to be a fall peak (October) of almost equal magnitude to the spring peak while in 1991, there is a peak in December which is significantly greater than the spring peak whose magnitude is about 20 percent less than the normal spring peak (see magnitude of spring peaks in 1988, 1989, and 1990). We suspect the reduction in the 1991 spring peak is the result of the 2 days per week irrigation restrictions imposed by the District. In both 1989 and 1990, the fall/winter peak is a minor peak compared to the spring peak. In 1992, there is a return to the normal (in terms of magnitude) spring peak. In summary, it appears from analyzing the total pumpage data, that there is a major peak in the spring and a minor peak in the fall/winter. As a consequence, those utilities that adopt seasonal rates should assess the peak seasonal quantity charge during the 4-month period, February through May. It is this peak that dictates the capacity of the system and the magnitude of the capacity related fixed costs.

2. In addition to analyzing total Districtwide pumpage data, we also analyzed the pumpage data for some individual utilities. This pumpage data, together with net irrigation requirements (NIR) and the level of irrigation restrictions for the particular utility, are presented in Figures D-6 through D-16. Some of the individual utilities were selected because of their historical population increases in late fall/early winter (Venice, Winter Haven, and Lakeland). The purpose of analyzing the pumpage data for these individual utilities was to determine the relationship between the two peaks and the NIR weather variable. That is, we wanted to determine if the fall/winter minor peak was also, at least partially, related to weather or due solely to the arrival of part-time residents/tourists.

The NIR is defined as evapotranspiration (ET) less effective precipitation (EP). Therefore, the NIR in month t is defined as:

$$(NIR)_t = ET_t - EP_t$$

and represents the average amount of water required to prevent stress on turf grass.

Effective precipitation, the precipitation that directly offsets ET requirements, is estimated using a widely used equation by the USDA[1] as follows:

$$EP_t = [1.25*(RAIN_t*25.4)^{0.824} - 2.93] * [10^{0.000955*(ET_t*25.4)}]/25.4$$

where:

EP_t	=	*effective precipitation in month t (inches)*
$RAIN_t$	=	rain in month t (inches)
ET_t	=	evapotranspiration in month t (inches)

Essentially, this equation recognizes that EP is less than rainfall. Some rain is lost as runoff or percolates into the ground past the turf grass root zone and so is not effective in offsetting ET.

In examining the plots of pumpage versus NIR in Figures D-6 through D-16, it can be seen that generally both the major spring peaks in pumpages and the minor fall/winter peak correspond to relative peaks in NIR. It is shown that there is a significant peak in NIR in late fall/early winter for almost all of the utilities analyzed, including the utilities with a significant increase in population during the fall/early winter. This indicates that even this minor peak is, at least partially, weather driven rather than totally due to any population increase.

Despite our findings, we see no problem with the District allowing utilities with a part-time population that exceeds 20 percent of the total population to either assess seasonal rates during both peak periods (that is assess a higher quantity charge during both the late spring/early summer and late fall/early winter peaks) or exempt these utilities from having to adopt seasonal rates and allow them to instead adopt another conservation promoting rate structure form that better meets their particular needs for rate equity and revenue stability.

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[1] *Evaporation and Irrigation Water Requirements*, ASCE Manuals and Reports on Engineering Practice No. 70, 1990.

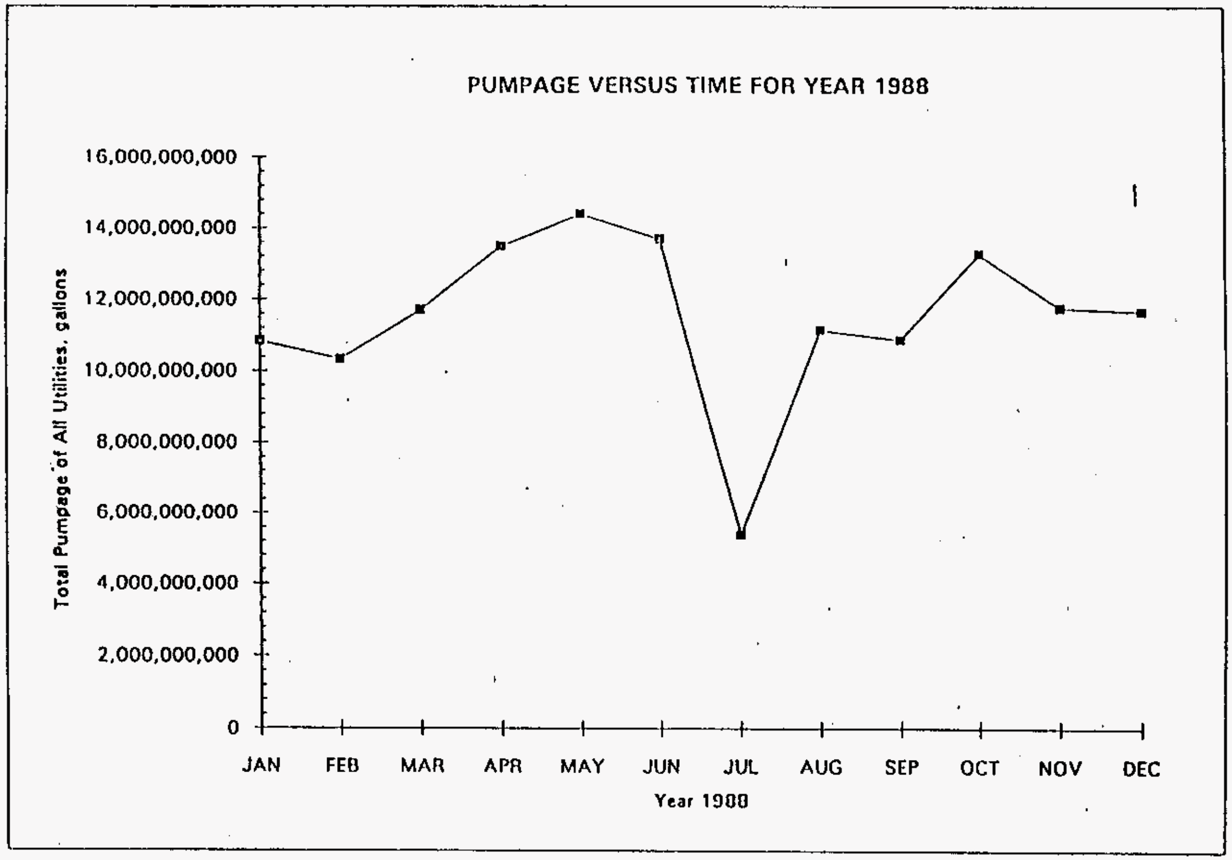

Figure D-1

EXHIBIT
PAGE OF

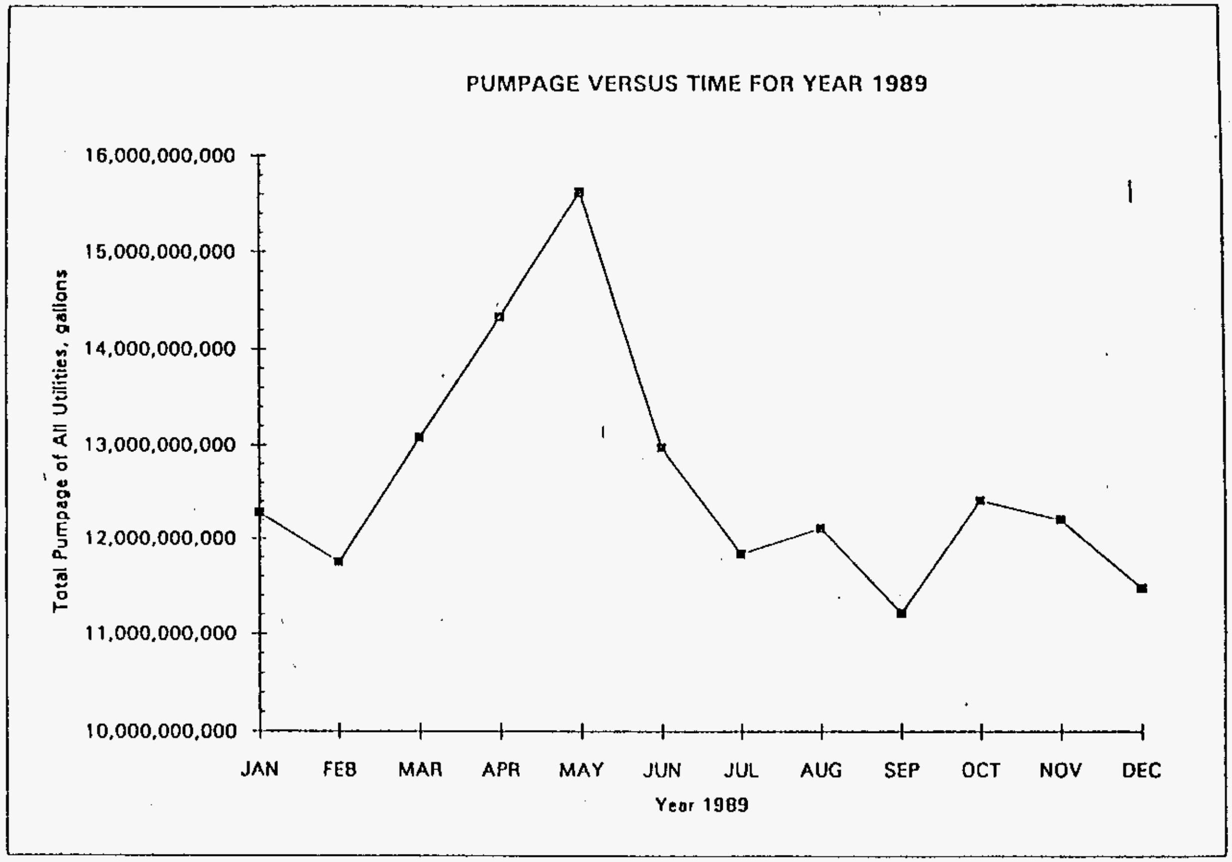

Figure D-2

EXHIBIT (JBW-2)
PAGE 77 OF 91

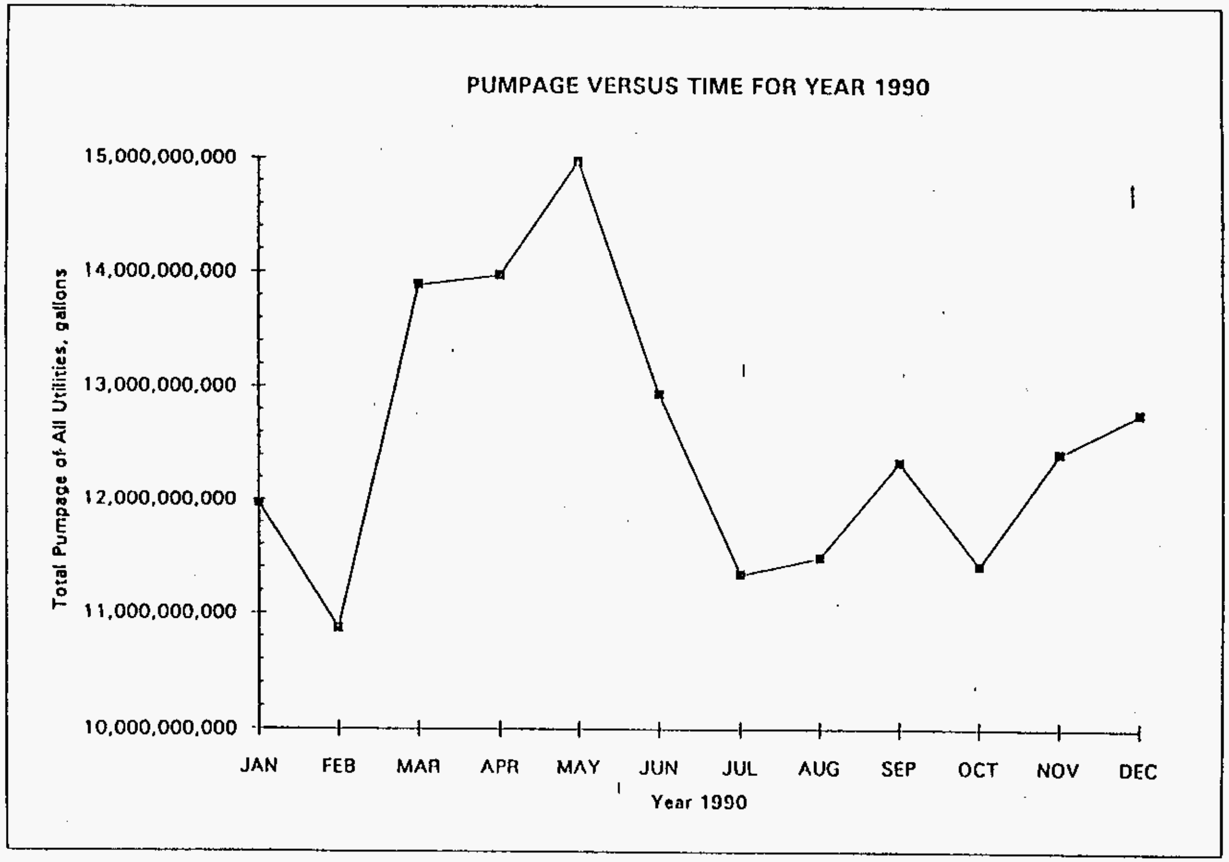

Figure D-3

EXHIBIT (JDW-2)
PAGE 78 OF 91

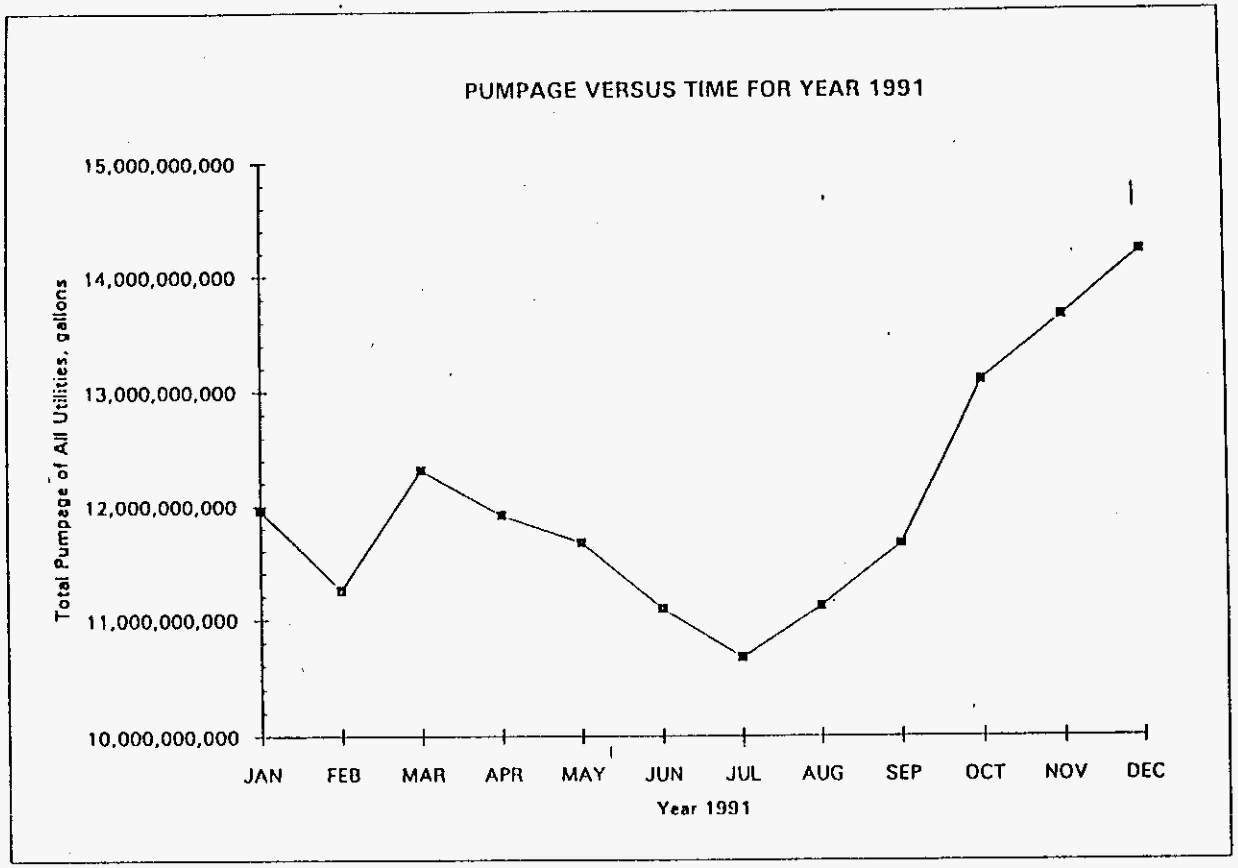

Figure D-4

EXHIBIT
PAGE 79 OF 91

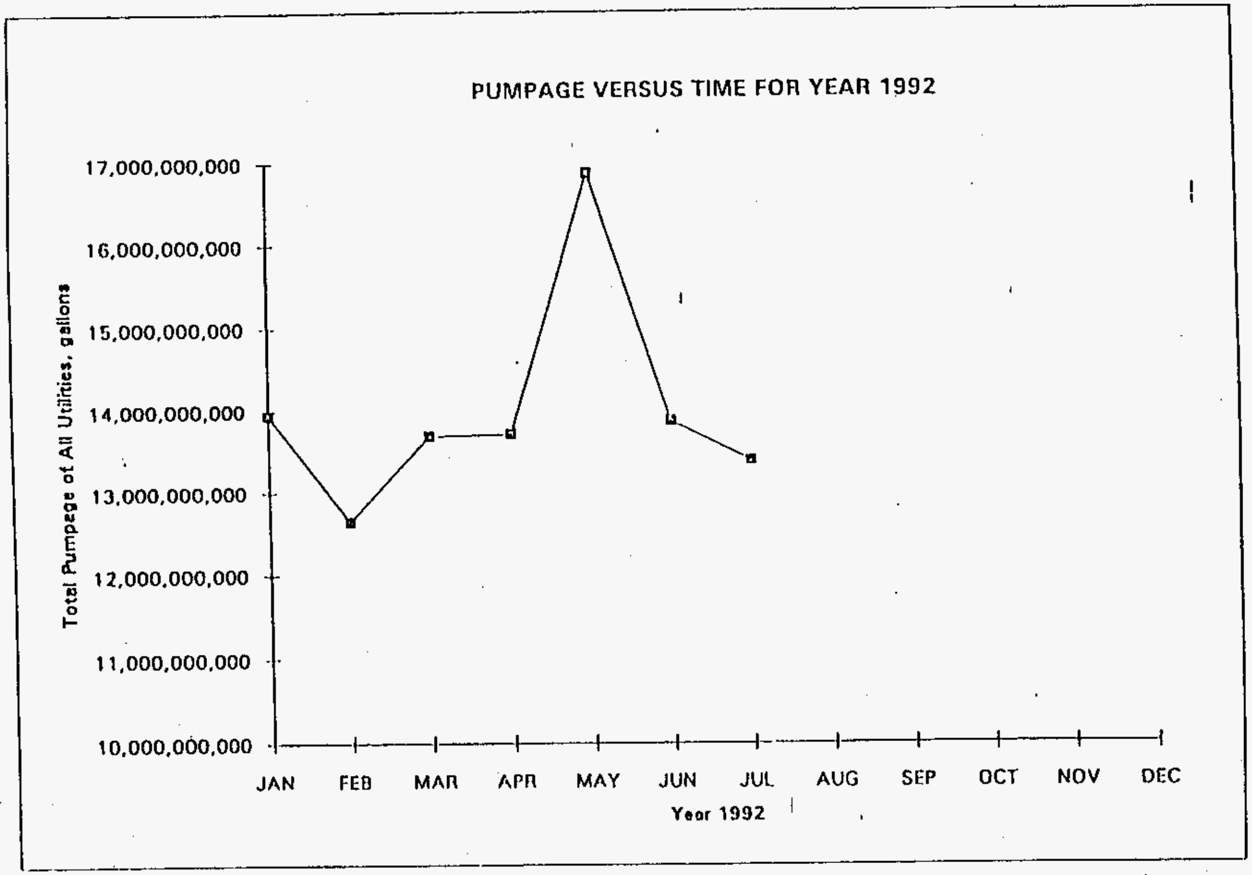

Figure D-5

EXHIBIT ____

PAGE ____ OF ____

VENICE, CITY OF

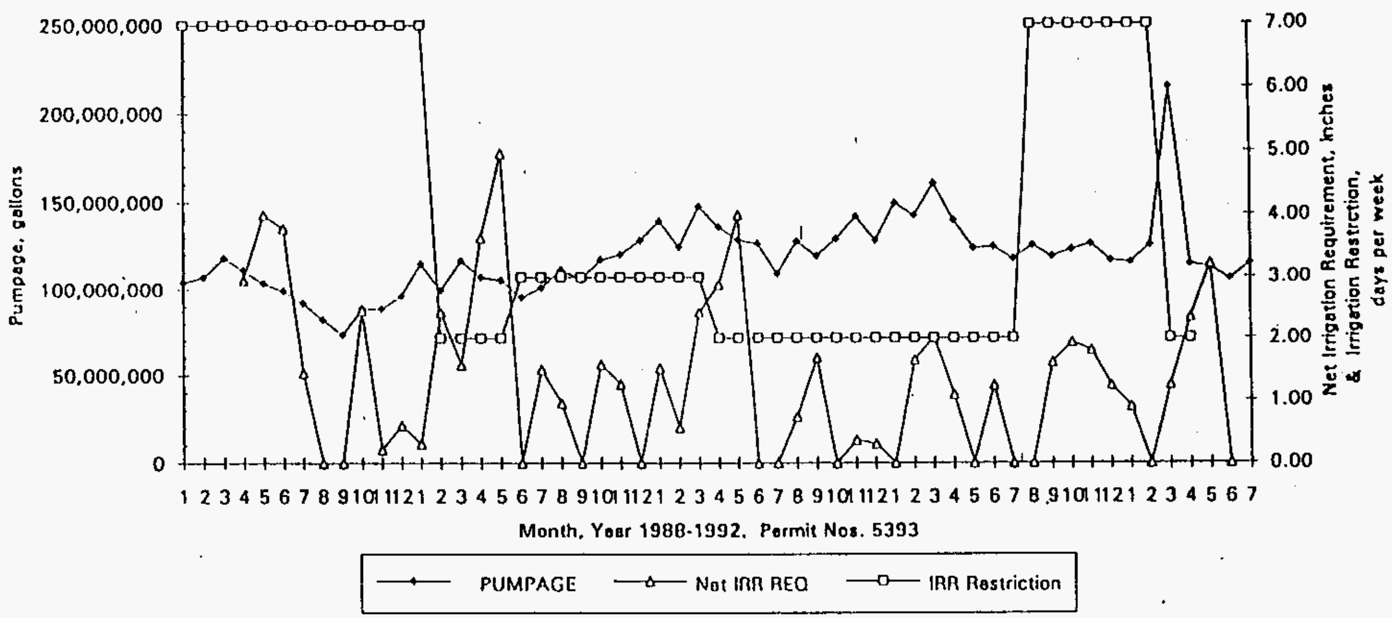

Figure D-6

EXHIBIT (JBW-2)
PAGE 81 OF 91

WINTER HAVEN, CITY OF

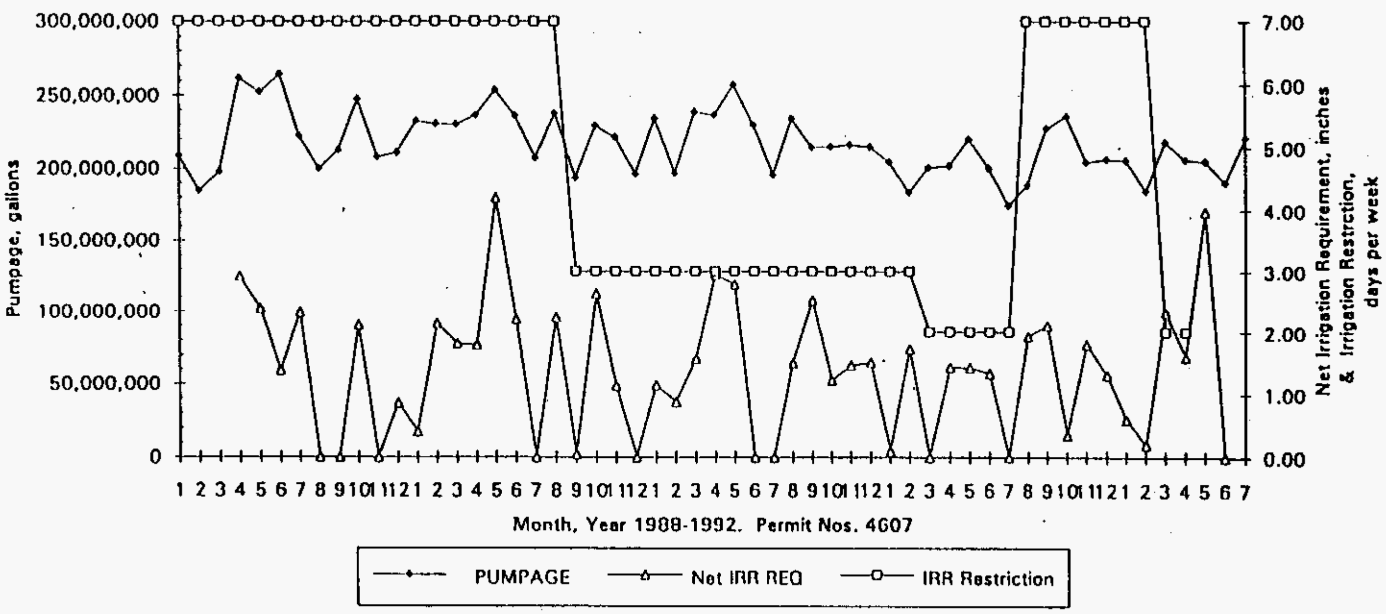

EXHIBIT ______
PAGE 82 OF 91

LAKELAND, CITY OF

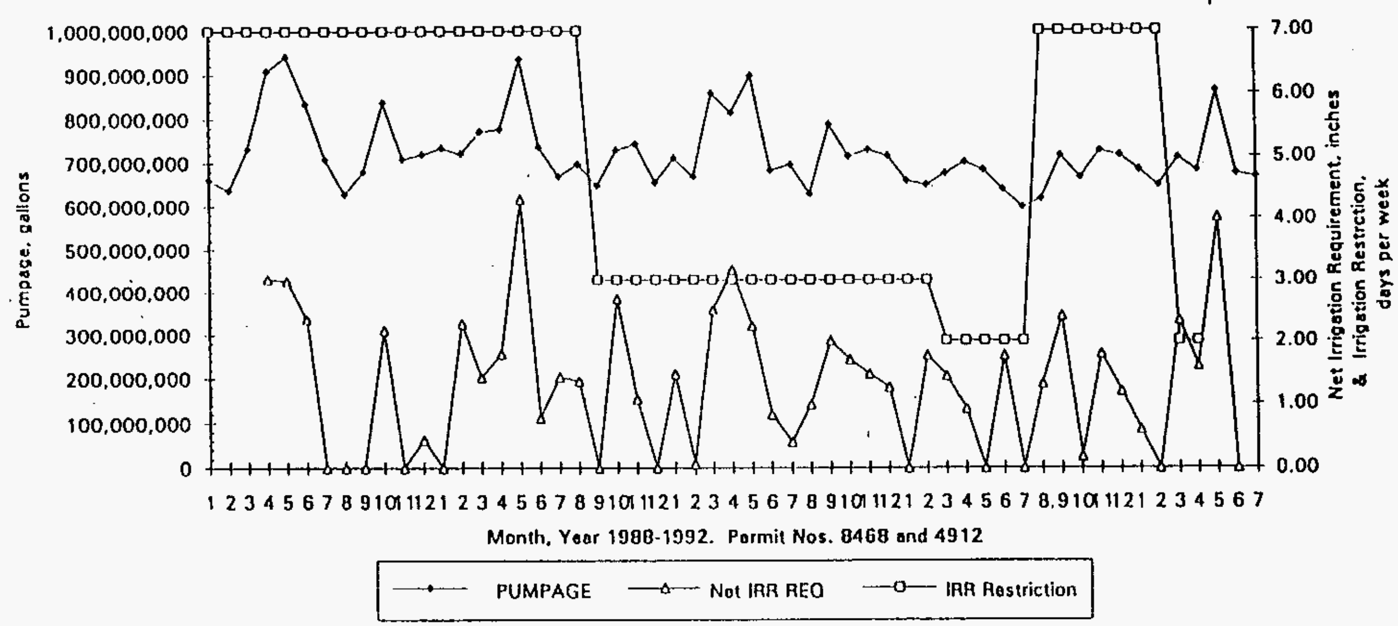

Figure D-8

EXHIBIT ______ (JBN-2)

PAGE 83 OF 91

ROYAL OAKS AT INVERNESS INC.

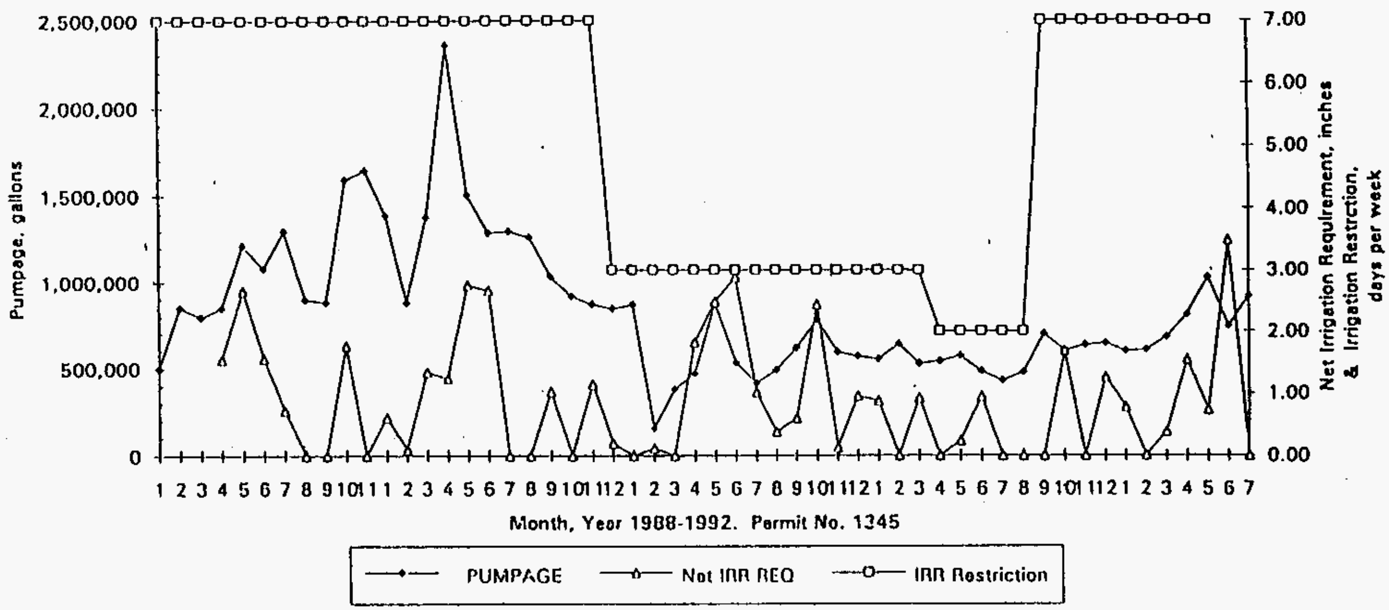

EXHIBIT (JBK-2)
PAGE 84 OF 91

INVERNESS, CITY OF

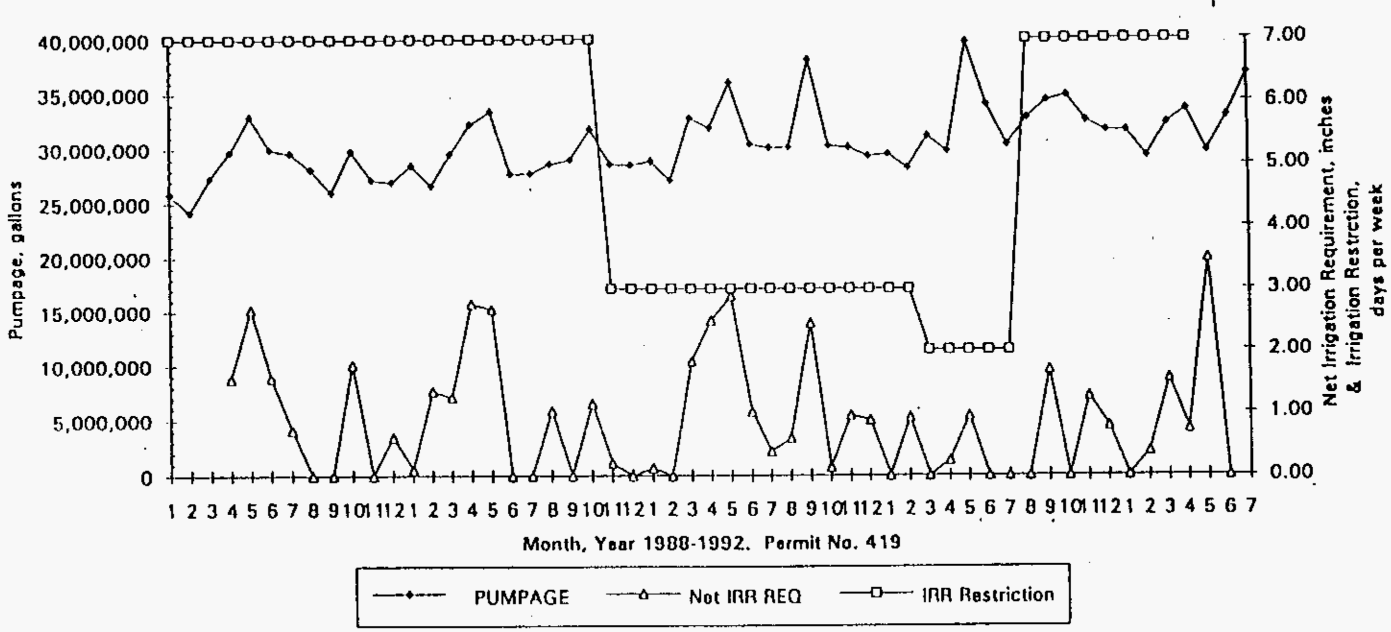

Figure D-10

EXHIBIT (PBI-2)
PAGE 85 OF 91

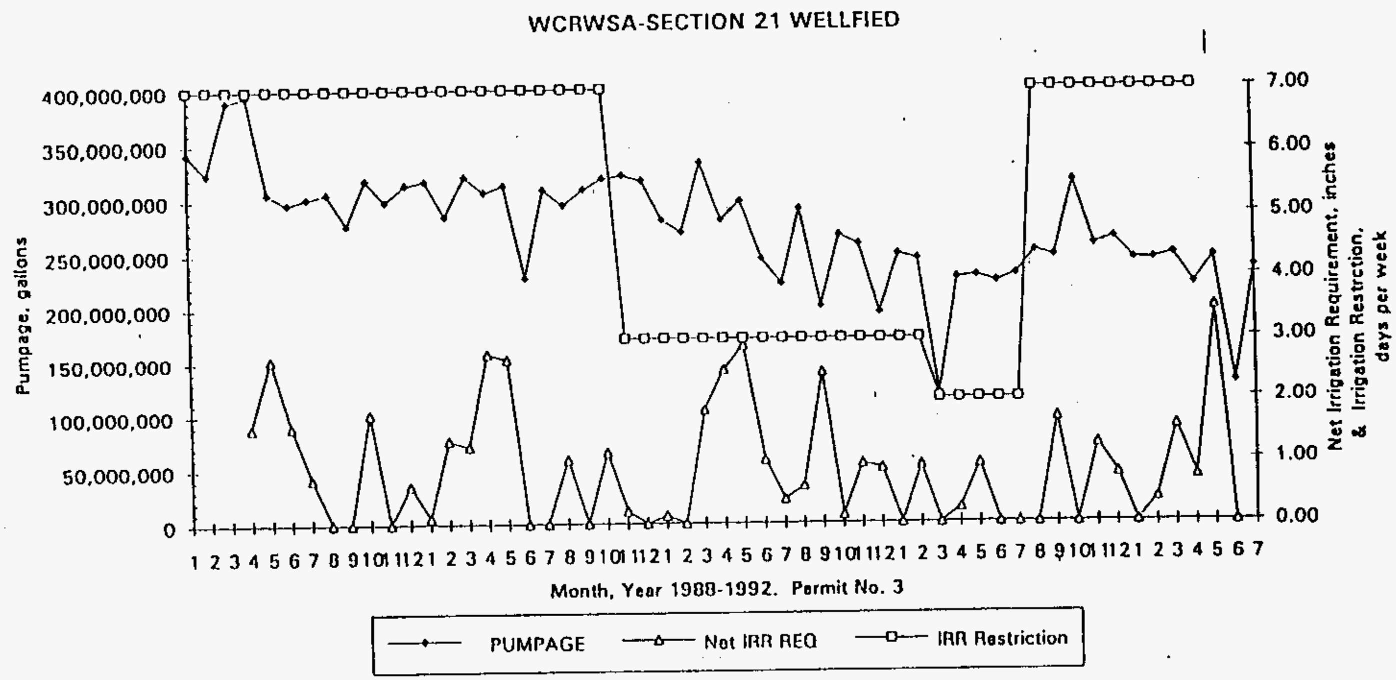

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EXHIBIT (JPC-2)
PAGE 86 OF 91

BRADENTON, CITY OF

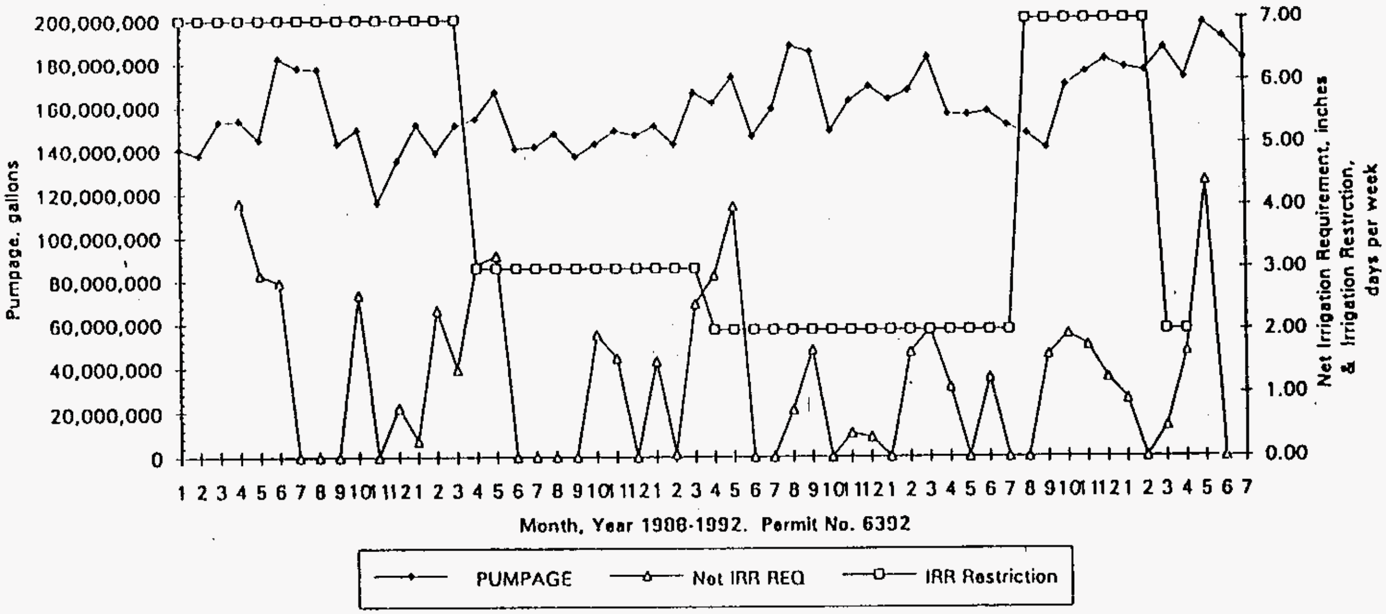

Figure D-12

EXHIBIT ______

PAGE ____ OF ____

TEMPLE TERRACE, CITY OF, DEPT.

