NATIONAL MULTIPLE FAMILY SUBMETERING AND ALLOCATION BILLING PROGRAM STUDY

Prepared by:

Peter W. Mayer, Erin Towler, and William B. DeOreo
Aquacraft, Inc. Water Engineering and Management

Erin Caldwell and Tom Miller
National Research Center, Inc.

Edward R. Osann and Elizabeth Brown
Potomac Resources, Inc.

Dr. Peter J. Bickel
University of California, Berkeley

Dr. Steven B. Fisher
Economist

Sponsored by:

United States Environmental Protection Agency, National Apartment Association, National Multi Housing Council, City of Austin, City of Phoenix, City of Portland, City of Tucson, Denver Water Department, East Bay Municipal Utility District, San Antonio Water System, San Diego County Water Authority, Seattle Public Utilities, and Southern Nevada Water Authority

DISCLAIMER

Printed in the U.S.A.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

FOREWORD

As water utilities pursue options for new supplies, one option involves capturing savings from water conservation programs. This process also includes continually searching for additional water conservation opportunities through new measures and new technologies. Beneficiaries of improved efficiencies and cost-effective savings include water and wastewater utilities, the utility customer, and the environment.

One potential source of water savings is in the multi-family sector where utilities typically bill the owner through one master meter and the residents pay for their water and wastewater as part of the monthly rent. Embedded in this paradigm is little or no incentive for the end user, the resident, to save water because there is no direct pricing signal since water is paid for in the rent.

As water and wastewater costs increase faster than the rate of inflation, multi-family dwelling owners are seeking to shift these uncontrolled costs directly to the resident instead of including them as part of the rent. Owners are using two basic methods to bill residents. One method involves billing for actual consumption via metering. The second method involves billing based upon an allocation formula, such as the number of people, number of bedrooms, square footage, etc. However, the allocation method does not appear to provide an incentive for residents to save water because the pricing signal is diluted since the charge is based upon a pre-determined formula and not on actual use. One of the primary objectives of this study was to investigate the savings potential if multi-family residents are billed for their use either through actual metering or some type of allocation formula.

Nationally, up to 4% of multi-family residents may now be metered and charged for their consumption based upon actual volume of use. Another 9% pay for their water through various allocation formulas and about 2% are billed through a combination of metering and allocation programs. That leaves about 85% of multi-family residents still paying for their water and wastewater as part of their rent, often referred to as “in-rent”. Because the water use of around 60 million people, 20-25% of all residents, could be reduced, there is a great deal of interest in the potential water savings, the cost and benefits involved in capturing savings, and the administrative issues associated with separate billing programs. While some utilities are metering individual multi-family dwelling units, most are not. And while still other utilities have investigated local water savings associated with separate billing systems, such as the City of Austin, Las Vegas Valley Water District, San Antonio Water System, and Seattle Public Utilities, study funding partners agreed that much more empirical data were needed on this subject.

The study had five main objectives: 1) to determine the water savings potential in the multi-family sector resulting from both direct metering and allocation programs, 2) to understand the current regulatory framework governing separate billing programs across the U.S., 3) to access the current business practices in the billing service companies (read and bill industry), 4) to draw conclusions from the findings, and 5) to make recommendations that offer consumer protection, provide ethical business practices for the industry, and capture cost-effective water savings.

This report reflects the results of an effort that began over three years ago in cooperation with the EPA, two national apartment associations, and 10 water utilities. It is hoped that the information presented in this report will be found timely, useful, and objective; will add to the current body of knowledge; and that the appropriate organizations, including water utilities, will consider adopting and implementing the study's recommendations.

ACKNOWLEDGMENTS

The project team wishes to express our sincere thanks to the following individuals and groups for their assistance on this project: John Flowers, Jason Bayne, Leslie Martien, Kristina Kaprich, Lee Tyson, John Wright, Eddie Wilcut, Tracey Berry, Tom Babcock, Barbara Buus, Linda Smith, Barry Lindley, Hector Dominguez, Bernie Brown II, John Loughry, G. Hossein Parandvash, Judith Ranton, Teri Liberator, Don Holmes, Jeff Sandberg, Dan Strub, Tony Gregg, Fiona Sanchez, Phil Regli, Theodore Pritchett, Bryan Harper, Kent Sovocool, Al Dietemann, Cherilyn Mathisen, Tim Skeel, Norm Davis, Maureen Hall, Luis Generoso, Dale Lessick, Elliot Fry, Angela Elliott, Chris Robbins, Mitchell Morgan, Warner White, Rita Martinez, John Sheahen, Delphie Morales, Mark Siporen, Chuck Stolberg, Marc Treitler, National Submetering and Utility Allocation Association, American Utility Management, Archstone, Minol, National Water and Power, US Water Works, USI Energy, Viterra, WaterMaster, and Wellspring.

Peer review of the final report is deeply appreciated and was provided by the following individuals and organizations: John Nelson of John Olaf Nelson Water Resource Management; the National Submetering and Utility Allocation Association; Larry Spielvogel, PE; and Doug Koplow, Earth Track, Inc.

This research would never have been completed without the cooperation of the multi-family property owners, managers, and residents that completed the various mail and telephone surveys conducted in this study.

This study would not have been possible without the vision and generous resource commitments from the following sponsoring organizations: United States Environmental Protection Agency; National Apartment Association; National Multi Housing Council; City of Austin; City of Phoenix; City of Portland; City of Tucson; Denver Water Department; East Bay Municipal Utility District; San Antonio Water System; San Diego County Water Authority; Seattle Public Utilities; and Southern Nevada Water Authority.

We are also deeply thankful for the assistance and time commitment provided by the following participating water utilities: City of San Diego, Hillsborough County Water Department, Southern Nevada Water Authority, Las Vegas Valley Water District, Irvine Ranch Water District, and Indianapolis Water.

We are grateful to the members of an ad hoc committee that helped us understand the various plumbing codes and the issues surrounding point-of-use meters. These individuals included Henry Oppermann, Steven Cook, Ken Lake, Jim Nehl, Don Faber, Brad Drier, Wade Smith, Al Dietemann, Eddie Wilcut, and Mike Kobel.

We would like to extend our sincere appreciation to the members our project oversight committee (POC) who represented their respective agencies and helped guide this effort. The POC members included: John Flowers, Eileen Lee, Barbara Vassallo, Calvin Finch, Tony Gregg, Dan Strub, Al Dietemann, John Loughry, Eddie Wilcut, Judi Ranton, G. Hossein Parandvash, Vickie Driver, Kent Sovocool, Tom Babcock, Joe Babcock, and Linda Smith.

Finally, this project would never have come to fruition without the guiding spirit of the project manager Dick Bennett of the East Bay Municipal Utility District. He conceived, organized, and administered this project. His support, diligence, management skills, and enthusiasm were instrumental in every phase of this effort.

EXECUTIVE SUMMARY

More and more buildings in the multi-family housing sector are converting to systems where each multi-family dwelling unit pays for water and wastewater directly instead of including these charges as part of the rent. The three most common ways in which separate billing is accomplished are: (1) Through direct submetering of water use by means of a water meter installed on a single or multiple points of entry water line(s); (2) Through a Ratio Utility Billing System (RUBS), which bases the water bill on an allocation formula that uses floor space, number of occupants, etc.; or (3) A hybrid of the two where total water use is estimated based on the ratio of metered hot (or cold) water use (and sometimes selected appliances) in a unit to the total water use of all occupants. It is estimated that there are now more than 1.2 million apartment renter households that are billed separately for water and sewer using one of these billing system methods (NMHC 2001).[1]

RESEARCH OBJECTIVES

The goals of the National Multiple Family Submetering and Allocation Billing Program Study were to determine the merits of separate billing programs including the potential water savings, costs and benefits from various perspectives, and the accompanying administrative and regulatory issues. In the study, a retrospective analysis of water use in multi-family properties in 13 cities was conducted. The 13 study cities were weighted towards the West and southwestern region of the United States, but contain a wide variety of utilities serving a broad and diverse group of customers. Properties equipped with submeters or that have undergone a billing system conversion (impacted properties) were identified and compared against control (in-rent) properties where water and wastewater fees are included as part of the rent. The study compared the two groups using historic billing data provided by participating water utilities combined with an extensive series of mail surveys and site visits. The data collected for study provides a wealth of information about how submetering and allocation affect water use, property owners, and residents. Embedded in these data are insights into this developing industry, including the

[1] Based on data from the 2001 American Housing Survey. Assumes a multi-family property has at least five dwelling units. The number is higher if smaller properties are included in the analysis.

quantitative aspects of separate billing. The data are also useful for examining the impacts of the 1992 Energy Policy Act plumbing standards and other factors that may influence water use. It is anticipated that the database of submetered and allocated billing program information developed for this study will be a resource for researchers and planners to explore for years to come, particularly if it is maintained and updated.

TERMINOLOGY AND DEFINITIONS OF BILLING METHODS

The following terms and definitions are used throughout this report.

In-Rent Properties

In-rent properties refer to all properties where the owner does not separately bill residents for water and wastewater. A slight variation of this standard "in-rent" arrangement can occur when there is a homeowners association (HOA) at a property that collects flat monthly fees.

Impact Properties

Impact properties refer to all properties that bill separately for water and/or wastewater by submetering, ratio utility billing systems, or a hybrid of the two. Within these different billing methods, the party actually billing for water needs to be defined. The ***owner*** refers to either an individual or an organization that owns and/or manages a rental property. A third-party ***billing service company*** (billing company) is a private, for-profit entity that provides billing services for water, wastewater, trash collection, and energy to owners of multi-family properties. A ***utility*** is a regulated provider of water and/or wastewater service to a set of customers. Utilities may be public or private entities and they are responsible for treating, delivering, and billing for water and/or wastewater.

Submetering

Submetering in this report is defined as full capture metering that occurs downstream of a water utility master meter. There are three different types of submetering that can occur:

Single point of entry submetering

Dual point of entry submetering

Point-of-use submetering

Hybrid Metering

Hybrid metering, referred to as “hot water hybrid” (HWH) in this report, are billing systems where only a portion of the water such as the hot water consumption (or occasionally the cold water) for each unit in a multi-family dwelling is measured. This information is then typically used to extrapolate the total water bill.

Ratio Utility Billing Systems

Ratio utility billing systems (RUBS) use an allocation formula to estimate water consumption for each unit in a multi-family dwelling. RUBS systems are not based on the actual consumption at each unit, rather individual bills are prorated from the overall utility master meter bill based on one or a combination of quantitative measures such as square footage, number of occupants, or number of fixtures.

RESEARCH APPROACH

The project team developed a multifaceted approach to accomplish the research objectives set out for this study.

1. **Selection of participating study sites**: After invitations were sent to utilities and water providers across the United States and Canada followed by personal phone calls and contact, representatives from 13 study sites volunteered to participate and partially fund this research. These 13 participating water providers were: (1) Denver Water, Colorado; (2) Seattle Public Utilities, Washington; (3) City San Diego Water Dept., California; (4) Hillsborough County, Florida; (5) City of Phoenix, Arizona; (6) City of Tucson, Arizona; (7) City of Austin, Texas, (8) San Antonio Water System, Texas; (9) City of Portland, Oregon; (10) East Bay Municipal Utility District, California; (11) Irvine Ranch Water District, California; (12) City of Indianapolis, Indiana; and (13) Southern Nevada Water Authority & Las Vegas Valley Water District, Nevada. Participation required the utility to provide complete billing data for the multi-family subclass from their service area and project support.
2. **Quality assurance and quality control (QAQC)**: Procedures to ensure the quality of the data and the research methods were implemented throughout the study.

3. **Owner/postcard survey**: To identify "impact"[2] properties in each utility, owner surveys were developed, tested and implemented to all eligible properties in each utility. This survey was necessary because in most cases there was no independent source of information about what properties use the various billing systems in any utility service area, and the study did not want to rely on information supplied solely from the billing companies, many of whom could not share their client lists in any case. In order to avoid a fatal bias in the study group selection, postcards were sent to all owners of multi-family properties listed in the water providers billing databases. The responses from this survey were used to identify the impact properties.
4. **Database development**: All data collected in this study including historic water billing records and survey response data were stored in a customized Microsoft Access database.
5. **Manager survey:** To obtain detailed information about properties identified in the owner/postcard survey, a survey was developed, tested and sent to managers of impacted and in-rent properties.
6. **Regulatory and policy review:** To evaluate the administrative and regulatory issues surrounding third party billing programs throughout the country, surveys were sent to various potential regulators in all 50 states and to more than 100 of the largest water and wastewater utilities. Additionally a detailed policy literature review was conducted.
7. **Matched pair selection and site visits:** Study team utilized the results from the manager survey to make statistically similar pair matches for site visits and comparison. A site visit protocol was developed and the study team worked with participating utilities to conduct site visits.
8. **Resident survey**: To solicit resident opinions and experiences with different billing methods, a survey instrument was developed, tested, and sent to residents using addresses provided on the manager survey. Some residents also provided copies of their water and wastewater bills sent by various read and bill companies or owners.
9. **Read and bill company survey**: To obtain information about billing practices and policies a survey was sent to 36 third party billing companies.
10. **Statistical analysis and modeling**: Once the data collection and analysis was complete, the

[2] Impact properties – multi-family properties billing separately for water and/or wastewater services using RUBS, submetering, hot water hybrid, or other methods.

research team used all of the assembled information to develop analytical tools and relationships to quantify potential water savings and explain indoor multi-family residential water use.

11. **Final products**: The final products of this research project include this final report and the database.

RESEARCH FINDINGS

Prevalence of Billing for Water and Wastewater at Multi-family Properties

RUBS, submetering, or hybrid metering was reported in 13.4% of the 7942 properties that responded to the owner/postcard survey. However, looking at the number of units indicated on the postcard survey, 35.4% of units are billed through RUBS, submetering, or hybrid systems. This represents the best estimate from this study of the prevalence of this practice in the multi-family sector. The postcard survey was sent to the owner of every multi-family property in the billing databases of the participating study sites that fit the initial criteria[3]. Nation-wide the prevalence of separate billing for water and wastewater may be somewhat less because the study sites selected to participate in this study often had a notable concentration of properties receiving water and wastewater bills based on data provided by billing service companies.

Table ES.1.1 Breakdown of each billing method for all properties identified

		Billing Method					
		In-Rent	**HWH**	**Sub.**	**RUBS**	**Other***	**Total**
All respondents	Properties	6760	42	311	717	142	7972
	% of properties	84.8%	0.5%	3.9%	9.0%	1.8%	100%
	Units	286,355	3,912	47,547	112,049	10,400	460,263
	% of units	62.2%	0.8%	10.3%	24.3%	2.3%	100.0%

*Includes “Other” as well as respondents who left the question blank.

Estimated Water Use By Different Billing Methods

One of the central purposes of this study was to determine the water savings associated with submetered and allocation billing programs in multi-family housing. This research question was the over-arching theme for the entire project and a majority of time and effort was spent collecting and analyzing data to provide information on the potential water savings from submetering and RUBS. Keep in mind that this study did not set out to estimate national "averages" of impact property water use, and the selected properties were not selected to be representative of the entire United States. Rather the primary goal was to determine the impacts of different billing programs.

Why are water savings so important? Water providers are keenly interested in identifying effective approaches to reducing water demand, as new supplies become increasingly expensive and difficult to obtain. National and state agencies are interested in improving water efficiency and promoting proven methods for achieving savings. The utility billing industry has promoted the practice of charging multi-family customers for water and wastewater services not only as a way to improve property owners' net operating income, but also as a way to effect water conservation. Water savings could provide justification for encouraging, promoting, and expanding billing programs and could unite water providers, regulators, and billing companies in a common goal. As a result there has been intense interest in this question.

To reach a conclusion regarding how water use differs between billing types, seven main analyses were conducted. The number of properties included in each analysis is included in Table ES.1.2. The results of each analysis are discussed in the sections that follow.

Table ES.1.2 Number of properties included in each analysis, by billing type

Description of Analysis	**Number of Properties by Billing Method**				
	In-Rent	**Sub.**	**RUBS**	**HWH**	**Total**
Postcard Survey	6493	273	595	41	7402
Manager Survey	858	118	177	22	1175
Statistical Model #1	705	101	150	-	956
Statistical Model #2	703	100	150	-	953
Statistical Model #3	531	79	136	-	746
Matched Pair	29	21*	14	-	64
Pre-Post Conversion	-	6	39	1	46

*7 HWHs were grouped with the submetered for this analysis

Submetering

Submetering was found to achieve statistically significant water savings of 15.3 percent (21.8 gal/day/unit) compared with traditional in-rent properties after correcting for factors such as year of construction (before 1995, 1995 or later), average number of bedrooms per unit, presence of play areas, presence of cooling towers, utility's average commodity charge for water and wastewater, whether a property was a rental or individually owned, and classification of the

[3] See Chapter 3 for details.

property as a retirement community. Not all submetered properties used less water and the statistical model that demonstrated these savings predicted only about 25% of the variability in water use in the observed properties. Summarized water use analysis comparing submetered and in-rent properties is shown in Table ES.1.3. Statistically significant savings from submetering was found in every single comparison and analysis conducted in this study. Water savings ranged from –5.55 to –17.5 kgal per unit per year, or –15.20 to –47.94 gallons per unit per day (gpd) which is between -11% to -26%. Based on an evaluation of the different data sets, analyses, and models, the researchers concluded that multivariate model #2, highlighted in blue, provides the "best estimate" of expected water use and savings at submetered properties[4]. The number of properties used in each analysis can be seen in Table ES.1.2.

Table ES.1.3 Summarized water use analysis results, submetering

Data source or Analysis	Annual Indoor Water Use per Unit kgal (gpd)		Estimated Difference in Water Use (± 95% confidence interval)	Statistically Significant at 95% confidence level?
	In-Rent (or pre-conversion)	Submetering		
Postcard Survey	53.21 (145.8)	44.87 (122.9)	-15.7% ± 6.2%	*yes*
Manager Survey	51.61 (141.4)	46.07 (126.2)	-10.7% ± 9.3%	*yes*
Model #1	52.33 (143.4)	43.73 (119.8)	-16.4% ± 9.3%	*yes*
Model #2	52.19 (143.0)	44.23 (121.2)	-15.3% ± 9.3%	*yes*
Model #3	53.19 (145.7)	43.14 (118.2)	-18.9% ± 10.3%	*yes*
Matched Pair	57.59 (157.8)	47.61 (130.4)	-17.3% ± 17.0%	*yes*
Pre-Post Conversion	68.21 (186.9)	50.71 (138.9)	-25.7% ± 27.2%	*yes**
Conclusion	**52.19 (143.0)**	**44.23 (121.2)**	**-15.3% ± 9.3%**	***yes***

* Test was significant at the 94% confidence level.

RUBS

This study found no evidence that Ratio Utility Billing Systems (RUBS) reduced water use by a statistically significant amount compared with traditional in-rent arrangements, and the data showed that the difference between water use in RUBS and in-rent properties was not statistically different from zero. While some RUBS properties used less water on average than

[4] Submetered properties were identified by manager survey responses. Through the site visits, it was found that 3 out of 20 properties visited (15%) had indicated on the manager survey that they were submetered, but were found to only be metering the the hot water. Thus, the submetered sample is likely to contain some hot water hybrids.

in-rent properties, others used the same or more water on average than in-rent properties. Summarized water use analyses comparing RUBS and in-rent properties are shown in Table ES.1.4. Typically the 95 percent confidence interval for RUBS spanned a range that included an increase in expected water use as well as water savings. Statistically significant water use savings from RUBS were detected in only a single comparison test – the matched pair sample. The matched pair comparison relied on the smallest RUBS sample size in the study and, as explained in detail in the body of the report, the in-rent control sample did not appear to be representative of the population of in-rent properties in the study. Based on an evaluation of the different data sets, analyses, and models, the researchers concluded that multivariate model #2, highlighted in blue, provided the single "best estimate" of expected water use at RUBS properties. After correcting for a wide variety of factors and evaluating numerous different analytic models, the researchers concluded that no statistically significant impact from RUBS could be reliably expected. The number of properties used in each analysis can be seen in Table ES.1.2.

Table ES.1.4 Summarized water use analysis results, RUBS

Data source or Analysis	**Annual Indoor Water Use per Unit kgal (gpd)**		**Estimated Difference in Water Use** (± 95% confidence interval)	**Statistically Significant at 95% confidence level?**
	In-Rent **(or pre-conversion)**	**RUBS**		
Postcard Survey	53.21 (145.8)	52.10 (142.7)	-2.1% ± 4.3%	no
Manager Survey	51.61 (141.4)	53.45 (146.4)	3.6% ± 7.8%	no
Model #1	52.33 (143.4)	52.76 (144.5)	0.8% ± 7.4%	no
Model #2	52.19 (143.0)	52.58 (144.1)	0.7% ± 7.4%	no
Model #3	53.19 (145.7)	51.48 (141.0)	-3.2% ± 7.7%	no
Matched Pair	66.19 (181.3)	47.80 (131.0)	-27.8% ± 19.2%	*yes**
Pre-Post Conversion	55.32 (143.4)	52.85 (144.4)	-4.5% ± 8.8%	no
Conclusion	**52.19 (143.0)**	**52.58 (144.1)**	**0.7% ± 7.4%**	**no**

* Results from this analysis are further explained in Chapter 5.

Hot Water Hybrid

Hot water hybrid billing systems may achieve water savings, however in this study the sample of hot water hybrid properties was too small to produce reliable results that can be generalized to the broader population. Analysis of data from the limited sample of hot water hybrid properties does suggest that water savings, somewhat smaller than the magnitude found in submetering, *may* be achieved through this billing methodology. This study was unable to verify this finding of savings in a reliable, statistically rigorous manner because of the small sample size. Summary water use analysis results for hot water hybrid properties are shown in Table ES.1.5. The number of properties available for each analysis can be seen in Table ES.1.2. It should be noted that during the site visits it was discovered that 15% of the hot water hybrid properties had been mislabeled by the mangers as submetered. This indicates that HWHs may be more common that originally thought, and is suggestive that they may have comparable savings to submetering. However, further research is needed to verify this.

Table ES.1.5 Summarized water use analysis results, hot water hybrid

Data source or Analysis	**Annual Indoor Water Use per Unit kgal (gpd)**		**Estimated Difference in Water Use** (± 95% confidence interval)	**Statistically Significant at 95% confidence level?**
	In-Rent **(or pre-conversion)**	**Hot Water Hybrid**		
Postcard Survey	53.21 (145.8)	49.61 (135.9)	-6.8% ± 15.7%	no
Manager Survey	51.61 (141.4)	44.79 (122.7)	-13.2% ± 20.5%	no

Multivariate Model Results – Best Estimate of Water Use and Savings

The purpose of the multivariate regression modeling and analysis in this study was to account or "correct" for factors that influence water use so that submetered and RUBS properties could be compared against in-rent properties on an equal basis. For example, if a submetered property was built in 1998 and equipped with water efficient fixtures it was important to correct for this so that water savings associated with the efficient fixtures not be incorrectly attributed to submetering when comparing against in-rent properties built before EPACT plumbing standards were put in place.

Using the relevant factors identified through the ANOVA and Pearson Correlation analyses, numerous multivariate regression models were developed using identified factors as the independent variable and annual indoor per unit water use as the dependent variable.[5] Nearly all

[5] Indoor water use was normalized by total number of units rather than on occupied units because vacancy rates were not found to be a statistically significant factor. Indoor water use was not normalized on a per occupant basis because many survey respondents left that question blank thus reducing the potential sample size. In addition, the

of these models included the billing methodology (submetering or RUBS) as a factor. The results of this methodology are a set of models that account for a variety of different factors shown to influence water use. At the same time these models also evaluate the impact of submetering vs. in-rent billing and RUBS vs. in-rent billing. Step-wise regression was also used to create a multivariate model that includes all of the relevant independent variables shown to have statistical significance.

The single most statistically powerful predictive multivariate regression model developed in this study was Model #2. This model was selected as the “best estimate” of water use and savings in submetered and RUBS properties because of the large sample size (n=953), because it had one of the highest coefficients of determination (R^2=0.245) of any of the more the 50 models examined by the researchers, and because the overall model was found to be statistically significant at the 95% confidence level. Model #2 includes eight independent variables identified as significant from the ANOVA and Pearson Correlation analyses. In addition, a ninth variable, the use of a RUBS, was forced into the model. Even though it was not found to be statistically significant whether a property used RUBS was central to this study and it was important that the variable be included explicitly. The resulting nine independent variables were:

- Average number of bedrooms per unit
- Year the property was built (1994 and earlier or 1995 and later)
- Rental property (private and government subsidized) vs. non-rental properties (i.e. condominiums, private resident owned, and other)
- Utility’s average commodity charge for water and wastewater
- Presence of a play area
- Presence of a cooling tower
- Classification as senior citizen/retirement community
- RUBS
- Submetering

Fundamental information and statistics from the regression model are presented Table ES.1.6. The adjusted coefficient of determination (R^2) for Model #2 is 0.245. This indicates that the model explains about 25 percent of the variability in the data. The coefficient of determination (R^2) is a measure of the goodness of fit of the model to the actual data on which

site visits determined that the reported number of residents was a less accurate value than the reported number of the model was based. A model with a perfect fit would have an R^2 value of 1.0. The P-value for the model itself is 0.00 indicating that whatever fit does exist is statistically significant at the 95% confidence level.

Table ES.1.6 Model #2 summary statistics, coefficient of determination, and significance

R	R Square	Adjusted R Square	Std. Error of the Estimate	Degrees of Freedom	F	P-value
0.502	0.252	0.245	21.39659	952	35.366	0.000

Predictors: (Constant), submetering, rental property (compared to non-rental property), play area, cooling tower, is the property considered a senior citizen/retirement community, average price utility charges for water and wastewater, RUBS, property built before 1995 (compared to properties built 1995 or later), average number of bedrooms per unit
Dependent Variable: Indoor water use per unit (average 2001, 2002)

The coefficients presented in Table ES.1.7 present the magnitude of the "effect" of the different independent variables in the model. The coefficients are additive, and details about how to formulate the generic equation from these coefficients are found in the body of the report. Of particular interest are the coefficients for RUBS and submetering. In Model #2, eight of the nine independent variables were statistically significant. The only factor that wasn't statistically significant was RUBS. The B coefficient shows the magnitude of the effect, and is graphically displayed in Figure ES.1.1 and Figure ES.1.2. For submetering the B coefficient was –7.96 indicating that submetered properties used 7.96 kgal per unit *less* water than in-rent properties after adjusting the other significant independent variables. This effect was statistically significant at the 95% confidence level.

The B coefficient is a measure of the effect of each factor in the model. It is worth noting that three factors in this model were found to be more significant influences on multi-family water use than submetering. These are: (1) whether the property was built before 1995; (2) whether the property has a cooling tower; and (3) the average number of bedrooms per unit.

Another three factors were found to have an influence on water use with similar magnitude to submetering. These are: (1) whether the property is a senior/retirement community; (2) whether the property has a play area; and (3) whether the property is a rental.

---

units. Finally, the relationship between total indoor water use at a property and number of units was almost linear.

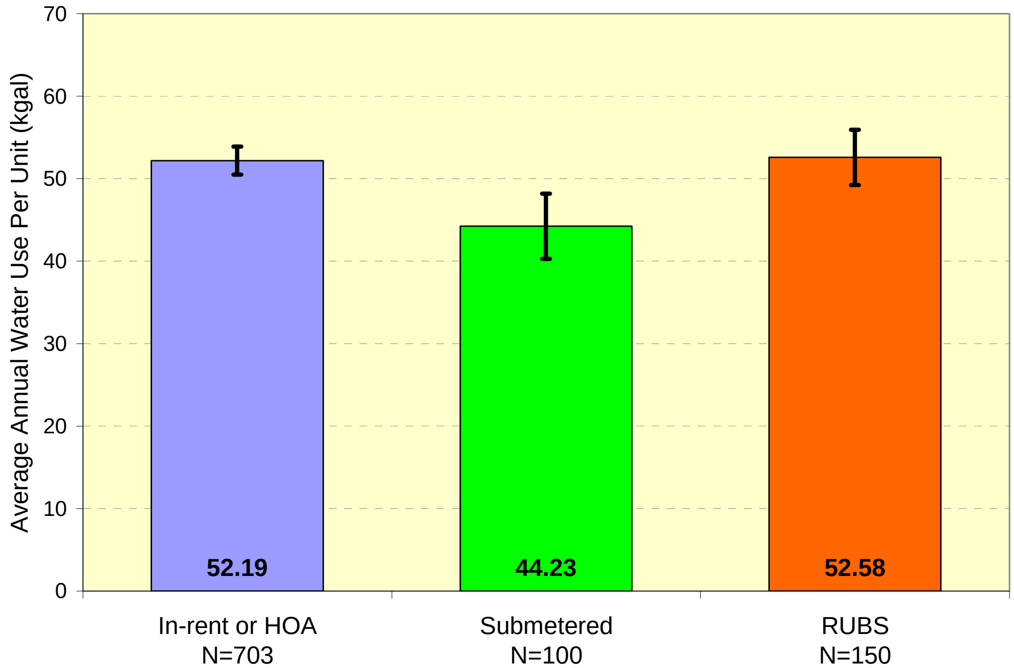


Figure ES.1.1 Adjusted average annual water use per unit – Model #2

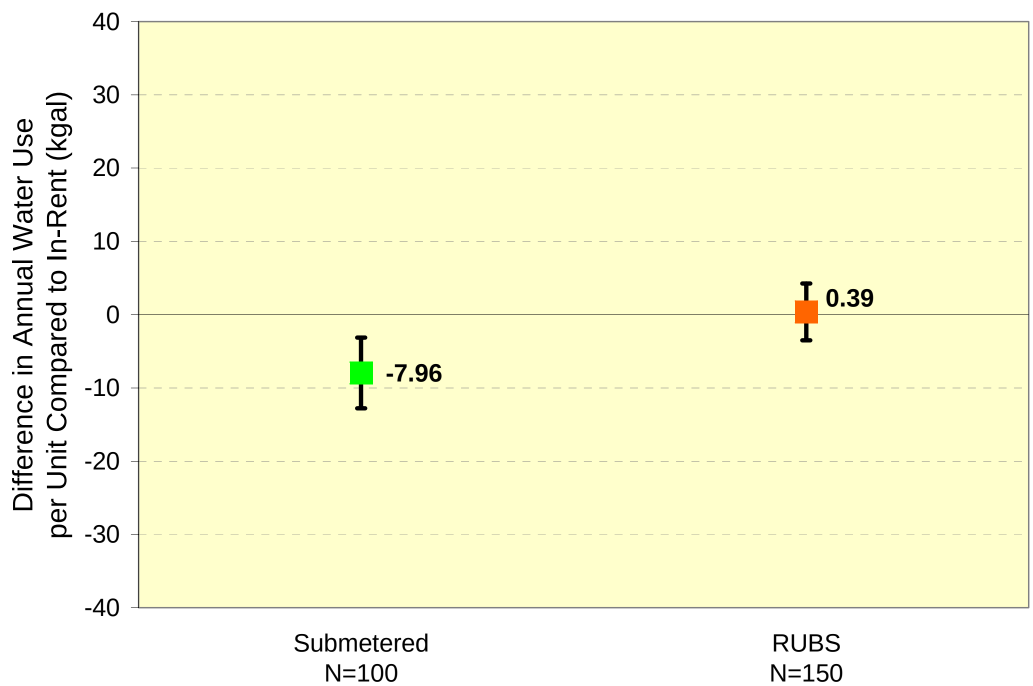


Figure ES.1.2 Difference in adjusted average annual water use of impacted properties compared to in-rent properties – Model #2

Table ES.1.7 Model #2 coefficients and significance of independent variables

Independent Variable	B*	Std. Error	t	P-value
(Constant)	19.95	4.61	4.323	.000
Property was built before 1995	10.84	2.29	4.736	.000
Property is a senior citizen/retirement community	-6.70	2.56	-2.618	.009
Property has a play area	6.80	1.94	3.513	.000
Property has a cooling tower	11.55	3.31	3.493	.001
Property is a rental†	6.84	1.74	3.926	.000
Property is billed through RUBS method	0.39	1.98	0.197	.844
Property is submetered	-7.96	2.47	-3.225	.001
Average commodity charge for water/wastewater‡	-2.01	.28	-7.072	.000
Average number of bedrooms per unit‡	17.44	1.54	11.313	.000

Dependent Variable: Indoor water use per unit (average 2001, 2002)
* Represents the magnitude of each independent variable in kgal per year per dwelling unit
† Rentals include private and government subsidized rentals. (Non-rentals include condominiums, private resident owned, and other).
‡ Continuous variables, change is seen for every dollar or bedroom added.

Besides submetering, seven other independent variables (listed in Table ES.1.7) in the model were also statistically significant. Properties built before 1995 used 10.8 kgal per unit *more* than properties built after 1995 – this is presumably largely the result of the high efficient plumbing fixtures (toilets, showerheads, and faucet aerators) mandated for new construction by the 1992 Energy Policy Act (EPACT). The average number of bedrooms per unit is a reasonable surrogate for the number of people living in each dwelling unit. These models suggest that for every additional bedroom water use is *increased* by an average of about 17.4 kgal per unit. Rental properties used 6.8 kgal per unit *more* than properties that were non-rentals (condominiums, private resident owned, and other). Properties classified as senior citizen or retirement communities used 6.7 kgal per unit *less* than standard mixed-age multi-family properties. For every dollar increase in the average price charged by a utility per kgal, the water use at a property decreased 2.0 kgal per unit. Properties that reported having a play area used 6.8 kgal per unit *more* than properties without that amenity. The presence of a cooling tower increased per unit water use by 11.6 kgal. The prevalence of each of these characteristics in the manager survey respondents can be found in Chapter 4's section on "Manager Survey Results" or in the enumerated manager survey results in Appendix B.

COSTS AND BENEFITS

Beyond quantifying the water savings that can be measured by implementing a multi-family water and wastewater billing program, there are many issues that arise concerning these systems for utilities, for property owners, and for residents. As is true with any developing field, there are clear advantages to these systems, as well as costs and drawbacks that need to be addressed.

Utility Perspective

Supporting the installation of submeters represents an opportunity for water utilities to capture cost-effective water savings. Savings can be captured in new construction by either requiring the individual metering of multi-family units or by offering incentives in both existing and new multi-family dwellings. Because RUBS has not been found to render reliable savings, it is not cost-effective for utilities to offer incentives promoting RUBS programs. However, since the findings of this report indicate that the savings from fixture upgrades are more substantial than from submetering, utilities should consider offering cost-effective incentives for change-outs for all multi-family properties.

Table ES.1.8 shows a range of avoided costs for utilities, assuming annual savings of 7.96 kgal per dwelling unit (du) (21.8 gallons/du/day) from submetering. A utility avoided cost of $500/AF would translate into a present value savings of $152 for each dwelling unit that is submetered, assuming a 20 year useful life. The present value of benefits to the utility could be considered a justifiable subsidy that the utility could offer for submetering or other conservation efforts. Obviously, agency avoided cost and assumptions about product life impact the value of submetering for each utility.

Owner Perspective

In most cases, billing separately for water and wastewater will increase the owner's net operating income and property value. Despite the initial capital investment, submetering can be a cost-effective option for owners. In addition, submetering technology has improved so that the cost for submetering new construction and submetering most existing properties is reasonable. In the case of allocation, there is no initial investment and the payback is immediate. Owners could use this increase in income to improve overall water efficiency on the property, including fixture upgrades. Nevertheless, before converting to a separate billing system, owners should be aware of the applicable federal, state, and local regulations.

Table ES.1.8 Avoided costs from submetering, utility perspective

Annualized Combined Water and Sewer Avoided Cost ($/acre-ft)	($/kgal)	Equivalent PV Avoided Cost* ($)	Water Saved (gal/du/year)	Submeter Useful Life† (years)	Value of Water and Sewer Benefits ($/year)	PV of Benefits to Utility‡ ($)
$200	$0.61	$3,432	7,957	20	$5	$61
$300	$0.92	$5,148	7,957	20	$7	$91
$400	$1.23	$6,864	7,957	20	$10	$122
$500	$1.53	$8,580	7,957	20	$12	$152
$600	$1.84	$10,295	7,957	20	$15	$183
$700	$2.15	$12,011	7,957	20	$17	$213
$800	$2.46	$13,727	7,957	20	$20	$243
$1,000	$3.07	$17,159	7,957	20	$24	$304

* Assumes discount rate of 5% and a term of 40 years.
† Assumes that AMR submeters will be replaced twice in twenty years.
‡ Assumes discount rate of 5% and the assumed term of the submeter useful life (in this case, 20 years).

Table ES.1.9 shows the benefit/cost analysis for the life-cycle of a variety of submeter installation costs. In all of the cases, the owner is assumed to pay the monthly service fee. The benefit/cost ratio varies from 1.9 to 5.1 in all of the cases, assuming a utility water and wastewater commodity charge of $5.27[6]. It should be noted that many owners would not stay with a property for the life cycle of submeters, rather most only own a property for an average of five years. If one looks at the simple payback for owning a property for five years, using the same assumptions from Table ES.1.9, the simple payback is less than one year for all cases. Table ES.1.10 shows the benefit/cost ratios for owners who chose to allocate. Here, the benefit/cost ratios range from 4.9 to 7.6.

A key component in these analyses is an assumption that the owner does not reduce the rent to the residents as part of a submetering program. The result is a net increase in rental costs to residents, and the researchers found that this was the most common practice during billing conversion. It is possible that an owner might choose to reduce rental rates in an amount similar to what each resident is paying for water every month. If the owner were also to pay the monthly service charge, then the resident would experience no net increase in rental costs and the owner's benefit/cost ratio would be reduced substantially. This does not appear to be a common practice.

Resident Perspective

Based on the results obtained in the resident survey, consumers have varied opinions on water billing programs. Often these programs result in a water bill in addition to a monthly rent charge. While consumers receive electric or gas bills, many have come to expect that water charges are included in the rent. As currently practiced, water and wastewater billing programs do not appear to be an appealing option for residents of multi-family dwellings. Also, residents are typically charged a service fee (in conformance with applicable state and local law) in addition to their volumetric or allocated charge. Thus, in the short term, these billing programs cause an increase in monthly costs for residents. While there may be environmental benefits such as increased water conservation, there are many uncertainties involving separate billing that could be perceived as negative. Until separate billing for water and wastewater has some definitive standards and protections for residents, it is unlikely that most residents will embrace it. Direct metering and billing of water for apartment residents encourages water efficiency and promotes a water billing system that is as transparent as other utilities like gas and electricity, phone and cable whereby residents pay for what they use.

If a property owner were to reduce the rent in the approximate amount of the total water and wastewater bill (including the service fee), then the resident might experience no net increase in rental costs if all else is held constant. As noted above, this does not appear to be a common practice. If the property owner were to pay the service fee as recommended (see Recommendation 8, subsection 9), then the overall cost impact to the resident might be reduced. However as practiced today, it appears that water and wastewater billing programs result in increased costs for residents.

---

[6] This was the average of the water and wastewater commodity charges for the thirteen study sites.

Table ES.1.9 Cost and benefit per unit analysis for owners who chose to submeter

Submetering Method	Efficient Fixtures?	Annual Water Use* (gal/du)	Useful Life[†] (years)	Annual Value of Water and Sewer Benefits[‡]	PV of Benefits[§]	Capital or "First" Costs ($/du)			Annual Service Fee[§§]	Meter Replace-ment[***]	PV of Costs [†††]	B/C Ratio
						Meter, Transmitter, and Installation[**]	Receiver, Computer, and Software[††]	Fixture Replace-ment [‡‡]				
Submeter - New Construction	Yes	52,195	20	$275	$3,428	$125	$25	$0	$ 36	$125	$675	5.1
Submeter - Retrofit	Yes	52,195	20	$275	$3,428	$300	$25	$0	$ 36	$125	$850	4.0
	No	52,195	20	$275	$3,428	$300	$25	$255	$ 36	$125	$1,105	3.1
POU metering[‡‡‡]	Yes	52,195	20	$275	$3,428	$560	$25	$0	$ 36	$300	$1,597	2.1
	No	52,195	20	$275	$3,428	$560	$25	$255	$ 36	$300	$1,852	1.9

[*] Based on the total water use of the average in-rent unit (143.0 gal/du/day)

[†] Assumes that Automatic Meter Reading (AMR) equipment is used, and that based on current technology, that the battery life is limited to 10 years, and it is best to replace the entire meter, register, transmitter, and battery at same time (even though standard life for a meter is 15 years). Assumes that POUs will need to be replaced every 5 years.

[‡] Based on a commodity charge for water and wastewater of $5.27 per kgal (the average commodity charge for the thirteen study sites).

[§] The present value of annually occurring benefits is calculated with a discount rate of 5%.

[**] May vary by property and location.

[††] Calculated on a per property basis. This assumes a $2,500 base cost spread over 100 units.

[‡‡] Includes hardware and installation cost for a dwelling unit that is retrofit with 1.2 toilets for $234, 2 aerators for $4, and 1 showerhead for $17. Not applicable to dwelling units that have already been equipped with hardware operating within 125% of EPACT standards. Only accounts for the first time cost, does not account for any ongoing replacement/maintenance schedule at the property.

[§§] Assumes monthly service fee of $3 is paid by owner.

[***] Replacement costs for submeters (which will be replaced every 10 years) and POU meters (which will be replaced every 5 years).

[†††] The present value of annually occurring costs is calculated at a discount rate of 5%.

[‡‡‡] Assumes 7 meters per apartment, and $80 per meter (includes hardware and installation).

Table ES.1.10 Cost and benefit for owners who choose to allocate

Billing Method	Efficient Fixtures?	Annual Water Use* (gal/du)	Useful Life† (years)	Annual Value of Water and Sewer Benefits‡	PV of Benefits§	Fixture Upgrade Cost** ($/du)	Annual Service Fee†† ($/du)	PV of Costs	B/C Ratio
RUBS	Yes	52,195	20	$275	$3,428	$ 0	$ 36	$449	7.6
	No	52,195	20	$275	$3,428	$ 255	$ 36	$704	4.9

* Based on the total water use of the average in-rent unit (143.0 gal/du/day).
† Assumes that the program will be in place for 20 years.
‡ Based on a commodity charge for water and wastewater of $5.27 per kgal (the average commodity charge for the thirteen study sites).
§ The present value of annually occurring benefits is calculated with a discount rate of 5%.
** Includes hardware and installation cost for a dwelling unit that is retrofit with 1.2 toilets for $234, 2 aerators for $4, and 1 showerhead for $17. Not applicable to dwelling units that have already been equipped with hardware operating within 125% of EPACT standards. Only accounts for the first time cost, does not account for any ongoing replacement/maintenance schedule at the property.
†† Assumes monthly service fee of $3 is paid by owner.
‡‡ The present value of annually occurring costs is calculated at a discount rate of 5%.

ANALYSIS OF PRICE ELASTICITY

Economic goods have a downward sloping demand curve. This means that the higher the price of the good, the less of it that is purchased. Within this broad statement, specific goods respond very differently to price. Some goods respond very little to price change, and others respond strongly. Economists have developed the concept of "price elasticity of demand" to characterize these differences. Price elasticity of demand is defined for each point on the demand curve as: The percentage change in consumption per percentage change in price. Since elasticity is a percent divided by a percent, it is a unitless number.

The elasticity analysis examined the price elasticity of water use based on utility water and wastewater rates. To simplify the analysis, the average non-seasonal (indoor) water use per unit per year in kgal (using 2001 and 2002 billing data) was calculated for each participating study site. These values were then plotted against the combined utility water and wastewater rate in $/kgal. The results are shown in Figure ES.1.3. The cost for water and wastewater ranged substantially from $2.83/kgal to $10.11/kgal, providing a useful data set for analysis. To improve the model fit, the data point from Indianapolis was removed from the elasticity model. Indianapolis was the only study site to feature a declining block rate structure (i.e. the more water used, the lower the price). All other utilities had either flat rate or increasing block rate structures designed to send an increasing price signal as demand increases.

Two regression equations and curves were fit to these data to determine the price elasticity of demand – a straight line and a power curve. The fit of both models was quite good and the range of elasticities calculated fits well with previous research in this area. The straight line model had the highest coefficient of determination (r^2) value of 0.6437. Elasticities calculated through the straight line model ranged from -0.12 at $2.83/kgal to –0.65 at $10.11/kgal with an average of –0.29 and a median of –0.20. The constant elasticity power curve model had a coefficient of determination value of 0.5477. The elasticity calculated through this power model was –0.275. These results are shown in Table ES.1.11. The research team concluded that if a single elasticity value were to be selected, the preponderance of the results from this analysis point to an elasticity of –0.27. However, the linear model result clearly shows that elasticity varies with price and this should be taken into account when applying these values to planning and rate models.

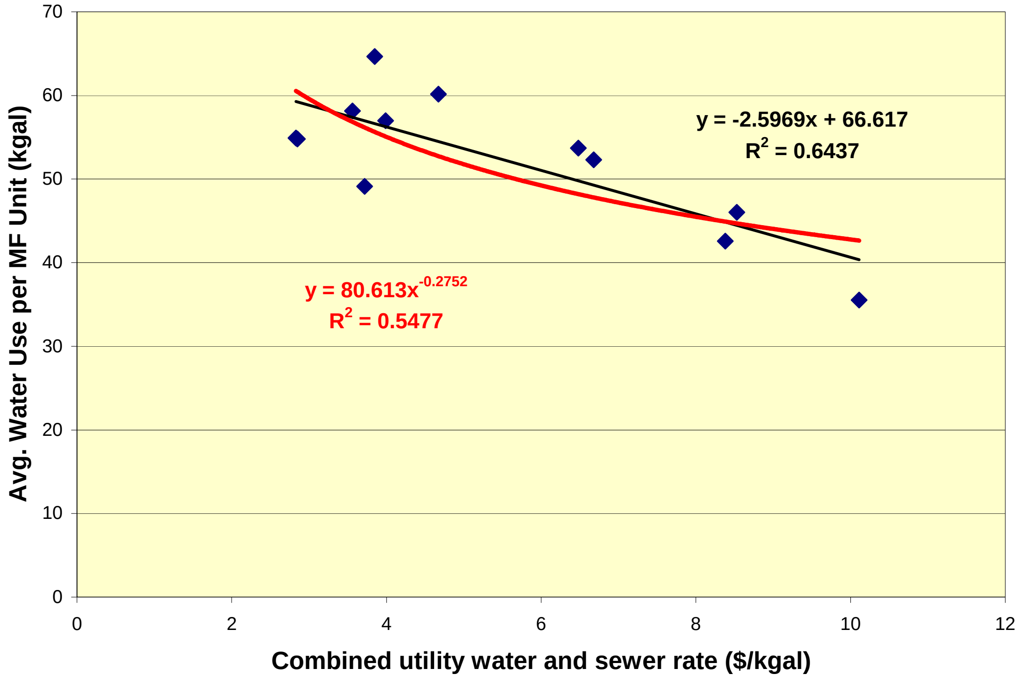


Figure ES.1.3 Demand curve and demand equations, elasticity analysis #1 (utility rates)

Table ES.1.11 Elasticity values, analysis #1 (utility rates)

Price ($/kgal)	Straight Line Model Elasticity	Power Curve Model Elasticity
2.83	-0.1240	-0.2752
2.85	-0.1250	-0.2752
3.56	-0.1611	-0.2752
3.72	-0.1696	-0.2752
3.85	-0.1766	-0.2752
3.99	-0.1842	-0.2752
4.67	-0.2226	-0.2752
6.48	-0.3380	-0.2752
6.68	-0.3521	-0.2752
8.38	-0.4852	-0.2752
8.53	-0.4982	-0.2752
10.11	-0.6505	-0.2752
Conclusion: Elasticity = -0.27		

A second elasticity analysis examined the price elasticity of water use based on water and wastewater rates charged by third party billing service companies. A preponderance of the results from this analysis point to a likely range of elasticity values from -0.07 to -0.16 for submetered properties.

Policy Implications of Price Elasticity Analyses

The results of the elasticity analysis indicate that multi-family dwelling owners and managers are significantly more responsive to price than are residents who are submetered because the calculated percent difference in price elasticity is larger in the utility rate analysis by 70% or more. This result suggests that property owners are more likely to take action to conserve water on their properties in response to a change in price. It also implies that the owners have more opportunities to conserve water because they have a wider variety of uses over which they have control than do the residents, who basically control just their own domestic use. This has significant policy implications because as properties are converted to submetering and RUBS billing programs, owners no longer receive an effective price signal from the utility bill. This implies that the impetus to reduce demand and conserve water on the part of managers and owners is all but lost once a billing program is implemented. While the impact of water pricing is then passed on to the residents, it is apparent that they are much less sensitive to price than are the owners. Because many residents rent or lease their dwelling units, they are unlikely to invest in water conserving fixtures such as toilets, clothes washers, showerheads, faucets and leak repair. In many cases residents may not be permitted to install new fixtures. Leak repair remains the responsibility of the property manager and should be performed as a routine matter.

Interior Retrofits and Billing Programs

These results suggest that if utilities are interested in accelerating the installation of water conserving fixtures and appliances in their service area, it may be necessary to mandate these installations as a condition of conversion to a water and wastewater billing program. Once a water and wastewater billing program is implemented, most incentives to make these changes will be lost (except in common areas) and it is unlikely that residents will make these changes to their own units. Incentive based programs have spurred fixture change out and utilities may wish to encourage installation of water efficient fixtures in conjunction with their approval of water billing program in their service area.

REGULATORY FRAMEWORK REVIEW

The framework of regulations and related policies for multi-family water and wastewater billing systems is complex, quickly evolving, and unsettled, both at the federal level and in many states. During the time this research study has been in preparation, significant changes in the policy framework have been adopted by the federal government, several states, and major local jurisdictions, and important issues remain in flux.

Safe Drinking Water Regulation

In August 2003, seeking to encourage water conservation benefits attributed to submetering, the Assistant Administrator for Water proposed a significant re-interpretation of the Safe Drinking Water Act regarding submetered systems. In a policy shift that was finalized in December 2003, EPA noted that the "sale" of water had not actually been defined in the Safe Drinking Water Act, and that henceforth a multi-family property with submetered billing to residents would not be subject to the national primary drinking water regulations. Calling submetering an "effective but little-used tool" to promote water conservation, EPA clearly signaled a pullback from any insistence at the federal level that submetered systems would be required to perform the monitoring and record-keeping tasks of public water utilities, even if they nominally remained "public water systems." But citing a lack of evidence to support water saving benefits, the *new policy pointedly excluded RUBS and hot water hybrid allocation systems* from its scope, and urged states to consider whether flexibility was warranted for such systems as well. A challenge to EPA exclusion of RUBS and hybrid systems from this new policy has been mounted by a consortium of interested parties.

State Regulatory Survey

A survey of state policies toward multi-family billing systems is maintained by the National Submetering and Utility Allocation Association (NSUAA), a trade association for companies involved in multi-family billing for all types of utility services, i.e., water, wastewater, electric, natural gas, solid waste, etc. NSUAA attempts to track state and local policies toward both submetering and RUBS, as well as whether service fees are allowed as part of a billing system.

NSUAA cautions readers not to rely on this summary information as legal advice, noting that information is subject to frequent change and deals with matters of interpretation. With the permission of NSUAA, the latest (March 2004) overview of state policies regarding water and wastewater billing systems is presented in Table ES.1.12.

Table ES.1.12 NSUAA Summary of State Regulatory Policies

State	Submetering Allowed?	RUBS Allowed?	Service Fees Allowed?
Alabama	Yes	Yes	Yes
Alaska	Yes	Yes	Yes
Arizona	Yes	Yes	Yes
Arkansas	Yes	Yes	Yes
California	Yes	Yes	Yes
Colorado	Yes	Yes	Yes
Connecticut	Yes	Yes	Yes
Delaware	Yes	**NO** (only prior to 1996)	Yes
Florida	Yes	Varies by county	Yes
Georgia	Yes	Yes	Yes
Hawaii	Yes	Yes	Yes
Idaho	Yes	Yes	Yes
Illinois	Yes	Yes	Yes
Indiana	Yes	Unclear	Yes
Iowa	Yes	Yes	Yes
Kansas	Yes	Yes	Yes
Kentucky	Yes	Yes	Yes
Louisiana	Unclear	Yes	Yes
Maine	Yes	Yes	Yes
Maryland	Yes	Yes	Yes
Massachusetts	**NO** (legislation pending)	**NO**	**NO**
Michigan	Yes	Yes	Yes
Minnesota	Yes	Yes	Yes
Mississippi	Yes	**NO**	**NO**
Missouri	Yes	Yes	Yes
Montana	Yes	Yes	Yes
Nebraska	Yes	Yes	Yes
Nevada	Yes	Yes	Yes
New Hampshire	Yes	Yes	Yes
New Jersey	Yes	Yes	Yes
New Mexico	Yes	Yes	Yes
New York	Yes	Yes	Yes
North Carolina	Yes	**NO**	Yes
North Dakota	Yes	Yes	Yes
Ohio	Yes	Yes	Yes
Oklahoma	Yes	Yes	Yes
Oregon	Yes	Yes	Yes
Pennsylvania	Yes	Yes	Yes
Rhode Island	Yes	Yes	Yes
South Carolina	Yes	Yes	Yes
South Dakota	Yes	Yes	Yes
Tennessee	Yes	Yes	Yes
Texas	Yes	Yes	**NO**
Utah	Yes	Yes	Yes
Vermont	Yes	Yes	Yes
Virginia	Yes	Yes	Yes
Washington	Yes	Yes	Yes
West Virginia	Yes	Yes	Yes
Wisconsin	Yes	Yes	Yes
Wyoming	Yes	Yes	Yes
D.C.	Yes	Yes	Yes

Data developed by Marc Treitler and Brian Willie, Co-chairs of the Legislative and Regulatory Committee of the NSUAA. Information about the NSUAA can be found at <www.nsuaa.org>. March 2004.

RECOMMENDATIONS

Guiding Principles for Submetering and RUBS Billing Programs

In light of the key findings and issues identified in this report, six principles are offered here to guide the development of policies to address separate billing systems for multi-family water and wastewater charges.

1. Submetering is a practice that offers documented water savings. As such, submetering should be fostered by public policies seeking to encourage water savings, together with appropriate measures to protect the consumer.

2. RUBS is a practice lacking statistically reliable water savings, while offering both similar and distinctive drawbacks compared with submetering. As such, RUBS implementation should be carefully bounded by public policy.

3. Any water and wastewater billing system – whether submetering, RUBS, or various hybrid systems – will reduce a multi-family property owner's incentive to invest in in-unit plumbing efficiency upgrades in pre-1995 structures. The initiation of any separate billing system in pre-1995 dwellings should be coupled with complete plumbing fixture upgrades within a specified time period.

4. The potential drinking water quality issues that may arise within the water systems of multi-family properties – such as backflow, cross-connection, metal uptake, and deterioration of buried distribution lines – should be approached with solutions that address all properties with comparable vulnerabilities, rather than narrowly focusing on properties that implement a water and wastewater billing program.

5. Best Management Practices for the billing of water and wastewater in multi-family housing should be implemented by the appropriate regulatory agency to ensure consumer protection for property owners and residents and to promote adoption of multi-family submetering.

6. Submetering equipment manufacturers, professional installers, third-party billing services, and owners should be held to reasonable standards of accuracy, reliability, and professional competence and conduct.

Public Policy and Business Practices

A transformation is taking place in the responsibility for water and wastewater service in multi-family properties across the United States. Consistent with the guiding principles outlined above, the researchers offer the following recommendations to increase the likelihood that this transformation advances the public interest while fairly rewarding private investment and initiative.

Policies for Water and Wastewater Utilities

Water and wastewater utilities should implement the following measures to encourage submetering and to secure the benefits of improved efficiency for their systems.

Recommendation 1 – Require notice. Utilities should require multi-family property owners that seek to implement or convert to any billing system, or which have converted in the past, to notify the utility and/or agency. The utilities should keep permanent records of the properties using any water and/or wastewater billing system. As this report demonstrates, the water savings resulting from submetering can be substantial, and the water savings resulting from plumbing upgrades can be even more substantial. But the value for utilities is greatest if these savings can be recognized, plotted into trends, and incorporated into capital facility planning. If a utility does not know what fraction of its multi-family housing has already converted to separate water and wastewater billing methods, it will be hard-pressed to estimate the additional savings potential that remains from additional conversion. The status of separate billing and associated plumbing conversion (as recommended above) should be kept as current as possible.

Recommendation 2 – Apply volumetric billing to all multi-family properties. Ensure that volumetric billing is applicable to all multi-family properties for both water and wastewater charges. Although the prevalence of flat or fixed rate structures (where no portion of the charge varies with volume of use) for multi-family structures is unknown, it persists for single-family residences in many communities[7] and may be broadly applicable at least to duplexes, 3-family, and 4-family dwellings in such locations. If multi-family resident billing is to be effective in sending a price signal to consumers in multi-family housing, then a responsive price signal has to be sent by the utility in the first place. Where outdoor use and attendant seasonal variation is large, many communities offer seasonal adjustment factors for wastewater service billed from

[7]In a survey of 420 California cities and districts in 2000, 86% of those surveyed maintained flat (non-volumetric) charges for wastewater service. Surveys in other states by the same firm found non-volumetric charges at 66% of surveyed utilities in Washington, 46% in Oregon, and 32% in Arizona (Black & Veatch 2000).

the water meter and/or exemptions from wastewater charges for submetered outdoor use. Submetering of irrigated landscapes offers an additional opportunity to manage outdoor water use efficiently, and should be encouraged in its own right for large parcels, such as multi-family dwelling complexes.

Recommendation 3 – Promote submetering and fixture retrofit. Encourage submetering through judicious targeting of utility water conservation incentives to multi-family submetering conversions. Utilities with active water conservation programs should consider steps to encourage full and partial capture submetering as well as plumbing fixture replacement in pre-1995 buildings. Since submetering offers substantially more savings than RUBS, utilities should consider directing some or all of their plumbing retrofit incentives in the multi-family sector to properties that choose submetering. Tiered incentives to provide additional benefits for properties electing to submeter is another approach. Fixture retrofit should also be promoted in properties that have already undergone billing conversion. While the design and absolute levels of incentive programs are highly site-specific, utilities should look to their incentive programs as an important tool for tipping the balance toward submetering.

Recommendation 4 – Explore direct billing of multi-family residents in new construction. In the interest of encouraging water efficiency gains, utilities should be open to expanding their role beyond traditional master metering of multi-family properties, particularly in new construction. As automated meter reading technology becomes more widely adopted by utilities themselves, the need for direct access by utility personnel to water meters serving multi-family dwellings becomes far less frequent. New construction allows flexibility for the placement of meters in locations designed to be accessible from, or in close proximity to, public space. Duplexes, 3-family, and 4-family units may be easily plumbed for meters from public space. These and other opportunities will present themselves to utilities willing to take the initiative to improve water efficiency and customer service. It should be noted that some utilities may not be interested or willing to venture into multi-family billing that would add a large number of new customers with a high turnover rate.

Policies for State and Local Governments

State law should clearly establish the legal framework for all forms of multi-family billing systems. In lieu of a patchwork of state agency administrative actions, enactment of statutory language that specifically addresses multi-family billing for water and wastewater service is preferable, and would help ensure consistent policy across all agencies and localities. Similarly, state legislation is preferable to a local ordinance, but local action may well be necessary if state legislation is not forthcoming.

Recommendation 5 – Metering for all new multi-family construction.[8]

a. Low-rise multi-family construction: All new multi-family structures of one to three stories should provide for the measurement of *all* of the water use in each unit. This may be accomplished either through the installation of total-capture submeters for each unit, the installation of utility service meters for each unit, *or* the installation of multiple submeters affixed at every point of use in each unit. Upon occupancy, water and wastewater charges are to be billed to residents based only upon their water usage recorded by these individual measurement devices.

b. High-rise multi-family construction: All new multi-family structures of more than three stories constructed after a date which is four years after the effective date of the low-rise requirement above, should provide for the measurement of the water use in each unit. This may be accomplished either through the installation of total-capture submeters for each unit, multiple submeters affixed at points of use throughout each unit, or metered hot (or cold) water use as the basis for allocating all in-unit water use. The allowance of four additional years should be sufficient to resolve any remaining technical issues posed by high-rise plumbing configurations and meter placement. Upon occupancy, water and wastewater charges are to be billed to residents based only upon their water usage recorded by these individual measurement devices, or through an approved hot/cold water hybrid allocation system.

Recommendation 6 – Efficient plumbing fixtures required when implementing a billing program. Owners may institute a billing system or continue an already existing billing system for water and wastewater charges *provided* that prior to the institution of any separate billing program or for an existing program within 12 months of official notification, owners comply with the applicable provision (a or b) below:

a. **Older Properties:** Owners of multi-family structures constructed *before* January 1, 1995 (or one year after the effective date of a state or local statute setting a 1.6 gpf standard for

[8] Subsidized and low income housing developments will likely need to be exempted from this regulation because of various national, state, and local regulations governing the maximum allowable charges for rent and utilities. In addition it may be prohibitively expensive to redesign and submeter some high rise buildings designed with a central boiler.

all new toilets, if earlier), must perform a water audit in each unit to ensure, any leaks identified have been repaired, and each toilet, showerhead, and faucet aerator is either newly manufactured and installed within the previous 12 months, or operating at no more than 125% of the flush volume or flow rate, respectively, contained in the Energy Policy Act of 1992.

b. **Newer Properties:** Owners of multi-family structures constructed *after* January 1, 1995 (or one year after the effective date of a state or local statute setting a 1.6 gpf standard for all new toilets, if earlier) must perform a water audit in each unit to ensure, any leaks identified have been repaired, and each toilet, showerhead, and faucet is operating at no more than 125% of the flush volume or flow rate, respectively, contained in the Energy Policy Act of 1992.

Recommendation 7 – Once submeters are installed a RUBS system cannot be used. Formula allocation systems (RUBS) may not be used in buildings where total-capture meters or partial-capture hybrid systems for individual units have been installed, even if the submetering billing program has been abandoned. To preserve the potential for water savings and maintain the relative benefit to consumers to more equitably distribute costs, abandonment of submetered systems should be discouraged. Limited allocation and estimated billing may be permitted in submetered properties on a temporary basis when specific meters cannot be read or are being serviced or replaced.

Recommendation 8 – Consumer protection. State or local landlord-tenant law or similar legal framework should address the special concerns arising from multi-family water and wastewater billing systems. The section below contains recommended practices for property owners, billing service companies, and water utilities to ensure that consumers are treated fairly. Any number of these practices could be fashioned into a statutory requirements. The degree to which some or all of these provisions are written into law will be based upon the experience of each jurisdiction.

Best Management Practices for Billing of Water and Wastewater Service in Multi-Family Housing[9]

The researchers believe a comprehensive set of best practices in the form of regulated industry standards, would benefit all parties involved, including residents, property owners, water providers, regulators, and the billing service providers themselves. The best management

[9]These best practices were adopted from and expand upon the guidelines published by the NSUAA

practices (BMPs) should be implemented by the appropriate regulatory oversight agencies. BMP standards could greatly improve resident understanding and satisfaction with third party billing, and reduce consumer complaints to regulators.

Based on the research results, the following standards for best management practices for water and wastewater billing practices are recommended. BMPs for the billing service industry and for property owners are essentially the same and apply equally. In many cases, property owners and managers handle their own billing for water and are in fact the billing entity. Regardless of who produces the bill, either the owner/manager or a third party billing service company, it is incumbent upon the owner/manager to ensure the proper implementation of these best management practices. The owner maintains the underlying responsibility for the way the billing program is implemented and managed.

Resident rights related to water billing are closely tied to the BMPs for the water billing industry and provide a set of reasonable expectations for residents receiving water and wastewater bills from largely unregulated billing entities.

These best practices are intended to apply generally to *both* submetering and RUBS billing unless specifically noted.

1) **Billing entity.** Where permitted by law, water and wastewater utility bills may be issued by a property owner or qualified billing agent. Billing agents shall have appropriate insurance coverage.

2) **Water cannot be dedicated to public use.** Water and wastewater service will only be provided to residents of the property. Non-residents and the general public will not be served. (In many states, this ensures that the property owner is not deemed to be a public utility).

3) **Common area and vacant units.** The property owner shall pay for water and wastewater service used in common areas, administrative offices, vacant dwelling units, and other portions of the property not designated as dwelling units. Residents are only financially responsible for their own water and wastewater service costs. In RUBS properties, common areas should be separately metered. If not possible, a reasonable estimate of common area usage can be made that is based on the property's specific common area amenities.

4) **Water audit and leak repair.** Before instituting any separate billing system, the property owner/manager shall conduct a water audit of all units and common areas, testing for leaks, including toilet tank flapper valve leaks, and repair all leaks identified. Upon institution of the separate billing system, the property owner/manager shall commit

to a reasonable standard of leak repair in all units, and shall maintain sufficient supplies of materials as may be necessary to ensure that common types of leaks (such as toilet flappers) are promptly repaired. When properly reported, non-emergency leakage at any plumbing fixture or fitting should be repaired within 5 business days. The process for reporting leaks and the owner/manager's commitment to leak repair shall be clearly stated in each resident's bill, and shall also be disclosed as part of the lease agreement.

5) Pass through of water and wastewater costs. Both the commodity and fixed service charges for water and wastewater shall be equivalent to the commodity charges contained in the property owner's bill from the local water and wastewater utility.[10] Neither the billing entity nor the owner/manager shall inflate the costs of these charges. Utility commodity charges and the billing entity charges shall be clearly stated on every bill provided to residents and such rates and charges shall also be disclosed as part of the rental agreement.

6) Submetering and RUBS methods and notification. Water and wastewater bills to residents shall be calculated on the basis of fair and reasonable methods of cost allocation, including submeter readings or allocation formulas. The measurement or allocation method and/or formula is considered a matter of public record and shall be clearly stated on every bill provided to residents. The water and wastewater billing arrangement shall be fully disclosed to the resident in the rental agreement. When a new billing program is started, owners shall provide residents with at least 60 days notice prior to implementation. Billing can only begin after lease signing/renewal.

7) Billing practices. Water and wastewater bills shall be sent promptly after meter readings are made or after the master-meter bill from the utility is received. This is essential to ensure that the price signal is received in reasonably close proximity to the time of consumption. A reasonable amount of time (minimum of 10 business days) shall be allotted between the residents' receipt of a bill and the date payment is due.