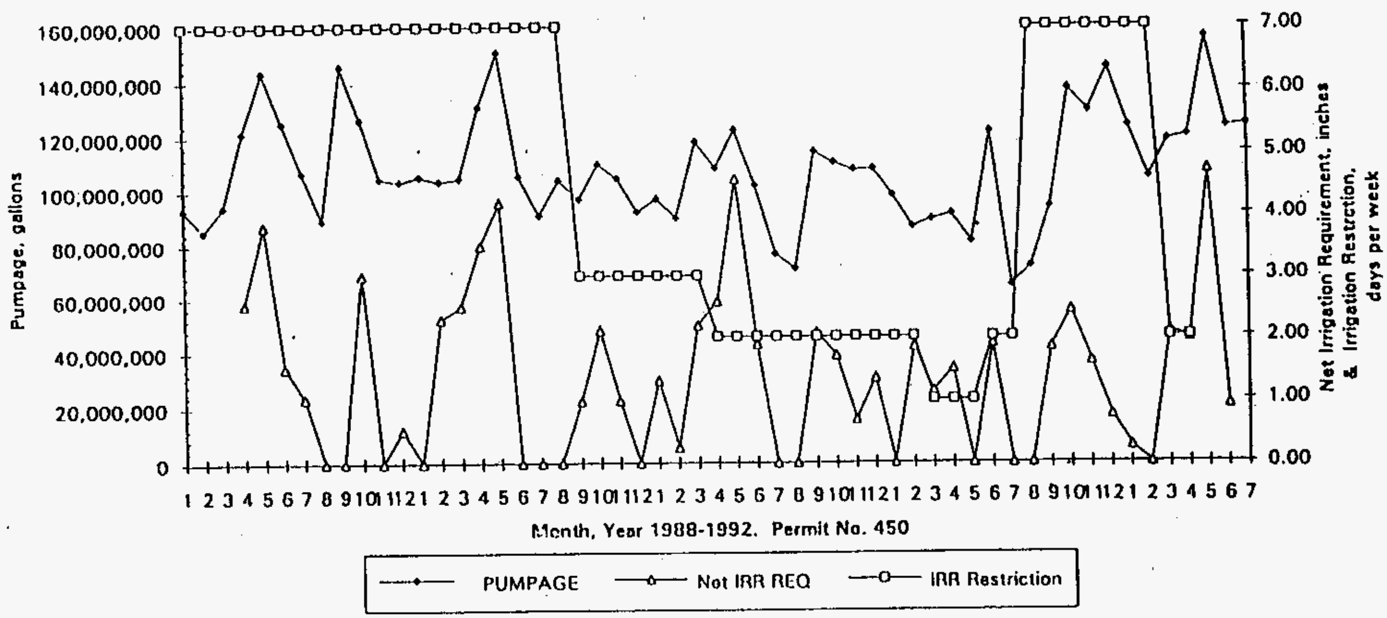

EXHIBIT ____ (JBW-2)

PAGE 88 OF 91

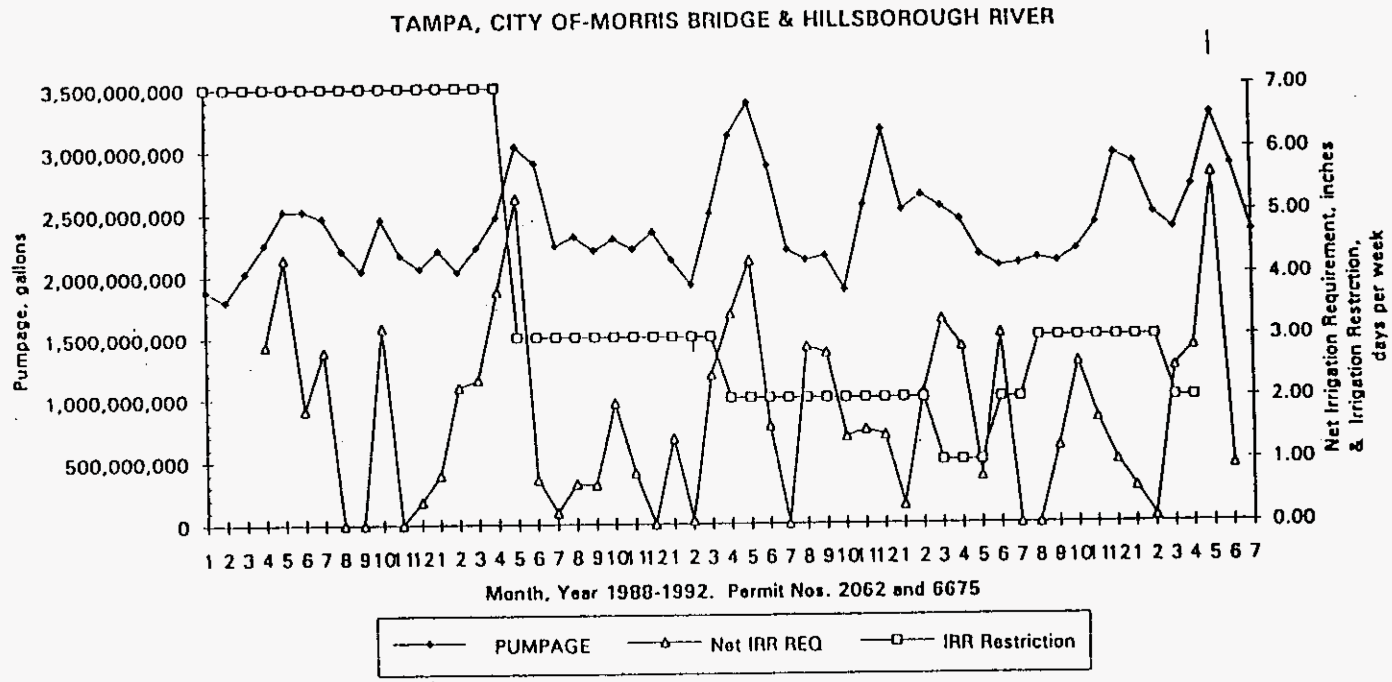

Figure D-14

EXHIBIT ____
PAGE 89 OF 91

LAKE PLACID, TOWN OF

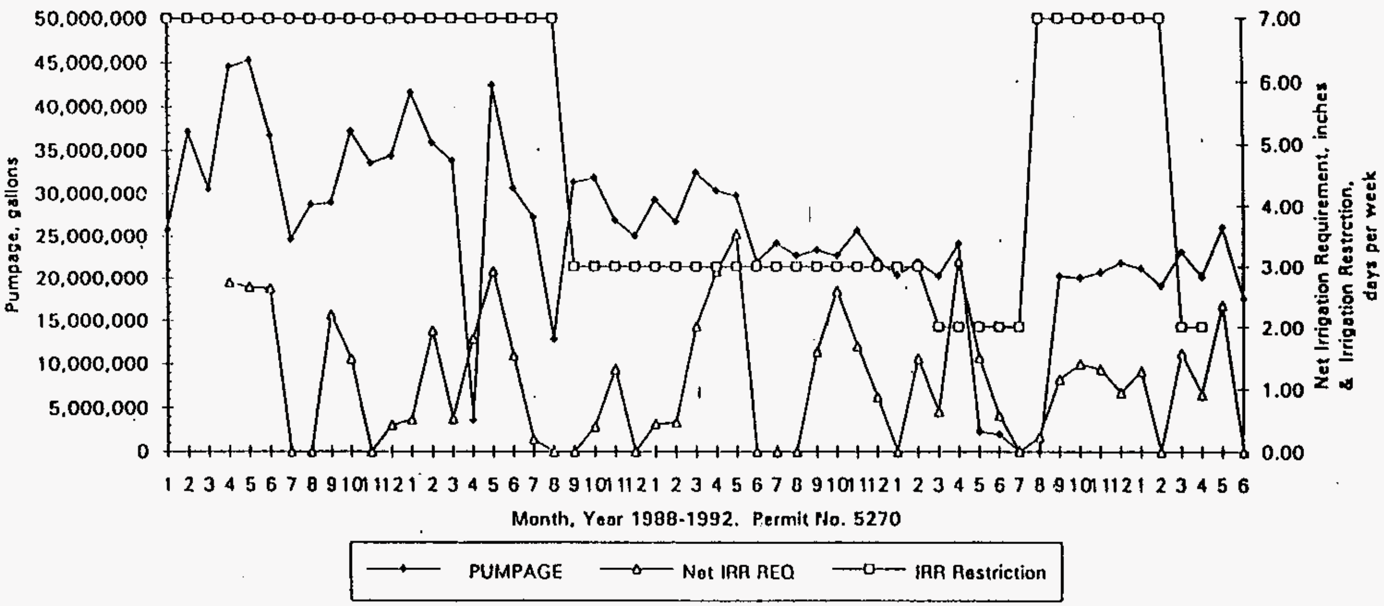

EXHIBIT (B)
PAGE 90 OF 91

LAKE PLACID HOLDING COMPANY

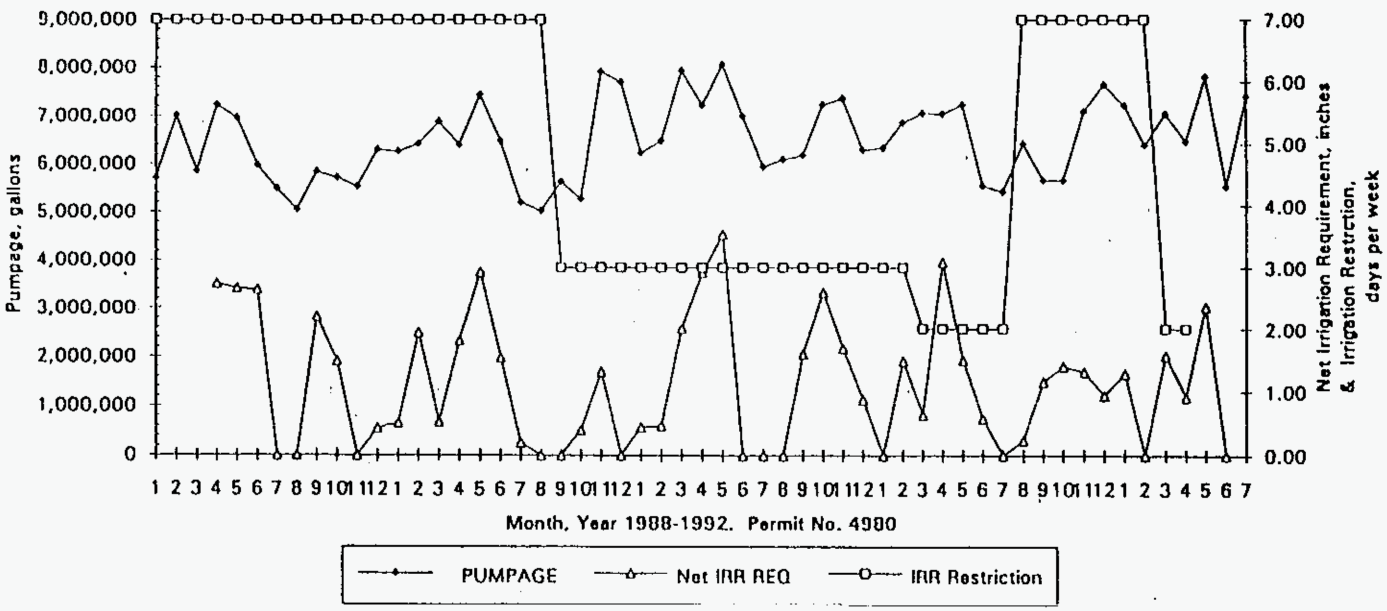

Figure D-16

EXHIBIT (JBW-2)

PAGE 91 OF 91

EXHIBIT (JBW-3)

PAGE 1 OF 153

Southwest Florida
Water Management District

WATER PRICE ELASTICITY STUDY

AUGUST 1993

PREPARED BY

BROWN AND CALDWELL

in association with John B. Whitcomb, Ph.D.

EXHIBIT (JBW-3)
PAGE 2 OF 153

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EXHIBIT (JB61-3)

PAGE 4 OF 153

Contents

CONTENTS

EXHIBIT (JBW-3)

PAGE 6 OF 153

CONTENTS (continued)

EXHIBIT (JBW-3)

PAGE 7 OF 153

LIST OF TABLES

EXHIBIT (JBW)-3)

PAGE 8 OF 153

LIST OF FIGURES

EXHIBIT (JBL-3)

PAGE 9 OF 153

EXECUTIVE SUMMARY

Increasing water demands together with limited and more expensive water supplies have increased the interest of water purveyors in the use of price to moderate demand. In order to use price to moderate water demand, it is necessary to quantitatively determine the impact of price on water demand. It is, therefore, the objective of this study to quantify the relationship between water price and water demand for customers within the Southwest Florida Water Management District (SWFWMD) service area. This is accomplished by determining the price elasticity of water demand for various classes of customers. Price elasticity measures the percentage change in demand resulting from a 1 percent change in price all other factors held constant. The results of this study are integrated into a computer rate model that can assist utilities within the SWFWMD in assessing the impacts on both water use and revenue resulting from adoption of alternative rate structures.

Research Design

In order to determine the relationship between water price and water demand, it is necessary to develop a research methodology. This includes determining: (1) what water utilities to include in the study, (2) what specific customer classes to analyze, and (3) what statistical approach to use to measure the impacts of price.

Utility Selection. SWFWMD staff and Brown and Caldwell jointly selected ten utilities to participate in the study. A number of criteria were used in the selection process. Because the objective of this study is to estimate price elasticity, the most important criterion was to obtain utilities with different water prices: A diverse and wide ranging set of water prices increases our ability to discern the influence of water price. Also sought were utilities from different regions of the SWFWMD service area, those interested and capable of providing water use data, some with shallow groundwater levels, some overlying deep sand soils, and at least one private utility. Based on these criteria, the utilities listed in Table ES-1 were selected for inclusion in the study.

Customer Disaggregation. Because water price affects different customers in different ways, we studied specific classes of water users. Single family homes are by far the largest class of customers within the SWFWMD service area comprising over two-thirds of the total number of customers and about one-half of the total water use. As a consequence, we spent a major portion of our effort estimating the price response for this customer class.

Table ES-1 Participating Utilities

No.	Utility	County	1990 population	Private utility
1.	City of Bradenton	Manatee	44,303	No
2	Hillsborough County	Hillsborough	130,149	No
3	City of Lakeland	Polk	118,507	No
4	City of Lake Placid	Highlands	4,410	No
5	Manatee County	Manatee	190,240	No
6	City of St. Petersburg	Pinellas	282,392	No
7	Spring Hill Utilities	Hernando	52,187	Yes
8	City of Tampa	Hillsborough	468,458	No
9	City of Venice	Sarasota	18,079	No
10	City of Winter Haven	Polk	30,011	No

We also analyzed water use for ten other customer classes. We selected classes that we believe to be relatively common within the SWFWMD service area and would, therefore, represent a significant amount of the nonsingle-family water use within each utility and within the District. Consideration was also given to selecting classes that would serve as good indicators for other similar types of customers based on our professional judgment. The classes selected are listed in Table ES-2.

Table ES-2 Other Customer Classes

No.	Description	SIC code
1	Apartments	
2	Car washers	7542
3	Hospitals	806
4	Hotels/Motels	701
5	Laundromats	721
6	Nursing Homes	805
7	Office Buildings	81
8	Restaurants	5812
9	Schools (Elementary)	821
10	Universities and Colleges	822

Statistical Approach. To measure the impact of water price on water use, water use models (regression equations) are developed. On the left hand side of such an equation is water use. On the right side are coefficients (ß), explanatory variables (*X*), and a residual term.

$$WATER = f(\beta, X)$$

Regression analysis estimates the coefficients that best explain water use given the explanatory variables. Generally, this is done by finding the set of coefficients that minimize the variance (least squares) of the residual term. From this approach, we can estimate the impact of water price while controlling for other identified influences.

The modeling process consists of three major steps: identification, estimation, and verification. The identification stage concerns selection of the explanatory variables and the functional form of the model. This stage requires a mix of reasoning and experimenting. Based on reasoning, we first identify likely explanatory variables. For example, we obviously expect outdoor irrigation to increase with hot, dry weather and decrease with cool, wet weather. Hence, our models include weather variables. In addition, it is obvious that outdoor irrigation will increase with irrigable area and indoor use with number of occupants. In some cases, however, it is not clear which of among several alternative explanatory variables is most appropriate. For example, as discussed in Chapter 2, we have different hypotheses regarding customer reaction to stepwise changes in marginal price when block rates exist. We experiment to see which price specification works best.

Regarding the functional form of the models, we allow for a flexible functional form that can capture both nonlinear relationships and interactions among variables. In the past, linear water use models have been popular because their estimation is computationally easy. Advances in computer hardware and software, however, have made it increasingly possible for researchers to specify nonlinear models allowing for a more detailed mapping of the demand curve.

Data Collection

The data used in this study came from a variety of sources. The data common to all customer classes includes water and sewer prices, water use, weather and soils, irrigation restrictions, and groundwater depth. Data specific to single family residential customers (number of persons in home, lot size, property value, presence of a pool, type of irrigation system, household income, presence of an irrigation well, and presence of different water fixtures) came from 1990 U. S. Census information, county tax records and/or the results of a telephone survey. Data specific to the other customer classes came from a mail survey.

Results for Single-Family Homes

We used regression analysis, based on pooled cross-sectional time-series data, to determine the functional relationship between water use and a set of explanatory variables including price as discussed in Chapter 5. The analysis incorporates water use, water and sewer price, weather, irrigation restrictions, well depth, data from county tax assessors records, and telephone survey data for 1,200 homes. Various combinations of explanatory variables together with both linear and percentage adjustment model forms were considered. Completion of the identification, estimation, and verification stages of the modeling process led to estimates of three demand functions. Demand curves for low, medium, and high tax assessor property values are shown in Figure ES-1. The curves are negatively sloped, nonlinear, and show water use increases with higher property values, especially at lower prices.

Figure ES-2 plots price elasticity, which ranges between -0.01 and -0.57, by price level and property value. A number of observations can be made. First, at prices over $1.50, higher property value customers are more price elastic. At a price of $3.00, for example, price elasticity for low, medium and high property value homes is -0.25, -0.43, and -0.57 respectively. Perhaps this results because high value homes, which use significantly more water, have more discretionary water use (irrigation) from which they can cut back. Another explanation is that wealthy customers have greater ability to purchase water efficient devices (e.g., low volume toilets) and access source substitutes (e.g., irrigation wells). Hence, they have more options to reduce their water use in response to a rate hike. At prices below $1.50, price elasticities are similar among the different wealth groups.

Another observation concerns the shape of the elasticity curves. For low value homes, price elasticity increases with price until $1.50. At this point, these customers are most active in reducing discretionary uses and making the simple adjustments needed to use water more efficiently. With further price increases, however, water savings become progressively harder to achieve and price elasticity heads steadily towards zero. Customers find their utility derived from remaining water use is high (e.g. water for cooking and bathroom uses), and hence are less willing to make further water cuts in response to price increases. For medium and high value homes, the same pattern exists but the inflection points where customers are most sensitive to price occur around $2.50 and $3.00 respectively. Therefore, it takes higher prices before wealthier customers react most aggressively in reducing water consumption. When they do, however, they do decrease it at a much faster rate than lower property value customers. By the time price increases to $6, there is little difference in water use based on property value.

FIGURE ES-1. SINGLE-FAMILY DEMAND CURVES

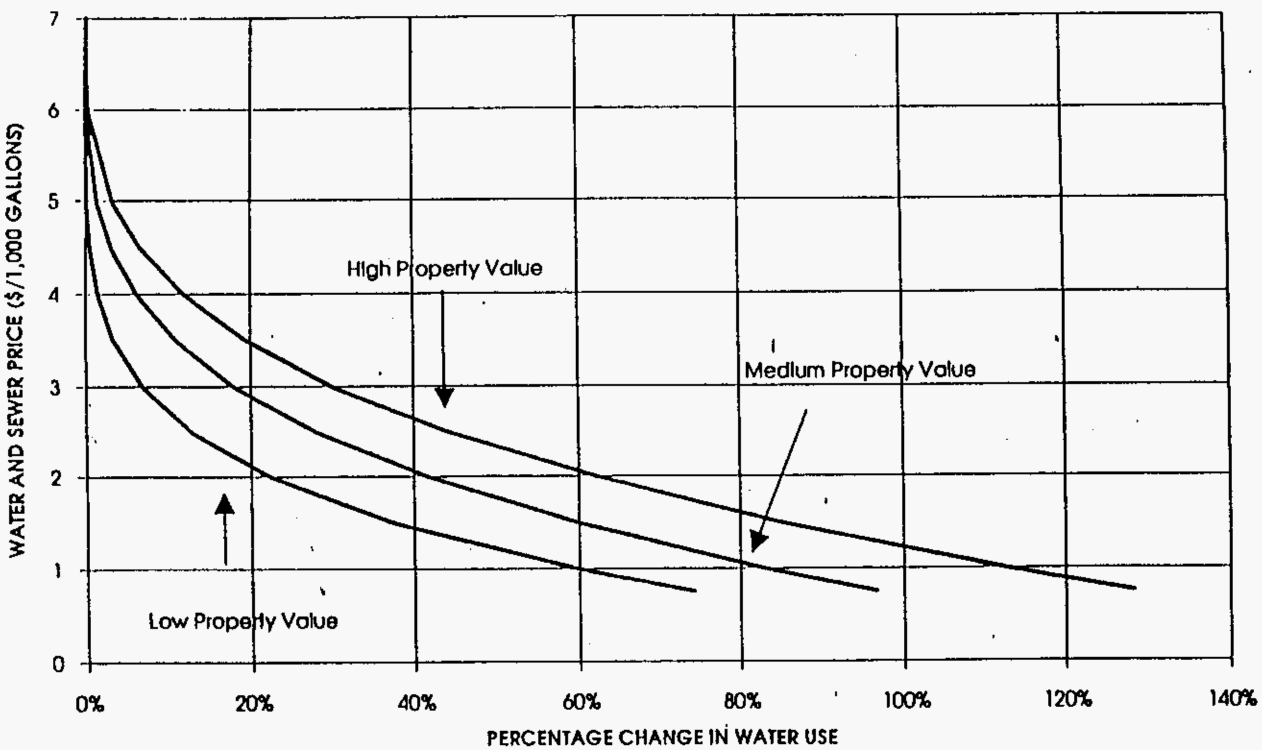

EXHIBIT ____ (JBK-3)
PAGE 13 OF 153

FIGURE ES-2. SINGLE-FAMILY PRICE ELASTICITY CURVES

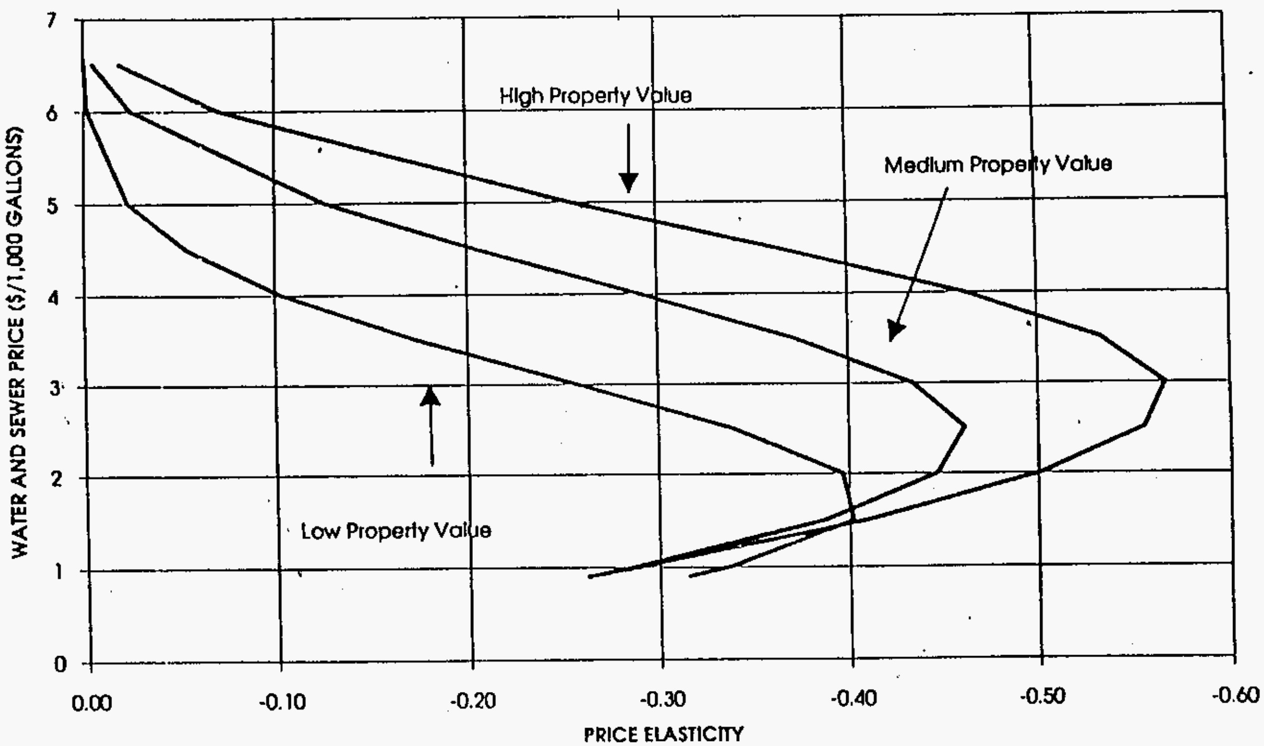

EXHIBIT (4B)-3)

PAGE 14 OF 153

Results for Commercial Customers

For the 10 commercial customer classes, we also develop regression models based on pooled cross-sectional time-series data to estimate the functional relationship between water use and water price while also controlling for other factors affecting water use. Other factors include weather, irrigation restrictions, availability of groundwater, and customer-specific data from mail surveys. To account for seasonal differences in water use among customers, the nonsingle-family models also include a seasonal business variable based on information elicited through the mail surveys.

Chapter 6 describes our investigation of price elasticity for the 10 commercial customer classes (apartments, car washes, hospitals, hotels/motels, laundromats, nursing homes, office buildings, restaurants, elementary schools, and universities and colleges). The apartment class is by far the largest nonsingle-family user class both in terms of number of customers and water use. Based on 1990 U.S. Census records, approximately 44 percent of dwelling units in the SWFWMD service area are in multiple unit complexes. In this study, we denote apartments as commercial (apartment owner's perspective) although, of course, they are residential.

A major finding of the nonsingle-family analysis is that apartments, which are the second biggest users of water within the SWFWMD service area, are very price inelastic. Water use per dwelling unit is relatively consistent among utilities irrespective of price. We do find, on the other hand, that car washes, hotels/motels, laundromats, office buildings, restaurants, and elementary schools respond, to a limited degree, to price. Price elasticities range from -0.14 to -0.71 as shown in Table ES-3. Analyses on hospitals and nursing homes did detect a negative price elasticity. The sample size for universities proved too small to make any inferences about price elasticity.

Table ES-3 Summary Results for Commercial Customers

Class	Total monthly observations (N)	Accounts	Unit factor	*Mean water use* gal/day/unit	*Mean marginal price* $/1,000 gals	Price elasticity at means	Model R2
Apartments	4,807	174	Apartments	107	3.01	0	0.64
Car wash	514	17	None	4,672	2.74	-0.70	0.17
Hospitals	671	22	Beds	96	3.05	0	0.04
Hotels/motels	3,525	113	Rooms	145	2.51	-0.48	0.43
Laundromats	1,511	58	Washers	172	2.97	-0.14	0.06
Nursing homes	1,983	54	Rooms	96	2.67	0	0.54
Office buildings	3,763	116	1,000 ft²	92	3.00	-0.33	0.29
Restaurants	3,274	122	Seats	29	3.10	-0.28	0.19
Schools (elementary)	2,497	67	Students	6.0	3.33	-0.25	0.32
Universities	287	9	Students	13.6	2.05	Indeterminate	0.001
Total	22,832	752					

Chapter 1
Introduction

CHAPTER 1

INTRODUCTION

This is an empirical study designed to determine the relationship between water price and water use for certain categories of customers within the Southwest Florida Water Management District (SWFWMD) service area. Increasing water demands together with limited and more expensive water supplies have increased the interest of water purveyors in the use of price to moderate demand. The results of this study are integrated into a computer rate model that can assist utilities within the SWFWMD service area to assess the impacts on water use and revenues resulting from adoption of alternative rate structures.

The results of previous research provide some guidance on expected price elasticities.[1] Estimates, however, differ widely. The differences in price elasticities among the various empirical studies are commonly attributed to differences in such factors as modeling approach, types of customers, climate, and price level. Unfortunately, the lack of consensus on the level of price elasticities leaves policy makers with a range that is so large that they offer water purveyors little useful information on expected water use changes with respect to price. For a utility that is changing its rate structure, the difference between assuming an elasticity of -0.2 as compared to an elasticity of -0.6 can have a dramatic impact on revenues. This uncertainty tends to discourage the use of price as a management tool. The purpose of this study is to more precisely identify price elasticities as a function of price level and other nonprice variables for customers in the SWFWMD service area so to reduce this uncertainty.

A major challenge in conducting this study is to control for impacts of nonprice factors on water use. Figure 1-1 plots mean water use against mean marginal water price (including sewer charges when appropriate) for a sample of single-family homes from 10 different water utilities within the SWFWMD service area. The sample of homes is described in detail in Chapter 4. The line that best fits the data (minimizes the square of the vertical deviations) clearly shows that as water price increases water use decreases. Because water use is influenced by a variety of factors, however, one needs to beware of assuming a strict causal relationship. Differences in water use among utilities may, in part, be caused from differences in other factors such as weather, irrigation restrictions, average lot size or wealth. For example, the homes in the City of Bradenton have relatively low average lot size (8,312 ft^2), while homes in Hillsborough have the highest average lot size (15,529 ft^2). Given that water use increases with lot size, these observations partially explain why single-family residential water use within the City of Bradenton lies below the demand curve while single-family residential water use in Hillsborough lies above the demand curve. This point illustrates the need for a complete analysis

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[1]A survey of water price elasticity studies conducted prior to 1984 can be found in Boland, J. J., B. Dziegielewski, D. D. Baumann, and E. M. Opitz, *Influence of Price and Rate Structures on Municipal and Industrial Water Use*, U. S. Army Crops of Engineers Contract Report 84-C-2, June 1984.

of water use with respect to all factors. Much of the effort in this study goes towards accounting for nonprice factors. This controlling for exogenous factors increases the precision and reliability of our knowledge of the response of water use to price.

Another major challenge in conducting this study is developing a price specification. In many cases, it is not clear what exact "price signal" is being received by customers. The price to which customers respond becomes ambiguous when customers are charged different prices for water and sewer service depending on how much water they use in a specific billing period. Chapter 2 addresses this issue and presents alternative price specifications which are then used in the water use models.

Chapter 3 presents a description of the research design. The water use from customers within ten different SWFWMD water utilities is analyzed. Although a number of criteria are used in selecting which utilities to include, the primary aim is to include utilities representing a wide range of water prices. Utilities included in the study are from the City of Bradenton, Hillsborough County, City of Lakeland, City of Lake Placid, Manatee County, City of St. Petersburg, Spring Hill Utilities, City of Tampa, City of Venice, and the City of Winter Haven. Because price can have a different impact on different types of customers, we disaggregate customers with similar water use characteristics into different classes. The impact of price on water use for single-family homes and 10 other distinct user classes is analyzed.

Chapter 4 defines and summarizes the wide variety of data used in our analysis. Some data come from existing sources such as weather data from the National Oceanic and Atmospheric Administration (NOAA). Other data are generated solely for the purpose of this study from telephone and mail surveys.

Single-family homes are the most common users within the SWFWMD. They account for over three quarters of municipal customers and one-half of municipal water use.[2] Therefore, a majority of our effort is spent in estimating price elasticity for single-family homes. The results of this portion of the study is presented in Chapter 5. The analysis of the impact of price on water use for ten other customer classes including apartments, car washes, colleges and universities, elementary schools, hospitals, laundries, hotels/motels, nursing homes, office buildings, and restaurants is documented in Chapter 6.

Chapter 7 presents the results of an analysis of aggregate water use for the City of Winter Haven in order to determine the price elasticity of aggregate demand. The empirically determined price elasticity of aggregate demand is compared to the aggregate price elasticity calculated by multiplying the price elasticities for the various customer classes, as determined in our micro analysis, by the weighted average water usage by each customer class to determine if the results are consistent.

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[2]Based on detailed records from Tampa and Winter Haven.

FIGURE 1-1. SINGLE-FAMILY HOME MEAN WATER USE AND MARGINAL PRICE

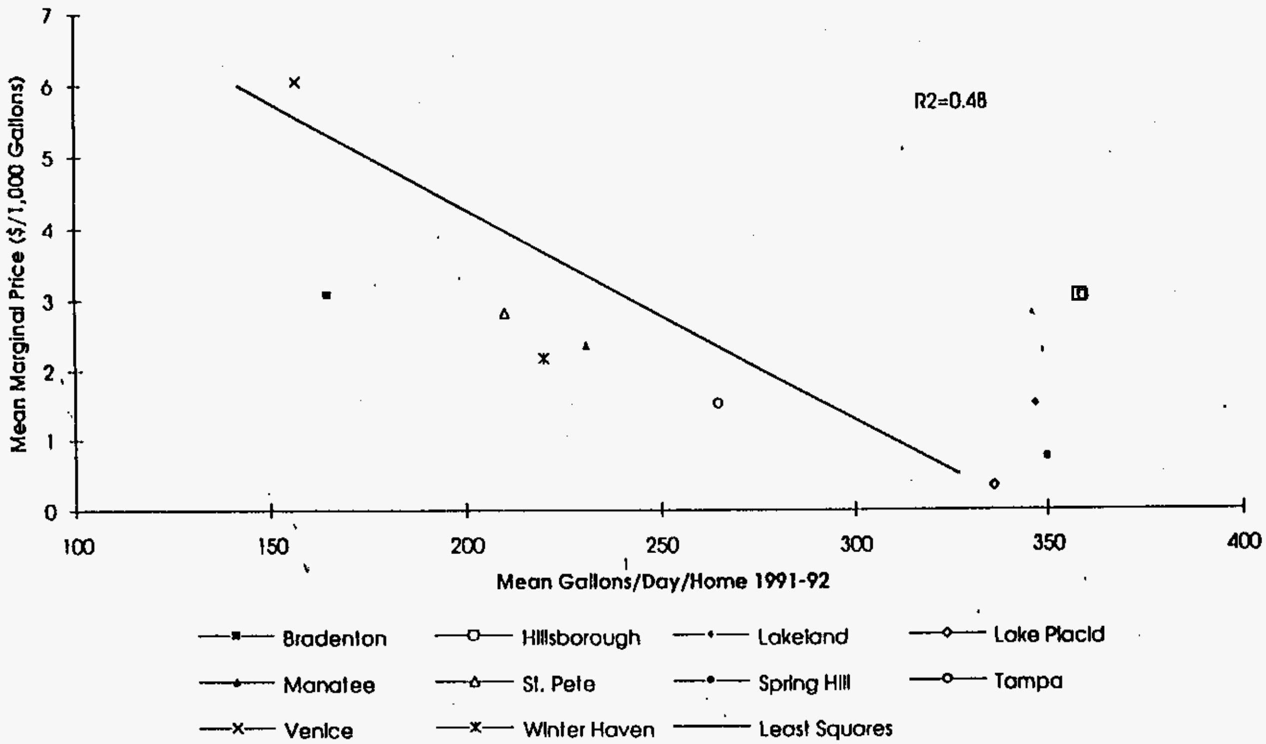

EXHIBIT (JBW-3)
PAGE 20 OF 153

Chapter 2
Price Theory

CHAPTER 2

PRICE THEORY

The first law of demand in economic theory is that as the price of a commodity increases the quantity demanded decreases. Empirical research has consistently shown this relationship to be true for water. Although the direction of the relationship is well understood, the precise relationship between water price and demand is not. In some cases, changes in water price have little impact on water use; while in other cases, water use is very sensitive to price.

This chapter reviews issues that are central to estimating the relationship between water price and water use. The first section sets out our objective of mapping out the demand curve and defines price elasticity. Subsequently, we discuss the second law of demand—price elasticity is greater in the long run than short run. Third, some of the utilities included in our investigation employ a block rate pricing structure and thus we must hypothesize as to what price signal customers are responding. We hypothesize that the customers' perception of block rates may be more accurately captured in our models by using "ramped" rates instead of block rates. Lastly, we address two estimation problems that arise when analyzing the price impact of block rates relating to income effects and simultaneity bias.

Demand Curves

A demand curve expresses the functional relationship between water price and water use. Such a curve, with water price on the vertical axis and water use on the horizontal axis, is shown on Figure 1-1. A distinctive property of a demand curve is that it is negatively sloped, that is, as water price increases, water use decreases.

Economists commonly use the term "price elasticity" when referring to the relationship between water use and water price. Price elasticity measures the percentage change in quantity demanded resulting from a one percent change in price, all other factors held constant.[1] That is, price elasticity, denoted as η, is defined as:

$$\eta = \frac{Percentage\ Change\ in\ Water\ Use}{1\ \ Percent\ Change\ in\ Price}$$

For example, if a water price increase of 1 percent lead to a 0.2 percent reduction in water use, price elasticity would be -0.2.

[1]Using calculus, price elasticity at a given point on the demand curve equals $\partial Q/\partial P * P/Q$.

Although price elasticity estimates are negative, as a result of negatively sloped demand curves, price elasticity can vary as a result of various factors. The type of customer class is one such factor. As discussed in Chapter 3, we analyze the impact of price on the water use of single-family homes and 10 other user classes, each of which may have differently shaped demand curves. Price level is another factor. Price elasticity at high water price levels (e.g., $6/1,000 gallons) can be dramatically different than at low price levels (e.g., $1/1,000 gallons). To accommodate for this possibility, we allow the water demand curves to take on a flexible functional form. Demand curves are not necessarily, for example, restricted to being linear. In addition, for single-family customers, price elasticity is measured as a function of different property values. Wealthy people may behave differently to a price increase than nonwealthy people. Using this level of detail helps us better customize our prediction of the price responsiveness of users within a particular Southwest Florida Water Management District (SWFWMD) utility in the computer rate model.

We are restricted to estimating that portion of the demand curve between the prices charged by utilities in our study, ranging from $0.40 to $7.05/1,000 gallons. Fortunately, this is a relatively wide range, and should cover most of the prices faced by customers within the SWFWMD service area. Theoretically, the demand curve intersects both axes. At some exceedingly high water price (e.g., $100/1,000 gallons), customers would choose not to purchase any water from a water utility. Customers would obtain water from wells, private suppliers (e.g. bottled), or other external sources. At the other extreme, a zero price would lead to a surge in water use.[2] Little attention is given to these extreme cases, however, because of their minimal practical value. Water managers are most often concerned with the slope of the demand curve in the vicinity of current prices.

When a customer's sewer bill is linked directly to water consumption (i.e., not a flat rate), both water and sewer charges contribute to the overall price signal sent to customers.[3] This is the case for all customers receiving sewer service in this study. For single-family customers, however, it is common to have a limit on how much water is assessed the quantity or commodity portion of the sewer bill. Typically, the sewer cap is set at about 10,000 gallons/month/home. Utilities expect that water use above the cap is for outdoor purposes and, therefore, is not returned to the sewer system and should not be considered in computing the sewer bill.

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[2]Lake Placid charges a zero price for the first 5,000 gallons/month. Because this threshold is commonly exceeded, however, we can not accurately predict what would happen to water use if all water was charged at a zero price (i.e., flat rate). Therefore, we list the next lowest price of $0.40/1,000 gallons as the lower bound.

[3]Throughout this report, reference to water price pertains to the combination of water and applicable sewer prices.

Short-Run and Long-Run Elasticity

The second law of demand concerns short- versus long-run response to price. Changes in water use result from a combination of behavioral changes (e.g., not letting the water run while brushing teeth) and structural changes (e.g., converting landscape from turf grass to xeriscape). In the short-run, customers can affect behavioral changes but are limited in their ability to alter capital investments in outdoor landscaping and water using appliances and fixtures. Once a customer makes a water related investment it becomes a sunk cost. It may take a long time before that investment needs replacing. It may take an extreme climate fluctuation (e.g., freeze) before landscaping gets replanted with drought-tolerant alternatives (xeriscape). Bathroom fixtures (e.g., toilets) may last for over 30 years. Hence, while price increases may induce customers to act sooner, it may take some customers years to complete desired changes. In addition, it may take a customer a number of billing cycles just to understand the ramifications of a rate structure change. Because of these factors, price elasticity can be expected to be greater in the long run than in the short run.[4]

All utilities analyzed in this study had relatively constant prices, after adjusting for inflation, during the study period. As a consequence, price elasticities estimated in this study are long-run in nature. Customers have had years to adjust their water using behavior, fixtures and landscaping to desired levels. Because of the absence of significant price changes during the study period, it was not possible to measure short-run price elasticities.

Block Rates

With block rates, a customer pays a different unit price with increasing increments of water use during a billing period. In the SWFWMD service area, the presence of increasing block rates are common. Water gets progressively more expensive with increasing use.

In contrast, sewer prices are uniform. A given customer pays the same price for each unit of water.[5] For single-family customers, however, the presence of sewer caps effectively create declining block rates. Once water use exceeds a given threshold amount, the marginal sewer price becomes zero. The combination of water and sewer charges can lead to a multitude of price signals.

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[4]Carver, P. H., and J. J. Boland, Short- and Long-Run Effects of Price on Municipal Water Demand, *Water Resources Research*, 16(4), 609-616, 1980.

[5]The price paid among customers, however, can differ. In some utilities (e.g. Spring Hill) commercial class categories with higher wastewater concentrations of suspended solids (SS) and biochemical oxygen demand (BOD) pay a higher unit price than residential customers.

Figure 2-1 shows combined water and sewer prices for single-family homes within the ten utilities included in this study. A great variation in price exists.[6] Hillsborough has the highest combined price at $7.05/1,000 gallons. When water use exceeds the sewer cap of 8,000 gallons/month, however, price drops as it consists only of the water charge of $1.80/1,000 gallons. Venice, on the other hand, has no sewer cap. Its relatively high priced water equals $6.21 for all units of water sold. On the low end is Lake Placid where water price is zero for the first 5,000 gallons/month and $0.80/1,000 gallons thereafter. Appendix A lists the water and sewer prices for each utility over the study period.

Block or Ramped Rates

With multiple prices, it is important to determine what overall price signal is being sent to customers. Obviously, marginal price is a relevant price signal. Marginal price equals the price paid by a customer for the last unit of water bought during a billing period. For customers considering reducing their water use by 1 unit, marginal price equals the financial reward for doing so.

For customers using water that is near a block threshold level, however, the price signal may be a combination of prices from the two blocks. Given an inclining two-block price structure, for example, a customer that would otherwise be in the second block may remain in the lower priced first block because that customer does not want to pay the higher second block price for the next unit of water use. In this case, marginal price equals the first block price. The second block price, however, had an influence in keeping this customer in the first block. Hence, the second block price is part of the price information to which that customer responds.

Conversely, customers barely entering the second block may be influenced by price in the nonmarginal first block. Water customers often make decisions without perfect information and may only have a vague notion if they are going to enter a second block in a given billing period, especially at the beginning of a billing period. Hence even if they end up entering the second block, resulting uncertainty may have led them to perceive a lower marginal water price.

To test the hypothesis that customers respond to a combination of block prices, we create an alternative price specification—ramped marginal price. As a customer moves towards a block threshold, the price in the first block becomes less important and the price in the second block becomes more important. When a customer is at the threshold, prices from both blocks are given equal weight. Finally, as a customer goes beyond the threshold, the influence of the first block price progressively diminishes to zero. Where should the ramps begin and end? This is a question that must be answered by analyzing the data. Ramps are set at different intervals away from the block threshold, at plus and minus 1, 2, 3, 4, and 5 thousand gallons/month per home.

[6]The price variation is larger than that shown in Figure 2-1 as 40 percent of single family homes do not receive and hence are not charged for sewer service.

FIGURE 2-1. SINGLE-FAMILY HOME WATER AND SEWER PRICES FOR 1992

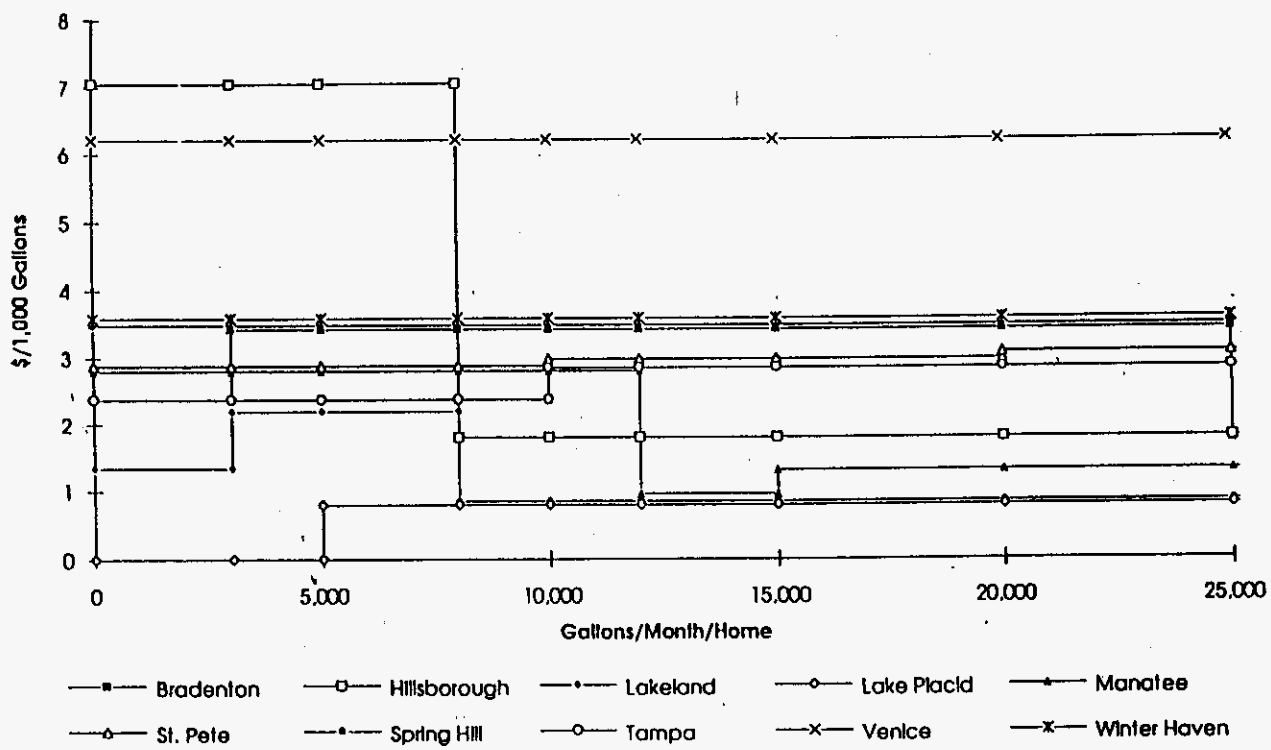

EXHIBIT (JBW-3)
PAGE 26 OF 153

To illustrate the concept, Figure 2-2 shows the location of the ramps for a utility with an *inclining two-block rate structure*. It has been assumed that the ramps are linear.

It is interesting to note that as the ramps get longer, ramped price becomes closer to average price. Some researchers have preferred to use average price in their models based on the ideas expressed above for ramped rates. If, on the other hand, the data support very short ramps, then marginal price is the price signal being received. *If ramps are moderate in length*, then for some customers marginal price is the best indicator (customers not near a block threshold) and some type of average price is *best for* others (customers near a block threshold).

Bill Difference

In the context of electricity demand, Taylor and Nordin[7] developed an income correction, known as a bill difference variable, for customers facing block rate pricing structures. Essentially, the bill difference variable is an income variable measuring additions or subtractions to consumer income arising from differences in block rates and fixed charges. Most recent empirical demand analyses associated *with water* and *electric* utilities using block rate pricing, incorporate a bill difference term in their models.[8]

To illustrate, assume two identical customers facing the same marginal water price but different rate structures. The first customer faces a uniform rate where all water is charged at price P_2 and where the resulting water quantity demanded is Q_2 as shown on Figure 2-3. The second customer, facing an increasing two-block rate structure, pays the lower price P_1 for water up to Q_1 and price P_2 for water above that amount. Both customers pay *the same marginal price*. The second customer's water bill, however, is lower by $(P_2 - P_1)*Q_1$ because of the lower priced first block. This creates a relative increase in *disposable income* which can be used to buy more goods. If water and income are positively related, the second customer will buy more water moving out to Q_3. *Thus, given identical* customers facing the same marginal price, differences in rate structures can cause different demands for water. In a similar manner, decreasing block rate structures lead to relative decreases in disposable income. Differences in the fixed bill (monthly service charge) among utilities can also lead to income effects.

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[7]Taylor, L. D., The Demand for Electricity: A Survey, *Bell Journal of Economics*, 6(1), 74-110, 1975; Nordin, J. A., A Proposed Modification of Taylor's Demand Analysis: Comment, *Bell Journal of Economics*, 7(2), 719-721, 1976.

[8]For example, Agthe, D. E., and R. B. Billings, Dynamic Model of Residential Water Demand, *Water Resources Research*, 16(3), 476-480, 1980; Howe, C. W., The Impact of Price on Residential Water Demand: Some New Insights, *Water Resources Research*, 18(4), 713-716, 1982.

FIGURE 2-2. RAMPED MARGINAL PRICE

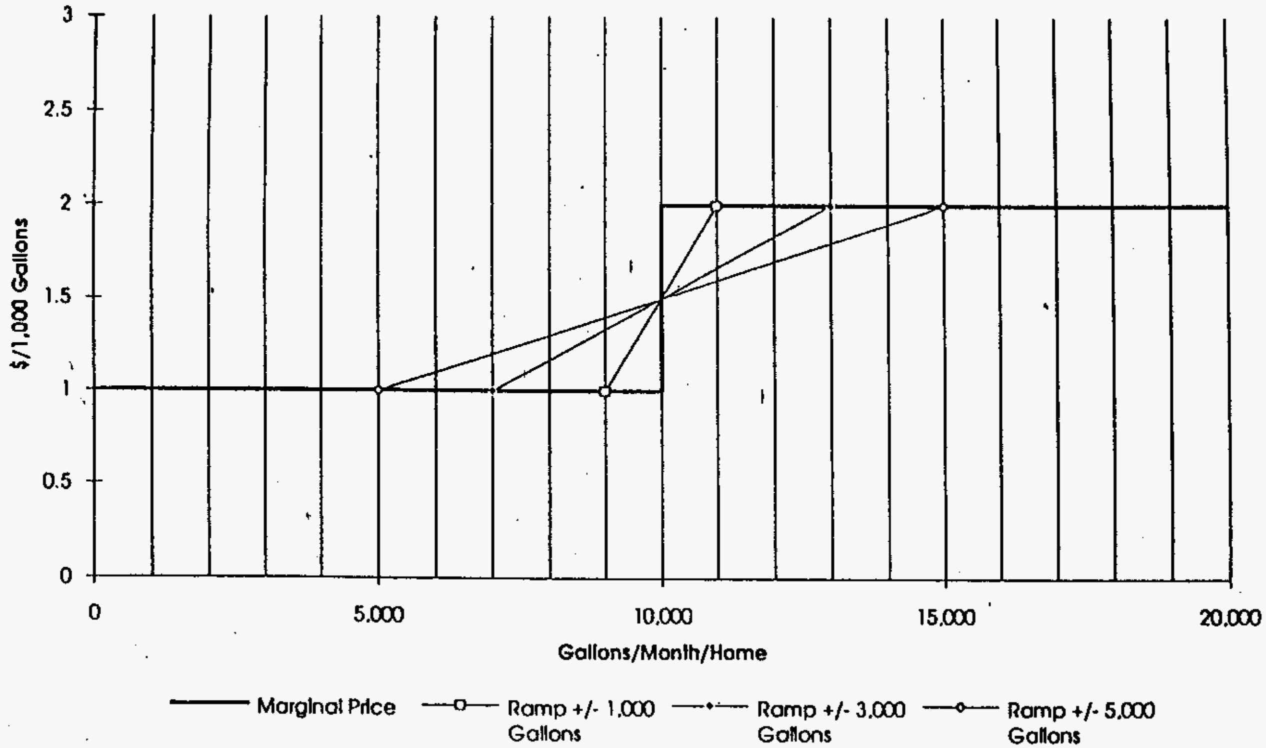
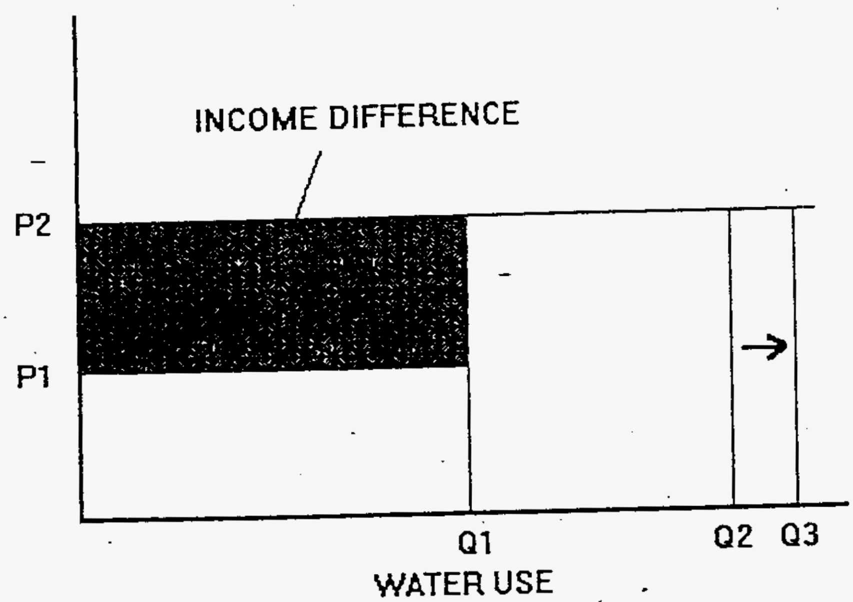


FIGURE 2-3. BILL DIFFERENCE ILLUSTRATION



To account for these income effects, researchers have used a bill difference variable defined as the difference between a customer's total water bill (including fixed charge) and the amount paid if all water is purchased at the marginal price (excluding fixed charge). This bill difference variable can be subtracted from the wealth variable in the demand equation to effect the correction as is done in Chapter 5.

Simultaneous Equation Bias

Block rates also complicate the estimation process by creating an endogenous relationship between water use and water price. Based on the first law of demand, water use is negatively related to water price. With block rates, however, water price also changes depending on water use. This recursive relationship violates one of the assumptions of regression analysis[9] and can lead to biased coefficients.

Researchers have employed instrumental variables of marginal price to correct for this type of endogenous relationship.[10] The instrumental variable, which is highly correlated with marginal price but not correlated with the error term of the demand equation, is typically constructed using simultaneous equations. The first equation [2-1] consists of the structural demand equation where water use is a function of a vector of coefficients (β1), marginal price (MP) and a vector of other explanatory variables (X). In the second equation [2-2], MP is a function of a vector of coefficients (β2), block prices and water use.

$$\text{WATER USE} = f(\beta 1, \text{MP}, \text{X}) \qquad [2\text{-}1]$$
$$\text{MP} = f(\beta 2, \text{BLOCK PRICES}, \text{WATER USE}) \qquad [2\text{-}2]$$

Typically, a two-stage least squares approach is used to estimate this system of equations. The second equation is estimated first to obtain an instrumental variable of marginal price. The instrumental variable is then substituted for marginal price in [2-1] and that equation estimated. This procedure removes the simultaneity bias.

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[9]The violation is that the price explanatory variable and the residual term are no longer uncorrelated.

[10]Agthe, D. E., R. B. Billings, J. L. Dobra, and K. Raffieee, A Simultaneous Equation Demand Model for Block Rates, *Water Resources Research*, 22(1), 1-4, 1986; Chicoine, D. L., S. C. Deller, and G. Ramamurthy, Water Demand Estimation Under Block Rate Pricing: A Simultaneous Equation Approach, *Water Resources Research*, 22(6), 859-863, 1986; Jones, C. V., and J. R. Morris, Instrumental Price Estimates and Residential Water Demand, *Water Resources Research*, 20(2), 197-202, 1984.

The bill difference variable also has an endogenous relationship with water use. This problem can be handled in an analogous manner by creating a third equation to obtain an instrumental variable for the bill difference (BD) variable. We used this two-stage approach in estimating the single-family models described in Chapter 5.

$$BD = f(\beta 3, \text{BLOCK PRICES, WATER USE}) \qquad [2\text{-}3]$$

EXHIBIT (JBW-3)

PAGE 32 OF 153

Chapter 3
Research Design

CHAPTER 3

RESEARCH DESIGN

A proper research design is critical in accurately determining the relationship between water price and water use. Major design decisions include (1) what water utilities to include, (2) what specific customer classes to analyze, and (3) what statistical approach to use to measure the impacts of price. These issues are discussed in this chapter. Another design issue, what customers within each utility and within each class to include in the study, is discussed in Chapter 4.

Utility Selection

Southwest Florida Water Management District (SWFWMD) staff and Brown and Caldwell jointly selected 10 utilities to participate in the study. A number of criteria are used in the selection process. Because the objective of this study is to estimate price elasticity, the most important criterion is to obtain utilities with different water prices. A diverse and wide ranging set of water prices increases our ability to discern the influence of water price. Also sought are utilities from different regions of the SWFWMD service area, those interested and capable of providing water use data, some with shallow groundwater levels, some overlying deep sand soils, and at least one private utility. Based on these criteria, the utilities listed in Table 3-1 were selected for inclusion in the study. Figure 3-1 shows their location within the SWFWMD service area.

Customer Disaggregation

Because water price affects different customers in different ways, we study specific classes of water users. Single-family homes are by far the largest class of customers within the SWFWMD service area comprising over three quarters of the total number of customers and about one-half of the total water use.[1] As a consequence, we spent a major portion of our effort estimating the price response for this customer class. This effort is described in Chapter 5.

We also analyze water use for ten other customer classes. We select classes that we believe to be relatively common within the SWFWMD service area and, therefore, represent a significant amount of the nonsingle-family water use within each utility and within the District. Consideration is also given to selecting classes that would serve as good indicators for other similar types of customers based on our judgment. The classes selected are listed in Table 3-2.

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[1]Based on detailed records from Tampa and Winter Haven.

Table 3-1 Participating Utilities

No.	Utility	County	1990 Population	Private Utility
1	City of Bradenton	Manatee	44,303	No
2	Hillsborough County	Hillsborough	130,149	No
3	City of Lakeland	Polk	118,507	No
4	City of Lake Placid	Highlands	4,410	No
5	Manatee County	Manatee	190,240	No
6	City of St. Petersburg	Pinellas	282,392	No
7	Spring Hill Utilities	Hernando	52,187	Yes
8	City of Tampa	Hillsborough	468,458	No
9	City of Venice	Sarasota	18,079	No
10	City of Winter Haven	Polk	30,011	No

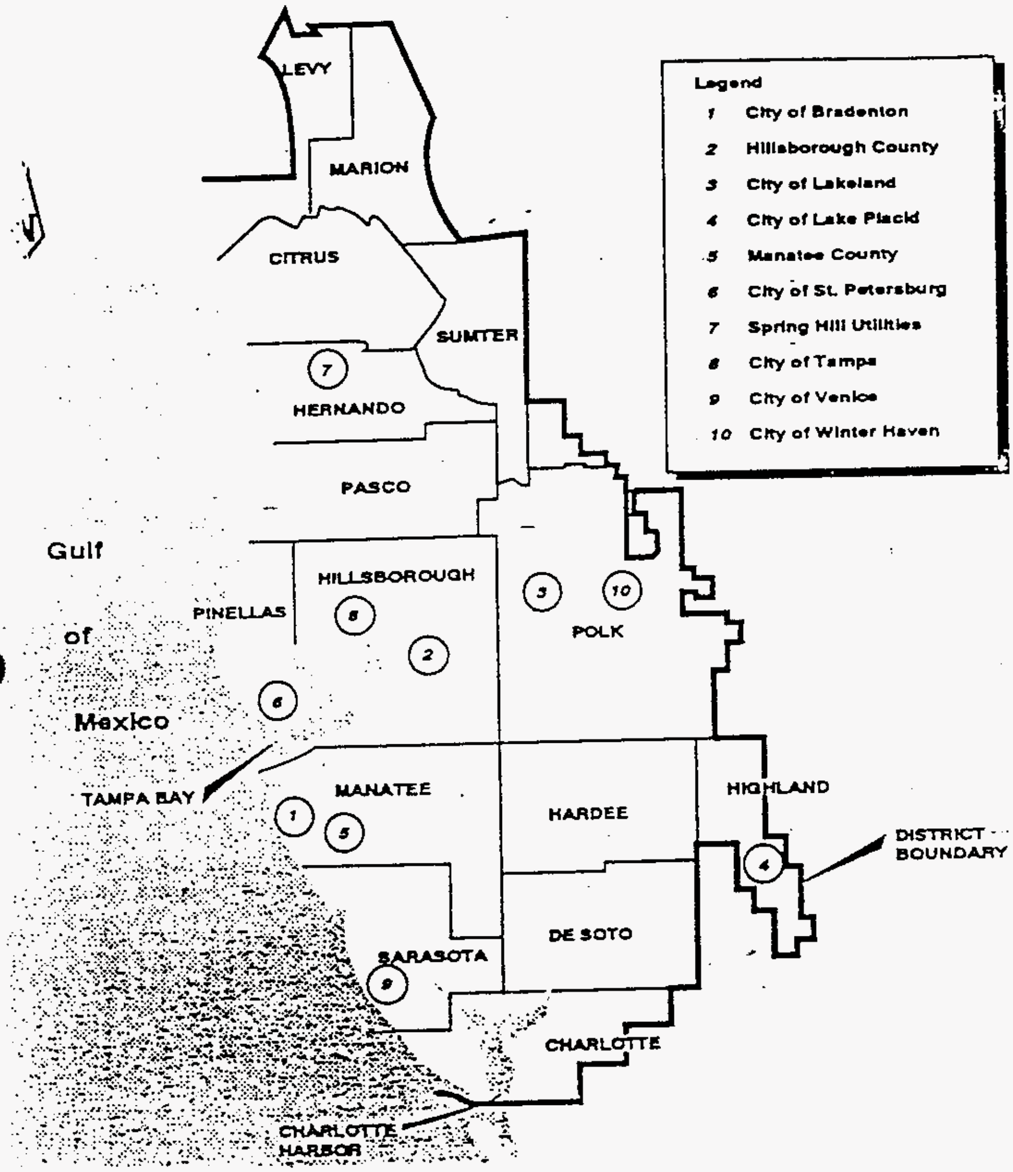

Figure 3-1 Location of Water Utilities

Table 3-2 Other Customer Classes

No.	SIC Code	Description
1	-	Apartments
2	7542	Car Washes
3	806	Hospitals
4	701	Hotels/Motels
5	721	Laundromats
6	805	Nursing Homes
7	81	Office Buildings
8	5812	Restaurants
9	821	Schools (Elementary)
10	822	Universities and Colleges

Chapter 6 covers the analysis of the impact of price on water use for these customer classes.

Statistical Approach

To measure the impact of water price on water use, water use models (regression equations) are developed. On the left hand side of such an equation is water use. On the right side are a vector of coefficients (β), explanatory variables (X), and a residual term.

$$\text{WATER} = f(\beta, X) + \text{RESIDUAL} \qquad [3\text{-}1]$$

Regression analysis estimates the coefficients that best explain water use given the explanatory variables. Generally, this is done by finding the set of coefficients that minimize the variance (least squares) of the residual term. Using this approach, we estimate the impact of water price while controlling for other identified influences.

The modeling process consists of three major steps: identification, estimation, and verification. The identification stage concerns selection of the explanatory variables and the functional form of the model. This stage requires a mix of reasoning and experimenting. Based on reasoning, we first identify likely explanatory variables. For example, we obviously expect outdoor irrigation to increase with hot, dry weather and decrease with cool, wet weather. Hence, our models include weather variables. In addition, it is obvious that outdoor irrigation increases with irrigable area and indoor use with number of occupants. In some cases, however, it is not clear which of among several alternative explanatory variables is most appropriate. For example, as discussed in Chapter 2, we have different hypotheses regarding the length of the ramp needed in constructing the ramped marginal price when block rates exist. We experiment to see which price specification works best.

Regarding the functional form of the models, we allow for a flexible functional form that can capture both nonlinear relationships and interactions among variables. In the past, linear water use models have been popular because their estimation is computationally easy. Advances in computer hardware and software, however, have made it increasingly possible for researchers to specify nonlinear models allowing for a more detailed mapping of the demand curve.

Estimation of the coefficients in the models is done using nonlinear least squares. If certain assumptions hold, then estimated coefficients take on the desirable properties of being consistent, asymptotically efficient, and asymptotically normally distributed.[1] As part of the verification process, we test to see if the residuals are independently, identically, and normally distributed. Transformations to correct for assumption violations are made as necessary. We also correct for simultaneity bias as described in Chapter 2.

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[1]Judge, G.G., W.E. Giffiths, R.C. Hill, H. Lutkepohl, and T. Lee, 1985. The Theory and Practice of Econometrics, 2nd Edition. John Wiley and Sons, New York, New York.

EXHIBIT (JBW-3)
PAGE 38 OF 153

Chapter 4 Data Collection

CHAPTER 4

DATA COLLECTION

The data used in this study comes from a variety of sources. In this chapter, we first describe data common to both the single-family water use models presented in Chapter 5 and the commercial water use models presented in Chapter 6. The data common to all customer classes includes water use, weather and soils, irrigation restrictions, and groundwater depth. Price is covered in Chapter 2. Finally, we discuss data specific to each customer class.

Water Use

Water use data comes from meter recordings made by the utilities for billing purposes. In most cases, meter reads are made at monthly intervals. Exceptions include Tampa which reads its meters bimonthly and Venice which reads some of its meters quarterly. The bimonthly and quarterly readings are converted into monthly observations by assuming that water use occurs uniformly between reads.

The utilities were asked to provide water data for the four year period July 1988 to June 1992. Although all utilities had the most recent data, some did not have data for earlier months. Table 4-1 shows the periods for which water use was provided by each utility. Utilities also provided information on which customers receive sewer service and which customers have irrigation meters. For customers with irrigation meters, we combine water and irrigation meter water use. Our sample includes 18 single-family customers with irrigation meters.[1]

We eliminate water use observations that are either zero or over 10 times the average water use for that customer. This removes periods when a property was vacant or unusual periods such as when a water leak occurred.

Weather and Soils

We calculate monthly turfgrass evapotranspiration (ET), effective rainfall (ER), and net irrigation requirement (NIR) over the study period for each utility. Weather stations selected to represent each utility are shown in Table 4-2. Each utility has a National Oceanic and Atmospheric Administration (NOAA) rain and temperature gauge located near or within their service area. We use two stations for Tampa depending upon which station is closer to a particular customer. To calculate ET, we also need solar radiation and wind speed which is not

[1]As all 18 customers received sewer service from a utility, it is unclear whether water or combined water and sewer price should be assigned to these customers. We set price equal to the average of the two.

Table 4-1 Water Use Histories

Utility	Period
Bradenton	Feb-89 to Jun-92
Hillsborough	Jul-88 to Jun-92
Lakeland	Sep-89 to Jun-92
Lake Placid	Jul-88 to Jun-92
Manatee	Aug-89 to Jun-92
St Petersburg	Jul-88 to Jun-92
Spring Hill	Dec-88 to Jun-92
Tampa	Jul-88 to Jun-92
Venice	Jan-91 to Jun-92
Winter Haven	Oct-90 to Jun-92

Table 4-2 Weather Stations

Utility	Temperature and Rainfall	Solar Radiation and Wind Speed
Bradenton	Bradenton 5 ESE	Bradenton 5 ESE
Hillsborough	Temple Terrace	Bradenton
Lakeland	Lakeland	Lake Alfred
Lake Placid	Archbold Biologic	Avon Park
Manatee	Bradenton 5 ESE	Bradenton 5 ESE
St. Petersburg	St. Petersburg	Bradenton 5 ESE
Spring Hill	Weeki Wachee	SWFWMD
Tampa	Tampa ARPT & Temple Terrace	Bradenton
Venice	Venice	Bradenton 5 ESE
Winter Haven	Winter Haven	Lake Alfred

measured at most stations. For each utility, we assign a nearby NOAA or SWFWMD weather station that does measure solar radiation and wind speed. If a station has a missing observation, we use the next closest station to obtain a substitute value.

In calculating ER, we include the effect of the type of soil as a factor. Turfgrass planted in deep sand soils, which are highly permeable, cannot retain precipitation in the root zone as well as other soils. As a consequence, less rain becomes effective in offsetting ET. Using the Florida General Soils Atlas published by the Florida Department of Administration in 1975, we identify deep sand soils as those classified as areas dominated by sandy draughty soils not subject to flooding. Customers in Hillsborough, Lakeland, Lake Placid, Spring Hill, and parts of St. Petersburg overlie deep sand soils. Other areas predominately have sandy loam soils. Appendix B contains the formulas used to calculate ET, ER, and NIR and lists monthly values of the weather parameters used in the calculations for each utility.

Figure 4-1 plots ET, rain, and NIR by month over the study period. ET has a distinct, consistent seasonal pattern: low in the winter and high in the summer. ET for turfgrass averages 41 inches per year over all utilities.[2] Average annual rainfall equals 51 inches per year, over half which comes in the summer months June through September typically from convective thundershowers. However, less than half of the rainfall, about 18 inches, is effective in reducing ET. Rain from large rainfall events, which are common, tends to get lost as runoff or percolate past the shallow root-zone of turfgrass. In contrast to ET, rainfall is variable. A utility can experience significant deviations in its normal seasonal pattern (e.g., May 1991). In addition, there are significant differences in the amount of rainfall among the utilities. NIR equals the difference between ET and ER and averages about 23 inches per year over the study period.[3] In general, NIR peaks in the spring months (May) and then again to a lesser extent, after the summer rains, in fall (October). Because rain is variable, NIR is also variable.

Irrigation Restrictions

Irrigation restrictions are an important consideration in this study. In response to drought conditions, the SWFWMD has at times mandated irrigation restrictions limiting <u>when</u> municipal irrigation (e.g., lawn watering) can take place. Limits include both time-of-day and day-of-week restrictions. Restrictions do not limit the amount of water a customer can use for irrigation during allowable times.

Table 4-3 lists the irrigation restrictions in effect over the study period for each of the utilities. Restrictions were most severe in the spring of 1991.

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[2]Weather averages are computed over a 4-year study period and may differ from long-term normals.

[3]Because of management and mechanical inefficiencies with sprinkler irrigation systems, actual water use is probably significantly higher than NIR indicates.

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FIGURE 4-1. WEATHER AVERAGES
10 UTILITY COMPOSITE

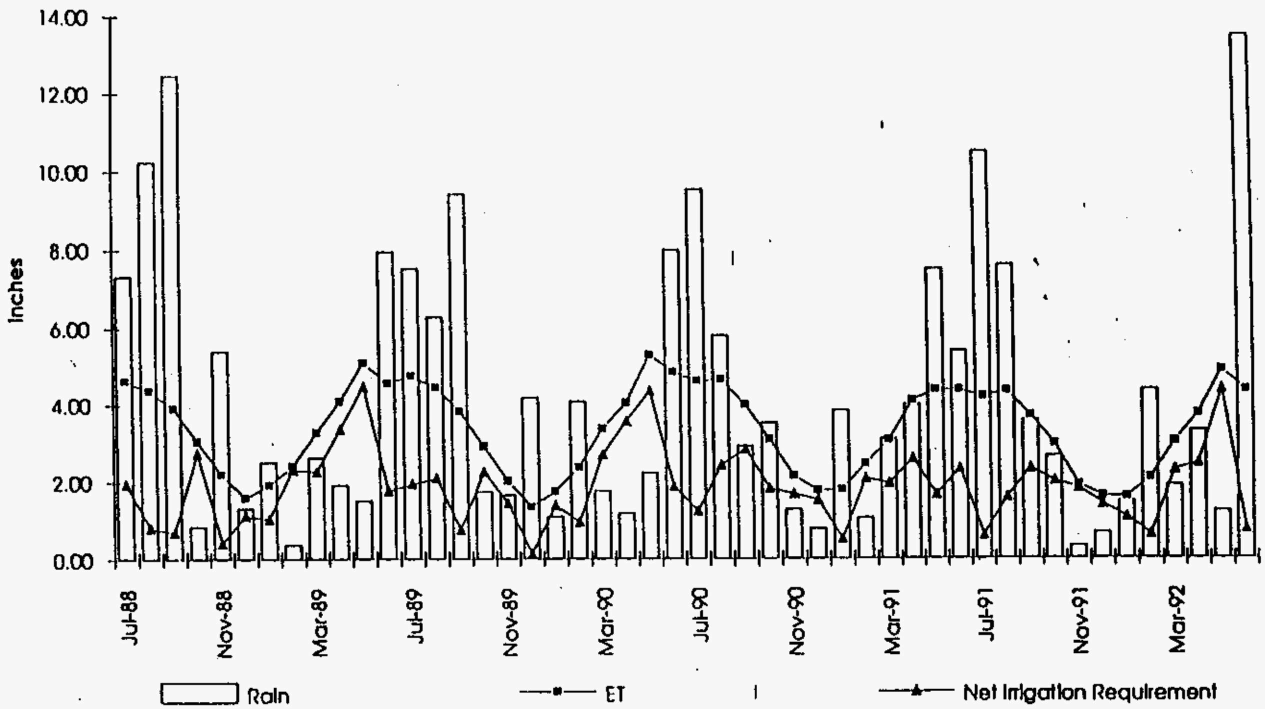

EXHIBIT (JBW-3)
PAGE 42 OF 153

EXHIBIT : (JBW-3)

PAGE 43 OF 153

TABLE 4-3. SWFWMD IRRIGATION RESTRICTIONS

Definitions: 1st Digit =Days per week that landscape irrigation premitted

2nd Digit =0 if no intra-day restrictions
=1 if irrigation prohibited between 9 a.m. and 5 p.m.
=2 if irrigation prohibited between 10 a.m. and 4 p.m.
=3 if irrigation restricted to 5 a.m. to 9 p.m. and also 5 p.m. to 9 p.m. for non-in-ground sprinkling syst
=4 if irrigation restricted to 7 p.m. to 9 p.m.

DATE	Bradenton	Hills-borough	Lakeland	Lake Placid	Manatee	St. Pete	Spring Hill	Tampa	Venice	Winter Haven
Jul-88	70	70	70	70	70	70	70	70	70	70
Aug-88	70	70	70	70	70	70	70	70	70	70
Sep-88	70	70	70	70	70	70	70	70	70	70
Oct-88	70	70	70	70	70	70	70	70	70	70
Nov-88	70	70	70	70	70	70	70	70	70	70
Dec-88	70	70	70	70	70	70	70	70	70	70
Jan-89	70	70	70	70	70	70	70	70	70	70
Feb-89	71	71	71	71	71	71	70	71	24	71
Mar-89	71	71	71	71	71	71	70	71	24	71
Apr-89	31	71	71	71	31	71	70	71	24	71
May-89	31	71	71	71	31	71	71	31	24	71
Jun-89	31	71	71	71	31	71	71	31	31	71
Jul-89	31	71	71	71	31	71	71	31	31	71
Aug-89	31	71	71	71	31	71	71	31	31	71
Sep-89	31	31	31	31	31	31	71	31	31	31
Oct-89	31	31	31	31	31	31	71	31	31	31
Nov-89	31	31	31	31	31	31	71	31	31	31
Dec-89	31	31	31	31	31	31	31	31	31	31
Jan-90	31	31	31	31	31	31	31	31	31	31
Feb-90	31	31	31	31	31	31	31	31	31	31
Mar-90	31	31	31	31	31	31	31	31	31	31
Apr-90	21	21	31	31	21	21	31	21	21	31
May-90	21	21	31	31	21	21	31	21	21	31
Jun-90	21	21	31	31	21	21	31	21	21	31
Jul-90	21	21	31	31	21	21	31	21	21	31
Aug-90	21	21	31	31	21	21	31	21	21	31
Sep-90	21	21	31	31	21	21	31	21	21	31
Oct-90	21	21	31	31	21	00	31	21	21	31
Nov-90	21	21	31	31	21	21	31	21	21	31
Dec-90	21	21	31	31	21	21	31	21	21	31
Jan-91	21	21	31	31	21	00	31	21	21	31
Feb-91	21	21	31	31	21	00	31	21	21	31
Mar-91	23	13	23	23	23	13	23	13	23	23
Apr-91	23	13	23	23	23	13	23	13	23	23
May-91	23	13	23	23	23	13	23	13	23	23
Jun-91	23	13	23	23	23	13	23	13	23	23
Jul-91	21	21	21	21	21	21	21	21	21	21
Aug-91	72	21	72	72	72	72	72	31	71	72
Sep-91	72	71	72	72	72	72	72	31	71	72
Oct-91	72	71	72	72	72	72	72	31	71	72
Nov-91	72	71	72	72	72	72	72	31	71	72
Dec-91	72	71	72	72	72	72	72	31	71	72

EXHIBIT (JBW-3)

PAGE 44 OF 153

TABLE 4-3. SWFWMD IRRIGATION RESTRICTIONS (Continued)

Definitions: 1st Digit =Days per week that landscape irrigation premitted

2nd Digit =0 if no intra-day restrictions
=1 if irrigation prohibited between 9 a.m. and 5 p.m.
=2 if irrigation prohibited between 10 a.m. and 4 p.m.
=3 if irrigation restricted to 5 a.m. to 9 p.m. and also 5 p.m. to 9 p.m. for non-in-ground sprinkling syst
=4 if irrigation restricted to 7 p.m. to 9 p.m.

DATE	Bradenton	Hills-borough	Lakeland	Lake Placid	Manatee	St. Pete	Spring Hill	Tampa	Venice	Winter Haven
Jan-92	72	71	72	72	72	72	72	31	71	72
Feb-92	72	71	72	72	72	72	72	31	71	72
Mar-92	22	21	22	22	22	22	72	21	21	22
Apr-92	22	21	22	22	22	22	72	21	21	22
May-92	22	21	22	22	22	22	72	21	21	22
Jun-92	22	21	22	22	22	22	72	21	21	22

* West Hillsborough had 0 day per week irrigation in Oct 90, Jan 91 and Feb 91 due to a transmission line break (no single family homes affected)

Groundwater Depth

For customers within certain regions of the SWFWMD, installation of an irrigation well can be an attractive alternative to buying utility water for irrigation. Groundwater serves as a source substitute. In regions that have shallow water tables, installation of wells is most attractive, as drilling and pumping costs are minimized. In Lakeland and St Petersburg, for example, numerous wells exist that are less than 50 feet in depth. While this water can be inexpensive, it is often high in organics and nonpotable. It is common, therefore, for customers to drill shallow wells only for irrigation purposes and to purchase potable water from a utility. In contrast, water customers in areas without easy access to groundwater are much more reliant on utility water. Table 4-4 shows well depths reported to the SWFWMD from 1987 to 1991 for wells up to 4 inches in diameter. We use the average well depth as an explanatory variable in our models (see Appendix E).

SINGLE-FAMILY HOMES

Data specifically concerning single-family homes came from three sources: the 1990 U.S. Census, the county tax assessor, and a telephone survey.

1990 U.S. Census

From each utility, we picked 20 street blocks containing single-family homes. The selection process involved two criteria, both based on review of information in the 1990 Census of Population and Housing Summary Tape File 1A (STF 1A) produced by the U.S. Department of Commerce, Bureau of the Census. First, we chose blocks whose housing stock is at least 90 percent single-family homes. Next, we selected blocks so that the owner-specified property values over all blocks in each utility are in proportion to the owner-specified property values in the SWFWMD service area as a whole. This is done so that we would get a consistent balance of low, medium, and high value housing among utilities.

We obtained address ranges for the homes on each block by consulting geographic information system (GIS) computer maps based on county 1990 U.S. Census TIGER files.

County Tax Records

Each county in Florida maintains tax assessor records available to the public. Using the address ranges obtained from the GIS maps, we went to various county tax assessor offices and retrieved specific street addresses, assessed property values, lot size, house size, and pool information for each single-family home in our study. The number of customers with tax assessor records is 2,814.

Table 4-4. Groundwater Well Depths and Soil Type

Utility	Bradenton	Hills-borough	Lakeland	Lake Placid	Manatee	St. Pete	Spring Hill	Tampa	Venice	Winter Haven
Township	35	29	28	36	35	31	23	29	39	28
Range	17	20	23 & 24	29	17	16	17	18	19	26
Well Depth (Feet)										
0-25	0	0	0	0	0	163	0	0	2	0
26-50	1	1	0	206	1	117	124	2	4	44
51-75	1	0	2	44	1	0	256	5	23	12
76-100	43	9	1	6	43	4	326	3	14	0
101-125	50	8	1	4	50	6	322	9	13	5
126-150	13	15	4	4	13	15	131	11	29	5
151-175	9	21	1	5	9	14	39	4	9	8
176-200	7	22	3	1	7	39	33	10	6	8
200+	17	42	19	1	17	36	49	11	11	40
Total Wells	141	118	31	271	141	394	1280	55	111	122
Ave Depth	127	176	190	49	127	69	100	149	121	127
Soil Type	0	1	1	1	0	0	1	0	0	1

Irrigation well depths reported to SWFWMD over 1987-91 for wells equal to or less than 4" in diameter.

Soil type definitions using Florida General Soils Atlas for selected single-family blocks:
1 = areas dominated by sandy droughty soils not subject to flooding
0 = otherwise
*Soil Type = 1 for St Petersburg single family block 22503

EXHIBIT (JBW-3)
PAGE 46 OF 153

Telephone Survey

To find out specific information about individual *single-family homes*, we designed and conducted a telephone survey in September 1992. Using the street addresses from the County tax assessor records, we consulted reverse telephone directories which list telephone numbers by street address.

The survey provides information concerning septic systems, outdoor irrigation systems, reclaimed water, irrigation wells, home ownership, number of occupants, presence of a pool, presence of different water fixtures, property value, and household income. We successfully contacted and obtained completed surveys from 1,213 of the 2,814 single-family customers for which we had County tax assessor data. We believe this 43 percent response rate is high for this type of survey. Appendix C includes the survey and a summary of responses. A summary of the majority responses is presented in Table 4-5.

Table 4-5 Summary of Single-Family Telephone Survey

	Percent	
Question	Yes	No
Receive sewer service from utility?	75	25
Use hose-based irrigation systems?	63	37
Have irrigation well?	34	66
Own home?	95	5
Lived in home for over 4 years?	85	15
Have pool?	20	80
Have clothes washing machine?	98	2
Have dish washer?	63	37
Have garbage disposal?	47	53

Furthermore, a total of 13 customers responded that they receive reclaimed wastewater for irrigation purposes. We excluded these customers from the analysis leaving 1,200 customers in our data base. For customers having in-ground irrigation systems, irrigation timers, irrigation wells, and pools, we asked if they had been installed within the last 4 years. If the answer was yes, we asked for the date so that we could adjust for this fact in our time series observations.

To gauge a customer's wealth, the survey asked the occupant to select one of ten ranges of property values and one of nine ranges of household income. We encountered customer reluctance to disclose such information, especially income. Only 87 percent answered the property value question and only 65 percent answered the income question.

Fortunately, we also have property values obtained from county tax assessor records. We use this source in our models for two reasons. First, the tax records provide property values for all homes. Second, we regard tax assessor data to be more consistently measured among customers than what we elicit from the telephone survey.

It may be useful, however, to know the relationship between the property values obtained from the tax assessor and other wealth variables for planning purposes. The property values obtained from the County tax assessor are correlated with both the property values and income obtained from those customers answering the corresponding telephone survey questions[4] and from the property values obtained from the U.S. Census, using ordinary least squares regression. The results are presented in the relations set forth below.

$PVTELE_i$	$= 23{,}763 + 0.93385 * PVTAX_i$	$R^2=0.47$ N=1054	[4-1]
$INCOME_i$	$= 21{,}966 + 0.3486 * PVTAX_i$	$R^2=0.18$ N=786	[4-2]
$PVCENSUS_i$	$= 1.1447 * PVTAX_i$	$R^2=0.20$ N=1,200	[4-3]

where,

$PVTELE_i$ = property value of home i from telephone survey (mean=$81,082)
$PVTAX_i$ = property value of home i from county tax records (mean=$60,696)
$INCOME_i$ = annual household income for home i from telephone survey (mean=$42,955)
$PVCENSUS_i$ = median owner-specified property value within block group of home i from 1990 U.S. Census (mean=$79,413)

As expected, all three wealth measures have a positive correlation with property values obtained from the County tax assessor (i.e., all coefficient are greater than zero at the 1 percent significance level). The County tax assessor values, however, are below those found by the survey and Census. The mean property value from tax records is $60,696 and the mean property values from the survey and U.S. Census are $81,082 and $79,413 respectively. Because of these differences, utilities cannot simply substitute survey or Census property values for tax assessor property values when calculating price elasticity. As the results of Chapter 5 show, price elasticity changes with property value.

[4]Because the telephone questions about wealth are categorical, we assume property and income values are half way between the defined ranges. For example, if a customer answers that property value is between $60,000 and $80,000, then property value is set to $70,000 in the regression analysis.

In most applications of our results, however, Census information may be the only readily available source. Utilities can use this data, but only after it is transformed to become commensurate with County tax assessor property values. In this case, this can be accomplished by using equation [4-3].

COMMERCIAL CLASSES

For commercial customers, information on individual customers comes from the results of a mail survey. In general, the surveys elicit information regarding number of units (e.g., apartment units, restaurant seats, hospital beds), business hours, seasonality, and outdoor irrigation. Details varied to some degree among classes and, therefore, a unique survey is designed for each class. The surveys and summaries of responses are presented in Appendix D. This information is used in developing the explanatory variables for water use in Chapter 6.

We decided that using a mail survey was the best way to gather this information. Some survey questions, namely questions eliciting seasonal business patterns, are believed to be too detailed for a telephone survey. To improve accuracy, we wanted the respondent to have time to read and reread questions and to be able to check written records or other sources of information. For schools and universities, we obtained student enrollment from the Florida Department of Education.

Regarding sample size, our goal is to obtain survey and water use data for at least 100 customers in each of the 10 commercial classes. To attain a wide water price variation, we want the sample to be balanced over the utilities as best as possible.