8) Records retention and inspection. The property's master water and wastewater utility bills shall be retained for a period of not less than 24 months, and shall be available for inspection by any resident at reasonable hours and without charge. However, a nominal fee can be charged for any requests to copy bills.

9) Fees. The billing entity may charge reasonable fees. Fees are divided into two categories: (a) ***recurring service fees***; and (b) ***other fees***. ***Recurring service fees*** (also called monthly fees, administrative fees, or meter fees) shall be charged to the property owner/property manager, not to the residents. Where not subject to regulation, the owner is in the best position to negotiate favorable service fee charges with the billing company and responsibility for recurring service fees gives the owner an interest in negotiating the best fee. Property owners should pay the meter service fee since it is part of the

[10] In most cases, these charges will be based on the local utilities' rate schedules for multifamily housing, often priced by the size of the service connection to the master meter. In the case of duplex, 3-family, and 4-family units, the smaller service connections to these structures may result in their being charged at the same rate as single-family residences.

infrastructure of the building and as such would be like repair and maintenance of any building supplied fixture or appliance. ***Other fees*** (new account fees, late fees, returned check fees, and other reasonable fees that relate to a specific resident account) shall be paid by the residents.

10) Complaints and disputes. A fair method for promptly resolving complaints and billing disputes shall be established by the billing entity that should have parity to the process that exists for the property owner contesting a bill to the local water utility. The billing entity shall be available during normal business hours via a toll free number, printed on every bill, to handle billing questions and complaints.

11) No shutoff of service. As stated by law, water and wastewater service cannot be shutoff to residents by the owner or his agents. The rental agreement can provide for a utility deposit or other legal remedy through which unpaid utility bills can be collected.

12) Information to be included in regular bills. The bill is the fundamental communication between the billing entity and the resident. As such, bills must be clear, comprehensible, and comprehensive. Billing entity water and wastewater bills shall include:

(a) Clear statement of the current water and wastewater commodity charges and fees as well as any overdue or pending amounts;

(b) Billing period covered by the bill;

(c) Date payment is due;

(d) Date after which payment is overdue;

(e) Explanation of the billing method (Submetering, RUBS, hybrid);

(f) Explanation of how charges are determined for current billing period. For ***submetering*** this will simply be a beginning and ending meter read, the volume consumed, and the commodity rate per unit volume. For ***hybrid metering*** this will be a beginning and ending meter read, the (hot or cold water) volume consumed, the calculation for allocating the remaining water volume, and the commodity rate per unit volume. For ***RUBS*** this should include the total volume of water used at the property (as measured by the utility at the master meter(s)), the deductions for common area, the percent of remaining amount allocated to the individual unit, the volume allocated to the unit, and the commodity rate per unit volume.

(g) Utility commodity charges and the billing entity commodity charges (to assure equivalence);

(h) Information for reporting leaks;

(i) Toll free or local telephone number for customer complaints and billing disputes, and a brief description of the dispute resolution process.

Policies for the US Environmental Protection Agency

Recommendation 9 – Property owners should not be subject to the full suite of National Primary Drinking Water Regulations. Property owners should not be subject to the full suite of National Primary Drinking Water Regulations, with attendant registration and monitoring requirements, solely by virtue of their action to adopt a billing system for water and wastewater service, whether submetering or RUBS. The implementation of either billing system is unlikely to change the quality of water provided to customers on the property.

During the course of this study, EPA's interpretation of the requirements of the Safe Drinking Water Act have undergone substantial change on this issue, and the Assistant Administrator's memorandum to Regional Administrators dated December 16, 2003, goes a long way toward adopting this recommendation. The new guidance was drawn to focus on submetering, due to the potential of submetering to support full-cost pricing and the lack of documented water savings attributable to RUBS. EPA should, however, recognize that the value added to a property owner's balance sheet by instituting a billing system – either RUBS or submetering – creates an opportunity to fund the conversion of long-lasting but inefficient plumbing fixtures and fittings to EPACT compliant plumbing. Plumbing conversion will achieve immediate and significant water use reductions in properties of either billing type.

Recommendation 10 – EPA should promote water efficiency in multi-family housing. As part of its "Sustainable Infrastructure Program," the EPA Office of Water should devise a road map for the research, demonstration, and deployment of emerging technologies and practices that can make significant breakthroughs in multi-family water use efficiency. Property owners and their trade associations, water and wastewater utilities, state and local governments, tenant associations, landscape contractors, building contractors, and environmental advocates are all potential stakeholders and partners in such an effort. EPA should help accelerate the transformation of water and wastewater billing practices in multi-family housing through targeted research, technical assistance, model ordinances, voluntary bench-marking, and public recognition. While this report advances our understanding of the benefits of submetering, the report has also found several other variables that significantly effect the water consumption of multi-family housing. The transfer of utility bill payment to residents is an important foundation upon which to build additional gains in water use efficiency.

Policies for Point of Use Meters

<u>Recommendation 11 – Explore policies for POU standards</u>. The current plumbing codes do not adequately address POU meters on a number of issues. Industry consensus standards are needed for application condition accuracy, installation protocols, product labeling, and maintenance. IAPMO[11], NIST[12], and ASME[13] must evaluate the recommended changes in the plumbing standards.

Based upon the conclusions drawn from the ad hoc committee discussions the following recommendations are offered as standards for POU meters:

<u>Labeling and Identification</u>: Meters shall have the name of the manufacturer, model and serial number, approved orientation positions, and approved temperature ranges.

<u>Manufacturer</u>: Shall specify installation criteria.

<u>Maintenance</u>: Maintenance requirements for POU meters should be consistent with larger utility meters.

<u>Low Battery Voltage</u>: Data transmission needs to be deterministic in that either the data is transmitted accurately or not at all.

<u>Visible Meter Reads:</u> The meter shall have an encoded non-volatile memory. Metered customers shall have ready access to current reading values.

<u>Accuracy</u>: Changes to the current accuracy standards need to be addressed through applications to the appropriate plumbing organizations.

<u>Installation Standards</u>: Use or cite AWWA M6 Manual as reference and follow manufacturer installation specifications. Create a new IAPMO installation standard for water submeters.

[11] International Association of Plumbing and Mechanical Officials
[12] National Institute of Standards and Technology
[13] American Society of Mechanical Engineers

CHAPTER 1 INTRODUCTION

More and more buildings in the multi-family housing sector are converting to billing systems where the occupants in each dwelling unit pay for water and wastewater directly through actual metering or allocation programs instead of including these charges as part of the rent. The three most common ways to convert to direct billing are through the use of water submeters, billing allocation formulas, or a combination of these two methods. Submetering and allocation issues are becoming more and more prevalent as these conversion systems spark the interest of property managers, water conservationists, and government officials across the country.

Submetering and allocation have gained recognition primarily because of the steep increase in water prices. Between 1990 and 1998, the cost of water and wastewater to consumers increased 45 percent, as measured by the Consumer Price Index. This rise is almost double the 25 percent increase in consumer prices in general during that period (Goodman 1999). An analysis of water and wastewater prices from 1986-1998 in 38 cities projected that urban water and wastewater prices would escalate at a rate that is 3% above inflation in the coming decades (DOE 2000). This trend has continued over the past five years and is not expected to abate. The rising price of water can be attributed to the increasing need for utility infrastructure repair and the need to meet more stringent regulations at the federal, state, and local levels.

Water price increases have had a pronounced effect on multi-family property owners, raising the cost of doing business. Although individual metering has become standard in single family housing, multi-family housing is typically built with one master meter for all units. Traditionally, property owners have paid the water and wastewater bill and recovered the costs through monthly rent payments. However, as water prices rise at a faster rate than inflation, property owners are seeking ways to control these costs. Some multi-family housing owners are opting for submetering and other methods of allocating water costs, effectively passing the burden of cost increases onto the residents.

Water billing in multi-family properties stands in contrast to the seemingly routine manner in which other utilities like electricity and gas are billed directly to residents. Direct billing of any utility (beyond telephone service) in the multi-family sector was uncommon prior to energy shortages and attendant price spikes of the late 1970s. President Carter issued Executive Order 12003, which addressed the issue of energy efficiency and made specific reference to conservation gains that could be garnered across property types including the multi-family property sector by mandatory conservation measures. The Public Utility Regulatory Act of 1978 directed that states restrict the use of master metering (that is, one meter for the entire apartment property) to cases where the owner could demonstrate that the costs of individually metering apartments exceeded the lifetime cost savings from reduced electricity usage from individual metering (16 U.S.C. 2623).

In recent years the potential water savings that could be achieved through submetering and allocation billing has attracted the interest of water planners and conservationists. Population growth has placed heightened pressure on water supplies, increasing the need for effective water conservation measures. It is generally acknowledged that consumers are more discretionary with their water use when there is a direct correlation between water consumption and cost. Submetering provides a direct relationship between the two. Metering and then billing customers for the amount of water they actually use has been shown to be an effective conservation tool in the single-family residential sector (Porges 1957, Hanke and Flack 1968, Flechas 1980). The savings attributed to billing allocation methods in multi-family housing have been less conclusive. The premise of these systems is that the price signal provided by an individual bill could help consumers to undertake water-conserving behavior in their own interest while meeting collective water conservation goals. The feedback mechanism of a bill has been shown to be important in reducing electricity demand, especially when feedback is immediate (Seligman and Darley 1977). The extent to which a similar feedback mechanism impacts water use continues to be tested and debated.

Improvements in metering technology and the development of third party billing service companies have facilitated the growth of separate billing in the multi-family sector. Technical advancements in water meters have made them less expensive, smaller, and remotely readable. These improvements have made installation payback periods more reasonable, especially if meters are installed during initial building construction. Alternatively, allocation billing methods are viable options when submetering is deemed too expensive or technically infeasible, a typical problem in older buildings. In addition, the third-party billing industry has been evolving with the help of entrepreneurial companies that market, install, and maintain these billing systems for property owners.

In 1998, 15.0%, or 15.4 million, of all U.S. households were dwelling units with 5 or more units (National Multi Housing Council 1998a). It is estimated that there are now more than 1.2 million apartment renter households that are billed separately for water and sewer (NMHC 2001).[14] That means that the vast majority of multi-family housing units have *not yet* been affected, suggesting further opportunity exists for expansion of third party billing and possible water savings. However, the rapid development and expansion of third party billing systems have raised questions that require further study and discussion.

RESEARCH EFFORT

In the National Multiple Family Submetering and Allocation Billing Program Study, a retrospective analysis of water use in multi-family properties in 13 cities was conducted. Properties that bill for water via submetering, allocation, or a hybrid systems (impacted properties) were identified and compared against control (in-rent) properties where water and wastewater fees are included as part of the rent. Using historic billing data and survey data, a variety of analyses were conducted to compare the water usage of the two groups. In addition, efforts were made to identify how these billing systems are affecting residents, managers, and utilities.

This report summarizes the methodology and important findings of this study, and attempts to determine the merits of separate billing programs including the potential water savings, costs, benefits, and accompanying administrative and regulatory issues. It also includes recommendations based upon the conclusions of the study.

Study Limitations

The researchers made every effort to ensure that the data and results presented in this study are as complete and accurate as possible. However, every research effort has its own distinct limitations and it is important that they are acknowledged by the researchers and understood by the reader. A research project of this magnitude must rely on a variety of

[14] Based on data from the 2001 American Housing Survey. Assumes a multi-family property has at least five dwelling units. The number is higher if smaller properties are included in the analysis.

assumptions and it is recognized that changes in some of these assumptions could impact the results.

One of the central efforts of the research project was to disaggregate each property's water use data into seasonal and non-seasonal (outdoor and indoor) use. This process was not necessary for properties equipped with separate irrigation meters, but it was necessary for the rest of the properties, and was accomplished by using the established method of average winter consumption (AWC). However, because many of the properties are located in warm regions, manager survey results indicated that irrigation occurred 12 months out of the year at some of the properties. This reduces the accuracy of the indoor/outdoor disaggregation and hence some outdoor demand may still be include in the indoor use estimates for these properties.

Similarly, at some properties indoor water use for common area such as offices, meeting rooms, and other facilities may be included in the indoor per unit calculation. However, the manager survey sought information on some of these potential common area water uses and every effort was made to correct for these uses during the statistical modeling effort.

Exhaustive effort was made to select study sites that were geographically balanced, however, the 13 study sites that participated in this project are weighted towards the West and Southwest regions of the U.S. Many of these study sites have a historic interest in demand planning and management and have instituted water conservation programs, which often include public information campaigns. These factors should be considered as possible behavioral influences, and might cause these results to differ from a national response.

The concentration of impact properties at each study site also varied considerably. For example, in the postcard survey, Austin had 233 RUBS properties, while Hillsborough County only had 3 RUBS properties. This could cause results to be weighted towards the areas of greater concentration.

Finally, this research study relied heavily on survey data. Even with a careful design, survey questions can be subject to interpretation. For example, by comparing the written survey responses with the actual site visits, it was found that there is some confusion among property managers in distinguishing between total-capture and partial-capture submetering. We have attempted to acknowledge discrepancies like this where applicable, and they are noted in the text.

TERMINOLOGY AND DEFINITIONS OF BILLING METHODS

In-Rent Properties

In-rent properties refer to all properties where the owner does not separately bill residents for water and wastewater. In these properties, the water and wastewater bill is considered one of the operational costs of running the property, and the owner sets the monthly rent to recover these overhead expenses and also maintain the net operating income of the property. A slight variation of this standard "in-rent" arrangement can occur when there is a homeowners association (HOA) at a property that collects monthly fees. Sometimes the HOA dues will include a flat fee for water and wastewater, as well as other fees for trash, cable TV, landscaping, et cetera. However, since the water and wastewater fee does not vary with the monthly water bill and does not come as a separate bill, these properties are usually considered part of the in-rent category.

Impact Properties

Impact properties refer to all properties that bill separately for water and/or wastewater by submetering, ratio utility billing systems, or a hybrid of the two. Within these different billing methods, the party actually billing for water needs to be defined. The ***owner*** refers to either an individual or an organization that owns and/or manages a rental property. A third-party ***billing service company*** (billing company) is a private, for-profit entity that provides billing services for water, wastewater, trash collection, and energy to owners of multi-family properties. A water ***utility*** is a regulated provider of water and/or wastewater service to a set of customers. Utilities may be public or private entities and they are responsible for treating, delivering, and billing for water and/or wastewater.

Submetering

Submetering is defined as any metering that occurs downstream of a water utility master meter. Submetering usually implies that a billing system is in place where *all* of the actual water consumption in each unit in a multi-family dwelling is measured using one or more water meters (called submeters). Figure 1.1 shows an example of remote registers used for submetering. Water bills are then based on the actual usage in each individual unit. Wastewater charges may also be based on the submetered water use, or alternatively, based upon an allocation formula. There are three different types of these total-capture submetering systems that can occur:

Single point of entry submetering

Dual point of entry submetering

Point-of-use submetering

Figure 1.1 Example of remote registers for submetering

Single point of entry submetering refers to a system where all of the water enters a multi-family dwelling unit through a single pipe. This requires that one submeter be installed on the incoming cold water line. This is the simplest and most common type of submetering. Plumbing systems in new construction can usually be designed to incorporate this type of submetering if specified.

Dual point of entry submetering refers to a system where water enters a multi-family dwelling unit through two pipes - one for hot and one for cold water. In this case, two water meters are installed, one on the hot and one on the cold water line.

Point-of-use submetering refers to a system where small water meters are installed on the supply line of each water using fixture and appliance in a multi-family dwelling unit. Each unit may be equipped with between 5 and 20 (or more) water meters. Meter reads are typically accomplished via radio telemetry to a central computer. This approach can be used when it is not possible to install submeters through single or dual point of entry – usually in older or high-rise buildings.

By the strict definition, a submetered property receives an overall master meter bill from the local water utility, and each unit's consumption is read, billed, and collected by either the owner or a billing service company. This way, the owner recoups the costs from resident consumption and only pays for the water used in the common areas. A slight variation on this is utility-submetering, where each unit's consumption is measured and billed directly by the local utility. This is not technically "submetering", since there is no building master meter, but the effect of sending an individual bill and consumption report to each unit is the same as submetering. With utility-submetering, any common and/or outdoor areas are also individually metered by the utility.

Hybrid Metering

Hybrid metering, referred to as "hot water hybrid" (HWH) in this report, are billing systems where only the hot (or cold[15]) water consumption for each unit in a multi-family dwelling is measured. Figure 1.2 shows an example of a hot water hybrid. This information is then typically used to extrapolate the total water bill in one of three ways. Under the first method the percentage of hot water used per dwelling unit is calculated (Unit A hot water use ÷ sum of all hot water use = Unit A%). The total (hot and cold) water use at the dwelling unit is calculated by multiplying the percentage per dwelling unit by the total residential demand from the utility bill (Unit A% X total use = Unit A total use). The second method estimates cold water usage using one of the standard RUBS allocation formulas (see below). The cold water allocation is added to the hot water measurement to determine the total use. The third method simply applies a standard multiplier to the hot water use to calculate total use in the unit (Unit A hot water use X 2.5 or other standard multiplier = Unit A total use). Often, but not always, a portion of the total master meter bill is paid by the owner, to account for common area usage, irrigation, administrative offices, etc.

Figure 1.2 Example of a hot water hybrid meter setup

[15] Cold water hybrid systems appear uncommon

A slight variation on hybrids is hot water/point-of-use submetering. This is a system where there is a single hot water entry line that is submetered, and selected cold water end uses are measured using point-of-use meters (as described above). Often, a point-of-use meter is only installed on each of the toilets, and the rest of the cold water is allocated by one of the methods described above.

Hot water hybrids are often mistakenly labeled as “submetered”. However, it is really only partial-capture submetering, since only a portion of the water usage is physically measured. Therefore, they were considered a distinct type of billing in this study.

Ratio Utility Billing Systems

Ratio utility billing systems (RUBS) use an allocation formula to estimate water consumption for each unit in a multi-family dwelling. RUBS systems are not based on the actual consumption at each unit, rather individual bills are prorated from the overall utility master meter bill. Typically, the monthly (or bi-monthly) water bill will be allocated between occupied units based on one or a combination of quantitative measures. The allocation formula can be based on a dwelling unit’s area (square footage), number of bedrooms, number of occupants, number of bathrooms, or number of fixtures. Often, but not always, a portion of the total master meter bill is still paid by the owner, to account for common area usage, irrigation, administrative offices, etc.

RUBS example #1, occupancy **–** After a property subtracts 25% for common area use, the remaining water bill is $3,000 for combined water and wastewater. If the entire complex has 300 residents, and Unit A has 4 residents, then Unit A’s prorated portion of the bill is: $\frac{4}{300} * \$3000 = \$40$. Thus, Unit A would receive a bill with an estimated consumption charge of $40.

RUBS example #2, square footage **–** After a property subtracts 25% for common area use, the remaining water bill is $3,000 for combined water and wastewater. If the entire complex has a total square footage of 50,000 sf, and Unit A is 1,000 sf, then Unit A’s prorated portion of the bill is: $\frac{1{,}000}{50{,}000} * \$3000 = \$60$.

A variation on RUBS occurs when each unit is billed with a flat monthly fee that is based on one of the aforementioned quantitative measures. For example, a property may send a bill to all the two bedroom units for $20 per month, the one bedroom units receive a bill of $10 per month, and the three bedroom units receive a bill of $30 per month. Owners and billing service companies often consider this to be a RUBS method, but it differs because it is not based on the actual consumption at the property and the amount charged to each unit does not vary from month to month.

Logistics of Separate Billing

There are few logistical limitations for RUBS conversions, as it does not require any plumbing modifications or hardware. Barriers to RUBS conversion are more likely to come in the form of local or state regulation or objections from residents. From a technical standpoint, conversion from in-rent to RUBS only requires a billing service company, a list of dwelling unit addresses, and an accurate count of the quantitative measure(s) that the allocation is based upon.

The ability to convert from in-rent to submetering at a particular property depends entirely on the plumbing configuration at the site. In general, the options include the types of submetering and hot water hybrid systems that are defined above. Table 1.1 gives a technical overview of what types of plumbing will allow for the various submetering options.

Table 1.1 Multi-family plumbing configurations and the possibilities for submetering

Plumbing Type	Typical Buildings	Submetering Options
Single cold water entry with individual unit hot water heaters	Single story and some new multi-story	Single meter measures all water use
Single entry for hot and cold with central boiler	Single story and some new multi-story	One meter measures hot water use and one meter measures cold water use
Shared vertical hot and cold pipes with central boiler	High-rise and older multi-story	Point-of-use metering on each hot and cold entry point
Shared cold pipes with individual unit hot water heaters	Multi-story and garden style	Meter measures hot water use, cold water allocated based on hot water use
		Meter measures hot water use, cold water allocated based on ratio utility billing system
		Meter measures hot water use, cold water measured at point-of-use

Adapted from " Making Sense of Submetering". 2002. The Wellspring Monitor Monthly Newsletter

PROJECT TEAM

The Study contract was awarded to a team of consultants led by Aquacraft, Inc. of Boulder, Colorado. The team included National Research Center (NRC) of Boulder, Colorado, Dr. Peter J. Bickel, Department of Statistics, University of California, Berkeley, Edward R. Osann President of Potomac Resources, Inc. and Dr. Stephen Fisher, an economics consultant based in Boulder, Colorado. The project team worked in close consultation to develop the organization, methodology, study procedures, and quality control assurance for the research effort. Then each member performed specific tasks over the two-year study period.

Richard Bennett, EBMUD, served as project manager and was also responsible for contracting with participating water utilities.

Aquacraft, Inc. led the research effort, coordinated project activities, contributed to the survey development, analyzed the data, and prepared the final report.

NRC was responsible for the survey development, testing, distribution, and follow-up. They also performed some statistical analyses of the data and assisted with final report preparation.

Dr. Peter Bickel served as the statistical consultant for sampling and analytic procedures. Edward R. Osann of Potomac Resources spearheaded the task of providing regulatory evaluation and national guidelines. Dr. Stephen Fisher served as the economics consultant for data analysis. An overview of the project organization can be seen in Figure 1.3.

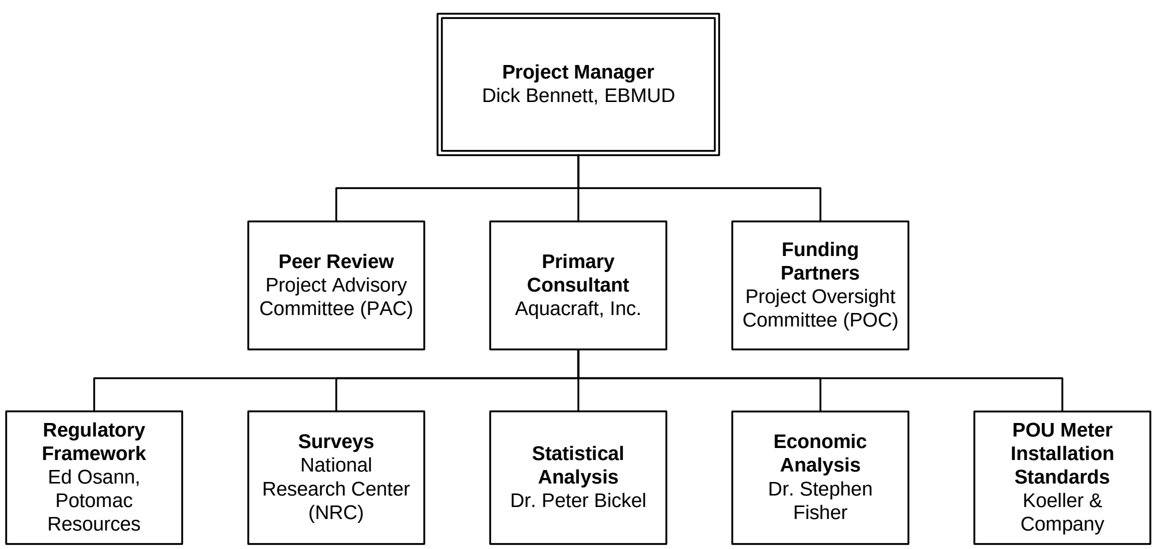


Figure 1.3 Project organization chart

HOW TO USE THIS REPORT

This report details the findings of the Study and is divided into 8 chapters. Detailed appendices that include copies of survey instruments, cover letters, enumerated survey results, actual bills from billing service company, selected statistical methods used. The report also includes an extensive list of references and a glossary. The report chapters are briefly described here.

Executive Summary provides a brief overview of the research, findings, conclusions and recommendations.

Chapter 1 is an introduction to the Study.

Chapter 2 is a detailed review of recent literature pertaining to submetered and allocated property water usage and the impacts of metering and billing on resource consumption.

Chapter 3 presents the study approach, procedures, and methodology used by the project team. This chapter includes details of study site selection, all survey sampling procedures, supplemental data collection, and quality assurance and control procedures. Readers interested in conducting similar research should find information in this chapter useful.

Chapter 4 is a summary of the study site characteristics and survey results. This includes detailed results from each survey implemented in the study.

Chapter 5 details the analysis of water use. This chapter includes a variety of analyses conducted on the data, as well as a summary of the water savings for each billing method.

Chapter 6 describes the various costs and benefits of these billing systems from the perspective of owners, utilities, and residents. It also includes a discussion of price elasticity and economics.

Chapter 7 includes a review of the regulatory framework for separate billing methods.

Chapter 8 discusses relevant issues regarding point-of-use meters.

Chapter 9 presents a summary of the findings, conclusions, and recommendations for policy.

Appendix A includes copies of each of the survey instruments employed throughout the study.

Appendix B includes the enumerated survey responses from the postcard, manager, resident, and read and bill company surveys.

Appendix C includes a sampling of water bills from billing service companies and owners.

Appendix D includes additional statistical results.

CHAPTER 2 LITERATURE REVIEW

As the population continues to grow, measures must be taken to ensure there is adequate water supply to meet current and future demand. The capital investment, environmental concerns, and regulatory obstacles inherent in the development of new water supplies often make demand side management an attractive option. But what are the best and most effective measures to curb the use of such an essential commodity as water? Economists typically advocate the use of price while engineers typically advocate the use of efficient technology. In fact, the union of the two ideas is the premise upon which submetering and ratio utility billing systems (RUBS) are based. The extent to which pricing and efficient technology are effective continues to be studied. This literature review begins with an examination of the role of price in water consumption, moves to metering, and finally takes a look at the effect of current billing methods on multi-family water use.

PRICE AND WATER DEMAND

The relationship between the retail price of water and consumption has been explored extensively because of its implications for water planners and providers. Basic economics assumes water price and consumption are inversely related, and a convenient way to quantify the relationship is through price elasticity. Elasticity is defined as the percentage change in quantity consumed for each percent change in price. An elasticity of one implies that a one percent change in price results in a one percent decline in quantity consumed. Price elasticity measures the sensitivity of water use relative to changes in the price of water, after controlling for various influential factors such as weather and income (AWWA 2000). In general, the price elasticity of water is negative because theoretically, as the price of water increases, water use decreases. A price elasticity with an absolute value between zero and one is considered inelastic, or relatively unresponsive to rate change. An absolute value greater than one is considered elastic. A product's elasticity depends on how many uses it has, the quantity and availability of its substitutes, and its relative importance within the consumer's overall budget (Schlette and Kemp 1991). Numerous studies have been conducted on this topic and a summary of some of the more relevant studies can be seen in Table 2.1.

Table 2.1 Chronological summary of selected price and elasticity studies

Researcher	Price Elasticity	Notes
Howe and Linaweaver (1967)	-0.231	*21 areas in US:* Residential indoor use.
	-0.703	*10 areas in Western US:* Residential outdoor use.
	-1.57	*11 areas in Eastern US:* Residential outdoor use.
Gibbs (1978)	-0.51	*Miami, FL:* Using marginal price.
	-0.62	*Miami, FL:* Using average price.
Camp (1978)	-0.03 to -0.29	*10 Northern MS cities:* Linear equation.
	-0.35 to -0.40	*10 Northern MS cities:* Logarithmic equation.
Danielson (1979)	-0.27	*Raleigh, NC:* Using disaggregated data for total residential demand.
	-0.305	*Raleigh, NC:* Using disaggregated data for winter demand.
	-1.38	*Raleigh, NC:* Using disaggregated data for summer demand.
Billings and Agthe (1980)	-0.27 to -0.61	*Tucson, AZ:* Using two price variables and increasing block rates.
Carver and Boland (1980)	-0.1	*Washington, DC:* Short-term residential demand.
Howe (1982)	-0.06	*21 areas in US:* Residential indoor use.
	-0.568	*10 areas in Western US:* Total summer demand.
	-0.427	*11 areas in Eastern US:* Total summer demand.
Planning and Management Consultants (1984)	-0.2 to -0.4	*National:* Total residential water use, reviewed over 27 water demand studies.
	-0.7 to -1.6	*National:* Outdoor residential water use, reviewed over 5 water demand studies.
	-0.06 to -0.8	*National:* Indoor residential water use, reviewed over 5 water demand studies.
Billings and Day (1989)	-0.72	*3 utilities around Tucson, AZ:* Increasing block rate and service charges.
Schneider and Whitlatch (1991)	-0.262	*Columbus, OH:* Long-term residential.
	-0.119	*Columbus, OH:* Short-term residential.
Hewitt and Hanemann (1995)	-1.57 to -1.63	*Denton, TX:* Discrete/continuous choice model, block rate pricing of residential demand, may have been influenced by summer irrigation.
Hanemann (1998)	-0.01 to -1.38	*National:* Reviewed municipal and industrial water demand studies from 1951 to 1991.
Goodman (1999)	-0.7	*57 US cities:* Extrapolates from single-family to multi-family sector.
Pint (1999)	-0.04 to -0.47	*Alameda County, CA:* Total summer demand, steeply increasing block rates during drought.
	-0.07 to -1.24	*Alameda County, CA:* Total winter demand, steeply increasing block rates during drought.
Cavanagh, Hanemann, and Stavins (2001)	-1.00*	*11 cities in US and Canada:* Using block price structure.
	-0.19*	*11 cities in US and Canada:* Using uniform marginal price structure.

* Price coefficients (measure household sensitivity to price), not elasticities.

A review of the literature unearthed a multitude of studies, each analyzing a different aspect of the relationship between water price and consumption. A review of more than 50 water demand studies concluded that the typical range for price elasticity is -0.2 to -0.4 for total residential demand, between –0.7 and –1.6 for residential outdoor demand, and between –0.06 and –0.8 for residential indoor demand (Planning and Management Consultants 1984). Overall, water demand studies in North America from 1951 to 1991 revealed a price elasticities that ranged from –0.01 to –1.38 (Hanemann 1998). The variability in elasticity estimates for residential demand was investigated by Espey, Espey, and Shaw (1997). A meta-analysis was performed on 124 elasticity estimates from 24 journal articles from 1967 to 1993. Evapotranspiration rates, rainfall, pricing structure, and season were all found to significantly affect price elasticity. Income was also found to be an important explanatory variable, although it was not found to significantly affect price elasticity in their study. Residential versus commercial demand, as well as long-run versus short-run price responsiveness, were also deemed influential. On the other hand, population density, household size, and temperature were not found to significantly affect price elasticity.

Most studies have found that indoor demand is generally less elastic than outdoor demand. Because this study is concerned with multi-family housing units, where residents are rarely responsible for outdoor water use, indoor price elasticity is the most applicable. Howe and Linaweaver's study in 1967 was the first time that residential demand was separated into the two components of indoor and outdoor use. This study was instrumental in convincing people that price does have a significant impact on water consumption. In the 1967 Howe and Linaweaver study, thirty-nine areas in the US were examined and it was found that indoor use, estimated from winter consumption, was relatively inelastic (-0.23). Outdoor demand was more elastic, especially in the humid East compared to the dry West. Howe refined the study in later years, and found an indoor elasticity of –0.06 (1982). Danielson (1979) found an indoor elasticity of –0.30. Both studies also confirmed that indoor use was less elastic than outdoor use.

Indoor use is less elastic than outdoor use because indoor uses tend to be fundamental to human survival and lifestyle. There are few substitutes for indoor water, beyond bottled water for drinking, and the many essential hygienic uses contribute to its inelasticity. Outdoors, it is less imperative that a car be washed or a lawn watered, and it's this discretionary water use that makes it more elastic. In addition, water bills represent a small portion of an overall residential budget. In fact, the median monthly water bill for an average U.S. customer in 1998 was less than $16 (Cavanagh, Hanemann, and Stavins 2001). Furthermore, the typical resident is unaware of how much water they are using for any given purpose, thus contributing to the price inelasticity.

One of the most hotly contested subjects in estimating price elasticities revolves around the price variable. The price variable is a dicey subject because often, monthly water bills are not straightforward calculations. Most studies have used either a marginal or average price. Marginal price is based on the cost of providing the next unit of water, whereas average price simply divides the total cost by the total water use. Gibbs (1978) was the first to argue for the use of marginal rather than average price. Billings and Agthe (1980) employ marginal price as well as a difference price variable. However, price perception tests found that customers respond to average price rather than marginal price in electricity bills (Shin 1985) and water bills (Nieswiadomy 1992). This finding could be testament to the fact that the more complex the water bill, the more difficult it is for customers to establish the link between usage and cost.

There are also countless rate structures that utilities can choose to meet their revenue and customer needs. The three main types: flat, uniform, and block rates, can take many different forms. Several studies, including Camp (1978), Young et al. (1983), Stevens, Miller, and Willis (1993), Corral (1997), and Cavanagh, Hanemann, and Stavins (2001) have examined the role of price structures on demand. The effects of various price structures in the Tucson, Arizona, metropolitan area have also been extensively studied (Young 1973, Cuthbert 1989, Billings and Day 1989, Martin and Kulakowski 1991). In a study that extrapolates single-family water usage to multi-family housing, Goodman (1999) used marginal price and estimated an elasticity of -0.70. Hewitt and Hanemann (1995) used a discrete/continuous choice model, finding one of the highest estimates of elasticity (-1.6), although it may have been influenced by summer irrigation.

There have also been studies that examined price elasticity over the long term versus the short term. By definition, in the “long term” all costs are variable, so the consumer has more options to adjust to prices. In the short run, at least some costs are fixed, so the consumer is more constrained. Studies have indicated that there is a significant time lag before residents fully react to price increases (Schneider 1991, Carver and Boland 1980, Espey, Espey, and Shaw 1997). In addition, studies have shown that price can be an effective tool during water shortages (Moncur 1989, Corral 1997, Pint 1999).

The price elasticity of water demand is a matter for empirical investigation. Virtually all studies show that water usage does respond to price signals. The empirical estimates of elasticity depend on all the factors mentioned above.

METERING AND ALLOCATION

Before the advent of metering, water utilities collected revenue through property taxes or later, a flat fee. Even when metering became possible, many utilities chose to charge a uniform rate because of its simplicity (AWWA 2000). However, as demand for water increased, charging on a per-unit basis was recognized as the favored method for encouraging conservation and efficiency. Several studies were conducted to determine how metering affected municipal water use. Porges (1957) examined national data from 1,474 municipal water systems and concluded that 100% metering would reduce per capita water use by over 25%. In Boulder, Colorado, per capita consumption dropped about 40 percent over the period from 1960, when Boulder was only 5 percent metered, to 1965 when it was fully metered (Hanke and Flack 1968). Moreover, Boulder's water use stabilized at the lower levels; a study showed that consumers did not return to their old use patterns four or five years after meters were installed (Hanke 1970). Flechas (1980) compared Denver, Colorado, water customers and reported that a 47% water reduction would have been achieved for flat rate users if they were metered in 1976. These studies helped to make residential metering the standard practice it is today.

Although individual metering has become the accepted norm in single-family housing, multi-family housing is typically built with one master meter for all units. Traditionally, property owners have paid the water utility bill and recovered the costs through monthly rent payments. In recent years as water and wastewater costs have risen, multi-family dwelling owners have sought to remove these costs from the rent to improve their net operating income by shifting water costs directly to residents. A similar shift occurred in the electric industry during the 1970s when prices rose. The savings associated with these cost shifts remains a topic of ongoing research.

Electric Industry

The energy crisis that occurred in the 1970s forced Americans to take stock of their energy consumption. President Carter issued Executive Order 12003, which addressed the issue of energy efficiency and made specific reference to conservation gains that could be garnered across property types including the multi-family property sector by mandatory conservation measures. The Public Utility Regulatory Act of 1978 directed that states restrict the use of master metering (that is, one meter for the entire apartment property) to cases where the owner could demonstrate that the costs of individually metering apartments exceeded the lifetime cost savings from reduced electricity usage from individual metering (16 U.S.C. 2623).

Reducing energy demand became a national goal. Guides were published about metering and allocation methods, especially targeting multi-family housing owners and managers (McClelland 1980), ("Alternatives" 1981).

McClelland (1980) conducted a comprehensive study that examined methods of invoking energy conservation in multi-family housing. The effect of RUBS was compared to submetering and in-rent payments for 14 properties in Dallas, TX, Atlanta, GA, Denver, CO, and Charlotte, NC. It was found that energy savings depended on the energy function. For energy used for cooling, lights, and appliances, RUBS saved 8% versus submetering savings of 22%. For energy used for heating and hot water, RUBS and submetering both induced savings of 5%. The total electric savings showed RUBS at 5% versus 14% for submetering. It was also found that after the first year, energy savings with RUBS increased. The study also surveyed residents about their reactions to RUBS. Residents found the greater control over shelter costs to be an advantage, but also found that bills based on the group rather than individual usage to be a disadvantage. Many survey respondents under RUBS reported a preference for utilities-included fixed rents or individual metering. However, RUBS managers did not believe that implementing RUBS affected vacancy rates.

In 1983, McClelland conducted a study that examined how tenant payment of electric bills affected energy use and owner investment. Tenant-payment properties in Atlanta and Portland were surveyed to determine how much the various owners had invested in energy efficiency. It was found that owners of these properties had made improvements to their equipment and buildings, suggesting that the financial concerns of tenants were affecting owner behavior. However, Atlanta properties with tenant-paid gas heat, owner-paid gas heat, and tenant-paid electric heat were surveyed and compared, and it was found that owners with tenant-payment had done less than their owner-paying counterparts. This suggested that tenant payment did depress owner actions to improve energy efficiency, but not to the degree that had been expected. Additionally, McClelland looked separately at formula billing in this context. It was determined that with a short-term energy reduction of 5%, the long-term benefit would essentially be nothing if tenant payment deters owner actions enough to reduce the annual change rate by 0.5%. It was concluded that formula allocation was not the most effective method for programs that are designed to reduce energy use over the long-term.

Water Industry

According to the National Multi Housing Council (NMHC), by 1995 occupied rental multi-family buildings with 5 or more units had 83% of occupants paying separately for electricity, whereas only 7% were paying separately for water and wastewater (1998b). However, the water industry has begun to follow the lead of the electric industry on metering and allocation billing, particularly after similar cost pressures have increased the price of water and wastewater services. A difference is that the electric and gas utilities fostered this change, whereas water utilities have shied away from this for a variety of legal, liability, and revenue reasons. Thus, water metering and allocation have developed independently through property owners and private third-party businesses – and without the same regulation that drove the changeover in the electric industry. As with any emerging industry, proper research and verification are essential to ensure its appropriate progression. To this end, researchers have begun to analyze separate billing in the multi-family sector. This section includes an overview of the important findings, advancements, and lessons learned from some of the relevant studies. A summary of their results can be seen in Table 2.2.

Simulation and probability models were the first techniques used to estimate how water use is affected by metering. Blackburn (1994) conducted one such study in New York City's multi-family housing sector, where most multi-family buildings were completely unmetered, and simply billed a flat rate. The study examined the impact that metering would have on these multi-family dwellings. Using simulation methods, this study predicted how many property owners would install conservation measures such as low-flow toilets, showerheads, and faucet aerators as a result of metering. A conservative estimate suggested that an overall reduction of 12.5 percent would be reached due to the conservation measures. Higher demand buildings could be expected to reduce usage by 30 to 60 percent. Conservation was deemed a likely response by owners to try to gain control over water costs after metering occurred. This was thought to be especially true since the city was offering a program to place an annual maximum cap on water bills for owners who undertook a range of conservation measures. In addition, generous rebates were being offered for low-flow fixtures. The study also looked at buildings that had recently become metered in the Jamaica Water Supply Company, which were predicted to be using 35 percent less water because of conservation due to metering. The study also examined how metering would affect owners and the multi-family housing industry in light of operating costs and rent stabilized housing.

Metered single-family water use has also been used to estimate multi-family water use. Gordon's (1999) master's thesis examined the potential influence of individual metering on water use in multi-family dwellings in Massachusetts, a state in which both RUBS and submetering are currently prohibited. Data on water consumption patterns of owner occupied single-family homes and multi-family rental properties was gathered from three Massachusetts towns and cities. Renters who are not billed for water consumption were found to use a statistically significant greater amount of water than their single-family owner occupant counterparts who pay for their own consumption. The study's weakness was rooted in the fact that there were no actual metered multi-family residences with which to make comparisons.

Goodman (1999) conducted a study that extrapolated single-family water demand data to multi-family rental communities. The study considered household survey data from single family homes and information on water prices from 57 geographically diverse cities. Multi-family units were matched by household characteristics to single family data. The study estimated a reduction in water consumption of 52% when multi-family residents shifted from paying a zero marginal price (i.e. not being directly charged for water), to paying the national average based on personal usage. This reduction shows the "pure" effect of marginal price and does not include the effects of income, family size, or other non-price characteristics. This reduction is a long-term projection and assumes the installation of water conserving fixtures. It was also noted that the single family demand data could conceivable include irrigation, however the study indicated that lawns and gardens did not significantly influence single family water use (Goodman 1999).

Preliminary predictions of water savings led to more buildings being metered, which allowed studies to deduce water savings based on actual usage. Seattle Public Utilities (SPU) in Washington conducted a demonstration project in 1995 that compared water use in one submetered and five control (in-rent) apartments. Results from the submetered building yielded encouraging average savings of 27% of water and wastewater use. This study prompted SPU to conduct a study in 1996 comparing water usage in nine buildings (before and after submetering) with different resident incomes, demographics, and building ages. Average water savings for the nine apartments was 7.7% (8.5 gpd/unit) (Dietemann 1999). The most sizable savings were seen with high water users. Of the nine buildings, seven showed savings, but in two buildings water use increased. Dietemann attributed the variations in savings to include “time of year of water use, high resident turnover, and master meter accuracy issues” (1999). Dietemann suggests that controlling those variables, as well as a more complete analysis using control groups, would allow for more generalized savings conclusions.

The National Apartment Association and the National Multi Housing Council commissioned a study that examined 32 multi-family properties in Florida, Texas, and California. The study included 14 in-rent, 9 submetered, and 9 RUBS properties. The study attempted to quantify changes in water consumption due to different billing methods. In general, it was found that residents that pay for water use less. Including common areas, the median submetered property used 18-39 percent less water than in-rent properties and the median RUBS property used 20-27 percent less than the in-rent sample. When common areas were excluded, submetered properties used between 22-33% less water and RUBS properties used between 6-22% less water. When submetered and RUBS properties were paired with in-rent properties based on age, size, and location, the median submetered property used between 26 and 55 percent less water than its control pair. The RUBS property used similar water on a per capita basis, but 32% less on a per occupied square foot basis. Intra-property results, which looked at consumption in buildings before and after converting to a separate billing system, were less conclusive (Koplow and Lownie 1999).

The Koplow and Lownie study, however, did not control for the installation of low-flow fixtures in the sample selection process, nor report on any retrofits performed over the study. The authors have clarified that the conserving impacts of plumbing retrofits were intentionally included with the impacts of billing programs because of an observed linkage between retrofits and billing program implementation. Income (or rent) was also excluded from the selection criterion. In addition, participants were selected through an “outreach campaign”, rather than randomly, which could have introduced a bias. Finally, the small sample size precludes the study from being able to apply results to properties in general (Strub 2000).

In 1998, the City of Austin Water Conservation Division and Capstone Properties conducted a pilot study that examined the savings gained from submetering hot water heaters in two similar apartment buildings in Austin, Texas. The study included a resident survey that found that if faced with a separate billing measure, the majority of residents preferred metering hot water to various allocation methods. For the first building, analysis showed that submetering positively impacted the residents' hot water consumption for all tested variables, decreasing water use from 5 to 12% (or 107.7 fewer gallons of hot water per month). However, results from the second building did not show submetering to significantly reduce water consumption. Demographics might help to explain why, since residents in the second building paid slightly higher rent and had higher income than the first. In addition, the submetering method employed only monitored hot water use, therefore rendering it possible for residents to have decreased cold water use, which wouldn't have been visible from the available data (Strub 2000). Limitations of the study were its small sample size and that some common area water usage was estimated, rather than actually metered, thus potentially over or under stating total resident consumption.

Wilcut (2002) performed a study in San Antonio, Texas, which compared water consumption patterns between submetered, bill allocated, and non-allocated multi-family residences. Establishments were classified by lease cost per square foot, date of construction, number of units per establishment, annual occupancy rates, allocation status, average monthly water consumption, and presence or absence of low-flow plumbing fixtures. Researchers identified 15 establishments, 5 properties per billing method. The study was successful in proving three concepts: (1) The introduction of a billing system decreases water consumption. In this study, submetering decreased consumption by about 18.5 gpcd (31.3%), and allocation decreased consumption by 1.6 gpcd (2.7%). (2) The study found that the presence of low-flow fixtures is more important for savings than the method of billing. Regardless of billing method, low-flow toilets and fixtures decreased use by 29.3 gpcd (39%). (3) There is no correlation between cost per square foot for lease space (intended as a proxy for socioeconomic status) and per capita water consumption. One hindrance for this study was the small sample size, thus making the results less significant for generalization purposes. In addition, it was recognized that due to the age of the submetered properties, most were equipped with low-flow fixtures.

Another study might want to target RUBS and in-rent properties that have more low-flow fixtures. Also, it was noted that the water rates charged during the study were among the lowest in Texas and the U.S.

Mobile home parks have also been targeted for submetering. The impacts of submetering water usage at two mobile home communities were evaluated in the Las Vegas Valley Water District, Nevada. Rosales, Weiss, and DeOreo (2002) reported a monthly water reduction of seven and twelve percent for the two study sites. Overall savings was 4,056 kgal per year from the 388 mobile units, or 10.5 kgal per year per household. The study also utilized flow trace data, which identified the source of savings to be a decrease in domestic water use and repair of leaks. These results were encouraging, and probably conservative, because significant water savings were achieved in communities that already had low baseline use and where retrofits have previously occurred.

Table 2.2 Chronological summary of selected multi-family water savings studies.

Researcher	Billing Method*	% Savings	Notes
Blackburn (1994)	Met.	12.5%	*New York, NY*: Predicted for all unmetered MF housing, based on conservation measures such as the installation of low-flow fixtures.
	Met.	30 to 60%	*New York, NY*: Predicted for unmetered high-end MF housing users, based on conservation measures such as the installation of low-flow fixtures.
	Met.	35%	*New York, NY*: Predicted savings for metered MF users, based on conservation measures such as the installation of low-flow fixtures.
Dietemann (1999)	Sub.	27%	*Seattle, WA*: Pilot study, compared one sub. building with 5 control buildings.
	Sub.	7.7%	*Seattle, WA*: Compared nine buildings before and after metering. Seven showed savings, two showed an increase of usage.
Gordon (1999)	Sub.	na	*Boston metro, MA*: Found SF owners who are billed for water use significantly less water than MF renters who weren't billed for water use.
Koplow and Lownie (1999)	Sub.	18 to 39%	*FL, TX, CA*: 9 sub. properties were compared against 14 control buildings. Study didn't account for differences in low-flow fixtures between compared properties.
	RUBS	6 to 27%	*FL, TX, CA*: 9 RUBS properties were compared against 14 control buildings. Study didn't account for differences in low-flow fixtures between compared properties.
Goodman (1999)	Sub.	52%	*57 US cities*: Estimated savings from when residents change from paying zero marginal price to national average, assumes installation of low-flow fixtures. Extrapolated from SF data.
Strub (2000)	HWH	5 to 12%	*Austin, TX*: Compares one apartment before and after metering.
	HWH	na	*Austin, TX*: Compares one apartment before and after metering. No significant decrease in water use, attributed to higher income/rent.
Wilcut (2002)	Sub.	31%	*San Antonio, TX*: 5 sub. properties were compared against 5 control buildings.
	RUBS	3%	*San Antonio, TX:* 5 RUBS properties were compared against 5 control properties.
Rosales, Weiss, and	Sub.	7%	*Las Vegas, NV*: Compares mobile home community before and after metering.
DeOreo (2002)	Sub.	12%	*Las Vegas, NV*: Compares mobile home community before and after metering.

*Met. = Master meter, Sub. = Submeter, HWH = Hot water hybrid, RUBS = ratio utility billing system.

CHAPTER 3 RESEARCH METHODS, APPROACH, AND PROCEDURES

OVERVIEW OF RESEARCH PROCESS

The research process for the National Submetering and Allocation Billing Program Study (the Study) was developed by the project team in response to EBMUD's request for proposals. The general research plan outlined in that proposal has been followed throughout the research and analysis process. Once the project was awarded to the consultant team, a detailed work plan was developed to implement the research described in the initial proposal.

The general flow of the research effort moved from building the study team and formally contracting with participating water utilities, to collecting data from surveys and service companies, and finally to data analysis and modeling. Quality control and assurance measures were implemented at each stage of the research process to ensure a high level of accuracy in all aspects of the project.

Work on the project moved through an orderly development process for each site based on the flow chart model in Figure 3.1. Most of the process was repeated for each individual study site. The general process at each study site began by obtaining a complete list of historic billing data for all multiple family properties in their district and surveying this group to identify the billing method and characteristics of each property. All of the items in Figure 3.1 are briefly detailed here and explained in greater depth later in the chapter.

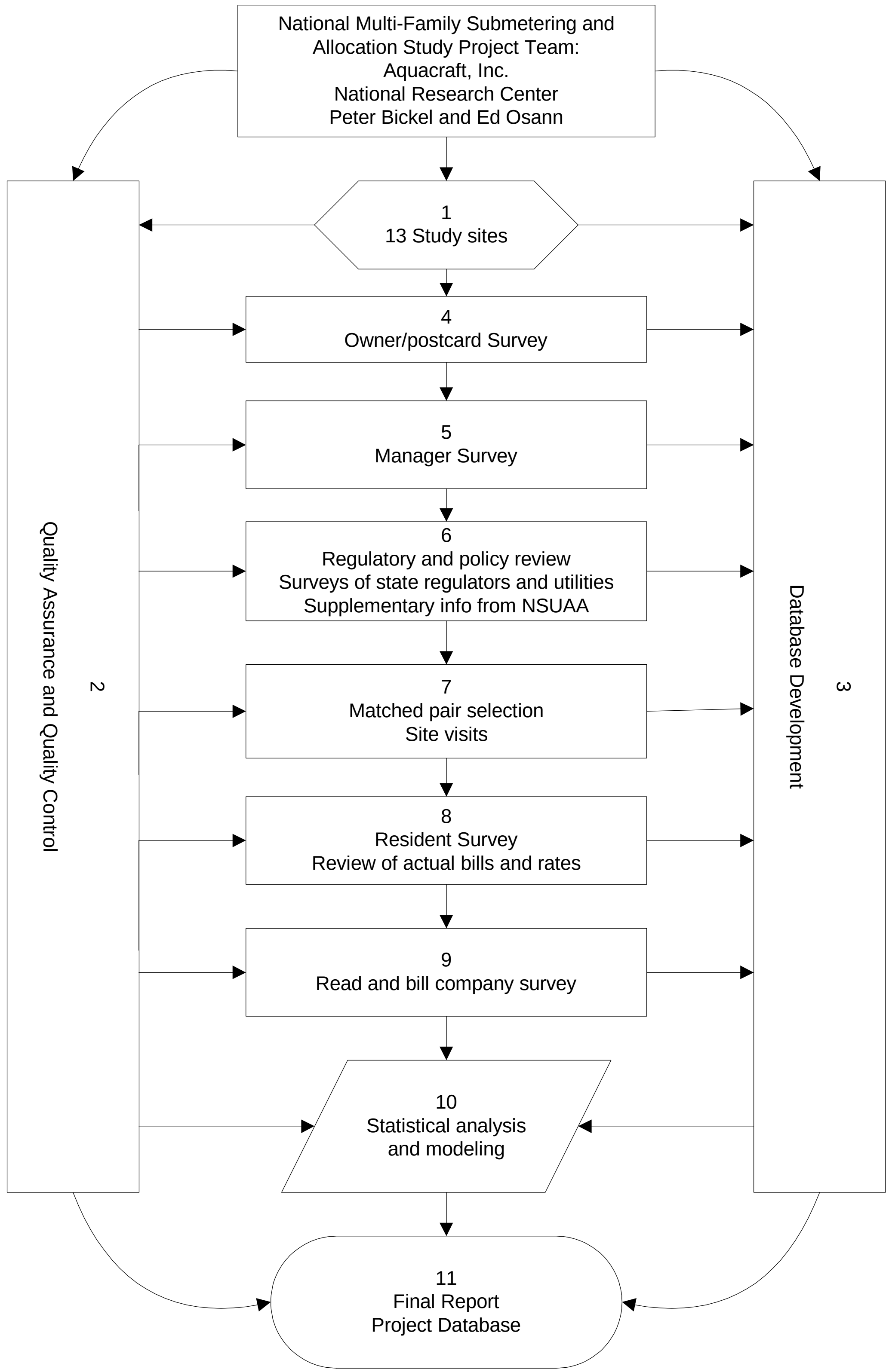


Figure 3.1 National Multiple Family Submetering and Allocation Billing Program Study flow chart

1. **Selection of participating study sites**: Study sites included Austin, San Antonio, Hillsborough Co., Denver, Seattle, Portland, Phoenix, Tucson, Oakland, Indianapolis, San Diego, Las Vegas, and Irvine. Participation required the local utility to provide complete billing data for their service area and project support.
2. **Quality assurance and quality control (QAQC)**: Procedures to ensure the quality of the data and the research methods were implemented throughout the study.
3. **Database development**: All data collected in this study including historic water billing records and survey response data were stored in a customized Microsoft Access database. **QAQC –** Accuracy of all data input into the database was reviewed by multiple team members, statistical tests to ensure representativeness were performed, on-going data analysis and information updates throughout the research process resulted in continual improvement of data quality.
4. **Owner/postcard survey**: To identify "impact"[16] properties in each utility, postcard surveys were developed, tested and implemented to the property owners of all eligible multi-family properties in each utility. **QAQC –** Project manager, PAC/POC review of survey instrument. Statistical tests performed to ensure the water use characteristics of each sample was statistically similar to that of the population.
5. **Manager survey:** To obtain detailed information about properties identified in the owner/postcard survey, a survey was developed, tested and sent to property managers of impacted and in-rent properties. **QAQC –** Project manager, PAC/POC review of survey instrument. Data input quality control review and checks. Statistical tests performed to ensure the water use characteristics of respondents was statistically similar to postcard survey sample from which it was drawn.
6. **Regulatory and policy review:** To evaluate the administrative and regulatory issues surrounding third party billing programs throughout the country, surveys were sent to various potential regulators in all 50 states and to more than 100 of the largest water and wastewater utilities. Additionally a detailed policy literature review was conducted. **QAQC –** Project manager, PAC/POC review of survey instruments. NSUAA review of state by state policy

findings and provision of supplementary policy data. NSUAA review of regulatory and policy review and recommendations.

7. **Matched pair selection and site visits:** Study team utilized the results from the manager survey to make statistically similar pair matches for site visits and comparison. Site visit protocol developed. Study team and participating utilities conducted site visits. **QAQC –** Project manager, PAC/POC review of match pair methodology and site visit protocol. Consultant review of all site visit data and historic billing data for matched pair samples.
8. **Resident survey**: To solicit resident opinions and experiences with different billing methods, a survey instrument were developed, tested, and sent to residents using addresses provided on the manager survey. Some residents also provided copies of their water and wastewater bills sent by various read and bill companies. **QAQC –** Project manager, PAC/POC review of survey instrument. Data input quality control review and checks.
9. **Read and bill company survey**: To obtain information about billing practices and policies a survey was sent to 36 third party billing companies. **QAQC –** Project manager, PAC/POC review of survey instrument. Data input quality control review and checks.
10. **Statistical analysis and modeling**: Once the data collection and analysis was complete research team used all of the assembled information to develop analytical tools and relationships to quantify potential water savings and explain indoor multi-family residential water use. **QAQC –** Team statistician Dr. Peter Bickel frequently reviewed the statistical analysis and modeling effort, making suggestions for refinements and further analyses.
11. **Final products**: The final products of this research project include this final report and the database. **QAQC –** An extensive PAC/POC and peer review process was established to ensure the final report is of the highest possible quality. QAQC procedures for the database development were implemented throughout the research process and are listed above.

[16] Impact properties – multi-family properties billing separately for water and/or wastewater services using RUBS, submetering, hot water hybrid, or other methods.

STUDY SITE SELECTION

The Study aimed to include a large and diverse sample of in-rent and impact properties from cities in geographically diverse sections of the United States. There were two fundamental requirements for participation in the study: (1) the site had to have a reasonable population of submetered and RUBS properties; and (2) the local water utility had to be willing to cooperate and assist with the study including providing water billing data. To find locations that met the first requirement, the research team collected complete lists of customer properties across the U.S. from as many submetering and customer billing companies as possible. Utilities in all of these locations were contacted repeatedly to solicit their participation. Ultimately, 13 cities fitting both criteria were selected for the study.[17]

Billing Industry Conversion Data

There are a number of companies that install submeters and/or provide water billing services to owners of multi-family properties using one of the billing methods previously described. Since most water utilities did not know precisely which multi-family properties subscribe to these services, it was necessary to work with the submetering industry to obtain complete lists of accounts that they have converted. Companies that cooperated with this phase of the study and provided useful information were American Utility Management, Archstone, Minol, National Water and Power, US Water Works, USI Energy, Viterra, WaterMaster, and Wellspring. From these companies, over 1,300 properties were identified in cities across the nation. In addition, Texas requires all properties that have undergone conversion to register on the Texas Commission of Environmental Quality (TCEQ) web site - http://www.tceq.state.tx.us/index.html. Using the data available on this web site, additional submetered and RUBS properties in Texas and in particular in Austin and San Antonio were identified.

The data provided by the service companies and available through other sources was utilized to identify cities with a reasonably large population of submetered, RUBS, and hot water hybrid properties. The study team made an effort to contact every water utility in cities meeting

[17] Significant time and effort was spent trying to recruit additional study sites from the eastern US and local contacts were enlisted to help in the recruitment effort, but very few utilities expressed any interest and/or willingness to cooperate with the research effort.

minimum impact property population standards to offer the opportunity to participate in the study.

Selected Study Sites

Not surprisingly, utilities that have had a historic interest in water demand planning and management were found to have a high concentration of converted properties. Therefore, the final 13 study cities are weighted towards the West and Southwestern region of the United States, but contain a wide variety of utilities serving a broad and diverse group of customers. In addition, this Study focused primarily on indoor water use, which as been found to be quite similar nationally according to previous studies (Mayer et. al 1999, Brown and Caldwell Consulting Engineers 1984). Figure 3.2 is a map identifying the location of the all study cities. The participating utilities and supporting agencies were:

1) City of Austin, Texas
2) City of San Antonio, Texas
3) Denver Water Department, Colorado
4) City of Portland, Oregon
5) Seattle Public Utilities, Washington
6) San Diego Water Department, California
7) Tampa Water Department and the Southwestern Florida Water Management District, Florida
8) East Bay Municipal Utility District, California
9) Irvine Ranch Water District, California
10) City of Phoenix, Arizona
11) City of Tucson, Arizona
12) City of Indianapolis, Indiana
13) Southern Nevada Water Authority and Las Vegas Valley Water District, Nevada

Figure 3.2 National Multiple Family Submetering and Allocation Billing Program Study sites

HISTORIC BILLING DATA

As a requirement of participating in the study, utilities were asked to provide complete copies of billing data from their multi-family customers dating back to 1994 and to act as a clearinghouse for surveys. The billing datasets had to include the:

- Account number
- Billing address
- Service address
- Account status
- Date of account initiation
- Meter reading dates, meter readings, and consumption data for a 12 month period (this covers 7 meter readings on a bimonthly billing cycle, and 13 meter readings on a monthly billing cycle)

Table 3.1 shows the billing data the years of data obtained from each participating utility. Every utility was able to provide complete 2000 and 2001 data, eleven utilities provided 2002 data, and eight utilities were able to provide data back to at least 1996.

Table 3.1 Water billing data provided by each participating utility

Utility	Years of Complete Data Provided	Notes
San Antonio, TX	1996 - 2002	
Tucson, AZ	1996 - 2002	
Phoenix, AZ	1996 - 2002	
Oakland, CA	2000 - 2002	
Denver, CO	1992 - 2002	
Portland, OR	1998 - 2001	Experienced billing database failure and could not provide 2002 billing data without manual extraction of each record.
Austin, TX	2000 - 2002	
Indianapolis, IN	2000 - 2001	Stopped responding to communication and cooperating with the study during the manager survey process. Did not provide 2002 billing data. Research continued to the extent possible without utility cooperation.
Irvine, CA	1996 - 2002	
Las Vegas, NV	1995 - 2002	
Seattle, WA	1995 - 2002	
Hillsborough Co., FL	2000 - 2002	
San Diego, CA	1996 - 2002	

SURVEY DEVELOPMENT AND IMPLEMENTATION

The goal of the surveying components of the project were to obtain detailed information about billing methods, water-using appliances and fixtures, water-using habits, household characteristics, and demographic information from the multi-family properties in each study site. Additional surveys sought information on regulation of third party billing by states and water providers, third party billing practices and implementation, and resident knowledge, attitudes, and opinions about third party billing. The following is a list of all surveys implemented in this study. Actual survey instruments can be found in Appendix A.

Postcard survey – survey of all eligible multi-family accounts to identify impact properties within each participating utility service area

Manager survey – obtain detailed information about properties identified through the postcard survey (both impact and in-rent properties)

Matched pair protocol/survey – confirm information from the manager survey as well as directly observe additional property characteristics such as percent of landscaping devoted to turf and actual volume/flow rates of dwelling unit fixtures

Resident survey – obtain resident opinions and experiences with different billing methods and obtain copies of actual bills

Read and bill company survey – obtain information about billing practices and policies

Survey of Potential Regulators – obtain information on current regulations on billing methods from a variety of agencies including:

State safe drinking water administrators

State PUC officials – water commissioners and assistant water commissioners

State bureau of weights and measures officials – meter division

100 of the largest utilities (and 3 additional sponsor utilities) – general manager, engineering staff, or metering manager

The project team developed each survey questionnaire through an iterative review process that included field pre-testing and review by the project manager and advisory committee. The surveys were designed so that the respondents had only to complete the questionnaire, and either fold it in half or place it in an envelope (depending on the survey), both of which were already addressed and stamped, and drop it in the mail. Respondents were only asked to identify themselves on the manager survey and on the regulatory surveys, in case more information or clarification was needed.

National Research Center (NRC) was responsible for implementation of the postcard, manager, and resident surveys, the three largest in the study. NRC printed, mailed, and tabulated the surveys. Each survey was printed with the utility logo and/or some introduction by an official in order to improve response rates. NRC printed the mailing labels using the address information provided by the utility customer database. To facilitate respondent needs, a phone number for a NRC staff person was made available to answer questions and provide assistance.

Returned surveys were collected by each utility and sent to NRC directly or via Aquacraft for entry into a Microsoft Access database table. Upon completion of the database entry work, the participating utility was informed of the final response rate and survey response details.

Upon completion of the survey entry work, a summary table was created for each city for each survey. All responses were totaled and the appropriate descriptive statistics were calculated. Participating utilities and research team members were updated as needed.

Regulatory surveys were implemented by Potomac Resources, Inc. and the read and bill company survey was implemented by Aquacraft, Inc. Site visits were conducted by Aquacraft and NRC in conjunction with the participating water utilities.

Use of PROPID to Preserve Customer Anonymity

A unique random number was assigned to each account number in the sample frame. This number was called the PROPID. The address labels for the survey mailing lists contained the PROPID that identified the customer. Each response therefore contained a unique PROPID. This was loaded with the response record into an ACCESS database table. Each response record could therefore be linked to the historic water use database that also contained the PROPID. At the conclusion of the study, the databases prepared for future researchers will only contain the PROPID, not the actual account number, service address or customer name, thus preserving the anonymity of the participating customers.

POSTCARD, MANAGER, AND RESIDENT SURVEYS

The research plan called for three distinct and sequential surveys: the postcard survey, the manager survey, and the resident survey. Although more surveys were implemented in this study, these three formed the core of the data collection effort. The postcard survey identified the type of billing method and the number of units at each property. Through properties identified in the postcard survey, a far more detailed survey instrument was sent to managers of the individual properties in order to find out more about each property. Respondents to the manager survey were asked to provide addresses for the individual units at their property. Many did provide this address information and subsequently surveys were sent to residents at these multi-family properties seeking information about individual water use habits and opinions and experiences with the water billing methodology.

Mail surveys were selected to obtain information about multi-family housing because of the relative ease of implementation and low cost compared to other options such as on-site audits or telephone surveys. Because the Study had 13 study sites spread across the country, the project team determined that a mail survey would be the only feasible method for obtaining the required information given the available budget. Telephone surveying was used as part of the manager survey to increase the response rate.

Postcard Survey

The initial project survey was a postcard survey. The postcard survey was sent to the owner or on-site manager of all multi-family residences that met initial screening criteria based on billing data. This criteria eliminated properties that used less than 200,000 gallons of water in 2001 and had fewer than 10 dwelling units[18]. A typical single-family home uses about 140,000 gallons per year on average. Eligible properties that met these criteria were considered the sample frame. Two different survey forms were used in 12 of the cities: a "short form" postcard survey for individual properties and a "long form" postcard survey for customers that handle billing accounts for more than 4 properties. A sample postcard survey instrument is re-printed in Appendix A. It was unnecessary to send the postcard to Irvine Ranch Water District because information on third party billing and the number of units per property was available from their customer billing database.

The postcard survey form was simple and to the point. It asked if residents in the building are paying for water (and wastewater) via submetering, RUBS, hot water hybrid, or if it is included in the rent or homeowner association dues. It also asked if the billing is handled in-house by a billing service company. In addition it asked how many units the property has.

This survey was printed on a postcard with a utility logo and included a brief explanation of the study. To facilitate respondent needs, a phone number for a NRC staff person was made available to answer questions and provide assistance. As promised in the description of the study, a drawing was held to award a prize of $100 to a randomly selected respondent.