Consulting commercial telephone directories, we sought to randomly select 30 customers from each class and from each utility to send mail surveys. For most classes, however, 30 candidate customers do not exist within the service area of a utility. For hospitals, for example, only 61 customers are identified over all utilities. In these cases, we survey all the customers available.

The mail surveys were sent out by SWFWMD staff in July 1992. For those failing to respond, a follow-up mailing was made in August 1992. Preliminary results showed our sample size to be smaller than expected[5] and as a consequence, we selected additional candidate customers and sent out another mailing in March 1993.

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[5]For 16.7 percent of the commercial customers to which we sent surveys, we received a completed mail survey but could not obtain matching water use. This loss occurred because a utility could not match the name and address we gave them to the corresponding billing account (especially Spring Hill and Winter Haven). Brown and Caldwell also inadvertently sent mail surveys to some customers located just outside of the targeted utilities' service boundaries.

EXHIBIT (JBW-3)

PAGE 50 OF 153

For the customers sent mail surveys, we sent name and address listings to each corresponding utility requesting water billing histories. We obtained water use and survey data for 752 customers. Table 4-6 shows a summary of the number of customers by class and utility.

Table 4-6. Commercial Customers with Water and Survey Data

Utility	Apartments	Car Wash	Hospital	Hotel	Laundry	Nursing Home	Office	Restaurant	School	University	Grand Total	Target Group Size	Response Rate
Bradenton	16	2	2	4	4	6	12	9	7	0	62	290	21%
Hillsborough	14	0	3	1	4	2	16	12	18	0	70	239	29%
Lake Placid	1	1	0	1	0	0	0	5	2	0	10	21	48%
Lakeland	8	2	0	15	9	9	10	15	1	2	71	272	26%
Manatee	13	0	0	15	5	2	21	28	6	2	92	215	43%
Spring Hill	0	0	0	1	0	0	0	3	1	0	5	63	8%
St. Pete	57	6	1	19	13	23	5	30	19	2	174	656	31%
Tampa	51	4	13	52	23	10	51	12	13	3	232	795	29%
Venice	4	3	1	4	0	1	1	8	0	0	22	120	18%
Winter Haven	10	0	2	1	0	1	0	0	0	0	14	170	8%
Grand Total	174	17	22	113	58	54	116	122	67	9	752	2,741	27%
Target Group Size	673	68	86	452	217	141	379	525	173	27	2,741		
Response Rate	26%	25%	26%	25%	27%	38%	31%	23%	39%	33%	27%		

Chapter 5 Results for Single-Family Customer

CHAPTER 5

RESULTS FOR SINGLE-FAMILY CUSTOMERS

This chapter describes our investigation of the price elasticity of water demand for single-family residential customers. We use regression analysis to determine the functional relationship between water use and a set of explanatory variables including price. The analysis incorporates water use, water and sewer price, weather, irrigation restrictions, well depths, data from County tax assessors records, and telephone survey data for 1,200 homes as described in Chapter 4. Various combinations of explanatory variables together with models of different functional form are considered. This chapter describes the model whose price elasticity results we recommend be incorporated into the conservation promoting water rate structure computer program.

Model Functional Form

We incorporate three features into the functional form of the water use model. First, the model must be flexible in mapping the demand function. Price elasticity may vary significantly with price level and, as a result, the demand curve must be pliant.[1]

Second, the model can treat nonprice explanatory variables as either shifters or transformers of the demand curve. When an explanatory variable is a shifter, it moves the entire demand curve to the left or right depending on its value. In our model, shifters do not alter price elasticity because they do not change the slope of the demand curve. A transformer, in contrast, changes the slope of the demand curve. In our model, property value acts as a transformer. At a given water price, we test to see if price elasticity varies among customers with different property values. This feature is important for planning purposes. High and low income communities may have different responses to an identical price change.

The third feature of this model is that it measures the percentage change in water use occurring from changes in certain explanatory variables, that is, the model is a percentage adjustment model.[2] This type of model differs from linear models, in the way the change in water use to the change in an explanatory variable is specified. The change is in relative, not absolute, terms. For example, a $1 increase in water price would lead to a "x" gallon/day change in water use as measured via a linear model but would lead to a "y" percentage change in water use as measured via a percentage adjustment model. Because our analysis covers customers with

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[1]Previous research has restricted the demand curve to be linear in shape or calculated through a logarithmic transformation.

[2]An example of a percentage adjustment model is shown in Whitcomb, J. B., Water Reductions From Residential Audits, *Water Resources Bulletin*, 27(5), 1991.

a wide range of water use, we believe that the proportional view better captures the impact of price and the other factors on water use.[3]

Recommended Model

Completion of the identification, estimation, and verification stages of the modeling process results in us recommending the following model:

$$
\begin{aligned}
WATER_{i,t} = \; & ((105 + 23*PER_i + 0.69*NIR_{i,t}*LOT_i) && [5\text{-}1a]\\
& *(1 - 0.073*IR1_{i,t} - 0.023*IR2_{i,t} + 0.002*IR3_{i,t}) && [5\text{-}1b]\\
& *(1 + 0.18*(DWELL_i - DWELLAVE)/DWELLAVE) && [5\text{-}1c]\\
& + 47*POOL_{i,t}) && [5\text{-}1d]\\
& *(1 + PVLOW_i*0.0000327*(7.05-MP2_{i,t})^{5.45} && [5\text{-}1e]\\
& + PVMED_i*0.00085*(7.05-MP2_{i,t})^{3.82} && [5\text{-}1f]\\
& + PVHIGH_i*0.00298*(7.05-MP2_{i,t})^{3.30}) && [5\text{-}1g]
\end{aligned}
$$

where,

$WATER_{i,t}$	= gallons/home/day for home i in month t
PER_i	= number of occupants in home i from telephone survey
$NIR_{i,t}$	= net irrigation requirement in inches in utility serving home i in month t
LOT_i	= lot size of home i in 1,000 ft^2 from tax records (min=5, max=18)
$IR1_{i,t}$	= 1 if irrigation limited to 1 day per week; 0 otherwise
$IR2_{i,t}$	= 1 if irrigation limited to 2 days per week; 0 otherwise
$IR3_{i,t}$	= 1 if irrigation limited to 3 days per week; 0 otherwise
$DWELL_i$	= average well depth in feet in utility serving home i
DWELLAVE	= average of $DWELL_i$ over all homes in all utilities (121 feet)
$PVLOW_i$	= 1 if assessed property value < $48,000; 0 otherwise
$PVMED_i$	= 1 if $48,000 <= assessed property value < $71,000; 0 otherwise
$PVHIGH_i$	= 1 if assessed property value >= $71,000; 0 otherwise
$MP2_{i,t}$	= marginal water and sewer price in $/1,000 gals. (1992 dollars) with +/- 2,000 gallon ramp
$POOL_{i,t}$	= 1 if home i in month t has pool; 0 otherwise

The amount of the variation in water use explained by the model (R^2) equals 0.59. The total number of observations is 42,257. All coefficients take on their expected mathematical sign and are significantly different from zero (10 percent significance level, T-ratio greater than 1.28, one-tailed test), except the coefficient for the 3 day per week irrigation restriction. The following sections describe the model and our observations concerning explanatory variables. Table 5-1 summarizes statistical details of he variables and model estimation.

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[3]Using the same explanatory variables, the amount of variance explained (R^2) by the percentage adjustment model was 2 percentage points higher than with the linear model.

Table 5-1. Single Family Home Model

```
VARIABLE DEFINITIONS:
WATERi,t-gallons/home/day for home i in month t
PERi     =number of occupants in home i from telephone survey
NIRi,t   =net irrigation requirement in inches for home i in month t
ETi,t    =evapotranspiration in inches for home i in month t
ERi,t    =effective rainfall in inches for home i in month t
LOTi     =lot size in 1,000 ft2 from tax records (min=5, max=18)
IR1i,t   =1 if irrigation limited to 1 day per week; 0 otherwise
IR2i,t   =1 if irrigation limited to 2 days per week; 0 otherwise
IR3i,t   =1 if irrigation limited to 3 days per week; 0 otherwise
DWELLi   =average well depth in feet in utility serving home i
DWELLAVE=average of DWELLi over all utilities
POOLi,t =1 if home i in month t has pool; 0 otherwise
PVLOWi   =1 if assessed property value < $48,000; 0 otherwise
PVMEDi   =1 if $48,000 <= assessed property value < 71,000; 0 otherwise
PVHIGHi =1 if assessed property value > $71,000; 0 otherwise
MP2i,t   =marginal water and sewer price with +/- 2,000 gallon ramp in $/1,000 gal
RESi,t   = residual term
```

VARIABLE DESCRIPTIVE STATISTICS:

NAME	N	MEAN	ST. DEV	VARIANCE	MINIMUM	MAXIMUM
WATER	42257	274.33	228.59	52255.	30.592	1500.0
PER	42257	2.5626	1.2491	1.5602	1.0000	9.0000
NIR	42257	1.9282	1.1507	1.3242	0.00000	5.2900
ET	42257	3.3073	1.1736	1.3773	1.2000	5.8200
EP	42257	1.3791	1.1653	1.3579	0.00000	4.4400
LOT	42257	9.8974	3.2699	10.692	5.0000	18.000
IR1	42257	0.42384E-01	0.20146	0.40588E-01	0.00000	1.0000
IR2	42257	0.33502	0.47200	0.22279	0.00000	1.0000
IR3	42257	0.26235	0.43992	0.19353	0.00000	1.0000
PV	42257	64.053	21.646	468.54	45.000	150.00
DWELL	42257	120.84	43.834	1921.5	49.000	190.00
POOL	42257	0.20484	0.40359	0.16289	0.00000	1.0000
PVLOW	42257	0.32790	0.46945	0.22039	0.00000	1.0000
PVMED	42257	0.33832	0.47644	0.22700	0.00000	1.0000
PVHIGH	42257	0.33378	0.46792	0.21895	0.00000	1.0000
MP2	42257	2.1649	1.5441	2.3843	0.00000	7.0500

```
MODEL SPECIFICATION SELECTED:
WATERi,t =       ((c1 + c2*PERi + c3*NIRi,t*LOTi)
                 *(1 + c4*IR1i,t + c5*IR2i,t + c6*IR3i,t)
                 *(1 + c7*(DWELLi-DWELLAVE)/DWELLAVE)
                 + c8*POOLi,t)
                 *(1 + PVLOWi*c9*(7.05-MP2i,t)**c10
                 + PVMEDi*c11*(7.05-MP2i,t)**c12
                 + PVHIGHi*c13*(7.05-MP2i,t)**c14)
                 + c15*RESi,t-1 + RESi,t
```

MODEL ESTIMATES:

	COEFFICIENT	ST. ERROR	T-RATIO
c1	104.63	3.5531	29.447
c2	22.545	1.1426	19.730
c3	0.68519	0.47182E-01	14.522
c4	-0.72949E-01	0.18753E-01	-3.8901
c5	-0.22972E-01	0.97350E-02	-2.3597
c6	0.18606E-02	0.11990E-01	0.15518
c7	0.18082	0.23555E-01	7.6766
c8	47.055	3.6378	12.935
c9	0.32736E-04	0.24164E-04	1.3548
c10	5.4492	0.38075	14.312
c11	0.84964E-03	0.49904E-03	1.7026
c12	3.8230	0.30515	12.529
c13	0.29770E-02	0.85778E-03	3.4705
c14	3.2958	0.14398	22.891
c15	0.69480	0.35108E-02	197.90

R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.5905
UTILITIES = 10
HOMES = 1,200
N = 42,257

Base Water Use

The first term, [5-1a], of the model estimates base water use as a function of an intercept, number of occupants, net irrigation requirement, and lot size. Estimation finds that the intercept equals 105 gallons/day, water use increases by 23 gallons/day with each occupant, and water use increases by 0.69 gallons/day for each inch of NIR for each 1,000 ft^2 of lot. This first term in the model represents base water use because other terms in the model fall out when no irrigation restrictions are in effect, when well depth is at its mean value, when there is no pool, and when price equals $7.05 per 1,000 gallons. Changes in these variables from these conditions lead to percentage changes in base water use as described in the next sections.

An alternative model specification includes both ET and ER instead of NIR. We find the coefficients are nearly identical and opposite in sign, as expected. Because this specification does not improve the model's ability to explain water use, we chose the simpler model that has just the one weather variable NIR.

We also explore refinements to the lot size variable. We find that lot size over 18,000 ft^2 does not correlate with increased water use. This may result from the fact that only the area immediately surrounding a house is irrigated, and not the entire lot in the case of houses with very large lots. Only 5 percent of the homes in our study have lot sizes exceeding 18,000 ft^2. Similarly, we find that lot sizes below 5,000 ft^2, 4 percent of the houses in our sample, do not correlate with decreased water use. The lot size variable (in 1,000 ft^2) is set to a minimum of 5 and a maximum of 18 to reflect these findings. Within the range of 5,000 to 18,000 ft^2, we find water use to be closely proportional to lot size.

In a search for a better measure of irrigable area (better than lot size) to use as an explanatory variable, we subtract home size, as obtained from tax records, from lot size. This new variable, however, does not improve the explanatory power of the model. This may result from the fact that the home size available from tax records does not measure the base area or "footprint" of the home, but rather the total square footage of a house including multiple stories (if any). Therefore, only for one-story homes would lot size minus home size be a valid surrogate for irrigable area. This is not always the case in our sample group.

Irrigation Restrictions

The imposition of irrigation restrictions correlates with water use reductions as shown in the term designated [5-1b]. The greatest water use reductions occurred when irrigation was limited to 1 day per week. Water use during the 1 and 2 day per week limitations dropped by 7.3 and 2.3 percent respectively. The IR3 coefficient is positive and not statistically different from zero. Hence, we conclude that the 3 day per week irrigation restriction was ineffective at lowering water use. Attempts to account for time of day differences in the restrictions (e.g., 9 a.m. to 5 p.m.) were not successful.

Well Depth and Pools

Groundwater level is an important variable in the water use model as indicated by term [5-1c]. In areas with high groundwater levels, water users have a readily available substitute to utility water for irrigation. In total, 34 percent of the homes in our study report having irrigation wells. These homes tend to come from areas with high groundwater levels. We include the DWELL variable in the model to help account for the viability of an irrigation well.[4] Every percent change in DWELL from its mean value DWELLAVE (121 ft), leads to a 0.18 percent change in water use. If DWELL is 60, for example, then the 50.4 percent decrease from DWELLAVE leads to a 9.1 percent decrease in water use. The presence of a pool correlates with a 47 gallon/day increase in water use.

Property Value

The model estimates three demand curves relating to homes with low, medium, and high property values. Each property value designation accounts for a third of the homes (400) in the study. A slight adjustment is made to assessed property values to account for income differences arising from the use of different rate structures as discussed in Chapter 2. We calculated a bill difference variable defined as the difference between a customer's total water and sewer bill (including fixed charges) and the amount paid if all water is purchased at marginal water and sewer prices (excluding fixed charges) as follows:

$$BD_{i,t} = BILL_{i,t} - MP_{i,t} * WATER_{i,t} \qquad [5\text{-}2]$$

where,

$BD_{i,t}$ = bill difference variable for customer i in month t

$BILL_{i,t}$ = total water bill including both the fixed charge and quantity charge for customer i in month t

For customers facing block rates, we estimate an instrumental variable of bill difference because of the endogenous relationship between the bill difference variable and water use as discussed in Chapter 2. For those customers facing a uniform rate, the bill difference variable simply equals the fixed service charge and requires no correction.

[4]Appendix E explains why DWELL is preferred over the presence of an irrigation well as an explanatory variable.

The next step is to convert the bill difference variable into terms of property value. Using equation (4-2) from Chapter 4, dividing the bill difference by 0.348641 translates income dollars into property value dollars. For each customer, this result is then annualized over the study period and subtracted from the property value variable. This completes the bill difference adjustment to the property value variable for each customer.

Price

Each demand curve is estimated using two price coefficients. The first is a scaler and the second an exponent. Price is subtracted from 7.05, the highest price in the study, so as to set 7.05 as the price corresponding to base water use. The advantage of this specification is that it allows the demand curves to take on a pliant form as shown in Figure 5-1. The curves are negatively sloped and show water use increases with higher property values, especially at lower prices. They are highly nonlinear.[5] To adjust for inflation, all prices have been are converted into 1992 dollars using the U.S. Department of Labor consumer price index for U.S. cities.

We analyze six alternative ramp specifications for those customers facing block rates as discussed in Chapter 2. Ramps start and end at 0 (i.e., no ramp), 1-, 2-, 3-, 4-, and 5-thousand-gallons/month increments on each side of a block threshold. Among the ramp options, ramps extending plus and minus 2,000 gallons/month best fit the data (highest R^2). We conclude, therefore, that customers perceive block rate structures more in terms of ramps rather than rigid block increments.

Figure 5-2 plots price elasticity by price level and property value. A number of observations can be made. First, at prices over $1.50, higher property value customers are more price elastic. At a price of $3.00, for example, price elasticity for low, medium and high property value homes is -0.25, -0.43, and -0.57 respectively. Perhaps this results because high value homes, which use significantly more water, have more discretionary water use (irrigation) from which they can cut back. Another explanation is that wealthy customers have greater ability to purchase water efficient devices (e.g., low volume toilets) and access source substitutes (e.g., irrigation wells). Hence, they have more options to reduce their water use in response to a rate hike. At prices below $1.50, price elasticities are similar among the different wealth groups.

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[5] If the demand curves are truly linear, the price exponents would equal one. This is clearly not case as the exponents equal 5.45, 3.82, and 3.30 for low, medium and high property value customers respectively.

FIGURE 5-1. SINGLE-FAMILY DEMAND CURVES

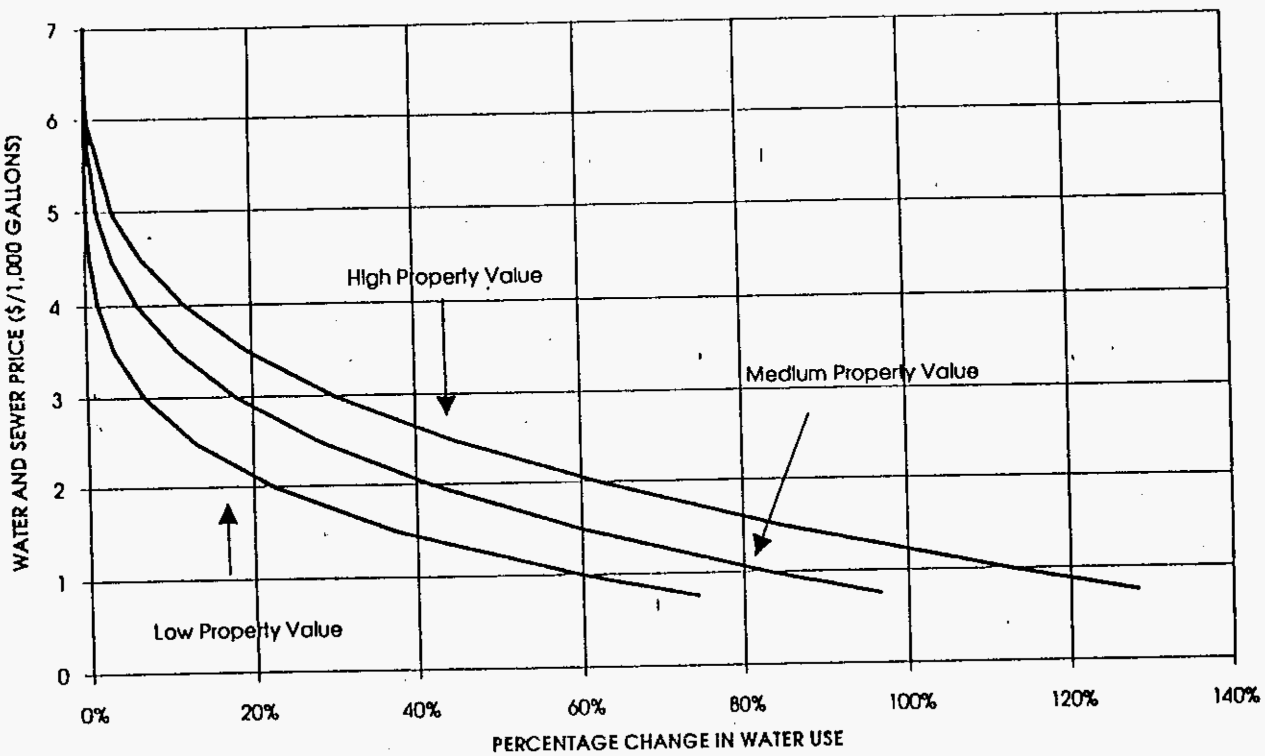


EXHIBIT (JBL-3)
PAGE 59 OF 153

FIGURE 5-2. SINGLE-FAMILY PRICE ELASTICITY CURVES

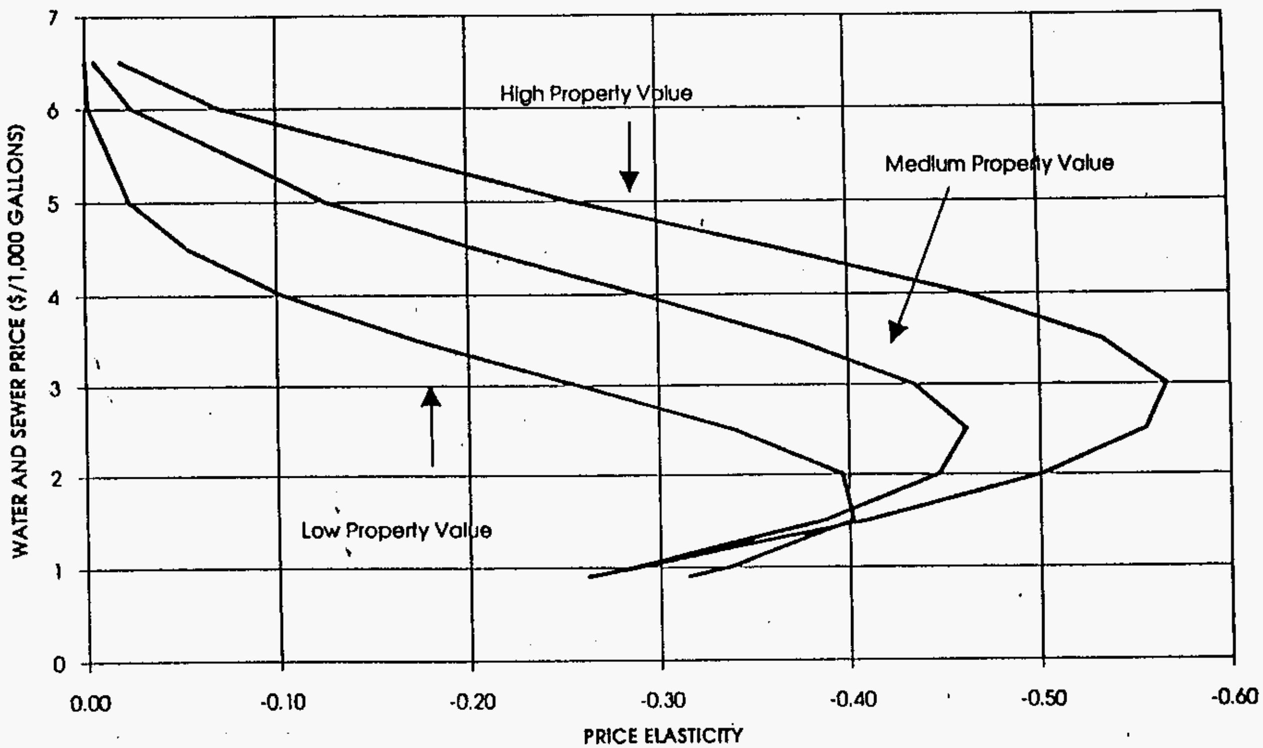


EXHIBIT ______
PAGE ____ OF ____

Another observation concerns the shape of the elasticity curves. For low value homes, price elasticity increases with price until $1.50. At this point, these customers are most active in reducing discretionary uses and making the simple adjustments needed to use water more efficiently. With further price increases, however, water savings become progressively harder to achieve and price elasticity heads steadily towards zero. Customers find their utility derived from remaining water use is high (e.g. water for cooking and bathroom uses), and hence are less willing to make further water cuts in response to price increases. For medium and high value homes, the same pattern exists but the inflection points where customers are most sensitive to price occur around $2.50 and $3.00 respectively. Therefore, it takes higher prices before wealthier customers react most aggressively in reducing water consumption. When they do, however, they do decrease it at a much faster rate than lower property value customers. By the time price increases to $6, there is little difference in water use based on property value.

Irrigation System and Timer

Further analysis shows that a definite correlation exists between water use and in-ground irrigation systems both with and without timers. In-ground systems without irrigation timers correlate with a 5 percent increase in water use. Those with irrigation timers correlate with a further 25 percent increase in water use. Do in-ground systems cause increased water use or do large turf areas just tend to have in-ground systems? To the extent that it is the latter, inclusion of the irrigation system variables may distort the interpretation of other coefficients, namely the price and lot size coefficients. For example, if a low water price caused customers to have larger lawns, but customers with larger lawns installed in-ground systems with timers, then the model may attribute the greater water use to in-ground systems with timers and not price. Appendix E describes a similar problem with irrigation wells. As a result, we do not include irrigation system variables in our recommended model.

Estimation

This section describes the estimation of the single family water demand equations shown on Figure 5-1. We use nonlinear least squares to estimate the values of the coefficients using Shazam 7.0 econometric software. Three correction transformations are undertaken to improve the desirable statistical properties of the coefficients.

The first correction concerned the variance of the residual which is not constant among customers. A heteroskedastic residual term violates one of the assumptions of regression which leads to estimators that are not asymptotically efficient and whose estimated variances are, in general, biased. To correct for this situation, econometricians often use a weighting technique (i.e., weighted least squares). Through graphical plots, we find that the residual's standard deviation increased closely with lot size. Using lot size as our weight, we divide both sides of demand equation [5-1] by lot size as shown below and re-estimate the coefficients. This procedure corrects for problems arising with heteroskedasticity.

$$WATER_{i,t}/LOT_i = f(\beta,X)/LOT_i \qquad [5\text{-}3]$$

where,

ß	=	vector of coefficients to be estimated
X	=	vector of explanatory variables

Diagnostic tests also find the residual to be autocorrelated. Regression coefficients are not asymptotically efficient when the residual is autoregressive. To correct for this fact, we include a first order regressive term to the error component. The model is as follows:

$$WATER_{i,t} = f(\beta,X) + \rho * RES_{i,t-1} + RES_{i,t} \qquad [5\text{-}4]$$

where,

ρ	=	first order autoregressive coefficient

The last correction concerns simultaneity bias as discussed in Chapter 2. For customers facing block rates, we reduce possible simultaneity bias by developing a second equation that explains marginal price (with the ramp) as a function of block prices and quantity of water purchased. The resulting simultaneous set of equations are estimated using a two-stage least squares approach. Through the reduced form price equation, we calculate the instrumental price variable for customers in Hillsborough, Lakeland, Lake Placid, Manatee, St. Petersburg, and Tampa using a different set of estimators for each utility. We do not include customers from Spring Hill, Winter Haven, or Venice because they charge uniform rates and, therefore, are not subject to simultaneity bias. We also do not have to include water only customers in Hillsborough and Lakeland because, in the absence of the sewer charge and dismissing the 2,000-gallon first block price in Lakeland, they are charged a uniform rate. Although Bradenton has three blocks separated at 3,000 and 25,000 gallons/month, the customers in our sample almost always exceeded the first block and never entered the third block. Hence, they too effectively faced a uniform charge. In addition, as Tampa switched from uniform to block water rates in January of 1990, we exclude observations before this time. The resulting values of instrumental price variables are substituted into the demand equation which is then estimated using nonlinear least squares. An analogous procedure is undertaken to also remove simultaneity bias from the bill difference variable.

The definition of the variables, variable descriptive statistics, and the coefficients of the final model are shown in Table 5-1. All coefficients take on their expected mathematical sign and are significantly different from zero at the 10 percent significance level (T-ratios greater than 1.28 for one tailed tests) with one exception. The model did not find water savings for the 3-day-per-week irrigation restriction to be statistically significant.

Chapter 6 Results for Commercial Customers

CHAPTER 6

RESULTS FOR COMMERCIAL CUSTOMERS

Little is known about how commercial customers respond to water price. Previous research has focused almost entirely on the estimation of price elasticities of either residential or aggregate water use. To our knowledge, the only significant study on price elasticity of commercial customers was conducted by Lynne et al[1] on customers located in the Miami, Florida area. The price elasticities for five categories of users were calculated and the results are listed in Table 6-1.

Table 6-1 *Lynne et al Study*

Class Description	Number of Customers	Price Elasticity at Mean Price and Water Use
Department Stores	20	-1.33
Grocery Stores	19	-0.76
Hotels/Motels	40 and 93	-0.12 and -0.24
Eating and Drinking Establishments	24	-0.174
Other businesses	34	-0.48

This chapter describes our investigation of price elasticity for 10 commercial customer classes. As described in Chapter 3, the commercial classes include apartments, car washes, hospitals, hotels/motels, laundromats, nursing homes, office buildings, restaurants, elementary schools, and universities and colleges. The apartment class is by far the largest nonsingle-family user class both in terms of number of customers and water use. Based on 1990 U.S. Census records, approximately 44 percent of dwelling units in the Southwest Florida Water Management District (SWFWMD) service area are in multiple unit complexes. In this study, we denote apartments as commercial (apartment owner's perspective) although of course they are residential.

This chapter consists of sections discussing the water use modeling of each of the ten customer classes. The demand curves are mapped as conventional functions of price. Unfortunately, we do not have large enough sample sizes or the balance of customers from each utility to map out more precise, nonlinear demand curves as is done with the single-family

[1]Lynne, G. D., W. G. Luppold, and C. Kiker, Water Price Responsiveness of Commercial Establishments, Water Resources Bulletin, 14(3), 719-729, 1978.

residential customers. For each class, we look at a wide set of possible explanatory variables including class-specific information from the mail surveys, weather, average well depth, and irrigation restrictions. Because business activity can vary seasonally, especially for businesses affected by seasonal residents and tourism, the mail surveys elicit seasonal business patterns for six of the classes.

After removing variables with coefficients with the wrong expected mathematical sign and those not statistically different from zero at the 10 percent significance level (T-ratio less than 1.28, one-tailed test), we obtain our selected models. The models are linear and are corrected for first order autocorrelation. Because commercial customers do not face sewer use caps and rarely jump water price thresholds, we do not use ramp prices or correct for simultaneity bias.

Table 6-2 shows a summary of results for the commercial customers. The major finding is that for apartments we do not detect a negative correlation between water use and water price. We conclude from this evidence that apartments are very price inelastic (elasticity near 0). On the other hand, the other models suggest that the water use by car washes, hotels/motels, laundromats, office buildings, restaurants and schools is significantly affected by price, but is still classified as inelastic (elasticity less than -1). For hospitals and nursing homes, the model finds positive elasticities. We conclude that because of stringent hygiene requirements, these customers are highly inelastic. Finally, the sample size of universities is too small to make any interferences.

Apartments

Our sample includes 174 apartment buildings which have a total of 18,583 apartment units. Figure 6-1 plots mean water use per apartment unit against mean marginal price averaged over the July 1988 to June 1992 period for each utility. Water use is relatively constant in all utilities ranging between 100 to 150 gallons/day/unit. No relation between water use and price is visually evident.

Because apartment water use (like single family water use) can be affected by factors other than price, it is necessary to control for these factors in estimating the impact of price. We use multiple regression to measure the correlation between water use and selected explanatory variables including water price. The explanatory variables generated from mail survey data include average monthly occupancy rate, average number of occupants per unit, and the presence of clothes washers, dishwashers, garbage disposals, and a pool at the apartment complex. In addition, evapotranspiration, effective precipitation, irrigation restrictions, groundwater depth, and marginal water price are considered.

Table 6-2. Summary Results for Commercial Customers

CLASS	Total Monthly Observations (N)	Accounts	Unit Factor	Mean Water Use Gal / Day / Unit	Mean Marginal Price $/1,000 Gals	Price Elasticity At Means	Model R2
Apartments	4,807	174	Apartments	107	3.01	0	0.64
Car Wash	514	17	None	4,672	2.74	-0.70	0.17
Hospitals	671	22	Beds	96	3.05	0	0.04
Hotels/Motels	3,525	113	Rooms	145	2.51	-0.48	0.43
Laundromats	1,511	58	Washers	172	2.97	-0.14	0.06
Nursing Homes	1,983	54	Rooms	96	2.67	0	0.54
Office Buildings	3,763	116	1,000 ft2	92	3.00	-0.33	0.29
Restaurants	3,274	122	Seats	29	3.10	-0.28	0.19
Schools (Elementary)	2,497	67	Students	6.0	3.33	-0.25	0.32
Universities	287	9	Students	13.6	2.05	Indeterminate	0.001
Total	22,832	752					

Figure 6-1. Apartment Water Use

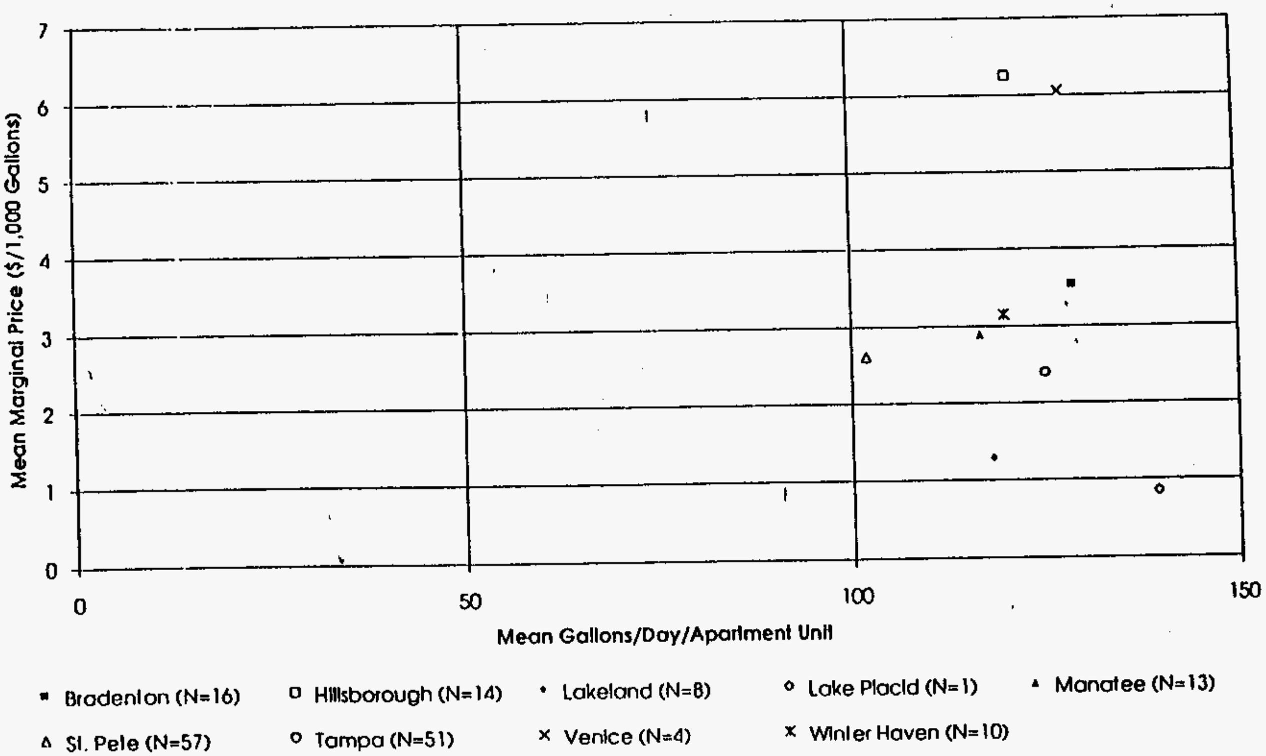


EXHIBIT (JBW-3)
PAGE 168 OF 153

Estimation of the model shows that only those coefficients representing number of occupied units, average number of occupants, and two out of three turf size variables took on their expected mathematical sign and are significant at the 10 percent significance level as shown in Table 6-3. The price coefficient both took on the wrong sign (positive) and is statistically not different from zero.

This evidence leads us to conclude that water use by apartments (multiple-family dwelling units) is very price inelastic. This may result from the fact that apartments units are rarely individually metered. As a consequence, apartment dwellers do not pay a water bill (it is indirectly included as part of rent) and often have no direct monetary motivation to conserve water (e.g., react swiftly to fix a toilet leak or leaky faucet). Because apartment owners, on the other hand, have a direct financial stake, increases in water price should motivate them to install new water efficient fixtures (e.g., low-volume toilets) or replant with less water intensive landscaping. Apparently, however, this has not occurred to an extent that is measurable.

Car Washes

Water use per car wash is shown on Figure 6-2. The mail survey obtained information from 17 customers on number of wash bays, days per week open, business hours on Thursdays, water recycling, and business seasonal patterns. Because businesses change their working hours throughout the week, we decided to look at Thursdays (when all businesses are open) to get a consistent measure.

In the car wash model, only the business seasonal pattern and marginal price take on their expected mathematical sign as shown in Table 6-4. Price elasticity equals -0.70 at mean water use and price. The Lake Placid car wash, which has dramatically lower water use, perhaps because of relatively low population in the surrounding area, was excluded from the analysis.

Hospitals

Figure 6-3 plots water use per hospital bed for each utility. Average gallons/day/bed equals 96 for the 22 hospitals analyzed. As shown in Table 6-5, only number of beds is significant in the regression model. The price coefficient takes on the wrong sign (positive).

Hotels/Motels

Figure 6-4 plots water use per hotel/motel room against price for each utility. For the 113 hotels/motels included, water use averages 145 gallons/day/room and has a large variation. Explanatory variables looked at in the models include number of rooms, seasonal occupancy, and presence of pools, on-site restaurants, and on-site laundries.