The Study's sampling framework was designed so that a 30 percent response rate to the postcard survey in each study site would be sufficient for selecting properties for the manager survey. The response rate goal was obtained in each city, ranging from 39% in Hillsborough County to 75% in Seattle. The overall response rate was 58.6% (7,972 postcards). Only Las Vegas required a second wave of surveys to be sent in order to reach the 30% goal. See Table 3.2 for details.

[18] This was only part of the criteria for the utilities that keep records of the number of dwelling units per property. Thus, in utilities without records on number of dwelling units, some properties with less than 10 units did receive a postcard survey.

Table 3.2 Postcard survey response rates

Utility	Sample Frame	Total delivered surveys	Undeliv-erables	Total completed surveys	Response rate*
San Antonio	844	619	225	382	61.7%
Tucson	1,111	1,028	83	443	43.1%
Phoenix	1,688	1,238	450	548	44.3%
Oakland	1,469	1,233	236	603	48.9%
Denver	1,731	993	738	697	70.2%
Portland	2,643	1,592	1051	1,173	73.7%
Austin	1,923	1,555	368	807	51.9%
Indianapolis	596	393	203	221	56.2%
Irvine	na	na	na	na	na
Las Vegas	1,400	925	475	489	52.9%
Seattle	2,585	1,462	1,123	1,089	74.5%
Hillsborough County	265	265	0	104	39.2%
San Diego	3,240	2,297	943	1,416	61.6%
TOTAL	19,495	13,600	5,895	7,972	58.6%

*Response rate calculated from delivered surveys and completed surveys

Manager Survey

After the postcard survey was completed, a survey instrument was sent to managers of individual properties requesting detailed information about the property characteristics, property amenities, water fixtures, and water bill payment. The survey included questions about the building size and landscape, rent rates, occupancy rates, building features and amenities, changes to water using fixtures and appliances, water bill payment methods, and others. The final survey was five pages long (8.5 x 11 inches, 11-point type), contained 43 multi-part questions and typically took 10 to 15 minutes to fill out. In the survey, 15 questions pertained to property characteristics, 3 to property amenities, 6 to water fixtures, and 17 to billing methods. The back page of the questionnaire was devoted to soliciting unit addresses for the resident survey, contact information, and return instructions. As with the postcard survey, a drawing for a cash prize ($500) was included, in hopes of increasing response rates. An example of the manager survey can be found in Appendix A.

The manager survey was sent to in-rent and impact properties identified through the postcard survey. In addition, impact properties identified by billing service companies and from web sources that had not responded to the postcard survey were also included in the manager survey. Service companies that provided this information included National Water and Power, Viterra, and Archstone. The web information was provided by a Texas utility registry (http://www.tceq.state.tx.us/index.html) and was only applicable to San Antonio and Austin. The number of properties identified through each source can be seen in Table 3.3. All in all, about 15% of all the surveys sent were obtained from sources other than the postcard survey.

Table 3.3 Manager survey properties identified through service companies and a Texas web site registry

City	Properties Identified Through:		Total
	Service Companies*	Web Registry†	
Austin	15	142	157
Denver	23	-	23
Oakland	17	-	17
Hills	8	-	8
Indianapolis	5	-	5
Irvine	18	-	18
Las Vegas	9	-	9
Phoenix	35	-	35
Portland	11	-	11
San Antonio	4	79	83
San Diego	35	-	35
Seattle	9	-	9
Tucson	31	-	31
Total	220	221	441

* Service companies include National Water and Power, Archstone, and Viterra
† Web properties are only for Austin and San Antonio

Since a lower percentage of impact properties were identified than originally anticipated, a saturation sampling technique was chosen for the manager survey so that every identified impact property received a manager survey. Within each city, impact properties were placed into bins according to number of units. The bin ranges for each city were determined by ordering all units in descending order and dividing them equally into thirds. Then, a stratified random sample of in-rent properties was drawn from corresponding bins. The goal was that for approximately every 1.2 impact surveys sent, 2 in-rent surveys would be sent. For example, if a city had 24 impact properties identified in its lowest bin (10 – 100 units), then about 40 properties would be picked from the in-rents that fell within the same bin range. If there were

210 possible in-rent properties with units from 10-100, then the selection interval would be five (210/40 rounded down to the integer). Then there would be a number randomly selected between 1 and 5 to be the first member of the sample. Assuming the random number is 3, the 3rd account would be chosen, and then every 5th thereafter would be selected, until the complete list for the first bin is exhausted. More in-rents properties were selected in order to increase the chance of finding a close match for each impact property during the matched pair process. There were three cities (Austin, San Antonio, and Hillsborough) where there were not enough in-rent responses to send 2 surveys for every 1.2 sent. In all three cases, every identified in-rent property was sent a manager survey. In the end, approximately 1.4 impact surveys were sent for every 2 in-rent surveys sent.

It should be noted that originally, the research plan aimed to exclude any properties with less than 10 units. However, the postcard survey results showed that in Oakland, the vast majority of properties had less than 10 units. So, in order to keep Oakland as a study site, it was decided to keep properties with less than 10 units in the sample.

To insure a high response rate, the manager survey was implemented in three mailed waves and a telephone follow-up with non-respondents. The first wave was addressed to the "Property Manager" at the service address (i.e. property address) of all of the properties selected through the aforementioned method. Since many multi-family dwellings do not have a property manager on-site, or the manager's unit number was unknown, a considerable number of surveys were returned, deemed "undeliverable" by the postal carrier. This set up the second wave of manager surveys. The mailing list for the second wave of manager surveys was comprised of the undeliverables and the delivered non-respondents to the first wave. The second wave of surveys were then sent to the billing address (rather than the service address), in hopes that someone there could answer the survey questions. For the delivered, non-respondents of the first wave, the second wave survey was re-sent to the service address.

In the third wave, manager surveys were sent to the billing address of any non-respondents from the second wave. Additionally, if any surveys were found to be undeliverable at the service and billing address, then the appropriate utility was contacted to find out if they had any address updates or change in service.

Because of the importance of this survey and the strong desire for a high response rate, at the conclusion of the third wave survey effort, the research team hired a company that specializes in "business to business" calling to conduct telephone follow-ups to site managers in hopes of increasing response rates. Some of the manager phone numbers were provided by the utilities, and the remaining were looked up in published directories by the calling company using the property name.

The overall goal was to have about 1,500 completed surveys, with about 150 per site. After an exhaustive effort that included the three waves of mailings described above and a phone follow-up, almost 1,300 useable responses were obtained, for an overall response rate of 45.1%. Table 3.4 shows the individual response rates by city, as well as the breakdown of responses from the mailing and phone surveying. The lowest response rate was found in Indianapolis (20.8%), and the highest response rate was in Portland (63.9%).

Table 3.4 Manager survey response rate

Utility	Number of Properties	Completed by Mail	Completed by Phone	Total Completes	Total Useable Completes*	Useable Response Rate
Austin	609	134	70	204	202	33.2%
Denver	183	77	22	99	98	53.6%
Oakland	105	26	22	48	34	32.4%
Hillsborough Co.	108	45	0	57	57	52.8%
Indianapolis	72	10	8	18	15	20.8%
Irvine	103	22	15	37	36	35.0%
Las Vegas	111	43	23	66	65	58.6%
Phoenix	242	98	29	127	127	52.5%
Portland	122	62	19	81	78	63.9%
San Antonio	339	114	20	134	132	38.9%
San Diego	290	83	34	117	116	40.0%
Seattle	352	154	37	191	188	53.4%
Tucson	220	102	39	141	139	63.2%
TOTAL	2,856	970	338	1,308	1,287	45.1%

*This excludes any properties that the research team did not have water billing data for or any properties that returned duplicate surveys.

Resident Survey

The goal of the resident survey was to obtain resident opinions and experiences with different billing methods and obtain copies of actual bills sent by billing service companies. Property managers were asked to provide specific address information for the residents in their complexes as part of the manager survey, and many complied with this request. Using the information, the next step was to randomly select residents to receive the resident survey. Dwelling unit addresses were chosen at random from the building unit ranges provided by the manager survey. A drawing was also held to award a cash prize of $500 to a randomly selected respondent. A copy of the resident survey can be found in Appendix A. The resident survey was implemented in two waves with survey instruments sent to the entire sample frame twice.

A total of 15,697 units were selected for the survey, with a goal of having about 3,000 (20%) completed questionnaires for analysis. The response overall response rate was 16.4%. The lowest response rate was in Indianapolis (5.5%) and the highest response rate was in Portland (27.2%). See Table 3.5 for detailed information on the resident survey response rate.

Table 3.5 Resident survey response rate

Utility	Sample Frame	Undeliverables	Total delivered surveys	Total usable completed surveys	Response rate*
San Antonio	2,325	na	2,325	313	13.5%
Tucson	1,821	315	1,506	253	16.8%
Phoenix	1,070	160	911	163	17.9%
Oakland	39	0	39	10	25.6%
Denver	1,431	185	1,247	194	15.6%
Portland	1,013	179	834	227	27.2%
Austin	2,793	na	2,793	383	13.7%
Indianapolis	80	25	55	3	5.5%
Irvine	1,201	73	1,129	231	20.5%
Las Vegas	665	3	663	82	12.4%
Seattle	1,393	212	1,181	149	12.6%
Hillsborough County	637	108	529	78	14.7%
San Diego	1,229	107	1,122	259	23.1%
TOTAL	15,697	1,365	14,332	2,345	16.4%

*Response rate calculated from delivered surveys and usable responses

MATCHED PAIR SAMPLE

The purpose of the site visits/matched pair analysis was to look closely at a small sample of in-rent and impact[19] properties that have similar characteristics. Properties with similar characteristics offer a unique opportunity for comparing water use between in-rent and impact properties, essentially controlling for property differences through the matched pair selection. Years of experience with survey research have taught water conservation professionals that self-reported information about water using fixtures like toilets, showerheads, and faucets is often inaccurate. The site visits were designed to confirm critical information from the manager survey and fill in additional details as well as information that had gone missing. Most importantly, the site visits were used to identify first hand the type of water using fixtures found at the site.

The research plan called for the selection of a matched pair sample from the manager survey respondents. Although the original plan called only for "pairs" consisting of one impact to one in-rent, the project's statistical consultants agreed that if a "triad" could be matched, a submetered and a RUBS property could be matched with the same in-rent property.

Matched Property Selection

Within each city, pairs or triads were selected to "match" as many critical variables as possible (based upon the responses of the manager survey). The key variables considered in the selection process were: year of construction, number of units on the property, average number of bedrooms per unit, average rent per unit, whether or not their were hook-ups for washing machines in the units, whether or not the toilets had been replaced, and whether or not the property was a senior citizen community. The matches were limited to properties classified as private rentals (mostly apartments), but a few privately owned residences (such as condominiums) were included out of necessity. In addition, in order to be included in a matched pair, impacted properties had to have converted to their current billing system by 2001 or earlier. Any government subsidized housing or mobile home parks were excluded. The researchers were blind to water use estimates for the properties during the matched property selection process. Given the relatively small number of impacted properties within each city, it was difficult to

[19] Impact properties – multi-family properties billing separately for water and/or wastewater services using RUBS, submetering, hot water hybrid, or other methods.

create exact matches on the given criteria. It was found that often the impacted properties (particularly submetered properties) were of more recent construction, while the in-rent properties were of older construction. Thus, in some cases the criteria were not as "tight" as would have been ideal[20].

Matched Property Site Visits

After the properties were selected, the project team prepared for the matched property site visits. As part of the participation agreement for this project, utilities agreed to assist with the site visit effort. Depending upon each utility's capabilities and availability during the time of the site visits, several options were offered. The first option was that the utility performs the site visits themselves, with the research team just providing the appropriate materials and over-the-phone training and support. Two of the utilities chose this option (EBMUD and San Antonio). The remaining utilities requested that a member of the research team travel to their city for on-site assistance. At minimum, the research team member would stay to conduct at least one of the site visits, providing materials and training for the utility to complete the rest of the visits. For the remaining utilities, the research team member conducted all of the site visits, and was accompanied by a representative of the utility. The site visits had two main parts:

- A brief 10-minute interview with the manager or on-site maintenance person about the property characteristics; and
- Inspection of a random sampling of the units in order to verify plumbing fixtures.

The purpose of much of the interview was to verify answers from the manager survey. The site visit team prepared a site visit protocol sheet for each interview that included questions and answers from the manager survey, as well as other, new questions about the property. A copy of the site visit protocol can be seen in Appendix A.

The site visit survey (protocol) also sought information about the property's landscape and irrigation. This information was important, as it could be used to verify whether or not the analytic separation of indoor and outdoor water usage was done appropriately. Most of the participating utilities were able to provide aerial photos or scaled maps of each selected property, from which the irrigated area could be calculated. When this information was not available, the site visit team used a measuring wheel to measure the irrigated area while on-site.

[20] All pairs were kept within the same utility, however, not all of the key variables noted in this section could be

The second part of the visit required that the team gain access into a sample of dwelling units to verify the plumbing fixtures. For obvious reasons of privacy and required notification, the team was typically only allowed access into vacant units. The initial goal was to visit about 10% of the total units on the property. In some cases this was possible, but often there were not enough vacant units available to visit, in which case the auditor would simply visit as many units as was possible.

During each unit visit, the auditor tested and recorded the flow rates of every faucet and showerhead in the dwelling unit using a Niagara flow bag. Then each toilet was carefully inspected to determine if it was a rated ultra low-flow (ULF) toilet. Some low-flow toilets have "1.6 gpf" stamped right on the porcelain, but many do not. For the remaining toilets, the toilet lid was removed and the date stamp (found either on the inside of the lid or inside on the side of the tank) was noted. Any toilet with a date of 1994 or later was deemed a low flow toilet. The make and model of the toilet was also recorded. The site visit team also noted any leaks in the unit (i.e. leaky shower diverter, leaky toilet flapper, dripping faucet, etc). Next, the team noted whether or not the unit came with clothes washer hook-ups. If the unit came with a clothes washer, the make and model was noted. If the property had any central laundry facilities, these were also visited, and the appropriate information was recorded on the site visit protocol. Figure 3.3 illustrates some of the tasks performed during the random unit site visits.

Figure 3.3 From left to right: a site auditor testing the faucet flow rate, inspecting the toilet lid for a date stamp, and testing the shower flow rate.

The original goal was to visit 80 properties and have 40 matched pairs (20 submetered and 20 RUBS) for analysis. A total of 77 site visits were completed and 64 of these were usable

matched on.

for analysis. The usable site visits fell short of the goal because a number of property managers declined to cooperate with the site visits. Although alternate properties were available it was not always possible to schedule a visit at the last minute. Table 3.6 shows the number of site visits conducted in each study site and the billing methodology used at these properties.

Table 3.6 Number of site visits conducted in each study city

Utility	Usable Site Visits					Total Complete Site Visits
	In-rent or HOA	Hot Water Hybrid*	Submetered*	RUBS	Total Usable	
San Antonio	2	0	1	1	4	4
Tucson	3	1	2	2	8	8
Phoenix	2	1	1	1	5	6
Oakland	3	0	2	1	6	7
Denver	3	1	0	3	7	7
Portland	3	1	0	2	6	7
Austin	1	0	1	1	3	6
Indianapolis	0	0	0	0	0	0
Irvine	2	1	1	0	4	7
Las Vegas	3	1	1	1	6	7
Seattle	3	1	2	1	7	8
Hillsborough Co.	2	0	2	0	4	5
San Diego	2	0	1	1	4	5
TOTAL	29	7	14	14	64	77

* Hot water hybrids and submetered properties were ultimately grouped together for this analysis.

Initially, hot water hybrids were excluded from being chosen in a matched pair. However, it was discovered during the initial site visits that some of the hot water hybrids were mistakenly labeled by manager survey respondents as submetered properties. Because the sampling was already limited and the visits had been completed, it was decided to include any hot water hybrids with the submetered properties. In addition, a few correctly labeled hot water hybrids were later chosen as alternates when a submetered property was not available.

QAQC – EVALUATION OF WATER USE FROM SURVEY SAMPLES

Important quality assurance and control tests were conducted to compare the water use of the survey respondents with the population from which they were drawn. In order for results from this study to be broadly applicable it is important that the samples investigated be representative of a known population. The conclusion was that the survey respondents as a group were representative of the population of multi-family homes from which they were drawn across the 13 study sites. This section of the report details these quality assurance statistical analyses.

Comparison of Postcard Survey Respondents with Sample Frame

The initial sample frame was the set of all multi-family properties in each participating study site (identified through the utility customer information system) that had more than 10 dwelling units and/or water use greater than 200 kgal in 2001. Postcard surveys were sent to all multi-family properties meeting these basic criteria. Quality assurance tests were conducted on entire group of respondents and on the sample of properties from each study site that returned the postcard survey to determine whether the water use characteristics of the postcard survey respondents were statistically similar to the population of multi-family water use accounts provided by the utilities (sample frame). To compare the respondents with the population, statistical tests were used to determine whether statistically significant differences existed in water use characteristics among the two groups.

A z-test was conducted at a 95 percent confidence level to determine if there was a statistically significant difference in the mean annual water use of respondents versus non-respondents or versus the population (Test 1 in Table 3.7). The most important comparison evaluated 2001 water use for the entire sample frame (n=19,495) with 2001 water use for the postcard survey respondents (n=7,972). The water use in these two groups was found to be statistically similar (i.e. not different) at a 95% confidence level. This means that on the basis of water use alone the postcard survey respondents were representative of the population of multi-family homes found in these 13 study sites.

Statistical comparison tests (Test 1 in Table 3.7) were performed for each participating study site. Also, if the participating utility provided the number of units from their customer information system, additional z-tests were conducted to determine if there were statistically significant differences between the average water use per unit (Test 2 in Table 3.7). Summary results of these tests are presented in Table 3.7. There were no statistically significant differences between the water use characteristics of the study groups except for Las Vegas where the postcard survey respondents has lower average annual water use. The research team was able to correct for this difference during the sampling process for the manager survey by oversampling from postcard respondents in the higher water use strata.

For Test 1, in most sites the initial owner survey multi-family accounts were statistically similar to the population in terms of annual water use. The exceptions were Tucson, Phoenix, and Las Vegas. In Tucson and Phoenix, the annual water use for respondents was higher than for the population. However, total number of units was also higher for the respondents than the population. Therefore, the difference in annual water use per unit in Tucson and Phoenix was not statistically significant. In Las Vegas, annual water use was lower for the respondents than it was for the sample frame. Corrective action was taken in manager survey selection so that the respondents would be more representative.

Where it was possible to compute, comparison Test 2 was the most valuable, since it looked at annual water use per unit – the fundamental variable for examining water use patterns in this study. For this test, all respondents were statistically similar to the annual water use per unit characteristics of the population. For a number of the cities, it was not possible to conduct Test 2. This was because not all utilities maintain information on the number of units for each multi-family account.

Table 3.7 Postcard survey statistical significance tests – survey respondents vs. sample frame

Study Site	Sample Frame (N)	Respondents (N)	Is there a significant difference between the 2001 annual water use of the postcard survey respondents and the sample frame?*	
			Test 1[†]	Test 2[‡]
San Antonio, TX	844	382	No	No
Tucson, AZ	1,111	443	Yes[§]	No
Phoenix, AZ	1,688	548	Yes[§]	No
Oakland, CA	1,469	603	No**	--[††]
Denver, CO	1,731	697	No	No
Portland, OR	2,643	1,173	No	--[††]
Austin, TX	1,923	807	No	--[††]
Indianapolis, IN	596	221	No	--[††]
Las Vegas, NV	1,400	489	Yes[‡‡]	--[††]
Seattle, WA	2,585	1,089	No	No
Hillsborough County, FL	265	104	No	No
San Diego, CA	3,240	1,416	No	No
ALL STUDY SITES	**19,495**	**7,972**	**No**	**--[††]**

*Significant differences measured between the two groups using the z confidence interval at the 0.05 level.
[†] Is annual water use significantly different?
[‡] Is annual water use per unit significantly different?
[§] Survey respondents were found to have a lower annual water use than the population, however, the number of units were also lower, thus making Test 2 not significant.
** Not significant at the 99% confidence interval
[††] Number of units was not available, so Tests 2 was not performed.
[‡‡] Survey respondents were found to have significantly different (i.e. lower) water use than the population. Corrective action taken in subsequent steps.

Comparison of the Manager Survey Respondents with the Postcard Survey Respondents

The manager survey was sent to in-rent and impact properties identified through the postcard survey. In addition, impact properties identified by billing service companies and from web sources that had not responded to the postcard survey were also included in the manager survey. Since a lower percentage of impact properties were identified than originally anticipated, a saturation sampling technique was chosen for the manager survey so that every identified impact property received a manager survey. The sample of in-rent properties was selected using a stratified random sampling methodology described earlier in this chapter.

Quality assurance tests were conducted on entire group of respondents and on the sample of properties from each study site that returned the manager survey to determine whether the water use characteristics of the manger survey respondents (sample) were statistically similar to the multi-family properties that responded to the postcard survey (population). To compare the respondents with the population, statistical tests were used to determine whether statistically significant differences existed in water use characteristics among the two groups.

A series of t-tests were conducted at a 95 percent confidence level to determine if there was a statistically significant difference in the mean annual water use of manager survey respondents versus the population. The results can be seen in Table 3.8. The most important comparison evaluated 2001 water use for the postcard respondents (n=7,319) with 2001 water use for the manager survey respondents (n=1,157). The water use in these two groups was found to be statistically different at a 95% confidence level, with a 2.09 kgal higher estimate for postcard survey respondents (53.54) compared to manager survey respondents (51.45). A similar difference was observed among the in-rent properties, but not among the impact properties. This may be due to manner in properties were sampled for the manager survey. All impact properties were selected, but in-rent properties were selected within strata based on the number of units per property, to allow the in-rent properties to more closely resemble the impact properties, which tended to be larger (more units per property) than in-rent properties.

This means that on the basis of water use alone the manager survey respondents were not statistically different from postcard survey respondents which in turn were determined to be representative of the population of multi-family homes found in these 13 study sites.

Table 3.8 Comparison of annual water use per unit in manager survey respondent properties and postcard survey respondent properties

Billing Method		Survey	
		Postcard	Manager
In-rent or HOA	Avg 2001 Water Use per Unit (kgal)*	53.95†	51.56†
	Number	N=6437	N=847
Submetered	Avg 2001 Water Use per Unit (kgal)*	44.76	46.20
	Number	N=259	N=113
RUBS	Avg 2001 Water Use per Unit (kgal)*	52.97	54.85
	Number	N=582	N=175
Hot water hybrid	Avg 2001 Water Use per Unit (kgal)*	51.85	47.17
	Number	N=41	N=22
All Designated Properties‡	**Estimated 2001 Water Use**	**53.54†**	**51.45†**
	Number	**N=7319**	**N=1157**

* Includes properties that were missing 2 or less months of data, where the average 2001 water use per unit is greater than 6 and less than 200 kgal/unit. Impact manager survey properties only include properties that converted to separate billing in 2000 or earlier.
† Significant differences measured between the two groups using a t-test at the 0.05 level.
‡ Includes all properties that are in-rent, submetered, RUBS, or hot water hybrid, but excludes any properties that indicated "other" or left the question blank. In addition, any property that left the number of units blank was excluded.

DATA ANALYSIS

Database Development

Development of the database for the Study was an on-going process beginning with the historic billing data obtained from each of the 13 study sites. Microsoft Access is a relational database that organizes data into a series of tables that can be linked with a common field. For this study a separate database was developed for each of the participating utilities. Each utility's database contained the same set of tables:

- Historic billing data on the sample frame accounts
- Survey data – coded responses from the mailed surveys

Each of these tables contained a common field called "PROPID" which was a unique number assigned during survey coding. The PROPID field enabled linking of survey data with historic billing data and allowed database programmers to develop any number of queries on the database to retrieve a wide variety of information. The PROPID also protected the privacy of individual respondents.

The final project database was built by combining the individual databases from each participating study site. Care was taken to preserve anonymity of individual respondents and properties by not including any names or addresses. All survey responses were included in the database. The final database was used by the project team to develop the causal water use models.

Refining Historic Water Consumption

Before any data analysis could proceed, the gross historic billing data were refined. This process required three steps: meter aggregation, consumption standardization, and the separation of seasonal and non-seasonal consumption.

Meter Aggregation

The first step in refinement was meter aggregation, as there can and frequently are multiple water billing accounts servicing one property. For all of the participating utilities, all accounts that had the same property name and/or address were grouped together under one property identification number, or PROPID. This facilitated the aggregation of water use from multiple accounts serving a single property into a single annual volume.

Consumption Standardization

To facilitate data analysis, a single table in the project database was constructed that contains the historic water consumption data for all properties identified through the postcard survey. To this end, each individual utility's database was queried for all water consumption data available from 1999 to 2002. Different utilities bill in different units (ccf or kgal) and can also have different billing periods (monthly or bimonthly). Thus, before being added to the final table, all data were standardized to similar monthly consumption periods based on read dates and the data were standardized to units of thousand gallons (kgal).

Separation of Seasonal and Non-Seasonal Demands

Where no separate irrigation meter was present, historic consumption data were separated into seasonal and non-seasonal (outdoor and indoor) components using an estimation methodology. The goal was to separate indoor water use from all other non-indoor demands using all available information about each property. Obviously, more information was available for properties that completed the manager survey than from those that just completed the postcard survey. Nevertheless, examining indoor water use alone in these properties was deemed important as well, since this enlarges the sample of impacted properties.

For the manager survey respondents, the first group examined were those that indicated that they have a separate irrigation meter. Using this information and utility database codes, irrigation-only accounts were identified for these properties and the seasonal use component was separated out by excluding irrigation only water from the indoor totals.

For all of the remaining properties, a methodology was developed to estimate seasonal use. Although the methods varied slightly, they were all based on the established method of average winter consumption (AWC). In the AWC method it is assumed that there is little to no seasonal use in the winter months of December, January, and February (or other non-irrigation months depending on the region and climate). The average monthly indoor water use for each property was calculated by taking the average of these three months. Multiplying the average winter monthly consumption by 12 gives as estimate of annual total indoor use. Outdoor use can be found by subtracting the annual indoor use from the total use.

$$Q_w = \frac{Q_{12} + Q_1 + Q_2}{3} \qquad \textbf{Equation 3.1}$$

where,

Q_w = Average winter monthly water consumption,

Q_i = Monthly water use, i = 12 (December), i = 1 (January), etc.

$$Q_w * 12 = Q_{indoors} \qquad \textbf{Equation 3.2}$$

where,

Q_w = Average winter monthly consumption

$Q_{indoors}$ = Total annual indoor water use

The exact method of seasonal separation for any manager survey respondents that did not have a separate irrigation meter varied slightly depending on whether or not the property indicated that it had an outdoor sprinkler system. It was discovered through the course of the study that a number of multi-family properties, particularly those without an automatic irrigation system, either had no landscaping to speak of or did not use significant water outdoors for irrigation. For those that did have a sprinkler system, if the minimum month differed from the average month by more than 10 percent, the AWC method was used to calculate baseline indoor use. Otherwise, the seasonal demands were estimated at zero. The remaining group in the sample included manager survey respondents that did not have an outdoor sprinkler system. Initially, it was assumed that this group would not have any seasonal use. However, inspection of the data showed that there might be some manual irrigation occurring in this group. In order to separate out any significant seasonal use at these properties, it was decided that if the minimum month differed from the average month by more than 15 percent, the AWC method was used. Otherwise, seasonal demand was estimated at zero.

For the postcard survey respondents that did not respond to the manager survey, a similar methodology was used. If the minimum month differed from the average month by more than 10 percent, the AWC method was used. Otherwise, seasonal demand was estimated at zero.

Water Use Analyses

The software application known as SPSS (Statistical Package for the Social Sciences) was used to perform descriptive and inferential statistical procedures on datasets taken from the database.

Using the most accurate estimates of water consumption. For most water analyses, some water estimates were eliminated. If the estimates included more than 2 months of missing data, they were not included. If the water estimates were less than 6 kgal per unit per year, or more than 200 kgal per unit per year, they were not included. If an impacted property had converted to the current billing system after 1999, water estimates for that property were not included.

Descriptive statistics. SPSS was used to produce descriptive statistics such as frequency distributions, means, medians and standard deviations. The software package was used to help create summary tables of survey results, such as those found in Appendix B. In some cases a 95% confidence interval was constructed around point estimates. A 95% confidence interval bounds the values in which, 95 times out of 100, confidence intervals constructed like these will contain the population value. For example, the estimated annual water use per unit among in-rent properties for which manager survey data are available averaged 51.6 kgal. The 95%

confidence interval ranged from 49.9 to 53.3 kgal. This means that in 95 of 100 samples are drawn this way, the actual annual water use per unit would be found within a range similarly constructed.

Bivariate analyses. In order to examine the association of property characteristics with water use, two types of bivariate analyses were performed. Using ANOVA (analysis of variance), the relationship between water use and "categorical" variables such as the designation of a property as a senior citizen/retirement community ("yes," "no" or "don't know") was examined. This test examines whether differences in the levels of the variable (water use in this example) are different in the specified subgroups. Factors with p-values less than 0.05 were considered "statistically significant," meaning that if there were no difference, the probability of seeing a result as or more extreme than that seen in the sample was less than 5%.

The relationship of continuous variables, such as average bedroom size or average rent, with water use were examined using Pearson correlations. A correlation statistic is produced which ranges from -1 to +1. Correlations of 0 indicate there is not a relationship between the two variables, while those close to -1 or +1 indicate strong negative or positive relationships. A p-value is shown, and in general, the 0.05 level is chosen to indicate statistical significance.

In addition, differences in characteristics among properties based on the water billing method used (a categorical variable, designated as "in-rent or HOA," "submetered," "RUBS," "hot water hybrid," or "other") were examined using ANOVA for continuous variables and chi-square for categorical variables. The chi-square test examines whether proportions are different between two groups; for example, whether a similar or different proportion of properties are considered retirement communities among the different billing types. A p-value is produced, and factors with p-values of less than 0.05 were considered "statistically significant," meaning that if there were no difference, the probability of seeing a result as or more extreme than that seen in the sample was less than 5%.

T-tests were used to test differences between water use estimates by billing method or by survey source (e.g., comparing water use estimates of postcard survey respondents to manager survey respondents). P-values are also produced for these tests.

Multivariate analyses. There were differences in the characteristics of in-rent properties compared to the impact properties; for example, submetered properties were more likely to be newer (41% were built after 1994 compared to 7% of in-rent properties), while RUBS properties were more likely to be larger complexes (71% had 100 or more units, compared to 32% of in-rent properties and 43% of submetered properties). In order to ensure that any observed differences in water use estimates between properties with different billing methods were not due to differences in the distribution of other characteristics associated with water use, multivariate analyses were performed to examine the relationship between billing method and water use estimates after adjusting for these factors. Multiple linear regression was used for these analyses.

The first step was to examine the bivariate relationships between water use and factors that might be associated. This was done using, first, the estimates of water use from the 2001 billing databases, and then again with the 2002 billing databases. Where a significant relationship was observed in both years, the factor was deemed appropriate for inclusion in a multiple linear regression model. A multiple linear regression model allows the simultaneous examination of the association of multiple factors with a single outcome measure of interest, often referred to as the "dependent variable." In this instance, estimated annual water use per unit was the dependent variable. The factors examined for an association with the dependent variable are referred to as "independent" or "predictor" variables. This simultaneous examination allows one to look at a particular association of interest, for example the association of water billing method, simultaneously "adjusted" for all the other variables in the model.

All factors identified as "significant" through the bivariate analyses were entered into a regression model. One of the options within the SPSS regression procedure for entering and removing variables from a regression model is known as "stepwise." A stepwise regression procedure enters variables one at a time into the model, beginning with the variable that explains the most variance in the dependent variable (water use, in this instance). As some factors may co-vary with each other, at each step after the first, the model is also examined to see if any factors should be removed that are no longer explaining unique variance in the dependent variable that remain important even in the presence of other factors in the model. For example, two factors were found to be associated with water use in the bivariate analyses: 1) whether or not the property could be considered a senior citizen or retirement community, and 2) the presence of a food service facility or restaurant on the property. However, most of the properties that had a food service facility or restaurant were also senior citizen or retirement communities. Once the first variable was included in the model, the second was no longer needed because it did not add unique information about water use.

Many of the factors examined had missing data, meaning that the item had not been answered on the manager survey, was answered as "don't know," or was not appropriate for a particular property (e.g., the monthly rent of units in an individually-owned complex). The cumulative effect of these missing data often resulted in a dramatically lower number of properties being included in the analysis than the number of properties for which water use data were available. Thus, the models calculated through stepwise regression only used the cases where all the variables to be examined were present for that case, even if a variable was ultimately eliminated from inclusion in the model. As both a test of the appropriateness of the model, and to check for any other variable that sometimes can be significantly associated with a dependent variable even if an automated method such as stepwise regression does not detect it, many regression models were examined using a method that required entry of certain variables to choose the most predictive models presented in Chapter 6.

The statistics produced for regression equations include a test of the hypothesis that there is no relationship between the dependent variable and the predictor variables. The results of this test are reported as an F-statistic with an associated p-value. In general, only models with a p-value of 0.05 or less are considered "significant," meaning that if there were no difference, the probability of seeing a result as or more extreme than that seen in the sample was less than 5%. In addition, an adjusted R-squared is calculated, which can be interpreted as the proportion of the variability in the dependent variable accounted for by the factors included in the regression model.

Regression coefficients are calculated for each predictor variable in the model. These coefficients can be interpreted as a "slope," that is, for every unit change in the predictor variable, the independent variable would change by the amount of the regression coefficient. A test of statistical significance is calculated for each regression coefficient, with a corresponding p-value.

The fit of the model and the appropriateness of the variables for inclusion in the model can be tested by examining a scatter plot of the predicted values (usually on the x-axis) and the residual values, usually on the y-axis. A predicted value for the dependent variable can be calculated for each case, given the values the independent variables in the model for each case. The residual values are the difference between the actual value of the dependent variable for a case and the predicted value. In a perfect model the residual value would be zero and all points would lie on the x-axis. If there is not an abnormal distribution of the dependent variable or of the other variables included in the regression model, the scatter plot will resemble a "cloud" or a "goose egg," with no discernible relationship or pattern between the predicted and residual values.

Adjusted means of the dependent variable can be calculated for subgroups of one of the independent variables, e.g., average annual water use per unit by billing method, adjusted for the other variables included in the model. This was done by applying the average values across the entire sample for each of the independent variables.

Matched pair and pre-post analyses. A dependent t-test is used to compare the mean difference score between paired measurements, as in a repeated measures (like the pre- and post-conversion analysis) or matched pair design. Like an independent t-test, a p-value is calculated.

SUPPLEMENTAL DATA COLLECTION

Supplemental data were used to provide additional information about each study site, utility, and various others affected by separate billing. Some of these data were used in the model estimation process and to qualify end use measurements.

Weather Data

So that the relationship between weather and water use could be explored during the data analysis and the water use model development, weather data was obtained for each study site. Average seasonal temperatures and measured precipitation were obtained from a representative weather station at each participating study site. The data was available over the Internet. If a study site did not have a weather station (as was the case for Irvine, CA and EBMUD, CA), geographically similar locations were used as representative stations.

Utility Water and Wastewater Rates

Water and wastewater rates were collected for each participating utility. In addition, information on rate structures was obtained. Many of these data were available over the Internet and were supplemented by utility personnel.

Survey of Potential Regulators

The Study included a survey that was sent to potential regulators across the nation to find out how they are addressing submetering and allocation issues. The survey was sent to:

State safe drinking water administrators

State PUC officials – water commissioners, asst. water commissioners

State bureau of weights and measures officials – meters division

Utility managers – 100 largest utilities (and 3 additional sponsor utilities): general manager, engineering staff, or metering manager

Edward R. Osann of Potomac Resources implemented the survey and the results are included in Chapter 5 of this report. The survey can be seen in Appendix A.

Read and Bill Company Survey

The Study included a survey that was sent out to companies directly involved in submetering and allocation billing across the nation. These Read and Bill Companies were surveyed to better understand the business practices and policies associated with submetering and allocation. The survey sought general information about the companies' client base as well as about their bills, fees, and customer service. There were questions specific to submetering including meter reading and testing practices, and to allocation including common area subtraction practices. The survey can be seen in Appendix A. Thirty-six Read and Bill Companies were surveyed in two waves, yielding responses from 18 companies (50 percent).

Tenant Advocacy Groups

The Study included an investigation of the prevalence of utility billing issues in tenant organizations. The investigation aimed to find out if tenant organizations had any stance on submetering and RUBS, and whether or not they were taking any action because of it. Over 60 tenant organizations across the country were contacted by phone or email. This effort yielded responses from 20 organizations. Respondents ranged from those who were barely aware of submetering and RUBS to others who were actively involved with these billing systems. Some of the stances and concerns from these groups are included in Chapter 4.

QUALITY ASSURANCE AND QUALITY CONTROL

The research team took care during every step of the project to ensure that the data collected, assembled, and analyzed for this study were as accurate as possible. To ensure a high level of quality and accuracy, a number of quality assurance and quality control measures and tests were developed and implemented at various stages of the study. Below are some of the tests that were conducted to assure quality control:

1. A carefully designed schedule was prepared and followed to assure that the field data collection work was accomplished on time and with a minimum of problems. All utility contacts were appraised of this schedule and commitments obtained to keep on track.
2. Bi-monthly progress reports were submitted to the project manager and distributed to the project advisory committees. On several occasions these reports generated questions and suggestions from committee members and others that were carefully considered by the project team.
3. The project manager and PAC/POC reviewed all survey instruments developed for this study. Survey instrument were developed, reviewed by several team members and oversight committee members, and then tested before implementation.
4. Sampling methods were reviewed by team statistician Dr. Peter Bickel and changes made where deemed appropriate before samples were selected.
5. After the postcard surveys were returned, significance tests were conducted to see if the water use of the postcard survey sample was representative of the population (see section in Chapter 3).
6. After the manager surveys were returned, a few discrepancies were found between the billing method indicated on the postcard survey and the manager survey. Follow-up phone calls were made to these properties to see if they had indeed switched billing methods in the meantime, or if they misread the question.
7. The accuracy of the manager surveys were tested by the property site visits that were conducted. Accuracy of data input was spot checked and errors corrected.
8. Through the property site visits, the accuracy of the seasonal demand estimate could be checked. First, measurements of irrigated areas could be obtained and irrigation application rates were calculated. Also, monthly consumption for all years available was graphed to obtain a visual picture of annual water use.
9. A Microsoft Access form was designed to enter postcard survey responses into the Access data base with the aim of minimizing data entry error for survey responses. Manager survey and resident survey data were entered by a contracted firm specializing in data entry. They use a "key and verify" method, in which all responses are entered twice, then compared for discrepancies, which are subsequently corrected. Their programming also contains "range checks" which disallow out-of-range responses for each question.

10. The PROPID number appearing on all returned survey forms was also entered into an Access database table. After the survey response database table was created for a given study site, the PROPID from each survey was cross-checked by the project team with the PROPID in the historic water use database table to assure an exact match.
11. Once the survey database table for a given study site was created, certain response columns were checked for the absence or presence of certain types of data entry errors. For example, the record for a year of construction had to fall within a reasonable range.
12. Senior team researchers (Dr. Thomas Miller, and William DeOreo, P.E.) and team statistician Dr. Peter Bickel reviewed all analyses presented in this report as well as the statistical methods employed.
13. A significant peer review process was created enabling the final report to be reviewed by the project manager, the PAC, the POC, and an independent peer review panel of experts. Recommended modifications, additions, and changes from these reviewers were incorporated into the final report.


ENERGYGUIDE
RUUD
RUUDGLAS
PACEMAKER

CHAPTER 4 STUDY SITE CHARACTERISTICS AND SURVEY RESULTS

STUDY SITE CHARACTERISTICS

The 13 study cities in the National Multiple Family Submetering and Allocation Billing Program Study were located in six distinct regions of North America.

1) West Coast– San Diego, Oakland, and Irvine, California.
2) Southwest – Phoenix and Tucson, Arizona; Las Vegas, Nevada; Austin and San Antonio, Texas.
3) Northwest – Seattle, Washington and Portland, Oregon
4) Mountain –Denver, Colorado.
5) Midwest – Indianapolis, Indiana.
6) Southeast – Hillsborough County, Florida.

Even study sites that were in close geographic proximity had unique characteristics, ranging from price of water to recent conservation efforts to specific building features. Multi-family homes in these study sites also differed in their water consumption patterns. This section compares some of the service area characteristics for the 13 Study sites. Even within each study site there was tremendous variability in the size, landscape, level of maintenance, and appearance of the participating properties.

Water and Wastewater Rates

Water and wastewater rates, as well as rate structures, varied tremendously in the 13 participating study sites. Most utilities had either an increasing block rate structure or a uniform rate structure for multi-family housing. Indianapolis was the only participant using a declining block rate structure. Water and wastewater rates per kgal are shown in Table 4.1. All rates are adjusted to kgal. Multi-tiered water rates are averaged as shown in the table. The goal was to identify a single cost per kgal for water and wastewater for all utilities in the study. In practice, the wastewater charge frequently appears as a fixed charge on a monthly bill, and it is typically calculated from winter-time consumption, which justifies its inclusion in the commodity charge. These costs represent the commodity charge *only*, and exclude any fixed charges and service fees, which vary by meter size, customer class, etc.

Table 4.1 Water and wastewater rates charge by utilities at participating study sites

Utility	Water* $/kgal	Wastewater $/kgal	Other	Total $/kgal	Comment/Explanation
Indianapolis	$ 1.38	$ 1.44		$ 2.82	Based on rates published on web site. Wastewater - from 2002 Raftelis Rate Survey. Declining block rate structure.
San Antonio	$ 1.30	$ 1.53		$ 2.83	Water - weighted avg. std. & seasonal rates - four blocks. Wastewater - from SAWS web site.
Irvine	$ 1.34	$ 1.51		$ 2.85	Assumes customers stay in first three blocks. Wastewater charge based on monthly 4 kgal/unit/month and $6.05 per unit per month charge.
Denver	$ 1.77	$ 1.95		$ 3.72	Provided by Denver Water, Planning Division. Weighted avg. of blocks based on actual water sales in each block.
Tucson	$ 2.17	$ 1.39		$ 3.56	MF flat rate + CAP charge (water). Wastewater charge based on monthly 4 kgal/unit/month and $138.80 per unit per year charge.
Phoenix	$ 2.20	$ 1.65		$ 3.85	Avg. of 3 seasonal rates + environmental charges (water). Wastewater - from 2002 Raftelis Rate Survey
Oakland	$ 2.57	$ 1.42		$ 3.99	Water & wastewater rates - from EBMUD web site.
Las Vegas	$ 1.78	$ 2.89		$ 4.67	Water - avg. of first three blocks. Wastewater charge based on monthly 4 kgal/unit/month and $138.80 per unit per year charge.
Austin	$ 2.49	$ 3.99		$ 6.48	Water - avg. of peak & off peak rates. Wastewater from city web site.
San Diego	$ 2.25	$ 4.43		$ 6.68	Water & wastewater from City of San Diego web site.
Hillsborough County	$ 2.48	$ 4.10	$ 1.80	$ 8.38	Water - avg. of first three blocks. Wastewater - from Hillsborough web site. Other = $1.80/kgal charge from Tampa Bay Water.
Portland	$ 2.19	$ 6.34		$ 8.53	Water - avg. of three blocks (from city web site). Wastewater - from 2002 Raftelis Rate Survey.
Seattle	$ 2.72	$ 7.39		$10.11	Water - avg of peak and off peak rates (from web). Wastewater - from SPU web site.

*Water rates adjusted to include multi-tiers and different rate structures.

Combined water and wastewater rates ranged from $2.82 per kgal in Indianapolis to $10.11 per kgal in Seattle. Wastewater rates were more variable than water rates with prices ranging from $1.39 per kgal (Tucson) to $7.39 per kgal (Seattle). Water rates ranged from $1.30/kgal (San Antonio) to $2.72/kgal (Seattle). In Hillsborough County, which buys its water from Tampa Bay Water (TBW), an additional $1.80/kgal surcharge is added by TBW. The combined water and wastewater rates are used to develop an estimate of price elasticity in Chapter 7.

Weather Patterns

Weather patterns vary considerably for the 13 participating study sites. Average temperature and precipitation data were obtained for each study site so that these factors could be considered in the water use analysis section of the report. Because use at each property was disaggregated into indoor and outdoor use, and the water use analyses focused on indoor use, these temperature and precipitation data were found not to be predictive of indoor water use at these study sites. However, these data do show the variability in these study sites. These data are presented in Table 4.2.

Table 4.2 Average seasonal temperature and precipitation in the study cities.

	Spring		Summer		Fall		Winter		Annual	
	Temp*	Precip*	Temp*	Precip*	Temp*	Precip*	Temp*	Precip*	Temp*	Precip*
San Antonio	68.8	9.2	83.3	8.9	70.0	9.4	52.5	5.4	68.7	32.92
Tucson	66.6	1.3	85.2	4.6	70.0	3.3	52.9	2.9	68.7	12.17
Phoenix	70.7	1.5	90.9	2.0	74.1	2.3	55.6	2.5	72.8	8.29
Oakland	58.6	5.5	64.8	0.3	62.3	4.8	52.2	12.4	59.5	22.94
Denver	48.1	5.5	70.9	5.5	50.3	3.1	30.9	1.6	50.1	15.81
Portland	51.8	8.7	66.4	3.2	54.6	10.1	41.1	15.0	53.5	37.07
Austin	68.4	9.7	83.2	8.1	69.9	9.6	52.3	6.3	68.5	33.65
Indianapolis	52.1	11.4	73.5	12.4	54.6	9.3	29.8	7.9	52.5	40.95
Irvine†	63.0	3.7	72.2	0.3	68.2	1.9	58.3	8.0	65.4	13.84
Las Vegas	66.6	1.0	88.7	1.0	68.3	0.9	48.7	1.7	68.1	4.49
Seattle	50.7	8.1	63.9	3.3	53.0	10.7	41.6	14.9	52.3	37.07
Hillsborough	72.2	7.5	82.2	19.6	75.6	10.5	62.4	7.2	73.1	44.77
San Diego	62.4	3.2	70.3	0.2	67.0	1.7	58.1	5.6	64.4	10.77

Source: www.srcc.lsu.edu
*Based on normal daily average temperature (degrees F) and normal monthly precipitation (in.) from 1971 - 2000.
† Uses local climate data from Santa Ana, CA

POSTCARD SURVEY RESULTS

Cooperation of property owners receiving surveys was excellent in all participating utilities and ranged from a low of 39 percent to a high of 75 percent based delivered surveys and on usable responses. The overall average rate was 58.6 percent. Response rates for each of the participating utilities is shown in Table 3.2.

The postcard survey provided information on the billing methods of the various properties. In addition, there were other properties for which billing methods were available (see procedures section). The breakdown for each billing method by city for all identified properties can be seen in Table 4.3. Because the postcards survey was essentially sent to every multi-family property in each study site, this result represents the best estimate in the Study of the actual percentage of in-rent and impact properties in the population. A total of 13.4% of surveyed properties were being separately billed for water and wastewater. An overwhelming majority of properties (84.8%) continued to have water and wastewater paid in the rent or through HOA dues. 1.8% of the respondents indicated “Other”. Respondents who left the question entirely blank were also included in the “Other” category. The breakdown can be seen in the pie chart shown in Figure 4.1.

Table 4.3 Breakdown of each billing method for all properties identified

Utility		**Billing Method**					
		In-Rent	**HWH**	**Sub.**	**RUBS**	**Other***	**Total**
San Antonio	n	183	4	16	159	20	382
	% of respondents	48%	1%	4%	42%	5%	100%
Tucson	n	357	1	36	34	15	443
	% of respondents	81%	0%	8%	8%	3%	100%
Phoenix	n	456	0	25	59	8	548
	% of respondents	83%	0%	5%	11%	1%	100%
Oakland	n	570	7	8	7	11	603
	% of respondents	95%	1%	1%	1%	2%	100%
Denver	n	623	0	12	50	12	697
	% of respondents	89%	0%	2%	7%	2%	100%
Portland	n	1127	7	10	18	11	1173
	% of respondents	96%	1%	1%	2%	1%	100%
Austin	n	478	8	79	233	9	807
	% of respondents	59%	1%	10%	29%	1%	100%
Indianapolis	n	188	1	11	10	11	221
	% of respondents	85%	0%	5%	5%	5%	100%
Las Vegas	n	442	0	17	20	10	489
	% of respondents	90%	0%	3%	4%	2%	100%
Seattle	n	953	11	23	89	13	1089
	% of respondents	88%	1%	2%	8%	1%	100%
Hillsborough	n	66	1	32	3	2	104
	% of respondents	63%	1%	31%	3%	2%	100%
San Diego	n	1317	2	42	35	20	1416
	% of respondents	93%	0%	3%	2%	1%	100%
Total	n	6760	42	311	717	142	7972
	% of respondents	84.8%	0.5%	3.9%	9.0%	1.8%	100%

*Includes “Other” as well as respondents who left the question blank.

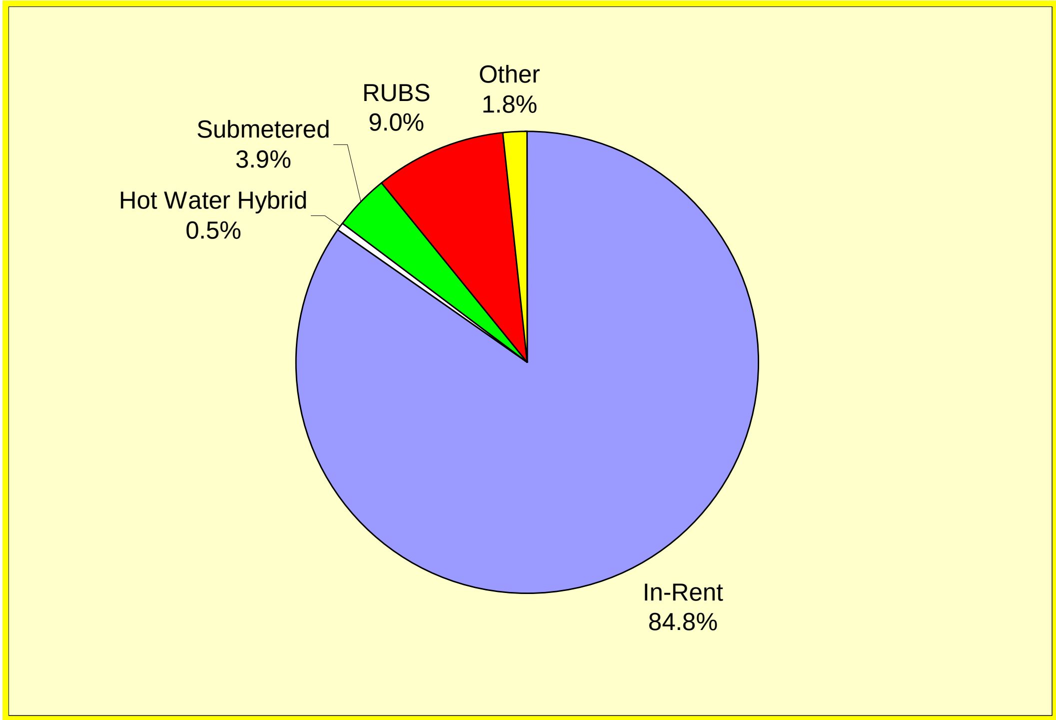


Figure 4.1 Percent of different billing methods among postcard survey respondents

The postcard survey also provided information about the number of units within each multi-family property. In general, it was found that the impact properties were larger and had a higher average number of units (175) than the in-rent properties (43). This was part of the motivation for taking a stratified sample based on number of units for the manager survey. In addition, the research plan originally aimed to exclude any properties with less than 10 units. However, in Oakland, the vast majority of properties had less than 10 units, so in order to not lose it as a study site, properties with less than 10 units remained in the sample. Table 4.4 shows these results.

Table 4.4 Average number of units from all identified properties*

Utility		Impact Properties				In-Rent
		HWH	Sub.	RUBS	Total Impact	
San Antonio	# Respondents	4	16	159	179	183
	Average # Units	200	278	197	204	99
Tucson	# Respondents	1	36	34	71	357
	Average # Units	50	50	280	156	53
Phoenix	# Respondents	0	25	59	84	456
	Average # Units	na	252	338	312	57
Oakland	# Respondents	7	8	7	22	570
	Average # Units	4	5	18	9	6
Denver	# Respondents	0	12	50	62	623
	Average # Units	na	347	194	224	52
Portland	# Respondents	7	10	18	35	1127
	Average # Units	24	66	83	67	20
Austin	# Respondents	8	79	233	320	478
	Average # Units	125	172	153	157	34
Indianapolis	# Respondents	1	11	10	22	188
	Average # Units	582	168	285	255	116
Las Vegas	# Respondents	0	17	20	37	442
	Average # Units	na	135	324	246	102
Seattle	# Respondents	11	23	89	123	953
	Average # Units	98	45	65	64	28
Hillsborough	# Respondents	1	32	3	36	66
	Average # Units	168	216	317	223	80
San Diego	# Respondents	2	42	35	79	1317
	Average # Units	19	217	148	181	42
Total	# Respondents	42	311	717	1070	6760
	Average # Units	93	167	184	175	43

*Number of respondents is lower than total number of postcard responses received, as not all respondents answered the question about the number of units.

Because the number of units at the impact properties are higher than at the in-rent properties, impact units are more prevalent than initially thought and constitute 35.4% of all units surveyed. Table 4.5 shows the breakdown of each billing method by number of units indicated on the postcard survey.

Table 4.5 Breakdown of each billing method for all units identified

	Billing Method					Total
	In-Rent	HWH	Sub.	RUBS	Other*	
No. of units	286,355	3,912	47,547	112,049	10,400	460,263
% of units	62.2%	0.8%	10.3%	24.3%	2.3%	100.0%

*Includes "Other" as well as respondents who left the question blank.

Annual Water Use Patterns

The 13 study sites in the NMF Submetering and Allocation Billing Program Study represent a diverse collection of multi-family water use patterns. Table 4.6 is a summary of the average 2001 water use per unit of properties identified in the postcard survey. Water use per unit ranged from a low of 33.3 kgal/unit in Seattle to a high of 62.5 in Austin.

Table 4.6 Average 2001 annual water use per unit for postcard survey respondents

Study Site	2001 Avg. Water Use Per Property (kgal) *	Avg. Number of Units per Property	Avg. Water Use per Unit (kgal/unit)
San Antonio	7790	146	53.4
Tucson	3931	73	53.8
Phoenix	5095	96	53.3
Oakland	300	6	53.0
Denver	3219	68	47.7
Portland	885	21	41.7
Austin	4280	68	62.5
Indianapolis	4624	129	35.7
Las Vegas	6517	111	58.6
Seattle	1051	31	33.4
Hillsborough	5913	129	45.7
San Diego	2107	48	43.6
Combined Avg.	2917	59	49.7

*Includes 2001 non-seasonal use for all properties with complete (2 or less missing months) 2001 billing data.

MANAGER SURVEY RESULTS

The purpose of the manager survey was to obtain detailed information about impact and in-rent properties to provide analytic variables for fairly evaluating water use and to better understand property characteristics and billing methodology. The survey included 43 questions about the building size and landscape, rent rates, occupancy rates, building features and amenities, changes to water using fixtures and appliances, water bill payment methods, and others. A copy of the manager survey is presented in Appendix A.

Property Characteristics

An important purpose of the manager survey was to determine the characteristics of the properties in the Study, in order to determine what characteristics are associated with water, and in what ways these characteristics were different by the type of water billing method used at the property. The full enumeration of results by water billing method can be found in Appendix B.

Two-thirds of the properties that returned the manager survey billed for water through the rent (in-rent) or homeowners association (HOA) dues. Ten percent of the managers completing the survey said they billed for water using submetering, 20 percent used an allocation system, 2 percent used hot water hybrids, and a very few said "other", or did not identify their water billing method. For ease of reference, properties using submetering, RUBS or hot water hybrid billing methods are identified as "impact" properties, while those properties where water is included in the rent or homeowner dues may be referred to as "in-rent" properties. The percentage of impact properties responding to the manager survey was higher than the postcard survey, which makes sense as they were "oversampled" from the postcard survey respondents to provide the largest sample size possible of impact properties for detailed analysis. A detailed explanation of the sampling methodology is presented in Chapter 3.

A majority of the properties responding to the survey were classified as rental properties[21]. A greater proportion of submetered (75%) and RUBS (88%) properties were private rentals compared to the in-rent properties (69%). Of the rental properties identified as in-rent, a larger proportion were likely to be government subsidized rentals compared to submetered and RUBS or hot water hybrid properties. The results are shown in Figure 4.2. The remaining non-rental properties were classified as condominiums (14.8%), private resident owned (8.1%), and other (3.7%).

[21] Rental properties included private rentals and government subsidized rentals.

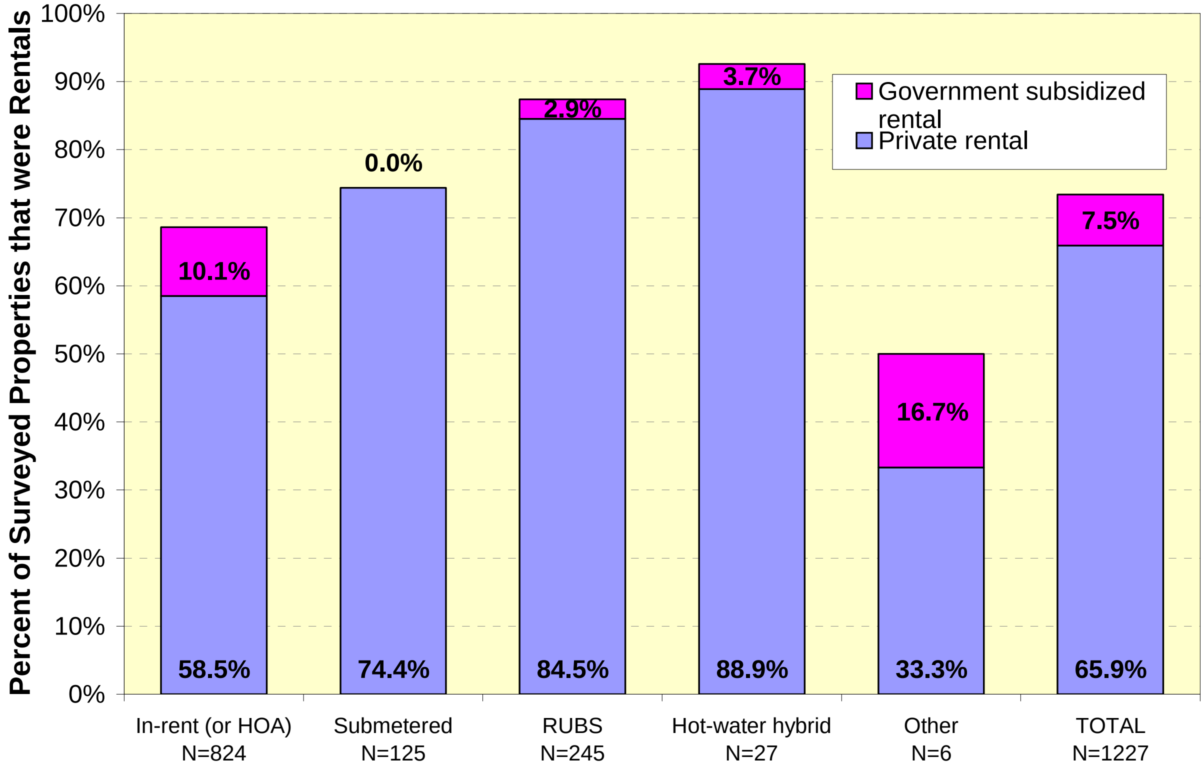


Figure 4.2 Rate of rentals in manager survey respondents

Impact properties were larger (had greater numbers of units) compared to the in-rent properties. About a third of the in-rent properties had 100 or more units, compared to 43% of submetered properties and 71% of RUBS properties. The average number of units per property was 98 for in-rent properties, 152 for submetered properties, 195 for RUBS properties, and 200 for hot water hybrid properties. These results are shown in Figure 4.3.

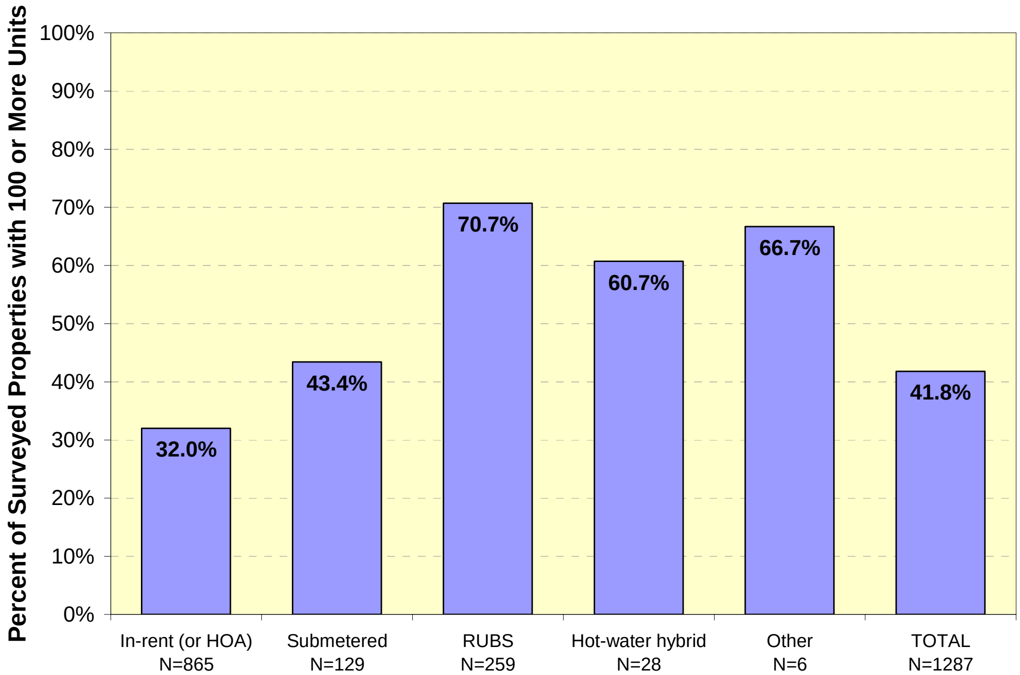


Figure 4.3 Properties with more than 100 units, manager survey respondents

In addition to having fewer units on the site, in-rent properties also reported having fewer buildings per site (or property). Forty-five percent of in-rent properties consisted of one or two buildings, compared to 20% of submetered properties, 23% of RUBS properties and 33% of hot water hybrid properties. A relatively small percentage of the properties responding to this survey included "high-rise" buildings, that is, buildings of more than 5 stories, although they were slightly more prevalent among the in-rent properties; 10% of in-rent properties had any buildings of more than 5 stories, compared to 3% of submetered, 4% of RUBS and 7% of hot water hybrid properties.

As would be expected given the smaller number of units per property, in-rent properties had fewer total people living in the complex compared to impact properties. Survey respondents reported that, on average, 177 people lived in the in-rent complexes, compared to 293 people per property in submetered properties, 386 people per property in RUBS properties, and 392 in hot water hybrid properties.

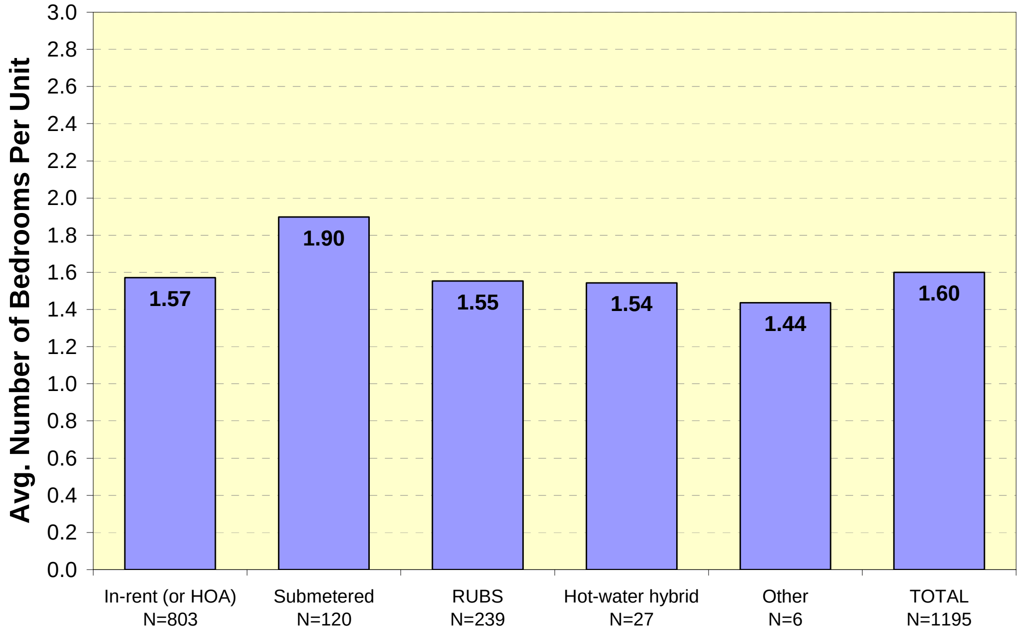


Figure 4.4 Average number of bedrooms per unit, manager survey respondents

Across all surveyed properties, the average number of bedrooms per unit was 1.60. Submetered properties had slightly larger units than the other types of properties, with an average unit size of 1.9 bedrooms. Complete results can be seen in Figure 4.4. Average rents were somewhat higher for impact properties compared to in-rent properties (Figure 4.5). Even after adjusting for the number of bedrooms per unit, the average rent per bedroom was slightly higher among impact properties; $494 per bedroom for submetered properties, $491 per bedroom for RUBS properties, $542 per bedroom for hot water hybrid properties, and $466 per bedroom for in-rent properties.

Impact properties were more likely to have been constructed in the last 10 years compared to in-rent properties. About 7% of in-rent properties had been constructed in 1995 or later, compared to 41% of submetered properties, 17% of RUBS properties and 19% of hot water hybrid properties. Results are shown in Figure 4.6.