EXHIBIT (JBW-3)

PAGE 70 OF 153

Table 6-3. Apartment Model

VARIABLE DEFINITIONS:

WATERi,t	=gallons/day for complex i in month t
UNITSi	=number of apartment units in complex i
OCCUPYi,t	=average monthly occupancy rate from mail survey
PERSONi	=number of occupants in unit from mail survey
WASHERi	=1 if clothes washer from mail survey; 0 otherwise
DISHi	=1 if dishwasher from mail survey; 0 otherwise
GARBAGEi	=1 if garbage disposal from mail survey; 0 otherwise
POOLi	=1 if complex i has pool; 0 otherwise
TURF1i	=1 if uses utility water to irrigate lawn area up to the size of single family lawn
TURF2i	=1 if uses utility water to irrigate lawn area larger than single family lawn but less than 1 acre
TURF3i	=1 if uses utility water to irrigate lawn area of 1 acre or more.
NIRi,t	=net irrigation requirement in inches
ETi,t	=evapotranspiration in inches
ERi,t	=effective rainfall in inches
IR1i,t	=1 if irrigation limited to 1 day per week; 0 otherwise
IR2i,t	=1 if irrigation limited to 2 days per week; 0 otherwise
IR3i,t	=1 if irrigation limited to 3 days per week; 0 otherwise
DWELLi	=average well depth in feet in utility serving i
MPOi,t	=marginal water and sewer price in $/1,000 gal

VARIABLE DESCRIPTIVE STATISTICS:

NAME	N	MEAN	ST. DEV	VARIANCE	MINIMUM	MAXIMUM
WATER	4806	11309.	16040.	0.25730E+09	128.29	0.13487E+06
UNITS	4806	105.53	148.24	21976.	4.0000	900.00
OCCUPY	4806	0.87867	0.15359	0.23589E-01	0.90000E-01	1.0000
PERSON	4806	2.0379	0.68226	0.46548	1.5000	4.5000
WASHER	4806	0.18976	0.39215	0.15378	0.00000	1.0000
DISH	4806	0.51998	0.49965	0.24965	0.00000	1.0000
GARBAGE	4806	0.60778	0.48830	0.23843	0.00000	1.0000
POOL	4806	0.55576	0.62460	0.39013	0.00000	3.0000
NIR	4806	1.9271	0.90350	0.81631	0.20500	4.6300
TURF1	4806	0.06658	0.24933	0.62163E-01	0.00000	1.0000
TURF2	4806	0.09322	0.29077	0.84545E-01	0.00000	1.0000
TURF3	4806	0.05493	0.22787	0.51925E-01	0.00000	1.0000
ET	4806	3.2834	1.1064	1.2242	1.4550	5.3200
ER	4806	1.3563	0.96700	0.93510	0.40000E-01	4.2200
IR1	4806	0.07761	0.26759	0.71603E-01	0.00000	1.0000
IR2	4806	0.37932	0.48527	0.23548	0.00000	1.0000
IR3	4806	0.23804	0.42593	0.18141	0.00000	1.0000
DWELL	4806	120.91	40.610	1649.2	49.000	190.00
MPO	4806	3.0395	1.2246	1.4996	0.67000	7.0500

MODEL SPECIFICATION SELECTED:

```
WATERi,t = UNITSi*OCCUPYi,t*(c1 + c2*PERSONi + c3*MPOi,t)
           + c4*TURF1i + c5*TURF2i + c6*TURF3i
```

MODEL ESTIMATES:

	COEFFICIENT	ST. ERROR	T-RATIO
c1	11.026	7.941	1.388
c2	29.954	2.676	11.16
c3	1.7107	1.934	0.8844
c4	3391.8	1084.	3.130
c5	-808.82	951.2	-0.8495
c6	4748.9	1157.	4.104
Auto	0.85562	0.79358E-02	107.82

R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.6377

Price elasticity at means = 0.0408

Figure 6-2. Car Wash Water Use

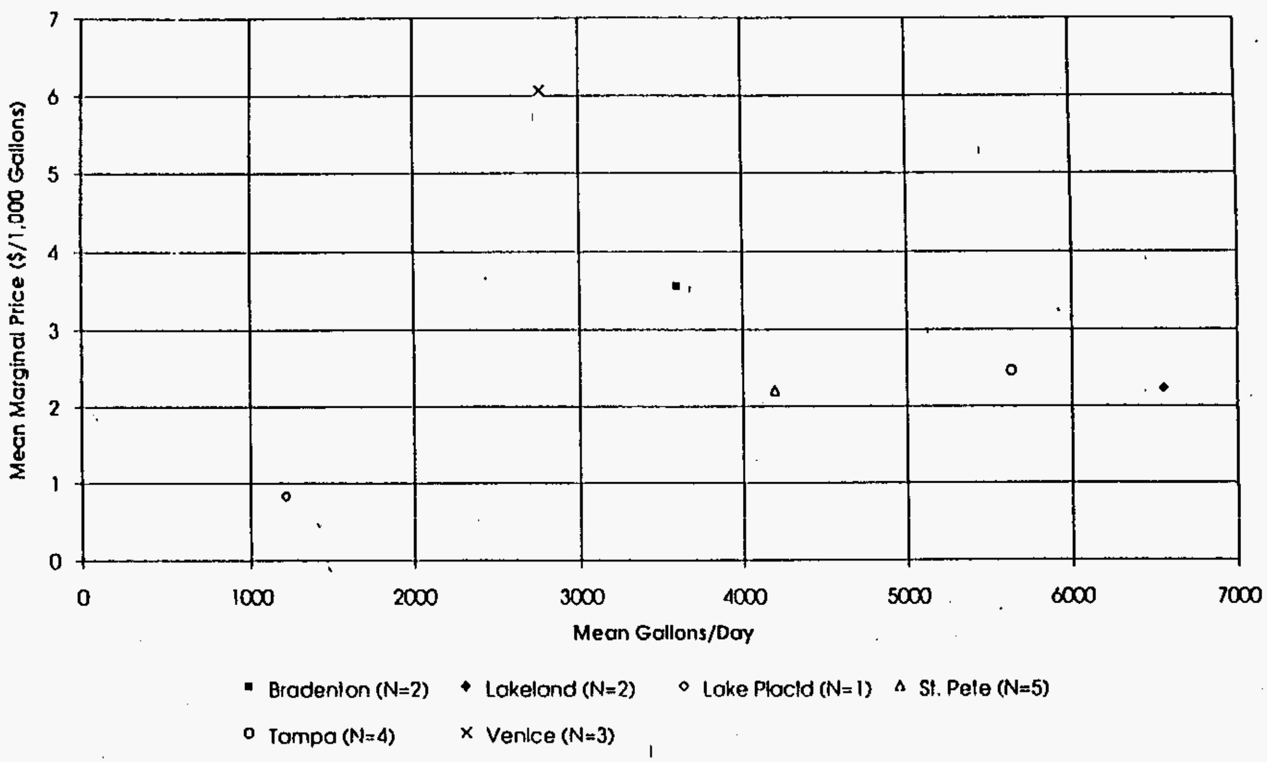


EXHIBIT (JBL-3)
PAGE 71 OF 153

Table 6-4. Car Wash Model

VARIABLE DEFINITIONS:

```
 WATERi,t =gallons/day for car wash i in month t
 SEASONi,t=1 - average monthly business level from mail survey
 BAYSi     =number of wash bays from mail survey
 DAYSOFFi =days per week closed from mail survey
 HOURSi    =number of hours open on Thursdays from mail survey
 RECYCLEi =1 if water recycled; 0 otherwise
 MPOi,t    =marginal water and sewer price in $/1,000 gal
```

VARIABLE DESCRIPTIVE STATISTICS:

NAME	N	MEAN	ST. DEV	VARIANCE	MINIMUM	MAXIMUM
WATER	514	4671.5	2712.9	0.73597E+07	427.63	13684.
SEASON	514	0.21665	0.18749	0.35153E-01	0.00000	0.80000
BAYS	514	2.0156	1.4210	2.0193	1.0000	4.0000
DAYSOFF	514	0.36770	0.48265	0.23295	0.00000	1.0000
HOURS	514	14.617	6.8855	47.410	8.5000	24.000
RECYCLE	514	0.83074	0.37535	0.14089	0.00000	1.0000
MPO	514	2.7423	1.0996	1.2091	1.0700	6.2100

MODEL SPECIFICATION SELECTED:

WATERi,t = c1 + c2*SEASONi,t + c3*MPOi,t

MODEL ESTIMATES:

	COEFFICIENT	ST. ERROR	T-RATIO
c1	8228.9	707.8	11.63
c2	-1193.0	522.3	-2.284
c3	-1186.7	222.4	-5.335
Auto	0.78040	0.28524E-01	27.360

R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.1722
Price elasticity at means = -0.6966

Figure 6-3. Hospital Water Use

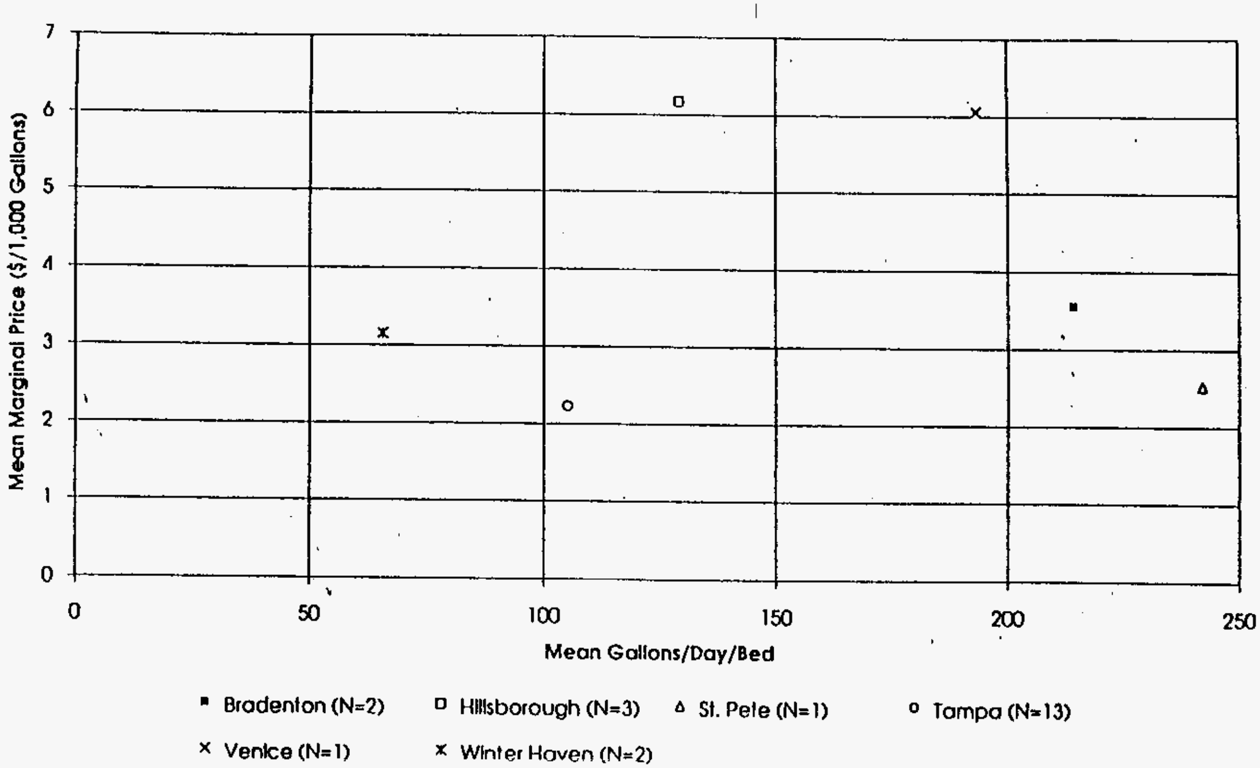


EXHIBIT (JBW-3)
PAGE 73 OF 153

Table 6-5. Hospital Model

VARIABLE DEFINITIONS:

WATERi,t	=gallons/day for hospital i in month t
BEDSi	=number of beds in hospital i
SEASONi,t	=average monthly occupancy rate from mail survey
TURF1i	=1 if uses utility water to irrigate lawn area up to the size of single family lawn
TURF2i	=1 if uses utility water to irrigate lawn area larger than single family lawn but less than 1 acre
TURF3i	=1 if uses utility water to irrigate lawn area of 1 acre or more
NIRi,t	=net irrigation requirement in inches
ETi,t	=evapotranspiration in inches
ERi,t	=effective rainfall in inches
IR1i,t	=1 if irrigation limited to 1 day per week; 0 otherwise
IR2i,t	=1 if irrigation limited to 2 days per week; 0 otherwise
IR3i,t	=1 if irrigation limited to 3 days per week; 0 otherwise
DWELLi	=average well depth in feet in utility serving i
MPOi,t	=marginal water and sewer price in $/1,000 gal

VARIABLE DESCRIPTIVE STATISTICS:

NAME	N	MEAN	ST. DEV	VARIANCE	MINIMUM	MAXIMUM
WATER	671	29482.	28844.	0.83196E+09	1118.4	0.15530E+06
BEDS	671	307.53	283.22	80213.	50.000	1024.0
SEASON	671	0.67154	0.21179	0.44853E-01	0.20000E-01	0.97000
TURF1	671	0.21841E-01	0.14628	0.21397E-01	0.00000	1.0000
TURF2	671	0.62402E-01	0.24207	0.58600E-01	0.00000	1.0000
TURF3	671	0.88924E-01	0.28486	0.81143E-01	0.00000	1.0000
NIR	671	2.0122	0.96021	0.92200	0.20500	4.6300
ET	671	3.9926	1.5170	2.3014	1.5350	6.2650
ER	671	1.4047	1.0718	1.1487	0.40000E-01	4.5250
IR1	671	0.53651E-01	0.22550	0.50849E-01	0.00000	1.0000
IR2	671	0.36215	0.48098	0.23134	0.00000	1.0000
IR3	671	0.29955	0.45840	0.21013	0.00000	1.0000
DWELL	671	142.75	24.540	602.20	69.000	176.00
MPO	671	3.0464	1.4439	2.0847	0.67000	7.0500

MODEL SPECIFICATION SELECTED:

WATERi,t = c1 + c2*BEDSi + c3*BEDSi*MPOi,t

MODEL ESTIMATES:

	COEFFICIENT	ST. ERROR	T-RATIO
c1	7320.8	5448.	1.344
c2	-1.6374	20.23	-0.8093E-01
c3	22.999	6.518	3.529
Auto	0.87592	0.22088E-01	39.656

R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.0439

Price elasticity at means = 0.7680

Figure 6-4. Hotel/Motel Water Use

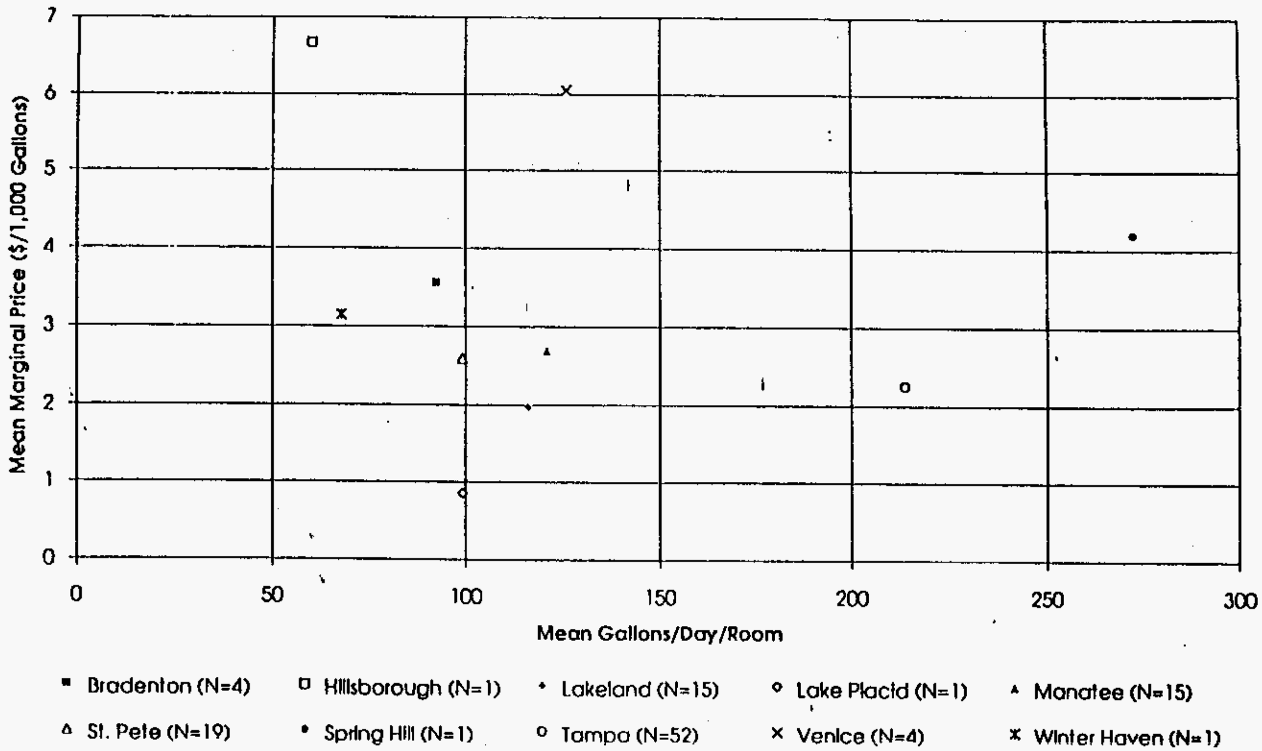


EXHIBIT ____

PAGE 75 OF 153

Results show that only the number of occupied rooms, presence of on-site laundries, and marginal price take on the expected mathematical sign and are significant (5 percent significance level). Price elasticity at the mean water use and price is -0.48 as shown in Table 6-6.

Laundromats

Figure 6-5 plots water use per washer against price for laundromats within each utility. There appears to be a general decrease in water use as price increases. For the 58 laundromats, the average water use is 172 gallons/day/washer.

The model includes number of washers, seasonal business patterns, days open per week, hours open on Thursdays, and marginal price. Number of washers, seasonal business patterns, and marginal price are significant at the 5 percent significance level. Days per week and hours on Thursdays are significant at the 10 percent significance level. Price elasticity at the mean water use and price is -0.14 as shown in Table 6-7.

Nursing Homes

Florida's popularity with retired seniors has lead to a large nursing home industry. Average water use per bed, as plotted on Figure 6-6, equals 96 gallons over the 54 nursing homes in our sample. The water use model accounts for beds, annual occupancy, weather, irrigation restrictions, groundwater depth, and marginal price. Only beds and occupancy prove useful in explaining water use. The price coefficient is positive as shown in Table 6-8.

Office Buildings

Figure 6-7 plots office water use against price for each utility. Over 116 buildings, average gallons/day/1,000 square feet of building equals 92. The selected model includes square footage, marginal price, and turf size as explanatory variables as shown in Table 6-9. Price elasticity at mean water use and price equals -0.33.

Restaurants

Figure 6-8 plots restaurant water use against price. Only sit-down restaurants that served food on plates and used flatware that require washing are included. Average water use in gallons/day/seat was 29 over the 122 restaurants in the sample. From the mail survey, we elicited number of seats, days per week open, business hours on Thursdays, and seasonal business patterns. In our questionnaire, we also asked if the restaurant used disposable dinnerware. A total of 19 replied yes and they are excluded from the analysis. The model finds price elasticity at mean water use and price equal to -0.28 as shown in Table 6-10.

Table 6-6. Hotels/Motel Models

VARIABLE DEFINITIONS:

WATERi,t	=gallons/day for hotel/motel i in month t
ROOMSi	=number of rooms in hotel/motel i
OCCUPYi,t	=average monthly occupancy rate from mail survey
POOLi	=1 if pool from mail survey; 0 otherwise
EATi	=1 if on-site restaurant; 0 otherwise
WASHi	=1 if on-site laundry; 0 otherwise
TURF1i	=1 if uses utility water to irrigate lawn area up to the size of single family lawn
TURF2i	=1 if uses utility water to irrigate lawn area larger than single family lawn but less than 1 acre
TURF3i	=1 if uses utility water to irrigate lawn area of 1 acre or more
ETi,t	=evapotranspiration in inches
ERi,t	=effective rainfall in inches
IR1i,t	=1 if irrigation limited to 1 day per week; 0 otherwise
IR2i,t	=1 if irrigation limited to 2 days per week; 0 otherwise
IR3i,t	=1 if irrigation limited to 3 days per week; 0 otherwise
DWELLi	=average well depth in feet in utility serving i
MPOi,t	=marginal water and sewer price in $/1,000 gal

VARIABLE DESCRIPTIVE STATISTICS:

NAME	N	MEAN	ST. DEV	VARIANCE	MINIMUM	MAXIMUM
WATER	3525	13137.	20443.	0.41792E+09	131.58	0.16944E+06
ROOMS	3525	90.591	97.507	9507.5	6.0000	400.00
OCCUPY	3525	0.64246	0.20192	0.40770E-01	0.40000E-01	1.0000
POOL	3525	0.60879	0.48809	0.23823	0.00000	1.0000
EAT	3525	0.25447	0.43562	0.18977	0.00000	1.0000
WASH	3525	0.83858	0.36797	0.13540	0.00000	1.0000
TURF1	3525	0.19276	0.39453	0.15565	0.00000	1.0000
TURF2	3525	0.66704E-01	0.24954	0.62272E-01	0.00000	1.0000
TURF3	3525	0.16280	0.36924	0.13634	0.00000	1.0000
NIR	3525	1.9729	0.90626	0.82130	0.20500	4.6300
ET	3525	3.8583	1.4534	2.1125	1.3800	6.2650
ER	3525	1.3945	1.0188	1.0380	0.40000E-01	4.3900
IR1	3525	0.61277E-01	0.23987	0.57538E-01	0.00000	1.0000
IR2	3525	0.37730	0.48478	0.23501	0.00000	1.0000
IR3	3525	0.31007	0.46259	0.21399	0.00000	1.0000
DWELL	3525	133.25	36.947	1365.1	49.000	190.00
MPO	3525	2.5048	0.85262	0.72695	0.67000	7.0500

MODEL SPECIFICATION SELECTED:

WATERi,t = ROOMSi*OCCUPYi*(c1 + c2*WASHi - c3*MPOi,t)

MODEL ESTIMATES:

	COEFFICIENT	ST. ERROR	T-RATIO
c1	142.61	33.23	4.292
c2	75.662	24.00	3.153
c3	-44.219	7.326	-6.036
Auto	0.87394	0.00817	106.95144

R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.4340
Price Elasticity at means = -0.4809

Figure 6-5. Laundry Water Use

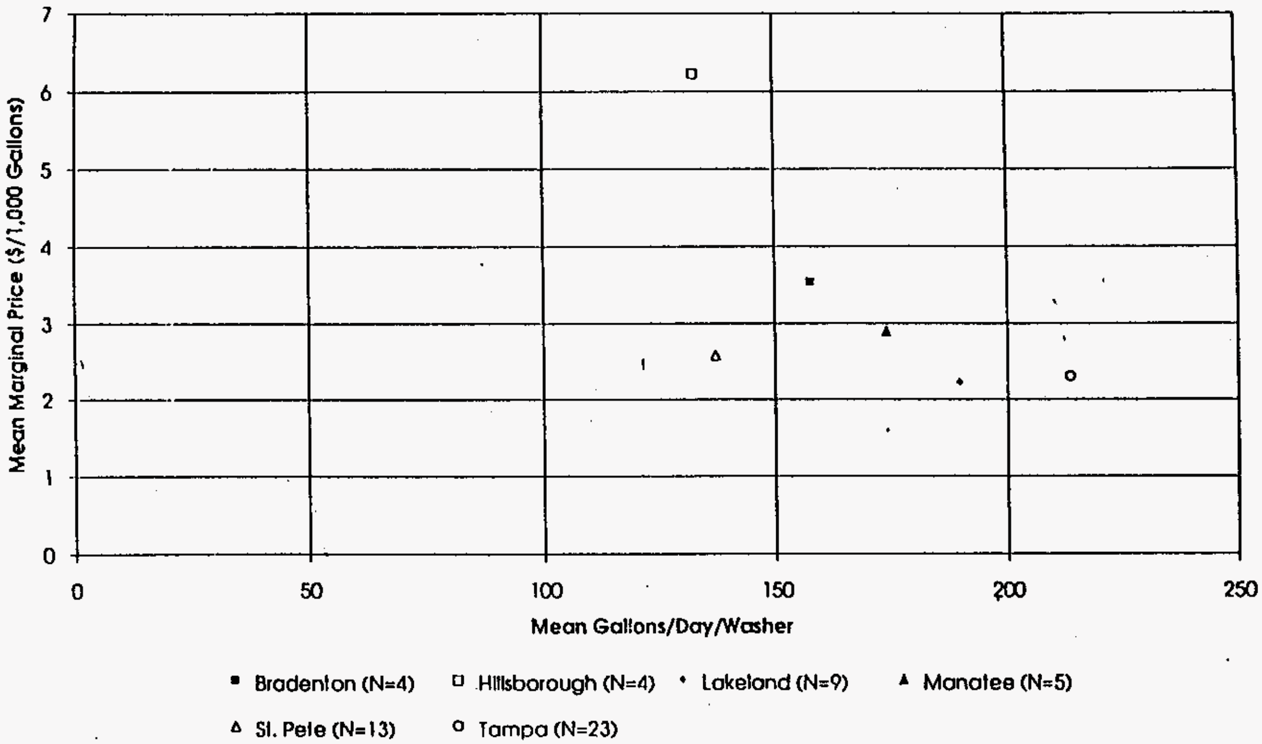


EXHIBIT ____
PAGE 78 OF 153

Table 6-7. Laundry Model

VARIABLE DEFINITIONS:

- WATERi,t =gallons/day for laundromat i in month t
- WASHERSi =number of washers in laundromat i
- SEASONi,t=1 - average monthly business level from mail survey
- DAYSOFFi =days per week closed from mail survey
- HOURSi =number of hours open on Thursdays from mail survey
- MPOi,t =marginal water and sewer price in $/1,000 gal

VARIABLE DESCRIPTIVE STATISTICS:

NAME	N	MEAN	ST. DEV	VARIANCE	MINIMUM	MAXIMUM
WATER	1511	4528.2	4269.5	0.18229E+08	131.58	31382.
WASHERS	1511	26.445	7.9080	62.537	10.000	52.000
SEASON	1511	0.19737	0.16841	0.28361E-01	0.00000	0.93000
DAYSOFF	1511	0.25782E-01	0.24094	0.58053E-01	0.00000	2.0000
HOURS	1511	14.860	2.8690	8.2310	10.000	24.000
MPO	1511	2.9666	1.2824	1.6446	0.68000	7.0500

MODEL SPECIFICATION SELECTED:

WATERi,t = WASHERSi*(c1 + c2*SEASONi,t + c3*DAYSOFFi + c4*HOURSi + c5*MPOi,t)

MODEL ESTIMATES:

	COEFFICIENT	ST. ERROR	T-RATIO
c1	230.39	25.53	9.025
c2	-44.643	22.62	-1.973
c3	-61.587	43.96	-1.401
c4	-1.9950	1.529	-1.304
c5	-7.9343	2.824	-2.810
Auto	0.85172	0.13972E-01	60.957

R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.0616
Price elasticity at means = -0.1423

Figure 6-6. Nursing Home Water Use

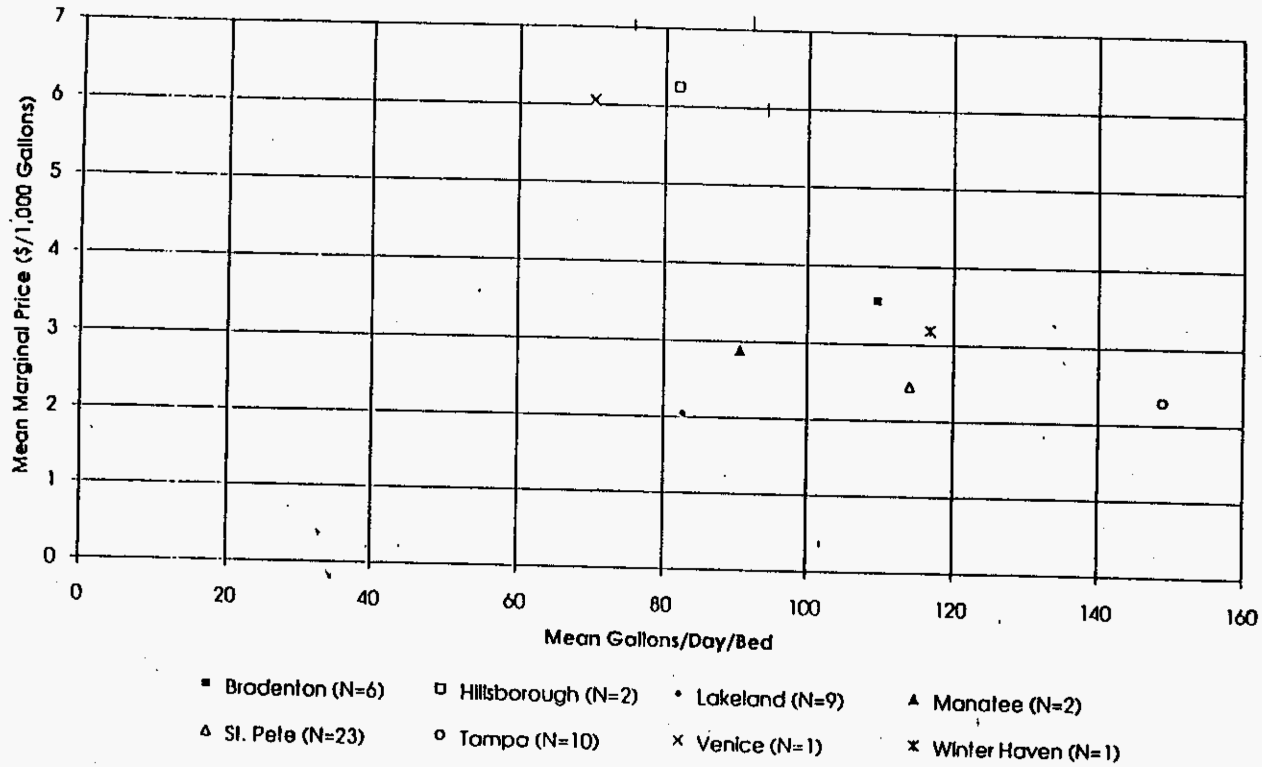


EXHIBIT ____

PAGE 80 OF 153

EXHIBIT (JBW-3)

PAGE 81 OF 153

Table 6-8. Nursing Home Models

VARIABLE DEFINITIONS:

WATERi,t=gallons/day for nursing home i in month t
BEDSi =number of beds in nursing home i
OCCUPYi =average occupancy rate from mail survey
TURF1i =1 if uses utility water to irrigate lawn area up to the size of single family lawn
TURF2i =1 if uses utility water to irrigate lawn area larger than single family lawn but less than 1 acre
TURF3i =1 if uses utility water to irrigate lawn area of 1 acre or more
NIRi,t =net irrigation requirement in inches
ETi,t =evapotranspiration in inches
ERi,t =effective rainfall in inches
IR1i,t =1 if irrigation limited to 1 day per week; 0 otherwise
IR2i,t =1 if irrigation limited to 2 days per week; 0 otherwise
IR3i,t =1 if irrigation limited to 3 days per week; 0 otherwise
DWELLi =average well depth in feet in utility serving i
MPCi,t =marginal water and sewer price in $/1,000 gal

VARIABLE DESCRIPTIVE STATISTICS:

NAME	N	MEAN	ST. DEV	VARIANCE	MINIMUM	MAXIMUM
WATER	1983	11431.	11135.	0.12399E+09	463.82	96036.
BEDS	1983	118.50	109.21	11926.	26.000	700.00
OCCUPY	1983	0.89915	0.12778	0.16327E-01	0.25000	1.0000
TURF1	1983	0.46394E-01	0.21039	0.44264E-01	0.00000	1.0000
TURF2	1983	0.91780E-01	0.28879	0.83399E-01	0.00000	1.0000
TURF3	1983	0.39839E-01	0.19563	0.38271E-01	0.00000	1.0000
NIR	1983	1.9626	0.91831	0.84330	0.20500	4.6300
ET	1983	3.8145	1.4057	1.9760	1.5350	6.2650
ER	1983	1.4438	1.0495	1.1014	0.40000E-01	4.5250
IR1	1983	0.63540E-01	0.24399	0.59533E-01	0.00000	1.0000
IR2	1983	0.33434	0.47188	0.22267	0.00000	1.0000
IR3	1983	0.23701	0.42536	0.18093	0.00000	1.0000
DWELL	1983	112.22	45.738	2092.0	69.000	190.00
MPO	1983	2.6713	0.99180	0.98367	0.67000	7.0500

MODEL SPECIFICATION SELECTED:

WATERi,t = BEDSi*OCCUPYi*(c1 + c2*MPCi,t) + c3*TURF1i*NIRi,t + c4*TURF2i*NIRi,t + c5*TURF3i*NIRi,t

MODEL ESTIMATES:

	COEFFICIENT	ST. ERROR	T-RATIO
c1	74.359	8.123	9.154
c2	8.1467	2.977	2.737
c3	324.62	448.5	0.7237
c4	782.55	320.6	2.441
c5	804.74	485.9	1.656
Auto	0.80659	0.13676E-01	58.979

R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.5421
Price elasticity at means = 0.1897

Figure 6-7. Office Water Use

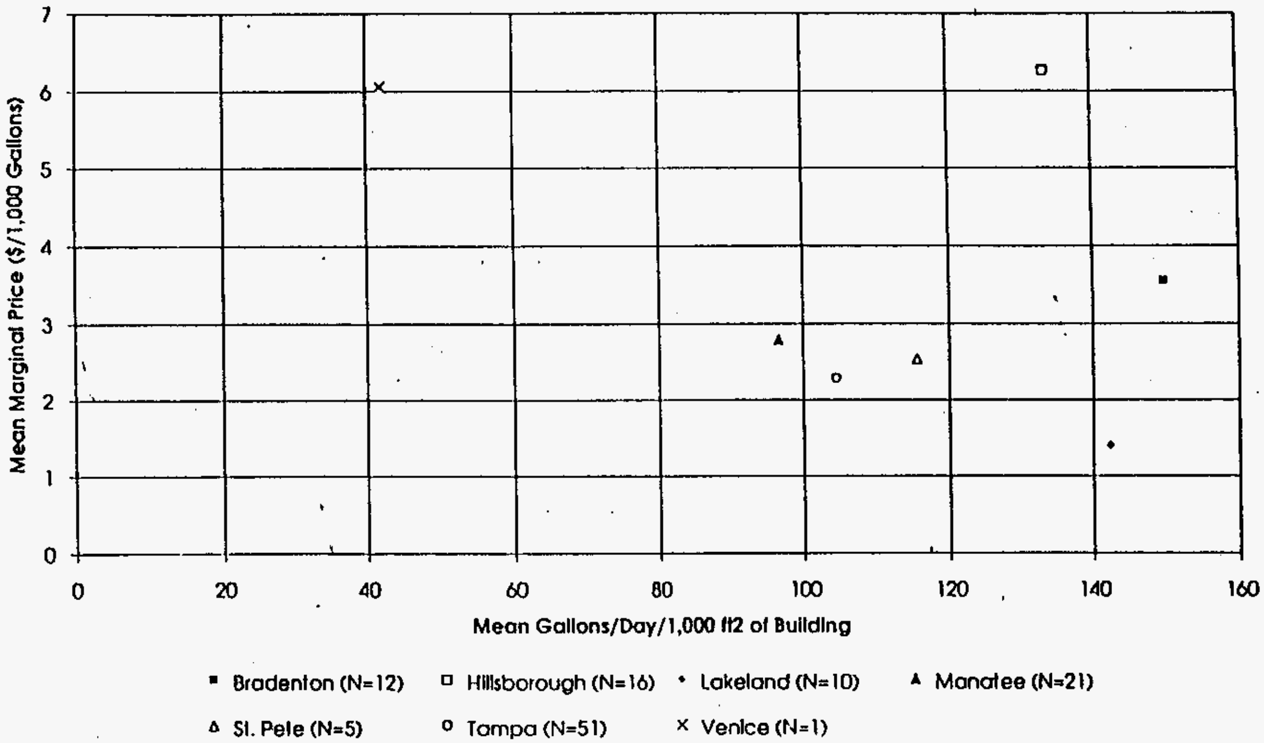


EXHIBIT ___ (JBK-3)
PAGE 82 OF 153

Table 6-9. Office Models

VARIABLE DEFINITIONS:

WATERi,t	=gallons/day for building i in month t
SPACE	=1,000 square feet of building i
TURF1i	=1 if uses utility water to irrigate lawn area up to the size of single family lawn
TURF2i	=1 if uses utility water to irrigate lawn area larger than single family lawn but less than 1 acre
TURF3i	=1 if uses utility water to irrigate lawn area of 1 acre or more
NIRi,t	=net irrigation requirement in inches
ETi,t	=evapotranspiration in inches
ERi,t	=effective rainfall in inches
IR1i,t	=1 if irrigation limited to 1 day per week; 0 otherwise
IR2i,t	=1 if irrigation limited to 2 days per week; 0 otherwise
IR3i,t	=1 if irrigation limited to 3 days per week; 0 otherwise
DWELLi	=average well depth in feet in utility serving i
MPOi,t	=marginal water and sewer price in $/1,000 gal

VARIABLE DESCRIPTIVE STATISTICS:

NAME	N	MEAN	ST. DEV	VARIANCE	MINIMUM	MAXIMUM
WATER	3763	8592.7	18735.	0.35099E+09	16.447	0.23273E+06
SPACE	3763	93.145	118.89	14135.	0.91200	735.63
TURF1	3763	0.60856E-01	0.23910	0.57167E-01	0.00000	1.0000
TURF2	3763	0.33484E-01	0.17992	0.32371E-01	0.00000	1.0000
TURF3	3763	0.62450E-01	0.24200	0.58566E-01	0.00000	1.0000
NIR	3763	1.9637	0.94020	0.88398	0.20500	4.6300
ET	3763	3.9603	1.4924	2.2271	1.5350	6.2650
ER	3763	1.4417	1.0679	1.1404	0.45000E-01	4.5250
IR1	3763	0.60324E-01	0.23812	0.56700E-01	0.00000	1.0000
IR2	3763	0.39304	0.48849	0.23862	0.00000	1.0000
IR3	3763	0.29710	0.45704	0.20889	0.00000	1.0000
DWELL	3763	146.98	25.222	636.17	69.000	190.00
MPO	3763	3.0063	1.5270	2.3317	0.67000	7.0500

MODEL SPECIFICATION SELECTED:

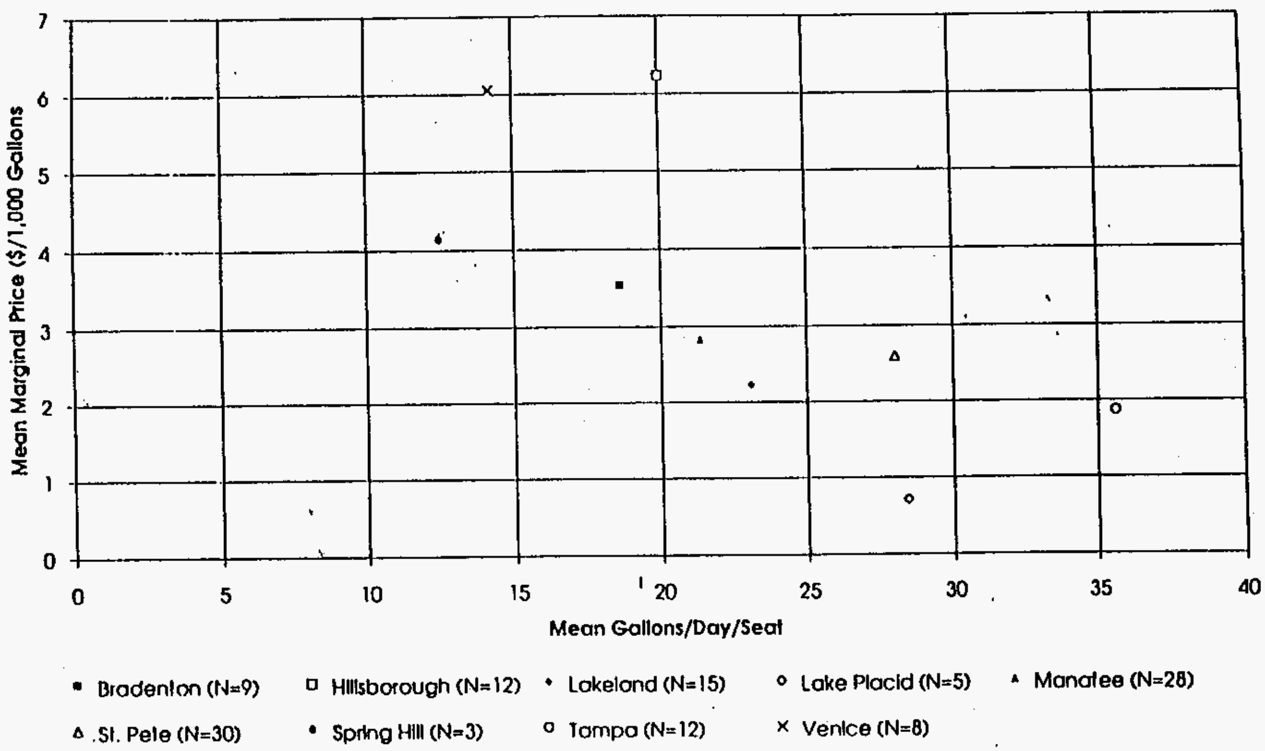
WATERi,t = c1*SPACEi + c2*SPACE*MPOi,t + c3*TURF1i + c4*TURF2i + c5*TURF3i

MODEL ESTIMATES:

	COEFFICIENT	ST. ERROR	T-RATIO
c1	77.276	10.15	7.611
c2	-12.979	4.552	-2.851
c3	334.99	2098.	0.1597
c4	440.64	2641.	0.1669
c5	33069.	2496.	13.25
Auto	0.87818	0.00780	112.62424

R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.2897
Price elasticity at means = -0.3534

Figure 6-8. Restaurant Water Use



EXHIBIT

PAGE 84 OF 153

EXHIBIT (JBW-3)

PAGE 85 OF 153

Table 6-10. Restaurant Models

VARIABLE DEFINITIONS:

WATERi,t	=gallons/day for restaurant i in month t
SEATSi	=number of seats in restaurant i
SEASONi,t=1	- average monthly business level from mail survey
DAYSOFFi	=days per week not open from mail survey
HOURSi	=number of hours open on Thursdays from mail survey
TURF1i	=1 if uses utility water to irrigate lawn area up to the size of single family lawn
TURF2i	=1 if uses utility water to irrigate lawn area larger than single family lawn but less than 1 acre
TURF3i	=1 if uses utility water to irrigate lawn area of 1 acre or more
NIRi,t	=net irrigation requirement in inches
ETi,t	=evapotranspiration in inches
ERi,t	=effective rainfall in inches
IR1i,t	=1 if irrigation limited to 1 day per week; 0 otherwise
IR2i,t	=1 if irrigation limited to 2 days per week; 0 otherwise
IR3i,t	=1 if irrigation limited to 3 days per week; 0 otherwise
DWELLi	=average well depth in feet in utility serving i
MPOi,t	=marginal water and sewer price in $/1,000 gal

VARIABLE DESCRIPTIVE STATISTICS:

NAME	N	MEAN	ST. DEV	VARIANCE	MINIMUM	MAXIMUM
WATER	3274	4719.3	11735.	0.13771E+09	65.789	0.16868E+06
SEATS	3274	164.77	94.750	8977.5	29.000	540.00
SEASON	3274	0.21443	0.15859	0.25149E-01	0.00000	0.90000
DAYSOFF	3274	0.26206	0.50935	0.25944	0.00000	2.0000
HOURS	3274	12.452	4.5335	20.553	6.0000	24.000
TURF1	3274	0.11301	0.31666	0.10027	0.00000	1.0000
TURF2	3274	0.44288E-01	0.20577	0.42340E-01	0.00000	1.0000
TURF3	3274	0.11607E-01	0.10712	0.11475E-01	0.00000	1.0000
NIR	3274	1.8799	0.86385	0.74624	0.20500	4.6300
ET	3274	3.7464	1.3757	1.8925	1.3800	6.2650
ER	3274	1.4835	1.0355	1.0724	0.45000E-01	4.5250
IR1	3274	0.44899E-01	0.20711	0.42896E-01	0.00000	1.0000
IR2	3274	0.41387	0.49260	0.24266	0.00000	1.0000
IR3	3274	0.24863	0.43228	0.18687	0.00000	1.0000
DWELL	3274	125.87	44.870	2013.3	49.000	190.00
MPO	3274	3.1033	1.4990	2.2470	0.00000	7.0500

MODEL SPECIFICATION SELECTED:

WATERi,t = SEATSi*(c1 + c2*SEASONi + c3*DAYSOFFi + c4*HOURSi + c5*MPOi,t) + c6*TURF1i + c7*TURF2i + c8*TURF3i

MODEL ESTIMATES:

	COEFFICIENT	ST. ERROR	T-RATIO
c1	46.412	9.060	5.123
c2	-9.5175	3.847	-2.474
c3	-14.751	5.004	-2.948
c4	-0.69137	0.4862	-1.422
c5	-2.6153	1.844	-1.419
c6	1889.4	1152.	1.640
c7	3337.4	1792.	1.863
c8	4264.9	3732.	1.143
Auto	0.28901	0.00800	111.09146

R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.1898

Price elasticity at means = -0.2843

Schools (Elementary)

With a sample of 67 elementary schools, water use averaged 6 gallons/day/student. Figure 6-9 plots water use against price. Including number of students, weather, groundwater depth, and marginal price, the model estimates price elasticity at mean water use and price to be -0.25 as shown in Table 6-11.

Universities and Colleges

Our sample of universities and colleges equaled only 9. Water use per student is plotted against price for each utility on Figure 6-10. A great variation is water use is shown. The model, shown in Table 6-12, which includes students and marginal water price, finds price elasticity to be -0.98 at the mean water use and price. Because the R^2 of the model is so low (0.001), however, we do not believe inferences are valid in this case. In our opinion, price elasticity is indeterminate.

Figure 6-9. School Water Use

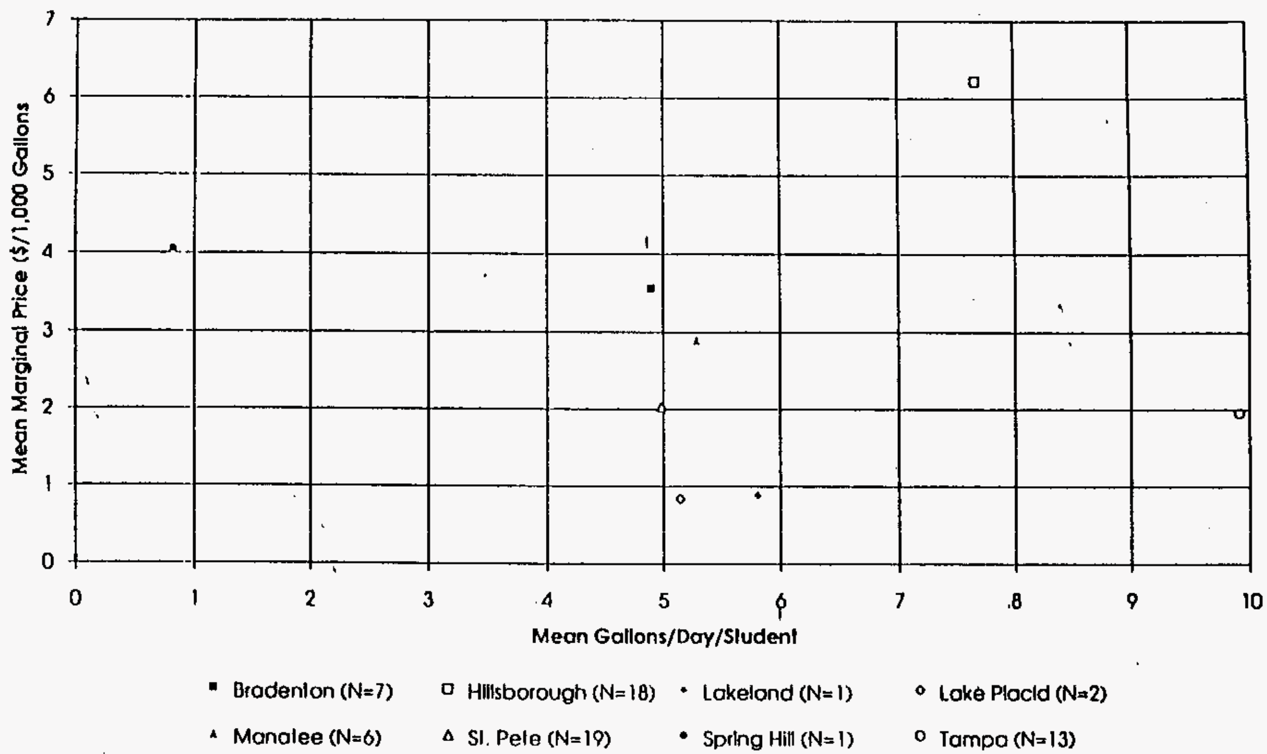


Table 6-11. School Models

VARIABLE DEFINITIONS:

WATERi,t	=gallons/day for school i in month t
STUDENTi,t	=number of students enrolled at school i in month t
ETi,t	=evapotranspiration in inches
ERi,t	=effective rainfall in inches
IR1i,t	=1 if irrigation limited to 1 day per week; 0 otherwise
IR2i,t	=1 if irrigation limited to 2 days per week; 0 otherwise
IR3i,t	=1 if irrigation limited to 3 days per week; 0 otherwise
DWELLi	=average well depth in feet in utility serving i
MPOi,t	=marginal water and sewer price in $/1,000 gal

VARIABLE DESCRIPTIVE STATISTICS:

NAME	N	MEAN	ST. DEV	VARIANCE	MINIMUM	MAXIMUM
WATER	2497	4000.0	3679.2	0.13537E+08	125.00	28289.
STUDENT	2497	665.78	278.03	77301.	46.000	2049.0
ET	2497	3.3121	1.1105	1.2332	1.4550	5.3200
ER	2497	1.3930	1.0012	1.0023	0.45000E-01	4.2200
IR3	2497	0.21025	0.40757	0.16611	0.00000	1.0000
IR2	2497	0.34361	0.47501	0.22563	0.00000	1.0000
IR1	2497	0.68883E-01	0.25331	0.64164E-01	0.00000	1.0000
DWELL	2497	124.14	45.877	2104.7	49.000	190.00
MPO	2497	3.3303	1.9711	3.8852	0.67000	7.0500

MODEL SPECIFICATION SELECTED:

WATERi,t = STUDENTi*(c1 +c2*ETi,t + c3*ERi,t + c4*DWELLi + c5*MPOi,t)

MODEL ESTIMATES:

	COEFFICIENT	ST. ERROR	T-RATIO
c1	2.7264	0.6386	4.269
c2	0.51518	0.1079	4.776
c3	-1.0092	0.9763E-01	-10.34
c4	0.33503E-01	0.5237E-02	6.397
c5	-0.41749	0.1074	-3.888
Auto	0.61573	0.15926E-01	38.661

R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.3163
Price elasticity at means = -0.2472

Figure 6-10. University and College Water Use

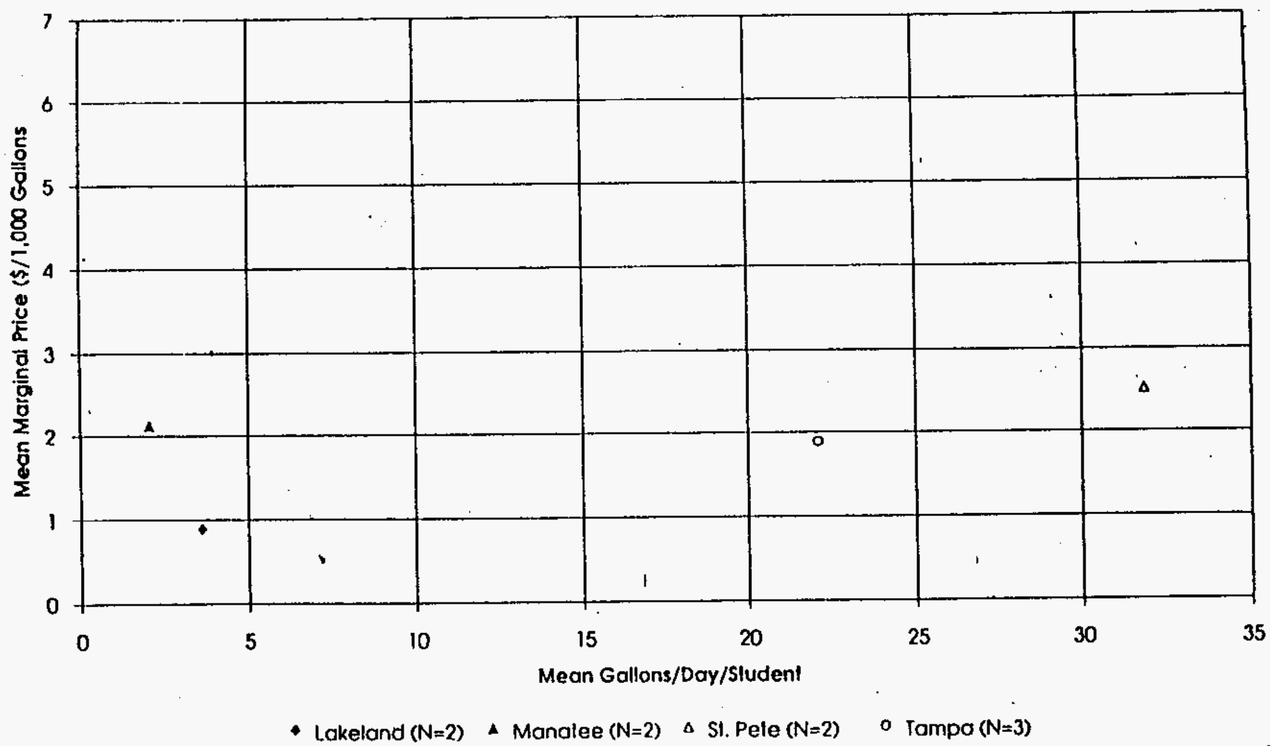


EXHIBIT
PAGE 89 OF 153

Table 6-12. University and College Models

VARIABLE DEFINITIONS:

WATERi,t	=gallons/day for school i in month t
STUDENTi,t	=number of students enrolled at school i in month t
ETi,t	=evapotranspiration in inches
ERi,t	=effective rainfall in inches
IR1i,t	=1 if irrigation limited to 1 day per week; 0 otherwise
IR2i,t	=1 if irrigation limited to 2 days per week; 0 otherwise
IR3i,t	=1 if irrigation limited to 3 days per week; 0 otherwise
DWELLi	=average well depth in feet in utility serving i
MPOi,t	=marginal water and sewer price in $/1,000 gal

VARIABLE DESCRIPTIVE STATISTICS:

NAME	N	MEAN	ST. DEV	VARIANCE	MINIMUM	MAXIMUM
WATER	287	28708.	33288.	0.11081E+10	690.79	0.16655E+06
STUDENT	287	2111.8	2010.7	0.40429E+07	217.00	8529.0
ET	287	3.8783	1.4663	2.1499	1.5350	6.2650
ER	287	1.3674	1.0443	1.0906	0.45000E-01	4.3500
IR1	287	0.66202E-01	0.24907	0.62036E-01	0.00000	1.0000
IR2	287	0.32753	0.47013	0.22102	0.00000	1.0000
IR3	287	0.28223	0.45087	0.20328	0.00000	1.0000
DWELL	287	127.12	42.496	1805.9	69.000	190.00
MPO	287	2.0518	0.79596	0.63355	0.68000	3.1000

MODEL SPECIFICATION SELECTED:

WATERi,t = STUDENTi*(c1 - c2*MPOi,t)

MODEL ESTIMATES:

	COEFFICIENT	ST. ERROR	T-RATIO
c1	22.118	8.326	2.657
c2	-5.5769	2.800	-1.992
Auto	0.76040	0.38598E-01	19.700

R-SQUARE BETWEEN OBSERVED AND PREDICTED = 0.0012
Price elasticity at means = -0.9808

Chapter 7 Analysis of Aggregate Data

EXHIBIT (JBW-3)

PAGE 92 OF 153

CHAPTER 7

ANALYSIS OF AGGREGATE DATA

We have performed a cursory analysis of aggregate water use for the City of Winter Haven in order to determine the price elasticity of aggregate water demand. This empirically determined price elasticity of aggregate demand is compared to the aggregate price elasticity calculated by multiplying the price elasticities for the various customer classes, as determined in our micro analysis, by the weighted average water usage of each customer class to determine if the results are consistent.

Winter Haven Aggregate Data

The City of Winter Haven is selected for our analysis of price elasticity of aggregate demand because it had the largest price increase (27 percent in November 1991) of all ten utilities analyzed over the study period.

Water use information consisted of monthly billing totals for the 4-year period, November 1988 through October 1992. Account information consisted of the number of accounts by customer class on an annual basis. This account information is interpolated to obtain monthly values. The unit of analysis is gallons/day/account for both single-family residential and commercial customer classes.

Water use, in gallons/day/account, is regressed on the weather variables, NIR, ET, and ER. We found only a very weak correlation with NIR, which was not significantly different from zero at the 10 percent significance level for either customer class. The R^2 was 0.06 and 0.001 for the single-family residential and commercial customer classes, respectively. Lagging the weather variables by 1 month or using ET and ER did not improve the correlation. As a consequence, we do not control for weather in our analysis.

Instead, we compare mean water use before and after the November 1991 price increase. As shown in Table 7-1, single-family water use for the 3 years prior to the rate hike is 164 gallons/day/account and for the year after the price hike, it is 136 gallons per day. This 28 gallon/day or 17 percent drop is probably largely due to the 27 percent increase in price (water and sewer charges). This implies an elasticity of -0.56. This estimate happens to nearly coincide with the estimate from the analysis of micro data. As shown on Figure 5-1, price elasticities for low and high value properties at $3/1,000 gallons are -0.32 and -0.76, respectively. Because this aggregate analysis measures the short-term response and the demand curves on Figure 5-1 measure the long-term response, the aggregate price elasticity appears to be high.

Table 7-1 Winter Haven Aggregate Billing Data

	SINGLE FAMILY			COMMERCIAL			REAL				
DATE	TGallons	Accounts	Gal/Day/Acct	TGallons	Accounts	Gal/Day/Acct	PRICE	ET	ER	NIR	IR
Nov-88	63,047	11,689	177	48,618	2,565	624	2.67	2.23	2.23	0.00	7
Dec-88	54,464	11,700	153	43,166	2,563	554	2.67	1.65	0.28	1.37	7
Jan-89	66,331	11,710	186	52,682	2,562	677	2.66	2.11	0.86	1.25	7
Feb-89	62,893	11,721	148	44,667	2,560	574	2.65	2.51	0.05	2.46	7
Mar-89	59,440	11,732	167	48,369	2,559	622	2.63	3.41	0.79	2.62	7
Apr-89	67,186	11,743	188	59,826	2,557	770	2.61	4.38	1.39	2.99	7
May-89	65,397	11,754	183	59,333	2,556	764	2.60	5.52	0.68	4.95	7
Jun-89	78,893	11,765	221	47,143	2,554	607	2.59	5.35	1.77	3.59	7
Jul-89	79,690	11,771	223	61,664	2,562	792	2.59	4.48	2.82	1.66	7
Aug-89	59,145	11,776	165	60,644	2,569	648	2.58	5.33	1.72	3.61	7
Sep-89	55,846	11,782	156	46,740	2,577	697	2.57	4.28	2.46	1.82	3
Oct-89	58,542	11,787	163	51,333	2,584	653	2.56	3.20	0.15	3.04	3
Nov-89	58,387	11,793	163	44,489	2,592	565	2.56	2.26	0.50	1.76	3
Dec-89	63,272	11,798	176	45,672	2,600	578	2.55	1.41	1.41	0.00	3
Jan-90	68,092	11,804	190	64,113	2,607	809	2.53	1.95	0.31	1.64	3
Feb-90	59,624	11,809	166	63,492	2,615	673	2.51	2.60	0.90	1.70	3
Mar-90	53,996	11,815	150	53,234	2,622	668	2.50	3.69	1.07	2.62	3
Apr-90	75,652	11,820	211	67,728	2,630	847	2.50	4.27	0.60	3.67	3
May-90	56,336	11,826	157	51,343	2,637	640	2.49	5.25	1.30	3.94	3
Jun-90	98,638	11,831	274	86,260	2,645	1,073	2.48	5.18	3.25	1.93	3
Jul-90	62,507	11,818	174	53,387	2,666	659	3.00	4.91	3.62	1.29	3
Aug-90	59,193	11,805	165	52,032	2,688	637	2.97	4.73	1.81	2.92	3
Sep-90	55,040	11,792	154	82,987	2,709	1,008	2.95	4.12	0.80	3.32	3
Oct-90	57,074	11,778	159	66,854	2,731	805	2.93	3.18	1.01	2.17	3
Nov-90	54,505	11,765	152	65,410	2,752	782	2.92	2.16	0.22	1.94	3
Dec-90	57,040	11,752	160	66,707	2,774	791	2.92	1.72	0.00	1.72	3
Jan-91	46,152	11,739	129	53,728	2,795	632	2.90	1.86	0.94	0.92	3
Feb-91	39,490	11,726	111	50,585	2,816	591	2.90	2.32	0.22	2.10	3
Mar-91	44,237	11,713	124	52,938	2,838	614	2.89	3.15	1.84	1.31	2
Apr-91	52,625	11,699	148	64,263	2,859	739	2.89	4.29	1.58	2.71	2
May-91	47,776	11,686	134	48,719	2,881	566	2.88	4.71	1.85	2.86	2
Jun-91	57,384	11,673	162	61,484	2,902	697	2.87	5.15	2.18	2.97	2
Jul-91	46,074	11,685	130	45,413	2,901	515	2.87	4.57	4.05	0.52	2
Aug-91	36,995	11,697	104	49,194	2,901	558	2.86	4.83	1.63	3.21	7
Sep-91	48,396	11,710	136	56,227	2,900	638	2.85	4.39	1.24	3.16	7
Oct-91	54,852	11,722	154	58,183	2,899	660	2.84	3.45	1.68	1.77	7
Nov-91	44,100	11,734	124	52,378	2,898	594	3.60	2.10	0.00	2.10	7
Dec-91	57,748	11,746	162	66,367	2,898	754	3.60	1.76	0.08	1.68	7
Jan-92	45,359	11,758	127	49,033	2,897	557	3.59	1.71	0.50	1.21	7
Feb-92	50,608	11,770	141	60,543	2,896	688	3.58	2.23	1.12	1.11	7
Mar-92	42,894	11,783	120	53,978	2,895	613	3.56	3.33	0.39	2.94	2
Apr-92	46,135	11,795	129	51,932	2,895	590	3.55	4.18	1.39	2.79	2
May-92	47,113	11,807	131	50,960	2,894	579	3.55	5.32	0.58	4.73	2
Jun-92	67,102	11,819	187	71,002	2,893	807	3.54	4.69	4.17	0.52	2
Jul-92	44,939	11,819	125	50,049	2,893	569	3.53				
Aug-92	58,936	11,819	164	63,050	2,893	717	3.52				
Sep-92	39,057	11,819	109	48,299	2,893	549	3.51				
Oct-92	41,558	11,819	116	49,303	2,893	561	3.50				
Average			157			671	2.93				
Average Nov88-Oct91			164			684	2.72				
Average Nov91-Oct92			136			632	3.55				
Change			-28			-52	0.83				
% Change			-17.13%			-7.64%	30.51%				
Arc Elasticity			-0.56			-0.25					

For the commercial class, water use drops from 684 to 632 gallons/day/account after the rate increase. This implies an elasticity of -0.25. This seems to be a reasonable number given the results of our commercial class micro analysis. Winter Haven's commercial class includes apartments.

We did not control for irrigation restrictions in our aggregate analysis. Given the results from our empirical study, using micro data, this should not cause much of a distortion. Two- and three-day restrictions for the single-family class were estimated to correlate with a 2.7 and 0.004 percent drop, respectively. Both the pre- and post-periods had restrictions at some time.

To summarize, the aggregate Winter Haven data appears to validate the results of our micro study. If anything, the aggregate data indicate that the price response occurs faster than expected. We would caution, however, anyone from reading too much into the results of this analysis. Factors other than price could have been partially responsibly for the reduction in use after the November 1991 rate increase.

The only purpose for this cursory analysis is to determine if the results of the aggregate analysis reasonably approximate the results of the micro analysis.

EXHIBIT (J)(3)(a)-3)

PAGE 95 OF 153

Appendix A

EXHIBIT ______ (JBW-3)

PAGE 96 OF 153

APPENDIX A

WATER AND SEWER PRICES

Table A-1. Combined Water and Sewer Prices $/1,000 gallons (Not adjusted for inflation).

Utility	Service	Blocks Gallons/Month	Commercial Included	Jul-88	Aug-88	Sep-88	Oct-88	Nov-88	Dec-88	Jan-89	Feb-89	Mar-89	Apr-89	May-89	Jun-89
Bradenton	Water	0-3,000	Yes	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22
		Over 3,000	Yes	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74
	Water & Sewer	0-3,000	Yes	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37
		3,000-25,000	Yes	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42
		Over 25,000	No	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74
Hillsborough	Water	Uniform	Yes	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
	Water & Sewer	0-8,000	Yes	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
		Over 8,000	No	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
Lakeland	Water	0-2,000	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Over 2,000	Yes	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
	Water & Sewer	0-2,000	No	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
		2,000-8,000	Yes	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10
		Over 8,000	No	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Lake Placid	Water & Sewer	0-5,000	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Over 5,000	No	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Manatee	Water	0-15,000	Yes	0.90	0.90	0.90	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
		Over 15,000	Yes	1.00	1.00	1.00	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
	Water & Sewer	0-12,000	Yes	2.74	2.74	2.74	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.64	2.54
		12,000-15,000	No	0.90	0.90	0.90	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
		Over 15,000	Yes	1.00	1.00	1.00	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
St. Pete	Water	0-10,000	Yes	1.01	1.01	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
		10,000-20,000	No	1.05	1.05	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
		Over 20,000	No	1.11	1.11	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13
	Water & Sewer	0-10,000	Yes	2.45	2.45	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98
		10,000-20,000	No	2.49	2.49	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03
		20,000-30,000	No	1.11	1.11	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13
		30,000-40,000	No	1.11	1.11	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13
		Over 40,000	No	1.11	1.11	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13
Spring Hill	Water	Uniform	Yes	0.71	0.71	0.71	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
	Water & Sewer	0-10,000	Yes*	3.28	3.28	3.28	3.37	3.37	3.37	3.37	3.37	3.37	3.37	3.37	3.37
		Over 10,000	No	0.71	0.71	0.71	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
Tampa	Water	0-9,724	No	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
		Over 9,724	No	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
	Water & Sewer	1st Block	Yes	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21
		2nd Block	Yes	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21	2.21
Venice	Water	Uniform	Yes	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91	1.91
	Water & Sewer	Uniform	Yes	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18	4.18
Winter Haven	Water	Uniform	Yes	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
	Water & Sewer	Uniform	Yes	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33

*For Non-residential customers multiply by 1.16

EXHIBIT (JBW-3)
PAGE 97 OF 153

Table A-1. Combined Water and Sewer Prices

Utility	Service	Blocks Gallons/Month	Commercial Included	Jul-89	Aug-89	Sep-89	Oct-89	Nov-89	Dec-89	Jan-90	Feb-90	Mar-90	Apr-90	May-90	Jun-90
Bradenton	Water	0-3,000	Yes	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22
		Over 3,000	Yes	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74
	Water & Sewer	0-3,000	Yes	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37
		3,000-25,000	Yes	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42
		Over 25,000	No	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74
Hillsborough	Water	Uniform	Yes	1.30	1.30	1.30	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45
	Water & Sewer	0-8,000	Yes	5.00	5.00	5.00	5.55	5.55	5.55	5.55	5.55	5.55	5.55	5.66	5.55
		Over 8,000	No	1.30	1.30	1.30	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45
Lakeland	Water	0-2,000	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Over 2,000	Yes	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
	Water & Sewer	0-2,000	No	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
		2,000-8,000	Yes	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10
		Over 8,000	No	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Lake Placid	Water & Sewer	0-5,000	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Over 5,000	No	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Manatee	Water	0-15,000	Yes	0.70	0.70	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
		Over 15,000	Yes	1.05	1.05	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31
	Water & Sewer	0-12,000	Yes	2.54	2.54	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80
		12,000-15,000	No	0.70	0.70	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
		Over 15,000	Yes	1.05	1.05	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31
St. Pete	Water	0-10,000	Yes	0.98	0.98	0.98	0.98	0.98	0.98	1.07	1.07	1.07	1.07	1.07	1.07
		10,000-20,000	No	1.03	1.03	1.03	1.03	1.03	1.03	1.12	1.12	1.12	1.12	1.12	1.12
		Over 20,000	No	1.13	1.13	1.13	1.13	1.13	1.13	1.17	1.17	1.17	1.17	1.17	1.17
	Water & Sewer	0-10,000	Yes	1.98	1.98	1.98	1.98	1.98	1.98	2.43	2.43	2.43	2.43	2.43	2.43
		10,000-20,000	No	2.03	2.03	2.03	2.03	2.03	2.03	2.48	2.48	2.48	2.48	2.48	2.48
		20,000-30,000	No	1.13	1.13	1.13	1.13	1.13	1.13	2.53	2.53	2.53	2.53	2.53	2.53
		30,000-40,000	No	1.13	1.13	1.13	1.13	1.13	1.13	1.17	1.17	1.17	1.17	1.17	1.17
		Over 40,000	No	1.13	1.13	1.13	1.13	1.13	1.13	1.17	1.17	1.17	1.17	1.17	1.17
Spring Hill	Water	Uniform	Yes	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
	Water & Sewer	0-10,000	Yes*	3.37	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40
		Over 10,000	No	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
Tampa	Water	0-9,724	No	0.61	0.61	0.61	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
		Over 9,724	No	0.61	0.61	0.61	0.77	0.77	0.77	1.25	1.25	1.25	1.25	1.25	1.25
	Water & Sewer	1st Block	Yes	2.21	2.21	2.21	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37
		2nd Block	Yes	2.21	2.21	2.21	2.37	2.37	2.37	2.85	2.85	2.85	2.85	2.85	2.85
Venice	Water	Uniform	Yes	1.91	1.91	1.91	1.91	1.91	1.91	2.35	2.35	2.35	2.35	2.35	2.35
	Water & Sewer	Uniform	Yes	4.18	4.18	4.18	4.18	4.18	4.18	5.14	5.14	5.14	5.14	5.14	5.14
Winter Haven	Water	Uniform	Yes	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
	Water & Sewer	Uniform	Yes	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33

*For Non-residential customers multiply by 1.16

EXHIBIT (JPH-3)
PAGE 98 OF 153

Table A-1. Combined Water and Sewer Prices

Utility	Service	Blocks Gallons/Month	Commercial Included	Jul-90	Aug-90	Sep-90	Oct-90	Nov-90	Dec-90	Jan-91	Feb-91	Mar-91	Apr-91	May-91	Jun-91
Bradenton	Water	0-3,000	Yes	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22
		Over 3,000	Yes	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74
	Water & Sewer	0-3,000	Yes	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37
		3,000-25,000	Yes	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42
		Over 25,000	No	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74
Hillsborough	Water	Uniform	Yes	1.45	1.45	1.45	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55
	Water & Sewer	0-8,000	Yes	5.55	5.55	5.55	6.35	6.35	6.35	6.35	6.35	6.35	6.35	6.35	6.35
		Over 8,000	No	1.45	1.45	1.45	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55
Lakeland	Water	0-2,000	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Over 2,000	Yes	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
	Water & Sewer	0-2,000	No	1.25	1.25	1.25	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34
		2,000-8,000	Yes	2.10	2.10	2.10	2.19	2.19	2.19	2.19	2.19	2.19	2.19	2.19	2.19
		Over 8,000	No	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Lake Placid	Water & Sewer	0-5,000	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Over 5,000	No	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Manatee	Water	0-15,000	Yes	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
		Over 15,000	Yes	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31
	Water & Sewer	0-12,000	Yes	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80
		12,000-15,000	No	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
		Over 15,000	Yes	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31
St. Pete	Water	0-10,000	Yes	1.07	1.07	1.07	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
		10,000-20,000	No	1.12	1.12	1.12	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18
		Over 20,000	No	1.17	1.17	1.17	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28
	Water & Sewer	0-10,000	Yes	2.43	2.43	2.43	2.55	2.55	2.55	2.55	2.55	2.55	2.55	2.55	2.55
		10,000-20,000	No	2.48	2.48	2.48	2.65	2.65	2.65	2.65	2.65	2.65	2.65	2.65	2.65
		20,000-30,000	No	2.53	2.53	2.53	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75
		30,000-40,000	No	1.17	1.17	1.17	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75
		Over 40,000	No	1.17	1.17	1.17	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28
Spring Hill	Water	Uniform	Yes	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
	Water & Sewer	0-10,000	Yes*	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.49	3.49
		Over 10,000	No	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
Tampa	Water	0-9,724	No	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
		Over 9,724	No	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
	Water & Sewer	1st Block	Yes	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37
		2nd Block	Yes	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85
Venice	Water	Uniform	Yes	2.35	2.35	2.35	2.35	2.35	2.35	2.70	2.70	2.70	2.70	2.70	2.70
	Water & Sewer	Uniform	Yes	5.14	5.14	5.14	5.14	5.14	5.14	5.91	5.91	5.91	5.91	5.91	5.91
Winter Haven	Water	Uniform	Yes	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
	Water & Sewer	Uniform	Yes	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83

*For Non-residential customers multiply by 1.16

EXHIBIT ___ (JBW-3)
PAGE 99 OF 153

Table A-1. Combined Water and Sewer Prices

Utility	Service	Blocks Gallons/Month	Commercial Included	Jul-91	Aug-91	Sep-91	Oct-91	Nov-91	Dec-91	Jan-92	Feb-92	Mar-92	Apr-92	May-92	Jun-92
Bradenton	Water	0-3,000	Yes	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22
		Over 3,000	Yes	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74
	Water & Sewer	0-3,000	Yes	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37
		3,000-25,000	Yes	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42	3.42
		Over 25,000	No	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74
Hillsborough	Water	Uniform	Yes	1.55	1.55	1.55	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80
	Water & Sewer	0-8,000	Yes	6.35	6.35	6.35	7.05	7.05	7.05	7.05	7.05	7.05	7.05	7.05	7.05
		Over 8,000	No	1.55	1.55	1.55	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80
Lakeland	Water	0-2,000	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Over 2,000	Yes	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
	Water & Sewer	0-2,000	No	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34
		2,000-8,000	Yes	2.19	2.19	2.19	2.19	2.19	2.19	2.19	2.19	2.19	2.19	2.19	2.19
		Over 8,000	No	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Lake Placid	Water & Sewer	0-5,000	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Over 5,000	No	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Manatee	Water	0-15,000	Yes	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
		Over 15,000	Yes	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31
	Water & Sewer	0-12,000	Yes	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80
		12,000-15,000	No	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
		Over 15,000	Yes	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31
St. Pete	Water	0-10,000	Yes	1.08	1.08	1.08	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16
		10,000-20,000	No	1.18	1.18	1.18	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26
		Over 20,000	No	1.28	1.28	1.28	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36
	Water & Sewer	0-10,000	Yes	2.55	2.55	2.55	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88
		10,000-20,000	No	2.65	2.65	2.65	2.98	2.98	2.98	2.98	2.98	2.98	2.98	2.98	2.98
		20,000-30,000	No	2.75	2.75	2.75	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.08
		30,000-40,000	No	2.75	2.75	2.75	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.08
		Over 40,000	No	1.28	1.28	1.28	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.08
Spring Hill	Water	Uniform	Yes	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
	Water & Sewer	0-10,000	Yes*	3.49	3.49	3.49	3.49	3.49	3.49	3.49	3.49	3.49	3.49	3.49	3.49
		Over 10,000	No	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
Tampa	Water	0-9,724	No	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
		Over 9,724	No	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
	Water & Sewer	1st Block	Yes	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37	2.37
		2nd Block	Yes	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85
Venice	Water	Uniform	Yes	2.70	2.70	2.70	2.70	2.70	2.70	2.84	2.84	2.84	2.84	2.84	2.84
	Water & Sewer	Uniform	Yes	5.91	5.91	5.91	5.91	5.91	5.91	6.21	6.21	6.21	6.21	6.21	6.21
Winter Haven	Water	Uniform	Yes	0.89	0.89	0.89	0.89	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
	Water & Sewer	Uniform	Yes	2.83	2.83	2.83	2.83	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59

*For Non-residential customers multiply by 1.16

EXHIBIT ___ (JBW-3)

PAGE 100 OF 153

EXHIBIT (JBW-3)

PAGE 101 OF 153

Appendix B

APPENDIX B

WEATHER DATA

To calculate net irrigation requirement (NIR) for turfgrass, we must calculate both evapotranspiration (ET) and effective rain (ER). Researchers find that ET in Florida is best estimated using a modified Penman equation by Jones et al.[1] as presented in Table B-1. The input into this energy balance equation includes maximum temperature, minimum temperature, incoming solar radiation, and wind speed. ER is the amount of rain that satisfies ET requirements. Because rain can be lost as runoff or can percolate past the rootzone of turf, not all rain is effective at offsetting ET. We use an empirical equation formulated by the United States Agricultural Department-Soil Conservation Service[2] to estimate ER as shown in Table B-2.

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[1]Jones, J. W., et al., *Estimated and Measured Evapotranspiration for Florida Climate, Crops, and Soils*, Bulletin 840, December 1984.

[2]Jensen, M. E., R. D. Burman, and R. G. Allen editors, *Evapotranspiration and Irrigation Water Requirements*, ASCE Manuals and Reports on Engineering Practice No. 70, New York, pp. 67-68, 1990.

B-2

Table B-1. Penman ET Equation

ET_c = $K_c * ET_p$

ET_p =

$$\frac{\Delta}{\Delta+\gamma}[(1-\alpha)R_s-\sigma(T_{ave}+273)^4(0.56-0.08\sqrt{e_d})(1.42\frac{R_s}{R_{so}}-0.42)]/\lambda$$

$$+\frac{\gamma}{\Delta+\gamma}[0.263(e_a-e_d)(0.5+0.0062u_2)]$$

where,

ET_c	=	ET for turfgrass (mm/day)
K_c	=	crop coefficient for turfgrass ≈ 1, given albedo = 0.23
ET_p	=	ET for reference crop (mm/day)
Δ	=	slope of saturated vapor pressure curve of air (mb/°C)
		= 33.8639 [0.05904 $(0.00738*T_{ave} + 0.8072)^7$ - 0.0000342]
γ	=	psychrometric constant = 0.66 (mb/°C)
α	=	albedo of green vegetated surface = 0.23
R_s	=	incoming solar radiation (cal/cm^2/day)
σ	=	Stefan-Boltzmann constant = 11.71 x 10^{-8} (cal/cm_2/day/°K)
T_{min}	=	minimum temperature (°C)
T_{max}	=	maximum temperature (°C)
T_{ave}	=	$(T_{min} + T_{max})/2$ (°C)
e_{min}	=	vapor pressure at minimum temperature (mb)
		= 33.8639 [$(0.00738*T_{min} + 0.8072)^8$ - $0.000019(1.8*T_{min} + 48)$ + 0.001316]
e_{max}	=	vapor pressure at maximum temperature (mb)
		= 33.8639 [$(0.00738*T_{max} + 0.8072)^8$ - $0.000019(1.8*T_{max} + 48)$ + 0.001316]
e_{ave}	=	average vapor pressure (mb) = $(e_{min} + e_{max}) / 2$
λ	=	latent heat of vaporization of water (cal/cm^2/day) = $59.59-0.55*T_{avg}$
u_2	=	wind speed at a height of 2 meters (km/day)
R_{so}	=	cloudless solar radiation (cal/cm^2/day) at following latitudes

Lat.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
27°30'	429	572	615	717	742	787	750	703	649	540	462	397
28°00'	424	567	612	716	742	788	751	703	646	536	457	392
28°30'	419	563	609	715	742	789	752	703	644	532	452	387

Table B-2. USDA-SCS ER Equation

ER = $f(D)*(1.25*RAIN^{0.824} - 2.93)*10^{0.000955*ET}$

where,

f(D) = adjustments for normal depth of water depletion in soil prior to irrigation
ER = effective rain for month (mm)
RAIN = rain for month (mm)
ET = ET for month (mm)

The f(D) term adjusts for water depletion depths different than 75 mm. Smaller depletion depths, which turf certaintly has, allow for less rainfall to become effective. The adjustment term is defined using the equation defined below.

f(D) = $0.53 + 0.0116*D - 8.94*10^{-5}*D^2 + 2.32*10^{-7}*D^3$

where,

D = normal depth of depletion prior to irrigation (mm)

To estimate D, we used the following equation from Keller and Bliesner[3]:

D = $MAD/100 * W_A * Z$

where,

MAD = management allowed deficit (%)
W_A = available water holding capacity of soil (mm/m)
Z = effective root depth (m)

Assuming MAD = 50%, W_A = 42 for deep sand soils and 125 otherwise (sandy loams), and Z = 0.15, then D = 3.15 mm with deep sand soils and 9.375 mm otherwise. Inserting these values into the adjustment term results in f(D) = 0.565 and 0.631 for deep sand soils and other soils respectively.

[3]Keller, J., and R. D. Bliesner, *Sprinkle and Trinkle Irrigation*, Van Nostrand Reinhold, New York, pp. 28-33, 1990.

EXHIBIT (JBW-3)

PAGE 105 OF 153

Table B-3

MONTH	BRADENTON RAIN Inches	AND MANATEE MAX TEMP F	MIN TEMP F	ET PENMAN Inches	EFFECT RAIN Inches	NET IRR REQ Inches
Jul-88	12.94	91.0	73.0	4.70	4.64	0.06
Aug-88	13.63	92.0	74.0	4.44	4.44	0.00
Sep-88	15.57	90.0	73.0	3.89	3.89	0.00
Oct-88	0.58	85.0	62.0	3.22	0.20	3.02
Nov-88	5.15	81.0	61.0	2.41	1.84	0.57
Dec-88	0.92	73.0	51.0	1.61	0.33	1.28
Jan-89	2.66	78.8	55.9	1.98	0.99	0.99
Feb-89	0.13	77.0	53.8	2.57	0.00	2.57
Mar-89	2.97	80.9	59.4	3.41	1.18	2.22
Apr-89	1.38	83.9	60.1	4.27	0.59	3.68
May-89	2.44	88.6	64.9	5.15	1.09	4.06
Jun-89	9.06	91.7	71.6	4.69	3.42	1.28
Jul-89	9.82	93.0	73.1	4.96	3.72	1.25
Aug-89	7.99	93.6	73.2	4.32	3.00	1.32
Sep-89	13.40	91.6	73.0	3.70	3.70	0.00
Oct-89	1.26	85.5	65.7	2.88	0.50	2.38
Nov-89	0.59	81.9	58.9	2.03	0.19	1.84
Dec-89	4.47	70.0	46.0	1.43	1.43	0.00
Jan-90	0.29	78.7	55.0	1.68	0.05	1.63
Feb-90	4.07	80.3	58.5	2.40	1.49	0.91
Mar-90	1.09	81.4	57.5	3.39	0.44	2.95
Apr-90	1.33	84.0	60.0	4.00	0.56	3.44
May-90	1.91	90.4	68.6	5.68	0.89	4.79
Jun-90	8.70	92.2	71.1	4.75	3.31	1.44
Jul-90	8.55	92.4	73.2	4.46	3.21	1.25
Aug-90	6.60	93.7	73.7	4.76	2.61	2.15
Sep-90	3.39	92.3	72.1	3.90	1.37	2.52
Oct-90	7.11	87.7	67.2	3.16	2.54	0.61
Nov-90	2.85	81.2	58.6	2.17	1.06	1.10
Dec-90	2.05	78.3	54.3	1.89	0.77	1.13
Jan-91	3.79	77.1	57.6	1.88	1.36	0.52
Feb-91	1.20	76.2	54.3	2.64	0.47	2.17
Mar-91	1.04	78.7	57.5	2.82	0.40	2.42
Apr-91	4.57	85.9	64.8	3.95	1.80	2.15
May-91	9.39	89.6	69.9	3.89	3.37	0.52
Jun-91	4.15	91.3	71.7	3.76	1.64	2.13
Jul-91	10.61	92.0	73.5	4.05	3.77	0.27
Aug-91	8.18	92.2	74.1	4.19	3.04	1.15
Sep-91	2.74	92.4	72.1	3.36	1.10	2.26
Oct-91	1.21	86.6	65.5	2.65	0.48	2.37
Nov-91	0.06	77.7	54.9	1.89	0.00	1.89
Dec-91	0.44	78.5	53.9	1.64	0.12	1.52
Jan-92	0.98	72.2	48.4	1.59	0.35	1.24
Feb-92	7.13	76.4	54.7	2.11	2.11	0.00
Mar-92	4.05	77.7	55.8	2.95	1.53	1.42
Apr-92	2.93	84.5	61.2	3.60	1.18	2.41
May-92	0.15	86.7	66.6	4.66	0.00	4.66
Jun-92	22.34	91.3	71.1	4.17	4.17	0.00
Min	0.06	70.0	46.0	1.43	0.00	0.00
Max	22.34	93.7	74.1	5.68	4.64	4.79
Average	4.96	84.8	63.5	3.33	1.67	1.66
Annual Ave	59.47			39.97	20.08	19.89

EXHIBIT (JBW-3)

PAGE 106 OF 153

Table B-3

HILLSBOROUGH

MONTH	RAIN Inches	MAX TEMP F	MIN TEMP F	ET PENMAN Inches	EFFECT RAIN Inches	NET IRR REQ Inches
Jul-88	6.66	91.0	74.0	4.74	2.33	2.40
Aug-88	11.39	91.0	74.0	4.41	3.65	0.76
Sep-88	15.72	90.0	74.0	3.92	3.92	0.00
Oct-88	0.27	84.0	63.0	3.22	0.02	3.19
Nov-88	7.60	81.0	61.0	2.39	2.30	0.09
Dec-88	1.36	74.0	52.0	1.62	0.44	1.18
Jan-89	3.55	77.3	56.9	1.95	1.14	0.81
Feb-89	0.26	75.4	54.3	2.53	0.02	2.51
Mar-89	1.47	79.5	60.1	3.38	0.52	2.86
Apr-89	1.07	82.6	61.3	4.28	0.39	3.89
May-89	1.63	89.7	67.1	5.29	0.65	4.64
Jun-89	14.03	91.1	73.6	4.74	4.44	0.30
Jul-89	12.23	91.9	74.6	4.99	4.00	0.99
Aug-89	9.31	91.9	74.0	4.30	3.05	1.25
Sep-89	5.39	90.6	74.1	3.70	1.83	1.87
Oct-89	1.58	84.7	66.0	2.86	0.55	2.31
Nov-89	1.71	79.6	58.1	1.96	0.57	1.39
Dec-89	6.93	66.5	45.8	1.34	1.34	0.00
Jan-90	0.61	76.6	55.5	1.62	0.16	1.46
Feb-90	4.18	78.8	59.5	2.37	1.35	1.02
Mar-90	2.03	80.8	58.5	3.40	0.73	2.67
Apr-90	2.79	82.7	61.4	4.00	1.02	2.98
May-90	1.26	90.0	71.0	5.80	0.51	5.29
Jun-90	4.53	91.7	73.7	4.83	1.67	3.16
Jul-90	12.28	91.3	73.7	4.44	3.90	0.55
Aug-90	9.46	92.7	75.0	4.78	3.17	1.61
Sep-90	3.60	92.4	73.1	3.93	1.29	2.64
Oct-90	2.05	87.2	68.0	3.15	0.72	2.43
Nov-90	2.07	81.5	58.9	2.16	0.69	1.47
Dec-90	0.27	78.1	55.6	1.90	0.02	1.87
Jan-91	3.23	75.6	57.7	1.82	1.04	0.79
Feb-91	0.77	74.3	54.1	2.58	0.24	2.34
Mar-91	5.10	77.1	77.1	3.16	1.69	1.47
Apr-91	3.92	86.2	67.4	4.03	1.40	2.63
May-91	10.34	89.8	72.6	3.95	3.27	0.68
Jun-91	5.86	89.8	72.8	3.74	1.97	1.77
Jul-91	11.56	89.7	74.8	4.01	3.61	0.40
Aug-91	10.03	91.2	75.2	4.19	3.23	0.96
Sep-91	2.28	91.7	72.1	3.33	0.81	2.52
Oct-91	1.00	85.1	65.5	2.80	0.33	2.47
Nov-91	0.38	76.0	55.6	1.84	0.07	1.77
Dec-91	1.06	74.9	54.3	1.55	0.33	1.22
Jan-92	2.05	69.0	50.6	1.52	0.66	0.86
Feb-92	5.15	72.5	54.6	2.01	1.60	0.41
Mar-92	1.60	74.9	54.6	2.84	0.55	2.29
Apr-92	3.69	82.9	62.8	3.58	1.29	2.29
May-92	1.18	88.9	68.9	4.75	0.45	4.31
Jun-92	7.03	90.7	73.0	4.19	2.37	1.82
Min	0.26	66.5	45.8	1.34	0.02	0.00
Max	15.72	92.7	77.1	5.80	4.44	5.29
Average	4.66	83.7	64.8	3.33	1.49	1.85
Annual Ave	55.88			39.97	17.83	22.15