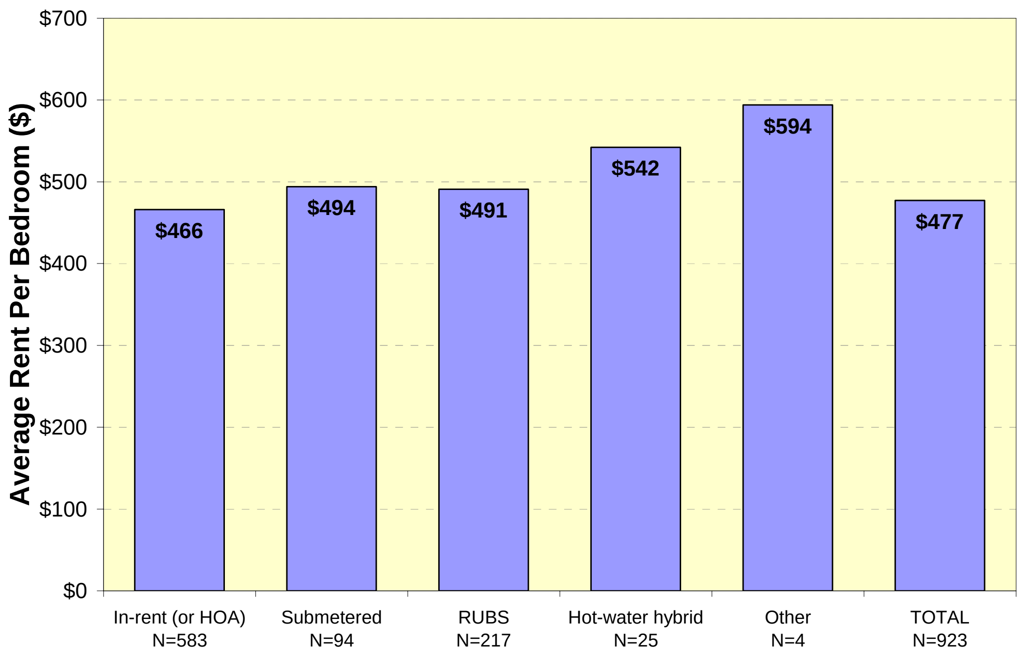


Figure 4.5 Average rent per bedroom, manager survey respondents

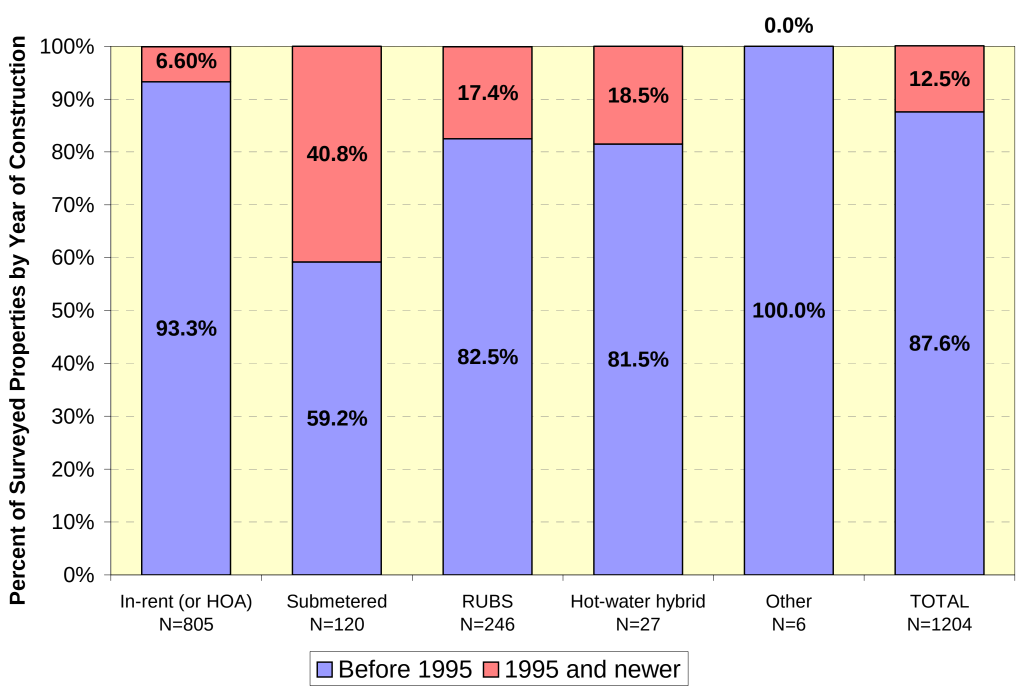


Figure 4.6 Percent of properties built before 1995 and built since 1995

Estimated vacancy rates were similar among the impact and in-rent properties, ranging from an average vacancy rate of 5.6% among in-rent properties to 7.2% among RUBS properties.

The manager survey asked whether the property could be considered a “senior citizen community.” Overall, about 9% of properties were classified in this manner. The proportion was higher (12%) among in-rent properties compared to submetered (6%), RUBS (0%) and hot water hybrid properties (4%). Results are shown in Figure 4.7.

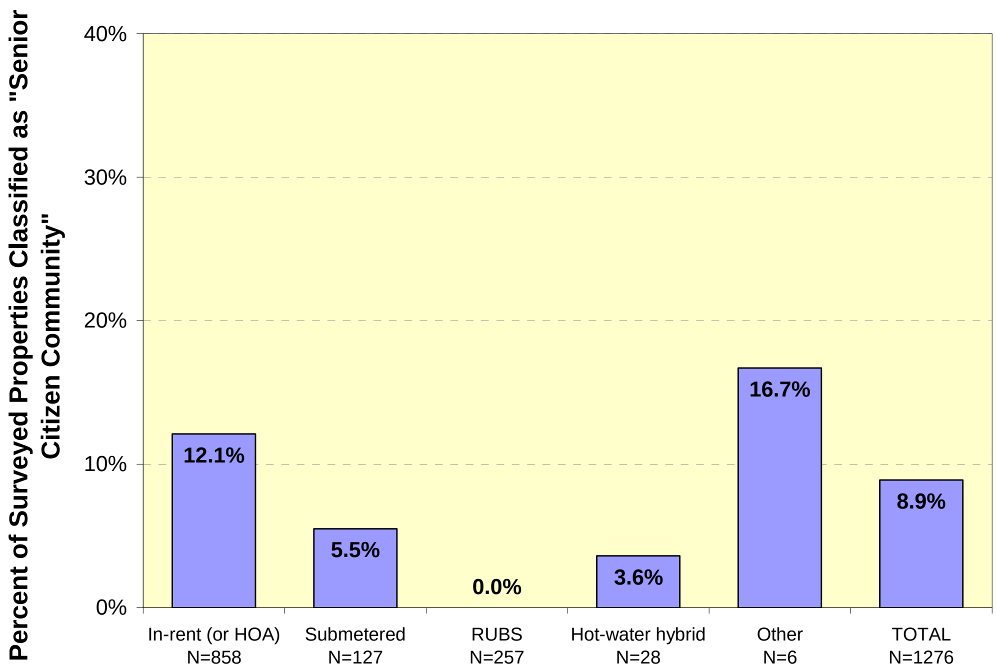


Figure 4.7 Percent of properties classified as “senior citizen community”

Several questions on the survey asked about the presence of various building-related amenities and features on the property. Swimming pools were reported by more than 50% of the survey respondents. RUBS properties were most likely to have a swimming pool (indoor or outdoor) (78%) while 54% of submetered properties and 45% of in-rent properties reported having a pool (see Figure 4.8).

A similar pattern of greater presence of water-using amenities among impact properties was observed for many of the amenities included on the survey (see Figure 4.9). One of the exceptions was cooling towers, which were more likely to be reported on the property for in-rent complexes (8%) than submetered (0%), RUBS (3%) or hot water hybrid properties (0%).

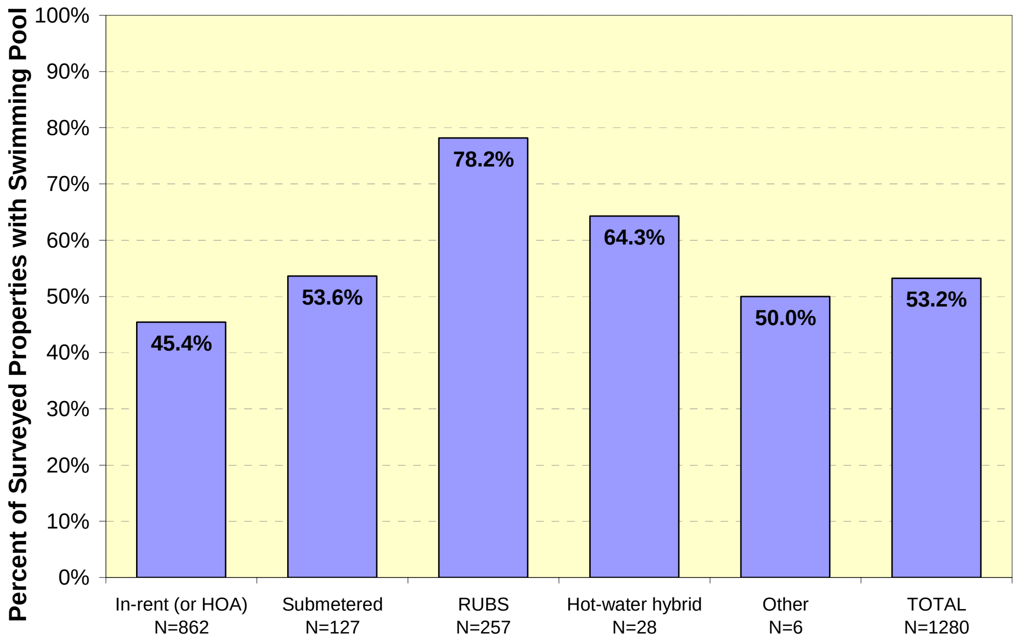


Figure 4.8 Percent of properties with a swimming pool (indoor or outdoor)

The estimated proportion of property devoted to irrigated landscape was similar among impact and in-rent properties, about 30%. In-rent properties were somewhat less likely to have an outdoor water sprinkler system (61%) compared to submetered (77%), RUBS (78%) or hot water hybrid properties (75%). In-rent properties were also somewhat less likely to water all months of the year (33%) compared to submetered (54%) and RUBs (44%) properties, although hot water hybrid properties were about equally likely to water all months of the year (32%).

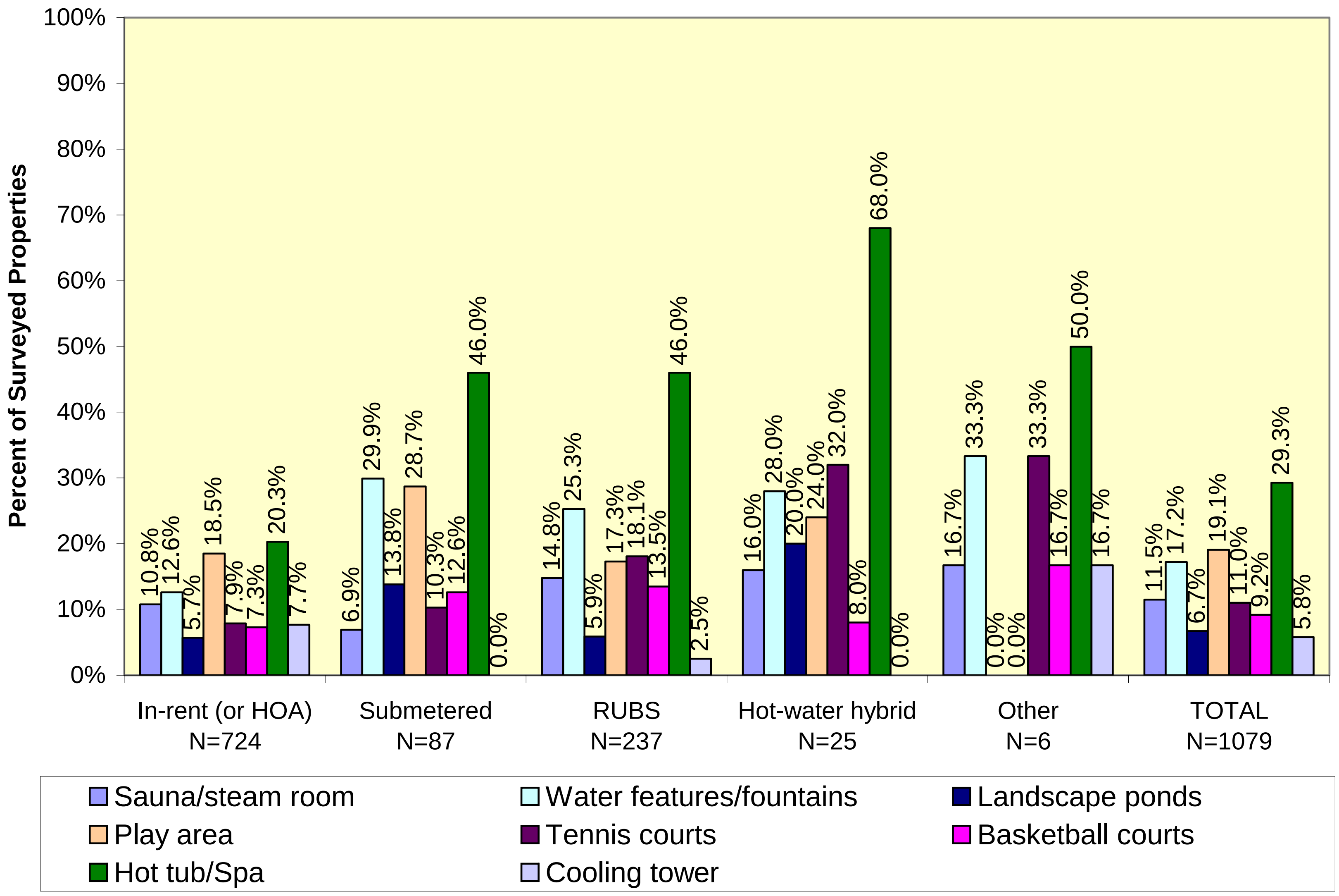


Figure 4.9 Percent of properties with various common area and building-related amenities and features

Impact properties were also more likely to have dishwashers and hook-ups within the dwelling units for washing machines (see Figure 4.10). Among properties with washing machine hook-ups, on average about 80% of the units had washing machines.

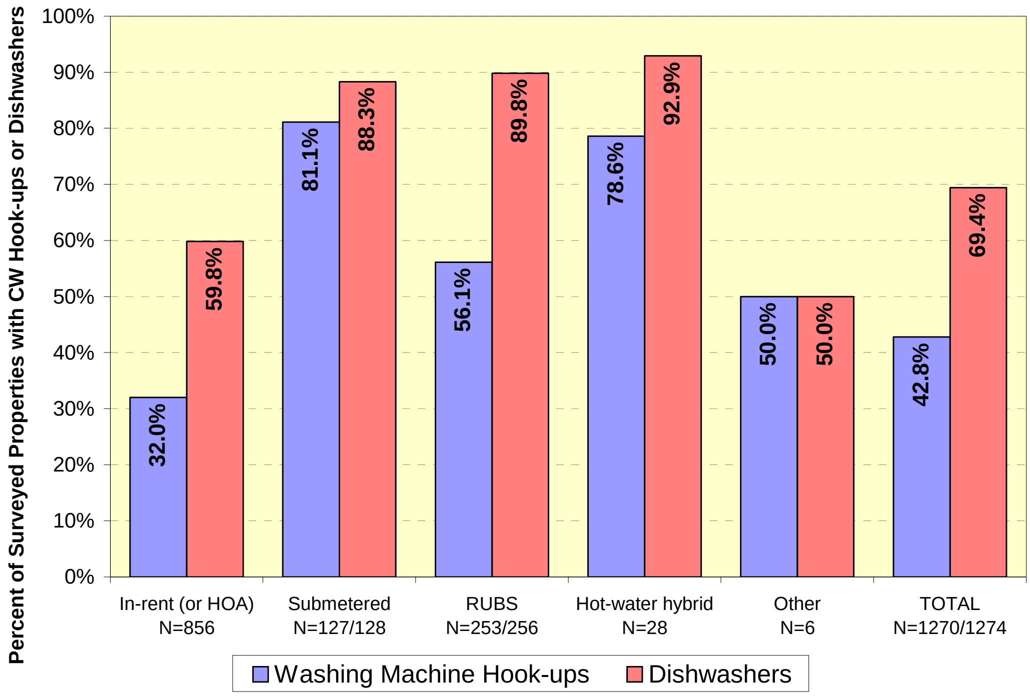


Figure 4.10 Percent of properties with clothes washer hook-ups or dishwashers

Water Bill Payment

A series of questions were included in the survey to assess property managers' experiences with the water billing method being used at their property. Questions about the percent of properties using each billing method (RUBS, submetering, in-rent) can be found in the postcard survey results section earlier in this chapter. The postcard survey is a better "snapshot" of the entire population of multi-family housing and hence the responses to these questions are more generally applicable than similar responses from the manager survey, where impact properties were "over-sampled'.

After being asked in what manner residents were billed for their water consumption, property managers were asked why a particular billing method had been selected. Impact property managers often reported water conservation as a major reason; this option was selected by 32% to 50% of respondents. The billing method in use was generally considered to be the easiest way to bill for water usage, between 33% and 46% of impact property managers chose this as one of their responses, although only 26% of in-rent managers checked this response. Increased profitability was chosen by 20% to 33% of impact property managers, but only mentioned by 3% of in-rent property managers. Detailed results are shown in Table 4.7.

Table 4.7 Reason billing method was chosen, manager survey respondents

Why was this billing method selected?*	In-rent (or HOA)	Sub-metered	RUBS	Hot water hybrid	Other	Total
It conserves water usage by residents	1.9%	49.6%	32.0%	48.1%	33.3%	14.5%
It is the easiest way to bill for water usage	25.7%	45.7%	39.5%	33.3%	33.3%	31.0%
Increased profitability of property	3.2%	19.7%	21.9%	33.3%	33.3%	9.7%
We must comply with local laws and regulations	5.2%	8.7%	16.4%	18.5%	16.7%	8.3%
It is the least expensive way to bill for water	11.8%	9.4%	16.4%	18.5%	33.3%	12.8%
Other	32.1%	9.4%	11.3%	14.8%	16.7%	24.8%
Don't know	34.3%	21.3%	21.5%	14.8%	33.3%	29.8%
Number	N=789	N=127	N=256	N=27	N=6	N=1205

* Percents may add to more than 100% as respondents could give more than one answer.

Managers of in-rent properties were asked whether they had considered converting to RUBS or submetering. About a quarter (24.6%) said they had. Some of the negative issues they considered included the expense of such an undertaking (55%) or resident resistance (37%). On the positive side, 53% considered resident water savings, and 29% the potential for increased profitability of the property. Results are shown in Table 4.8.

Other utilities or services can be billed directly to multi-family housing residents. Electricity is the most common service to be separately billed for with 87% of managers indicated that residents are billed individually for electricity. Approximately 29% reported that residents are billed for natural gas or heating oil. Residents of 11% of surveyed properties are billed individually for garbage collection.

Table 4.8 Issues considered before converting to a separate billing system

What did you consider when thinking about converting?* †	In-rent (or HOA) Properties
Too expensive	54.7%
It conserves water usage by residents	52.5%
Increased profitability of property	28.5%
Resident resistance	37.4%
It is the least expensive way to bill for water	10.1%
It is the easiest way to bill for water usage	9.5%
We must comply with local laws and regulations	3.4%
Prohibited by law	1.7%
Other	16.8%
Don't know	3.9%
Number	N=179

* Percents may add to more than 100% as respondents could give more than one answer.
† Only asked of those in-rent or HOA properties who considered converting

Table 4.9 Other services for which residents are billed

Which of the following are residents billed individually for?*	In-rent (or HOA)	Sub-metered	RUBS	Hot water hybrid	Other	Total
Electric	84.1%	93.8%	93.4%	100.0%	75.0%	87.4%
Natural gas/heating oil	26.9%	51.5%	21.9%	33.3%	50.0%	28.7%
Garbage	3.7%	31.5%	19.1%	37.5%	25.0%	10.7%
Don't know	1.0%	.0%	.0%	.0%	.0%	.7%
Other	7.3%	10.8%	12.5%	8.3%	.0%	8.8%
None	17.2%	16.9%	13.7%	20.8%	25.0%	16.6%
Number	N=806	N=130	N=256	N=24	N=4	N=1220

* Percents may add to more than 100% as respondents could give more than one answer.

Not all properties that charge separately for water use a third party billing service company to handle the billing. Among the impact properties, RUBS (60%) and hot water hybrid properties (78%) were more likely to use a third-party billing company than were submetered properties (45%). This result indicates that a number of submetered properties are either billed by the local water provider or by the property owner or management company. Result are shown in Table 4.10. It should be noted that in Table 4.10 there are some inconsistencies, for instance 7.0% of respondents that said that they were billed by RUBS also said that no one billed them for water usage, rather it was included in-rent or HOA dues. This is likely due to the respondent misinterpreting the survey question.

Table 4.10 Who bills residents for water, manager survey respondents

Who bills the residents for water usage at this property?	In-rent (or HOA)	Sub-metered	RUBS	Hot water hybrid	Other	Total
No one – in-rent or HOA dues	91.4%	3.1%	7.0%	3.7%	33.3%	62.6%
Third party billing service company	0.5%	44.9%	60.2%	77.8%	16.7%	19.3%
Owner or manager	1.8%	29.9%	27.0%	7.4%	33.3%	10.2%
Local utility	1.7%	18.9%	2.7%	7.4%	0.0%	3.8%
Other	3.3%	2.4%	2.7%	3.7%	16.7%	3.2%
Don't know	1.2%	0.8%	0.4%	0.0%	0.0%	1.0%
Total	100.0% N=815	100.0% N=127	100.0% N=256	100.0% N=27	100.0% N=6	100.0% N=1231

Impact property managers were asked how long the current billing system had been in place. Submetered properties were more likely to have been submetered since development of the property (47%), while only 12% of RUBS and 21% of hot water hybrid properties had used these billing systems since property construction. For most of the converted properties where the managers reported the date, the conversion happened recently, within the last 5 years (83%). When asked whether residents had complained when the new billing system was put in place, more managers of RUBS (61%) or hot water hybrid properties (47%) reported experiencing resident complaints compared to submetered properties (22%). Among submetered properties, the expense was the most common complain reported (50%). Expense was also a common complaint among RUBS (61%) and hot water hybrid properties (63%), but residents were even more likely to complain about the perceived inequity of the systems (RUBS, 66%; hot water hybrids, 88%). These results are presented in Figure 4.11 and in Table 4.11.

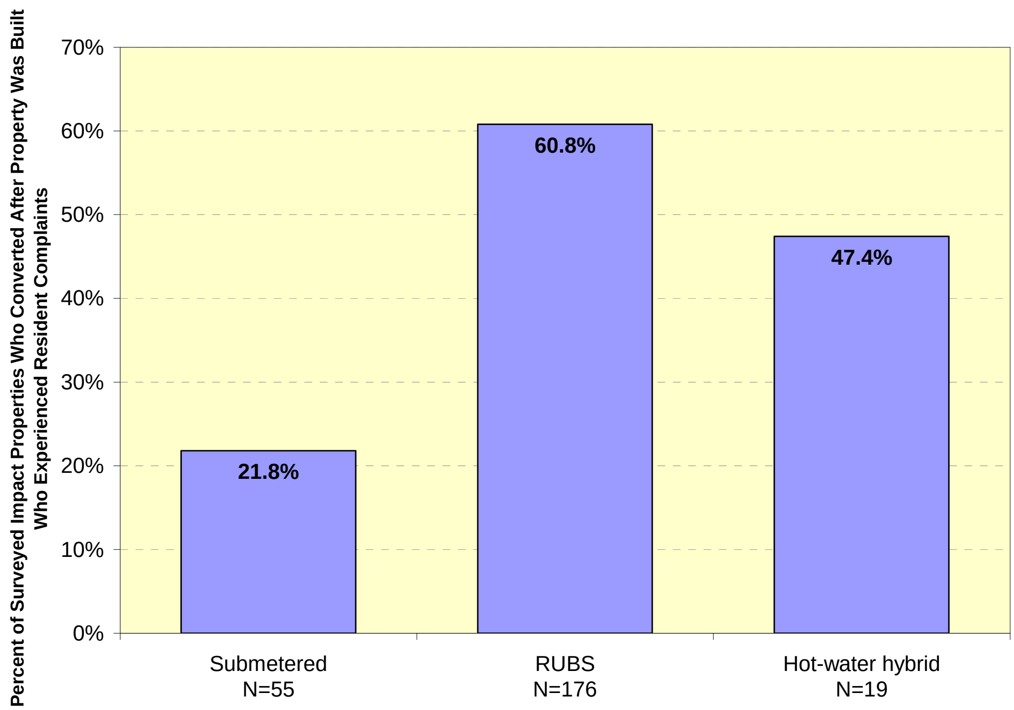


Figure 4.11 Impact properties that experienced billing complaints after conversion

Table 4.11 Type and frequency of complaints about billing methods

What were some of the complaints?* †	Submetered	RUBS	Hot water hybrid	Total
Too expensive	50.0%	61.4%	62.5%	60.3%
Unfair	16.7%	66.3%	87.5%	62.8%
Too complicated	0.0%	8.9%	37.5%	9.9%
Other	50.0%	18.8%	37.5%	23.1%
Number	N=12	N=101	N=8	N=121

* Percents may add to more than 100% as respondents could give more than one answer.
† Only asked of impact properties where there were complaints

Managers of converted impact properties reported encountering few administrative difficulties when the properties were converted. Resistance from residents was a more common problem among RUBS (28%) and hot water hybrid properties (39%) than among submetered properties (7%). These results are presented in Table 4.12.

Table 4.12 Administrative difficulties reported with separate billing programs

What were some of the admin. difficulties encountered?* †	Submetered	RUBS	Hot water hybrid	Total
None	60.3%	44.1%	35.7%	48.8%
Didn't have to convert	16.5%	5.9%	3.6%	9.2%
Difficulty obtaining permits	0.0%	0.0%	3.6%	0.3%
Resistance from government or regulatory officials	0.8%	0.9%	3.6%	1.1%
Resistance from local water utility	0.0%	0.0%	3.6%	0.3%
Resistance from residents	6.6%	28.2%	39.3%	22.0%
Don't know	10.7%	14.5%	21.4%	13.8%
Other	5.8%	10.5%	14.3%	9.2%
Number	N=121	N=220	N=28	N=369

* Percents may add to more than 100% as respondents could give more than one answer.
† Only asked to impact properties

About 30% of properties reported water bill non-payment rates of more than 10%. The average non-payment rate reported was 6.4%. Residents are most frequently billed monthly for water (94% of properties), and the large majority (83%) of properties include wastewater service charges with the residents' water bill. Many impact properties also include a monthly service charge on the residents' water bill; 46% of submetered properties, 26% of RUBS properties, and 61% of hot water hybrid properties.

Most rental impact properties (92%) include language about the residents' paying for water in the lease agreement. In many cases (82%), managers indicated that a resident's security deposit could be docked for failure to pay the water bill[22].

Water Fixture Change-out

Managers of properties built before 1995 (when the 1992 EPACT would have been in full effect) were asked whether they had replaced plumbing fixtures within the dwelling units on their property since 1995. As shown in Figure 4.12 below, about 10% to 30% of properties constructed before 1995 had replaced three-quarters or more of the toilets, faucets, showerheads or washing machines since 1995. The proportions were roughly similar between impact and in-rent properties.

[22] It has since been brought to the researchers' attention that it is illegal in some states for managers to use resident security deposits for utility bill non-payment.

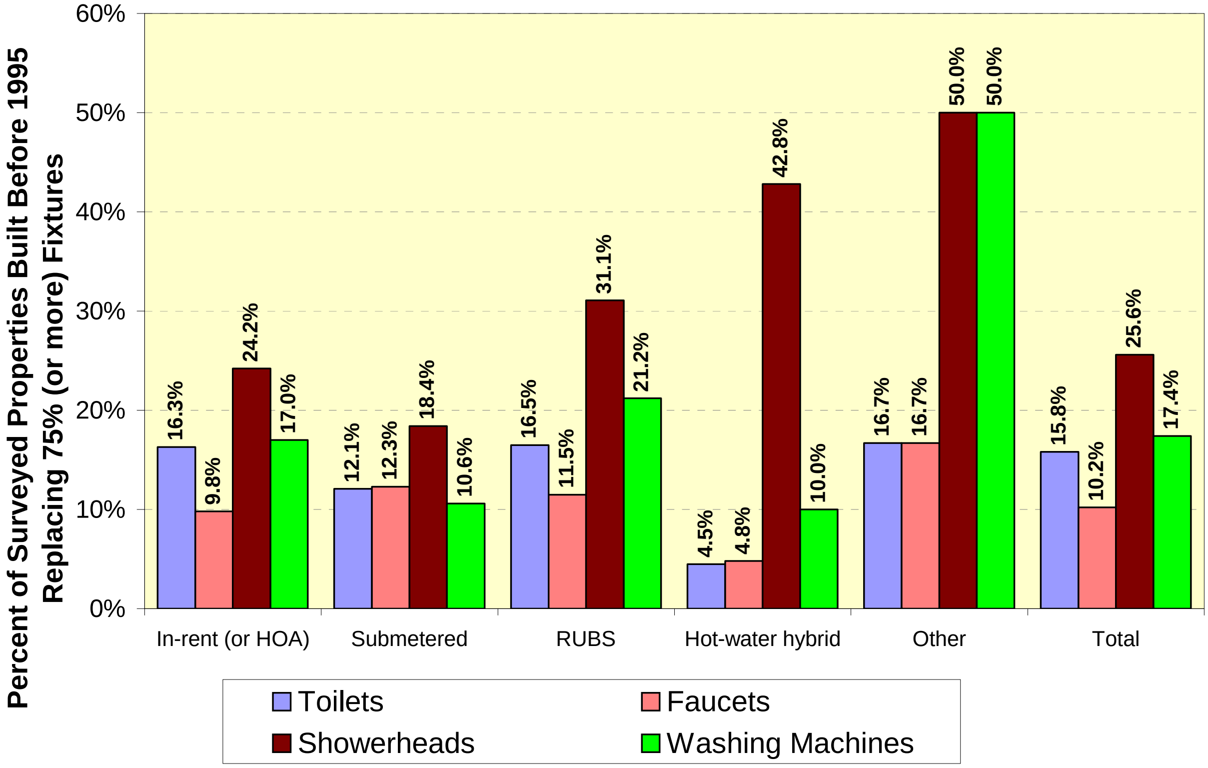


Figure 4.12 Percent of surveyed properties built before 1995 that replaced 75% or more fixtures since 1995

Annual water use per unit by fixture change-out in properties built before 1995 is shown in Table 4.13. There is not a clear relationship between fixture change-out and annual water use per unit. However, a large proportion of the property managers responding to the survey did not know whether the fixtures had been changed out, or what percent of them had been changed out. In addition, even when the percent that had been changed out had been reported, it wasn't necessarily accurate. Of the properties built before 1995, when the properties selected for the matched pair sample were inspected during site visits, discrepancies in the proportion of low-flow toilets and showerheads were found 30% of the time, and about 50% of the time for low-flow faucets. (It should be noted that the site visit protocol had auditors testing actual flow from the fixtures while the manager survey asked property owners or managers whether fixtures had been replaced since 1995.)

Table 4.13 Annual water use per unit (kgal) for properties built before 1995 by fixture change-out rate

Have fixtures been replaced since 1995?		All Properties Mean	All Properties Number
Toilets	No or yes, replaced less than 25%	50.90	N=322
	Yes, replaced 25% to 75%	55.54	N=183
	Yes, replaced 76% to 100%	50.60	N=147
	Yes, don't know what percent replaced	53.01	N=128
	Don't know if fixtures replaced or not	52.26	N=150
Faucets	No or yes, replaced less than 25%	51.39	N=227
	Yes, replaced 25% to 75%	53.14	N=308
	Yes, replaced 76% to 100%	49.78	N=92
	Yes, don't know what percent replaced	52.52	N=167
	Don't know if fixtures replaced or not	52.13	N=126
Showerheads	No or yes, replaced less than 25%	48.95	N=170
	Yes, replaced 25% to 75%	54.96	N=222
	Yes, replaced 76% to 100%	52.02	N=230
	Yes, don't know what percent replaced	50.87	N=156
	Don't know if fixtures replaced or not	53.29	N=141

MATCHED PAIRS SITE SURVEY RESULTS

The purpose of the site visits/matched pair analysis was to look closely at a small sample of in-rent and impact properties that have similar characteristics. Properties with similar characteristics offer a unique opportunity for comparing water use between in-rent and impact properties, essentially controlling for property differences through the matched pair selection. In the end, there were 21 submeter/in-rent matches and 14 RUBS/in-rent matches.

Site Visits

The site visits provided the research team the opportunity to audit first-hand a subset of the properties being used in the analysis. During the planning and completion of these site visits, some interesting observations were made, which merit being noted, despite being anecdotal in nature.

The biggest limitation of the site visits was the difficulty in planning the visits. In general, there were many properties that refused to participate. Properties would not always provide reasons for not participating, whether it was the time commitment or the study. This caused a larger problem, since if a suitable alternate for the uncooperative property did not exist, its match would have to be dropped as well.

From the visits, it was found that there was some confusion surrounding the details of the billing methods at these properties. In general, on-site property managers were not well versed in the details and the formulas used for the billing methods, especially for allocation and hot water hybrids. Hot water hybrids seemed to be of particular confusion for many on-site property managers. In the interview during the site visit, often an auditor would find out that a property that had been classified as "Submetered" on the manager survey would really only have a submeter on the hot water line, thus making it a hot water hybrid. This happened in three out of twenty properties that had been labeled as submetered, or about 15% of the time. Only some of the on-site property managers would know how the cold water was allocated at this property. In addition, there were two properties that were visited that were billing on RUBS systems, but when the auditors entered the units, they observed that the units had submeters. One of the properties said that they were not aware that there were submeters in the units. The other property said that they were aware of the submeters, but that they did not use them because it would take so much time to manually read each of them. The auditors informed the property that the submeters in the apartments could be remotely read.

A striking finding of the site visits was how much turnover existed with the management of the properties. Often, the on-site property manager was a relatively new hire. Because of this, the better resource for the auditors was often a member of the maintenance staff. In general, the maintenance staff seemed to have been there longer and was typically very knowledgeable of the property. In addition, for any information that could not be gained from those sources during site visits, the auditor would make follow-up phone calls to the management company, owner, or any other contact provided. In general, after exhausting these options, the desired information was gained.

Comparison of Site Visit Surveys with Manager Survey Results

By comparing the site visit surveys with the manager survey results, the accuracy of the manager survey could be checked. In general, the site visits did serve to verify most of the manager survey responses. Fixture change-out in properties built before 1995 verified low-flow toilets and showerheads about 30% of the time, while low-flow faucets were verified only 50% of the time. The site visits were also important because they often helped to fill in some of the important responses that may have been left blank or as don't knows. A comparison of the property characteristics between the surveys can be seen in Appendix D.

RESIDENT SURVEY RESULTS

A total of 2,345 surveys (from 354 different properties) were returned from residents that were mailed a survey. Of these, 745 came from properties where water is included in the rent or homeowner dues, 393 from submetered properties, 1,011 from RUBS properties, 93 from hot water hybrid properties, and 103 from utility-submetered properties. It should be acknowledged that resident turnover rate is high in the multi-family sector, thus the resident survey responses intend to show a snapshot of resident opinion and dwelling unit characteristics. The full set of resident survey results by type of water billing can be found in Appendix B.

Water Using Fixtures

The first part of the resident questionnaire was devoted to questions pertaining to the water using fixtures and amenities within residents' dwelling units. Figure 4.13 and Figure 4.14 show the proportion of residents with at least one of each listed fixture. All respondents had at least one toilet, one bathroom sink, and one kitchen faucet. Residents from in-rent (38%), submetered (42%) and utility-submetered properties (51%) were more likely to have an outdoor faucet or hose compared to those in RUBS (14%) or hot water hybrid properties (8%). Overall, about 7% of residents said they had an indoor utility sink, with not much variation by type of property. These results are shown in Figure 4.14.

Residents from impact properties were somewhat more likely to have garbage disposals (82% to 96%), dishwashers (87% to 97%), and washing machines (55% to 82%) in their units than were residents from in-rent properties, where 77% had garbage disposals, 57% had dishwashers, and 35% had washing machines.

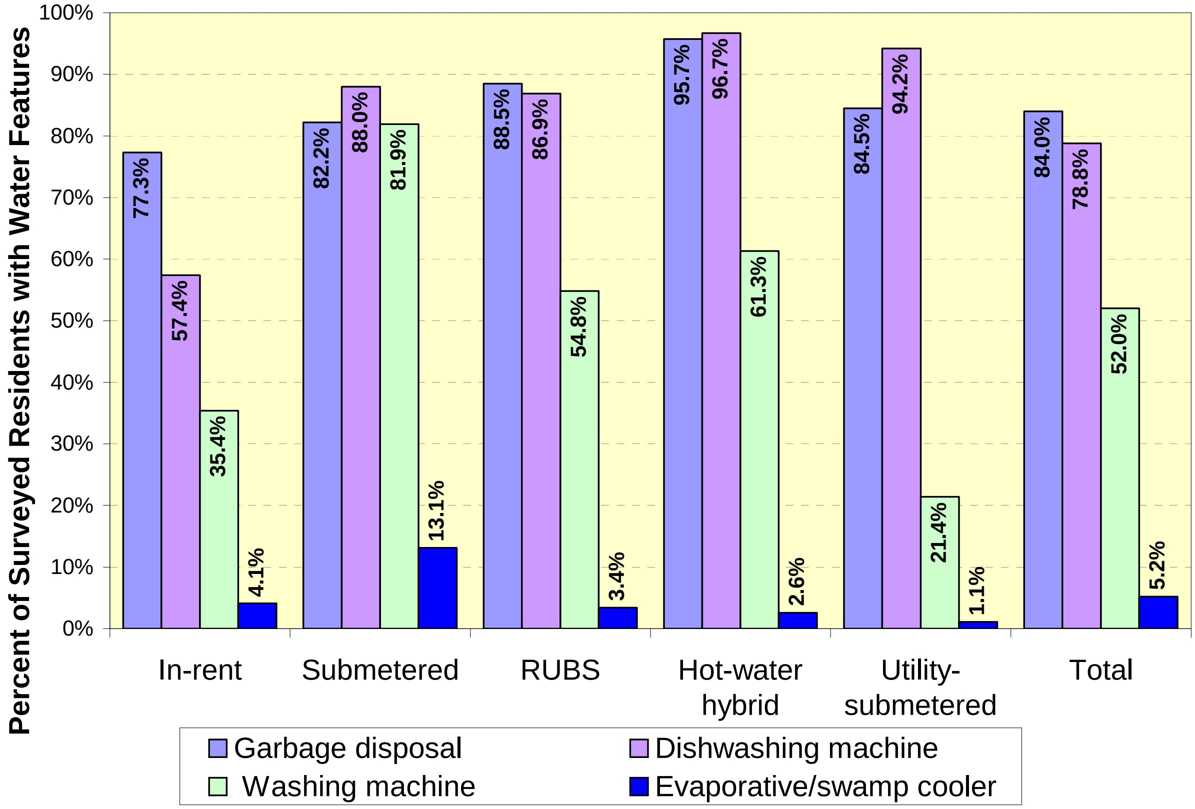


Figure 4.13 Presence of water using features, resident survey respondents

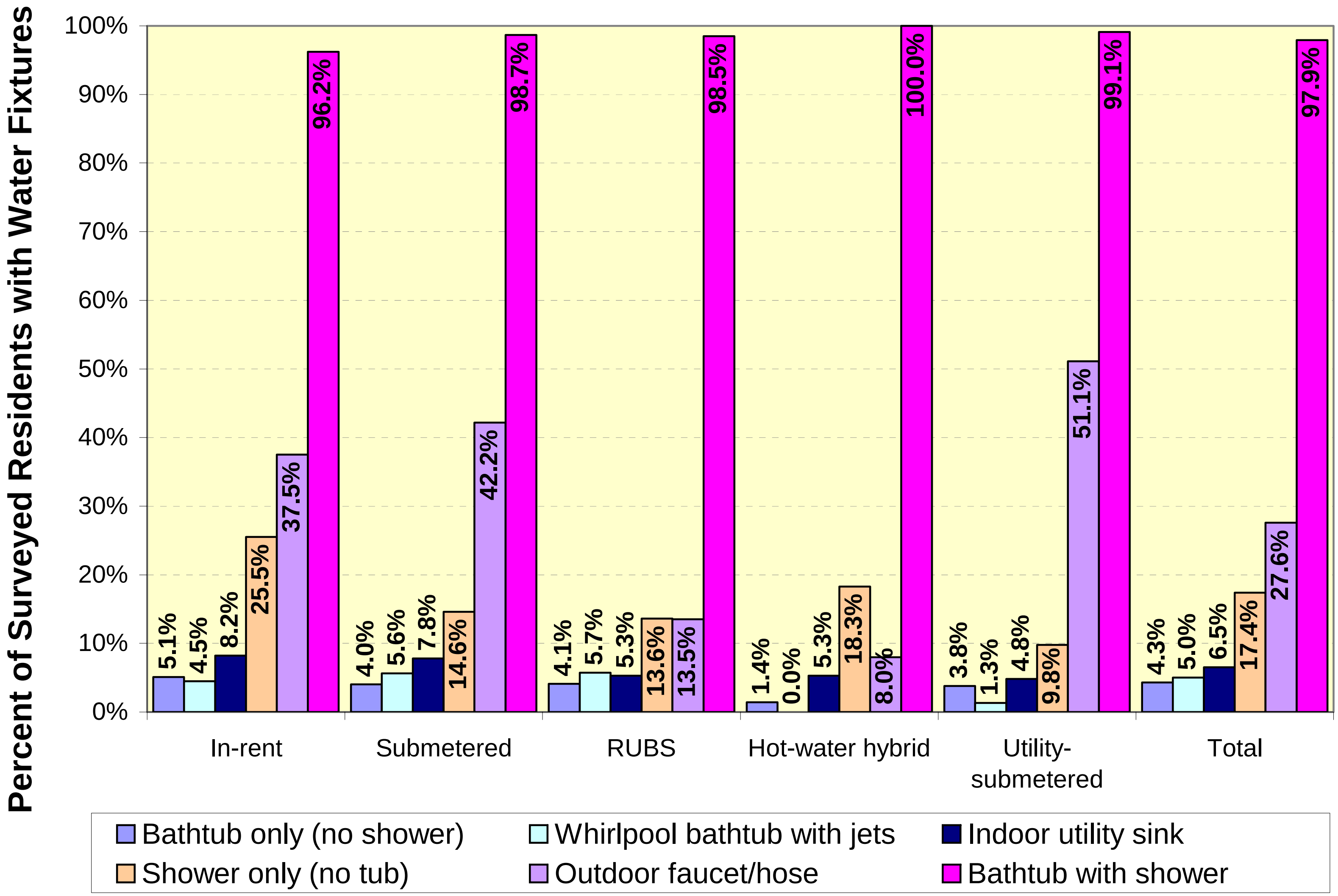


Figure 4.14 Presence of water using fixtures and features, resident survey respondents

Roughly similar proportions of residents (about 58%) from all properties said they watered indoor potted plants, however higher proportions of those from in-rent (61%) and submetered properties (62%) watered personal outdoor areas compared to those in RUBS (7%), hot water hybrid (4%) and utility-submetered properties (7%). Residents in these properties had also been more likely to have an outdoor faucet or hose. The potential for an additional end use (outdoor irrigation) at these properties is investigated further in the water use analysis chapter.

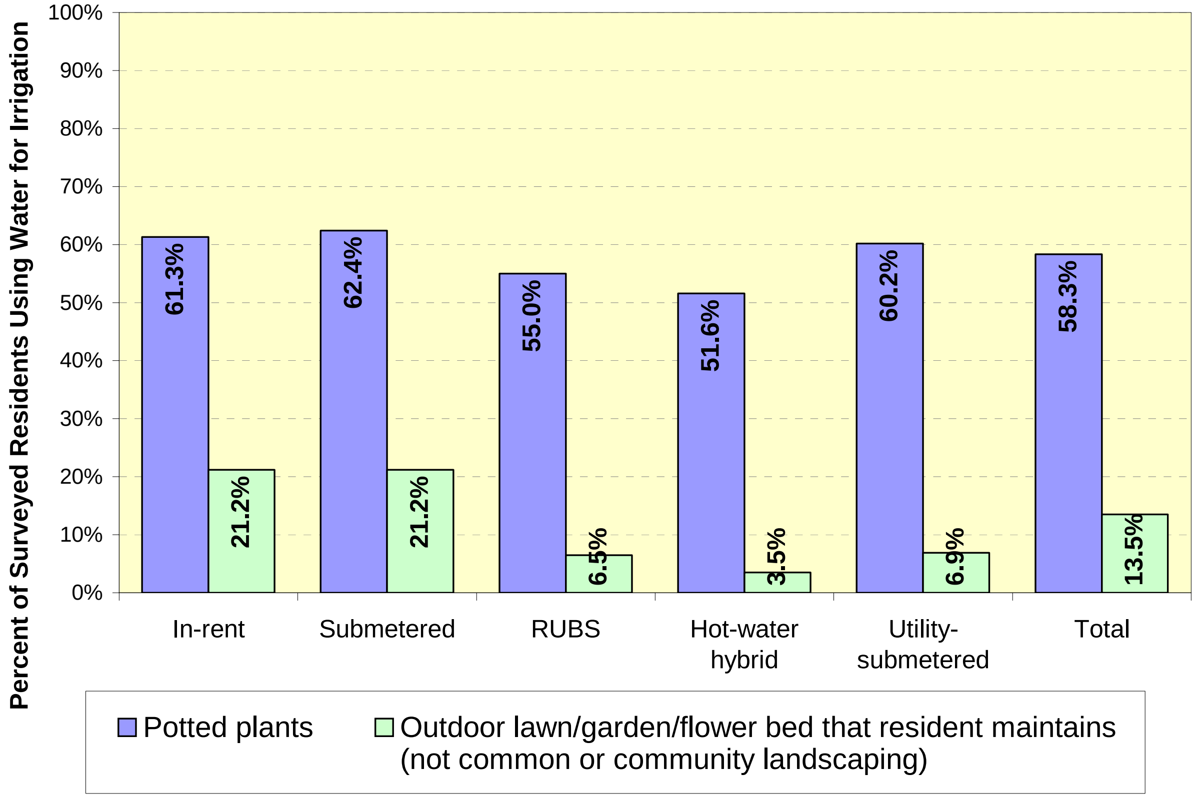


Figure 4.15 Frequency of water use for irrigation, resident survey respondents

Water Conservation

A key question of this study is whether the type of water billing method impacts water use. Residents were asked how important they felt it was to conserve water in their own household, and how important it was for households in their community to practice regular water conservation. In general, residents from all types of properties were equally likely to view water conservation as important; about a third overall felt it was "extremely important" for their household (37%) and their community (35%) to conserve water. Those in utility-submetered properties were somewhat less likely to feel it was "extremely important" for their household (30%) or their community (26%) to conserve.

About 84% of respondents reported taking some kind of water conservation action. When asked what type, about 70% said they have used the dishwasher less, 60% have taken shorter showers, 56% use the washing machine less often, 52% use the garbage disposal less often, 45% have repaired leaks in toilets or faucets. Fourteen percent have installed low-flow toilets, and another 10% have installed a water-saver insert in their toilet. These results are presented in Table 4.14.

Table 4.14 Reported resident action taken to conserve water

What action resident has taken to conserve water*	In-rent or HOA	Sub-metered	RUBS	Hot water hybrid	Utility-sub-metered	Total
Use dishwasher less/use fuller loads	52.0%	76.9%	78.5%	83.8%	87.5%	70.3%
Take shorter showers	54.9%	58.5%	63.6%	58.1%	57.5%	59.5%
Use washing machine less/use fuller loads	48.6%	70.2%	56.8%	71.6%	38.8%	56.3%
Use garbage disposal less often	48.5%	46.5%	55.1%	58.1%	52.5%	51.5%
Repaired leaks in faucet/toilet	50.4%	38.5%	41.7%	40.5%	56.3%	44.5%
Washing car less often	28.0%	36.6%	28.4%	31.1%	36.3%	30.1%
Installed LF showerheads	37.9%	30.2%	22.5%	32.4%	21.3%	29.1%
Installed ULF toilets	23.8%	10.5%	8.8%	8.1%	3.8%	13.7%
Installed toilet inserts	14.9%	8.9%	8.0%	4.1%	7.5%	10.2%
Installed LF faucet aerators	14.4%	9.8%	6.4%	8.1%	.0%	9.4%
Re-use household water	10.5%	8.3%	9.4%	8.1%	5.0%	9.4%
Other	10.2%	6.8%	8.3%	4.1%	8.8%	8.5%
Had a home water audit done	1.3%	0.9%	0.7%	0.0%	0.0%	0.9%
Number	N=617	N=325	N=827	N=74	N=80	N=1923

* Percents may add to more than 100% as respondents could give more than one answer.

Residents were also asked whether their property owners had taken any water conservation actions. Residents of in-rent properties were more likely to report that their property owner had taken some action (27%) compared to residents in RUBS (16%), hot water hybrid (14%), utility-submetered (13%) or submetered properties (8%). When asked what specific actions their property owner had taken to conserve water, 60% of residents from all types of properties said they had repaired leaks. Additionally, many said they had installed low-water-use fixtures, such as low-flow showerheads (45%), ULF toilets (35%), water saver inserts for toilets (21%) or low-flow aerators (19%). In nearly every category of action, a higher percentage of residents from in-rent properties reported their property owner had taken action to conserve water. In-rent property owners were much more likely to install ULF toilets according to the resident respondents. While 27% of submetered and RUBS respondents indicated ULF toilets had been installed, 44% of in-rent respondents reported this change. These results are presented in Table 4.15.

Table 4.15 Reported property owner action taken to conserve water

What action property owner has taken to conserve water*†	In-rent or HOA	Sub-metered	RUBS	Hot water hybrid	Utility-sub-metered	Total
Repaired leaks in faucet/toilet	63.2%	48.3%	58.9%	30.8%	76.9%	59.9%
Installed LF showerheads	47.2%	41.4%	43.6%	53.8%	30.8%	45.0%
Installed ULF toilets	44.0%	27.6%	27.0%	30.8%	7.7%	34.5%
Installed toilet inserts	25.9%	20.7%	16.0%	23.1%	15.4%	21.2%
Installed low-flow faucet aerators	22.3%	17.2%	14.7%	15.4%	15.4%	18.5%
Other	14.5%	34.5%	14.7%	23.1%	.0%	15.8%
Re-use household water for landscaping	2.6%	0.0%	1.8%	0.0%	0.0%	1.9%
Number	N=193	N=29	N=163	N=13	N=13	N=411

* Percents may add to more than 100% as respondents could give more than one answer.
† Only asked of those who rent their residence.

When asked from where they obtained information about water conservation, television news (47%) and television public service announcements (46%) were the most commonly cited sources. Newspapers (45%), and water bill inserts (41%) were also frequently indicated. Thirty-one percent of respondents heard water conservation information in radio public service announcements, and 22% from radio news. Twenty-two percent received water conservation information through their homeowner or apartment newsletters.

While respondents from all properties were about equally likely to deem water conservation as important, and to have reported undertaken water conservation efforts, those living in submetered or hot water hybrid properties were more likely to report that the way they were billed for water impacted their water conservation endeavors. Nearly 48% from submetered and 47% from hot water hybrid properties said their household was more likely to conserve water due to the billing method, compared to 23% of those from in-rent properties and

28% of those from RUBS properties. About a third (36%) of those who lived in utility-submetered units said the billing method influenced their household's water consumption.

Experience with Water Billing

Many respondents to the resident survey were confused or mistaken about how they paid for water. Residents were asked to identify the method by which they were billed for water. Table 4.16 displays the responses of the residents, organized by the category of water billing method as identified by the owners or managers of the properties. Overall, 14% admitted they didn't know how they were billed. Among those whose water is included the rent or resident dues, 85% correctly identified their water billing method. Only 57% of residents in submetered properties did so, 44% of those in RUBS properties, and 25% of those in hot water hybrid properties.

Table 4.16 Reported water billing method, resident survey respondents

How are you billed for water usage at this property?	In-rent or HOA	Submetered	RUBS	Hot water hybrid	Utility-sub-metered*	Total
included in rent or in HOA dues	85.2%	11.3%	25.1%	8.7%	0.0%	39.9%
based amount of hot water used	.4%	4.4%	3.3%	25.0%	0.0%	3.3%
individual water meters; charged for individual water usage	1.0%	55.6%	7.8%	29.3%	0.0%	14.2%
calculated on square footage	0.1%	1.3%	8.0%	2.2%	0.0%	3.8%
calculated on number of rooms	0.0%	0.0%	1.0%	0.0%	0.0%	0.4%
calculated on number of bedrooms	0.1%	0.0%	2.0%	0.0%	0.0%	0.9%
calculated on number of occupants	0.0%	0.5%	10.8%	0.0%	0.0%	4.8%
calculated on number of fixtures	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
other calculation	0.6%	2.1%	14.6%	5.4%	0.0%	7.1%
other	2.1%	3.1%	4.9%	0.0%	0.0%	3.3%
don't know	7.9%	17.9%	18.1%	23.9%	0.0%	14.3%
multiple methods	2.6%	3.8%	4.2%	5.4%	0.0%	3.5%
utility submetered	0.0%	0.0%	0.0%	0.0%	100.0%	4.5%
Total	100.0% N=725	100.0% N=390	100.0% N=999	100.0% N=92	100.0% N=103	100.0% N=2309

*Note: These residents were not asked how they were billed for water usage.

Residents responding to the survey were asked whether they were assessed a service charge on their water bill. Forty-four percent of residents from submetered properties said their bill included a service charge, while 22% of those from RUBS properties and 33% of those from hot water hybrid properties reported their water bill included a service charge. A large proportion were unsure, 37% from submetered properties, 51% from RUBS properties, and 40% from hot water hybrid properties. Those who reported they paid a service charge were asked how much the fee was. The average amount reported was about $4.00; $3.91 by residents of submetered properties, $4.61 by residents of RUBS properties and $4.17 by residents of hot water hybrid properties.

Those completing the questionnaire were asked their opinion about they way in which they were billed for water. Satisfaction was highest among utility-submetered residents (54%), followed by in-rent residents (46%), submetered residents (39%) and RUBS residents (37%). Dissatisfaction was highest among those living in hot water hybrid properties (50%), followed by residents of RUBS properties (39%), residents of submetered properties (31%), with only 14% of residents of in-rent properties saying they were "dissatisfied." These results are shown in Figure 4.16

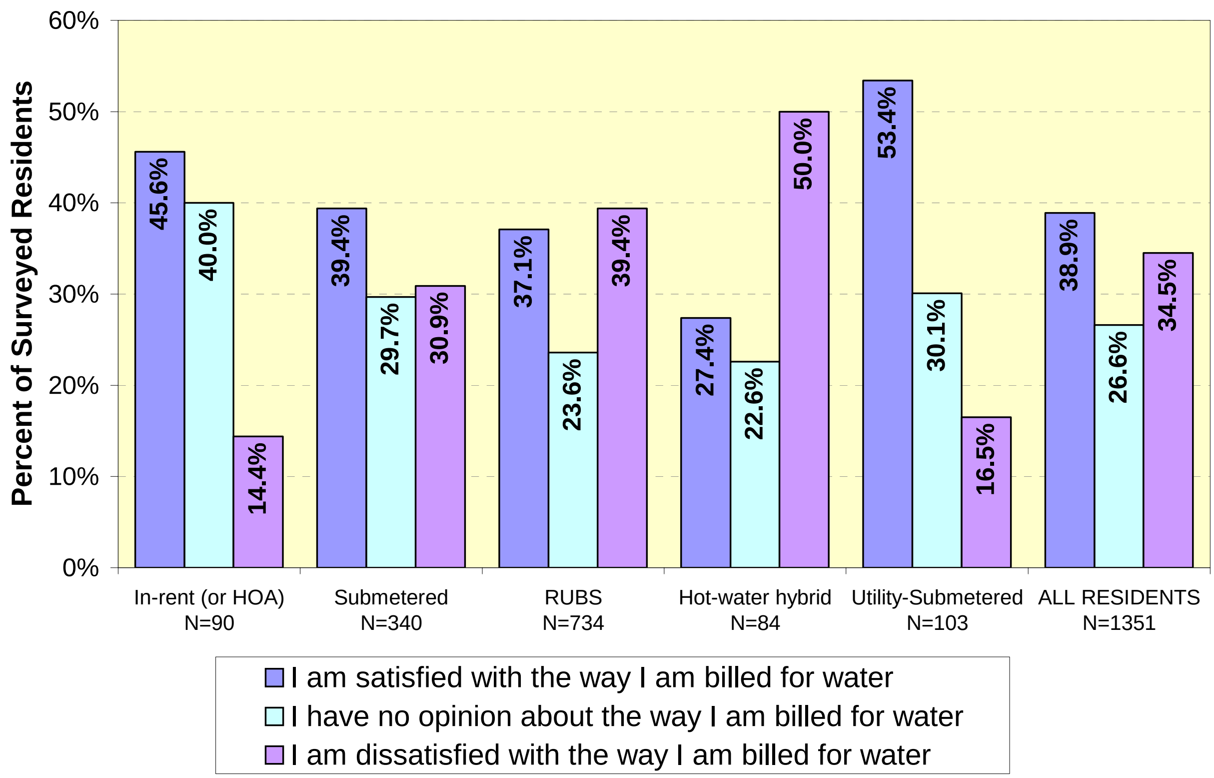


Figure 4.16 Resident satisfaction rates by water billing method

When asked why they were dissatisfied, the most common complaint was about the accuracy of reported water consumption; mentioned by 38% of all *dissatisfied* residents, but 60% of hot water hybrid residents, 42% of RUBS residents, and 22% of submetered residents. Twenty-eight percent of *dissatisfied* residents indicated they disliked the rates paid for water or paying for other residents' or the complex's water use. Among those living in RUBS properties, 35% mentioned paying for other water use as a source of discontent, and an additional 18% said they did not like that the water bill was not based on their actual usage. Nineteen percent of dissatisfied residents were also unhappy about the service charge added to their water bill. These results are presented in Table 4.17.

Table 4.17 Residents reasons for dissatisfaction with water billing method

Why are you dissatisfied?*	Submetered	RUBS	Hot water hybrid	Total
Accuracy of reported water consumption	22.2%	41.5%	60.0%	38.3%
Rates	27.8%	28.0%	30.0%	27.8%
Paying for other's/complex	11.1%	35.4%	0.0%	27.8%
Service charge	33.3%	15.9%	20.0%	19.1%
Not based on my actual usage	11.1%	18.3%	0.0%	14.8%
Billing method/calculation unclear	16.7%	9.8%	10.0%	12.2%
Late fees	11.1%	9.8%	10.0%	9.6%
Based on square footage, not occupants	0.0%	6.1%	0.0%	4.3%
No incentive to conserve	0.0%	4.9%	0.0%	3.5%
Other	50.0%	47.6%	80.0%	51.3%
Number	N=18	N=82	N=10	N=115

* Percents may add to more than 100% as respondents could give more than one answer.

Surveyed Resident Characteristics

Reported demographic characteristics of residents are shown in the Table 4.18. Among properties with an in-rent or HOA water billing method, 28% of surveyed residents owned their unit. This was somewhat lower among residents in submetered properties (21%), and much lower among residents of RUBS (3%) and hot water hybrid properties (1%). All the utility-submetered units were renter-occupied.

Table 4.18 Ownership and rental rates, resident survey respondents

Do you rent or own your residence?	In-rent or HOA	Submetered	RUBS	Hot water hybrid	Utility-submetered	Total
Own	27.6%	20.8%	3.3%	1.1%	.0%	13.7%
Rent	72.4%	79.2%	96.7%	98.9%	100.0%	86.3%
Total	100.0% N=735	100.0% N=390	100.0% N=1001	100.0% N=92	100.0% N=103	100.0% N=2321

Average monthly rent varied substantially among in-rent and impact properties according to the resident survey respondents. More than 26% of the in-rent respondents reported monthly rent of less than $300 compared with less than 2% for impact properties. The distribution of rental costs are shown in Table 4.19. Using the mid-point in each range the weighted average monthly rent was calculated for each billing method. The utility-submetered accounts in Irvine had the highest rent - $1,307 per month on average. Submetered properties averaged $916 per months, RUBS $773 per month, and in-rent $552 per month. Keep in mind these rates are not corrected for size of dwelling unit and could be weighted towards respondents from specific properties. Results from the manager survey offer a better estimate of the cost of rent for each billing method and study site.

Table 4.19 Rental costs by billing method, resident survey respondents

How much is your monthly rent?*	In-rent or HOA	Submetered	RUBS	Hot water hybrid	Utility-submetered	Total
Less than $300	26.3%	0.3%	1.5%	1.1%	2.0%	7.9%
$300-$499	19.7%	4.6%	10.5%	8.0%	0.0%	11.4%
$500-$799	36.0%	46.5%	50.3%	54.5%	3.0%	43.7%
$800-$1,299	14.7%	30.0%	33.0%	23.9%	38.0%	27.5%
$1,300-$1,699	2.7%	15.2%	4.0%	12.5%	44.0%	7.8%
$1,700-$1,999	0.4%	2.3%	0.4%	0.0%	12.0%	1.3%
$2,000-$2,499	0.0%	0.3%	0.1%	0.0%	1.0%	0.2%
$2,500 or more	0.2%	0.7%	0.1%	0.0%	0.0%	0.2%
Total	100.0% N=517	100.0% N=303	100.0% N=942	100.0% N=88	100.0% N=100	100.0% N=1950
Avg. Monthly Rent†	$ 552	$ 916	$ 773	$ 814	$ 1,307	$ 767

* Only asked of those who rent their residence.

†Based on the mid-point of each range and the percent of respondents in each range.

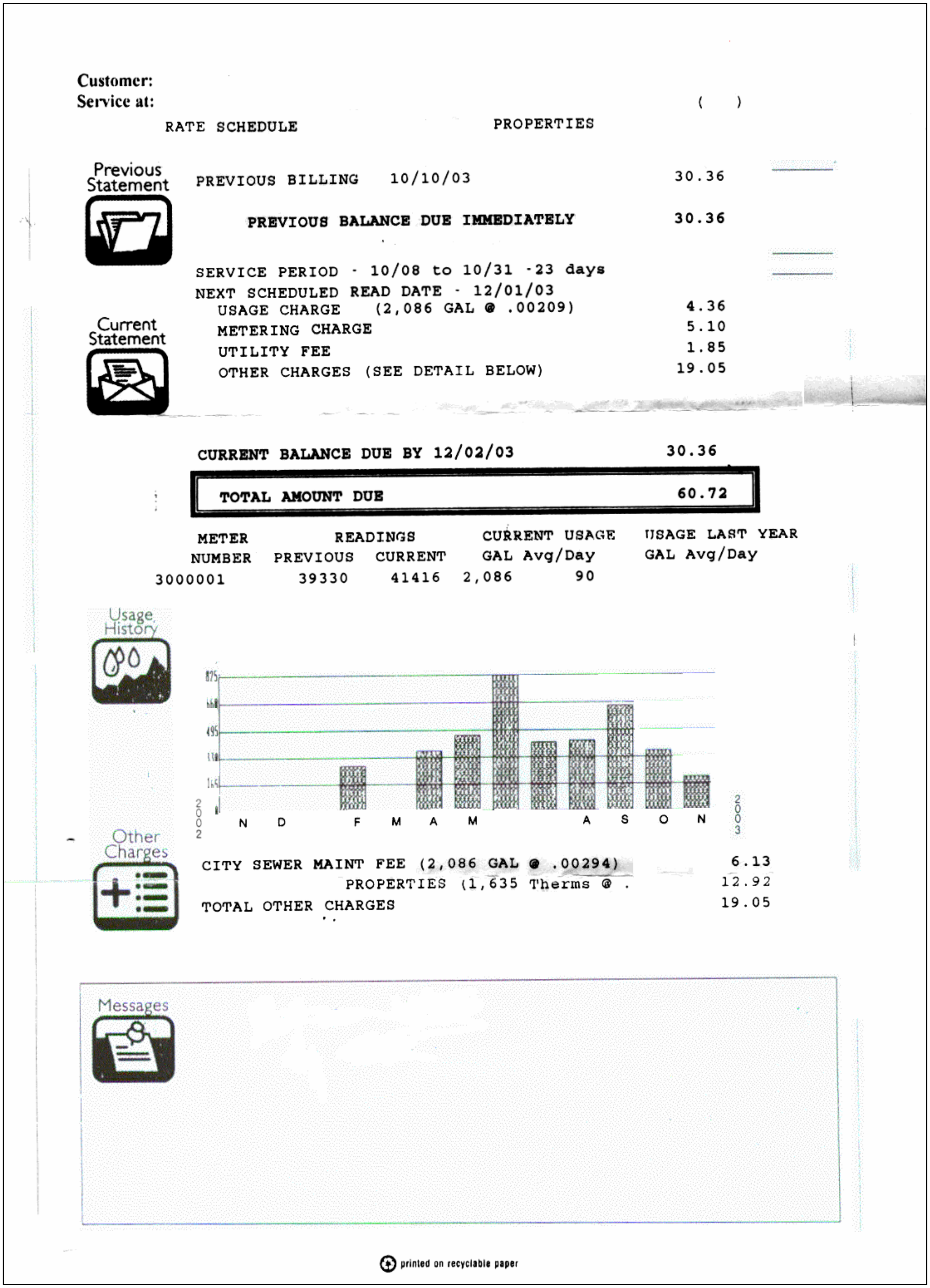
Actual Water and Wastewater Bills

As part of the resident survey, respondents were asked to include a copy of a recent submetered, RUBS, HWH, or utility submetered water and wastewater bill. Several hundred residents complied with this request and provided sample bills along with their returned resident survey. The research team was able to use these bills to evaluate the commodity charges, bill clarity and presentation, service charges, and a number of other factors. A sample of these bills are presented below along with notes and commentary. All identifying information about the customer and billing entity has been removed from the bill to preserve anonymity.

Submeter Sample Bills

Five sample submeter water bills are presented below. Additional sample bills can be found in Appendix C. In general the bills sent by submetering companies were comprehensible and provided most of the information a customer might expect particularly when compared with some of the bills sent to RUBS customers.