EXHIBIT (JBW-3)

Table B-3

MONTH	LAKELAND RAIN Inches	MAX TEMP F	MIN TEMP F	ET PENMAN Inches	EFFECT RAIN Inches	NET IRR REQ Inches
Jul-88	13.77	94.0	72.0	4.90	4.41	0.49
Aug-88	10.93	94.0	74.0	4.72	3.58	1.14
Sep-88	7.63	92.0	73.0	4.01	2.52	1.49
Oct-88	1.15	86.0	63.0	3.17	0.40	2.77
Nov-88	7.19	82.0	61.0	2.19	2.16	0.03
Dec-88	1.59	75.0	52.0	1.59	0.51	1.08
Jan-89	3.87	79.1	56.4	1.96	1.23	0.73
Feb-89	0.14	79.3	53.2	2.51	0.00	2.51
Mar-89	2.89	83.7	59.4	3.39	1.02	2.37
Apr-89	3.64	86.7	60.7	4.28	1.33	2.96
May-89	1.11	93.1	66.3	5.43	0.43	4.99
Jun-89	7.27	94.7	71.3	5.27	2.60	2.67
Jul-89	4.82	95.0	72.8	4.43	1.72	2.71
Aug-89	6.02	95.6	73.2	5.21	2.19	3.02
Sep-89	15.18	93.2	72.6	4.18	4.18	0.00
Oct-89	0.43	86.2	65.5	3.17	0.10	3.07
Nov-89	1.48	80.4	58.4	2.19	0.49	1.70
Dec-89	5.51	68.5	45.1	1.40	1.40	0.00
Jan-90	0.40	78.9	55.4	1.91	0.08	1.83
Feb-90	4.29	81.4	58.7	2.59	1.40	1.19
Mar-90	1.18	82.3	57.5	3.58	0.42	3.16
Apr-90	1.15	84.9	60.7	4.21	0.42	3.79
May-90	4.40	91.6	69.4	5.28	1.66	3.62
Jun-90	7.24	93.9	72.1	5.32	2.59	2.72
Jul-90	7.66	94.0	73.2	5.00	2.68	2.32
Aug-90	6.35	94.4	73.1	4.94	2.26	2.68
Sep-90	3.33	93.1	72.3	4.26	1.22	3.04
Oct-90	2.22	87.6	67.5	3.29	0.79	2.50
Nov-90	0.86	80.2	59.4	2.24	0.27	1.97
Dec-90	0.35	77.2	54.9	1.69	0.06	1.63
Jan-91	3.12	77.0	55.1	1.78	1.00	0.78
Feb-91	0.59	76.0	53.8	2.26	0.16	2.10
Mar-91	2.47	81.7	58.4	3.13	0.87	2.26
Apr-91	5.34	87.2	65.8	4.24	1.87	2.38
May-91	10.65	90.9	70.6	4.77	3.51	1.25
Jun-91	5.21	92.7	71.2	5.18	1.93	3.25
Jul-91	13.23	92.4	73.1	4.56	4.18	0.38
Aug-91	5.46	93.3	73.8	4.76	1.96	2.80
Sep-91	2.68	92.6	72.4	4.32	1.00	3.32
Oct-91	5.41	84.8	65.7	3.48	1.81	1.66
Nov-91	0.10	75.6	55.7	2.01	0.00	2.01
Dec-91	0.43	76.0	55.8	1.67	0.09	1.57
Jan-92	1.48	71.4	50.0	1.66	0.48	1.18
Feb-92	5.11	76.1	55.0	2.26	1.61	0.65
Mar-92	1.13	79.8	56.6	3.33	0.39	2.94
Apr-92	3.87	86.2	61.8	4.17	1.39	2.78
May-92	1.47	91.4	67.6	5.35	0.58	4.77
Jun-92	13.09	93.6	71.4	4.74	4.18	0.55
Min	0.10	68.5	45.1	1.40	0.00	0.00
Max	15.18	95.6	74.0	5.43	4.41	4.99
Average	4.48	85.6	63.7	3.58	1.48	2.10
Annual Ave	53.72			43.00	17.79	25.21

EXHIBIT (JBW-3)

PAGE 108 OF 153

Table B-3

LAKE PLACID

MONTH	RAIN Inches	MAX TEMP F	MIN TEMP F	ET PENMAN Inches	EFFECT RAIN Inches	NET IRR REQ Inches
Jul-88	9.29	92.0	69.0	4.73	3.50	1.23
Aug-88	10.20	92.0	70.0	4.51	3.74	0.77
Sep-88	2.41	91.0	70.0	3.89	1.00	2.89
Oct-88	1.81	86.0	59.0	2.76	0.71	2.04
Nov-88	3.80	82.0	59.0	1.91	1.36	0.55
Dec-88	1.73	76.0	49.0	1.52	0.64	0.88
Jan-89	2.03	79.9	51.4	1.80	0.76	1.05
Feb-89	0.33	78.6	48.0	2.24	0.07	2.17
Mar-89	4.11	82.6	55.9	3.01	1.56	1.46
Apr-89	2.98	87.1	55.6	3.86	1.22	2.64
May-89	2.21	91.9	60.6	4.63	0.96	3.67
Jun-89	4.79	93.9	67.1	4.59	1.95	2.64
Jul-89	7.60	93.5	68.8	4.69	2.94	1.76
Aug-89	7.80	93.2	68.8	4.37	2.95	1.42
Sep-89	8.10	91.9	69.8	4.01	2.99	1.02
Oct-89	4.35	86.1	63.1	3.05	1.64	1.41
Nov-89	0.97	82.0	55.8	2.07	0.36	1.71
Dec-89	2.54	69.5	43.2	1.38	0.91	0.47
Jan-90	2.21	79.7	53.6	1.88	0.82	1.06
Feb-90	3.27	81.3	56.6	2.45	1.23	1.22
Mar-90	1.79	83.2	54.6	3.42	0.73	2.69
Apr-90	1.34	84.8	55.8	4.09	0.57	3.52
May-90	1.72	91.5	64.9	4.99	0.77	4.22
Jun-90	9.20	93.1	67.3	4.89	3.50	1.39
Jul-90	10.89	93.2	71.0	5.05	4.08	0.97
Aug-90	9.40	93.9	68.5	4.79	3.55	1.24
Sep-90	3.88	92.1	69.3	4.15	1.57	2.58
Oct-90	0.53	87.7	65.3	3.13	0.18	2.96
Nov-90	0.45	82.7	56.3	2.13	0.13	2.00
Dec-90	1.01	79.1	51.3	1.64	0.37	1.27
Jan-91	5.17	78.3	55.4	1.83	1.79	0.04
Feb-91	1.48	77.6	50.5	2.68	0.58	2.10
Mar-91	4.61	81.7	54.7	3.61	1.78	1.83
Apr-91	2.03	87.5	62.1	4.78	0.89	3.89
May-91	5.87	90.9	67.3	5.38	2.44	2.94
Jun-91	7.37	92.3	69.2	5.08	2.92	2.16
Jul-91	8.66	92.3	70.2	4.47	3.25	1.23
Aug-91	7.39	93.5	70.2	4.63	2.85	1.77
Sep-91	4.70	91.4	68.7	4.14	1.87	2.28
Oct-91	2.98	86.2	64.9	3.49	1.19	2.30
Nov-91	0.86	78.2	54.2	2.06	0.31	1.75
Dec-91	0.88	78.0	53.6	1.69	0.31	1.38
Jan-92	0.36	73.1	46.7	1.68	0.08	1.60
Feb-92	4.73	78.3	51.1	2.28	1.69	0.58
Mar-92	2.26	79.7	52.5	3.23	0.91	2.32
Apr-92	4.91	86.1	56.4	4.01	1.93	2.08
May-92	3.84	90.6	63.0	5.11	1.65	3.46
Jun-92	15.77	92.6	67.9	4.59	4.59	0.00
Min	0.33	69.5	43.2	1.38	0.07	0.00
Max	15.77	93.9	71.0	5.38	4.59	4.22
Average	4.30	85.8	60.4	3.47	1.62	1.85
Annual Ave	51.65			41.60	19.45	22.15

Table B-3

ST. PETERSBURG

MONTH	RAIN Inches	MAX TEMP F	MIN TEMP F	ET PENMAN Inches	EFFECT RAIN Inches	NET IRR REQ Inches
Jul-88	7.65	89.0	77.0	4.79	2.97	1.82
Aug-88	10.21	92.0	77.0	4.54	3.75	0.79
Sep-88	25.51	89.0	76.0	3.96	3.96	0.00
Oct-88	0.30	82.0	68.0	3.36	0.06	3.30
Nov-88	6.94	78.0	66.0	2.49	2.40	0.09
Dec-88	0.67	71.0	56.0	1.65	0.23	1.43
Jan-89	1.98	75.3	61.1	2.00	0.75	1.25
Feb-89	0.43	73.1	58.2	2.56	0.12	2.44
Mar-89	2.47	77.2	62.2	3.39	1.00	2.39
Apr-89	0.35	81.1	66.0	4.41	0.09	4.32
May-89	1.05	86.1	71.6	5.40	0.47	4.93
Jun-89	8.46	88.5	75.3	4.72	3.23	1.50
Jul-89	7.72	90.8	77.5	5.08	3.04	2.04
Aug-89	5.73	90.5	77.1	4.36	2.25	2.11
Sep-89	7.70	88.8	76.4	3.72	2.81	0.91
Oct-89	1.52	82.3	69.4	2.88	0.60	2.28
Nov-89	1.68	77.2	62.6	1.97	0.64	1.33
Dec-89	2.92	65.2	48.9	1.35	1.04	0.31
Jan-90	0.47	73.2	57.5	1.56	0.14	1.42
Feb-90	5.35	76.0	61.3	2.33	1.89	0.44
Mar-90	1.17	77.4	63.0	3.45	0.48	2.97
Apr-90	0.69	79.9	65.7	4.06	0.27	3.79
May-90	1.95	86.5	73.2	5.82	0.91	4.91
Jun-90	11.02	89.3	75.6	4.82	4.07	0.75
Jul-90	7.57	89.6	76.1	4.47	2.89	1.58
Aug-90	5.44	89.8	77.7	4.81	2.21	2.60
Sep-90	1.84	89.0	76.6	3.95	0.78	3.18
Oct-90	1.28	84.1	71.8	3.20	0.52	2.68
Nov-90	0.88	78.0	63.6	2.18	0.32	1.86
Dec-90	0.24	75.2	58.8	1.96	0.02	1.94
Jan-91	6.20	73.3	60.3	1.82	1.82	0.00
Feb-91	0.55	72.5	57.8	2.63	0.18	2.44
Mar-91	1.07	74.6	74.6	3.04	0.42	2.61
Apr-91	2.11	83.5	69.7	4.03	0.89	3.14
May-91	7.16	87.3	74.5	3.92	2.67	1.25
Jun-91	2.74	89.3	76.3	3.78	1.12	2.66
Jul-91	10.57	90.4	77.3	4.08	3.77	0.32
Aug-91	6.47	89.9	78.1	4.25	2.49	1.76
Sep-91	6.21	89.4	76.4	3.36	2.29	1.07
Oct-91	1.08	82.5	70.4	2.85	0.42	2.42
Nov-91	0.20	73.0	59.3	1.82	0.00	1.82
Dec-91	0.62	73.6	58.0	1.56	0.20	1.36
Jan-92	2.80	67.2	53.2	1.50	1.01	0.49
Feb-92	4.52	71.6	57.6	2.02	1.60	0.41
Mar-92	2.41	74.1	59.6	2.92	0.95	1.97
Apr-92	2.89	80.9	66.6	3.61	1.17	2.45
May-92	0.22	86.0	72.1	4.79	0.02	4.77
Jun-92	6.94	88.8	75.8	4.21	2.64	1.57
Min	0.20	65.2	48.9	1.35	0.00	0.00
Max	25.51	92.0	78.1	5.82	4.07	4.93
Average	4.08	81.5	68.0	3.36	1.41	1.96
Annual Ave	48.99			40.35	16.89	23.46

EXHIBIT (JBW-3)

PAGE 110 OF 153

Table B-3

SPRING HILL

MONTH	RAIN Inches	MAX TEMP F	MIN TEMP F	ET PENMAN Inches	EFFECT RAIN Inches	NET IRR REQ Inches
Jul-88	5.18	93.0	67.0	4.57	1.85	2.72
Aug-88	8.01	93.0	67.0	4.24	2.67	1.57
Sep-88	18.35	92.0	66.0	3.72	3.72	0.00
Oct-88	0.78	87.0	52.0	2.77	0.25	2.52
Nov-88	3.61	83.0	51.0	1.94	1.15	0.78
Dec-88	1.82	75.0	42.0	1.43	0.58	0.84
Jan-89	2.60	79.0	47.8	1.73	0.84	0.89
Feb-89	0.70	79.3	44.7	2.21	0.21	2.01
Mar-89	1.84	80.8	52.2	2.95	0.64	2.30
Apr-89	2.70	84.7	52.7	3.26	0.95	2.32
May-89	2.81	88.9	58.2	4.75	1.07	3.68
Jun-89	8.23	92.4	69.2	3.60	2.63	0.96
Jul-89	5.59	92.4	71.6	4.98	2.03	2.95
Aug-89	7.20	91.8	70.9	4.50	2.47	2.03
Sep-89	9.74	91.4	71.3	3.46	3.02	0.44
Oct-89	1.63	84.5	61.6	2.69	0.56	2.13
Nov-89	2.92	79.2	53.9	1.79	0.94	0.85
Dec-89	5.69	63.0	38.1	1.20	1.20	0.00
Jan-90	2.32	75.5	48.7	1.81	0.76	1.05
Feb-90	5.61	78.9	54.8	2.16	1.74	0.42
Mar-90	3.54	81.2	54.4	3.07	1.21	1.87
Apr-90	0.47	84.9	57.8	4.19	0.13	4.07
May-90	0.86	91.4	67.3	4.56	0.31	4.25
Jun-90	6.75	93.7	71.4	4.66	2.35	2.31
Jul-90	14.80	93.5	73.6	4.41	4.41	0.00
Aug-90	3.73	94.1	73.6	4.24	1.35	2.89
Sep-90	4.09	93.9	70.4	3.89	1.44	2.44
Oct-90	3.69	88.5	65.6	2.98	1.25	1.74
Nov-90	0.94	83.2	56.2	2.12	0.30	1.82
Dec-90	0.36	79.4	53.0	1.79	0.06	1.73
Jan-91	3.59	76.6	55.9	1.79	1.14	0.66
Feb-91	1.67	76.5	52.0	2.22	0.56	1.66
Mar-91	4.95	79.2	54.8	2.94	1.62	1.32
Apr-91	5.38	87.5	64.4	3.86	1.84	2.02
May-91	7.50	91.8	69.2	4.56	2.56	2.00
Jun-91	4.98	91.7	70.1	4.50	1.78	2.72
Jul-91	10.10	92.7	74.1	4.08	3.23	0.85
Aug-91	11.97	93.4	73.9	3.71	3.66	0.05
Sep-91	3.35	93.7	70.4	3.35	1.17	2.18
Oct-91	1.50	86.8	62.3	2.43	0.51	1.92
Nov-91	0.67	79.8	52.7	1.87	0.19	1.68
Dec-91	1.27	78.8	51.3	1.57	0.41	1.16
Jan-92	1.34	73.9	43.7	1.56	0.43	1.13
Feb-92	3.95	76.2	51.9	1.94	1.25	0.69
Mar-92	0.90	77.6	53.4	2.87	0.29	2.58
Apr-92	3.04	85.0	57.2	3.56	1.08	2.48
May-92	0.75	89.5	63.4	4.72	0.26	4.46
Jun-92	6.09	92.5	69.2	4.36	2.11	2.24
Min	0.36	63.0	38.1	1.20	0.06	0.00
Max	18.35	94.1	74.1	4.98	4.41	4.46
Average	4.37	85.2	59.9	3.16	1.38	1.78
Annual Ave	52.39			37.99	16.54	21.35

Table B-3

TAMPA

MONTH	RAIN Inches	MAX TEMP F	MIN TEMP F	ET PENMAN Inches	EFFECT RAIN Inches	NET IRR REQ Inches
Jul-88	3.40	91.0	74.0	4.74	1.44	3.29
Aug-88	11.09	91.0	74.0	4.41	4.00	0.41
Sep-88	13.56	90.0	74.0	3.92	3.92	0.00
Oct-88	0.09	84.0	63.0	3.22	0.00	3.22
Nov-88	5.97	81.0	61.0	2.39	2.09	0.30
Dec-88	1.64	74.0	52.0	1.62	0.61	1.01
Jan-89	1.54	77.3	56.9	1.95	0.58	1.37
Feb-89	0.41	75.4	54.3	2.53	0.11	2.42
Mar-89	1.79	79.5	60.1	3.38	0.73	2.65
Apr-89	0.71	82.6	61.3	4.28	0.28	4.00
May-89	0.24	89.7	67.1	5.29	0.03	5.26
Jun-89	7.41	91.1	73.6	4.74	2.88	1.86
Jul-89	8.86	91.9	74.6	4.99	3.41	1.58
Aug-89	7.90	91.9	74.0	4.30	2.97	1.33
Sep-89	6.11	90.6	74.1	3.70	2.30	1.40
Oct-89	1.89	84.7	66.0	2.86	0.75	2.11
Nov-89	2.05	79.6	58.1	1.96	0.77	1.19
Dec-89	4.72	66.5	45.8	1.34	1.34	0.00
Jan-90	0.53	76.6	55.5	1.62	0.16	1.46
Feb-90	4.58	78.8	59.5	2.37	1.65	0.71
Mar-90	1.71	80.8	56.5	3.40	0.70	2.70
Apr-90	1.47	82.7	61.4	4.00	0.62	3.38
May-90	1.76	90.0	71.0	5.80	0.82	4.98
Jun-90	5.16	91.7	73.7	4.83	2.11	2.72
Jul-90	10.01	91.3	73.7	4.44	3.67	0.77
Aug-90	3.27	92.7	75.0	4.78	1.40	3.38
Sep-90	2.42	92.4	73.1	3.93	1.01	2.92
Oct-90	2.63	87.2	68.0	3.15	1.04	2.11
Nov-90	0.66	81.5	58.9	2.16	0.23	1.93
Dec-90	0.19	78.1	55.6	1.90	0.00	1.90
Jan-91	2.41	75.6	57.7	1.82	0.89	0.93
Feb-91	0.41	74.3	54.1	2.58	0.11	2.46
Mar-91	1.27	77.1	77.1	3.16	0.51	2.65
Apr-91	1.54	86.2	67.4	4.03	0.65	3.38
May-91	6.88	89.8	72.6	3.95	2.58	1.37
Jun-91	3.78	89.8	72.8	3.74	1.50	2.24
Jul-91	9.92	89.7	74.8	4.01	3.55	0.45
Aug-91	7.35	91.2	75.2	4.19	2.77	1.42
Sep-91	3.43	91.7	72.1	3.33	1.35	1.99
Oct-91	0.78	85.1	65.5	2.80	0.29	2.51
Nov-91	0.30	76.0	55.6	1.84	0.06	1.79
Dec-91	0.67	74.9	54.3	1.55	0.22	1.32
Jan-92	1.47	69.0	50.6	1.52	0.54	0.98
Feb-92	3.67	72.5	54.6	2.01	1.33	0.68
Mar-92	0.95	74.9	54.6	2.84	0.37	2.48
Apr-92	2.17	82.9	62.8	3.58	0.89	2.69
May-92	0.10	88.9	68.9	4.75	0.00	4.75
Jun-92	7.03	90.7	73.0	4.19	2.67	1.53
Min	0.09	66.5	45.8	1.34	0.00	0.00
Max	13.56	92.7	77.1	5.80	4.00	5.26
Average	3.50	83.7	64.8	3.33	1.29	2.04
Annual Ave	41.98			39.97	15.48	24.49

EXHIBIT (JBW-3)

PAGE 112 OF 153

Table B-3

VENICE

MONTH	RAIN Inches	MAX TEMP F	MIN TEMP F	ET PENMAN Inches	EFFECT RAIN Inches	NET IRR REQ Inches
Jul-88	5.04	89.0	73.0	4.64	2.04	2.60
Aug-88	8.78	92.0	77.0	4.54	3.30	1.25
Sep-88	10.12	95.0	81.0	4.31	3.68	0.64
Oct-88	0.75	85.0	62.0	3.22	0.28	2.94
Nov-88	3.47	81.0	61.0	2.41	1.29	1.12
Dec-88	1.53	77.0	56.0	1.79	0.57	1.21
Jan-89	2.75	78.9	60.8	2.09	1.02	1.07
Feb-89	0.15	77.8	58.3	2.69	0.00	2.69
Mar-89	2.65	79.2	61.7	3.43	1.07	2.37
Apr-89	0.59	81.7	62.9	4.31	0.22	4.09
May-89	0.06	86.3	67.7	5.21	0.00	5.21
Jun-89	8.50	88.2	74.0	4.67	3.23	1.44
Jul-89	5.44	93.0	73.1	4.96	2.23	2.74
Aug-89	5.53	93.6	73.2	4.32	2.18	2.14
Sep-89	8.78	91.9	78.5	3.87	3.18	0.69
Oct-89	1.86	85.5	65.7	2.88	0.74	2.14
Nov-89	0.98	79.3	59.1	1.98	0.36	1.62
Dec-89	4.12	67.1	47.1	1.39	1.39	0.00
Jan-90	0.27	78.7	55.0	1.68	0.04	1.64
Feb-90	3.00	80.3	58.5	2.40	1.13	1.27
Mar-90	1.09	81.4	57.5	3.39	0.44	2.95
Apr-90	1.33	84.0	60.0	4.00	0.56	3.44
May-90	1.91	90.4	68.6	5.68	0.89	4.79
Jun-90	8.70	92.2	71.1	4.75	3.31	1.44
Jul-90	8.55	92.4	73.2	4.46	3.21	1.25
Aug-90	6.60	93.7	73.7	4.76	2.61	2.15
Sep-90	3.39	92.3	72.1	3.90	1.37	2.52
Oct-90	7.11	87.7	67.2	3.16	2.54	0.61
Nov-90	2.85	81.2	58.6	2.17	1.06	1.10
Dec-90	2.05	78.3	54.3	1.89	0.77	1.13
Jan-91	3.79	77.1	57.6	1.88	1.36	0.52
Feb-91	1.20	76.2	54.3	2.64	0.47	2.17
Mar-91	1.04	78.7	57.5	2.82	0.40	2.42
Apr-91	4.57	85.9	64.8	3.95	1.80	2.15
May-91	9.39	89.6	69.9	3.89	3.37	0.52
Jun-91	4.15	91.3	71.7	3.76	1.64	2.13
Jul-91	10.61	92.0	73.5	4.05	3.77	0.27
Aug-91	8.18	92.2	74.1	4.19	3.04	1.15
Sep-91	2.74	92.4	72.1	3.36	1.10	2.26
Oct-91	1.21	86.6	65.5	2.85	0.48	2.37
Nov-91	0.06	77.7	54.9	1.89	0.00	1.89
Dec-91	0.44	78.5	53.9	1.64	0.12	1.51
Jan-92	0.98	72.2	48.4	1.59	0.35	1.24
Feb-92	4.37	76.4	54.7	2.11	1.56	0.54
Mar-92	2.62	78.1	57.9	3.00	1.03	1.97
Apr-92	1.65	82.4	62.2	3.56	0.68	2.88
May-92	1.78	87.1	67.6	4.65	0.78	3.87
Jun-92	25.91	89.7	72.0	4.14	4.14	0.00
Min	0.06	67.1	47.1	1.39	0.00	0.00
Max	25.91	95.0	81.0	5.68	4.14	5.21
Average	4.22	84.5	64.5	3.35	1.48	1.86
Annual Ave	50.66			40.23	17.70	22.32

Table B-3

MONTH	WINTER HAVEN RAIN Inches	MAX TEMP F	MIN TEMP F	ET PENMAN Inches	EFFECT RAIN Inches	NET IRR REQ Inches
Jul-88	3.69	92.0	72.0	4.84	1.38	3.46
Aug-88	10.93	94.0	74.0	4.72	3.58	1.14
Sep-88	8.08	91.0	72.0	3.95	2.64	1.31
Oct-88	1.27	85.0	64.0	3.18	0.44	2.74
Nov-88	7.81	82.0	63.0	2.23	2.23	0.00
Dec-88	0.91	75.0	55.0	1.65	0.28	1.37
Jan-89	2.62	81.3	61.5	2.11	0.86	1.25
Feb-89	0.32	80.0	52.3	2.51	0.05	2.46
Mar-89	2.20	83.9	59.9	3.41	0.79	2.62
Apr-89	3.80	86.8	63.3	4.38	1.39	2.99
May-89	1.44	90.4	69.9	5.52	0.58	4.95
Jun-89	4.68	94.1	73.8	5.35	1.77	3.59
Jul-89	8.41	94.2	75.3	4.48	2.82	1.66
Aug-89	4.56	95.5	75.6	5.33	1.72	3.61
Sep-89	7.28	92.1	75.8	4.28	2.46	1.82
Oct-89	0.55	84.5	67.5	3.20	0.15	3.04
Nov-89	1.49	80.3	61.3	2.26	0.50	1.76
Dec-89	5.35	68.1	46.5	1.41	1.41	0.00
Jan-90	0.97	79.5	56.7	1.95	0.31	1.64
Feb-90	2.65	79.5	61.1	2.60	0.90	1.70
Mar-90	3.00	81.1	61.5	3.69	1.07	2.62
Apr-90	1.60	84.4	62.9	4.27	0.60	3.67
May-90	3.37	92.2	68.3	5.25	1.30	3.94
Jun-90	9.47	92.9	69.6	5.18	3.25	1.93
Jul-90	10.93	93.2	71.4	4.91	3.62	1.29
Aug-90	5.00	92.3	69.8	4.73	1.81	2.92
Sep-90	2.16	91.3	69.9	4.12	0.80	3.32
Oct-90	2.89	85.6	65.7	3.18	1.01	2.17
Nov-90	0.73	77.2	58.4	2.16	0.22	1.94
Dec-90	0.07	78.7	55.1	1.72	0.00	1.72
Jan-91	2.89	78.6	59.1	1.86	0.94	0.92
Feb-91	0.73	77.0	56.0	2.32	0.22	2.10
Mar-91	5.61	80.5	60.7	3.15	1.84	1.31
Apr-91	4.42	86.5	67.8	4.29	1.58	2.71
May-91	5.13	89.5	70.2	4.71	1.85	2.86
Jun-91	6.01	91.6	71.4	5.15	2.18	2.97
Jul-91	12.73	92.3	73.3	4.57	4.05	0.52
Aug-91	4.41	92.6	75.9	4.83	1.63	3.21
Sep-91	3.35	91.4	74.9	4.39	1.24	3.16
Oct-91	4.98	85.5	64.6	3.45	1.68	1.77
Nov-91	0.20	77.7	58.1	2.10	0.00	2.10
Dec-91	0.40	78.0	58.7	1.76	0.08	1.68
Jan-92	1.54	71.6	53.3	1.71	0.50	1.21
Feb-92	3.42	75.9	52.7	2.23	1.12	1.11
Mar-92	1.13	79.8	56.6	3.33	0.39	2.94
Apr-92	3.87	85.7	62.5	4.18	1.39	2.79
May-92	1.47	90.3	67.6	5.32	0.58	4.73
Jun-92	13.09	92.7	71.0	4.69	4.17	0.52
Min	0.07	68.1	46.5	1.41	0.00	0.00
Max	13.09	95.5	75.9	5.52	4.17	4.95
Average	4.03	85.3	64.7	3.60	1.36	2.23
Annual Ave	48.40			43.15	16.35	26.80

EXHIBIT (JBW-3)

PAGE 114 OF 153

APPENDIX B

WEATHER DATA

EXHIBIT (JBW-3)

PAGE 115 OF 153

Appendix C

APPENDIX C

SINGLE-FAMILY TELEPHONE SURVEY AND RESULTS

EXHIBIT ______ (JBW-3)

PAGE 117 OF 153

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

TELEPHONE SURVEY QUESTIONNAIRE - SINGLE FAMILY RESIDENTIAL

IDENTIFICATION:

Name of Interviewer: ______________________________

Date: ____________________ Time: __________ p.m.

BC ID Number: ____________________

Name, Address and Phone Number of Person Interviewed:

____

____

____

____

SINGLE FAMILY RESIDENTIAL

Hi, my name is ______________________, and I'm working with the Southwest Florida Water Management District. I'm sure you're aware of the potential problems we face in supplying adequate quantities of water to the increasing population of Florida. Well, we are involved in a study, the results of which will better enable us to serve you in the future. What we are asking is about five minutes of your time to answer a few questions concerning the way you use water. The answers you give will be kept confidential. Will you please help us?

IF THE RESPONDENT IS NOT SURE OF WHAT SWFWMD IS, SAY:

"The Southwest Florida Water Management District is a government agency responsible for managing the water resources of our 16 county region. The District does not sell water. It is only a regulatory agency."

IF THE RESPONDENT WANTS TO KNOW MORE ABOUT THE PURPOSE OF THE STUDY, SAY:

"The information will be used to try to determine how various factors, including water rates, affect water consumption."

IF THE RESPONDENT REFUSES TO PARTICIPATE, SAY:

"I hope we haven't inconvenienced you too much. If you have any questions about the water management district, or this survey please call 1-800-423-1476. Thank you!"

QUESTIONS:

1. Do you live in a single family residence?

YES ____ (go to single family questions)

NO ____ THEN ask, What kind is it?

If Duplex ________, Townhouse ________,

Apartment ________ or Condo ________, THEN

terminate interview. "I'm sorry, this survey is targeted towards single family residential water users so this will conclude the interview. I hope we haven't inconvenienced you too much. If you have any questions about the water management district, or this survey please, call 1-800-423-1476. Thank you!"

2. Is your household (INDOOR) water service supplied by a water utility or your own well? UTILITY ___ OWN WELL ____ NOT SURE (RESTATE QUESTION)

IF OWN WELL, TERMINATE INTERVIEW. "I'm sorry but this survey is targeted towards utility supplied customers with metered use so this will conclude the survey. I hope we haven't inconvenienced you too much. If you have any questions about the water management district, or this survey, please call 1-800-423-1476. Thank you!"

3. Is your sewer service provided by a utility or your own septic tank? UTILITY ___ SEPTIC TANK ___ NOT SURE ___

4. Do you use hoses and sprinklers or an in-ground sprinkler system to water your lawn?

IN-GROUND SPRINKLER SYSTEM ____ (GO TO 4a & 4b)

HOSES AND SPRINKLERS OR DON'T WATER _____ (SKIP TO QUESTION 6).

(circle one)

4.a. Has there been an in-ground sprinkler system since 1988? YES NO NOT SURE IF NO, ASK:

Approximately what month and year was it installed? Mo____ Yr____

4.b. Does the sprinkler system have an automatic timer?

NO _____(SKIP TO QUESTION 5) YES _____IF YES, ASK:

Has there been a timer since 1988? YES NO NOT SURE IF NO, ASK:

Approximately what month and year was it installed? Mo____ Yr____

5. Is your sprinkler system connected to a reclaimed water system?

NO _____ (SKIP TO QUESTION 6). YES ____ (GO TO 5a)

(circle one)

5.a. Was it connected before 1988? YES NO NOT SURE IF NO, ASK:

Approximately what month and year was it connected? Mo____ Yr____

6. Do you have an irrigation well or pump?

NO ____ (SKIP TO QUESTION 7) YES ____ (GO TO 6a)

6.a. Has there been a well or pump since 1988?

YES NO NOT SURE IF NO, ASK:

Approximately what month and year was it installed? Mo____ Yr____

7. Do you own your home? YES _____ NO _____

IF NO, ASK: Is your water bill included in your rent?

YES _____ NO _____ NOT SURE (RESTATE QUESTION, I.E. "do you pay a separate water bill in addition to your rent?"

8. Have you lived there over 4 years? YES _____ NO _____

IF NO, ASK: How many years have you lived there? ____ years?

EXHIBIT (JBW-3)

PAGE 120 OF 153

9. On average, how many people live in your home? ________

10. Do you have a swimming pool? (A KIDDIE POOL IS NOT A SWIMMING POOL)

NO ____ (SKIP TO QUESTION 11) YES (GO TO 10a)

(circle one)

10.a. Has there been a pool since 1988? YES NO NOT SURE IF NO, ASK:

Approximately what month and year was it installed? Mo____ Yr____

11. Do you have a washing machine? YES _____ NO ______

12. Do you have a dish washer? YES ____ NO ____

13. Do you have a garbage disposal? YES ____ NO ____

14. Have you installed any water conserving devices in your toilets? (TOILET DAMS, BRICKS, WATER BOTTLES, ETC.)

NO OR NOT SURE ____ (SKIP TO QUESTION 15) YES ____ IF YES, ASK:

Approximately what month and year were they installed? Mo____Yr____

15. Have you installed water conserving showerheads? YES ____ NO ____

NO OR NOT SURE ____ (SKIP TO QUESTION 16) YES____ IF YES, ASK:

Approximately what month and year were they installed? Mo____Yr____

16. I'm going to read a list of ranges for market value of homes. If you can estimate the market value of your home, please indicate in which range it falls:

(CIRCLE THE RANGE INDICATED)

a. < 40,000
b. 40,000 - 60,000
c. 60,000 - 80,000
d. 80,000 - 100,000
e. 100,000 - 130,000
f. 130,000 - 160,000
g. 160,000 - 200,000
h. 200,000 - 250,000
i. 250,000 - 300,000
j. >300,000
k. NOT SURE

17. The next list of values are for total household income before taxes and other deductions. Please indicate which range best fits your total household income:

(IF ASKED, INDICATE THAT STUDIES HAVE SHOWN THAT WATER USE IS RELATED TO INCOME. ANY INCOME DATA SUPPLIED WILL BE USED FOR STATISTICAL ANALYSIS PURPOSES ONLY. IT WILL NOT PASSED ON TO ANY OTHER GROUP OR AGENCY).

a. < 25,000
b. 25,000 - 40,000
c. 40,000 - 60,000
d. 60,000 - 80,000
e. 80,000 - 100,000
f. 100,000 - 120,000
g. 120,000 - 140,000
h. 140,000 - 160,000
i. > 160,000
j. NOT SURE

THIS IS THE END OF THE INTERVIEW. THANK YOU FOR YOUR ASSISTANCE IN BETTER MANAGING FLORIDA'S WATER RESOURCES. IF YOU HAVE ANY QUESTIONS ABOUT THE WATER MANAGEMENT DISTRICT, OR QUESTIONS ABOUT THIS SURVEY, PLEASE CALL 1-800-423-1476. THANK YOU!

Table C-1. Summary of Single-Family Home Telephone Survey.

Question	Answer	Bradenton	Hillsborough	Lake Placid	Lakeland	Manatee	Spring Hill	St. Pete	Tampa	Venice	Winter Haven	Total
		Count										
Q1	Yes	90	125	109	100	85	135	182	181	166	40	1,213
	No	0	0	0	0	0	0	0	0	0	0	0
Q2	Utility	90	125	109	100	84	135	182	181	166	40	1,212
	Well	0	0	0	0	0	0	0	0	0	0	0
	Not Sure	0	0	0	0	1	0	0	0	0	0	1
Q3	Utility	85	74	18	98	73	6	179	174	166	21	894
	Septic	2	48	91	1	10	126	0	4	0	19	301
	Not Sure	3	3	0	1	2	3	3	2	0	0	17
Q4	Hose	59	77	50	71	63	43	101	125	148	25	762
	In-Ground	31	46	59	29	22	92	81	55	18	15	448
	NONE	0	2	0	0	0	0	0	0	0	0	2
Q4b	No	9	13	25	13	8	10	19	22	1	10	130
	Yes	19	33	34	15	14	81	62	31	16	5	310
Q5	No	90	125	106	99	84	133	179	178	166	40	1,200
	Yes	0	0	3	1	1	2	3	3	0	0	13
Q6	No	36	115	73	96	39	98	67	136	113	21	794
	Yes	53	10	36	3	43	37	115	42	52	19	410
	Not Sure	1	0	0	0	0	0	0	0	0	0	1
Q7	No	6	11	2	5	4	8	1	15	11	3	66
	Yes	84	108	107	94	80	127	180	163	155	37	1,135
Q7b	No	2	4	1	4	0	7	4	0	0	0	22
	Yes	0	0	0	0	1	0	1	0	0	0	2

Table C-1. Summary of Single Family Home Telephone Survey.

Question	Answer	Count										Total
		Bradenton	Hillsborough	Lake Placid	Lakeland	Manatee	Spring Hill	St. Pete	Tampa	Venice	Winter Haven	
Q8	No	11	27	13	7	11	33	24	39	11	2	178
	Yes	79	98	95	93	74	102	158	142	155	38	1,034
Q9	1	18	6	25	17	10	19	26	39	33	12	205
	2	43	41	56	50	36	82	81	70	90	16	565
	3	8	28	16	18	14	18	34	34	20	7	197
	4	12	28	5	12	18	10	25	23	15	2	150
	4.5	0	1	0	0	0	0	0	0	0	0	1
	5	9	13	6	1	6	3	12	11	6	3	70
	6	0	6	1	2	0	2	3	2	0	0	16
	7	0	1	0	0	1	1	1	2	1	0	7
	8	0	0	0	0	0	0	0	0	1	0	1
	9	0	1	0	0	0	0	0	0	0	0	1
Q10	No	79	70	106	85	74	83	151	157	129	36	970
	Yes	11	55	3	15	11	52	31	24	37	4	243
Q11	No	4	0	1	0	3	1	4	8	1	1	23
	Yes	85	125	108	100	82	134	178	173	165	39	1,189
Q12	No	27	16	49	37	46	13	68	84	83	19	442
	Yes	62	108	60	63	38	122	114	97	83	21	768
Q13	No	28	41	72	58	59	39	96	139	85	30	647
	Yes	61	83	37	42	25	96	86	42	81	10	563
Q14	No	66	80	85	73	59	103	120	89	113	34	822
	Yes	23	42	24	25	24	32	62	92	53	6	383
	Not Sure	0	0	0	0	1	0	0	0	0	0	1
Q15	No	41	62	72	53	36	62	75	71	87	26	575

EXHIBIT (DBL-3)
PAGE 123 OF 153

Table C-1. Summary of Single-Family Home Telephone Survey.

Question	Answer	Count										Total
		Bradenton	Hillsborough	Lake Placid	Lakeland	Manatee	Spring Hill	St. Pete	Tampa	Venice	Winter Haven	
	Yes	48	70	37	47	48	73	107	110	78	13	631
Q16	A	6	0	30	5	3	1	2	8	4	11	70
	B	20	8	27	40	18	28	25	35	29	11	241
	C	28	42	10	14	28	49	33	47	75	5	331
	D	16	32	9	10	12	29	52	21	30	5	216
	E	4	21	7	7	6	8	31	22	10	0	116
	F	1	7	2	2	5	3	5	13	5	0	43
	G	0	0	4	3	0	0	4	4	0	0	15
	H	0	0	0	0	0	0	4	6	0	0	10
	I	0	1	1	1	0	0	0	2	0	0	5
	J	0	1	1	4	0	0	0	1	0	0	7
	K	12	9	16	8	9	16	26	13	11	5	125
Q17	A	13	5	45	17	10	30	28	37	42	9	236
	B	20	21	18	18	24	31	34	30	49	4	249
	C	9	30	12	8	11	8	23	28	24	7	160
	D	1	16	1	7	4	6	26	13	6	1	81
	E	1	10	3	3	2	0	5	14	3	0	41
	F	0	0	0	1	0	0	4	3	0	0	8
	G	0	1	0	0	0	1	0	5	0	0	7
	H	0	1	0	0	0	0	0	1	0	0	2
	I	0	0	0	1	0	1	0	0	0	0	2
	J	34	26	24	30	18	57	61	31	25	16	322

EXHIBIT (JBW-3)

PAGE 124 OF 153

EXHIBIT (JBL1-3)

PAGE 125 OF 153

Appendix D

EXHIBIT (JBW-3)

PAGE 126 OF 153

APPENDIX D

COMMERCIAL SURVEYS AND RESULTS

SWFWMD MULTI-FAMILY SURVEY
WATER SERVICE CONNECTION ADDRESS
FOR WHICH DATA IS REQUESTED:

INDOOR WATER USE

Q1 How many units are there at this address? ___

Q2 Please circle the range that best describes the average number of occupants per occupied unit.

a. 1 - 2 b. 2 - 3 c. 3 - 4 d. 4 - 5

Q3 Are water and sewer service included in the rent or maintenance fees? (circle one) yes no

Q4 Do units have washing machines? (circle one) yes no

Q5 Do units have dishwashers? (circle one) yes no

Q6 Do units have garbage disposals? (circle one) yes no

WATER CONSERVATION

If any of the following water conservation devices have been installed in the last four years, please enter the approximate date of installation in the appropriate space.

Q7 Low volume toilets month ___ year ___

Q10 Water conserving shower heads month ___ year ___

SEASONALITY

In the chart below, enter your average monthly occupancy rate as best you can.

	MONTH	AVERAGE MONTHLY OCCUPANCY RATE
Q13	January	___ %
Q14	February	___ %
Q15	March	___ %
Q16	April	___ %
Q17	May	___ %
Q18	June	___ %
Q19	July	___ %
Q20	August	___ %
Q21	September	___ %
Q22	October	___ %
Q23	November	___ %
Q24	December	___ %

PLEASE TURN OVER TO CONTINUE

EXHIBIT (JBW-3)

PAGE 128 OF 153

OUTDOOR USE

Q25 How many swimming pools are served by this water service connection? ___

Q26 Does your landscape irrigation water come from (circle one)

1. Your own well?
2. Reclaimed wastewater?
3. Water utility irrigation meter?
4. Water utility regular meter?
5. Not applicable - no landscaping irrigation.