Submeter bill #1 shown in Figure 4.17 from billing company #1 is among the clearest and most informative bills provided to the research team. **Pros:** Icons running down the left margin identify different sections of the bill including – previous statement, current statement, usage history, other charges, and messages. Actual metered consumption and the commodity charge ($/gallon) for water and wastewater are shown. Read dates and meter readings are shown. Service charges are broken down into two components – metering charge and utility fee (total = $6.95). Of particular note is the usage history graph, a useful feature found on no other bill provided to the research team. **Cons:** Overall layout and organization of the bill could be improved. Utility water and wastewater rates are not shown so there is no way for the customer to determine if commodity charges have been inflated. Note that customer service contact information is not shown on this portion of the bill, but is provided on a separate page not provided by the resident. Overall this is one of the best (if not the best) examples of an informative and clear bill obtained in this study.


Customer:
Service at: ( )

RATE SCHEDULE PROPERTIES

Previous Statement

PREVIOUS BILLING	10/10/03	30.36
PREVIOUS BALANCE DUE IMMEDIATELY		**30.36**

Current Statement

SERVICE PERIOD - 10/08 to 10/31 -23 days
NEXT SCHEDULED READ DATE - 12/01/03

USAGE CHARGE	(2,086 GAL @ .00209)	4.36
METERING CHARGE		5.10
UTILITY FEE		1.85
OTHER CHARGES (SEE DETAIL BELOW)		19.05

CURRENT BALANCE DUE BY 12/02/03	**30.36**
TOTAL AMOUNT DUE	**60.72**

METER NUMBER	READINGS PREVIOUS	READINGS CURRENT	CURRENT USAGE GAL	CURRENT USAGE Avg/Day	USAGE LAST YEAR GAL	USAGE LAST YEAR Avg/Day
3000001	39330	41416	2,086	90		

Usage History

Other Charges

CITY SEWER MAINT FEE	(2,086 GAL @ .00294)	6.13
PROPERTIES	(1,635 Therms @ .	12.92
TOTAL OTHER CHARGES		19.05

Messages

printed on recyclable paper

Figure 4.17 Submeter water bill #1 from billing company #1

Submeter water bill #2 from billing company #2 is presented in Figure 4.18. This bill, while better than some, does not provide all the useful information that it could. **Pros:** Billing company name and contact information were provided front and center (this information has been removed). Total amount due is shown prominently and in two places. Numerous services charges and fees are clearly delineated. Actual meter readings, billing period, and consumption are shown. Range of usage and average usage per unit for the property are shown at bottom of bill. **Cons:** Actual water commodity charge ($/gallons) not shown. Utility water and wastewater rates are not shown so there is no way for the customer to determine if commodity charges have been inflated. No way to determine how many of the numerous fees are from the billing company or are passed through from the water utility.

STATEMENT

Date
Jun 16, '03
Cust. No

( ) -

NAME:
CUSTOMER NUMBER:
ADDRESS:
CITY / STATE / ZIP:

Total Due
$16.64

WATER USE STATEMENT
Water Use 5/18/03 to 6/16/03

Previous Meter Read	124,070	Gallons
Current Meter Read	126,180	Gallons
Consumption	2,110	Gallons
Water Base Fee	$0.31	
Water Usage Fee	$5.33	
Sewer Fee	$4.95	
Environmental Water Fee	$0.31	
Environmental Sewer Fee	$1.23	
City Tax	$0.33	
State Tax	$0.37	
Jail Charge	$0.30	
"Draino" Tax	$0.01	
SubMeter Fee	$3.50	
Current Billing	$16.64	
Previous Period	$16.05	
Service Est. Charge / Late Fee	$0.00	
Payments	$16.05	
Total Due	**$16.64**	

Payment in full is required by 7/15/03.
Payment should be sent to the Association & made payable to HOA.
Including your water & dues payment in ONE check will save bank fees.
The range of water usage this month was from 0 to 14,000 gallons.
The average usage this month was 3,292 gallons.

Figure 4.18 Submeter water bill #2 from billing company #2

Submeter water bill #3 is shown in Figure 4.19. This is an example of a submetered water bill sent by the property management, not a third party billing company. **Pros:** Total amount due is shown prominently. Actual meter readings, consumption and commodity charge for water and wastewater are shown. Billing period is shown. Utility water rates are provided.

Cons: No consumption history or comparison data shown. Overall this is an informative and comprehensible billing statement.

Invoice: Water & Sewer/Billing Period: 09/16/03->10/15/03

Apartments

Prior Reading	New Reading	Water Usage (x 10 gal)	CCF= 748 gal. (Usage/748)	Rate= $1.11 per CCF	City Service Charge	Subtotal: Water
10055	10247	1920	2.56	2.84	1.48	4.32

Sewer CCF*$5.53	Sewer Subtotal:
11.49	11.49

Total Amount Due: **$15.81**

City of Seattle Charges: Winter Rate: 9/16 -> 5/15 =$1.69 CCF
Summer Rate: 5/16 -> 9/15 = $2.75 CCF

Payment due by: Nov 1, 2001.
Delinquent after: Nov 5, 2001

Remit payment to: The Apartments
Manager Box
Seattle, WA

***Please make separate rent & water checks due to ***

Figure 4.19 Submeter water bill #3

Submeter water bill #4 from billing company #3 is shown in Figure 4.20 and in Figure 4.21. Like the previous submeter bills, this is an informative and understandable bill. **Pros:** Total amount due is shown prominently. Actual meter readings, consumption and commodity charge for water and wastewater are shown. Billing period is shown. Customer service information is featured prominently and a detailed explanation of the bill and where to ask questions is included. Fees are broken out and clearly labeled. **Cons:** No consumption history or comparison data shown. Utility water and wastewater rates are not shown so there is no way for the customer to determine if commodity charges have been inflated. No way to determine what fees are from the billing company or are passed through from the water utility. Overall this is an informative and comprehensible billing statement.

Previous Balance for ALL Locations : 16.43 **Payments** 16.43
Beginning Balance as of 1/13/2004 : 0.00

Parcel #

Standard 12/10/2003 - 1/10/2004 (meter)

	Previous	Current	Usage	Unit - Measure
Readings	369	375	6	CF

Charge Description	Balance Forward			Current Charges
Water - Tier 1		3 @	0.59	1.77
Water - Tier 2		3 @	0.75	2.25
Base Water				3.00
Sewer				6.05
Trash				4.84
Total For				17.91

Your Old Account Number is:

MOVING OUT? NO NEED TO CALL . YOUR PROPERTY MANAGEMENT WILL PROVIDE US WITH THE INFORMATION.

Account Number :
Name :
Due Date : 2/2/2004

Invoice Number : 2279172
Invoice Date 1/13/2004

TOTAL AMOUNT DUE **17.91**

Phone: 800- • Fax: 888-
Hours: 8:30 am - 4:30 pm (pst) Monday through Friday
(Se Habla Español)

Contact Customer Service
via e-mail at

Figure 4.20 Submeter water bill #4 from billing company #3

UNDERSTANDING YOUR BILL

You are responsible for the payment of any combination of water, sewer, gas, electric, and trash services at you residence during the period of your occupancy. Please contact Customer Service Department to ensure that we have the correct date for initiation or termination of service. Each month, your bill will show dates for the services provided (Billing Period and the date by which payment must be received (Amount Due By)

PAYMENTS

- Bills are payable upon receipt.
- Payments not received by the statement's Amount Due By Date are considered delinquent (Past Due) and are subject to late fees.
- If you are unable to make payment at the present time, pleas call the Customer Service Department to make payment arrangements.
- You will be charged a service charge for each check which is returned unpaid for any reason and your service may be disconnected, if applicable by law, without further notice.

Non-payment of delinquent bills may result in termination of service, if applicable by law, and collection proceedings including notification of credit agencies, legal action and eviction proceedings, In the case of lessees including apartment residents, the property owner of record may be notified of non-payment which ma cause a default in your lease agreement. This may lead to eviction proceedings or attachment of your security deposit, where applicable. Mailing remittance does not constitute payment and assumes no liability for postal delay.

BILLING QUESTIONS

If you have a question about your bill, please contact a Customer Service Representative at the telephone number below.
If you have a dispute:

- You must first pay the undisputed amount to by the Amount Due By Date; and
- You must send written notice of your dispute to at the address shown on this bill. Late fees will be waived on the disputed amount and

  writing within 30 days of receipt of your notice.

Mailing Address

OFFICE HOURS
Customer Service Department (800)
Monday through Friday 8:30 am - 4:30 pm (PST)
(excluding holidays)
Se Habla Español
E-mail us at:

Payment Address With Stub

is a provider of utility billing and collection services and is not a direct provider of utility services.

Figure 4.21 Submeter water bill #4 from billing company #3 (continued)

Submeter water bill #5 shown in Figure 4.22 is from billing company #4. Units at this property have separately metered hot and cold water. No service fees are shown on this bill. **Pros:** Total amount due is shown prominently. Meter readings and consumption for cold and hot water are shown. Billing period is shown. Customer service information is featured prominently. **Cons:** Commodity charge for water and wastewater not shown. Utility water and wastewater rates are not shown so there is no way for the customer to determine if commodity charges have been inflated.

MONTHLY BILLING STATEMENT

PORTLAND, OR

IMPORTANT INFORMATION

ELECTRONIC WITHDRAWAL IS AVAILABLE FOR AUTOMATIC PAYMENT OF YOUR UTILITY BILL. PLEASE CALL 800- FOR MORE INFO.

Account Number:
Property:

Statement Date: 08/06/03

Account Summary

Previous Balance: $ 14.02
Payment Received: $ 14.02
Past Due Balance: $ 0.00
Current Charges: $ 17.77

Current Utility Service from 07/01/03 to 07/31/03

UTILITY	PREV	CURR	USAGE	CHARGE
Sewer	0	0	0	$ 12.65
Cold Water	3,373	3,529	156	$ 2.93
Hot Water	3,108	3,205	97	$ 2.19

Billing Questions: (800)
8 a.m. to 5 p.m. - Monday through Friday
Correspondence Address:

TOTAL AMOUNT DUE: $17.77

PLEASE PAY BY: 08/25/03

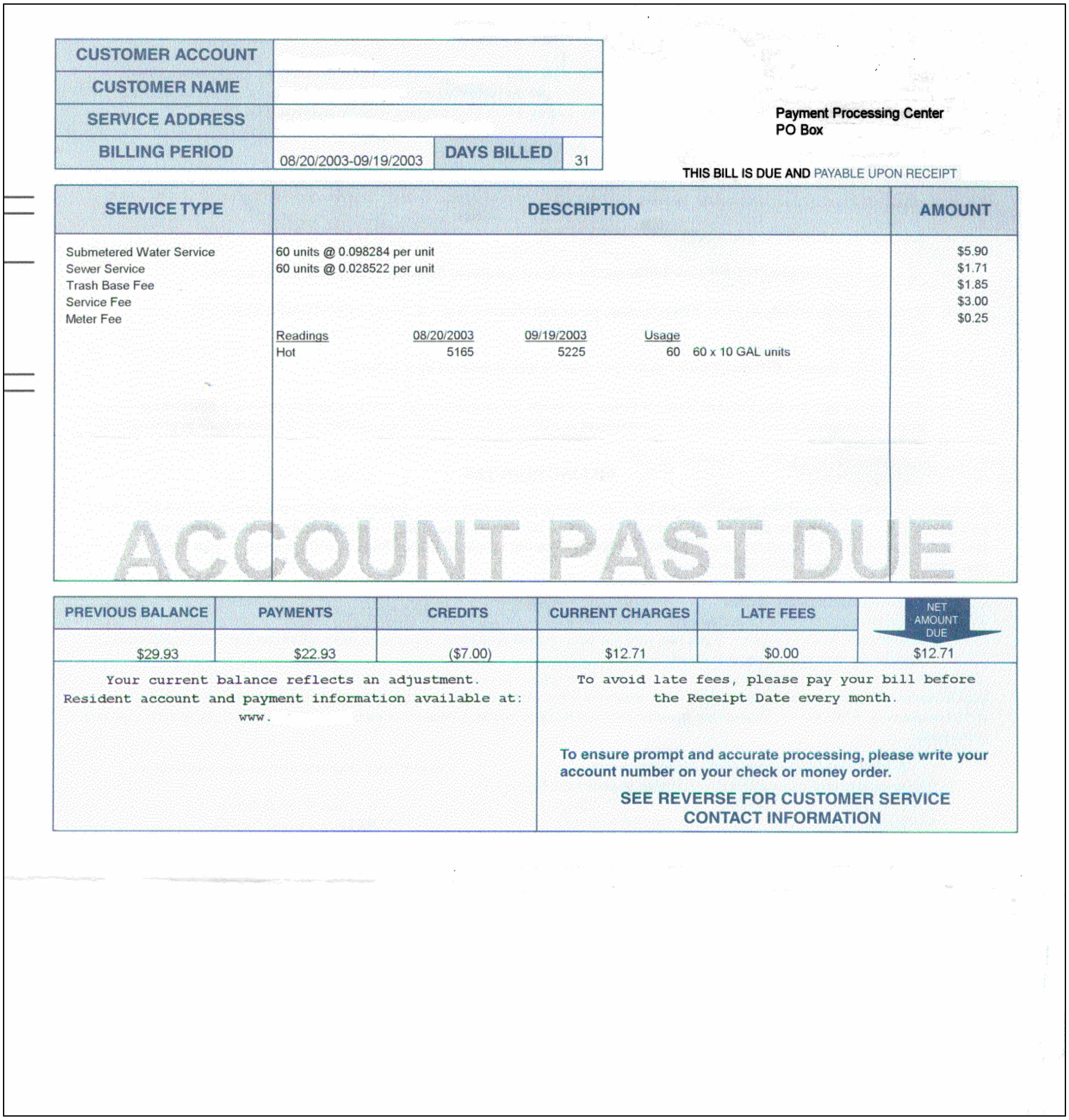
For Prompt Posting, write the account number on your check.
Detach portion below and return with payment in envelope provided.

Figure 4.22 Submeter water bill #5 from billing company #4

Hot Water Hybrid Sample Bills

Two sample hot water hybrid water bill are presented below. One of the fundamental problems with both HWH bills presented below is that no method or explanation is provided for how total water use is calculated from hot water use. The actual commodity charges for hot water shown on these bills are substantially higher than utility water charges, so it was presumed that the rate was intended to reflect hot and cold water usage. However, no explanation for this calculation could be found.

Hot water hybrid water bill #1 shown in Figure 4.22 is from billing company #5. **Pros:** Total amount due is shown prominently. Meter readings and consumption for hot water is shown. Billing period is shown. Customer service information is featured prominently on back of bill. Service fees and meter fees are clearly distinguished. **Cons:** Service type listed is "Submetered water service." While partially true, this does not give information to the customer that only the hot water usage is actually metered. Commodity charge for hot water ($9.82/kgal) is substantially higher than the utility rate for water and it is assumed this charge was designed to encapsulate cold water usage as well. No explanation or methodology for determining cold water use is provided on the bill. Utility water and wastewater rates are not shown so there is no way for the customer to determine if commodity charges have been inflated.



CUSTOMER ACCOUNT			
CUSTOMER NAME			
SERVICE ADDRESS			
BILLING PERIOD	08/20/2003-09/19/2003	DAYS BILLED	31

Payment Processing Center
PO Box

THIS BILL IS DUE AND PAYABLE UPON RECEIPT

SERVICE TYPE	DESCRIPTION	AMOUNT
Submetered Water Service	60 units @ 0.098284 per unit	$5.90
Sewer Service	60 units @ 0.028522 per unit	$1.71
Trash Base Fee		$1.85
Service Fee		$3.00
Meter Fee		$0.25

Readings	08/20/2003	09/19/2003	Usage	
Hot	5165	5225	60	60 x 10 GAL units

ACCOUNT PAST DUE

PREVIOUS BALANCE	PAYMENTS	CREDITS	CURRENT CHARGES	LATE FEES	NET AMOUNT DUE
$29.93	$22.93	($7.00)	$12.71	$0.00	$12.71

Your current balance reflects an adjustment.
Resident account and payment information available at:
www.

To avoid late fees, please pay your bill before the Receipt Date every month.

To ensure prompt and accurate processing, please write your account number on your check or money order.

SEE REVERSE FOR CUSTOMER SERVICE CONTACT INFORMATION

Figure 4.23 Hot water hybrid water bill #1 from billing company #5

Hot water hybrid water bill #2 shown in Figure 4.24 is from billing company #6. **Pros:** Meter readings and consumption for hot water is shown. Billing period is shown. Customer service information is featured prominently. Service fees and meter fees are clearly distinguished. Hot water hybrid methodology is presented although no explanation of the actual hot/cold ratio is provided. **Cons:** Commodity charge for hot water ($11.67/kgal) is substantially higher than the utility rate for water and it is assumed this charge was designed to encapsulate cold water usage as well. No data on total building cold water usage or the percentage associated with this customer is provided on the bill. Utility water and wastewater rates are not shown so there is no way for the customer to determine if commodity charges have been inflated.

ACCOUNT NUMBER	
LAST MONTH'S PAYMENT	36.14
BILL DATE	10/21/2003
DUE DATE	11/10/2003
AMOUNT DUE	33.08

1

FOR QUESTIONS REGARDING YOUR ACCOUNT, PLEASE CALL
1-800- OR
WEBSITE - WWW.
MON-FRI 8:00AM - 5:00PM PST

SAN DIEGO, CA
00003058 13 3058

SERVICE LOCATION	SERVICE FROM	SERVICE THRU	NUMBER OF DAYS
	9/11/03	10/10/03	29 DAYS

Charge Type	Previous Read	Current Read	Usage	Multiplier	UOM	Charges
SERVICE FEE						4.75
TRASH SERVICE						5.00
WATER SERVICE	6920	7800	880	1.000	GAL	10.27
SEWER SERVICE	6920	7800	880	1.000	GAL	13.06

* INDICATES THE UTILITY ACCOUNT WAS NOT IN YOUR NAME UPON MOVE-IN AS AGREED. THE OWNER WAS BILLED FOR THE PERIOD INDICATED ABOVE, HOWEVER, YOUR LEASE OBLIGATES YOU TO PAY FOR THIS UTILITY. PLEASE CONTACT THE UTILITY TO TRANSFER THE ACCOUNT INTO YOUR NAME.

YOUR BILL IS NOW BASED UPON THE PERCENTAGE OF HOT WATER CONSUMED IN YOUR UNIT COMPARED TO ALL UNITS OF THE APARTMENT COMPLEX, SHOWN AS FOLLOWS: (YOUR HOT WATER) DIVIDED BY (TOTAL HOT WATER USAGE OF ALL UNITS)= YOUR PERCENTAGE. YOUR BILL IS EQUAL TO YOUR PERCENTAGE OF THE APARTMENT COMPLEX'S WATER AND SEWER BILLS.

PLEASE CONTACT WITH ANY QUESTIONS ON THESE CALCULATIONS.

A LATE FEE MAY BE ASSESSED ON ANY UNPAID BALANCE THAT IS NOT RECEIVED BY THE DUE DATE

RETAIN THIS PORTION FOR YOUR RECORDS. NOTE: This bill is NOT from your local utility.

VES018
VES003 VES00301.RTP 00003058 / 00003058

Figure 4.24 Hot water hybrid water bill #2 from billing company #6

RUBS Sample Bills

Seven sample RUBS water bills are presented below. Additional sample bills can be found in Appendix C. Many of the RUBS bills provided by the residents provided minimal information. The selections presented here offer the range of RUBS bills from comprehensive to simplistic.

RUBS water bill #1 shown in Figure 4.25 comes from an apartment in San Antonio, Texas and is by far the most informative RUBS bill provided to the research team, however some important information is still lacking. Much of the information on the bill is based on recommendations from the Texas Natural Resource Conservation Commission. **Pros:** Shows the total water bill for the complex, the amount allocated to common area (25%) and the amount allocated to residents (75%). Cost per occupant is calculated. Telephone number for billing questions provided. **Cons:** Actual amount owed by resident not clearly delineated. Billing period not shown.

Allocated Water Bill for November 2003

Apartments

San Antonio, TX

October 22, 2003

Unit #

San Antonio, TX

The following calculations were used in determining your water bill:

Based on Service Dates to

Total Water Bill	$ 6,696.52
Adjustments	$ (304.94)
Total Bill	**$ 6,391.58**
Meter for Water	**$ 3,935.42**
Meter for Wastewater	**$ 2,456.16**
Percent Allocated to Property (of total bill)	25%
Percent Allocated to Tenants (of total bill)	75%
Dollar Amount Allocated to Property (25% of Total)	$ 1,597.90
Dollar Amount Allocated to Residents (75% of Total)	$ 4,793.69
Total Estimated Number of Residents per TNRCC's guidelines	768
Due Per Occupant (This Period)	$ 6.24

Payment is due by November 15, 2003. A 5% late fee will be added if received after due date.

Reimbursement Rate if based on the estimated occupancy level as approved by the Texas Natural Resource Conservation Commission.

Floorplan	Estimated occupants per floorplan(TNRCC)	Amount Due
One Bedroom	1.6	$ 9.99
Two Bedroom	2.8	$ 17.48

Please pay the amount that corresponds to the amount of bedrooms in your floorplan.

Make Checks Payable To:

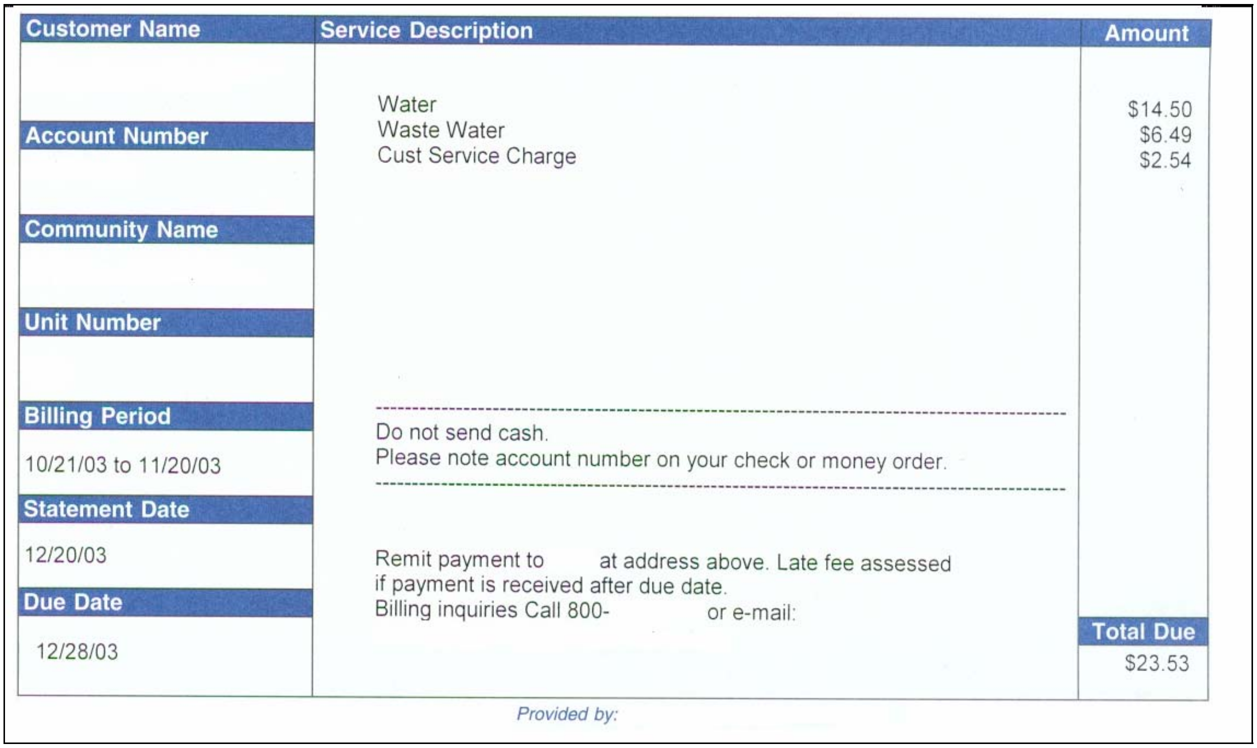
San Antonio, TX

This Retail Public Provider is the City of San Antonio (SAWS).
We are billing each Resident per the Texas Natural Resource Conservation Commission's Estimated Occupancy Method.
There is a 15 day grace period from date of invoice for payment. If payment is made after 15 days, a 5% late charge will apply.
In case of billing questions please call the Apartments main office 210-

Sincerely,

Figure 4.25 RUBS water bill #1

RUBS water bill #2 shown in Figure 4.26 was sent by billing company #7. This is a fairly simple RUBS bill and typical of many that were provided by residents. **Pros:** Amount owed by resident clearly shown. Service charge is delineated. Billing period shown. Customer service information and phone number featured prominently. **Cons:** No explanation of RUBS methodology. Total property water and wastewater charges not shown. Utility water and wastewater rates are not shown so there is no way for the customer to determine if commodity charges have been inflated.

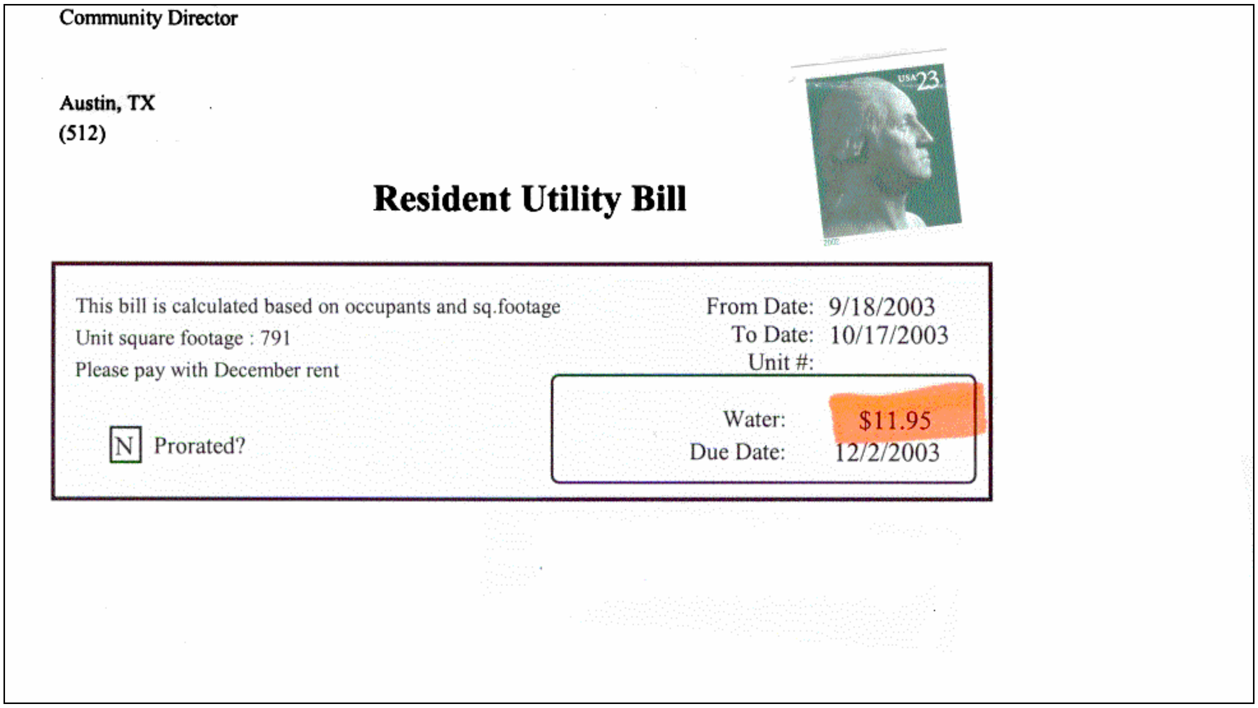


Customer Name	Service Description	Amount
	Water Waste Water Cust Service Charge	$14.50 $6.49 $2.54
Account Number		
Community Name		
Unit Number		
Billing Period	Do not send cash. Please note account number on your check or money order.	
10/21/03 to 11/20/03		
Statement Date		
12/20/03	Remit payment to at address above. Late fee assessed if payment is received after due date. Billing inquiries Call 800- or e-mail:	
Due Date		**Total Due**
12/28/03		$23.53

Provided by:

Figure 4.26 RUBS water bill #2 from billing company #7

RUBS water bill #3 shown in Figure 4.27 was sent to a property in Austin, Texas. This is another simple RUBS bill, typical of many that were provided by residents. **Pros:** Amount owed by resident clearly shown. Billing period shown. RUBS methodology is explained. Contact information for the community director is provided (although much of it was whited out to preserve anonymity). **Cons:** Total property water and wastewater charges not shown. Utility water and wastewater rates are not shown so there is no way for the customer to determine if commodity charges have been inflated. Service charge (if any) is not delineated.



Community Director

Austin, TX
(512)

Resident Utility Bill

This bill is calculated based on occupants and sq.footage
Unit square footage : 791
Please pay with December rent

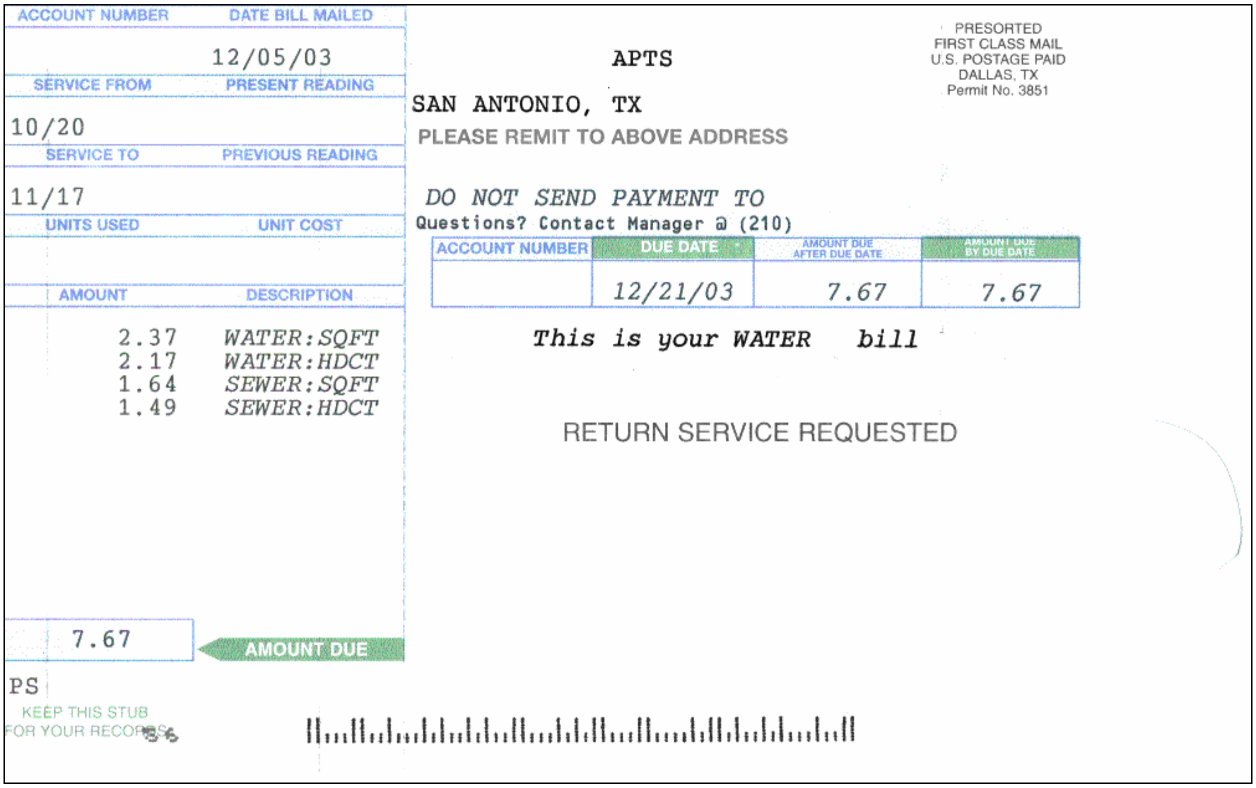
From Date: 9/18/2003
To Date: 10/17/2003
Unit #:

N Prorated?

Water: $11.95
Due Date: 12/2/2003

Figure 4.27 RUBS water bill #3

RUBS water bill #4 shown in Figure 4.28 was sent by billing company #8. **Pros:** Amount owed by resident clearly shown. Billing period shown. RUBS methodology (square footage and number of residents) is explained, although not in a clear way. Customer service phone number provided. **Cons:** RUBS methodology is not clearly explained. Specific factors for customer are not shown. Total property water and wastewater charges not shown. Utility water and wastewater rates are not shown so there is no way for the customer to determine if commodity charges have been inflated. Service charge (if any) is not delineated.



ACCOUNT NUMBER | DATE BILL MAILED
12/05/03
SERVICE FROM | PRESENT READING
10/20
SERVICE TO | PREVIOUS READING
11/17
UNITS USED | UNIT COST

AMOUNT	DESCRIPTION
2.37	WATER:SQFT
2.17	WATER:HDCT
1.64	SEWER:SQFT
1.49	SEWER:HDCT

7.67 AMOUNT DUE

PS
KEEP THIS STUB
FOR YOUR RECORDS

APTS

SAN ANTONIO, TX
PLEASE REMIT TO ABOVE ADDRESS

PRESORTED
FIRST CLASS MAIL
U.S. POSTAGE PAID
DALLAS, TX
Permit No. 3851

DO NOT SEND PAYMENT TO
Questions? Contact Manager @ (210)

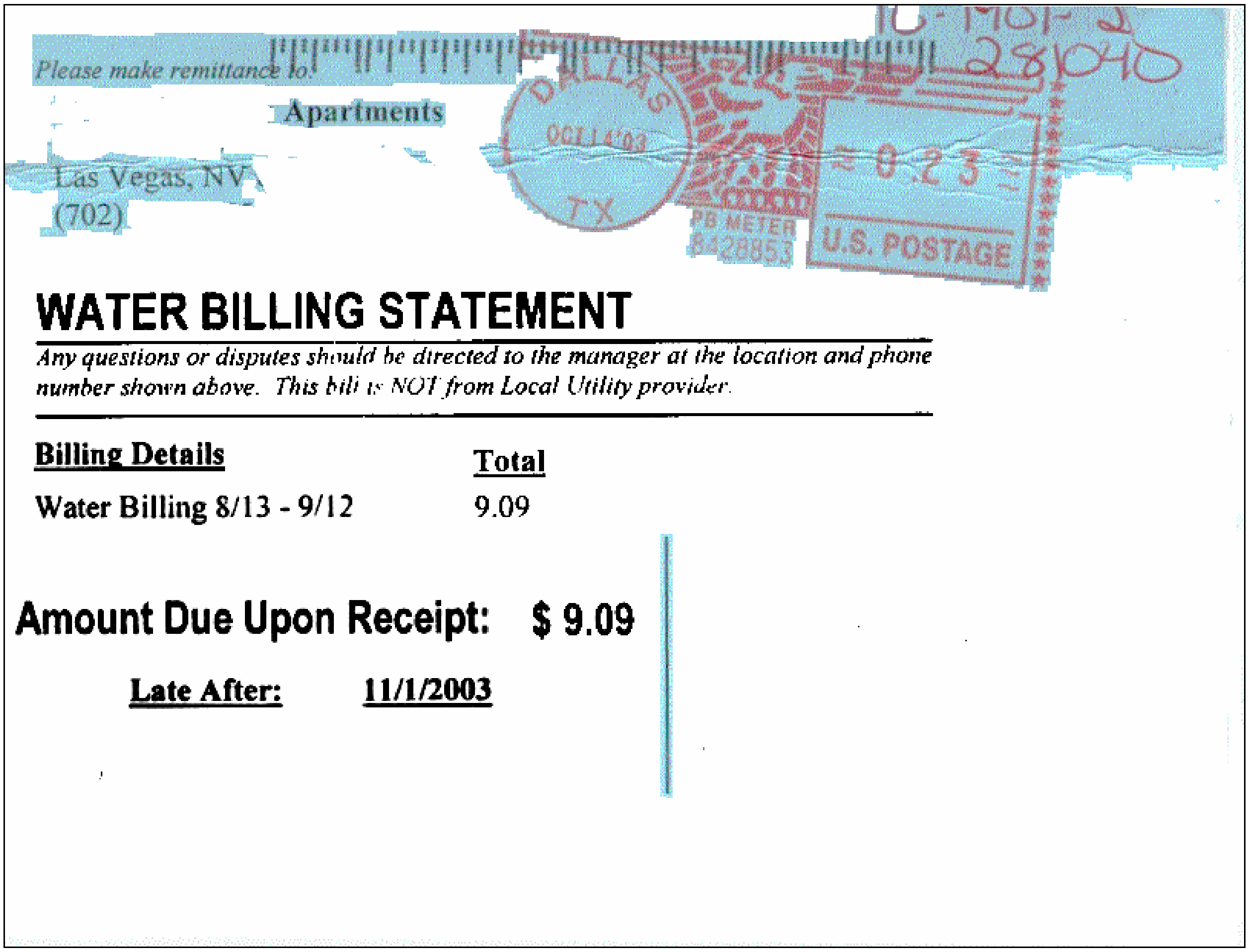
ACCOUNT NUMBER	DUE DATE	AMOUNT DUE AFTER DUE DATE	AMOUNT DUE BY DUE DATE
	12/21/03	7.67	7.67

This is your WATER bill

RETURN SERVICE REQUESTED

Figure 4.28 RUBS water bill #4 from billing company #8

RUBS water bill #5 shown in Figure 4.29 was sent to a customer in Las Vegas, NV. **Pros:** Amount owed by resident clearly shown. Billing period shown. Customer service phone number was provided (although much of it was whited out to preserve anonymity). **Cons:** RUBS methodology is not explained. Specific factors for customer are not shown. Total property water and wastewater charges not shown. Utility water and wastewater rates are not shown so there is no way for the customer to determine if commodity charges have been inflated. Service charge (if any) is not delineated.



Please make remittance to:

Apartments

Las Vegas, NV

(702)

DALLAS TX OCT 14'03

PB METER 8428853

U.S. POSTAGE 0.23

10-MOF-2 281040

WATER BILLING STATEMENT

Any questions or disputes should be directed to the manager at the location and phone number shown above. This bill is NOT from Local Utility provider.

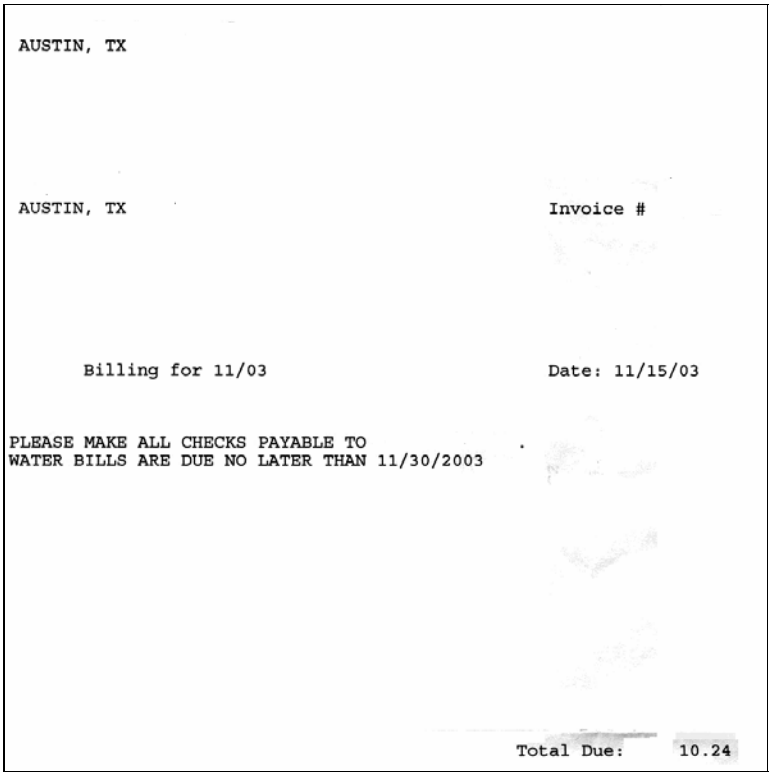
Billing Details	Total
Water Billing 8/13 - 9/12	9.09

Amount Due Upon Receipt: $ 9.09

Late After: 11/1/2003

Figure 4.29 RUBS water bill #5

RUBS water bill #6 shown in Figure 4.30 was sent to a customer in Austin, TX. **Pros:** Amount owed by resident clearly shown. **Cons:** RUBS methodology is not explained. Specific factors for customer are not shown. Total property water and wastewater charges not shown. Utility water and wastewater rates are not shown so there is no way for the customer to determine if commodity charges have been inflated. Service charge (if any) is not delineated. Customer service information and/or phone number not provided. Billing period not shown.



AUSTIN, TX

AUSTIN, TX

Invoice #

Billing for 11/03

Date: 11/15/03

PLEASE MAKE ALL CHECKS PAYABLE TO
WATER BILLS ARE DUE NO LATER THAN 11/30/2003

Total Due: 10.24

Figure 4.30 RUBS water bill #6

RUBS water bill #7 shown in Figure 4.31 was sent to a customer in Denver, CO. This bill is different from the others presented because it also includes rent as well as other services, although the water and wastewater portion are separated. **Pros:** Amount owed by resident clearly shown. **Cons:** RUBS methodology is not explained. Specific factor(s) for customer not shown. Total property water and wastewater charges not shown. Utility water and wastewater rates are not shown so there is no way for the customer to determine if commodity charges have been inflated. Service charge (if any) is not delineated. Customer service information and/or phone number not provided. Water and wastewater billing period not shown.

10/23/03
12:12 pm

Denver, CO

S T A T E M E N T O F A C C O U N T

Date: October 22, 2003
No.

Denver, CO

Unit Address:

Date	Transaction Description	Code	Charge	Credit	Balance
	Balance Forward:				-580.00
10/01/03	Rent	CA RENT	590.00		10.00
10/01/03	Senior Citizen Discount	PW SENR		10.00	0.00
10/22/03	Gas	CK UTIL	18.45		18.45
10/22/03	Water/Sewer	CK UTIL	36.91		55.36
10/22/03	Trash Removal	CK UTIL	4.01		59.37
11/01/03	Rent	CA RENT	590.00		649.37
11/01/03	Senior Citizen Discount	PW SENR		10.00	639.37

Figure 4.31 RUBS water bill #7

READ AND BILL COMPANIES AND SURVEY RESULTS

Billing service companies (also referred to as “read and bill companies” or “third party billing companies”) are the driving forces behind the rapid growth of submetering and RUBS water and wastewater billing systems. Through the National Submetering and Utility Allocation Association (NSUAA) the research team was able to identify 36 billing service companies operating across the United States. This is not a complete list. Many billing service companies are not active in the NSUAA and there a number of local service providers who focus on a single market.

Billing service companies work with property owners and managers to recover water and wastewater costs by sending individual bills to residents. Most companies offer a wide menu of options for property owners to choose from and can provide billing for water, wastewater, trash collection, and other services at the property including gas and electricity. Typically a property owner will contract with a billing service provider to handle resident water and wastewater billing for a fixed period of time. This agreement may include the installation of whole unit submeters, hot water only submeters, point of use (POU) submeters, or may be for RUBS. In some cases, once the agreement is in effect the utility water and wastewater bill will be send directly to and then paid by the third party billing company. However it is more common for the owner or property manager to continue to receive the utility bill and then pass the information along the billing service provider. The billing service provider sends the bills the residents, and the residents send their payments to the owner. The owner pays the full utility bill.

Billing service companies profess not to make a profit reselling water and wastewater services. The research team found that in most submetered properties the actual commodity charge for water and wastewater from the utility is passed straight through to the residents without any inflation. There were a few notable exceptions to this however. With RUBS it is frequently impossible to determine the actual commodity charge from the bill sent to the resident, and therefore it cannot be determined empirically if water and wastewater services are being inflated.

Billing service companies make a profit by including a service charge on every bill they send out. This service charge typically ranges from $1 to more than $6 per bill, and the average service charge is about $3.25 per bill. Like service charges assessed by water utilities, the third party billing company service charge is assessed irrespective of the amount of water used. In addition to the service charge, billing service companies may assess late fees and other charges on the resident's bill such as a metering fee. The exact fees charged are often determined on a property by property basis and depending upon the regulatory requirements of state or local jurisdiction.

As evidenced by the number of billing service companies doing business in the US, billing multi-family dwelling residents for water, wastewater, and other services is profitable. A simplistic analysis shows that a relatively small company sending out 30,000 bills per month and charging an average service fee of $3 per bill could gross more than $1 million per year. A large billing service company sending out 300,000 bills per month could gross more than $10 million per year. These are simplified gross revenue estimates and actual net revenue must take into account all of the costs of doing business, but the potential profitability of this type of business is apparent.

To learn more about billing service companies, their business practices, and how they operate the research team developed a survey instrument that was sent to the highest-ranking officer that could be identified at each billing service company.

Sample Size

A total of 36 surveys were sent to all water billing companies listed in the most recent roster from the National Submetering and Utility Allocation Association. A second mailing was sent to non-respondents. A total of 18 surveys (50% response rate) were completed and returned.

General Description of Billing Companies

The 18 companies that responded to the survey send a combined total of 1,428,200 individual bills per month. The largest company sends about 450,000 bills per month and the smallest about 2,500. The median was 36,000. Most of the companies began operating during the 1990s and 1997 was the median start date. The oldest company was started in 1984 and the newest in 2002. Just over 61% of the companies have a national clientele while the remaining 39% are regionally focused. About 61% of the companies are bonded and 39% are not.

Billing Method

The overwhelming majority of billing companies surveyed (94.7%) offer a combination of submetering, RUBS, and hot water hybrid billing methodologies. Only one company indicated that they provide RUBS billing exclusively. Approximately 44.7% of the bills sent out by respondents are to submetered dwellings, 48.6% of the bills go to RUBS units, and 6.6% of the bills are for hot water hybrid.

RUBS Methods

Many of the billing companies offer a wide variety of RUBS allocation methodologies to their customers. Billing based on the number of residents per unit was the most common allocation method followed by billing based on the area (square footage) of each dwelling unit. Table 4.20 shows the frequency of each methodology (percents add to more than 100% as respondents could give more than one answer). The “other” methods implemented included combinations of other allocation methods and other weighting factors customized on an individual property basis.

Respondents indicated that the practice of subtracting common area water use and/or irrigation from RUBS customers bills is a fairly common practice with 55.6 percent reporting that they make this subtraction for all of their RUBS customers. Another 38.9 percent reported making this adjustment for “some” RUBS properties. Only one respondent (5.6%) reported never subtracting for common area water use. In one case it was reported that metered common area use was subtracted from the total bill. The frequency and methods used to subtract for common area and/or irrigation usage are shown in Table 4.21.

Table 4.20 RUBS allocation methods

RUBS Allocation Method	% of Companies Using Method*
Based on number of residents per unit	94.4%
Based on area (square footage) of dwelling unit	83.3%
Flat fee	44.4%
Based on number of bedrooms	33.3%
Based on number of fixtures	27.8%
Based on number of bathrooms	22.2%
Other	22.2%

*Percents add to more than 100% as respondents could give more than one answer

Table 4.21 RUBS – common area/irrigation adjustment method

RUBS – Common Area/Irrigation Adjustment Method	% of Companies Using Method*
Based on property owner specifications	61.1%
Based on specific common area amenities present (i.e. swimming pool, hot tub, kitchen, landscaping, water feature, etc.)	61.1%
Based on a percentage of total water use (typically about 10 – 20%)	50.0%
Other methods	16.7%
Fixed dollar amount subtracted	5.6%
Fixed volume of water subtracted	5.6%
Not applicable	5.6%

*Percents add to more than 100% as respondents could give more than one answer

Submetering Methods

Most companies that bill using submeters use both manual and automatic meter reading (AMR) methods. More than 61% of respondents use manual meter reading and 94.4% use AMR at some or all of their submetered properties. The various AMR technologies being used by the responding companies include: Touch Read, Radio Read, wireless, 3G, Inovonics, RAMAR, Speed Read, Master Meter, Tap Watch, Hexagram, Quad Logic, and Wellspring point of use and pulse meter transmitter base station with modem.

Approximately 72% of respondents indicated that they have implemented a meter maintenance standard and 22% reported not having a maintenance standard. 76.5% of respondents reported having a meter testing standard for accuracy, while 17.6% said they do not have this type of standard. Nearly 78% of respondents said that submetered residents are allowed to request meter testing for accuracy. In about 60% of these cases the residents must pay for this testing themselves.

Customer Service, Bills, and Fees

Most billing company respondents (72.2%) reported having written customer service standards in place, while 27.8% of respondents indicated they do not have written customer service standards. However, every single company does put a contact telephone number on each water bill sent out. One third of the respondents said that they include informative historic consumption information on the water bill and two-thirds said they do not include this information.

None of the respondents (0.0%) indicated that they ever resell water at a profit at any of their client properties.

Non-Payment of Water Bills

Non-payment of water bills can be a problem for water utilities, but has been particularly troubling for third party billing service companies. Respondents to the survey indicated an average non-payment rate of 12.7 percent. The median non-payment rate reported was 10 percent with a minimum of 3 percent and a maximum of 35 percent. For comparison, the East Bay Municipal Utility District (EBMUD) in Oakland, CA reports a non-payment rate of less than 1 percent.

Service Charges

The average service charge applied to each water bill is $3.29 according to the survey respondents. The minimum service charge is $1.50 and the maximum reported was $6.15. The median was $3.00. Table 4.22 shows the frequency of use of different service charge determinations. The flat fee is by far the most common.

Table 4.22 Method for determining service charge

Method for Determining Service Charge	% of Companies Using Method*
Flat fee per bill	94.4%
Based on utility service charge	11.1%
Based on a percent of the bill	5.6%
Other	5.6%

*Percents add to more than 100% as respondents could give more than one answer

Late Fees

At the start of water billing service, 72.2% of the companies provide customers written information on the late fee payment structure, while 11.1% (2 respondents) do not. 16.7% or respondents indicated that they didn't know or that the question wasn't applicable.

Most service companies (66.7%) have their own specific time frame for late payment. The average number of days is 17.8 with a range of 5 to 28 days. About 17% of billing companies use the same late fee structure as the local utility, 11.1% allow until the next bill, and 1 company (5.6%) said they do not charge late fees.

Reported late fees ranged from $5 to $25 with 44.4% of respondents using a fixed dollar amount. Another 22.2% charge late fees based on a percent of the amount billed, typically 5 to 10 percent, and 11.1% use the same late fee structure as the local utility. Nearly 17% of respondents use their own distinct late fee structure.

Customer Complaints

All survey respondents (100%) reported that they have an established administrative process to handle customer complaints and all but one respondent (94.4%) indicated that they have gone through this complaint/dispute process with a customer. Typical customer complaints are presented in Table 4.23.

Table 4.23 Common customer complaints to billing companies

Common Customer Complaints	% of Companies Reporting These Complaints*
Amount of bill (consumption charge)	88.9%
Service charge	27.8%
Bill itself	22.2%
Customer service information	16.7%
Bill format	11.1%
Other	11.1%

*Percents add to more than 100% as respondents could give more than one answer

National Administrative Guidelines

Survey respondents were generally favorable to the idea of national administrative guidelines for the submetering and allocation billing industry, provided that the industry has real input. More than 55% of respondents said they might support national guidelines if there were industry input. Nearly 28% said they would support national guidelines, and 11.1% said they wouldn't.

CHAPTER 5 ANALYSIS OF WATER USE AND BILLING METHODS

The data collected for the National Multiple Family Submetering and Allocation Billing Program Study provides a wealth of information about how submetering and allocation affect water use, property owners, and residents. Drawn from these data are insights into this developing industry, including the quantitative aspects of separate billing. The data are also useful for examining the impacts of the 1992 Energy Policy Act plumbing standards and other factors that may influence water use. It is anticipated that the database of submetered and allocated data developed for this study will be a resource for researchers and planners to explore for years to come, particularly if it is maintained and updated through additional research projects.

This chapter presents the fundamental water use findings of the data collection from the selected properties and analysis portion of the study. These findings include comparisons of matched allocated, submetered, and in-rent properties, as well as a before and after comparison of impact properties. Water use data are taken from the 2001 and 2002 billing databases of the participating utilities. The largest sample is from properties described by respondents to the postcard survey, followed by the medium-sized sample of the properties described in the manager survey, and then smaller subsets including the matched pair respondents. Keep in mind that this study did not set out to estimate national "averages" of impact property water use, and the selected properties were not selected to be representative of the entire United States. Rather the primary goal was to determine the impacts of different billing programs.

No analysis and presentation of these water use data could hope to answer all of the questions that readers may have. For specific questions or analyses not presented here, the database assembled for this study is available from the researchers. For details about the database and how to obtain a copy contact Aquacraft, Inc. (www.aquacraft.com).

ESTIMATED WATER USE BY DIFFERENT BILLING METHODOLOGIES

One of the central purposes of this research study was to determine whether there is any validity to the commonly asserted premise that individual billing for water and wastewater services reduces water consumption by residents of multi-family properties. This notion seems intuitively clear, and matches common economic theory[23], but the only way to test it is to take a detailed look at the property level water consumption data combined with sufficient additional information about each property to allow construction of valid regression models that will correct for all of the important variables, and not incorrectly attribute water savings to the billing system when it is actually due to some other effect, such as the presence of ULF toilets. To add another dimension to the problem it was necessary to deal with not one, but three different forms of individual billing systems, and to test them separately. The fact that one system may save water is no guarantee that all individual billing systems will accomplish the same objective. The nature of the billing system, and how it is perceived by the resident, could easily be as important to the response of the customer as the mere fact of receiving a separate water bill. This study set out to test the effectiveness of submetering, RUBS allocations, and hot water hybrid billing programs as water conservation tools for multi-family housing. This research question has been an over-arching theme for the entire project and significant effort has been spent collecting and analyzing data to understand the potential water savings from submetering and RUBS.

Why are water savings so important? Water providers are keenly interested in identifying effective approaches to reducing water demand as new supplies become increasingly expensive and difficult to obtain. National and state agencies are interested in improving water efficiency and promoting proven methods for achieving savings. The utility billing industry has promoted the practice of charging multi-family customers for water and wastewater services not only as a way to improve property owners' net operating income, but also as a way to effect water conservation. Water savings could provide justification for encouraging, promoting, and expanding billing programs and could unite water providers, regulators, and billing companies in a common goal. As a result there has been intense interest in this question.

Analytic Methods

The methodology and analytic techniques used in this study are presented in detail in Chapter 3 in the Data Analysis section. Data sources and analytic methods are referenced in this section to foster understanding of the results presented, but please refer to Chapter 3 for specific information about the methodology.

It should be kept in mind when reviewing the results of the analyses that they are based on mathematical models and other statistical tools that seek to find the center point of a large

[23] See Chapter 6, "Economic Comparison of Submetering and RUBS" for details.

group of data, or a line that represents the best fit between two variables. Thus, by definition, there will always be data points above and below values predicted by even the best models. To appreciate this, just glance ahead to Figure 5.4 and Figure 5.5. These show how best fit lines are created for large sets of data that show a relationship between water use and the number of dwelling units present. The lines, if shown by themselves on these figures would give the appearance of great precision, however, when one looks at the scatter in the data it is clear that the model will not predict water use for any specific site very well, but will predict water use for a large group much better.

So, when the analysis shows that there is a 95% confidence level that there will be a specified difference in the average water use between two groups this should be thought of not as a prediction that water use of individual members of the group will vary by this amount, since due to the distribution of the data they might not, but as a prediction that there will be a 95% probability that the average water use of a number of examples chosen from the two groups will vary by this amount. From the perspective of any planning or policy study that deals with large groups the ability to understand group dynamics is the key to good decision making.

Summary of Findings on Water Savings

To reach a conclusion regarding how water use differs between billing types, seven main analyses were conducted. The number of properties included in each analysis is included in Table 5.1. The results of each analysis are discussed in the sections that follow. As the reader reviews the findings of each analysis, it may be helpful to refer back to Table 5.1, Table 5.2, and Table 5.3, as they summarize the relevant findings and can help to avoid confusing the various analyses.

Table 5.1 Number of properties included in each analysis, by billing type

Description of Analysis	Number of Properties by Billing Method (n)				
	In-Rent	Sub.	RUBS	HWH	Total
Postcard Survey	6493	273	595	41	7402
Manager Survey	858	118	177	22	1175
Statistical Model #1	705	101	150	-	956
Statistical Model #2	703	100	150	-	953
Statistical Model #3	531	79	136	-	746
Matched Pair	29	21*	14	-	64
Pre-Post Conversion	-	6	39	1	46

* 7 HWHs were grouped with the submetered for this analysis

Indoor water use was normalized on total number of units rather than on occupied units because vacancy rates were not found to be a statistically significant factor. Indoor water use was not normalized on a per occupant basis because 15% of survey respondents left that question blank thus reducing the potential sample size. The number of units on the property was answered by 100% of manager survey respondents. In addition, the site visits determined that the reported number of residents was a less accurate value than the reported number of units. Finally, the relationship between total indoor water use at a property and number of units was almost linear (see Figure 5.4).

Submetering

The analyses conducted on the data showed that submetering achieved water savings of 15.3 percent compared with in-rent properties. These savings were statistically valid and corrected for factors such as year of construction, average number of bedrooms per unit, average rent, presence of play areas, presence of cooling towers, average commodity charge for water and wastewater by the local utility, and classification of the property as a retirement community. A total of seven separate analyses were performed on the data, and all of them arrive at the same conclusion, summarized in Table 5.2, that properties that use submetering to bill customers for their measured water consumption use significantly less water than the traditional in-rent properties. Water savings ranged from 5.6 to 18 kgal per unit per year, or 15 to 48 gallons per unit per day. This represents a reduction in water use of 11% to 26% in properties employing submetering. Based on an evaluation of the different data sets, analyses, and models, the researchers concluded that multivariate model #2 provided the single "best estimate" of expected water use and savings at submetered properties[24]. The number of properties used in each analysis can be seen in Table 5.1. Details of all of these analyses are presented later in this chapter.

[24] Submetered properties were identified by manager survey responses. Through the site visits, it was found that 3 out of 20 properties visited (15%) had indicated on the manager survey that they were submetered, but were found to only be metering the the hot water. Thus, the submetered sample is likely to contain some hot water hybrids.

Table 5.2 Summarized water use analysis results, submetering

Data Source or Analysis	Annual Water Use per Unit (kgal)		Estimated Difference in Water Use (± 95% confidence interval)		Statistically Significant at 95% Confidence Level?
	In-Rent (or pre-conversion)	**Submetering**	**kgal/unit/year**	**Percent**	
Postcard Survey	53.21	44.87	-8.34 ± 3.29	-15.7% ± 6.2%	*Yes*
Manager Survey	51.61	46.07	-5.55 ± 4.81	-10.7% ± 9.3%	*Yes*
Model #1	52.33	43.73	-8.60 ± 4.86	-16.4% ± 9.3%	*Yes*
Model #2	52.19	44.23	-7.96 ± 4.84	-15.3% ± 9.3%	*Yes*
Model #3	53.19	43.14	-10.05 ± 5.47	-18.9% ± 10.3%	*Yes*
Matched Pair	57.59	47.61	-9.98 ± 9.77	-17.3% ± 17.0%	*Yes*
Pre-Post Conversion	68.21	50.71	-17.50 ± 18.55	-25.7% ± 27.2%	*Yes**
Conclusion	**52.19**	**44.23**	**-7.96 ± 4.84**	**-15.3% ± 9.3%**	***Yes***

* Test was significant at the 94% confidence level.

RUBS

The study failed to show any significant water savings associated with Ratio Utility Billing Systems (RUBS). With one exception, none of the analyses shown in Table 5.3 showed any significant reduction in water use that can be attributed to RUBS when compared with traditional in-rent arrangements. Typically the 95 percent confidence interval for RUBS spanned a range that included an *increase* in expected water use as well as water savings. Statistically significant water use savings from RUBS were detected in only a single comparison test – the matched pair sample. The matched pair comparison, however, is not considered reliable. It relied on the smallest RUBS sample size in the study and, as explained in detail later in this chapter, the in-rent control sample did not appear to be representative of the population of in-rent properties in the study.

Based on an evaluation of the different data sets, analyses, and models, the researchers concluded that multivariate model #2 provided the single "best estimate" of expected water use at RUBS properties. After correcting for a wide variety of factors and evaluating numerous different analytic models, the researchers concluded that no statistically significant impact from RUBS could be reliably expected. The number of properties used in each analysis can be seen in Table 5.1.

Table 5.3 Summarized water use analysis results, RUBS

Data Source or Analysis	Annual Water Use per Unit (kgal)		Estimated Difference in Water Use (± 95% confidence interval)		Statistically Significant at 95% Confidence Level?
	In-Rent (or pre-conversion)	RUBS	kgal/unit/year	Percent	
Postcard Survey	53.21	52.10	-1.11 ± 2.28	-2.1% ± 4.3%	No
Manager Survey	51.61	53.45	1.84 ± 4.04	3.6% ± 7.8%	No
Model #1	52.33	52.76	0.43 ± 3.89	0.8% ± 7.4%	No
Model #2	52.19	52.58	0.39 ± 3.88	0.7% ± 7.4%	No
Model #3	53.19	51.48	-1.71 ± 4.10	-3.2% ± 7.7%	No
Matched Pair	66.19	47.80	-18.39 ± 12.73	-27.8% ± 19.2%	*Yes*
Pre-Post Conversion	55.32	52.85	-2.48 ± 4.88	-4.5% ± 8.8%	No
Conclusion	**52.19**	**52.58**	**0.39 ± 3.88**	**0.7% ± 7.4%**	**No**

Hot Water Hybrid

The study results suggest that hot water hybrid billing systems may achieve water savings, however, the sample of hot water hybrid properties was too small to produce reliable results that can be generalized to the broader population. Analysis of data from the limited sample of hot water hybrid properties does suggest that water savings, somewhat smaller than the magnitude found in submetering, *may* be achieved through this billing methodology, but this study was unable to verify this finding in a statistically rigorous manner because of the small sample size. Summary water use analysis results for hot water hybrid properties are shown in Table 5.4. The number of properties available for each analysis can be seen in Table 5.1. It should be noted that it was found from the site visits that a significant proportion (15%) of the hot water hybrid properties had been mislabeled by the mangers as submetered. This indicates that HWHs may be more common that originally thought, and is suggestive that they may have comparable savings to submetering. However, further research is needed to verify this.

Table 5.4 Summarized water use analysis results, hot water hybrid

Data source or Analysis	Annual Water Use per Unit (kgal)		Estimated Difference in Water Use (± 95% confidence interval)		Statistically Significant at 95% confidence level?
	In-Rent (or pre-conversion)	Hot Water Hybrid	kgal/unit/year	Percent	
Postcard Survey	53.21	49.61	-3.60 ± 8.35	-6.8% ± 15.7%	no
Manager Survey	51.61	44.79	-6.83 ± 10.58	-13.2% ± 20.5%	no

Annual per Unit Water Use

Before examining the modeling results in detail it is useful to examine the basic water use statistics for the in-rent, RUBS, submetered, and hot water hybrid properties for respondents to the postcard survey and manager survey. This is simply the annual indoor per unit water use (kgal) in these properties for 2001 and 2002. Indoor and outdoor use were disaggregated for each property using the methodology described in Chapter 3. All impacted properties included in this analysis implemented their billing program in the year 2000 or earlier, so the data under examination represents the "post-conversion" period. A small number of outlier properties from the postcard and manager survey respondents that used less than 6 kgal per unit per year and more than 200 kgal per unit per year were discarded.[25]

Postcard Survey Respondents

Initially, it was hoped that a fairly good sample of RUBS and submetered properties could be identified within the service areas of the study sites from the utility data bases and/or information from the utility billing companies customer records. This proved to be untrue. The utilities had no record of which of their multi-family customers send individual water bills to their residents, and the utility billing companies were unwilling to provide complete lists of their customers in these cities. This led to the worry that the study would be based on a small or selective sample of properties, which would have invalidated the results. In order to solve this problem the Postcard Survey was sent out to *all of the multi-family customers*[26] in the service areas of each of the participating water providers.

A copy of the Postcard Survey is reprinted in Appendix A. The responses from this survey made up the largest sample group in the study, but it was never intended to serve as a data set for detecting differences in water use. The postcard survey was a short survey that asked only three questions: how customers are billed for water, who bills them, and how many units the property contains. The primary purpose of this survey was to identify a random sample of as many submetered and RUBS properties as possible and to learn the frequency with which each type of water billing system occurs in the overall group of multi-family customers. The key assumption was that the return rate for each group would be the same, which is believed to be a

[25] Discarded outliers were most frequently high values (>200 kgal/unit/year). The outliers were likely the result of inaccurate reporting on the number of units on the property or an inaccurate amount of consumption attributed to the property. In addition, if water data were unavailable for 2 or more months, the water data were discarded.

[26] See Chapter 3 for details.

reasonable assumption since there is no reason why the type of billing system being used would affect the likelihood of a survey being returned.

Because water billing data were available for all of the respondents it was possible to compare water use patterns for the respondents. It should be kept in mind, however, that the water use statistics derived from the postcard survey respondents are inconclusive by themselves because they are uncorrected for other property characteristics that might influence water use. It is important to keep in mind that there may be other factors (age of property, size, rent, etc.) which impact water use that are not factored into these analyses of the data from the properties owned or managed by postcard survey respondents. The purpose of the multivariate modeling effort (presented later in this chapter) was to correct for these factors. Only an analysis that takes these factors into consideration can be considered more conclusive about the cause of water use savings. However, it is instructive and suggestive to look at water use and to evaluate differences using the postcard survey respondents, especially since it is the largest available sample.

The 2001 and 2002 annual water use per unit summary statistics for the properties reported on by the postcard survey respondents are shown in Table 5.5. Overall, submetered properties used between 7.4 and 9.2 kgal less water per unit per year on average than the in-rent properties. RUBS properties used between 1.0 kgal less and 1.5 kgal more water per unit per year on average than in-rent properties. Hot water hybrid properties used between 2.1 and 3.4 kgal more water per unit per year on average than in-rent properties.