Please answer the following questions if you circled either water utility regular meter or water *utility irrigation meter* above.

Q27 Which of the following best describes the area irrigated by your system? (circle one)

1. An area up to the size of a single family residential lawn.
2. An area larger than a single family residential lawn but smaller than an acre.
3. An area of one acre or more.

Q28 Does the irrigation system operate on an automatic timer or does someone manually turn it on and off? (circle one)

1. Timer
2. Manual

SWFWMD Car Wash Survey
Car Wash Name and Address
for Which Data is Requested

Please use your best judgement in completing the following questions regarding your business:

1. INDOOR WATER USE

Is yours a tunnel wash operation? (please circle) Yes No

Is yours a hand wash (detail) operation? Yes No

If yours is not a tunnel wash or hand wash operation,
Q1 how many spray wash bays does your establishment have? ____

Q2 How many days per week are you open? ____

Q3 What are your business hours on Thursdays? ____ to ____

Does your system recycle wash water? Yes or No

Q4 Does your system recycle rinse water? Yes or No

2. SEASONAL PATTERN

In the chart below, identify the month that your business typically is most busy and enter 100 in the right column. For each of the other months, enter 100 minus the percentage reduction in business in comparison to the busiest month. For example, if sales are 20% lower in August than in the busiest month, enter 80 in the right column.

	MONTH	BUSINESS AS PERCENT OF BUSIEST MONTH
Q5	January	____ %
Q6	February	____ %
Q7	March	____ %
Q8	April	____ %
Q9	May	____ %
Q10	June	____ %
Q11	July	____ %
Q12	August	____ %
Q13	September	____ %
Q14	October	____ %
Q15	November	____ %
Q16	December	____ %

EXHIBIT (JBW-3)

PAGE 130 OF 153

SWFWMD Hospital Survey
Hospital Name and Address
for Which Data is Requested

Please use your best judgement in completing the following questions regarding your business:

Q1 1. INDOOR WATER USE

How many patient beds do you have? ___

2. SEASONAL PATTERN

In the chart below, enter average monthly bed occupancy as best you can.

	MONTH	AVERAGE MONTHLY OCCUPANCY
Q2	January	___ %
Q3	February	___ %
Q4	March	___ %
Q5	April	___ %
Q6	May	___ %
Q7	June	___ %
Q8	July	___ %
Q9	August	___ %
Q10	September	___ %
Q11	October	___ %
Q12	November	___ %
Q13	December	___ %

Q14 3. LANDSCAPE IRRIGATION

Does your irrigation water come from (circle one)

1. Your own well?
2. Reclaimed wastewater system?
3. Water utility irrigation meter?
4. Water utility regular meter?
5. No landscaping irrigation or landscaping maintained by company you lease from.

Answer the remaining questions on the back side only if you circled water utility regular meter or water utility irrigation meter above.

Q15 Which of the following best describes the area irrigated by your system? (circle one)

1. Only small, incidental landscape plantings around the building and parking areas.
2. An area up to the size of a residential lawn
3. An area larger than a residential lawn but smaller than 1 acre.
4. An area 1 acre or more.

Q16 Does the irrigation system operate on an automatic timer or does someone manually turn it on and off? (circle one)

1. Timer
2. Manual

SWFWMD Hotel/Motel Survey
Hotel/Motel Name and Address
for Which Data is Requested

Please use your best judgement in completing the following questions regarding your business:

Q1 1. INDOOR WATER USE

How many rooms (guest units) do you have? ____

2. SEASONAL PATTERN

In the chart below, enter average monthly occupancy as best you can.

	MONTH	AVERAGE MONTHLY OCCUPANCY
Q2	January	___ %
Q3	February	___ %
Q4	March	___ %
Q5	April	___ %
Q6	May	___ %
Q7	June	___ %
Q8	July	___ %
Q9	August	___ %
Q10	September	___ %
Q11	October	___ %
Q12	November	___ %
Q13	December	___ %

3. FACILITIES

Q14 How many swimming pools do you have? ____

Q15 Do you operate and manage an on-site restaurant?
(circle one) yes no

Q16 Do you have an on-site laundry for washing your linens and towels?
(circle one) yes no

Q17 4. LANDSCAPE IRRIGATION

Does your irrigation water come from (circle one)

1. Your own well?
2. Reclaimed wastewater system?
3. Water utility irrigation meter?
4. Water utility regular meter?
5. <u>Not applicable - no landscaping irrigation or landscaping maintained by company you lease from.</u>

Answer the remaining questions on the back side only if you circled water utility regular meter or water utility irrigation meter above.

EXHIBIT (JBW-3)

PAGE 133 OF 153

Q18 Which of the following best describes the area irrigated by your system? (circle one)

1. Only small, incidental landscape plantings around the building and parking areas.
2. An area up to the size of a residential lawn
3. An area larger than a residential lawn but smaller than 1 acre.
4. An area 1 acre or more.

Q19 Does the irrigation system operate on an automatic timer or does someone manually turn it on and off? (circle one)

1. Timer
2. Manual

EXHIBIT (JBW-3)

PAGE 134 OF 153

SWFWMD Laundromat Survey
Laundromat Name and Address
for Which Data is Requested

Please use your best judgement in completing the following questions regarding your business:

1. WATER USE

Q1 How many washing machines does your laundry have? ____

Q2 How many days per week are you open? ____

Q3 What are your business hours on Thursdays? ____ to ____

2. SEASONAL PATTERN

In the chart below, identify the month that your business typically is most busy and enter 100 in the right column. For each of the other months, enter 100 minus the percentage reduction in business in comparison to the busiest month. For example, if sales are 20% lower in August than in the busiest month, enter 80 in the right column.

	MONTH	BUSINESS AS PERCENT OF BUSIEST MONTH
Q4	January	____ %
Q5	February	____ %
Q6	March	____ %
Q7	April	____ %
Q8	May	____ %
Q9	June	____ %
Q10	July	____ %
Q11	August	____ %
Q12	September	____ %
Q13	October	____ %
Q14	November	____ %
Q15	December	____ %

SWFWMD Nursing Home Survey
Nursing Home Name and Address
for Which Data is Requested

Please use your best judgement in completing the following questions regarding your business:

1. INDOOR WATER USE

Q1 How many patient beds do you have? ___

Q2 What is your average occupancy rate? ___

2. Q3 LANDSCAPE IRRIGATION

Does your irrigation water come from (circle one)

1. Your own well?
2. Reclaimed wastewater system?
3. Water utility irrigation meter?
4. Water utility regular meter?
5. Not applicable - no landscaping irrigation or landscaping maintained by company you lease from.

Answer the remaining questions only if you circled water utility regular meter or water utility irrigation meter above.

Q4 Which of the following best describes the area irrigated by your system? (circle one)

1. Only small, incidental landscape plantings around the building and parking areas.
2. An area up to the size of a residential lawn
3. An area larger than a residential lawn but smaller than 1 acre.
4. An area 1 acre or more.

Q5 Does the irrigation system operate on an automatic timer or does someone manually turn it on and off? (circle one)

1. Timer
2. Manual

SWFWMD Office Building Survey
Office Building(s) Name and Address
for Which Data is Requested

Please use your best judgement in completing the following questions regarding your business:

1. INDOOR WATER USE

Q1 How many square feet of office space are there at this service address? ____

2. Q2 LANDSCAPE IRRIGATION

Does your irrigation water come from (circle one)

1. Your own well?
2. Reclaimed wastewater system?
3. Water utility irrigation meter?
4. Water utility regular meter?
5. Not applicable - no landscaping or landscaping maintained by company you lease from.

Answer the remaining questions only if you circled water utility regular meter or water utility irrigation meter above.

Q3 Which of the following best describes the area irrigated by your system? (circle one)

1. Only small, incidental landscape plantings around the building and parking areas.
2. An area up to the size of a residential lawn
3. An area larger than a residential lawn but smaller than 1 acre.
4. An area 1 acre or more.

Q4 Does the irrigation system operate on an automatic timer or does someone manually turn it on and off? (circle one)

1. Timer
2. Manual

SWFWMD Restaurant Survey
Restaurant Name and Address
for Which Data is Requested

Please use your best judgement in completing the following questions regarding your business:

1. INDOOR WATER USE
   - Q1 What is the seating capacity? ____
   - Q2 How many days per week are you open? ____
   - Q3 What are your business hours on Thursdays? ____ to ____
   - Q4 Are meals served on reusable or disposable dinnerware?
     (circle one) reusable disposable

2. SEASONAL PATTERN
   In the chart below, identify the month that your business typically is most busy and enter 100 in the right column. For each of the other months, enter 100 minus the percentage reduction in business in comparison to the busiest month. For example, if sales are 20% lower in August than in the busiest month, enter 80 in the right column.

	MONTH	BUSINESS AS PERCENT OF BUSIEST MONTH
Q5	January	____ %
Q6	February	____ %
Q7	March	____ %
Q8	April	____ %
Q9	May	____ %
Q10	June	____ %
Q11	July	____ %
Q12	August	____ %
Q13	September	____ %
Q14	October	____ %
Q15	November	____ %
Q16	December	____ %

3. LANDSCAPE IRRIGATION
   - Q17 Does your irrigation water come from (circle one)
     1. Your own well?
     2. Reclaimed wastewater system?
     3. *Water utility irrigation meter?*
     4. Water utility regular meter?
     5. Not applicable - no landscaping irrigation or landscaping maintained by company you lease from.

Answer the remaining questions on the back side only if you circled water utility regular meter or water utility irrigation meter above.

Table D-1. Mail Survey Results

	HOTEL/MOTEL		LAUNDRY		NURSING HOME	
QUESTION	Description	Value	Description	Value	Description	Value
Q1	Total Count	113	Total Count	58	Total Count	54
	Average	69	Average	25	Average	118
	Min	10	Min	3	Min	26
	Max	100	Max	63	Max	700
Q2	Total Count	113	Total Count	58	Total Count	54
	Average	69	Average	7	Average	90
	Min	10	Min	5	Min	25
	Max	100	Max	7	Max	100
Q3	Total Count	113	Total Count	58	1	22
	Average	81	Average	15	2	4
	Min	4	Min	10	3	4
	Max	100	Max	24	4	20
					5	4
					Total Count	54
Q4	Total Count	113	Total Count	58	1	10
	Average	80	Average	93	2	2
	Min	9	Min	57	3	8
	Max	100	Max	100	4	6
					Total Count	26
Q5	Total Count	113	Total Count	58	A	10
	Average	70	Average	93	M	16
	Min	20	Min	54	Total Count	26
	Max	100	Max	100		
Q6	Total Count	113	Total Count	58		
	Average	60	Average	91		
	Min	8	Min	66		
	Max	100	Max	100		
Q7	Total Count	113	Total Count	58		
	Average	59	Average	83		
	Min	12	Min	50		
	Max	100	Max	100		
Q8	Total Count	113	Total Count	58		
	Average	60	Average	75		
	Min	10	Min	15		
	Max	100	Max	100		

Table D-1. Mail Survey Results

QUESTION	HOTEL/MOTEL Description	HOTEL/MOTEL Value	LAUNDRY Description	LAUNDRY Value	NURSING HOME Description	NURSING HOME Value
Q9	Total Count	113	Total Count	58		
	Average	59	Average	69		
	Min	10	Min	7		
	Max	100	Max	100		
Q10	Total Count	113	Total Count	58		
	Average	53	Average	68		
	Min	10	Min	7		
	Max	97	Max	100		
Q11	Total Count	113	Total Count	58		
	Average	56	Average	69		
	Min	10	Min	15		
	Max	97	Max	100		
Q12	Total Count	113	Total Count	58		
	Average	58	Average	71		
	Min	5	Min	15		
	Max	100	Max	100		
Q13	Total Count	113	Total Count	58		
	Average	60	Average	77		
	Min	10	Min	40		
	Max	100	Max	100		
Q14	Total Count	113	Total Count	58		
	Average	0.63	Average	83		
	Min	0	Min	48		
	Max	2	Max	100		
Q15	N	85	Total Count	58		
	Y	28	Average	88		
	Total Count	113	Min	59		
			Max	100		
Q16	N	17				
	Y	96				
	Total Count	113				

Table D-1. Mail Survey Results

QUESTION	HOTEL/MOTEL Description	HOTEL/MOTEL Value	LAUNDRY Description	LAUNDRY Value	NURSING HOME Description	NURSING HOME Value
Q17	1	19				
	2	6				
	3	19				
	4	49				
	5	20				
	Total Count	113				
Q18	1	36				
	2	11				
	3	19				
	4	13				
	Total Count	79				
Q19	A	36				
	M	42				
	Total Count	78				
Q20						
Q21						
Q22						
Q23						
Q24						

EXHIBIT (JBW-3)

PAGE 141 OF 153

Table D-1. Mail Survey Results

QUESTION	OFFICE Description	OFFICE Value	RESTAURANT Description	RESTAURANT Value
Q1	Total Count	116	Total Count	122
	Average	88,607	Average	144
	Min	800	Min	6
	Max	735,630	Max	540
Q2	1	25	Total Count	122
	2	4	Average	6.72
	3	37	Min	5
	4	38	Max	7
	5	12		
	Total Count	116		
Q3	1	30	Total Count	122
	2	9	Average	12
	3	16	Min	4
	4	23	Max	24
	Total Count	78		
Q4	A	68	D	19
	M	12	R	103
	Total Count	80	Total Count	122
Q5			Total Count	122
			Average	88
			Min	25
			Max	100
Q6			Total Count	122
			Average	90
			Min	10
			Max	100
Q7			Total Count	122
			Average	94
			Min	25
			Max	100
Q8			Total Count-	122
			Average	84
			Min	25
			Max	100

EXHIBIT (JBW-3)

PAGE 142 OF 153

Table D-1. *Mail Survey Results*

QUESTION	OFFICE Description	OFFICE Value	RESTAURANT Description	RESTAURANT Value
Q9			Total Count	122
			Average	75
			Min	40
			Max	100
Q10			Total Count	122
			Average	71
			Min	20
			Max	100
Q11			Total Count	122
			Average	70
			Min	20
			Max	100
Q12			Total Count	122
			Average	68
			Min	20
			Max	100
Q13			Total Count	122
			Average	66
			Min	20
			Max	100
Q14			Total Count	122
			Average	71
			Min	20
			Max	100
Q15			Total Count	122
			Average	78
			Min	25
			Max	100
Q16			Total Count	122
			Average	84
			Min	25
			Max	100

EXHIBIT (JBW-3)

PAGE 143 OF 153

Table D-1. Mail Survey Results

QUESTION	OFFICE Description	OFFICE Value	RESTAURANT Description	RESTAURANT Value
Q17			1	7
			2	8
			3	18
			4	36
			5	53
			Total Count	122
Q18			1	36
			2	15
			3	8
			4	1
			Total Count	60
Q19			A	41
			M	18
			Total Count	59
Q20				
Q21				
Q22				
Q23				
Q24				

Table D-1. Mail Survey Results

QUESTION	APARTMENTS Description	APARTMENTS Value	CAR WASH Description	CAR WASH Value	HOSPITAL Description	HOSPITAL Value
Q9			Total Count	17	Total Count	22
			Average	79	Average	64
			Min	40	Min	2
			Max	100	Max	97
Q10	N	96	Total Count	17	Total Count	22
Move	Y	80	Average	61	Average	67
to	Total Count	174	Min	40	Min	33
Q8			Max	90	Max	97
Q11			Total Count	17	Total Count	22
			Average	55	Average	68
			Min	22	Min	33
			Max	86	Max	97
Q12			Total Count	17	Total Count	22
			Average	53	Average	69
			Min	20	Min	35
			Max	100	Max	94
Q13	Total Count	174	Total Count	17	Total Count	22
	Average	90	Average	60	Average	71
	Min	25	Min	30	Min	34
	Max	100	Max	86	Max	95
Q14	Total Count	174	Total Count	17	1	11
	Average	91	Average	70	2	0
	Min	25	Min	45	3	4
	Max	100	Max	100	4	5
					5	2
					Total Count	22
Q15	Total Count	174	Total Count	17	1	0
	Average	90	Average	78	2	1
	Min	25	Min	59	3	5
	Max	100	Max	100	4	5
					Total Count	11
Q16	Total Count	174	Total Count	17	A	9
	Average	87	Average	88	M	2
	Min	10	Min	70	Total Count	11
	Max	100	Max	100		

EXHIBIT (J BW-3)

Table D-1. Mail Survey Results

QUESTION	APARTMENTS Description	Value	CAR WASH Description	Value	HOSPITAL Description	Value
Q1	Total Count	174	Total Count	17	Total Count	22
	Average	107	Average	2.00	Average	277
	Min	4	Min	1	Min	50
	Max	900	Max	4	Max	1024
Q2	A	102	Total Count	17	Total Count	22
	B	56	Average	6.65	Average	74
	C	15	Min	6	Min	36
	D	1	Max	7	Max	95
	Total Count	174				
Q3	N	17	Total Count	17	Total Count	22
	Y	157	Average	14.15	Average	73
	Total Count	174	Min	8.5	Min	31
			Max	24	Max	95
Q4	N	135	N	4	Total Count	22
	Y	39	Y	13	Average	72
	Total Count	174	Total Count	17	Min	13
					Max	97
Q5	N	92	Total Count	17	Total Count	22
	Y	82	Average	95	Average	69
	Total Count	174	Min	75	Min	12
			Max	100	Max	97
Q6	N	76	Total Count	17	Total Count	22
	Y	98	Average	95	Average	67
	Total Count	174	Min	80	Min	8
			Max	100	Max	97
Q7	N	136	Total Count	17	Total Count	22
	Y	38	Average	97	Average	65
	Total Count	174	Min	90	Min	8
			Max	100	Max	97
Q8			Total Count	17	Total Count	22
			Average	88	Average	65
			Min	70	Min	4
			Max	100	Max	97

EXHIBIT (JBW-3)

PAGE 146 OF 153

Table D-1. Mail Survey Results

QUESTION	APARTMENTS Description	Value	CAR WASH Description	Value	HOSPITAL Description	Value
Q17	Total Count	174				
	Average	86				
	Min	10				
	Max	100				
Q18	Total Count	174				
	Average	85				
	Min	10				
	Max	100				
Q19	Total Count	174				
	Average	85				
	Min	10				
	Max	100				
Q20	Total Count	174				
	Average	84				
	Min	10				
	Max	100				
Q21	Total Count	174				
	Average	84				
	Min	9				
	Max	100				
Q22	Total Count	174				
	Average	85				
	Min	10				
	Max	100				
Q23	Total Count	174				
	Average	86				
	Min	15				
	Max	100				
Q24	Total Count	174				
	Average	87				
	Min	20				
	Max	100				

EXHIBIT (JBW-3)

PAGE 147 OF 153

Table D-1. Mail Survey Results

QUESTION	APARTMENTS Description	APARTMENTS Value	CAR WASH Description	CAR WASH Value	HOSPITAL Description	HOSPITAL Value
Q25	Total Count	174				
	Average	0.59				
	Min	0				
	Max	6				
Q26	1	73				
	2	10				
	3	11				
	4	36				
	5	44				
	Total Count	174				
Q27	1	21				
	2	27				
	3	17				
	Total Count	65				
Q28	A	75				
	M	26				
	Total Count	101				

EXHIBIT (JBW-3)

PAGE 148 OF 153

Q18 Which of the following best describes the area irrigated by your system? (circle one)

1. Only small, incidental landscape plantings around the building and parking areas.
2. An area up to the size of a residential lawn
3. An area larger than a residential lawn but smaller than 1 acre.
4. An area 1 acre or more.

Q19 Does the irrigation system operate on an automatic timer or does someone manually turn it on and off? (circle one)

1. Timer
2. Manual

Appendix
E

APPENDIX E

ESTIMATION OF IRRIGATION WELL LOGIT MODEL

EXHIBIT (JBW-3)

PAGE 151 OF 1534

APPENDIX E

ESTIMATION OF IRRIGATION WELL LOGIT MODEL

One may ask why the model includes the groundwater depth variable DWELL instead of a variable indicating the presence or absence of an irrigation well. This appendix explains why.

It is important to understand the differences between cause, steps, and effect in constructing the water demand equation. For example, consider a customer who responds to a water price increase by installing an irrigation well which, in turn, decreases water taken from a utility. Price serves as the cause, installation of an irrigation well as the step, and reduction in utility water use as the effect. Other steps could include, for example, improvements in irrigation efficiency, reductions in landscape area, or installation of water efficient bathroom fixtures.

In this study, we seek to measure the cause and effect relationship between water price and water use. This information is used in a computer rate model to predict the water use impact resulting from different rate structure options. Given this purpose, including the steps as explanatory variables in the water demand equation tends to bias price elasticity towards zero. This occurs because the step variables get credit for water use reductions that would otherwise be attributed to water price. Because sinking an irrigation well is one of most dramatic steps a customer can take to reduce utility water use, we do not want to exclude this from our measured price effect.

Groundwater level, on the other hand, is a cause variable. As groundwater level rises, the financial feasibility of an irrigation well increases, which if installed decreases water taken from a utility. Groundwater level is the cause, irrigation well again the step, and lower utility water use the effect. We need to control for different groundwater levels among utilities so as to not wrongly confuse its impact with price effects.

We tested our hypothesis that customers tend to install irrigation wells as water price increases and as groundwater depth rises. Other causal factors can also affect the decision of whether or not to include an irrigation well. Customers with larger irrigable areas that use a lot of water may find it relatively more worthwhile to sink a well. Wealthy customers might also be more inclined. As a way of quantifying the probability of a home having an irrigation well considering lot size, property value, average well depth, and marginal water price, we constructed a logit regression model. Logit models are appropriate when the dependent variable—irrigation well—takes on only binary values (0 or 1). The results show that the probability of an irrigation well increases with increasing lot size, property value, groundwater level, and marginal price. Figure E-1 plots the relationship between the probability of an irrigation well and both well depth and marginal price given all other variables are at their mean values. The probability of an irrigation well doubles from 32 to 64 percent when average well depth goes from 125 to 50 feet and from 25 to 50 percent when marginal price goes from $1 to $5 per 1,000 gallons. Details of the logit model are shown in Table E-1.

FIGURE E-1. PROBABILITY OF IRRIGATION WELL
OTHER VARIABLES AT MEANS

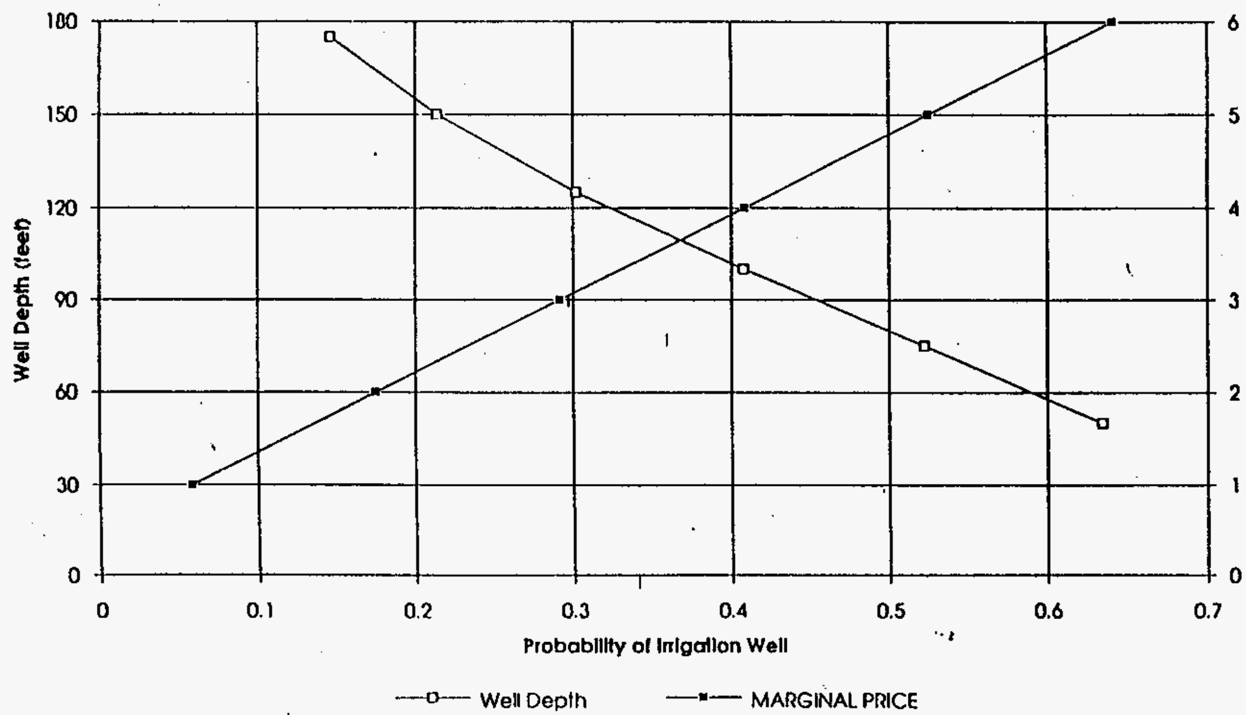

EXHIBIT JBK-3

PAGE 153 OF 153

TABLE E-1. LOGIT REGRESSION RESULTS

VARIABLE DESCRIPTIVE STATISTICS:

NAME	N	MEAN	ST. DEV	VARIANCE	MINIMUM	MAXIMUM
IWELL	42257	0.34503	0.47538	0.22599	0.00000	1.0000
MP2	42257	2.1649	1.5441	2.3843	0.00000	7.0500
LOT	42257	9.8974	3.2699	10.692	5.0000	18.000
DWELL	42257	120.84	43.834	1921.5	49.000	190.00
PV	42257	64.053	21.646	468.54	45.000	150.00

CORRELATION MATRIX:

	IWELL	MP2	LOT	DWELL	PV
IWELL	1.0000				
MP2	0.88401E-01	1.0000			
LOT	0.48331E-01	-0.19136	1.0000		
DWELL	-0.32117	0.11542	0.21902E-01	1.0000	
PV	0.12565	-0.12059E-01	0.31475	0.14455E-01	1.0000

LOGIT ANALYSIS DEPENDENT VARIABLE =IWELL
IWELL = f(MP2, LOT, DWELL, PV)
42257. TOTAL OBSERVATIONS
14580. OBSERVATIONS AT ONE
27677. OBSERVATIONS AT ZERO

VARIABLE NAME	ESTIMATED COEFFICIENT	ASYMPTOTIC STANDARD ERROR	T-RATIO	ELASTICITY AT MEANS	WEIGHTED AGGREGATE ELASTICITY
MP2	0.22268	0.71576E-02	31.111	0.32841	0.27900
LOT	0.37651E-01	0.35638E-02	10.565	0.25387	0.20541
DWELL	-0.18528E-01	0.27456E-03	-67.482	-1.5252	-1.1260
PV	0.12885E-01	0.52387E-03	24.596	0.56227	0.45935
CONSTANT	-0.20074	0.52209E-01	-3.8449	-0.13675	-0.10973

MADDALA R-SQUARE	0.1373
CRAGG-UHLER R-SQUARE	0.18962
MCFADDEN R-SQUARE	0.11465

	WATERATE Registered Users	City	State
1.	Aloha Utilities	Holiday	FL
2.	Black and Veatch	Orlando	FL
3.	Brooksv & Amaden, Inc.	Bradon	FL
4.	Central County Utilities, Inc.	Sarasota	FL
5.	Charlotte Harbor Water Association	Harbor Heights	FL
6.	Citrus County	Lacanto	FL
7.	City of Bartow	Bartow	FL
8.	City of Brooksville	Brooksville	FL
9.	City of Crystal River	Crystal River	FL
10.	City of Dade City	Dade City	FL
11.	City of Dunedin Water Division	Dunedin	FL
12.	City of Haines City	Haines City	FL
13.	City of Inverness	Inverness	FL
14.	City of Lake Placid	Lake Placid	FL
15.	City of Lakeland	Lakeland	FL
16.	City of N. Miami Beach Util.	N. Miami Beach	FL
17.	City of Northport	Northport	FL
18.	City of Oldsmar	Oldsmar	FL
19.	City of San Antonio	San Antonio	FL
20.	City of Sarasota	Sarasota	FL
21.	City of Sebring	Sebring	FL
22.	City of St. Petersburg	St. Petersburg	FL
23.	City of Tarpon Springs	Tarpon Springs	FL
24.	City of Winter Haven	Winter Haven	FL
25.	Florida Cities Water Company	Tampa	FL
26.	Florida City Water Association	Florida City	FL
27.	Florida Public Service Commission	Tallahassee	FL
28.	Florida Rural Water	Madison	FL
29.	Garden Grove Water Company	Winter Haven	FL
30.	Grenelefe Resort	Grenelefe	FL
31.	Hernando County Utilities Dept.	Brooksville	FL
32.	Hillsborough County, Public Util.	Tampa	FL
33.	Homosassa Water District	Homosassa	FL
34.	House Natural Res. Com.	Tallahassee	FL
35.	King Engineering, Inc.	New Port Richey	FL
36.	Law Environmental, Inc.	Tampa	FL
37.	Malcolm Pirnie, Inc.	Maitland	FL
38.	Manatee County Public Services	Bradenton	FL
39.	On Top of the World	Ocala	FL
40.	Orlando Utilities Commission	Orlando	FL
41.	Pasco County Utilities	New Port Richey	FL
42.	Pebble Creek Service Corp.	Tampa	FL
43.	Pinellas County Water Dept	Clearwater	FL
44.	Public Resource Mgmt. Group	Maitland	FL
45.	Resource Economics Consultants	Gainesville	FL
46.	Sarasota County Gov. Utl. Dept.	Sarasota	FL
47.	Sarasota County Utilities	Sarasota	FL

48.	SFWMD	West Palm Beach	FL
49.	Siesta Key Utilities Authority	Sarasota	FL
50.	Souther States Utilities	Apopka	FL
51.	SWFWMD	Brooksville	FL
52.	Town of Belleair	Belleair	FL
53.	Volusioa Council of Government	Daytona Beach	FL
54.	WCRWSA	Clearwater	FL
55.	SPAAC	Cairo	Egypt
56.	World Bank	Rio de Janeiro	Brazil
57.	City of Redwood City	Redwood City	CA
58.	City of Menlo Park	Menlo Park	CA

SWFWMD Conservation Rate Study
Weighting System Scoring
of Uniform Rate Structure Approved in
Docket No. 920199-WS

Criteria	Weighting %	Score	Weighted Score
1. Rate structure form	20	2.5	0.5
2. Allocation of fixed/variable charges	40	2	0.8
3. Sources of utility revenues	30	5	1.5
4. Communication on bill	10	4	0.4
Total	100		3.2

CALCULATING THE PRICE ELASTIC WATER CHANGE RESULTING FROM SSU's PROPOSED RATE STRUCTURE

Introduction

The price elastic water change to result from Southern States' proposed rate structure change is estimated using the Windows based software program WATERATE 3.1. WATERATE is a planning tool that simulates how changes in water and sewer rate structures impact water revenues and water demand. It automates complex calculations for the user's convenience and provides a comprehensive, flexible framework from which to evaluate rates. The model was developed for the Southwest Florida Water Management District (SWFWMD). Its default price elasticity assumptions are based on a large empirical study conducted for SWFWMD in 1993.

WATERATE is run for four different groupings of water plants. The groups consist of Previously Uniform, Previously Nonuniform, Marco Island, and Burnt Store. Previously Nonuniform includes the following 11 plants: Buenaventura, Deep Creek, Enterprise, Geneva, Keystone, Lakeside, Lehigh, Palm Valley, Remington Forrest, Spring Gardens, and Valencia Terrace. Marco Island and Burnt Store, which use a reverse osmosis treatment process, are separated because it is proposed that they will make up their own rate class. All other plants are contained in Previously Uniform.

For each of the four groups, running the model requires inputting data into five sets of tables. A description of the data and the assumptions made are described in the following section entitled "WATERATE Data Input". A summary of the data input into WATERATE is provided in Schedule: E1-4 of the MFRs, a copy of which is included in pages 4 through 6 of this exhibit for convenience.

WATERATE Data Input

Table 1 of WATERATE collects general information related to customer classes, type of rate structure, water billing units, current year, and inflation. Customers are divided into the classes of "residential" (single family) and "other". The reason for the class separation is that "residential" and "other" customers behave differently to water price changes; WATERATE accounts for this difference. The block rate option is selected for the residential class; it is selected because the sewer cap serves as an indirect block rate pricing vehicle (e.g., a zero price for water greater than six thousand gallons per month). Water units are in thousands of gallons (TG) and general price inflation is assumed to be 3.0 percent. WATERATE's algorithms make use of inflation adjusted or real prices. The base year is 1995 and the projected rate case year is defined as 1996. Although WATERATE can project over a three year period, in this application water use and revenues are projected only for 1996 to remain consistent with the FPSC rate case.

Table 2 of WATERATE collects price elasticity information. It is assumed that the residential customers follow the default long-run price elasticity patterns established in the SWFWMD study. It is also assumed that the residential property values of SSU's customer base are approximately equal to the residential property values found in SWFWMD's service area as a whole. For the "other" customers, the long-run unit price elasticity is assumed to be -0.20. That is, for every one percent increase in price, a -0.2 percent long-run decrease in water use would result. The general default multifamily and commercial long-run price elasticities in WATERATE are 0 and -0.25 respectively. Given about 20 percent of "other" water use is multiple family, the weighted long-run elasticity is assumed to be -0.20 (0.8*0.25). In the short-run, customers are limited in making all of their desired price related adjustments. Based on a three year horizon, it is assumed that 75 percent of the long-run price elastic impact will have taken effect.

Table 3 of WATERATE records the revenues allowed to be collected via water rates (revenue requirements) for rate year 1996. In addition, the direct short-run revenue requirements are inputted; these costs are the costs that vary proportionately with water use and include power purchased water, and chemicals. It is important to include these costs in the analysis because as water use decreases, revenue requirements will also decrease.

Table 4a of WATERATE collects number of accounts by meter size for each class including fire protection. Meters are converted into equivalent residential connections (ERCs) using meter ratios and summed. Table 4b of WATERATE collects expected annual water sales for the 1996 rate year. Table 4c of WATERATE collects bill frequency information for the residential class. Specifically, the percent of bills associated with 1 TG/month increments of water use are tabulated based on 1994 data. In addition, the percent of customers facing a price signal from a sewer bill is collected.

Table 5a of WATERATE records the base facility charge (BFC) per ERC for 1996. The BFC is set to recover 40 percent of revenue requirements. The BFC for fire protection meters is set at 1/12th the regular BFC charge. Gallonage charges are inputted into Table 5b of WATERATE. Both historical and 1996 water and sewer charges are included. Historical gallonage charges for the nonuniform class are derived as a weighted average of individual plants' gallonage charges. The weights are based on 1996 projected water use.

WATERATE Data Output

Alternative gallonage charges are entered into WATERATE until the revenues generated from rates for conventional (previously uniform and nonuniform) and RO (Marco Island and Burnt Store) treatment are as close as possible to total adjusted revenue requirements (revenue requirements listed in Table 3 adjusted for changes in the direct short-run revenue requirements resulting from water use changes). Revenues do not exactly equal adjusted revenue requirements because the gallonage charge in WATERATE only goes out to two decimal places.

Table 6a of WATERATE describes the revenue impacts from the proposed rates. This table shows the base revenue requirement, the adjusted revenue requirement, base facility charge revenues, and gallonage charge revenues by class. Table 6b of WATERATE shows the predicted annual water use change associated with each class for 1996. Table 6c of WATERATE shows the change in the water use distribution occurring from the water price changes.

SCHEDULE OF WATER RATES - 1996
Summary of Waterate Software Inputs and Outputs 1/

Company: SSU / FPSC Jurisdiction / Proposed Conventional and Reverse Osmosis Treatment
Docket No.: 950495-WS
Schedule Year Ended: 12/31/96
Water [x] Wastewater [ ]
Interim [ ] Final [x]
Historical [ ] Projected [x]
Present: FPSC Uniform [x] FPSC Non-uniform [x]
Proposed: Conventional [x] Reverse Osmosis [x]

FPSC
Schedule: E1-4
Page 1 of 3
Preparer: Bencini

Explanation: Provide a summary schedule of the Waterate software tool inputs and outputs.

		Conventional Treatment	Reverse Osmosis
Revenues 2/			
1 Original Rev. Req. Less Direct Short Run Exp.		$22,831,166	$10,458,202
2 Direct Short Run Expenses 3/		$3,201,573	$1,218,241
3 Total Original Revenue Requirement		$26,032,739	$11,676,443
4 Direct Short-Run RR Price Elastic Change 4/		-$257,819	-$32,872
5 Adjusted Revenue Requirement	L3-L4	$25,774,920	$11,643,571
6			
7 BFC Revenues	40% * L5 5/	$10,309,968	$4,657,428
8 Gallonage Revenues	60% * L5 5/	$15,464,952	$6,986,143
9 Total Revenues to be Collected from Rates	L7+L8	$25,774,920	$11,643,571
10			
11 **Billing Determinants 6/**			
12 Projected Monthly ERCs		93,866	16,324
13 Projected Consumption TG		8,040,449	2,183,794
14			
15 Projected Residential Consumption TG		7,074,030	1,101,846
16 Projected Multi-Family Consumption TG		81,741	282,106
17 Projected Other Consumption TG 7/		884,678	799,843
18 Total Projected Consumption TG	L15+L16+L17	8,040,449	2,183,795
19			
20 **Price Elasticity Adjustments 8/**			
21 Residential Price Elasticity Change TG		-826,884	-25,914
22 Multi-Family Price Elasticity Change TG		0	0
23 Other Price Elasticity Change TG		-49,169	-31,841

EXHIBIT (JBW-6)
PAGE 4 OF 6

SCHEDULE OF WATER RATES - 1996
Summary of Waterate Software Inputs and Outputs 1/

Company: SSU / FPSC Jurisdiction / Proposed Conventional and Reverse Osmosis Treatment

Docket No.: 950495-WS
Schedule Year Ended: 12/31/96
Water [x] Wastewater [ ]
Interim [ ] Final [x]
Historical [ ] Projected [x]
Present: FPSC Uniform [x] FPSC Non-uniform [x]
Proposed: Conventional [x] Reverse Osmosis [x]

Explanation: Provide a summary schedule of the Waterate software tool inputs and outputs.

Line	Description	Reference	Conventional Treatment	Reverse Osmosis
	Price Elasticity Adjustments cont. 8/			
24	Total Price Elasticity Change TG	L21+L22+L23	-876,053	-57,755
25				
26	Adjusted Projected Consumption TG	L18+L24	7,164,396	2,126,040
27				
28	Residential Price Elasticity Change Percentage	L21/L15	-11.7%	-2.4%
29	Multi-Family Price Elasticity Change Percentage	L22/L16	0.0%	0.0%
30	Other Price Elasticity Change Percentage	L23/L17	-5.6%	-4.0%
31	Overall Price Elasticity Change Percentage	L24/L18	-10.9%	-2.6%
32				
33	**Preliminary Rate Calculations 9/**			
34	BFC Rate	(L7/L12)/12	$9.15	$23.78
35	Gallonage Charge	L8/L26	$2.16	$3.29

1/ The information on this schedule is a brief summary of some of the inputs and outputs from the Waterate software tool. Refer to the testimony of John Whitcomb, Ph.D. for the complete set of input and output tables and discussion of the model.

2/ Revenues are required income from Schedule B-1. The numbers are slightly different due to an increase in the payroll tax which was not ran back through the Waterate model because the impact would have been minimal. The difference in revenues for Conventional Treatment is $32,534 (B1 revenue is higher), and for Reverse Osmosis the difference is $5,303 (B1 revenue is higher).

3/ Direct short-run revenue requirements is composed of purchased power, purchased water and chemicals. These are expenses that are directly related to water volume.

EXHIBIT (TBW-6)
PAGE 5 OF 6

SCHEDULE OF WATER RATES - 1996
Summary of Waterate Software Inputs and Outputs 1/

FPSC
Schedule: E1-4
Page 3 of 3
Preparer: Bencini

Company: SSU / FPSC Jurisdiction / Proposed Conventional and Reverse Osmosis Treatment
Docket No.: 950495-WS
Schedule Year Ended: 12/31/96
Water [x] Wastewater [ ]
Interim [ ] Final [x]
Historical [ ] Projected [x]
Present: FPSC Uniform [x] FPSC Non-uniform [x]
Proposed: Conventional [x] Reverse Osmosis [x]

Explanation: Provide a summary schedule of the Waterate software tool inputs and outputs.

	Conventional Treatment	Reverse Osmosis

4/ The predicted price elasticity driven decrease in consumption would also reduce the direct short-run costs. Refer to the testimony of John Whitcomb, Ph.D. for a detailed explanation of the Waterate model.

5/ The 40% base and 60% gallonage split for revenues is being used for this rate case. This qualifies as a conservation promoting rate structure according to the Brown & Caldwell weighting definition. Refer to the testimony of John Whitcomb, Ph.D. for details.

6/ The billing determinants provided did not include bulk water from Marco Island. The ERCs are stated as monthly numbers because that is how they are used in the Waterate software tool. The consumption number is after the conservation program adjustments. Refer to schedule E1-2 in the 1996 Conventional Treatment and Reverse Osmosis tabs for details. These numbers may not tie to other schedules due to rounding.

7/ Other consumption includes commercial, public authority and irrigation. SSU took the conservative approach by classifying irrigation in the same classification as commercial. This was done because the breakout of our irrigation customers by residential, multi-family and commercial classes is not possible at this time.

8/ The price elasticity adjustments are outputs from the Waterate software tool. They have been converted from a gallonage number to a percentage for application purposes. Please refer to the testimony of John Whitcomb, Ph.D. for details.

9/ The preliminary rates are derived from the Waterate software tool. They do not exactly match our final rates due to rounding and the slight increase in revenue requirements not taken into consideration in Waterate. In addition, any non-standard rate design classes (like raw water in the reverse osmosis treatment category), are not included.

Notes about the Waterate simulation:

Assumed 75% of long-run price elastic response.
Assumed long-run nonresidential price elasticity of -0.20 (0 for mult-ifamily and -.25 for other).
Fire protection BFC is 1/12 of BFC.
Bill frequency information based on 1994 water use consumption.
Non-uniform historical gallonage and sewer charges based on weighted average of prices.

EXHIBIT (TBW-6)
PAGE 6 OF 6