In both 2001 and 2002 the median RUBS water use was slightly higher than the median in-rent use while the median submetered water use was lower than the in-rent use value. The median annual water use per unit is lower than the mean (average) value within each billing method, suggesting a heavy tailed (possibly skewed as well) distribution. The lognormal distribution is often taken as a good fit for residential water use if the population is homogeneous. In this case, this is not so. There is no particular reason to expect that effects are multiplicative rather than additive. Consequently, the analysis was done on the natural scale. However, as a check, the analysis was also ran on the log scale, and found no qualitative difference in the conclusions.

Table 5.5 2001 and 2002 annual indoor per unit water use - postcard survey respondents

		In-rent or HOA	Submetered	RUBS	Hot water hybrid
2001	Average (kgal)	53.95	44.76	52.97	51.85
	Std Dev (kgal)	28.17	26.62	23.85	34.90
	Median (kgal)	47.44	40.10	49.36	40.21
	Number	N=6437	N=259	N=582	N=41
2002	Average (kgal)	52.94	45.56	51.45	49.52
	Std Dev (kgal)	28.94	26.01	25.36	34.57
	Median (kgal)	45.96	40.72	46.76	40.97
	Number	N=5096	N=254	N=558	N=29

Four separate t-tests (assuming unequal variance) were performed comparing the 2001 in-rent water use against the 2002 in-rent water use, the 2001 submetered water use against the 2002 submetered water use, and so on. Using an alpha value of 0.05, a 95% confidence interval, it was found that there was no statistically significant difference between the water use from these two years. Because of the increased statistical power of a larger dataset, annual indoor per unit water use data for 2001 and 2002 from the postcard survey respondents were combined by averaging the water use from each year. If water data were available from only one of the years, that estimate was used.

Summary water use statistics for the combined data set are shown in Table 5.6 and depicted graphically in Figure 5.2 and Figure 5.3. In-rent properties used the most on average (53.21 kgal/unit/year) followed next by RUBS (52.10 kgal/unit/year), hot water hybrid (49.61 kgal/unit/year) and submetered properties (44.87 kgal/unit/year). The standard deviation for these four groups were all on the same order of magnitude – approximately 50% of the mean. The highest standard deviation was found in the hot water hybrid group, which had the smallest sample size. The median water use was highest for the RUBS group.

Table 5.6 2001 and 2002 average annual indoor per unit water use - postcard survey respondents

		In-rent or HOA	Submetered	RUBS	Hot water hybrid
Average of 2001 and 2002	Average (kgal)	53.21	44.87	52.10	49.61
	Std Dev (kgal)	27.51	25.50	23.95	31.39
	Median (kgal)	46.66	39.94	48.14	41.45
	Number	N=6493	N=273	N=595	N=41

Figure 5.1 shows the frequency distribution of water use for each of these four groups, using the combined 2001-2002 historic billing data. These histograms are plotted as lines rather than bars to make it easier to compare the shape of each distribution. The in-rent, submetered, and RUBS frequency distributions are quite similar in shape with the RUBS curve slightly elevated in the 60 – 90 kgal/unit/year range. The hot water hybrid distribution appears to be markedly shifted to the left (suggesting lower water use), but higher use in the 70 – 110 kgal/unit/year range pushed the average up.

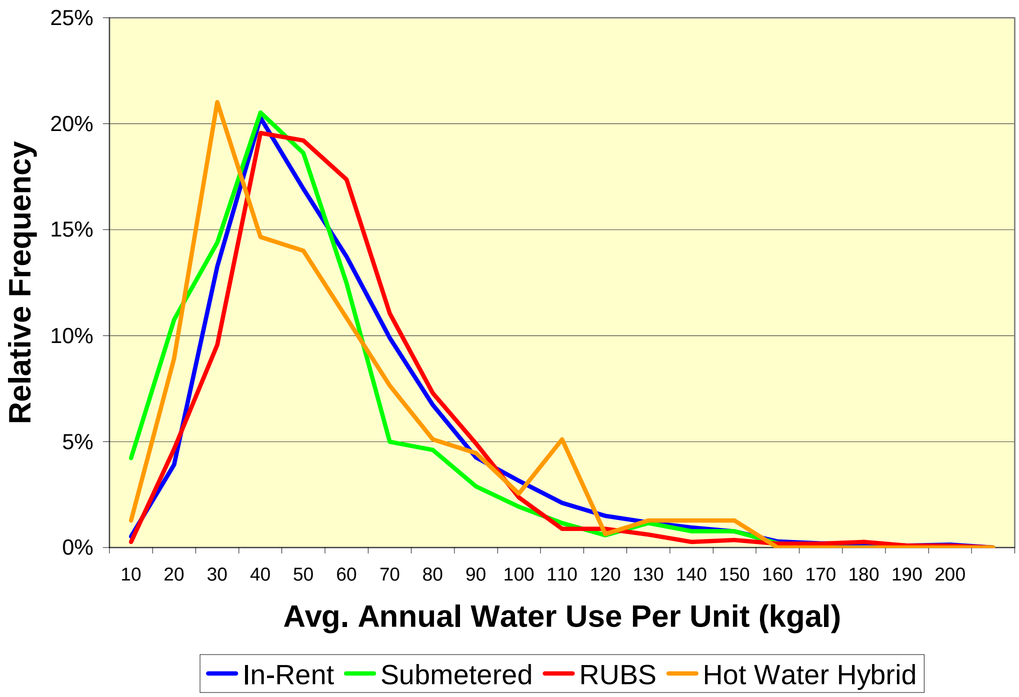


Figure 5.1 Frequency distribution, avg. annual water use per unit, postcard survey respondents

Three separate t-tests were performed comparing the annual per unit water use (2001 and 2002) from the in-rent properties first against the submetered properties, then the RUBS properties, and finally the hot water hybrid properties. The purpose of these analyses was to determine if a statistically significant difference in water use exists between any of these groups at the 95% confidence level. The results of these t-tests are shown in Table 5.7. The null hypothesis in each test was that the difference in mean water use was 0. The alpha-level for a 95% confidence level was 0.05. Only the difference in means between the in-rent and the submetered properties proved to be statistically significant at the 95% confidence level. There was no statistically significant difference found between water use at the in-rent properties and the RUBS or the hot water hybrid properties. This can also be observed in Figure 5.3, which shows that the confidence intervals around the estimate of the difference in the average water use of submetered properties compared to in-rent properties does not include 0.

Table 5.7 Statistical tests of postcard survey respondent properties: in-rent properties vs. impact properties

	In-Rent vs. Submetered	In-Rent vs. RUBS	In-Rent vs. Hot Water Hybrid
Means (kgal)	In-Rent = 53.21 Submetered = 44.87	In-Rent = 53.21 RUBS = 52.10	In-Rent = 53.21 HWH = 49.61
Hypothesized Mean Difference	0	0	0
Degrees of freedom	299	745	40
t Stat	5.278	1.070	.732
p-value (T<=t) two-tail	.000	.285	.469
Statistically significant difference?	Yes	No	No

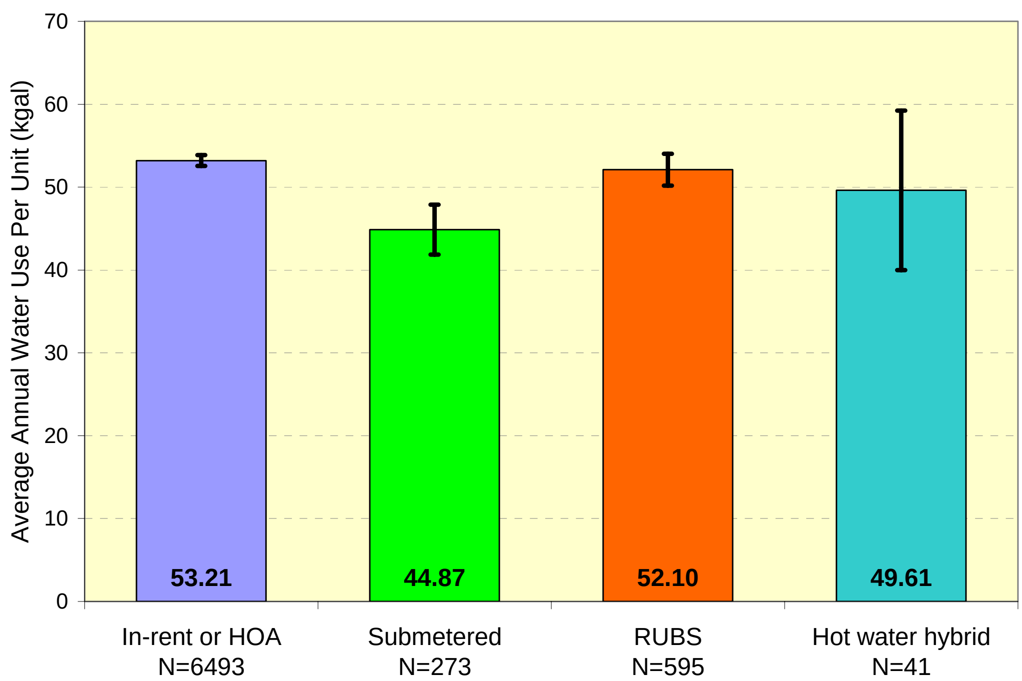


Figure 5.2 Average annual water use per unit – postcard survey respondents

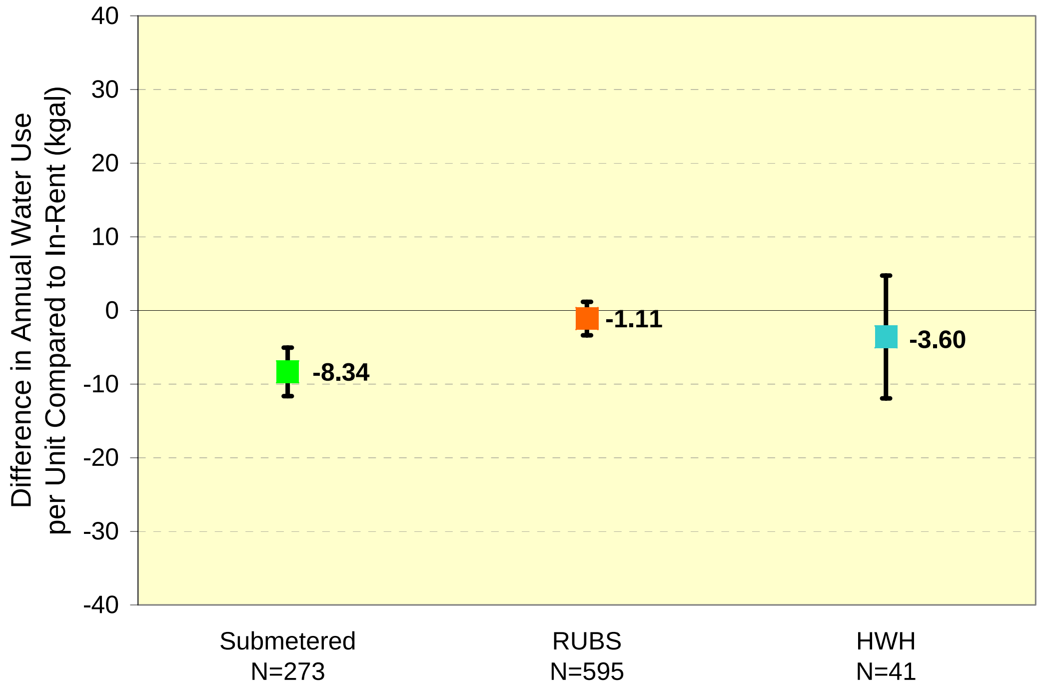


Figure 5.3 Difference in average annual water use compared to in-rent properties – postcard survey respondents

Manager Survey Respondents

The manager survey response group was considered the best and most reliable for analysis since it was a large group with good, detailed information for the important explanatory variables. The analyses shown in this section represent the key work, from which conclusions were drawn concerning the impact of water billing system on water consumption. This survey contained descriptive information about the property that included: plumbing fixtures, water-using amenities, billing information, occupancy, and more. A copy of the manager survey is reprinted in Appendix A. The analyses of the various factors from the manager survey are presented later in this chapter.

Unadjusted Comparison of Water Use of Manager Survey Respondent Properties

The 2001 and 2002 annual water use per unit summary statistics for manager survey respondents are shown in Table 5.8. On average, before adjusting for any differences in property characteristics between properties employing different billing methods, the submetered units used between 4 and 5 kgal less water per year than did units in the in-rent properties. The RUBS properties used between 0.4 *less* and 3.3 kgal *more* water per year on average. The hot water hybrid properties appeared to use substantially less water than either in-rent or RUBS properties, but the sample size of these properties was, again, too small to be considered conclusive.

Table 5.8 2001 and 2002 annual indoor per unit water use - manager survey respondents

		In-rent or HOA	Submetered	RUBS	Hot water hybrid
2001	Average (kgal)	51.56	46.20	54.85	47.17
	Std Dev (kgal)	25.43	23.65	23.72	37.34
	Median (kgal)	46.75	42.44	52.19	40.72
	Number	N=847	N=113	N=175	N=22
2002	Average (kgal)	52.60	47.04	52.95	43.33
	Std Dev (kgal)	27.91	22.35	23.98	38.06
	Median (kgal)	46.92	44.09	49.55	32.87
	Number	N=774	N=112	N=169	N=17

Four separate t-tests were performed comparing the 2001 in-rent water use against the 2002 in-rent water use, the 2001 submetered water use against the 2002 submetered water use, and so on. Using an alpha value of 0.05 that corresponds to a 95% confidence interval, it was found that there was no statistically significant difference between the water use from these two years. Because of the increased statistical power of a larger dataset, annual indoor per unit water use data for 2001 and 2002 from the manager survey respondents were combined by averaging the water use from each year. If water data were available from only one of the years, that estimate was used.

For most of the analyses in this report, water use was normalized by number of units, however, it is interesting to look at the results at the more basic level of total indoor water use verses number of units for each property. Also, it is very helpful to look at plots that show all of the data in addition to the best fit lines so that the fit of the model and the scatter of the data can be seen by the reader.

Figure 5.4 shows the relationship between the total indoor water use and the number of units by billing type for the manager survey respondents. Separate trendlines were fit to the data for in-rent, RUBS and submetered properties. The trendlines were plotted as power curves in order to determine their linearity. It is striking that in each case the exponent is very close to 1, which confirms that there is a linear relationship between the number of units on a property and its total indoor use. This also provides justification for normalizing the water use on the basis of the number of units. In Figure 5.5, a similar graph was developed for just those properties built after 1995. By including only those properties built after 1995, the uncertainty about water fixture efficiency is removed, since all properties should have efficient plumbing fixtures. Again, the relationship is still very close to linear for all groups, and the submetered trendline again lies below the in-rent and the RUBS lies above.

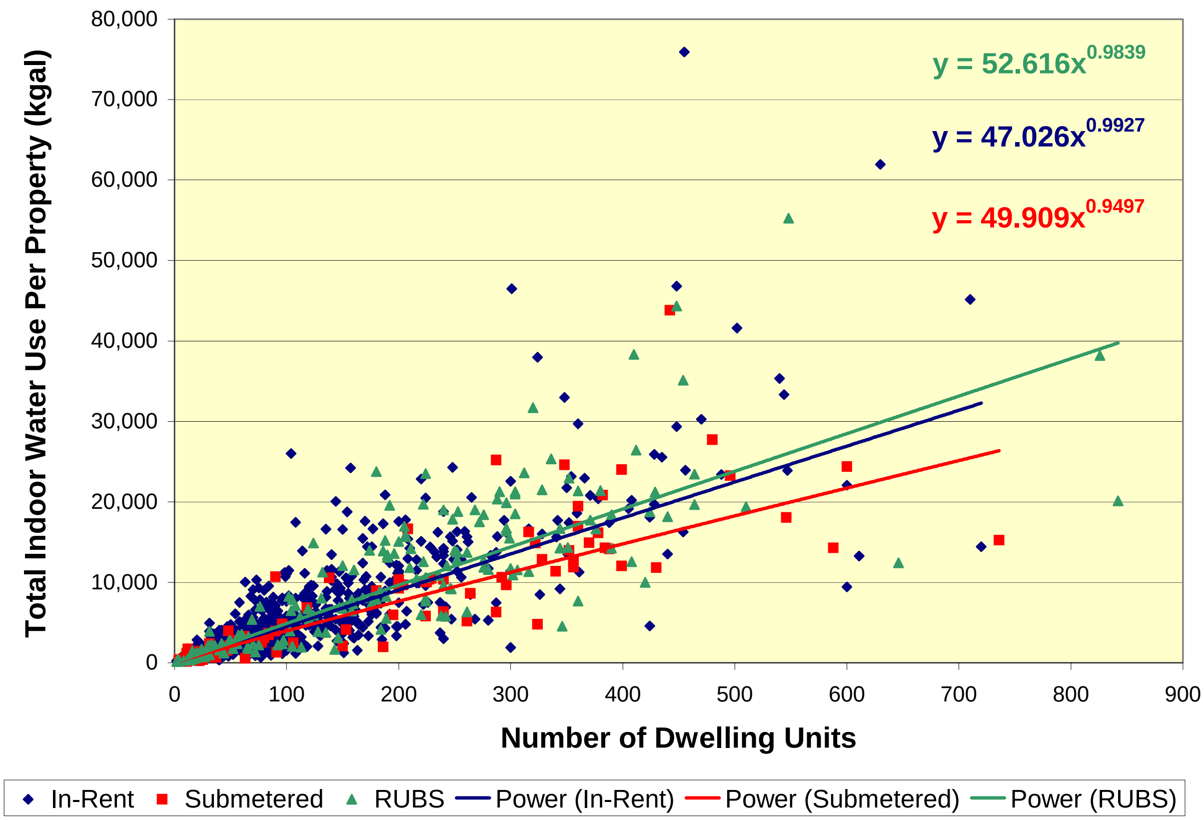


Figure 5.4 Total water use vs. dwelling units, all manager survey properties

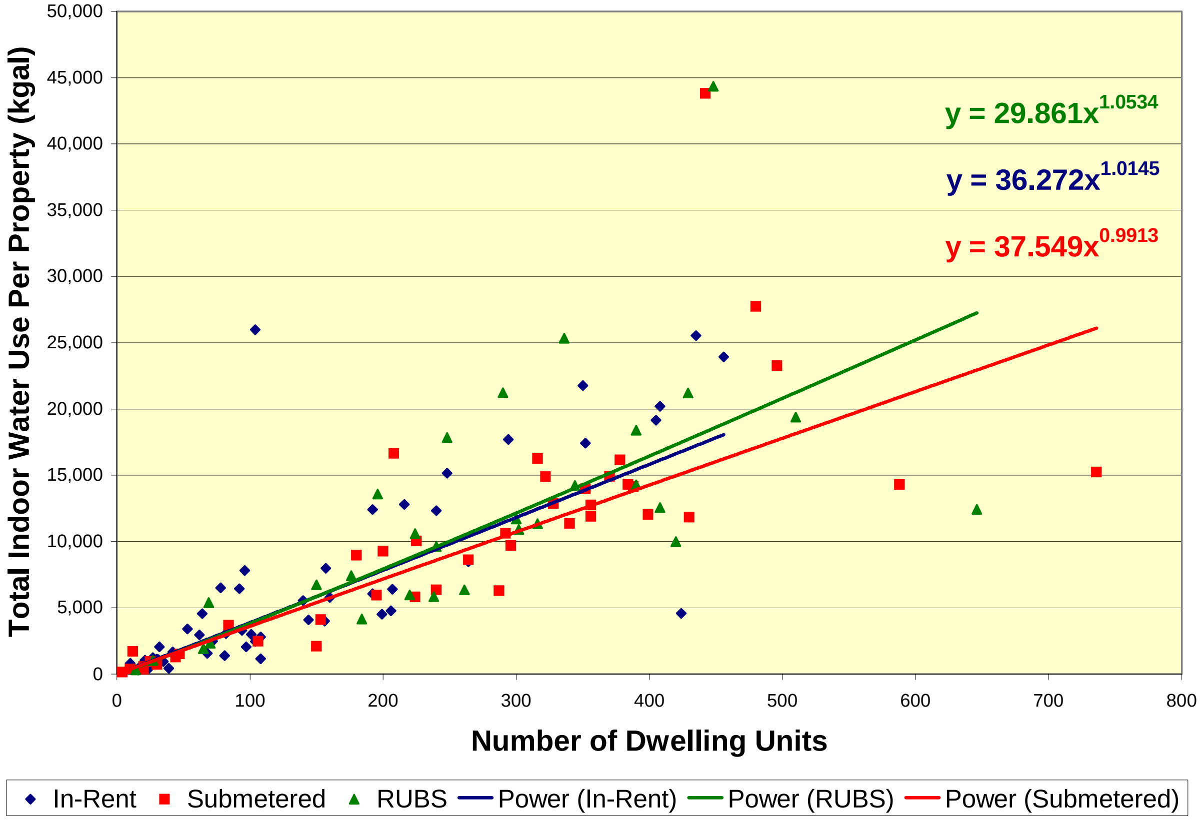


Figure 5.5 Total water use vs. dwelling units, properties built after 1995

The average water use by billing type for the manager survey respondents is shown in Figure 5.6, and the differences in water use compared to in-rent are shown in Figure 5.7. Water use in submetered properties was significantly lower than in in-rent properties, but no statistically significant differences were observed between RUBS properties and in-rent properties, or between hot water hybrid properties and in-rent properties (see Table 5.10).

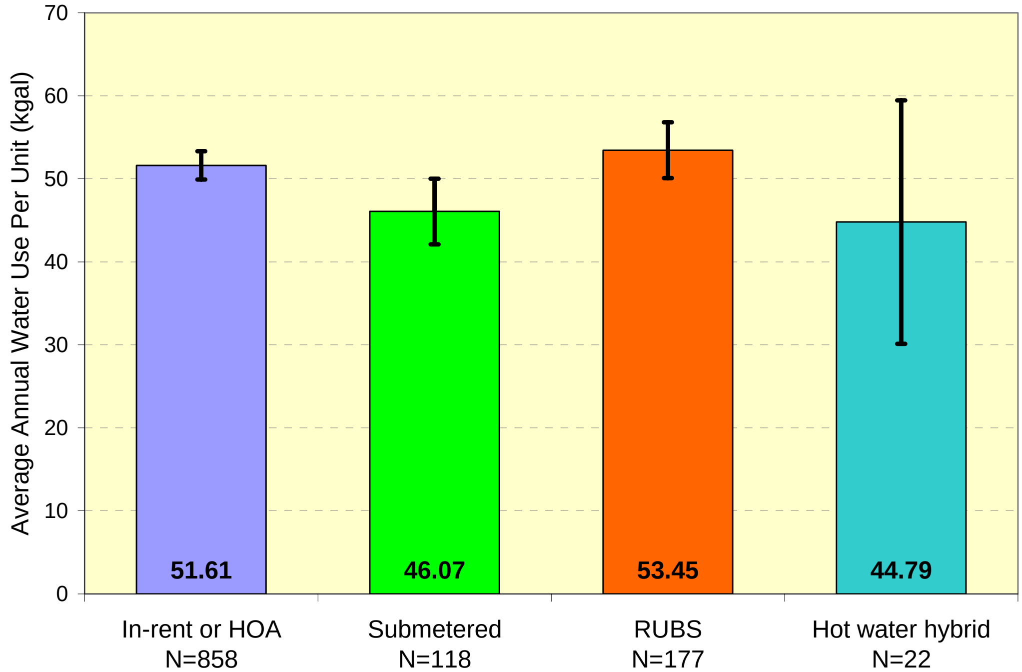


Figure 5.6 Average annual water use per unit – manager survey respondents

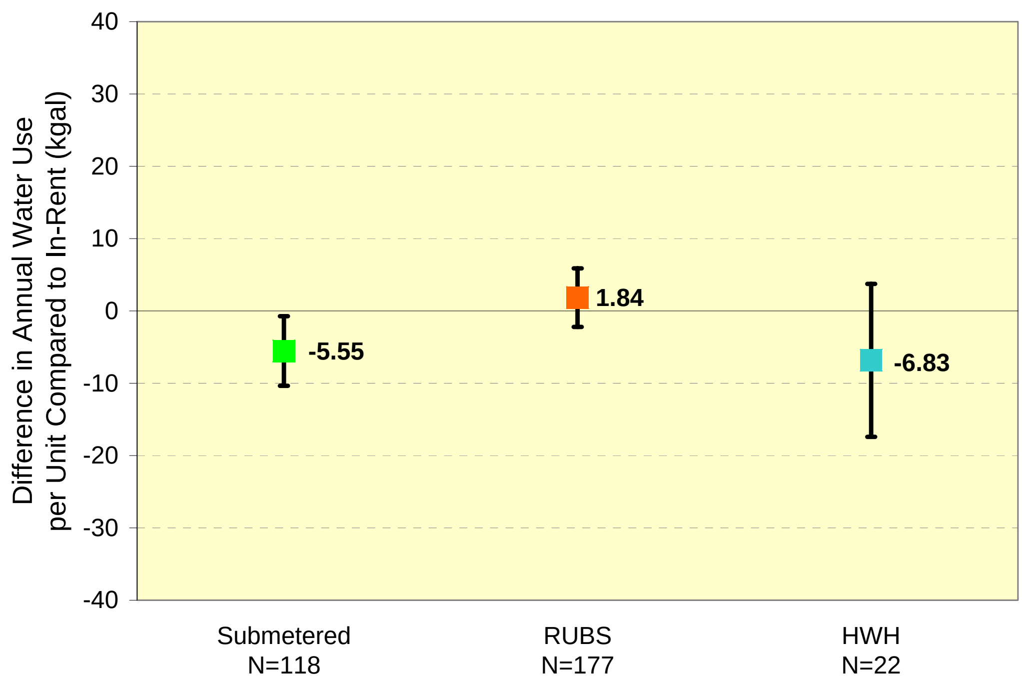


Figure 5.7 Difference in average annual water compared to in-rent properties – manager survey respondents

Table 5.9 2001 and 2002 average annual indoor per unit water use - manager survey respondents

		In-rent or HOA	Submetered	RUBS	Hot water hybrid
Average of 2001 and 2002	Average (kgal)	51.61	46.07	53.45	44.79
	Std Dev (kgal)	25.52	21.86	22.79	35.09
	Median (kgal)	46.04	43.12	48.92	38.80
	Number	N=858	N=118	N=177	N=22

Table 5.10 Statistical tests of manager survey respondent properties: in-rent properties vs. impact properties

	In-Rent vs. Submetered	In-Rent vs. RUBS	In-Rent vs. Hot Water Hybrid
Means (kgal)	In-Rent = 51.61 Submetered = 46.07	In-Rent = 51.61 RUBS = 53.45	In-Rent = 51.61 HWH = 44.79
Hypothesized Mean Difference	0	0	0
Degrees of freedom	164	275	22
t Stat	2.530	-.957	.906
p-value (T<=t) two-tail	.012	.339	.375
Statistically significant difference?	Yes	No	No

Comparison of Manager and Postcard Survey Samples

The question arises as to whether there was a response bias in the manager survey group. One way to test for such a bias would be to determine if there were statistically significant differences in water use between the postcard survey respondents and the manager survey respondents, which were a subset of the postcard respondents. These test were made in four separate t-tests that compared the annual per unit water use for 2001 and 2002 from the postcard and manager survey respondents by billing method. The results of these t-tests are shown in Table 5.11. The null hypothesis in each test was that the difference in mean water use was 0. The alpha-level was 0.05.

Table 5.11 Statistical tests comparing manager and postcard survey respondents' water use

	In-Rent	**Submetered**	**RUBS**	**Hot Water Hybrid**
Means (kgal)	Pcard = 53.21 Mngr = 51.61	Pcard = 44.87 Mngr = 46.07	Pcard = 52.10 Mngr = 53.45	Pcard = 49.61 Mngr = 44.79
Hypothesized Mean Difference	0	0	0	0
Degrees of freedom	1137	257	301	39
t Stat	1.704	.473	.687	.539
p-value (T<=t) two-tail	.089	.637	.493	.593
Statistically significant difference?	No	No	No	No

Frequency Distributions – Postcard and Manager Survey Respondents

Frequency distributions or histograms showing the average annual per unit water use for the postcard and manager survey samples by type of billing method are presented in Figure 5.8. These histograms use the combined 2001 and 2002 billing data set and are plotted as lines rather than bars to make it easier to compare the shape of each distribution. The water use distributions related to the postcard survey properties are shown as a shaded line and the distribution in water use from properties in the manager survey is shown as a solid line. All six distributions are quite similar in shape, underlining the similarities in per unit water use of these three groups. The distributions from the postcard and manager survey respondents within billing methodology often lay on top of each other.

The submetered frequency distributions are shifted slightly to the left, depicting the reduction in water use detected through the statistical analysis. The RUBS frequency distributions are shifted slightly to the right of the in-rent lines, but drop below the in-rent lines at the right hand tail of the distribution. These frequency distributions point out no startling differences between these groups, but do reconfirm the findings of the statistical analysis presented earlier in this chapter.

The next section of this chapter addresses the various factors – other than billing method – that affect water use and set the stage for the multivariate analyses that attempt to correct for these factors to identify whether there are potential water savings from different billing methodologies.

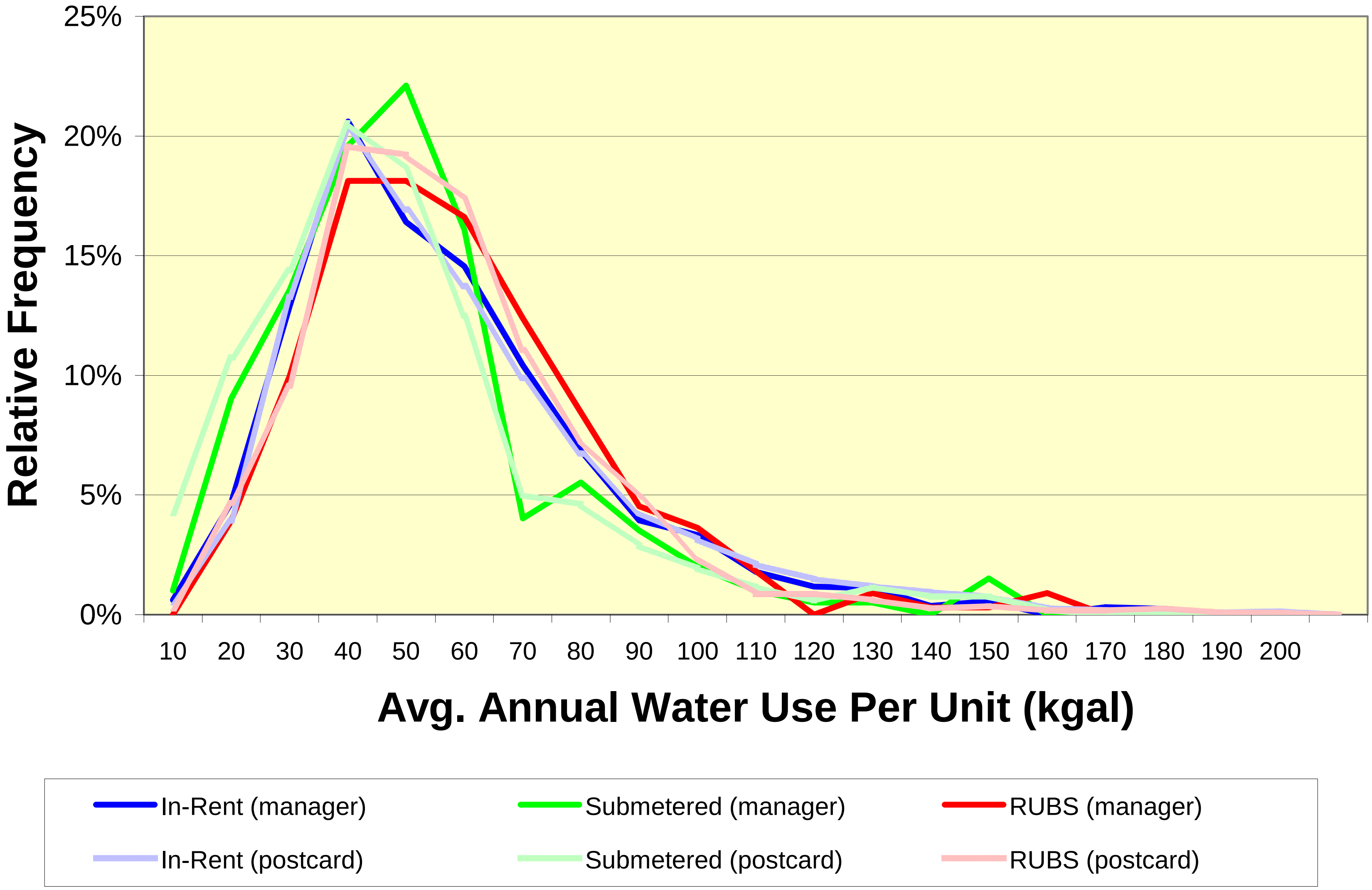


Figure 5.8 Frequency distribution, avg. annual water use per unit, manager and postcard survey respondents

Factors that Influence Water Use

The process of determining the impacts of water billing methods on water use began with an examination of the factors that may influence water use *other* than billing method. Using responses to the manager survey, linked with the cleaned historic billing data provided by each participating water provider, it was possible to evaluate the significance of a wide variety of factors on per unit per year water use. Wherever possible these factors were evaluated using historic billing data from 2001 and 2002. Only factors that were significant at the 95% confidence level in both years were considered for use in analytic models to evaluate the impacts of water billing methods.

Categorical Variables

Analysis of Variance (ANOVA) tests were performed to determine which of the nominal variables from the manager survey is statistically significant in explaining water use. Results from these analyses are presented in Table 5.12. The mean annual per unit water use (in kgal) for each set of property factors is shown along with the standard deviation (kgal) and the sample size. The p-value comes from the ANOVA test. Factors with p-values less than 0.05 were considered "statistically significant," meaning that if there were no difference, the probability of seeing a result as or more extreme than that seen in the sample was less than 5%. Only factors with a p-value of 0.05 or less in both 2001 and 2002 were selected for use in the multiple linear regression models. The factors in Table 5.12 are sorted by order of statistical significance with the most significant factors listed first. The dark line indicates the break point for factors selected for inclusion in advanced regression models.

Statistically significant categorical variables that were associated with per unit indoor water use in this sample of multi-family properties included:

- Year property was built (1994 or earlier, 1995 or later)
- Whether the property was a senior citizen/retirement community
- Presence of a swimming pool
- Low-flow (LF) faucet aerators
- ULF toilets
- Washing machine replacement
- Presence of a play area
- Presence of basketball court
- Presence of cooling tower
- Presence of food service facility or restaurant

Factors such as showerhead replacement and presence of an exercise room that were close to being statistically significant in both 2001 and 2002 were utilized in subsequent modeling, but were never found to improve the overall fit of the model and hence were eventually excluded.

Categorical Variables That Did Not Influence Water Use

The following list of factors were found *not* to have any statistically significant impact on per unit indoor water use in this sample of multi-family properties.

- Property classification (subsidized, private rental, condo, resident owned, etc.)
- Separate source of water for irrigation (well, irrigation ditch, etc.)
- Presence of a separate irrigation meter
- Presence of an automatic outdoor sprinkler system
- Presence of clothes washer hookups in each unit
- Presence of dishwashers in each unit
- Presence of a sauna/steam room
- Presence of water features/fountains
- Presence of landscape ponds
- Presence of tennis courts
- Presence of a spa
- Presence of a common shower area
- Presence of a club house
- Presence of common bathrooms
- Presence of one common laundry room
- Presence of more than one common laundry room
- Presence of a store or other commercial facility on the property
- Type of laundry facility (in-unit, common area, or mix)
- Presence of any common area laundry rooms

It is not surprising that factors related to outdoor use and irrigation showed no statistical significance since indoor and outdoor use were explicitly separated for this analysis as described in Chapter 3. It is interesting to note that common area laundry rooms did not offer any statistically significant water savings over in-unit laundries, a result that contradicts previous research on this subject (NRC 2001). Many common area property features such as tennis courts, spa, showers, club house, etc. did not have any statistically significant impact on water use.

Table 5.12 Association of categorical property characteristics with water use

Property Characteristic		Indoor Water Use per Unit in 2001 Mean (kgal)	Std. Dev.	N	P-Value*	Indoor Water Use per Unit in 2002 Mean (kgal)	Std. Dev.	N	P-Value*
Senior citizen/retirement community?	Yes	40.70	23.20	N=110	0.000	41.80	24.40	N=101	0.000
	No	52.70	25.50	N=1039		53.00	27.40	N=921	
	Don't know	48.10	12.00	N=4		44.00	11.50	N=4	
Does property have a pool?	Yes	55.50	26.70	N=581	0.000	55.40	26.20	N=551	0.000
	No	47.40	23.40	N=575		47.50	27.50	N=475	
Year Property was Built	1994 or earlier	52.60	25.80	N=966	0.000	52.60	27.90	N=855	0.012
	1995 or later	42.90	22.00	N=119		45.70	21.20	N=113	
Play area	no	49.70	24.20	N=978	0.000	50.00	26.50	N=864	0.000
	yes	61.10	29.40	N=185		61.50	28.70	N=169	
Cooling tower	no	50.90	24.90	N=1105	0.000	51.20	26.80	N=975	0.002
	yes	63.50	33.10	N=58		62.70	32.20	N=58	
Percent of the faucet aerators replaced since 1995	none or <100% replaced	52.50	25.70	N=904	0.001	52.80	28.10	N=792	0.009
	100% replaced, or built after 1994	45.20	22.70	N=169		46.70	22.20	N=161	
Basketball courts	no	50.90	24.90	N=1085	0.001	51.00	26.70	N=964	0.000
	yes	60.70	30.90	N=78		64.10	31.50	N=69	
Food service facility/restaurant	no	52.00	25.50	N=1123	0.001	52.30	27.40	N=1000	0.009
	yes	37.90	19.50	N=40		39.60	17.80	N=33	
Percent of toilets replaced since 1995	less than 75% replaced	53.00	26.20	N=819	0.001	53.30	28.20	N=712	0.016
	76% or more replaced, or built after 1994	47.00	23.20	N=273		48.50	24.90	N=258	
Percent of clothes washers replaced since 1995	none or <100% replaced	52.50	26.00	N=574	0.001	52.00	27.30	N=498	0.039
	all replaced, or built after 1994	46.20	22.50	N=222		47.50	23.10	N=202	
Percent of the showerheads replaced since 1995	none or less than 100% replaced	52.80	25.80	N=785	0.001	52.80	27.90	N=690	0.086
	all replaced, or built after 1994	47.90	23.60	N=290		49.40	25.70	N=266	
Type of laundry facilities	In-unit only	51.40	25.60	N=309	0.072	51.80	26.30	N=269	0.165
	Common area only	51.20	25.40	N=580		51.60	27.10	N=514	
	Mix of in-unit and common	53.60	24.20	N=166		54.00	28.00	N=154	
	No laundry facil.	44.30	23.90	N=74		44.80	27.00	N=62	

Property Characteristic		Indoor Water Use per Unit in 2001				Indoor Water Use per Unit in 2002			
		Mean (kgal)	Std. Dev.	N	P-Value*	Mean (kgal)	Std. Dev.	N	P-Value*
Separate source of water - well or ditch for irrigation?	Yes	43.20	26.60	N=28	0.081	41.80	19.90	N=26	0.062
	No	52.00	25.50	N=1058		52.50	27.50	N=938	
	Don't know	47.00	22.20	N=51		47.00	23.50	N=45	
Exercise room	no	52.30	26.30	N=866	0.093	52.90	28.70	N=760	0.040
	yes	49.40	22.70	N=297		48.90	22.50	N=273	
Other	no	51.30	25.00	N=1132	0.093	51.60	26.80	N=1004	0.082
	yes	59.10	39.00	N=31		60.50	37.40	N=29	
Do the units come with hook-ups for washing machines?	Yes	52.20	25.20	N=475	0.106	52.60	26.90	N=423	0.292
	No	50.50	25.30	N=654		50.90	27.20	N=576	
	Don't know	62.10	31.90	N=18		59.40	31.60	N=18	
More than one common laundry room/facility	no	50.90	25.40	N=871	0.132	51.40	26.60	N=773	0.357
	yes	53.50	25.60	N=292		53.20	29.00	N=260	
Outdoor sprinkler system?	Yes	52.40	25.80	N=744	0.141	52.80	26.30	N=671	0.141
	No	49.40	24.30	N=387		49.40	28.30	N=332	
	Don't know	56.50	26.80	N=10		57.10	24.80	N=9	
Store or other commercial facility	no	51.70	25.50	N=1136	0.149	52.00	27.30	N=1010	0.275
	yes	44.50	23.90	N=27		45.70	22.80	N=23	
Landscape ponds	no	51.80	25.70	N=1097	0.195	51.90	27.30	N=978	0.752
	yes	47.60	21.70	N=66		50.70	25.60	N=55	
Common shower	no	51.10	24.80	N=992	0.222	51.90	27.70	N=872	0.996
	yes	53.70	29.00	N=171		51.90	24.50	N=161	
Do all or some of the units come equipped with dishwashers?	Yes	52.00	24.10	N=777	0.261	51.70	25.50	N=691	0.190
	No	49.90	27.40	N=345		51.10	29.90	N=304	
	Don't know	56.20	31.40	N=28		61.40	32.50	N=25	
Club house	no	51.10	25.60	N=848	0.298	51.10	27.70	N=735	0.139
	yes	52.80	25.20	N=315		53.80	25.90	N=298	
Common kitchen	no	51.80	25.40	N=999	0.385	51.80	27.00	N=882	0.970
	yes	49.90	26.00	N=164		51.90	28.40	N=151	
One common laundry room/facility	no	51.90	26.20	N=653	0.566	51.90	27.70	N=577	0.977
	yes	51.00	24.50	N=510		51.80	26.60	N=456	
Is there a common laundry room?	yes	51.80	25.10	N=755	0.574	52.20	27.20	N=676	0.612
	no	51.00	26.20	N=408		51.30	27.30	N=357	
Tennis courts	no	51.60	25.50	N=1070	0.625	51.70	27.40	N=949	0.549
	yes	50.30	25.00	N=93		53.60	25.70	N=84	
Common bathrooms	no	51.70	25.10	N=841	0.637	52.30	28.10	N=729	0.411
	yes	51.00	26.30	N=322		50.80	25.10	N=304	
Water features/fountains	no	51.60	25.50	N=1005	0.812	52.30	28.10	N=880	0.256
	yes	51.10	25.50	N=158		49.50	21.50	N=153	
Is there a separate water meter for irrigation?	Yes	52.20	25.40	N=261	0.816	52.80	27.90	N=249	0.860
	No	51.70	25.60	N=727		51.70	27.40	N=623	
	Don't know	50.50	24.30	N=132		51.90	25.70	N=120	

Property Characteristic		Indoor Water Use per Unit in 2001 Mean (kgal)	Std. Dev.	N	P-Value*	Indoor Water Use per Unit in 2002 Mean (kgal)	Std. Dev.	N	P-Value*
How is the property classified?	Government subsidized	52.30	26.90	N=88	0.940	55.00	31.40	N=76	0.755
	Private rental	52.00	24.90	N=710		52.00	26.80	N=611	
	Condominium	50.30	24.90	N=170		51.00	27.20	N=167	
	Privt. resident owned	50.60	29.40	N=99		51.50	28.10	N=90	
	Other	52.10	24.90	N=43		48.50	21.10	N=42	
How is the property classified?	Non-Rental	50.7	26.3	N=312	.433	50.8	26.6	N=299	.410
	Rental	52.0	25.1	N=798		52.3	27.4	N=687	
Sauna/steam room	no	51.50	25.50	N=1060	0.947	52.00	27.40	N=936	0.579
	yes	51.70	25.50	N=103		50.40	25.90	N=97	
Spa/hot tub	no	51.50	25.70	N=897	0.948	51.90	28.20	N=778	0.878
	yes	51.60	24.70	N=266		51.60	24.20	N=255	

* Derived from an ANOVA test, indicates the probability of seeing a result as or more extreme than that seen in the sample. Factors with p-values less than 0.05 were considered "statistically significant," meaning that if there were no difference, the probability of seeing a result as or more extreme than that seen in the sample was less than 5%.

Continuous Variables

Continuous variables such as the average number of bedrooms per unit and average rent per bedroom could not be examined using ANOVA techniques so Pearson Correlation analysis was used. The results from this analysis examining the impacts of the continuous variables from the manager survey on per unit water use are shown in Table 5.13.

The Pearson product moment coefficient of correlation is a measure of the strength of the linear relationship between two variables - in this case property characteristics measured on a continuous scale from the manager survey and average water use per unit per year (McClave, et. al., 1997). In Table 5.13, the Pearson Correlation value is a number between –1 and 1 where a value close to zero indicates that there is no correlation. The hypothesis is that the Pearson Correlation is equal to zero, hence a p-value of 0.05 or less indicates that there is a less than 5% chance that a correlation as or more extreme than the one observed could have occurred if there were no relationship between the variables. All of the calculations assume that normal approximations hold so that the lack of a linear relationship is equivalent to independence. Again the dark line in Table 5.13 indicates the break point for statistically significant factors selected for inclusion in multiple linear regression models.

Continuous Variables that Were Associated with Water Use

Statistically significant factors that influenced per unit indoor water use from the Pearson Correlation analysis included:

- Average number of bedrooms per MF unit
- Average rent per bedroom
- Average number of people per unit
- Utility's average commodity charge for water and wastewater[27]
- Number of months of irrigation
- Percent of clothes washers replaced since 1995

Factors such as toilet replacement rates and faucet replacement rates that were close to being statistically significant in both 2001 and 2002 were utilized in subsequent modeling, but were never found to improve the overall fit of the model and hence were eventually excluded.

Continuous Variables that Were Not Associated with Water Use

The following list of factors were found *not* to have any statistically significant impact on water use in this sample of multi-family properties.

- Percent of property that is irrigated
- Number of residential buildings on property
- Average rent per unit
- Number of units in property
- Acreage of property
- Reported water and wastewater rate (from the manager survey)
- Vacancy rate
- Percent of units with clothes washers

It is not surprising that factors related to outdoor use and irrigation (acreage and percent irrigated) showed no statistical significance since indoor and outdoor use were explicitly separated for this analysis as described in Chapter 3. Similarly, all water use was calculated on a per unit basis hence the number of units in the property should not be an important factor. Interestingly, factors that are often considered important to water use such as average rent and vacancy rates were not statistically significant in this sample (although average rent per bedroom was statistically significant).

Table 5.13 Continuous factors from manager survey and Pearson Correlation

	Estimated Indoor Water Used per Unit in 2001			Estimated Indoor Water Used per Unit in 2002		
	Pearson Corre-lation	**N**	**P-value**	**Pearson Corre-lation**	**N**	**P-value**
Average Number of Bedrooms per Unit	0.323	N=1078	0.000	0.336	N=956	0.000
Average Rent per Bedroom	-0.243	N=817	0.000	-0.239	N=705	0.000
Average Number of People per Unit	0.174	N=1000	0.000	0.254	N=897	0.000
Utility's average commodity charge for water and wastewater	-0.278	N=1163	0.000	-0.255	N=1078	0.000
Number of months of irrigation	0.087	N=1163	0.003	0.091	N=1033	0.004
Percent of clothes washers replaced since 1995	-0.103	N=754	0.004	-0.096	N=666	0.013
What percent of the units have had their toilets replaced since 1995?	-0.074	N=1092	0.015	-0.054	N=970	0.093
What percent of the units have had their faucets replaced since 1995?	-0.071	N=1073	0.020	-0.050	N=953	0.122
About what percent of the total property is irrigated landscape?	0.047	N=947	0.150	0.055	N=846	0.108
In what year was the construction of the property completed?	0.042	N=1085	0.171	0.035	N=968	0.279
What percent of the units have had their showerheads replaced since	-0.042	N=1075	0.171	-0.015	N=956	0.653
How many residential buildings are on this property?	0.029	N=1144	0.327	0.055	N=1013	0.078
Average Rent per Unit	-0.029	N=817	0.404	-0.001	N=705	0.982
How many units are in this property?	0.019	N=1163	0.528	0.014	N=1033	0.645
About how many acres in the total property area?	-0.018	N=788	0.621	-0.011	N=703	0.773
Rate residents charged according to manager survey	0.049	N=56	0.718	0.619	N=30	0.000
Adjusted vacancy rate	0.009	N=1082	0.778	0.010	N=955	0.746
What is the current vacancy rate?	0.004	N=1082	0.893	-0.008	N=955	0.800
Percent of units with washing machines	0.000	N=1051	0.995	0.002	N=936	0.941

Evaluation of Covariance

It is also important to note that some of the factors that were found to be statistically significant in the ANOVA are closely related and hence covary. For example, the classification

[27] See Table 4.1 for these charges.

of a property as a senior citizen/retirement community is closely associated with the presence of a food service facility or restaurant. These factors can be said to covary. In subsequent multivariate modeling, once the classification of a property as a senior citizen/retirement community had been taken into consideration, the presence of food service facility or restaurant was no longer statistically significant, indicating it no longer added unique information. This analysis shows that senior citizen/retirement communities use about 12 kgal per unit per year less than standard multi-family housing – a 23% reduction.

Similarly, dividing properties into categories of age based on year of construction (1994 and earlier or 1995 and later) proved to be the most powerful measure of non-efficient vs. efficient water fixtures in the analysis. The federal Energy Policy Act (EPACT) of 1992 mandated the exclusive manufacture of ULF toilet, LF showerheads and LF faucet fixtures. Hence by 1995 all construction in the United States included these efficient fixtures. Newer properties equipped with efficient fixtures used 42.9 kgal per unit per year on average vs. 52.6 kgal per unit per year for older properties, a reduction of 9.7 kgal per unit per year (18%). It is likely that this reduction is primarily due to the presence of high efficiency fixtures (toilet, faucets, showerheads, and some high efficiency clothes washers) in the newer properties.

Reported replacement of toilets, faucets, showerheads, and clothes washers were less significant predictors of water use than property age. This was perhaps due to inaccurate reporting of fixture replacement rates on the manager survey. Discrepancies in the proportion of fixtures estimated to be “low-flow” were found over 30% of the time for showerheads and toilets and 50% of the time for faucets on the properties inspected on a site visit. However, the site visit protocol had auditors testing actual flow from the fixtures while the manager survey asked property owners or managers whether fixtures had been replaced since 1995. Although fixture replacement and presence of efficient toilets, faucets, and clothes washers was statistically significant in the preliminary ANOVA (Table 5.12), most of the difference in water use was accounted for by the new (post-1994) properties. If these new properties were removed from the analysis then the reported fixture replacement was no longer statistically significant. This clearly points out some of the problems with self-reported fixture replacement information from survey respondents, which was why the sponsoring utilities for this study insisted upon site visits to verify some manager survey information.

Multivariate Models to Determine Impacts of Water Billing Programs

The purpose of the multivariate regression modeling and analysis in this study was to account or "correct" for factors that influence water use so that submetered and RUBS properties could be compared against in-rent properties on an equal basis. For example, if a submetered property was built in 1998 and equipped with water efficient fixtures it was important to correct for this so that water savings associated with the efficient fixtures not be incorrectly attributed to submetering when comparing against in-rent properties built before EPACT plumbing standards were put in place.

Using the relevant factors identified through the ANOVA and Pearson Correlation analyses, numerous multivariate regression models were developed using identified factors as the independent variable and annual indoor per unit water use as the dependent variable. Nearly all of these models included the billing methodology (submetering or RUBS) as a factor. The results of this methodology are a set of models that account for a variety of different factors shown to influence water use. At the same time these models also evaluate the impact of submetering vs. in-rent billing and RUBS vs. in-rent billing, while holding constant other important characteristics of the properties[28]. Step-wise regression was also used to create a multivariate model that included all of the relevant independent variables shown to have statistical significance. Typically these models were run twice, first using billing data from 2001, which provided the largest sample size, and then again using billing data from 2002. Relevant models that showed fairly consistent results across the two years of billing data were identified for further evaluation. Because water use over these two years was shown to be statistically similar at a 95% confidence level, water use in 2001 and 2002 was averaged together for the final models presented below.

In these models, billing type was included as a "dummy" variable. When categorical variables with more than two levels, such as billing type, are included in a linear regression model, dummy variables must be created to account for each level (or category) of the categorical variable. One level is selected as the comparison group, and all other levels are then evaluated as compared to this category. Using this method means that comparisons cannot be made between other levels of the variable. In the case of billing method, the research question of interest was whether water savings were observed when residents received a water bill (through a method such as RUBS or submetering) compared to instances when residents did not receive a water bill, but the cost of water was included in the rent or homeowner's dues ("in-rent"). Thus, "in-rent" was chosen as the comparison group.

This type of variable transformation is necessary, because by definition there is not a numerical order to the categories of billing type; that is, if the number "1" is assigned to an in-rent property, the number "2" to a RUBS property, and a "3" to a submetered property, it does not make sense to describe submetered properties as being 2 units of billing method greater than in-rent.

To create the dummy variables for type of billing method, each property was classified using two variables, which were called RUBS and SUB. If residents at a property were billed using a RUBS methodology, the property was assigned a "1" for the RUBS variable and a "0" for the SUB variable. If residents at a property were billed using submeters, the property was assigned a "0" for the RUBS variable and a "1" for the SUB variable. Finally, if residents at a property did not receive a separate water bill from their rent or homeowner's dues, the property was assigned a "0" for the RUBS variable and a "0" for the SUB variable. Thus, to fully classify billing method, both RUBS and SUB must be included in the model. The resulting B coefficients demonstrate the differences in average water use between RUBS properties vs. in-rent properties and the differences in average water use between submetered properties vs. in-rent properties. If one of these variables was not included in the model, the comparison would be between the variable included and all other property types; for example, if the SUB variable only was included, the B coefficient would represent the average water savings in submetered properties compared to in-rent **and** RUBS properties, adjusted for other factors included in the model.

Many of the other variables found in one or more of the models presented below were included as dichotomous variables. For most, if the amenity or characteristic was present or "true" for a property, variable was coded as a "1" while the absence of the characteristic was coded as a "0." These variables included: senior citizen/retirement community, play area, and cooling tower. The B coefficient for these factors represents the difference in average amount of water observed in properties with the characteristics compared to those without, holding constant the other factors included in the model. "Property was built before 1995" was coded so that

[28] Prevalence of each characteristic can be found in Chapter 4 and Appendix B.

properties built before 1995 were coded as “1” while those built in 1995 or later were coded as “0.” When year is included in the model, the B coefficient can be interpreted as the difference in average water use between properties built before 1995 compared to those built in 1995 or later. The factor “property is a rental” was defined so that rental properties were coded as “1” while all non-rental properties were coded as “0.” Again, the B coefficient represents the difference in average water use between rental properties and non-rental properties.

There are a couple ordinal (continuous) variables included in one of more of the models presented below. These include: average number of bedrooms per unit, average rent, and average price charged for water by the local utility. For these variables, the B coefficient represents the average difference in the amount of water used per unit for every unit increase (e.g., bedroom size, dollar of rent, or dollar charged per kgal) in these predictor variables.

The three models selected for presentation in this report represent the range developed for this study from fairly simple models involving five independent variables to the complex step-wise regression model that includes numerous independent variables. Because of the inherent range of water use and human behavior associated with the use of water across different properties, cities, and regions, none of the models did a particularly good job of explaining the variability of water use observed in multi-family properties. These models do consistently show a statistically significant reduction in water use attributable to submetering programs at the 95 percent confidence level. The models do not show any statistically significant water savings from RUBS.

The coefficient of determination (R^2 value), a measure of the goodness of fit of the model, for these multivariate models were only on the order of 0.15 – 0.3, indicating that these models explain between 15 and 30 percent of the variability of the data. While not a particularly strong result in scientific and engineering research, these values are typical to what is found in studies of human behavior and attitudes in the social sciences. While these models are weakly predictive, they are useful in identifying the most important factors that influence water use in these multi-family properties. Submetering was the only billing methodology consistently found to effect a statistically significant reduction in water use. RUBS achieved statistical significance in only a few of the models developed and in some of those cases the sign of the coefficient indicated an *increase* in water use associated with the billing practice. Significant efforts were made to determine if there are any verifiable water savings associated with RUBS. None of the models showed a consistent, statistically significant decrease in water use due to RUBS.

Water Use Model #1 – Six Independent Variables

The first multivariate regression model presented uses a limited set of six independent variables that included average number of bedrooms per unit, year the property was built (1994 and earlier or 1995 and later), whether the property was a rental property or a non-rental property, average price charged for water by the local utility, submetering, and RUBS. Fundamental information and statistics are presented in Table 5.14.

The adjusted coefficient of determination (R^2) for the model is 0.224. This value indicates that this model explains only 22 percent of the variability in the data. The P-value for the model is 0.00 indicating that whatever fit does exist is statistically significant at the 95% confidence level.

Table 5.14 Model #1 summary statistics, coefficient of determination, and significance

R	R Squared	Adjusted R Square	Std. Error of the Estimate	Degrees of Freedom	F	P-value
0. 478	0.229	0.224	21.693	955	46.942	.000

Predictors: (Constant), Submetering, Rental property (compared to individually owned or other), RUBS, Property built before 1995 (compared to properties built 1995 or later), Utility's average commodity charge for water and wastewater, Average number of bedrooms per unit
Dependent Variable: Indoor water use per unit (average 2001, 2002)

The B coefficients presented in Table 5.15 present the magnitude of the "effect" of the different independent variables in the model. Of particular interest are the coefficients for RUBS and submetering. In Model #1, five factors were statistically significant – average number of bedrooms per unit, property is a rental (vs. non-rental), year property was built (1994 and earlier or 1995 and later), average price charged by the local utility for water and wastewater, and submetering. The only factor that wasn't statistically significant was RUBS. The effect of submetering and RUBS are shown graphically in Figure 5.9 and Figure 5.10.

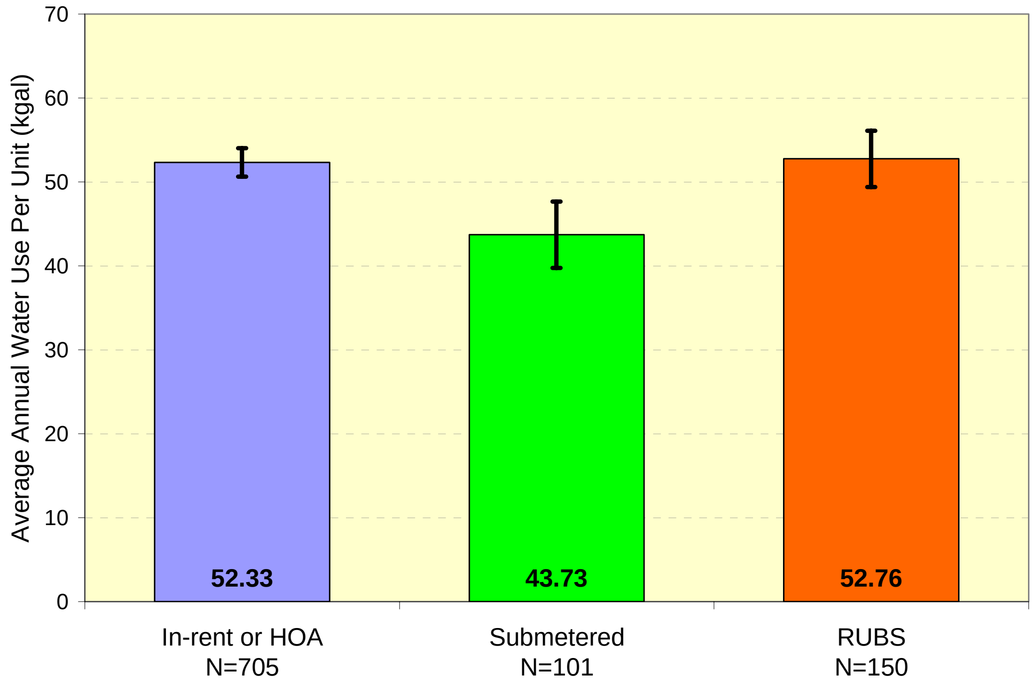


Figure 5.9 Adjusted average annual water use per unit – Model #1

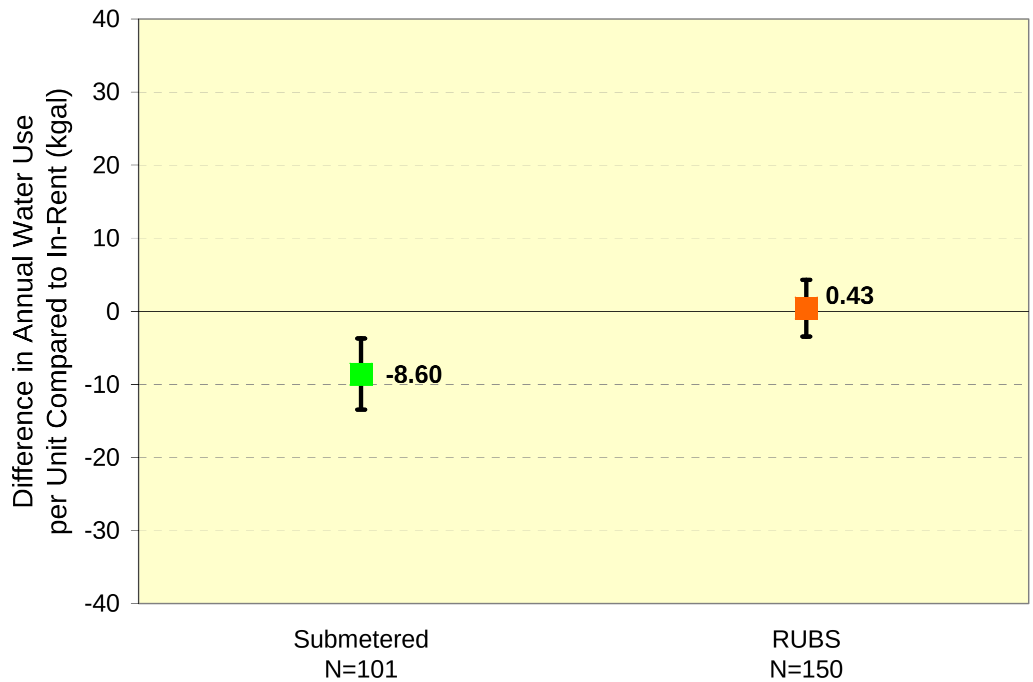


Figure 5.10 Difference in adjusted average annual water use of impacted properties compared to in-rent properties – Model #1

Table 5.15 Model #1 coefficients and significance of independent variables

Independent Variable	B*	Std. Error	t	P-value
(Constant)	20.80	4.55	4.576	.000
Property was built before 1995	10.38	2.31	4.504	.000
Property is a rental†	7.39	1.75	4.231	.000
Property is billed through RUBS method	0.43	1.98	0.217	.828
Property is submetered	-8.60	2.48	-3.466	.001
Average commodity charge for water/wastewater‡	-2.27	0.28	-8.055	.000
Average number of bedrooms per unit‡	18.59	1.51	12.282	.000

Dependent Variable: Indoor water use per unit (average 2001, 2002)

* Represents the magnitude of each independent variable in kgal per year per dwelling unit

† Rentals include private and government subsidized rentals. (Non-rentals include condominiums, private resident owned, and other).

‡ Continuous variables, change is seen for every dollar or bedroom added.

For submetering, the B coefficient was –8.6, indicating that submetered properties use 8.6 kgal per unit *less* water than in-rent properties after adjusting for the year the property was built, rental property status, average price of water, and the average number of bedrooms. This effect was statistically significant at the 95% confidence level.

Besides submetering, four other independent variables in the model were statistically significant. Properties built before 1995 used 10.4 kgal per unit *more* than properties built after 1995 – this is presumably largely the result of the high efficient plumbing fixtures (toilets, showerheads, and faucet aerators) mandated for new construction by the 1992 Energy Policy Act (EPACT). The average number of bedrooms per unit is a reasonable surrogate for the number of people living in each dwelling unit. These models suggest that for every additional bedroom, water use is *increased* by an average of about 18.6 kgal per unit. Rental properties used 7.4 kgal per unit *more* than non-rental properties (condominiums, private resident owned, and other). In addition, for every dollar more that a utility charges per thousand gallons of water and wastewater, properties used 2.3 kgal less water per unit.

It should be noted that all of the beta coefficients in Table 5.15 are additive and provide a method to estimate annual water usage for a given property. The generic equation including all of the statistically significant factors in Model #1 is as follows:

$$u = C_0 + Av + Bw + Dx + Ey + Fz$$

where:

u = Property's annual water usage (kgal/unit/year)

C_0 = Constant

A = Beta coefficient for “Property was built before 1995”

v = 1 if the property was built before 1995, 0 if the property was built after 1995

B = Beta coefficient for “Property is a rental”

w = 1 if the property is a rental, 0 if the property is not a rental

D = Beta coefficient for “Property is submetered”

x = 1 if the property is submetered, 0 if the property is not

E = Beta coefficient for “Average commodity charge for water/wastewater”

y = Value in dollars of the average commodity charge for water and wastewater at the property

F = Beta coefficient for “Average number of bedrooms per unit”

z = Average number of bedrooms per unit at the property

For example, if there is a property that was built before 1995, is *not* a rental, is submetered, has an average commodity charge of $5 per kgal, and has 2 bedrooms, the following equation could be used:

$$20.80 + (10.38)*1 + (7.39)*0 - (8.60)*1 + (-2.27)*5 + (18.59)*2 = 48.41$$

From the Model #1 equation, the annual water use could be estimated for the property as 48.41 kgal per unit per year.

To further investigate the issue of model fit a set of plots showing the predicted value (fitted value) on the x-axis and the residual value (actual value – predicted value) on the y-axis. The plot for Model #1 is shown in Figure 5.11. In a perfect model the residual value would be zero and all points would lie on the x-axis. Here where the model explains 22% of the variability in the data there is a wide scattering of data with a cluster of points along the x-axis.

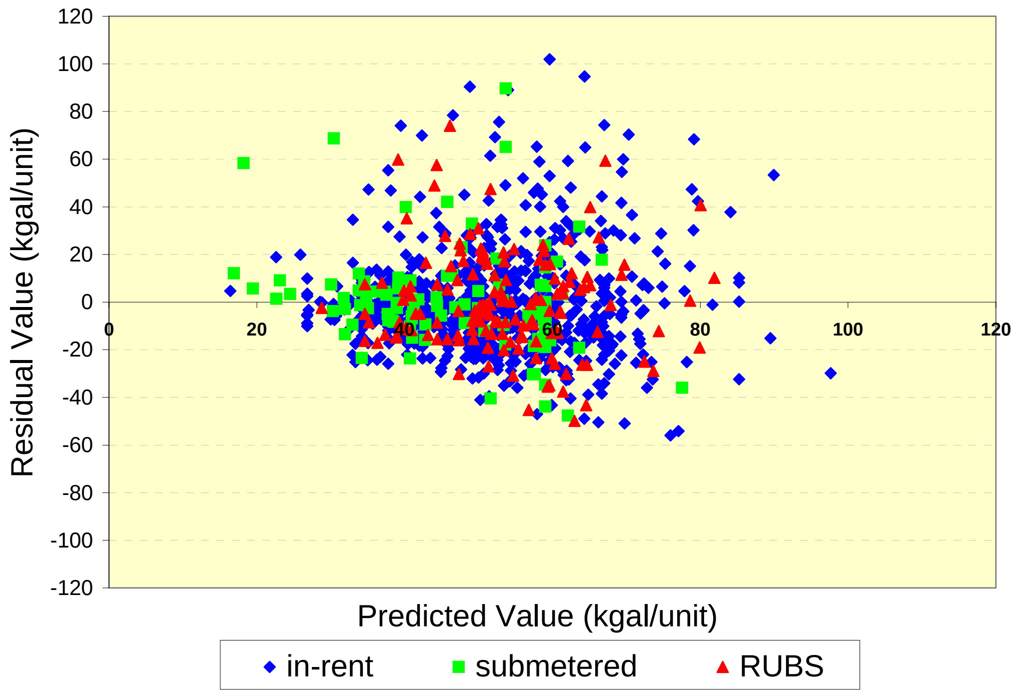


Figure 5.11 Model #1 predicted vs. residual value plot

Model #2 – Nine Independent Variables Including Property Ownership

The second multivariate regression model presented includes nine independent variables identified as significant from the ANOVA presented earlier in this chapter including:

- Average number of bedrooms per unit
- Year the property was built (1994 and earlier or 1995 and later)
- Rental property (private and government subsidized) vs. non-rental properties (i.e. condominiums, private resident owned, and other)
- Utility's average commodity charge for water and wastewater
- Presence of a play area
- Presence of a cooling tower
- Classification as senior citizen/retirement community
- RUBS
- Submetering

These factors were selected because of their established significance in determining water use and through a trial and error process where numerous models were constructed and evaluated. This model is quite similar to Model #3, which was developed through a stepwise regression process, the key difference being the exclusion of a rent variable and the inclusion of property ownership status (rental vs. non-rental property). The rent variable, while important, substantially reduces the sample size since about 25% of respondents to the manager survey didn't answer that particular question, especially among individually-owned properties, where managers may not know for what amount the units would rent.

Fundamental information and statistics from the regression model are presented in Table 5.16. The adjusted coefficient of determination (R^2) for Model #2 is 0.245. This indicates that the model explains about 25 percent of the variability in the data. The P-value for the model is statistically significant at the 95% confidence level.

Table 5.16 Model #2 summary statistics, coefficient of determination, and significance

R	R Squared	Adjusted R Square	Std. Error of the Estimate	Degrees of Freedom	F	P-value
0.502	0.252	0.245	21.397	952	35.366	0.000

Predictors: (Constant), submetering, utility's commodity average charge for water and wastewater, rental property (compared non-rental property), cooling tower?, play area?, is property considered a senior citizen/retirement community?, RUBS, property built before 1995 (compared to properties built 1995 or later), average number of bedrooms per unit

Dependent Variable: Indoor water use per unit (average 2001, 2002)

The coefficients presented in Table 5.17 present the magnitude of the "effect" of the different independent variables in the model. Of particular interest are the coefficients for RUBS and submetering. In Model #2, eight of the nine independent variables were statistically significant. The only factor that wasn't statistically significant was RUBS. The B coefficient shows the magnitude of the effect, and is graphically displayed in Figure 5.12 and Figure 5.13. For submetering the B coefficient was –8.0 indicating that submetered properties used 8.0 kgal per unit *less* water than in-rent properties after adjusting the other significant independent variables. This effect was statistically significant at the 95% confidence level.

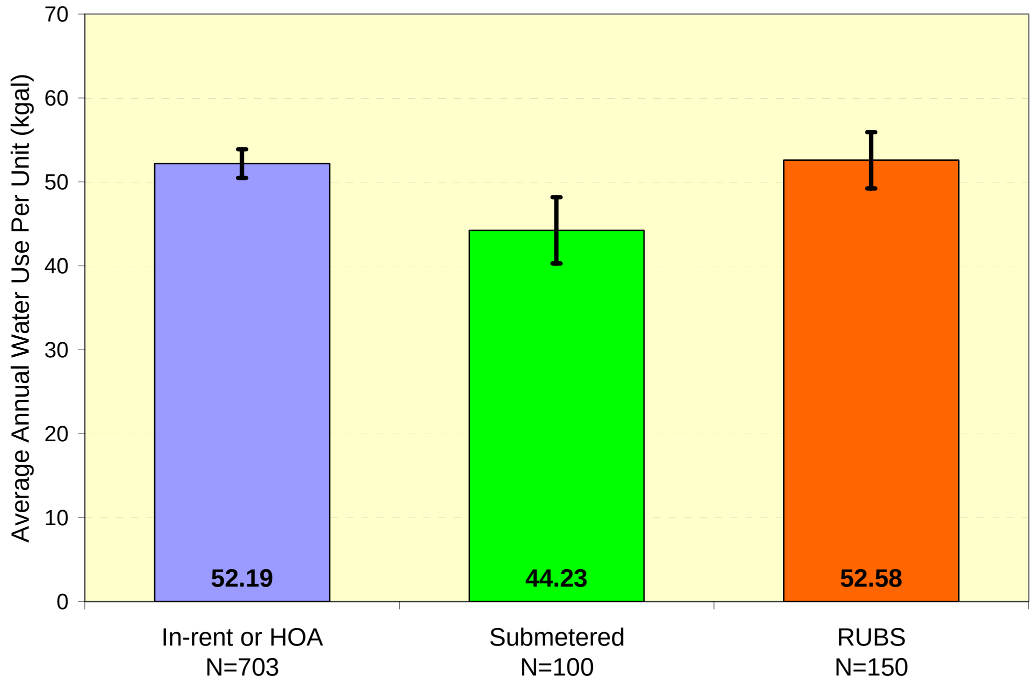


Figure 5.12 Adjusted average annual water use per unit – Model #2

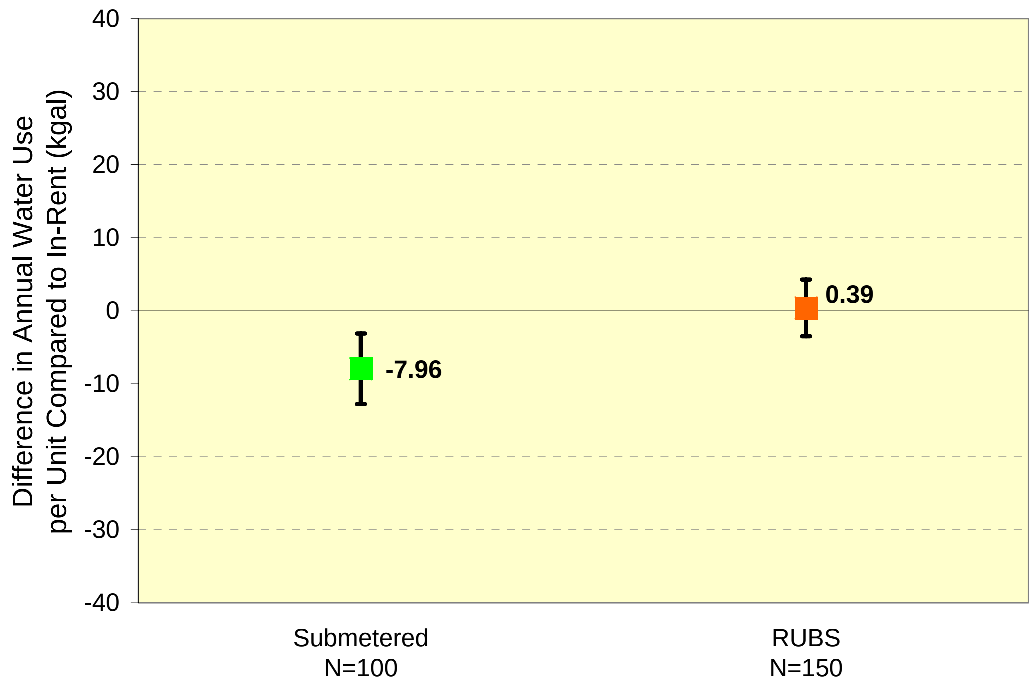


Figure 5.13 Difference in adjusted average annual water use of impacted properties compared to in-rent properties – Model #2

Table 5.17 Model #2 coefficients and significance of independent variables

Independent Variable	B*	Std. Error	t	P-value
(Constant)	19.95	4.61	4.323	.000
Property was built before 1995	10.84	2.29	4.736	.000
Property is a senior citizen/retirement community	-6.70	2.56	-2.618	.009
Property has a play area	6.80	1.94	3.513	.000
Property has a cooling tower	11.55	3.31	3.493	.001
Property is a rental†	6.84	1.74	3.926	.000
Property is billed through RUBS method	0.39	1.98	0.197	.844
Property is submetered	-7.96	2.47	-3.225	.001
Average commodity charge for water/wastewater‡	-2.01	.28	-7.072	.000
Average number of bedrooms per unit‡	17.44	1.54	11.313	.000

Dependent Variable: Indoor water use per unit (average 2001, 2002)
* Represents the magnitude of each independent variable in kgal per year per dwelling unit.
† Rentals include private and government subsidized rentals. (Non-rentals include condominiums, private resident owned, and other).
‡ Continuous variables, change is seen for every dollar or bedroom added.

Besides submetering, seven other independent variables in the model were also statistically significant. Properties built before 1995 used 10.8 kgal per unit *more* than properties built after 1995 – this is presumably largely the result of the high efficient plumbing fixtures (toilets, showerheads, and faucet aerators) mandated for new construction by the 1992 Energy Policy Act (EPACT). The average number of bedrooms per unit is a reasonable surrogate for the number of people living in each dwelling unit. These models suggest that for every additional bedroom water use is *increased* by an average of about 17.4 kgal per unit. Rental properties used 6.8 kgal per unit *more* than non-rental properties (condominiums, private resident owned, and other). Properties classified as senior citizen or retirement communities used 6.7 kgal per unit *less* than standard mixed-age multi-family properties. Properties that reported having a play area used 6.8 kgal per unit *more* than properties without that amenity. The presence of a cooling tower increased per unit water use 11.6 kgal per unit. For every dollar more that a utility charged per thousand gallons of water and wastewater, a property's water use would decrease by 2.0 kgal per unit per year.

It should be noted that all of the beta coefficients in Table 5.17 are additive and provide a method to estimate annual water usage for a given property. The generic equation for Model #2 follows the same logic as was outlined in the section on Model #1. For example, if there is a property that was built after 1995, has a play area, is a rental, is not individually billed for water (in-rent), has an average commodity charge of $5 per kgal, and has 1 bedroom, the following equation could be used:

$$19.95 + 6.80 + 6.84 + 5*(-2.01) + 1*(17.44) = 40.98$$

From the Model #2 equation, the annual water use could be estimated for the property as 40.98 kgal per unit per year.

Model #3 –Nine Independent Variables Including Cost of Rent

The third multivariate regression model presented has slightly more predictive power than the other models presented, but also represents a smaller sample of properties because it includes a cost of rent variable. Inclusion of a cost of rent variable, by definition, excludes properties that are non-rentals (condominiums, private resident owned, and other) as well as those that did not respond to the question. Excluding these properties makes this model less representative of the population of multi-family housing found in the US, which includes a mix of ownership arrangements.

Model #3 includes nine independent variables identified as significant from the ANOVA presented earlier in this chapter including:

- Average number of bedrooms per unit
- Year the property was built (1994 and earlier or 1995 and later)
- Average rent per bedroom
- Utility's average commodity charge for water and wastewater
- Presence of a play area
- Presence of a cooling tower
- Classification as senior citizen/retirement community
- RUBS
- Submetering

These factors were selected because of their established significance in determining water use and through an iterative stepwise regression process the statistical program evaluated the impact of different variables and selected those that provided the best fit. Researchers then modified the stepwise model to increase the sample size and include several other factors known to be significant predictors of water use. In view of the sample size, model selection effects were not deemed to be sufficiently important to be taken into account.

Fundamental information and statistics from the regression model are presented in Table 5.18. The adjusted coefficient of determination (R^2) for Model #3 is 0.260. This indicates that the model explains about 26 percent of the variability in the data. The P-value for the model is

0.00 indicating that whatever fit does exist is statistically significant at the 95% confidence level. This model included only 746 properties, about 22% fewer than Model #2.

Table 5.18 Model #3 summary statistics, coefficient of determination, and significance

R	R Squared	Adjusted R Square	Std. Error of the Estimate	Degrees of Freedom	F	P-value
0.519	0.269	0.260	21.235	745	30.149	0.000

Predictors: (Constant), submetering, utility's average commodity charge for water and wastewater, cooling tower?, play area?, is property considered a senior citizen/retirement community?, RUBS, property built before 1995 (compared to properties built 1995 or later), average number of bedrooms per unit, average rent per bedroom
Dependent Variable: Indoor water use per unit (average 2001, 2002)

The coefficients presented in Table 5.19 present the magnitude of the "effect" of the different independent variables in the model. Of particular interest are the coefficients for RUBS and submetering. For submetering the B coefficient was –10.1, indicating that submetered properties 10.1 kgal per unit *less* water than in-rent properties after adjusting the other significant independent variables. This effect was statistically significant at the 95% confidence level.

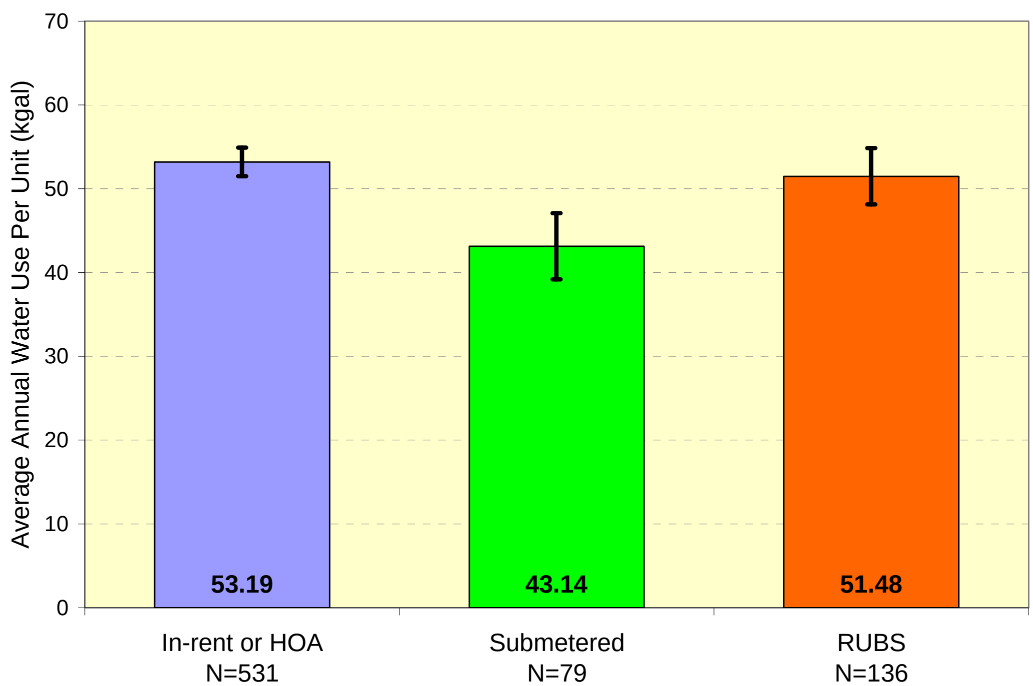


Figure 5.14 Adjusted average annual water use per unit – Model #3

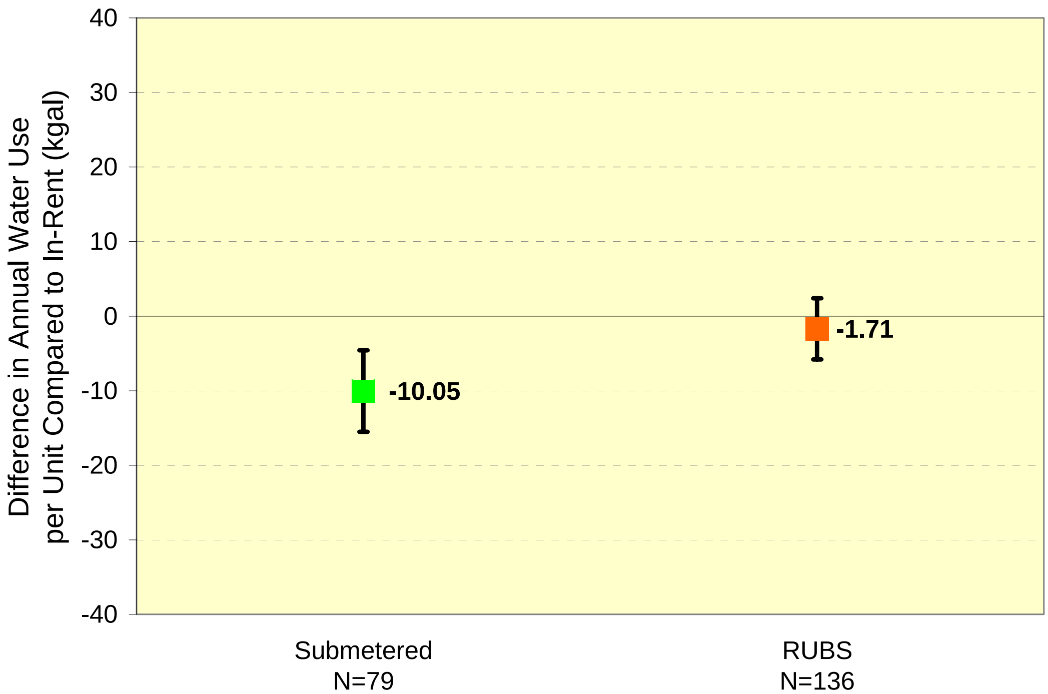


Figure 5.15 Difference in adjusted average annual water use of impacted properties compared to in-rent properties – Model #3

Table 5.19 Model #3 coefficients and significance of independent variables

Independent Variable	B*	Std. Error	t	P-value
(Constant)	27.37	5.15	5.315	.000
Property was built before 1995	11.40	2.55	4.470	.000
Property is a senior citizen/retirement community	-8.37	3.30	-2.539	.011
Property has a play area	6.54	2.13	3.064	.002
Property has a cooling tower	9.85	4.11	2.397	.017
Property is billed through RUBS method	-1.71	2.09	-0.817	.414
Property is submetered	-10.05	2.79	-3.604	.000
Average commodity charge for water/wastewater†	-1.76	0.32	-5.489	.000
Average number of bedrooms per unit†	18.18	1.86	9.753	.000
Average rent per bedroom†	-0.006	.004	-1.598	.111

Dependent Variable: Indoor water use per unit (average 2001, 2002)
* Represents the magnitude of each independent variable in kgal per year per dwelling unit
† Continuous variables, change is seen for every dollar or bedroom added

Besides submetering, five other independent variables in the model were also statistically significant. One that was not statistically significant was the average rent per bedroom at a property. It was found to covary with location, which is accounted for in the model with average commodity charge for water and wastewater. Properties built before 1995 used 11.4 kgal per unit *more* than properties built after 1995 – this is presumably largely the result of the high efficient plumbing fixtures (toilets, showerheads, and faucet aerators) mandated for new construction by the 1992 Energy Policy Act (EPACT). The average number of bedrooms per unit is a reasonable surrogate for the number of people living in each dwelling unit. These models suggest that for every additional bedroom water use is *increased* by an average of about 18.2 kgal per unit. Properties that reported having a play area used 6.5 kgal per unit more than properties without that amenity. The presence of a cooling tower increased per unit water use 9.9 kgal per unit. For every dollar more that a utility charged per thousand gallons of water and wastewater, a property's water use would decrease by 1.8 kgal per unit per year.

It should be noted that all of the beta coefficients in Table 5.19 are additive and provide a method to estimate annual water usage for a given property. The generic equation for Model #3 follows the same logic as was outlined in the section on Model #1. For example, if there is a property that was built before 1995, has a cooling tower, is submetered, has an average commodity charge of $3 per kgal, and has 1 bedroom, the following equation could be used:

$$27.37 + 11.40 + 9.85 - 10.05 + 3*(-1.76) + 1*(18.18) = 51.47$$

From the Model #3 equation, the annual water use could be estimated for the property as 51.47 kgal per unit per year.

Matched-Pair Analysis

As described in Chapter 3, the purpose of the matched pair analysis was to identify pairs or triads of properties within a single geographic area that differed in billing type but held constant as many building characteristics as possible that could influence water use. By augmenting the larger statistical analyses with this smaller more controlled study, we were able to test some of the prior findings "on the ground" by verifying at each site important characteristics of the match before testing the difference in water consumption for properties whose residents paid under different billing systems.

Because of the limited number of impact properties to choose from in any single jurisdiction, it was not possible to select pairs that were similar on scores of characteristics. All pairs were in the same jurisdiction which held external use factors constant such as weather, local water use regulations or surcharges and regional predispositions or programs encouraging conservation. Nevertheless, matching on other important characteristics was somewhat challenging because, typically, impact properties are newer, and/or larger, and/or charge a higher rent than in-rent properties.

A total of 77 properties were visited as part of the site visits for this study. Of the 77 visited properties, 64 met the necessary criteria for inclusion in the matched pair analysis. The number of matched pairs available for analysis was 21 submetered/in-rent properties, and 14 RUBS/in-rent properties.

Comparison of Water Use in Matched Pair Sample to Postcard and Manager Survey Samples

To make the fairest comparison of water use between the matched properties, the average water use per unit per year was calculated as the average of annual water use per unit across all years within a match where water use data were present for both properties within the match. To test the representativeness of the matched pair sample water use estimates compared to the postcard survey sample and manager survey sample, comparisons were made between the estimated water use in 2001 per unit in the postcard and manager survey sample to the estimated annual water use per unit for the matched pairs. As can be seen in Table 5.20 below, there were no statistically significant differences within the in-rent properties or the submetered properties matched pair water use estimates compared to the postcard survey sample or the manager survey sample. The in-rent matched pair water use estimate was higher the postcard and manager survey estimates, while the submetered matched pair water use estimate was also slightly higher than either other sample. Table 5.21 shows the same comparisons for the RUBS/in-rent pairs. Here, the difference between the in-rent properties chosen for the matched pairs and the in-rent manager survey respondents are significant ($p<0.05$), with the average in-rent match pair being about 15 kgal/unit *higher*. The difference between the in-rent properties chosen for the matched pairs and the in-rent postcard survey respondents are very close to significance ($p = 0.053$), with the in-rent match pair being about 13 kgal/unit *higher*. The RUBS properties chosen for the matched pair analysis are *lower* than the RUBS manager survey respondents by 6 kgal/unit and *lower* than the postcard survey respondents by 4 kgal/unit. These differences are not significantly different, however, with such a small N (14), the power to detect differences is quite small. The combination of the in-rent matched pairs having generally higher water use and the RUBS properties having generally lower water use suggests that these selected properties were not a representative sample. This provides testament to the fact that it is often difficult to get reliable results with small sample sizes, and helps to explain the anomalous savings found in the RUBS/in-rent matched pair analysis.

Table 5.20 Comparison of submetered to in-rent matched pair sample water use to postcard and manager survey sample

		Postcard Survey	Manager Survey	Matched Pairs
In-Rent	Mean	53.21	51.61	57.59
	Std. Deviation	27.51	25.52	22.22
	Number of Properties	N=6493	N=858	N=21
Submetered	Mean	44.87	46.07	47.61
	Std. Deviation	25.50	21.86	14.55
	Number of Properties	N=273	N=118	N=21

Table 5.21 Comparison of RUBS to in-rent matched pair sample water use to postcard and manager survey sample

		Postcard Survey	Manager Survey	Matched Pairs
In-Rent	Mean	53.21†	51.61*	66.19* †
	Std Deviation	27.51	25.52	22.80
	Number of Properties	N=6493	N=858	N=14
RUBS	Mean	52.10	53.45	47.80
	Std Deviation	23.95	22.79	17.84
	Number of Properties	N=595	N=177	N=14

* Differences between the matched pair sample and the manager survey sample are statistically significant, $p<0.05$, tested using ANOVA.
† Differences between the matched pair sample and the postcard survey sample are close to statistical significance, $p=0.053$ tested using ANOVA.

Comparison of Matched Pair Property Characteristics

There were twenty-one-matched pairs of buildings, in which one in the pair was submetered and the other recovered water costs through rent or homeowners association dues. There were fourteen RUBS properties matched to in-rent properties. Despite the best efforts to select properties similar in every way except billing method, properties could not be matched on scores of characteristics, and important differences might remain. Consequently, 50 characteristics of the property pairs were examined to determine the extent to which important differences persisted. None of these characteristics were statistically significant (tested using a dependent t-test or chi-square), although the small sample size means the power to detect differences was low, and thus only large differences would be detected.

Comparison of Water Use Between Matched Pair Properties

The average annual water consumption per unit for the submetered/in-rent matched pairs is shown in Table 5.22, while Table 5.23 displays the average annual water use per unit for the RUBS/in-rent matched pairs. All of the averages are shown in Figure 5.16 and the differences are shown in Figure 5.17.

Table 5.22 Average water use (kgal/unit/year), submetered/in-rent pairs

	Mean	Std. Deviation	Minimum	Maximum	N
In-Rent	57.59	22.22	25.89	98.13	21
Submetered	47.61	14.55	22.45	78.96	21

Table 5.23 Average water use (kgal/unit/year), RUBS/in-rent pairs

	Mean	Std. Deviation	Minimum	Maximum	N
In-Rent	66.19	22.80	33.63	98.31	14
RUBS	47.80	17.85	21.38	80.87	14

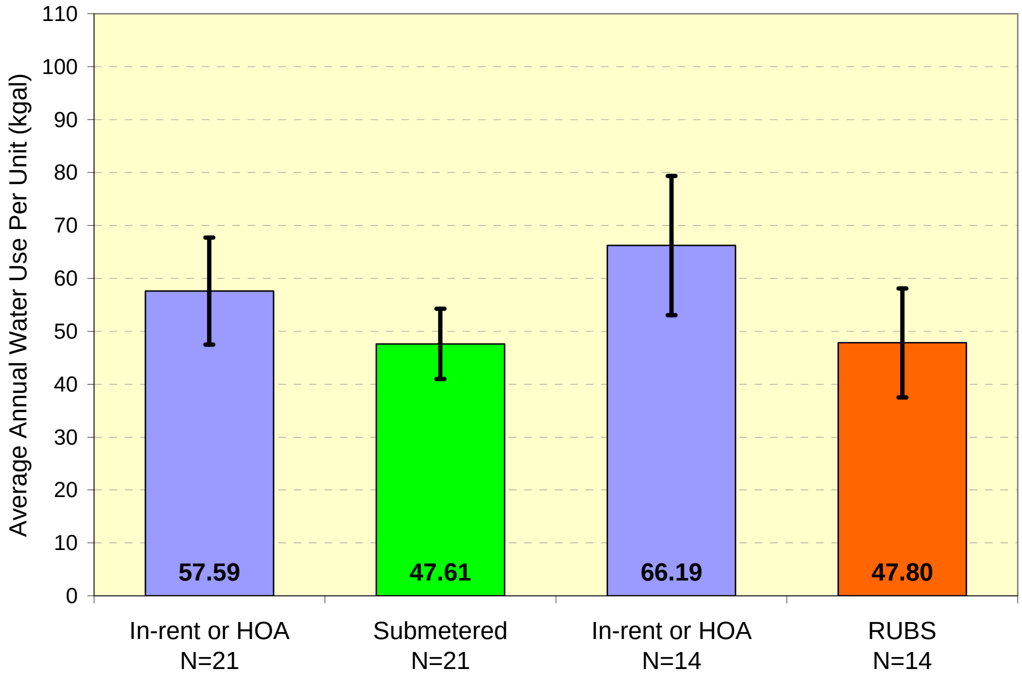


Figure 5.16 Average annual water use per unit – matched pair sample

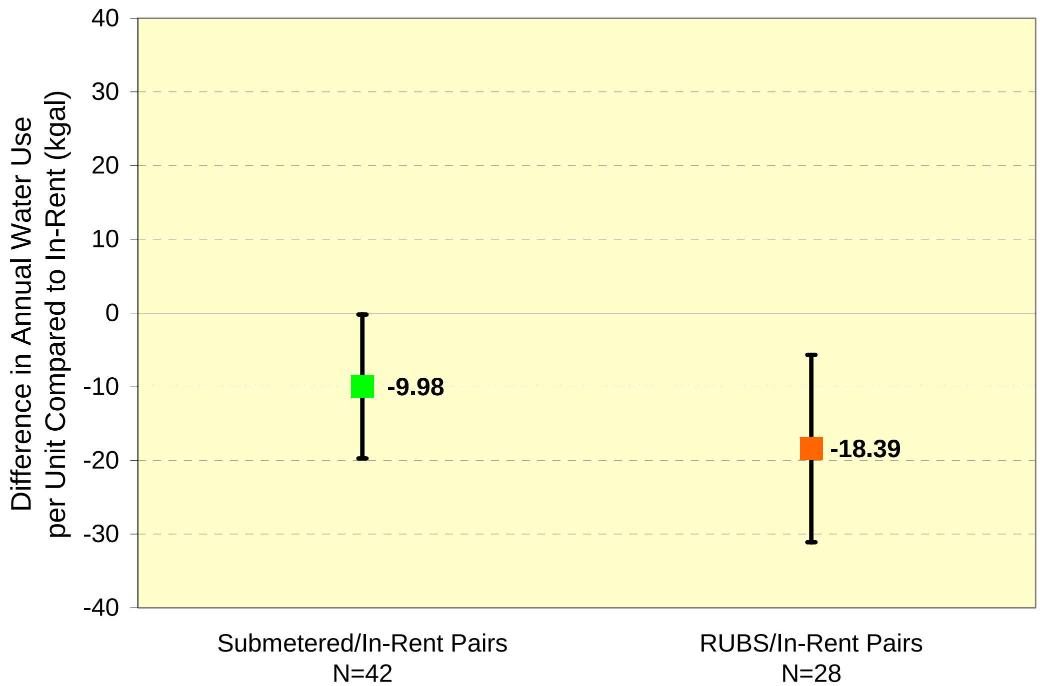


Figure 5.17 Difference in average annual water use of impacted properties compared to in-rent properties – matched pair sample

In Table 5.24 the P-value is shown for the difference in water usage between the submetered and in-rent matched properties along with the 95% confidence interval around this estimate. Using a dependent t-test, the difference in annual water use per unit was statistically significant (p=0.046). The 95% confidence interval around the water savings suggests that the difference in water use is likely to range from -0.2 to -19.7 kgal per unit per year in submetered properties compared to in-rent properties. Similarly, a statistically significant savings was found for RUBS (p=0.008), as shown in Table 5.25. This is the only analysis from the data collected for this Study in which such a finding was observed. As mentioned previously and discussed below, it appears the sample drawn for the RUBS/in-rent matched pair analysis was not representative of the entire manager survey sample.

Table 5.24 Average water use (kgal/unit/year) difference, submetered/in-rent pairs

	Mean Difference	Std. Error	P-value	95% Confidence Interval for Mean Difference	
				Lower Bound	Upper Bound
In-Rent compared to Submetered	-9.980	4.684	0.046	-19.750	-0.210

Table 5.25 Average water use (kgal/unit/year) difference, RUBS/in-rent pairs

	Mean Difference	Std. Error	P-value	95% Confidence Interval for Mean Difference	
				Lower Bound	Upper Bound
In-Rent compared to RUBS	-18.387	5.890	0.008	-31.112	-5.662

Four types of comparisons were included in this study (large sample from post card survey of managers; medium sample from mailed survey of managers; small sample of pre-post; and small sample of matched pairs), where each level intended to control better the differences in property characteristics that could subvert conclusions about billing type as the variable responsible for observed differences in water usage. If all levels of the study supported each other, conclusions would be strongest. Where three of the four levels are mutually supportive, but one is not, then one must examine the anomalous finding. In this study, the matched pair analysis, intended to control best for competing explanations for water use differences among properties with different billing types, included properties with annual average per unit water usage that was outside of larger sample parameters. With such a small sample of pairs, the selection of a few properties with atypically high or low water use is always a possibility. Among the in-rent and RUBS matched pairs, the in-rent water usage was uncommonly high, at an average of 66 kgal per unit per year compared to 53 kgal per unit per year in the largest property sample and the RUBS use was slightly low at an average of 48 kgal per unit per year compared to 52 kgal per unit per year in the largest property sample.

Since the researchers were blind to water use when selecting the sample, there could be no *a priori* control of abnormal water use. It seems that the exceptionally high water use in the in-rent properties matched to the RUBS properties most likely is the reason that this small matched-pair analysis shows a savings with RUBS. Just as it would be possible to find a small group of people whose reaction to a placebo pill would seem to help them recover quickly from the flu, we would not wish to conclude that the pill was, in fact, effective based on those limited findings when a larger study showed no such impact. Because the other analyses in this chapter where sample sizes were bigger and statistically controlled showed no water savings associated with RUBS, it is concluded that this small sample finding of a RUBS effect is most likely spurious.

Pre/Post Billing Conversion

The pre/post billing conversion analysis aimed to compare water use at the same property before and after a separate billing system was implemented. By keeping the building constant, the number of factors that could influence water use at a property are kept to a minimum.

Through the manager survey data, any property that had changed from an in-rent system to a separate billing system was identified, along with the year of the conversion. Forty-six such properties were identified that had made such a change in 2000 or in 2001, and for which water use data were available in years both before and after the conversion year. To avoid including the transitional period of conversion, the water data from the year of conversion was excluded.

Of the 46 properties identified, 39 had switched to RUBS, 1 to a hot water hybrid system, and 6 to submetering. The average annual water use before and after conversion for these properties is shown in Figure 5.18.

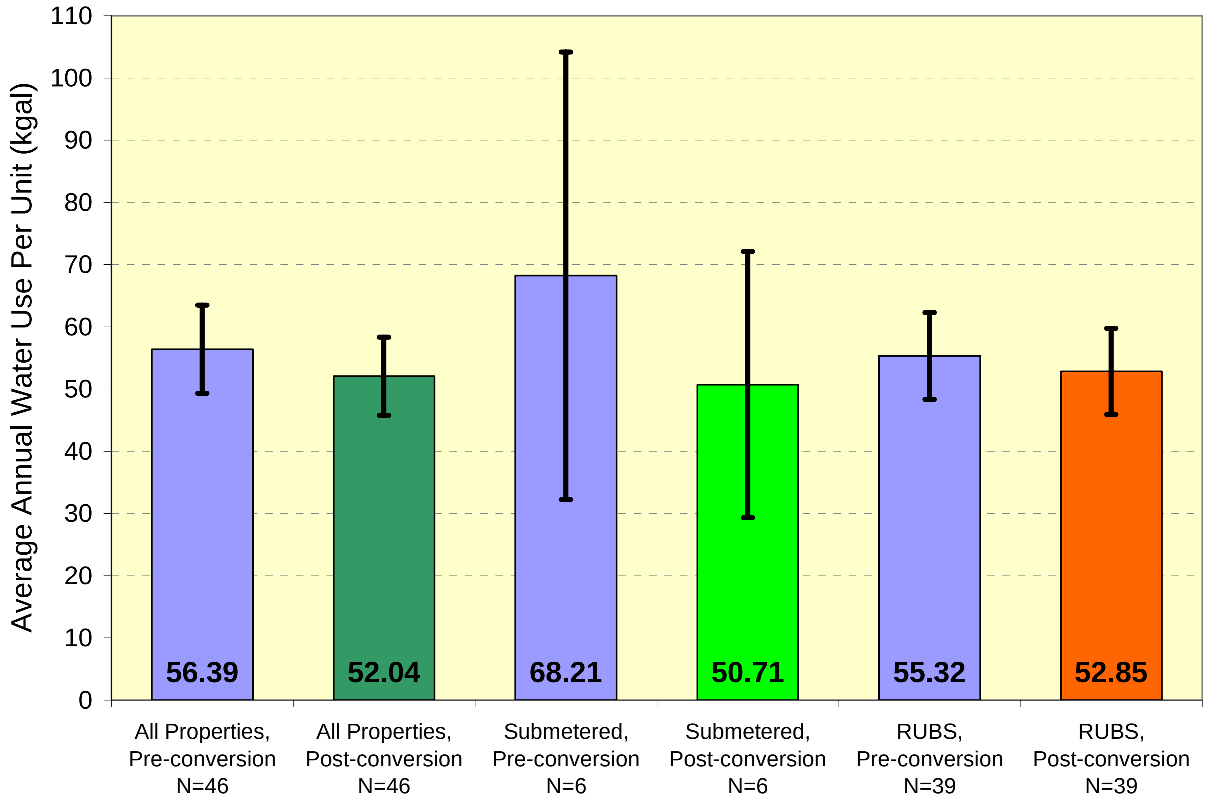


Figure 5.18 Average annual water use per unit before and after conversion

Table 5.26 shows that among all 46 properties, annual water use per unit *decreased* 4.4 kgal after conversion compared to water use prior to conversion. However, this difference just missed being statistically significant at the 0.05 level, as can be seen in Table 5.27 where the results of a dependent t-test are shown. It was statistically significant at the 93% confidence level.

Table 5.26 Estimated water use before and after conversion, all converted properties, N=46

	Mean	Std. Deviation
Estimated Annual Water Use per Unit Prior to Conversion	56.39	23.75
Estimated Annual Water Use per Unit After Conversion	52.04	21.09
Change in Estimated Annual Water Use Before and After Conversion	-4.35	15.90
Percent of Properties That Decreased Annual Water Use per Unit	56.52%	
Percent of Properties That Did Not Change Annual Water Use per Unit	6.52%	
Percent of Properties That Increased Annual Water Use per Unit	36.96%	

Table 5.27 Paired samples test, all converted properties

	Paired Differences					
	Mean Difference	**Std. Deviation**	**Std. Error Mean**	**t**	**df**	**P-value**
Estimated Annual Water Use per Unit Prior to Conversion - Estimated Annual Water Use per Unit After Conversion	4.350	15.902	2.345	1.856	45	0.070

Water savings were also examined by type of billing to which the properties converted. For submetering, the sample size was quite small (6 properties). The small sample size is not particularly surprising, since it often expensive to retrofit a property with submeters, and is more common in new construction. For converted submetered properties, water savings of about 17.5 kgal per unit per year were observed (see Table 5.28).

Table 5.29 shows that the differences from pre-conversion to post-conversion are statistically significant at the 94% confidence level. In addition, given the small sample size, the 95% confidence interval is quite wide around the submetering conversion water savings estimate, ranging from –36.1 to +1.1 kgal per unit per year. This is shown in comparison to all of the converted properties and the RUBS properties in Figure 5.19.

Table 5.28 Estimated water use before and after conversion, submetered properties

	Mean	**Std. Deviation**
Estimated Annual Water Use per Unit Prior to Conversion	68.21	34.24
Estimated Annual Water Use per Unit After Conversion	50.71	20.38
Change in Estimated Annual Water Use Before and After Conversion	-17.50	17.67
Percent of Properties That Decreased Annual Water Use per Unit	83.33%	
Percent of Properties That Did Not Change Annual Water Use per Unit	.00%	
Percent of Properties That Increased Annual Water Use per Unit	16.67%	

Table 5.29 Paired samples test, submetered converted properties

	Paired Differences					
	Mean Difference	Std. Deviation	Std. Error Mean	t	df	P-value
Estimated Annual Water Use per Unit Prior to Conversion - Estimated Annual Water Use per Unit After Conversion	17.500	17.675	7.216	2.425	5	0.060

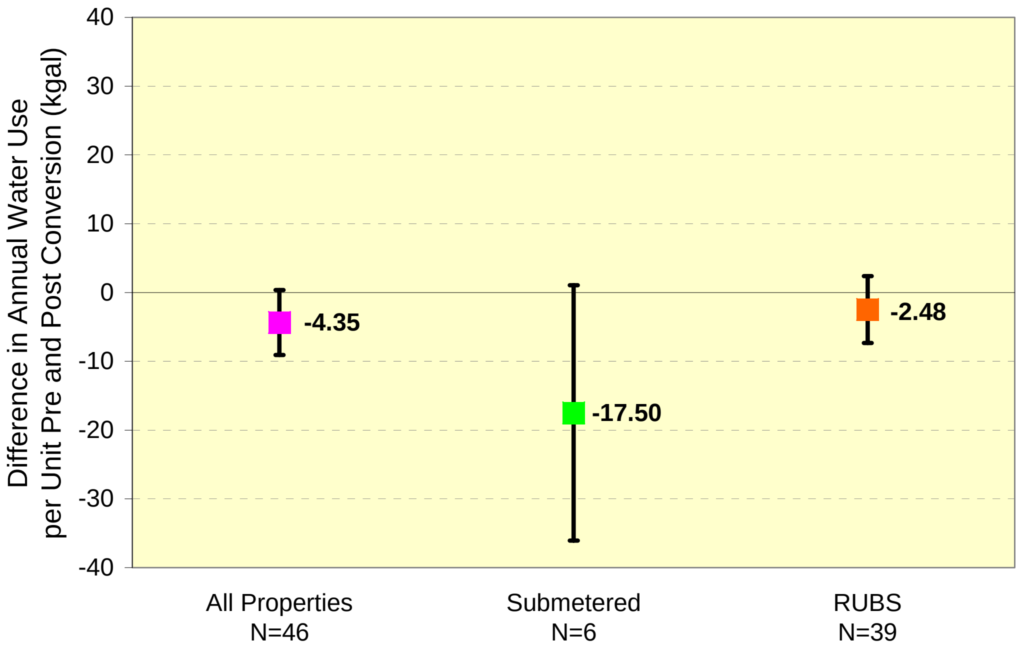


Figure 5.19 Difference in average annual water use, pre- and post-conversion

Differences among properties who converted to RUBS were also looked at separately. This sample size was larger (39 properties), which is not surprising since retrofitting a property with a RUBS system requires very few up front costs and does not require any plumbing modifications. Among these properties, savings averaged 2.5 kgal per unit per year, but were not found to be statistically significant (see Table 5.30 and Table 5.31).

Table 5.30 Estimated water use before and after conversion, RUBS properties N=39

	Mean	Std. Deviation
Estimated Annual Water Use per Unit Prior to Conversion	55.32	21.64
Estimated Annual Water Use per Unit After Conversion	52.85	21.37
Change in Estimated Annual Water Use Before and After Conversion	-2.48	15.05
Percent of Properties That Decreased Annual Water Use per Unit	53.85%	
Percent of Properties That Did Not Change Annual Water Use per Unit	7.69%	
Percent of Properties That Increased Annual Water Use per Unit	38.46%	

Table 5.31 Paired samples test, RUBS properties

	Paired Differences					
	Mean Difference	Std. Deviation	Std. Error Mean	t	df	P-value
Estimated Annual Water Use per Unit Prior to Conversion - Estimated Annual Water Use per Unit After Conversion	2.477	15.051	2.410	1.028	38	0.311

COMPARISON OF RESULTS WITH OTHER STUDIES

As described in Chapter 2 (Literature Review) there are a number of studies that have examined water use in submetered and RUBS properties to explore the impacts of these billing programs. One of the most striking differences between these previous studies and the National Submetering and Allocation Billing Program Study is the sample size. Table 5.32 shows the various sample sizes for the analyses from this study, as well as from other previous studies. It is important to note that in this study, each analysis that is listed uses a subset of data from the previous analysis, as each analysis becomes more and more refined. The large number of properties in this study allowed for numerous statistical analyses with substantial statistical power that were not possible with the small sample sizes of the previous studies.

Table 5.32 Comparison of sample size from multi-family billing program studies

Study	Description of Analysis	No. Properties Included in Analysis			
		In-Rent	Sub.	RUBS	HWH
National Submetering and Allocation Billing Program Study (2004)	Postcard Survey	6493	273	595	41
	Manager Survey	858	118	177	22
	Statistical Model #1	705	101	150	-
	Statistical Model #2	703	100	150	-
	Statistical Model #3	531	79	136	-
	Matched Pair	29	21*	14	-
	Pre-Post Conversion	-	6	39	1
Wilcut (2002)	Paired Comparison	5	5	5	-
Strub (2000)	Pre-Post Conversion	-	-	-	2
Koplow and Lownie (1999)	Paired Comparison	14	9	9	-
Dietemann (1999)	Paired Comparison	5	1	-	-
	Pre-Post Conversion	-	9	-	-

* 7 HWHs were grouped with the submetered for this analysis.

Table 5.33 shows a comparison of the water savings found in this study with previous research efforts (please refer to Chapter 2 for more details on these studies). In general, the 15% savings from submetering found in this study is lower than most of previous findings. An insufficient sample size precluded the inclusion of water savings conclusions for hot water hybrid properties. This study did not find statistically significant water savings from RUBS. The Wilcut (2002) study found moderate savings of 3% for RUBS properties, while the Koplow and Lownie (1999) found more substantial savings of 6% to 27%.

Since its publication in 1999, the water savings results from submetering and RUBS published in the Koplow and Lownie study have been frequently cited, particularly by the billing service industry. The differences in the findings between the Koplow and Lownie study and this study should be looked at more closely.

Table 5.33 Comparison of water savings found in previous billing research studies

Study	Description of Analysis	Savings Attributed to Billing Method		
		Sub.	RUBS	HWH
National Submetering and Allocation Billing Program Study (2004)	Statistical Model #2*	15%	-†	-‡
Wilcut (2002)	Paired Comparison	31%	3%	-
Strub (2000)	Pre-Post Conversion	-	-	5 to 12%
Koplow and Lownie (1999)	Paired Comparison	18% to 39%	6 to 27%	-
Dietemann (1999)	Paired Comparison	27%	-	-
	Pre-Post Conversion	8%	-	-

* This model provides the "best estimate" of expected water use and savings based on a preponderance of the data (see Model #2 in Chapter 6 for details).
† Average savings was found to be 1.4%, but was not statistically significant.
‡ Sample size was deemed to small to provide reliable results.

Koplow and Lownie found higher water savings for both submetering and RUBS compared with the National Submetering and Allocation Billing Program Study (current study). Although the sample size in the Koplow and Lownie study was small (n=32 compared with n=953 in this study), the statistical methods employed were generally sound. However, a critical assumption by Koplow and Lownie to combine the water savings from fixture conversion and water billing appears to have impacted their results. Surprisingly this assumption was not made explicit in Koplow and Lownie's report. However, recent personal communication with Doug Koplow revealed that the savings estimates in his 1999 study *included* savings attributable to fixture upgrades, as well as to the billing system itself. Doug Koplow wrote in a memo dated January 2004:

> "Based on discussions with building managers and property owners during our research, it became evident that the billing conversion and the capital upgrades were actually linked decisions in many cases. In order to make the billing for water more palatable, many buildings upgraded water using capital. It is therefore proper to attribute these capital-related reductions in consumption to a shift in billing methods, rather than deducting them from observed changes."

In contrast, the research from this study did not find any linkage between converting to a separate billing system and capital water fixture upgrades. To the contrary, results from the manager survey suggested comparable fixture change-out rates in properties built before 1995 among all billing methods. Furthermore, results from the resident survey indicated that in-rent property owners were more likely to take some sort of action to conserve water compared with impact property owners. The researchers in the National Submetering and Allocation Billing Program Study saw no justifiable reason to credit water savings properly attributable to fixture upgrades with any water billing program. Every effort was made in this study to specifically exclude savings from fixture upgrades (which are well documented in other research studies) and to focus on the savings attained from each billing program itself. This important difference could help to explain the reported savings estimates found by Koplow and Lownie in their 1999 work.



CHAPTER 6 COSTS AND BENEFITS

Beyond quantifying the water savings that can be measured by conversion, there are many issues that arise concerning these billing systems for utilities, for property owners, and for residents. As is true with any developing field, there are clear advantages to these systems as well as some costs and drawbacks that need to be addressed. This chapter takes on a variety of perspectives to examine some of the benefits, costs, and concerns that have surfaced because of changing water billing methods. Finally, the chapter examines the price elasticities of these billing system, as well as some other economic analyses.

UTILITY PERSPECTIVE

Perceived Benefits

Water and wastewater utilities in urban areas are typically highly structured and regulated organizations that are in the business of treating, delivering, and selling water to a broad customer base and then treating the wastewater produced by those customers. In water scarce regions and due to the high cost of treatment facility expansion, more and more utilities are embracing water conservation programs and methods to reduce demand. Although water providers remain skeptical of efforts to "re-sell" their product and services such as third party water and wastewater billing, they do recognize the potential benefits from the decrease in demand that separate billing could induce. Billing multi-family residents for water and wastewater could aid in this effort through behavior modification via price signal that could promote installation of low-flow fixtures, leak repair, and efficient use. It is also possible that billing multi-family residents could produce a process that might help utilities identify inaccurate master meters. Demand reduction allows utilities to defer, downsize, or cancel water and wastewater treatment facility upgrades, as well as to avoid new water supply development. Because these tasks require a large capital investment, conservation is an attractive way to minimize expenditures and rate increases.

The multi-family sector is of particular interest to water utilities since this sector has been found to have low response rates to conservation programs and water restrictions during drought and emergencies. During a recent water shortage, a large retail utility in California saw five major customer groups curtail use by an average of 27%, while the master metered multi-family sector only reduced usage by 18% (AWWA WCD 2001). This result is not surprising since master metering does not provide the end users (the residents) with a price signal and because emergency demand reduction typically comes from reducing outdoor irrigation and multi-family use is predominantly for indoor purposes. It is thought that direct billing could make multi-family customers more aware of water usage and more responsive to drought rate increases. If the utility were directly involved with billing, bill stuffers could inform the public of drought severity, as well as provide conservation tips and other educational materials. Utilities have historically been hesitant to take on the task of individual metering of multi-family units. It is uncertain whether cooperative arrangements between utilities and third party billing companies could be reached so that educational bill stuffers could be forwarded to privately billed customers during shortages. Since many different billing companies operate in each service area coordinating such an effort would be a challenge.

Perceived Concerns

Water utilities have not led the way for individual metering in multi-family housing for a variety of legal, liability, and revenue reasons. Many utilities have financial and logistical concerns over the prospect of substantially increasing their current client base. The multi-family sector has a high resident turnover rate, which would require for some utilities to bill more frequently. Individual customer billing in the multi-family sector also has a higher uncollected bill rate, which would have financial implications for utilities. Also, utilities are generally only responsible for the water line up to the master meter, so if utilities installed individual meters within a property, leaks within the property could cause access and liability issues. In addition, lack of regulation of the RUBS and submetering industry limits legal protection for utilities.

If future legislation does require water utilities to become directly involved in submetering, more concerns will inevitably surface. Plumbing configuration will become more important, as utilities opt for the best placement of meters to insure efficient reading. Also, utilities will have to rethink how the rate structures will be determined for multi-family customers that were previously subject to master meter rates. These concerns diminish considerably when third party companies and owners manage the separate billing independently. However, as a public service provider, most utilities would want to ensure that any billing provided by a third party is done in a manner that is fair to their customers.

Utilities also need to weigh the relative importance of submetering compared with other conservation measures. Although it is not an outright concern, an analysis of the costs and benefits of sponsoring rebate programs for submeters will be essential for utilities as this technology becomes more prominent.

Another interesting question concerns utilities that do not bill multi-family properties volumetrically, rather they bill through a fixed or flat rate. If a property owner in one of these unmetered properties wants to install submeters, issues would arise over what rates could be charged. Recommendation 2 of this report addresses this issue, which recommends that all multi-family properties be billed volumetrically.

Utility Cost/Benefit Analysis

Any water saved from submetering translates into a decrease in demand for a utility, which can help to reduce their costs. Utility avoided costs from conservation may include reduced energy demand (pumping), chemicals for treatment, and canceling, postponing, or downsizing new facilities. Table 6.1 shows a range of avoided costs for utilities, assuming annual savings of 7.96 kgal per dwelling unit (du) (21.8 gallons/du/day) from submetering. A utility avoided cost of $500/AF would translate into a present value savings of $152 for each dwelling unit that is submetered, assuming a 20 year useful life. The present value of benefits to the utility could be considered a justifiable subsidy for submetering, or other conservation efforts. Obviously, agency avoided cost and assumptions about product life impact the value of submetering for each utility.

Summary of Utility Perspective

Supporting the installation of submeters represents an opportunity for water utilities to capture cost-effective water savings. Savings can be captured in new construction by either requiring the individual metering of multi-family units or by offering incentives in both existing and new multi-family dwellings. Because RUBS has not been found to render reliable savings, it is not cost-effective for utilities to offer incentives promoting RUBS programs. However, since the findings of this report indicate that the savings from fixture upgrades are more substantial than from submetering, utilities should consider offering cost-effective incentives for change-outs for all multi-family properties.

Table 6.1 Avoided costs from submetering, utility perspective

Annualized Combined Water and Sewer Avoided Cost		Equivalent PV Avoided Cost*	Water Saved	Submeter Useful Life†	Value of Water and Sewer Benefits	PV of Benefits to Utility‡
($/acre-ft)	($/kgal)	($)	(gal/du/year)	(years)	($/year)	($)
$200	$0.61	$3,432	7,957	20	$5	$61
$300	$0.92	$5,148	7,957	20	$7	$91
$400	$1.23	$6,864	7,957	20	$10	$122
$500	$1.53	$8,580	7,957	20	$12	$152
$600	$1.84	$10,295	7,957	20	$15	$183
$700	$2.15	$12,011	7,957	20	$17	$213
$800	$2.46	$13,727	7,957	20	$20	$243
$1,000	$3.07	$17,159	7,957	20	$24	$304

* Assumes discount rate of 5% and a term of 40 years.
† Assumes that AMR submeters will be replaced twice in twenty years.
‡ Assumes discount rate of 5% and the assumed term of the submeter useful life (in this case, 20 years).

PROPERTY OWNER PERSPECTIVE

Perceived Benefits

The increase in water prices has had a pronounced effect on multi-family property owners, essentially raising the cost of doing business. Traditionally, property owners have paid the water and wastewater bill with the intention of recovering the costs through monthly rent payments. However, if water prices rise faster than market rental rates, property owners could experience an increase in operating costs. Thus, owners can benefit by transferring water costs directly to the residents. This decreases the overall operational costs for the owner and removes the uncertainty in estimating monthly water bills.

In most cases, billing separately for water and wastewater will increase the owner’s net operating income and property value. Despite the initial capital investment, submetering can be a cost-effective option for owners. In addition, submetering technology has improved so that the cost for submetering new construction and retrofitting most existing properties is reasonable. In the case of allocation, there is no capital investment and the payback is immediate. Nevertheless, before converting to a separate billing system, owners should be aware of the applicable federal, state, and local regulations.

Perceived Concerns

A large concern for owners is the cost of submetering. The cost of submetering depends on the type of meter installed and the time and place of installation. According to the literature, installations on new construction are the most favorable and inexpensive, averaging $200 per dwelling unit, whereas retrofitting can be more expensive, averaging $300 per dwelling unit (AWWA WCD 2001, Palmer 1999). Payback periods were previously cited between one and five years (Dietemann 1999), but have continued to decrease as submetering technology has improved and become less expensive. A more detailed cost/benefit analysis is conducted later in this section. In the study's manager survey, of managers that had considered converting to individual billing, "Too expensive" was the top consideration (54.7%). "It conserves water usage by residents" was the second consideration (52.5%), followed by "resident resistance" (37.4%) and "increased profitability of property (28.5%). All of the responses can be seen in Table 4.8 in Chapter 4.

Allocation, on the other hand, requires virtually no up front fees. For both allocation and submetering, if owners opt for a specialized read and bill company to provide the service, there is a service charge for each dwelling unit per month[29]. Although sometimes controversial, these fees can be passed on to the residents except where prohibited by law.

There are also regulatory and liability issues that may discourage some owners. Submetering is a plumbing modification, and therefore some local laws require permits, fees, and inspections. Furthermore, owners could be held liable if there are meter leaks or contamination due to backflow.

Another area of concern is the reaction of residents to submetering and RUBS. Residents may be hesitant to take on another monthly bill. In addition, when water and wastewater billing is introduced at lease renewal monthly rent is typically not lowered. Many property owners fear higher vacancy rates and resident complaints. In the manager survey, vacancy rates were very similar for submetered and RUBS properties (7.0% and 7.2% respectively), and they were slightly lower for the in-rents (5.6%). Many managers did report in the survey that there were resident complaints when they converted: 61% for RUBS, 47% for HWHs, and 22% for

[29] In the read and bill company survey, the average service fee was $3.29 per dwelling unit per month, with a minimum of $1.50 and a maximum of $6.14.

submetered. Complete responses of complaints can be seen in Figure 4.11 and Table 4.11 in Chapter 4.

Owners also need to have a method to recoup uncollected water bills. According to electric and gas utilities, and third party water billing companies, uncollected resident bills in multifamily properties range from 7% to 15% (AWWA WCD 2001). In the read and bill company survey, the average non-payment rate was 12.7%. However, in the manager survey, the average non-payment rate was reported to 6.1% for submetered and 6.4% for RUBS properties. Taking unpaid water bills out of a general security deposit has been one solution. In some states it is illegal to take utility bill payments out of the security deposit, and instead, a utility deposit can be collected for this purpose.

Owner Benefit/Cost Analysis

Submetered Properties

Based on results from the manager survey, the water analysis from this study, and industry prices, a more thorough economic analysis was performed on the costs and payback periods for submetering. The economic analysis is impacted by whether or not the owner lowers the rental payment by the estimated average water bill. Because most water and wastewater billing programs are introduced at lease signing and renewal, rental prices are often not lowered (but are arguably less likely to increase in the long term). In addition, many property owners consider the fact that water rates have been increasing at a rate higher than rental rates, and therefore don't lower the rent to try to recoup some of their net operating income loses. In this way, all water costs that are passed to the resident are realized as an increase in net operating income for the property owner. The increase in yearly revenue also helps to increase the property value.

Table 6.2 shows the benefit/cost analysis for a variety of installation costs, all of which assume automatic meter reading (AMR). The useful life of an AMR meter is 15 years, but the battery to run the transmitter only has a useful life of 10. Since the transmitter is either part of the meter register or an expensive stand-alone part, owners will typically replace the entire thing at 10 years. For this analysis, a 20 year life is assumed, which includes the initial installation and one replacement. For any AMR billing method, there is always a base cost per property that includes a receiver, computer, and software. This cost has less impact at larger properties, where the base cost can be spread over many units, than at smaller properties. In all of the cases, the owner is assumed to pay the monthly service fee. In addition, because recommendations from this report include mandatory fixture upgrades when converting to a billing program, the analysis includes the cost of retrofitting a dwelling unit. All calculations assumed that the utility commodity charge for water and wastewater was $5.27 per thousand gallons.[30] In this study, commodity charges for water and wastewater ranged from $2.82 to $10.11 per thousand gallons, and any benefit/cost ratio is going to greatly depend on the utility charges for a specific property.

Submetering in new construction yielded the highest benefit/cost ratio of 5.1. Retrofitting submeters in an existing property had benefit/cost ratios that varied from 3.1 to 4.0, depending on whether or not fixtures needed to be upgraded. Installing POU meters on all of the end uses in a unit resulted in a benefit/cost ratio from 1.9 to 2.1 depending on whether or not the fixtures needed to be upgraded. A common practice in POU metering involves only installing a single POU meter on the toilet and then a standard submeter on the hot water line, which, in terms of cost, is more comparable to the estimates for submetering.

Resident non-payment of water bills was not included in this cost/benefit analysis, as it was assumed that most owners collect a utility deposit to cover unpaid water bills. It should also be noted that many owners would not stay with a property for the life cycle of submeters, rather most only own a property for an average of 7 – 10 years (Urban Land Institute 2003). If one looks at the simple payback for owning a property for five years, using the same assumptions from Table 6.2, the simple payback is less than one year for all cases.

RUBS Properties

Unlike submetering, converting to allocation requires almost no up front fees. Because most water and wastewater billing programs are introduced at lease signing and renewal, rental prices are often not lowered (but are arguably less likely to increase in the long term). By keeping the rent the same, all water bills paid by the residents will result in reduced operating costs. Table 6.3 shows a cost benefit analysis for a property owner who implements a RUBS system. In this analysis, the owner is assumed to pay the monthly service fee. In addition, because recommendations from this report include mandatory fixture upgrades when converting to a billing program, the analysis includes the cost of retrofitting a dwelling unit. Benefit/cost ratios range from 4.9 to 7.6. It should be noted that resident non-payment of water bills was not

[30] This was the average of the water and wastewater commodity charges for the thirteen study sites.

included in this cost/benefit analysis, as it was assumed that most owners collect a utility deposit to cover unpaid water bills.

Table 6.2 Cost and benefit per unit analysis for owners who chose to submeter

Submetering Method	Efficient Fixtures?	Annual Water Use* (gal/du)	Useful Life† (years)	Annual Value of Water and Sewer Benefits‡	PV of Benefits§	Capital or "First" Costs ($/du): Meter, Transmitter, and Installation**	Capital or "First" Costs ($/du): Receiver, Computer, and Software††	Capital or "First" Costs ($/du): Fixture Replacement ‡‡	Annual Service Fee§§	Meter Replacement***	PV of Costs †††	B/C Ratio
Submeter - New Construction	Yes	52,195	20	$275	$3,428	$125	$25	$0	$ 36	$125	$675	5.1
Submeter - Retrofit	Yes	52,195	20	$275	$3,428	$300	$25	$0	$ 36	$125	$850	4.0
	No	52,195	20	$275	$3,428	$300	$25	$255	$ 36	$125	$1,105	3.1
POU metering‡‡‡	Yes	52,195	20	$275	$3,428	$560	$25	$0	$ 36	$300	$1,597	2.1
	No	52,195	20	$275	$3,428	$560	$25	$255	$ 36	$300	$1,852	1.9

* Based on the total water use of the average in-rent unit (143.0 gal/du/day)

† Assumes that Automatic Meter Reading (AMR) equipment is used, and that based on current technology, that the battery life is limited to 10 years, and it is best to replace the entire meter, register, transmitter, and battery at same time (even though standard life for a meter is 15 years). Assumes that POUs will need to be replaced every 5 years.

‡ Based on a commodity charge for water and wastewater of $5.27 per kgal (the average commodity charge for the thirteen study sites). Does not include fixed fees.

§ The present value of annually occurring benefits is calculated with a discount rate of 5%.

** May vary by property and location.

†† Calculated on a per property basis. This assumes a $2,500 base cost spread over 100 units.

‡‡ Includes hardware and installation cost for a dwelling unit that is retrofit with 1.2 toilets for $234, 2 aerators for $4, and 1 showerhead for $17. Not applicable to dwelling units that have already been equipped with hardware operating within 125% of EPACT standards. Only accounts for the first time cost, does not account for any ongoing replacement/maintenance schedule at the property.

§§ Assumes monthly service fee of $3 is paid by owner.

*** Replacement costs for submeters (which will be replaced every 10 years) and POU meters (which will be replaced every 5 years).

††† The present value of annually occurring costs is calculated at a discount rate of 5%.

‡‡‡ POU metering will often also bill for hot water energy, but that is not included in this payback calculation. Assumes 7 meters per unit, and $80 per meter (includes hardware and installation).

Table 6.3 Cost and benefit for owners who choose to allocate

Billing Method	Efficient Fixtures?	Annual Water Use* (gal/du)	Useful Life† (years)	Annual Value of Water and Sewer Benefits‡	PV of Benefits§	Fixture Upgrade Cost** ($/du)	Annual Service Fee†† ($/du)	PV of Costs	B/C Ratio
RUBS	Yes	52,195	20	$275	$3,428	$ 0	$ 36	$449	7.6
	No	52,195	20	$275	$3,428	$ 255	$ 36	$704	4.9

* Based on the total water use of the average in-rent unit (143.0 gal/du/day).
† Assumes that the program will be in place for 20 years.
‡ Based on a commodity charge for water and wastewater of $5.27 per kgal (the average commodity charge for the thirteen study sites). Does not include fixed fees.
§ The present value of annually occurring benefits is calculated with a discount rate of 5%.
** Includes hardware and installation cost for a dwelling unit that is retrofit with 1.2 toilets for $234, 2 aerators for $4, and 1 showerhead for $17. Not applicable to dwelling units that have already been equipped with hardware operating within 125% of EPACT standards. Only accounts for the first time cost, does not account for any ongoing replacement/maintenance schedule at the property.
†† Assumes monthly service fee of $3 is paid by owner.
‡‡ The present value of annually occurring costs is calculated at a discount rate of 5%.

Summary of Owner Perspective

In most cases, billing separately for water and wastewater will increase the owner's net operating income and property value. Despite the initial capital investment, submetering can be a cost-effective option for owners. In addition, submetering technology has improved so that the cost for submetering new construction and submetering most existing properties is reasonable. In the case of allocation, there is no initial investment and the payback is immediate. Owners could use this increase in income to improve overall water efficiency on the property, including fixture upgrades. Nevertheless, before converting to a separate billing system, owners should be aware of the applicable federal, state, and local regulations.

RESIDENT PERSPECTIVE

Perceived Benefits

Residents can benefit from submetering by gaining more control over their total housing costs. Residents often do not realize that they are paying for water, albeit indirectly, when it is included in the rent. By maintaining a system where the property owner pays the overall water bill, residents are more vulnerable to rent increases due to leaks, wasteful habits, and rising water prices. Through submetering, residents have an incentive to report leaks and modify other aspects of their water using behavior[31] – actions that can be rewarded through a lower water bill. In the short term, residents do experience an increase in monthly bills, but in the long term, rental prices are likely to come into equilibrium due to competition. In addition, residential water conservation contributes to a larger effort that helps to remove the need for future water rate hikes. RUBS can reap the same benefits if all residents are equally committed to monitoring their water use. However, because of its potential for inequity, resident benefits associated with RUBS are not guaranteed.

[31] In this study, reported resident actions taken to conserve water from the resident survey can be seen in Table 4.14.

Perceived Concerns

In the resident survey, residents were asked their opinion on how they are billed for water. For the impact properties, between 17 and 39% of the residents were dissatisfied. Please refer to Figure 4.16 for complete results and Table 4.17 for the reasons for dissatisfaction, both in Chapter 4. Some of these concerns are further discussed in this section.

A large concern for residents is how submetering or RUBS will affect their budget. Paying separately for utilities such as electricity and other services is common (see Table 4.9), but residents who have grown accustomed to not paying for water will need to start factoring those bills into their monthly budget. In the case of submetering and RUBS, residents may end up paying additional monthly service charges on their water bill. 33% of submetered and 16% of RUBS properties were dissatisfied at least partly because of the service charge. It should be noted that although service charges would also be present if the utility was submetering, there is a key difference between utility and third party service fees. Utility billing, by law, must be cost based – hence the service fees simply cover the costs of providing the water. Third party billing is for profit and is not necessarily cost based. Regardless, with separate billing the total cost of water is altered, and discrepancies may arise over how much, if at all, rent should be lowered when residents start paying individual water bills. However, water and wastewater billing programs are often introduced at lease signing or renewal, and owners can negotiate rent independently from water and wastewater charges.

RUBS can raise a variety of concerns for residents. In the resident survey, the top five issues for RUBS properties were: accuracy of reported water consumption (41.5%), paying for other's/complex (35.4%), rates (28.0%), not based on actual usage (18.3%), and other (47.6%). With RUBS, the question of equity is often raised, since large volume users end up being subsidized by lower volume users. These inequities are inherent in the allocation formulas themselves. Simply because one dwelling unit is larger in terms of square footage does not necessarily mean that its residents use more water. The underlying assumptions are not universal, and there are always exceptions. Unmetered common areas such as lawns, laundry rooms, and pools can be an issue when the volume used by these amenities is estimated. It has also been found that when owners do pay for unmetered common areas, their estimates of usage are often too low (Koplow and Lownie 1999). Hot water hybrids may be considered the "fairest" of all allocation methods, since it is based on some actual consumption.

Interestingly, only 10% of RUBS properties were dissatisfied because the "billing method/calculation unclear", while 17% of submetered properties cited that reason. This was surprising because many of the RUBS bills that were sent in by residents did not include actual billing methodology. This could indicate that residents may receive information on the billing method separate from their actual bill. Additionally, the confusion about submetering billing methods may corroborate a finding of this study: that people are not always sure whether their water use is being measured by total-capture submetering or partial-capture submetering (i.e. a hybrid system).

The lack of regulation makes it more difficult for resident concerns to be allayed. Based on survey responses, residents were more satisfied with utility billing vs. billing from a third party. Residents may fear being taken advantage of or overcharged. The shift of responsibility for water costs might also diminish the incentive for owners to maintain and improve water efficiency within individual dwelling units. The incentive may remain for efficiency and improvements to common areas and irrigation systems, where water use is still paid for by the property owner.

On the resident survey, residents were asked whether their property owners had taken any water conservation actions in the past few years. Residents of in-rent properties were more likely to report that their property owner had taken some action (27%) compared to residents in RUBS (16%), hot water hybrid (14%), utility-submetered (13%) or submetered properties (8%). Table 4.15 in Chapter 4 shows what conservation actions property owners have taken. Finally, unit entry is sometimes required to read submeters. This may be viewed as an intrusion by the resident, thus making meters outside the unit or remotely readable more desirable.

Resident Benefit/Cost Analysis

Submetered Properties

An economic analysis from the resident's point of view shows that decreased monthly water costs after submetering are not a guarantee. First, it depends on exactly how the resident was charged for water previously and whether or not their new bill includes a service fee. Table 6.4 summarizes the possible economic returns for a resident that lives at a property that converts from a flat HOA fee to submetered. This scenario assumes that the flat fee would be removed. In this case, residents that aren't charged a service fee could save from $54 to $77 per year.

With a service fee, residents could save up to $41 per year, but they could also lose up to $93 per year. Table 6.5 shows the economic return for a resident who lives in a property that converts from in-rent to submetered. This scenario assumes that rent remains unchanged upon converting to submetering. Here, the average residents will annually increase their expenses by $230 without a service fee, or $309 with a service fee. It should be noted that both of these tables show the resident economic analysis for the short term. It is possible that in the long term, rental prices could come into equilibrium due to competition, causing the financial impact to be lessened.

RUBS Properties

RUBS does not have much potential for monetary savings for residents. However, if a property owner reduces the rent accordingly and does not charge a service fee, initially the average resident should break even. The researchers found no examples of any property owners adopting this approach.

Summary of Resident Perspective

Based on the results obtained in the resident survey, consumers have varied opinions on water billing programs. Often these programs result in a water bill in addition to a monthly rent charge. While consumers receive electric or gas bills, many have come to expect that water charges are included in the rent. As currently practiced, water and wastewater billing programs do not appear to be an appealing option for residents of multi-family dwellings. Also, residents are typically charged a service fee (in conformance with applicable state and local law) in addition to their volumetric or allocated charge. Thus, in the short term, these billing programs cause an increase in monthly costs for residents. While there may be environmental benefits such as increased water conservation, there are many uncertainties involving separate billing that could be perceived as negative. Until separate billing for water and wastewater has some definitive standards and protections for residents, it is unlikely that most residents will embrace it. Direct metering and billing of water for apartment residents encourages water efficiency and promotes a water billing system that is as transparent as other utilities like gas and electricity, phone and cable whereby residents pay for what they use.

If a property owner were to reduce the rent in the approximate amount of the total water and wastewater bill (including the service fee), then the resident might experience no net increase in rental costs if all else is held constant. As noted above, this does not appear to be a common practice. If the property owner were to pay the service fee as recommended (see Recommendation 8, subsection 9), then the overall cost impact to the resident might be reduced. However as practiced today, it appears that water and wastewater billing programs result in increased costs for residents.

Table 6.4 Economic return for a resident that lives in a property that converts from a flat HOA fee to submetered

		Pre Submetered			Post Submetered				Economic Return per Unit	
		Avg Water Use (kgal/du)*		Monthly Cost per du	Avg Water Use (kgal/du)‡		Monthly Water Costs per Unit			
		Annual	Monthly	Flat HOA Fee†	Annual	Monthly	Water/WW Charge§	Service Fee**	Monthly	Annual
With	**Best Case**	52.19	4.35	$ 25.00	42.33	3.53	$ 20.08	$ 1.50	$ 3.42	$ 41.07
Service	**Avg Case**	52.19	4.35	$ 25.00	43.75	3.65	$ 22.49	$ 3.29	$ (0.78)	$ (9.39)
Fee	**Worst Case**	52.19	4.35	$ 25.00	46.61	3.88	$ 26.60	$ 6.14	$ (7.74)	$ (92.83)
Without	**Best Case**	52.19	4.35	$ 25.00	42.33	3.53	$ 18.58	na	$ 6.42	$ 77.07
Service	**Avg Case**	52.19	4.35	$ 25.00	43.75	3.65	$ 19.20	na	$ 5.80	$ 69.57
Fee	**Worst Case**	52.19	4.35	$ 25.00	46.61	3.88	$ 20.46	na	$ 4.54	$ 54.53

* "Best estimate" from Model #2 in Chapter 6

† Estimated value, could vary between properties.

‡ Utilizes range of percent water savings from report, where "best case" = 18.9%, "avg case" = 15.3%, and "worst case" = 10.7%

§ Based on a commodity charge for water and wastewater of $5.27 per kgal (the average commodity charge for the thirteen study sites). Does not include fixed fees.

** Utilizes the service fee range from the read and bill company survey.

Table 6.5 Economic return for a resident that lives in a property that converts from in-rent to submetered

		Pre Submetered			Post Submetered				Economic Return per Unit	
		Avg Water Use per Unit (kgal)*		Monthly Cost per Unit	Avg Water Use per Unit (kgal)†		Monthly Cost per Unit			
		Annual	Monthly	In-Rent	Annual	Monthly	Water Charge‡	Service Fee§	Monthly	Annual
With	**Best Case**	52.19	4.35	$ 0.00	42.33	3.53	$ 20.08	$ 1.50	$ (21.58)	$(258.93)
Service	**Avg Case**	52.19	4.35	$ 0.00	43.75	3.65	$ 22.49	$ 3.29	$ (25.78)	$(309.39)
Fee	**Worst Case**	52.19	4.35	$ 0.00	46.61	3.88	$ 26.60	$ 6.14	$ (32.74)	$(392.83)
Without	**Best Case**	52.19	4.35	$ 0.00	42.33	3.53	$ 18.58	na	$ (18.58)	$(222.93)
Service	**Avg Case**	52.19	4.35	$ 0.00	43.75	3.65	$ 19.20	na	$ (19.20)	$(230.43)
Fee	**Worst Case**	52.19	4.35	$ 0.00	46.61	3.88	$ 20.46	na	$ (20.46)	$(245.47)

* "Best estimate" from Model #2 in Chapter 6
† Estimated value, could vary between properties.
‡ Utilizes range of percent water savings from report, where "best case" = 18.9%, "avg case" = 15.3%, and "worst case" = 10.7%
§ Based on a commodity charge for water and wastewater of $5.27 per kgal (the average commodity charge for the thirteen study sites). Does not include fixed fees.
** Utilizes the service fee range from the read and bill company survey.

ANALYSIS OF PRICE ELASTICITIES

Economic goods have a downward sloping demand curve. This means that the higher the price of the good, the less of it that is purchased. Within this broad statement, specific goods respond very differently to price. Some goods respond very little to price change. Others respond a lot. Economists have developed the concept of "price elasticity of demand" to characterize these differences. Price elasticity of demand is defined for each point on the demand curve as: The percentage change in consumption per percentage change in price. Since elasticity is a percent divided by a percent it is a unitless number. Some examples clarify this concept.[32]

Price elasticity of demand should be negative. An elasticity of –0.2 means that a one percent increase in price will stimulate a 0.2% decrease in consumption. An elasticity of -2.0 means that a one percent increase in price will result in a 2% decrease in consumption.

Mathematically, the formula for price elasticity of demand is:

$$\frac{\Delta Q \div Q(p)}{\Delta p \div p}$$

where *Q(p)* is the quantity consumed at price p.

Elasticity typically will vary over the range of the demand curve. Another way to look at elasticity is to do some algebra and re-write the equation as:

$$\frac{\Delta Q \div \Delta p}{Q(p) \div p}$$

This is interpreted as the slope of the demand curve at point *p* divided by average consumption at *p*. (i.e. quantity consumed divided by costs.) On a straight-line, the slope remains constant over the range of the demand curve, but the average changes. Interestingly, it

[32]Economists also talk about income elasticity of demand, and even price elasticity of supply. Elasticity is a widely used concept. Therefore it is helpful to clarify specifically or by context what elasticity concept is being discussed.

is possible to construct a "constant elasticity" curve, which is a power curve, where elasticity is constant throughout its range.

The researchers developed two demand curves to evaluate elasticity of demand. The first demand curve was for utility master-metered water use using the historic billing data and manager survey results for the number of units per property. The second demand curve was for submetered water use using actual water bills submitted by residents to determine the price of water and the average water use per unit at the property (from historic billing data and manager survey results) for the demands. For each demand curve, researchers fit a straight line and a constant elasticity curve.

Elasticity Analysis #1 - Utility Metered Use

The first elasticity analysis examined the price elasticity of water use based on utility water and wastewater rates. These rates are presented in Chapter 4 (Table 4.1). To simplify the analysis, the average non-seasonal (indoor) water use per unit per year in kgal (using 2001 and 2002 billing data) was calculated for each participating study site. These values were then plotted against the combined utility water and wastewater rate in $/kgal. The results are shown in Figure 6.1. The cost for water and wastewater ranged substantially from $2.83/kgal to $10.11/kgal, providing a useful data set for analysis. Only indoor use was considered thus reducing the potential impacts of climate and other variables. To improve the model fit, the data point from Indianapolis was removed from the elasticity model. Indianapolis was the only study site to feature a declining block rate structure (i.e. the more water used, the cheaper the price). All other utilities had either flat rate or increasing block rate structures designed to send an increasing price signal as demand increases.

Two regression equations and curves were fit to these data to determine the price elasticity of demand – a straight line and a power curve. The fit of both models was quite good and the range of elasticities calculated fits well with previous research in this area. The straight line model had the highest coefficient of determination (r^2) value of 0.6437. Elasticities calculated through the straight line model ranged from -0.12 at $2.83/kgal to –0.65 at $10.11/kgal with an average of –0.29 and a median of –0.20. The constant elasticity power curve model had a coefficient of determination value of 0.5477. The elasticity calculated through this power model was –0.275. These results are shown in Table 6.6. The research team concluded that if a single elasticity value were to be selected, the preponderance of the results from this analysis point to an elasticity of –0.27. However, the linear model result clearly shows that elasticity varies with price and this should be taken into account when applying these values to planning and rate models.

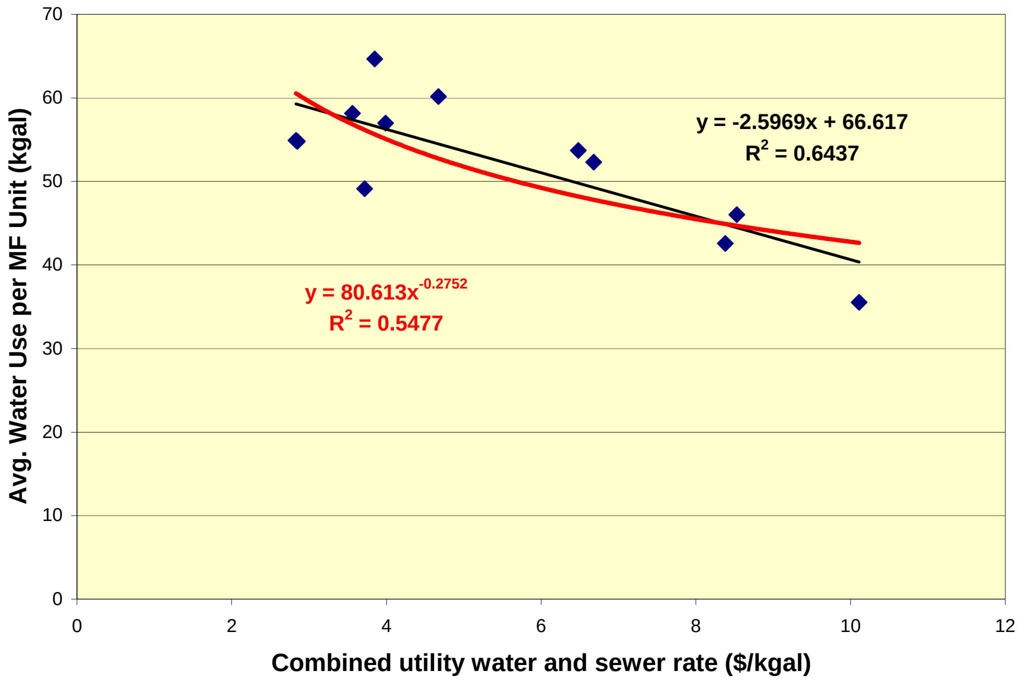


Figure 6.1 Demand curve and demand equations, elasticity analysis #1 (utility rates)

Table 6.6 Elasticity values, analysis #1 (utility rates)

Price ($/kgal)	Straight Line Model Elasticity	Power Curve Model Elasticity
2.83	-0.1240	-0.2752
2.85	-0.1250	-0.2752
3.56	-0.1611	-0.2752
3.72	-0.1696	-0.2752
3.85	-0.1766	-0.2752
3.99	-0.1842	-0.2752
4.67	-0.2226	-0.2752
6.48	-0.3380	-0.2752
6.68	-0.3521	-0.2752
8.38	-0.4852	-0.2752
8.53	-0.4982	-0.2752
10.11	-0.6505	-0.2752
Conclusion: Elasticity = -0.27		

Elasticity Analysis #2 Submetered Water Use

The second elasticity analysis examined the price elasticity of water use based on water and wastewater rates charged by third party billing service companies. The actual commodity charge for water and wastewater was calculated for each of the approximately 40 submetered bills provided by residents responding to the resident survey. Some bills came from the same property and other did not provide sufficient information required to calculate the actual commodity charges. Ultimately only the data from 26 individual submetered properties could be used in the elasticity analysis. Average annual indoor per unit water use for each property was extracted from the billing database to conduct the analysis.

The actual commodity rates charged by the third party billing service companies to residents ranged from \$1.05/kgal up to \$15.40/kgal for combined water and wastewater. This is the commodity rate only and does *not* include any service charges or flat fees. Since all of these submetered properties reside within the service area of one of the 13 study sites and the commodity rates in those areas are known to range from \$2.83/kgal to \$10.11/kgal, it is apparent that some service companies are under charging customers and some are clearly inflating the commodity rate substantially. The practice of inflating the water and wastewater commodity rate is illegal in many jurisdictions and could subject the property and billing company to a raft of local and national regulations.

Two regression equations and curves were fit to these data to determine the price elasticity of demand – a straight line and a power curve. These curves are shown Figure 6.2. The fit of both models was poor, substantially worse than for the utility rate analysis. The resulting elasticities are somewhat smaller than what were found in analysis #1. However, the range of elasticities calculated fits well with previous research in this area.

The straight line model had the lowest coefficient of determination (r^2) value of 0.0368. Elasticities calculated through the straight line model ranged from -0.02 at \$1.05/kgal to –0.35 at \$15.40/kgal with an average of –0.10 and a median of –0.07. The constant elasticity power curve model had a higher, but still rather low coefficient of determination value of 0.1199. The elasticity calculated through this power model was –0.16. These results are shown in Table 6.7. Because of the limited available data and the extremely poor fit of the demand curve models, the research team concluded a single elasticity value should not be selected. A preponderance of the results from this analysis point to a likely range of elasticity values from -0.07 to -0.16 for submetered properties.

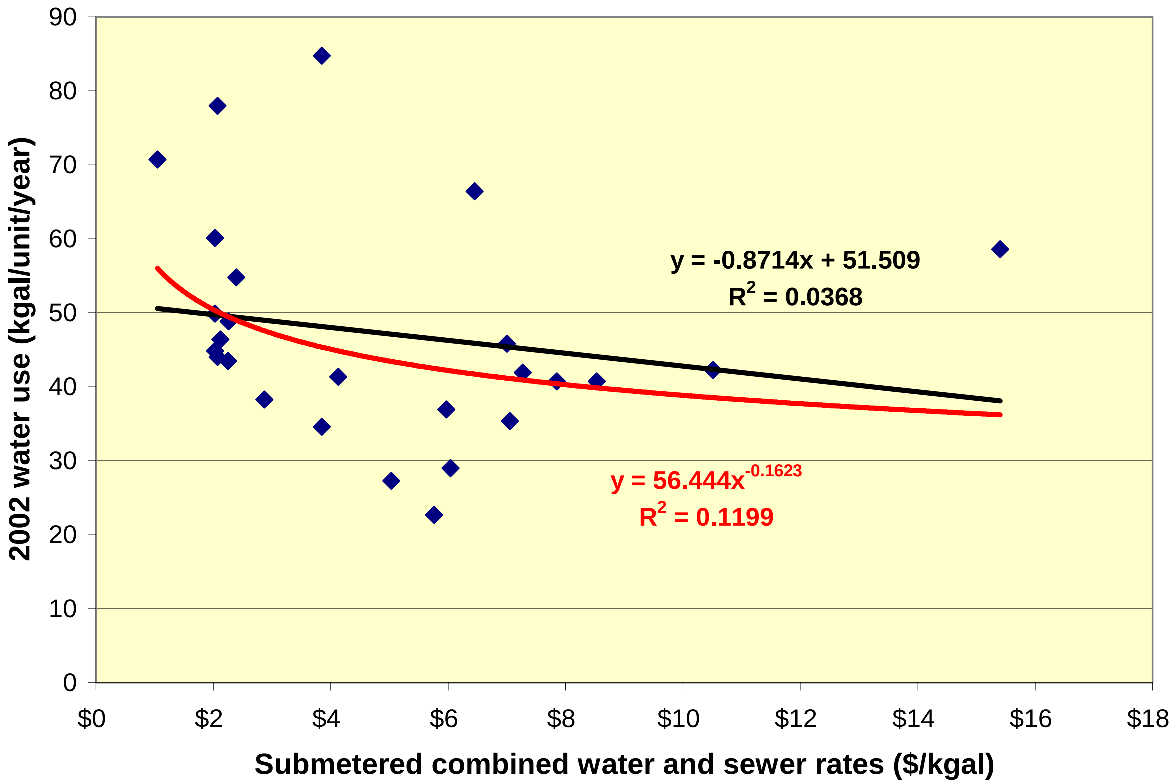


Figure 6.2 Demand curve and equations, elasticity analysis #2 (submetering rates)

These elasticity analyses are a straightforward and simple evaluation of elasticity. It should be noted that the elasticity analysis was considered important, but not a core component of this study, and hence less effort was dedicated to this component than would be in a study more strictly focused on elasticity. Typically a number of other factors are included in elasticity analysis including weather patterns and demographics. Of primary concern to the researchers was the potential influence of weather on price elasticity. The weather variable is essentially removed because this analysis only considers indoor water use. Even without the inclusion of other independent variables, the elasticity values calculated in this study are remarkably similar to those found in other studies that were particularly focused on this exact question.

Table 6.7 Elasticity values, analysis #2 (submetering rates)

Price ($/kgal)	Straight Line Model Elasticity	Power Curve Model Elasticity
1.05	-0.02	-0.16
2.03	-0.04	-0.16
2.03	-0.04	-0.16
2.03	-0.04	-0.16
2.07	-0.04	-0.16
2.07	-0.04	-0.16
2.12	-0.04	-0.16
2.25	-0.04	-0.16
2.26	-0.04	-0.16
2.39	-0.04	-0.16
2.87	-0.05	-0.16
3.85	-0.07	-0.16
3.85	-0.07	-0.16
4.13	-0.08	-0.16
5.03	-0.09	-0.16
5.76	-0.11	-0.16
5.97	-0.11	-0.16
6.04	-0.11	-0.16
6.45	-0.12	-0.16
7.00	-0.13	-0.16
7.05	-0.14	-0.16
7.27	-0.14	-0.16
7.85	-0.15	-0.16
8.53	-0.17	-0.16
10.51	-0.22	-0.16
15.40	-0.35	-0.16
Conclusion: Likely elasticity range = -0.07 to –0.16		

Policy Implications of Price Elasticity Analyses

The results of the elasticity analysis indicate that multi-family dwelling owners and managers are significantly more responsive to price than are residents who are submetered because the calculated percent difference in price elasticity is larger in the utility rate analysis by 70% or more. This result suggests that property owners are more likely to take action to conserve water on their properties in response to a change in price. It also implies that the owners have more opportunities to conserve water because they have a wider variety of uses over which they have control than do the residents, who basically control just their own domestic use. This has significant policy implications because as properties are converted to submetering and RUBS billing programs, owners no longer receive an effective price signal from the utility bill. This implies that the impetus to reduce demand and conserve water on the part of managers and owners is all but lost once a billing program is implemented. While the impact of water pricing is then passed on to the residents, it is apparent that they are much less sensitive to price than are the owners. Because many residents rent their dwelling units, they are unlikely to invest in water conserving fixtures such as toilets, clothes washers, showerheads, faucets and leak repair. In many cases residents may not be permitted to install new fixtures. Leak repair remains the responsibility of the property manager and should be performed as a routine matter.

Interior Retrofits and Billing Programs

These results suggest that if utilities are interested in accelerating the installation of water conserving fixtures and appliances in their service area, it may be necessary to mandate these installations as a condition of conversion to a water and wastewater billing program. Once a water and wastewater billing program is implemented, most incentives to make these changes will be lost (except in common areas) and it is unlikely that residents will make these changes to their own units. Incentive based programs have spurred fixture change out and utilities may wish to encourage installation of water efficient fixtures in conjunction with their approval of water billing program in their service area.

Summary of Elasticities and Comparisons with Other Studies

As noted earlier, the price elasticity values found in this study are quite comparable to values found in other research conducted over the past 35 years. A comparison of the results from this study and other elasticity studies is shown in Table 6.8. This table is truncated from Table 2.1 in Chapter 2 and contains only the elasticities that offered a reasonable comparison (i.e. indoor use, non-drought pricing). The elasticities found in this study fit squarely with results from other research starting with the classic Howe and Linaweaver work from 1967 that found a residential indoor use elasticity of –0.231. The 1999 Goodman study that extrapolated multi-family elasticity from single-family demand reported an elasticity value of –0.7. This is substantially higher than the –0.27 elasticity found in this study. Goodman’s elasticity is near the top end range of all the elasticities shown in Table 6.8. Selecting an elasticity value for a rate study is often more art than science and typically the value selected is one the rate planner is comfortable with and can defend to supervisors and the general public. The elasticities developed in this study represent one of the few attempts to empirically determine an exclusive price elasticity for the multi-family sector. As such, it contributes important information to the body of literature on the subject.

Table 6.8 Comparison of selected price and elasticity studies

Researcher/Study	Price Elasticity	Notes
Howe and Linaweaver (1967)	-0.231	*21 areas in US:* Residential indoor use.
Camp (1978)	-0.03 to -0.29	*10 Northern MS cities:* Linear equation.
	-0.35 to -0.40	*10 Northern MS cities:* Logarithmic equation.
Danielson (1979)	-0.27	*Raleigh, NC:* Using disaggregated data for total residential demand.
	-0.305	*Raleigh, NC:* Using disaggregated data for winter demand.
Billings and Agthe (1980)	-0.27 to -0.61	*Tucson, AZ:* Using two price variables and increasing block rates.
Carver and Boland (1980)	-0.1	*Washington, DC:* Short-term residential demand.
Howe (1982)	-0.06	*21 areas in US:* Residential indoor use.
Planning and Management Consultants (1984)	-0.2 to -0.4	*National:* Total residential water use, reviewed over 27 water demand studies.
	-0.06 to -0.8	*National:* Indoor residential water use, reviewed over 5 water demand studies.
Schneider and Whitlatch (1991)	-0.262	*Columbus, OH:* Long-term residential.
	-0.119	*Columbus, OH:* Short-term residential.
Hanemann (1998)	-0.01 to -1.38	*National:* Reviewed municipal and industrial water demand studies from 1951 to 1991.
Goodman (1999)	-0.7	*57 US cities:* Extrapolates from single-family to multi-family sector.
National Submetering and Allocation Billing Program Study (2004)	-0.27	12 US cities: Multi-family indoor use
	-0.07 to -0.16	Submetered indoor use. 26 multi-family properties in 3 different geographic regions.

ECONOMIC COMPARISON OF SUBMETERING AND RUBS BASED ON CONSUMER CHOICE THEORY

Consumer Choice theory can be used to analyze the economic implications for submetering and RUBS schemes.[33]

[33] This analysis was developed by team economist Dr. Stephen Fisher and Dr. G. Hossein Parandvash, Principal Economist for the City of Portland, Bureau of Water Works to examine the economic theoretical underpinnings of the submetering and RUBS systems.

According to the basic consumer choice model, a consumer draws satisfaction or utility from consumption of goods and services. However, the consumer is also constrained by the amount of money that she can spend and the prices of those goods and services. The consumer choice model includes a utility function, which reflects the level of consumer's satisfaction, and a budget constraint, which reflects the affordability of goods and services to the consumer. Usually, for the ease of analysis the model includes two commodities or "goods" and assumes the consumer spends all of the money on the goods considered. One of the goods usually represents a commodity of interest and the other represents a composite good that represents all other goods. The good that is the focus of attention in this analysis is water.

The consumer choice problem is to maximize satisfaction or utility subject to a budget constraint. The problem can be formulated as:

$$\max \ u = u(g, x)$$

$$\text{Subject to } p_g g + p_x x = m$$

where

u = the utility function
g = amount of water used
x = amount of all other goods consumed
p_g = price of water
p_x= composite price of all other goods
m = income or the money available for spending on goods and services

Conventional assumptions require for u to be continuous and twice differentiable and the budget constraint to be linear.

The problem can be solved by forming a Lagrangean function, setting the first order conditions to zero, and solving for g, x and λ as follows.

$$\mathcal{L} = u(g, x) + \lambda(m - p_g g + p_x x)$$

After taking the first order partial derivatives and setting them to zero we have

$$\frac{\partial \mathcal{L}}{\partial g} = 0 \qquad \Rightarrow \qquad \frac{\partial u}{\partial g} = \lambda \, p_g$$

$$\frac{\partial \mathcal{L}}{\partial x} = 0 \qquad \Rightarrow \qquad \frac{\partial u}{\partial x} = \lambda \, p_x$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = 0 \qquad \Rightarrow \qquad m = p_g g + p_x x.$$

$\frac{\partial u}{\partial g}$ and $\frac{\partial u}{\partial x}$ are the marginal utilities of water and other goods respectively. λ is the Lagrange multiplier that can be interpreted as the additional utility that a consumer can gain as a result of having one more dollar to spend. Partial differentiation of the Lagrangean function with respect to λ yields the budget constraint. By rearranging the first two equations we have

$$\frac{\partial u / \partial g}{p_g} = \lambda \text{ and } \frac{\partial u / \partial x}{p_x} = \lambda$$

or

$$\frac{\partial u / \partial g}{p_g} = \frac{\partial u / \partial x}{p_x}.$$

This indicates that the consumer achieves maximum satisfaction when the marginal utility per dollar from consumption is the same across all goods and services. The solution to the consumer choice problem is a set of demand equations for all goods and services involved. The demand for each good is a function of all prices and the amount of money available for spending.

$$g = g(p_g, p_x, m)$$

$$x = x(p_g, p_x, m)$$

where g and x are demand for water and all other goods respectively.

The consumer choice problem can be formulated to present both Submetering and RUBS cases. In the case of Submetering the resulted demand equation for water is the same as g above, however, the RUBS case is different. For RUBS case, one has to consider that there are *n* customers, which share the total water bill according to some allocation scheme. The total water used can be presented as

$$G = \sum_{i=1}^{n} g_i$$

where G is the total water consumed by all customers in the group and g_i is the water used by customer $i = 1, \cdots, n$. Therefore, the total bill is computed as $p_g G$. Let us assume that under RUBS scenario r_i is the portion of total water that is assigned to customer i, where $\sum_{i=1}^{n} r_i = 1$ and $0 < r_i < 1$. That means that customer i is assumed to be using $r_i G$ amount of water and has to pay $p_g r_i G$. Let us further assume that r_i^* is the actual portion of total water that customer i uses. In the event that r_i and r_i^* coincide, customer i pays the same amount as the Submetering case. However, most probably under RUBS case she is being over or undercharged for water. Naturally, most customers believe that they are being overcharged while their neighbors are being undercharged.

Furthermore, the typical RUBS customer faces a different price for water and therefore different budget constraint. The first order conditions derived from RUBS case for customer i are

$$\frac{\partial \mathcal{L}}{\partial g_i} = 0 \quad \Rightarrow \quad \frac{\partial u}{\partial g_i} = \lambda \frac{\partial \left(p_g r_i G \right)}{\partial g_i} = \lambda p_g r_i \text{ for } i = 1, \cdots, n$$

$$\frac{\partial \mathcal{L}}{\partial x} = 0 \quad \Rightarrow \quad \frac{\partial u}{\partial x} = \lambda p_x$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = 0 \quad \Rightarrow \quad m = p_g r_i G + p_x x.$$

Comparing demand for water derived from Submetering and RUBS case we have

$$g_{Sub} = g(p_g, p_x, m)$$
$$g_{RUBS} = g(p_g r_i, p_x, m)$$

where g_{Sub} and g_{RUBS} are demand for water by Submetering and RUBS customers respectively.

The demand equations show that since $r_i < 1$, the price seen by the RUBS customer is *less* than the price seen by the Submetering customer. That is, the RUBS price signal is "diluted" by the ratio factor r_i. Therefore, under the above assumptions, it is in the economic interest of the RUBS user to consume more water than the submetered user, even under identical water price rates.

In fact, given that the allocation ratios are set in advance and the fact that customers believe they are overcharged, it is in the economic interest of the RUBS customer to be the *largest* water user within the billing group. The customer does this in order to achieve maximum value for the amount she is charged by making sure that $r_i^* \geq r_i$. This example clearly points out the fundamental economic flaw in RUBS, where the customer by receiving a distorted price signal instead of reducing consumption, is encouraged to use more water to extract the maximum benefit from the money spent. On the other hand, the customer under Submetering scheme who pays directly for what she uses has an obvious direct incentive to be as efficient as possible.

CHAPTER 7 REGULATORY FRAMEWORK REVIEW

The framework of regulations and related policies for multi-family water and wastewater billing systems is both complex and quickly evolving. During the time that this research study has been in preparation, significant changes in the policy framework have been adopted by the federal government, several states, and major local jurisdictions, and important issues remain in flux. In this chapter, the most significant federal, state, and local policies toward multi-family billing methods are identified and discussed. The purpose for this review is not to assemble a manual of regulations for those making site-specific decisions about separate billing systems, but rather to provide policymakers and key stakeholders with an illustrative set of the most relevant policies and concepts found today, to stimulate discussion about the most appropriate future direction for policies toward these billing systems.

Following a brief overview of federal regulations and related polices, state policies toward water and wastewater billing methods are identified. State policies are outlined in two surveys undertaken prior to this report, and the findings of three original surveys of state agencies undertaken as part of this report are presented. A new survey of water utility managers regarding local billing method policies is also presented. Finally, key state and local policies drawn from all these sources and other available literature are discussed, organized around key themes or regulatory objectives.

FEDERAL POLICIES RELATING TO MULTI-FAMILY BILLING

Safe Drinking Water Regulation

During the past decade, the most visible federal policy regarding the installation of water and/or wastewater billing systems in multi-family dwellings has been the implementation of the Safe Drinking Water Act (SDWA). Section 1401 if this act defines a "public water system" as a system that provides water through pipes or other constructed conveyances to the public for human consumption, and has at least 15 service connections or regularly serves at least 25 people. Under the act, certain public water systems are subject to the national primary drinking water regulations. These regulations call for, among other things, regular monitoring of water systems for a wide variety of contaminants, remedial actions, and reporting requirements. Section 1411 of the act lays out four criteria which, if all were met, would exempt certain public water systems from compliance with the national primary drinking water regulations. One of these criteria is that the system "does not sell water to any person."

In response to inquiries and Congressional questions about the application of SDWA requirements to multi-family billing systems, EPA's Office of Ground Water and Drinking Water produced a policy memorandum in 1998 which spelled out the view of the issue from EPA headquarters. At that time, EPA took the position that property owners were selling water within the meaning of the act if charges for water were separately billed to residents. Thus either submetered or RUBS billing systems *would not qualify for a broad exemption* from compliance with the national primary drinking water regulations.

In the same 1998 policy guidance EPA noted that states have flexibility to designate these billing systems as "consecutive" water systems, which is a system that purchases water from another public water system and "may be afforded certain monitoring modifications" to "avoid unnecessary compliance activities." Noting the potential conservation benefits from submetering, EPA deemed the consecutive designation to be appropriate, subject to the states' assessment of the need for any of these systems to conduct additional monitoring to protect public health.

EPA's regional office in Atlanta, with geographic responsibility extending across most of the southeastern states, placed a decidedly less accommodating spin on the agency's nationwide guidance. In a memorandum in June 2000 to state drinking water officials, the Acting Director of the Water Management Division in Atlanta asserted that "EPA Region 4 takes the opinion that States should work to prevent the formation of these types of submetered systems, and should aggressively work to consolidate these submetered systems together with their 'parent systems.'" While concurring that submetered systems could be designated as consecutive water systems, and that consecutive systems "may be afforded certain monitoring modifications," this office took the position that states (to maintain primacy over the administration of the Safe Drinking Water Act) must require certain minimum on-site monitoring requirements of all submetered systems. These were to include routine bacteriological monitoring, lead and copper monitoring, and disinfection by-product monitoring. Additionally, monitoring of residual chlorine levels on a daily basis was recommended. Such monitoring requirements would effectively ban submetering and RUBS by making them completely impractical.

In 2002 Alabama's Department of Environmental Management fashioned a regulation acceptable to EPA regional officials that exempted submetered systems with demonstrably low risk - predominantly indoor piping, no on-site storage, no on-site pumping, no known cross-connection issues - from monitoring requirements, provided that they registered with the state and re-certified every three years.

In August 2003, seeking to encourage water conservation benefits attributed to submetering, the Assistant Administrator for Water proposed a significant re-interpretation of the Safe Drinking Water Act regarding submetered systems. In a policy shift that was finalized in December 2003, EPA noted that the "sale" of water had not actually been defined in the Safe Drinking Water Act, and that henceforth a multi-family property with submetered billing to residents would not be subject to the national primary drinking water regulations. Calling submetering an "effective but little-used tool" to promote water conservation, EPA clearly signaled a pullback from any insistence at the federal level that submetered systems would be required to perform the monitoring and record-keeping tasks of public water utilities, even if they nominally remained "public water systems." The new guidance noted that "the addition of a submeter should not in any way change the quality of water provided to customers on the property." States, however, would be free to exercise their own discretion regarding conditions that might be placed upon submetered systems, and how best to track them. The new policy guidance referred favorably to both Alabama's conditional criteria for monitoring relief and to Texas' requirement for replacement of inefficient plumbing fixtures as a condition for approving any separate billing system. But citing a lack of evidence to support water saving benefits, the *new policy pointedly excluded RUBS and hot water hybrid allocation systems* from its scope, and urged states to consider whether flexibility was warranted for such systems as well.

Weights and Measures Standards

The National Institute of Standards and Technology (NIST) is a non-regulatory federal agency within the U.S. Commerce Department's Technology Administration. NIST’s mission is to “develop and promote measurement, standards, and technology to enhance productivity, facilitate trade, and improve the quality of life” (NIST 2004a). The NIST Weights and Measures Division promotes uniformity of weights and measures standards nationwide. To that end, NIST initiated and organizes a professional organization of local, state, and federal regulators, scientists, and other stakeholders known as the National Conference on Weights and Measures (NCWM) to partner with the Weights and Measures Division to create model laws, regulations, and methods of practice. NIST publishes these documents, and if a locality or state adopts the rules, they become mandatory.

The primary product of NIST's Weights and Measures Division is NIST Handbook 44, "Specifications for Weights and Measures Devices" (NIST 2004b). The handbook is updated annually and covers scales, liquid-measuring devices, vehicle tanks used as measures, and fabric and other measurement devices. Water meters are covered under NIST Handbook 44 Section 3.36. The section outlines the standard design of water meters, testing procedures, and acceptable tolerances for meters. The handbook does not cover the frequency with which a meter must be tested, nor does it outline qualifications for the agency or person responsible for testing. Those responsibilities have been left to the local or state adopters to outline.

Water submeters for multi-family buildings fall within the scope of section 3.36 of Handbook 44. The standard for water meter accuracy is plus or minus 1.5% at normal flow and plus 1.5% or minus 5% at low flow. Handbook 44 has been adopted entirely in 39 states and partly in the remaining 11 states and is updated annually. Weights and measure officials respond to complaints by consumers regarding meter accuracy.

Water and Energy Efficiency Standards

Under the National Appliance Energy Conservation Act, the US Department of Energy administers a set of standards for the energy efficiency of certain newly manufactured consumer appliances and commercial equipment and the water efficiency of certain newly manufactured plumbing products. Following action by at least 17 states to set water efficiency standards for plumbing products, Federal legislation was enacted in 1992 containing uniform national standards for the efficiency of toilets, showerheads, urinals, lavatory and kitchen faucets, and faucet aerators. Although state standards went into effect at various dates as early as 1989, national standards covered all products manufactured or imported into the US beginning January 1, 1994. Non-conforming products manufactured or imported prior to that date were allowed to be sold from inventory. It has been shown that plumbing products meeting the efficiency standards enacted in 1992 reduce indoor residential water use by about 20% (Mayer et. al. 1999).

The Department of Energy has also adopted energy efficiency standards for certain water using appliance that encourage (but do not explicitly require) improved water efficiency. Efficiency standards for residential dishwashers are currently in place and efficiency standards for clothes washers have been increased in two steps, taking effect January 2004 and January

2007 respectively. The Department of Energy predicts that compliance with the 2007 standard will result in substantial national water savings over a twenty-year period.

Each of these standards has the potential to measurably influence the water consumption of multi-family dwellings. Since all of the standards identified above apply only to new products, the rate of product replacement is a primary determinant of the amount of water savings that may be achieved at any future date. (The pace of new construction is the other primary determinant.) Dishwashers and residential clothes washers have an average life of about 14 years. However, the average life of a residential toilet is about 20 to 25 years, and it is not uncommon for some fixtures to last 50 years or more. Fittings such as showerheads and faucets may experience comparable longevity. For long-lasting products such as plumbing, the age of the building stock will have an important influence on water consumption.

POLICIES OF STATES AND UTILITIES TOWARD MULTI-FAMILY BILLING

State Regulatory Survey

A survey of state policies toward multi-family billing methods is maintained by the National Submetering and Utility Allocation Association (NSUAA), a trade association for companies involved in multi-family billing for all types of utility services, i.e., water, wastewater, electric, natural gas, solid waste, etc. NSUAA first undertook this survey in 1999 and periodically updates the information as new policies are made known to its members and staff. NSUAA attempts to track state and local policies toward both submetering and RUBS, as well as whether service fees are allowed as part of a billing system.

NSUAA cautions readers not to rely on this summary information as legal advice, noting that information is subject to frequent change and deals with matters of interpretation. With the permission of NSUAA, the latest (March 2004) overview of state policies regarding water and wastewater billing is presented in Table 7.1.

Table 7.1 NSUAA Summary of State Regulatory Policies

State	Submetering Allowed?	RUBS Allowed?	Service Fees Allowed?
Alabama	Yes	Yes	Yes
Alaska	Yes	Yes	Yes
Arizona	Yes	Yes	Yes
Arkansas	Yes	Yes	Yes
California	Yes	Yes	Yes
Colorado	Yes	Yes	Yes
Connecticut	Yes	Yes	Yes
Delaware	Yes	**No** (only prior to 1996)	Yes
Florida	Yes	Varies by county	Yes
Georgia	Yes	Yes	Yes
Hawaii	Yes	Yes	Yes
Idaho	Yes	Yes	Yes
Illinois	Yes	Yes	Yes
Indiana	Yes	Unclear	Yes
Iowa	Yes	Yes	Yes
Kansas	Yes	Yes	Yes
Kentucky	Yes	Yes	Yes
Louisiana	Unclear	Yes	Yes
Maine	Yes	Yes	Yes
Maryland	Yes	Yes	Yes
Massachusetts	**No** (legislation pending)	**No**	**No**
Michigan	Yes	Yes	Yes
Minnesota	Yes	Yes	Yes
Mississippi	Yes	**No**	**No**
Missouri	Yes	Yes	Yes
Montana	Yes	Yes	Yes
Nebraska	Yes	Yes	Yes
Nevada	Yes	Yes	Yes
New Hampshire	Yes	Yes	Yes
New Jersey	Yes	Yes	Yes
New Mexico	Yes	Yes	Yes
New York	Yes	Yes	Yes
North Carolina	Yes	**No**	Yes
North Dakota	Yes	Yes	Yes
Ohio	Yes	Yes	Yes
Oklahoma	Yes	Yes	Yes
Oregon	Yes	Yes	Yes
Pennsylvania	Yes	Yes	Yes
Rhode Island	Yes	Yes	Yes
South Carolina	Yes	Yes	Yes
South Dakota	Yes	Yes	Yes
Tennessee	Yes	Yes	Yes
Texas	Yes	Yes	**No**
Utah	Yes	Yes	Yes
Vermont	Yes	Yes	Yes
Virginia	Yes	Yes	Yes
Washington	Yes	Yes	Yes
West Virginia	Yes	Yes	Yes
Wisconsin	Yes	Yes	Yes
Wyoming	Yes	Yes	Yes
D.C.	Yes	Yes	Yes

Data developed by Marc Treitler and Brian Willie, Co-chairs of the Legislative and Regulatory Committee of the NSUAA. Information about the NSUAA can be found at <www.nsuaa.org>. March 2004.

The South Carolina Survey

In 2002, the South Carolina Public Service Commission undertook a regulatory review of submetering activity in the state. As part of this effort, the agency staff commissioned a survey of the regulatory practices of other states. For this survey, the 50+ member agencies of the National Association of Regulatory Utility Commissions were surveyed by the National Regulatory Research Institute (NRRI). This review secured information from 18 states, and found that only North Carolina claimed to regulate submeters as public utilities. Commissions in Florida, New York, and Pennsylvania also reported that owners who submeter cannot charge the resident more than what is billed by the utility company. The results of the South Carolina Survey are shown in Table 7.2.

Table 7.2 South Carolina Survey Results

State	PSC Regulate?	Health Agency Regulate?	Bill Number
Colorado	No	No	
Delaware	No	No	
Florida	*	Unaware	fs 367.022 (8)
Georgia	No	No	
Idaho	No	No	
Indiana	No	No	
Massachusetts	Does not allow		
Mississippi	No	No response	s 2797, 2002
Missouri	No	No response	
New Hampshire	No	No	
New Jersey	Does not allow		
New York	†	No	
North Carolina	Yes	Yes	‡
Ohio	No	No	
Pennsylvania	**	Unaware	**
Washington	No	No	
West Virginia	No	No	
Wisconsin	No	No	

*Resellers can charge equal to or less than what the resellers pay. Resellers cannot recoup any administrative, metering, or billing expenses.

†Does not regulate as a utility. Requires that submeterer charge no more than if billed by the utility.

‡Fully regulated. NCUC Docket No. W-100, Sub 30, General Statute 62-110 (g) 1997

**Resellers may not charge an amount greater than what the utility would charge for the same quantity of service. 66 PA.C.S.A. secs 1313 & 3313.

New Surveys of State Agencies and Water Utility Managers

Significant challenges remain for parsing out regulatory responsibility and current practices in a new and evolving field, such as water and wastewater billing systems. In an effort to further document a range of possible regulatory scenarios, four surveys were developed targeting different groups of officials. The survey design also shed light on informational barriers and other challenges to policy implementation. Copies of survey instruments used are provided in Appendix A.

This regulatory policy survey was completed in two parts. The first survey was conducted from October 2002 through January 2003 and queried state public utility commissions, state weights and measures officials, and state drinking water officials. The second survey, conducted from October 2003 through January 2004, queried water utility managers to determine their perspective on regulation and shed more light on communication between utilities and regulators in the area of water and wastewater billing. Each survey documents the *perceptions* of public officials regarding this issue. The methodology for each survey set follows.

PUCs, Bureaus of Weights and Measures, and State Drinking Water Officials

Surveying was conducted from October 2002 through January 2003. The survey method included contacting potential survey candidates via e-mail or fax with a cover letter requesting participation in the survey and the survey itself. A follow-up letter and another copy of the survey were e-mailed or faxed again if there was no response from the candidate after the first week. Additional follow-ups to non-responsive drinking water administrators were conducted over the phone.

Because water billing systems can be regulated by different entities within a state, three of the most likely agencies were chosen as initial contacts:

1) **Bureaus of Weights and Measures –** State bureaus control how most commercial measuring devices are regulated. This body would potentially regulate submetering equipment.
2) **State Public Utility Regulatory Commissions –** in most states, private or investor-owned water utilities are regulated by this entity, similar to traditional electric and gas utility regulation. In those states where a single commissioner or staff member was identified as having the lead on water utility regulation, that official received the survey.

3) **State Drinking Water Officials**– Although the US EPA maintains federal regulations to implement the Safe Drinking Water Act, nearly all states have "primacy" to oversee the implementation of the law by drinking water utilities within their borders.

Three survey instruments were developed for these three regulatory agencies, each with general questions about billing systems, and agency specific questions. Table 7.3 is a summary of results from the initial e-mail/fax of the surveys as well as an e-mail/fax follow-up one-week later. A total of 156 surveys were sent out 29 returned.[34] The response rate for the first round of contact and follow-up was 18 percent.

Table 7.3 Response rate to state agency regulatory surveys

State Agency	Surveys Sent	Surveys Received
Weights and Measures	53	6
PUCs	53	12
Drinking Water Officials	50	11

Of the surveys initially returned, the most detailed answers came from the Drinking Water Administrators. In the interest of maximizing the information yield of the survey within available time and funding, after the second round of contacts, all further follow-up was directed at the drinking water administrators, while surveys were obtained from other agencies within the state when specifically suggested by these Administrators, or as time allowed. Administrators were contacted by phone and the survey was given orally. At the end of the survey period, there were a total of 64 surveys received or interviews conducted.

Water Utility Managers Survey

To augment the previous studies and develop further background on the regulation on water and wastewater billing systems across the United States, an additional survey was directed to retail drinking water utility managers. The focus of the survey was utility-level regulations and incentives (if any) for multi-family billing systems.

In order to get a meaningful sample of utility policies in this evolving field, the largest retail water utilities in the 100 largest US cities were targeted, along with those additional utilities supporting this study that did not meet the initial screening criteria. The 2002 US Census listing of the 100 largest US cities was matched with the names of utilities contained in

[34]Includes the US Virgin Islands, Puerto Rico, and the District of Columbia

the AWWA WaterStats 1999 database. Duplications and wholesale water agencies were manually removed, and special service districts serving targeted cities were located.

A total of 103 utilities were surveyed. General Managers (or equivalent title) were targeted for the utilities. Contacts for the utilities were found through web sites and phone calls. The survey instrument developed for the utilities had general questions about the utility's characteristics, and specific questions about multi-family units and billing systems (Appendix A).

Surveying was conducted from October 2003 through January 2004, concurrent with contact identification. The method of surveying, similar to the initial survey, included contacting potential survey candidates via e-mail or fax containing a cover letter requesting participation in the survey and the survey itself. A follow-up letter and another copy of the survey were e-mailed or faxed again if there was no response from the candidate after the first week. All additional follow-ups were conducted over the phone. Table 7.4 lists the response rates. The overall response rate, after all survey waves were completed, was 40%.

Table 7.4 Water utility manager survey response rate

Survey Round	Surveys Sent	Surveys Received
Initial round	103	6
Follow-up 1	97	11
Phone follow-up	86	15
Final follow-up round	60	9
Total received	243	41

State Agencies and Water Utility Managers Survey Results

The following sections summarize the results from the four surveys of regulatory policy described in the methodology. These are:

- Bureau of Weights and Measures Officials
- Public Utility Commissions
- State Drinking Water Administrators
- Water Utility Managers

Note that these results reflect the respondents' *perceptions* of state and local regulations. For that reason, information should not be taken as a literal regulatory review, but as a reflection of how well these regulations (or lack thereof) are understood by key staff within the agencies charged with their administration. Discussion of these discrepancies follows in the final section of the review.

Bureau of Weights and Measures Results

The state Bureaus of Weights and Measures (BWM) are tasked with regulating commercial measurement devices used within the states. The survey was intended to canvass the Bureaus to determine their level of involvement with the submetering of water, their processes for regulation, and the standards used for regulation. The results, despite being limited (and perhaps because of it), suggest that state BWMs have not been active in regulating water submeters. While most respondents identified a standard to be used should they be called upon to regulate a specific meter, none of the responses indicated that water submeters are frequently regulated.

A total of 53 surveys were sent out followed by one round of fax follow-ups and one round of phone follow-ups. The nine responses received are summarized in Table 7.5. The survey results from respondents from states with BWMs that partially regulate water submetering through the regulation of submeters, New York, Idaho, and California are summarized in the following sections.

Table 7.5 Survey responses from state Bureaus of Weights and Measures

State	Allows Submetering or RUBS	Regulates Water Submeters	Uses NIST Handbook for Equipment Standard
New York	Yes	Yes	Yes
Idaho	Yes	Yes	Yes
California	Yes	Yes	Yes
Oregon	No Answer	No	Yes
Arizona	No Answer	No	Yes
Maryland	No Answer	No	Yes
Minnesota	No Answer	No	No
Connecticut	No Answer	No	No
Pennsylvania	No Answer	No	No

New York. The state of New York's Bureau of Weights and Measures regulates the usage of water submeters according to the mandatory NIST Handbook 44 standard. The respondent indicated that the property owner notifies the Public Service Commission (NY PSC) when a submetering system is placed in service. The NY PSC then alerts the Bureau of Weights and

Measures, which dispatches a public official to test the accuracy of the submeters at the time of installation. No follow-up testing is mandated. The respondent noted that there was no specific incentive or discouragement for property owners to report submeter installation to the NY PSC, and there is no available listing of submetered premises.

Idaho. The Idaho Bureau of Weights and Measures is responsible for the regulation of water submeters, but not the actual submetering or billing. The job of the Idaho BWM is to assure the accuracy of the meters when called upon. The respondent reported that the state allows property owners to install water submeters in apartment buildings and allows the RUBS system for billing. The BWM uses NIST Handbook 44 as the standard for water submeters, but there is no standardized testing procedure in the state. The process by which the BWM is notified about the installation of water submeters is not outlined in state law.

California. The California Bureau of Weights and Measures is responsible for the regulations of water submeters, as allowed by law. The state allows property owners to install water submeters in apartments buildings and allows RUBS for billing as well. The BWM uses the NIST Handbook 44 as the standard for water submeters. Meters are tested and certified for compliance by the county BWM officials. Meters are required to be tested every 10 years for accuracy. The process by which the BWM is notified about the installation of water submeters is outlined in state law.

Public Utilities Commission Results

Regulation of public utilities is typically the responsibility of state Public Utility Commissions (PUCs). This survey was designed to assess the degree to which PUCs are regulating and responding to the issue of submetering. Of fifty surveys sent, twelve were returned. The surveys revealed differing levels of understanding and regulation of submetering and some ambiguities regarding agency responsibility.

Eleven of the 12 responding agencies – Colorado, Delaware, Maryland, Minnesota, Missouri, Nevada, Ohio, Oregon, Virginia, Washington, and West Virginia – reported that the rates and terms of service of water submetering and RUBS are not regulated by the state PUCs. The respondent from Washington noted a specific provision in the state Administrative Code (480-110) that declares submetering out of the PUC's jurisdiction. West Virginia reported that any submetering systems in the state (none were known) would be considered and regulated as public water utilities. The twelfth responding PUC, Florida, reported regulating the rates and terms of service of submetering and RUBS, and there only for such systems that charge more than the original master metered utility bill in the counties over which it has jurisdiction.

While reporting that the PUC does not regulate rates, commissions in Nevada, Ohio, and Washington did note that building owners in the state can collect variable and fixed fees, billing and reading service fees, meter installation fees, and late fees. Delaware only allows for fixed or standby charges at the utility's retail rate.

The respondent from Delaware reported that the state offers an incentive for submetering. The report, however, may have been unfounded, as no documentation of incentives was found elsewhere. As noted below in the drinking water official results section, that agency reported that submetering is not allowed in Delaware, which is incorrect.

Drinking Water Administrators Results

In response to 50 surveys sent to each state drinking water administrator, researchers received 44 responses. Of those, only 3 states, Delaware, New Jersey, and Oregon, reported that submetering is explicitly prohibited by the state or agency. Delaware and Oregon reported that RUBS is also explicitly prohibited by the state or agency. New Jersey reported that RUBS is not prohibited by the agency.[35] However, follow-up work has indicated that submetering is currently allowed in New Jersey.

Three states, Connecticut, Tennessee, and Texas responded to the inquiry about submetering requirements in certain situations, such as new apartment construction. The response from Connecticut indicated that submeter installation was required on individual units constructed after 1987. Further research did not find support for this claim in either regulations or legislation. The response from Texas indicated that the state required installation of submeters for individual units in new construction beginning January 1, 2003. The state of Tennessee reported that a bill was submitted to the legislature requiring individual submeters in apartment buildings. Further research found that in the 1999-2000 legislative session a bill requiring the installation of individual unit meters in multi-unit buildings built after January 1, 2001 (1999 TN H.B. 3159, SB 2848) failed to pass into law.

The survey further inquired if owners or managers are required to inform public agencies when a submetering or RUBS billing system is placed in service. Eight states, Alabama, Alaska,

[35] New Jersey uses the term "submetering" to refer only to the situation in which a profit is made by the party reselling the water. The term "checkmetering" is used in New Jersey to cover this survey's definition of submetering. This survey's definition of submetering was explicitly laid out in the cover letter and the survey itself.

Mississippi, Missouri, Pennsylvania, South Carolina, Tennessee, and Texas responded that owners or managers were required to inform public agencies. Alabama, Alaska, Mississippi, Missouri, and South Carolina reported that owners or managers report submetering to the state environmental protection and/or health agencies, the Alabama Department of Environmental Management, the Alaska Department of Environmental Conservation, the Mississippi Department of Health, Missouri Department of Water Quality, and the South Carolina Department of Health and Environmental Conservation, respectively. Alaska further reported that the Regulatory Commission of Alaska be informed. Pennsylvania, Tennessee, and Texas reported that a state agency must be informed, but did not report a specific agency. Further research indicated that in Texas, the Commission on Environmental Quality must be informed (TAC 291.122).

The variety of state responses regarding how submetering systems are regulated under the state drinking water program reflects the differing interpretations of US EPA regulations. Sixteen states reported that submetering and RUBS systems are regulated under the State Drinking Water Offices as public water systems. Twenty-four states report that submetering is not regulated under the program, and therefore has no status. Three of those states, Delaware, Oklahoma, and Washington, reported that other state drinking water agency guidelines regulated submetering. Delaware reported that submetering systems are only regulated by the agency if water treatment is installed on the water line. North Carolina reported that such systems are regulated as consecutive systems, and New Jersey regulators make a case-by-case determination on submetering and RUBS systems to decide how they are regulated.

Oklahoma and Washington reported that systems are regulated under other water quality regulations, not the state drinking water program. (OAC 252.631 in Oklahoma and WAC 246.290 in Washington) Two states, Texas and Wisconsin, report that submetered systems are regulated in some way other than those reported above. Wisconsin did not report how the systems are regulated. Texas reported regulations located in the Texas Administrative Code at 291.121.

Regarding implementation of new regulations or guidelines, only Mississippi and South Carolina reported considering new guidelines for the regulation of submetering and RUBS. However, both states reported that the process was in the very early stages and follow-up research found no progress reaching the public comment stage.

Water Utility Managers Results

A total of 40 public utilities and one private utility providing service to more than 28 million people nationwide responded to the survey of water utility managers. Although the survey was targeted at retail and/or combination retail and wholesale utilities, two wholesale-only water suppliers inadvertently remained in the sample universe. One responded to the survey, but the responses given were not incorporated into these results. Thus, a total of 40 targeted utilities responded to questions on this survey.

The majority of utilities that responded to the survey (32) sell water at a wholesale and retail level. The remaining eight respondents reported to be retail only utilities: Anaheim Public Utilities, City of Chesapeake Department of Public Utilities, East Bay Municipal Utility District, Glendale (AZ) Utilities Utility Department, Glendale (CA) Water and Power, Hillsborough County (FL), Las Vegas Valley Water District, and the City of St. Louis Water Division.

Regarding the resale of water, 29 respondents reported allowing the resale of water by third parties. These utilities were more divided on the question of allowing resale of water for a profit: 17 reported allowing profit, 8 reported that it was not allowed, and 4 were unsure.

Twenty-six utilities reported that they had no regulations regarding water submetering programs. Of those, 13 responded that the lack of regulations meant that submetering was allowed, but not utility regulated. The remaining 13 did not respond to the follow-up question regarding submetering being allowed. Of the 14 utilities that reported having regulations for submetering, only 2, the City of Buffalo Water Department and the Shreveport Department of Operational Services, reported that submetering is prohibited by the utility. In summation, a total of 25 utilities stated explicitly that submetering is allowed by the utility (whether they regulate it or not), 13 reported that it was prohibited, and 13 did not provide specific responses.

Twenty-nine of the respondents reported no regulations regarding RUBS. Of those, the Arlington (TX) Public Utilities and the Las Vegas Valley Water District explicitly prohibit the use of RUBS. The nine utilities with regulations regarding RUBS allowed it, and two utilities were unsure of RUBS regulatory status within the utility.

To determine how utilities approached the metering of multi-family buildings, respondents were asked to report whether the utility installed master meters, individual meters in each unit, or both. Eleven utilities reported that individual meters are installed by utilities and the remaining 26 respondents reported installing master meters only (see Table 6). Utility responses are summarized in Table 7.6.

Table 7.6 Summary of utility regulatory survey results

Utility	Re-sale of water permitted?	Submetering		RUBS		Multi-family Metering Type
		Regs?	Allowed?	Regs?	Allowed?	
Anaheim Public Utilities	No	Yes	Yes	Unknown	Yes	Some master; some individual
Arlington Water Utilities	Yes[*]	Yes	Yes	Unknown	No	Some master; some individual
Augusta Utilities Department	No	No		No		Master service meter
Austin Water Utility	No	Yes	Yes	No		Some master; some individual
Birmingham Water Works	Yes	No		No		Some master; some individual
Buffalo Water Department	No	Yes	No	No		Master service meter
Charlotte-Mecklenburg Utilities Department	Yes	No		No		Master service meter
Chesapeake Department of Public Utilities, City of	Yes	No	Yes	Yes	Yes	Master service meter
Cincinnati Water Works	No	No		No		Master service meter
Columbus Water Division	Yes	No	Yes	No	Yes	Master service meter
Dallas Water Utilities	Yes	No	Yes	No	Yes	Master service meter
Denver Water Department	Yes[†]	No		No		Master service meter
East Bay Municipal Utility District	Yes[*]	No	Yes	No	Yes	Master service meter; some individual
Glendale Utilities Department	Yes	Yes	Yes	Yes	Yes	Master service meter
Glendale Water and Power	Yes	Yes	Yes	No	Yes	Some master; some individual
Hillsborough County	Yes[*]	Yes	Yes	Yes	Yes	Master service meter
Houston Department of Public Works and Engineering	Yes[*]	No	Yes	No	Yes	Master service meter
Indianapolis Department of Waterworks	Yes	No	Yes	Yes	Yes	Some master; some individual
Las Vegas Valley Water District	Yes[‡]	Yes	Yes	No	No	Master service meter
Lubbock Water Utilities	Yes	No	Yes	Yes	Yes	Some master; some individual
Madison Water Utility	Yes	No		No		Some master; some individual
Mesa Municipal Water Dept.	Yes	No		No		Master service meter
Milwaukee Water Works	Yes	Yes	Yes	Yes	Yes	Master service meter
Minneapolis Billing Utility, City of	No	Yes	Yes	No		Master service meter
New York Department of Environmental Protection	Yes[**]	No		No		Some master; some individual
Newark Public Utilities, City Of	Yes[††]	No	Yes	No	Yes	Master service meter
Oklahoma City Department of Water and Wastewater Utilities	Yes	No	Yes	No	Yes	Master service meter
Omaha Metropolitan Utilities District	No	No	Yes	No	Yes	Master service meter
Portland (OR) Water Bureau	Yes	No	Yes	No	Yes	Master service meter
San Antonio Water System	No	No	Yes	No	Yes	Master service meter

Utility	Re-sale of water permitted?	Submetering		RUBS		Multi-family Metering Type
		Regs?	Allowed?	Regs?	Allowed?	
San Diego County Water Authority	NA	NA		N/A		
San Jose Water Company	Yes[*]	Yes	Yes	No	Yes	Master service meter
Seattle Public Utilities	Yes	No		Pending	Yes	Master service meter
Shreveport Department of Operational Services	Yes[††]	Yes	No	Yes	Yes	Master service meter
Spokane Department of Water and Hydroelectric Services	Yes[*]	No		No		Master service meter
St. Louis Water Division, City of	Yes	No	Yes	No	Yes	Master service meter
St. Paul Water Utility	No	Yes	Yes	Yes	Yes	Master service meter
Tacoma Public Utilities, Water Division	Yes	No		No		Master service meter
Toledo Water Division, City of	Yes[*]	Yes	Yes	No	No	Master service meter
Tucson Water, City of	Yes[††]	No	Yes	No		Some master; some individual
Tulsa Public Works Department	Yes	No	Yes	No	Yes	Some master; some individual

[*] Allows for resale, but not for a profit to the seller
[†] Only for wholesale customers, not for residential
[‡] Not for a profit, and only for trailer parks
[**] Wholesale yes, retail no position
[††] Unknown if resale for profit is allowed

DISCUSSION - KEY EXAMPLES OF STATE AND LOCAL POLICIES

It is clear from the foregoing that the regulatory environment for multi-family water and wastewater billing systems is unsettled, both at the federal level and in many states. To further understand regulatory frameworks and issues, it is helpful to outline the broad policy directions taken thus far by states, based on the responses to the surveys and information in the available literature. A limitation of the survey framework described above is that it reports *perceptions* of individuals regarding the submetering and RUBS regulations. To enhance the usefulness of this policy overview, follow-up interviews and background material (such as previous surveys and state specific literature searches) were used in the formation of this typology.

At least five types of regulatory environments are identified in this discussion:

- Landlord/Tenant Law
- Public Utility Regulation
- Safe Drinking Water Regulation
- Weights and Measures Regulation
- Local policy, legislation in progress, or no policy

Landlord/Tenant Law

In **Arizona**, submetering and RUBS are regulated under the Residential Landlord and Tenant Act – 2000 revision (Arizona Revised Statute Title 33, Chapter 10 33-1314.01). Under this act, the building owner *is allowed* to submeter or allocate billing to tenants. Owners are not required to report submetering to a state agency under the code. As long as the billing measure is clearly stated in the landlord/tenant agreement, the obligation of the building owner has been satisfied.

The relative simplicity of this code is likely responsible for the lack of confusion on the part of utilities. Three utilities were interviewed in Arizona, and although none of them referred to the code, all understood that submetering and RUBS were allowed, and that individual utilities were not responsible for installation or maintenance of metering equipment. One of the utilities, the City of **Tucson**, does offer individual meter installation service to building owners for a fee.

The **Phoenix** City Code (Section 6. Subsection 14-445) for the rental, leasing, and licensing for use of real property requires a multi-family building owner to pay .08 percent of the gross income from the rental property in taxes. Charges that the owner collects for utilities are considered part of the owner's gross income. Part (b) of the subsection indicates that if individual meters have been installed for each dwelling unit and the owner does not charge for more than the cost of water, the revenue collected is not considered part of the gross income.

The residential landlord-tenant code of **Delaware** (25 Del. C. Section 5312) authorizes water submetering in multi-family buildings, if separate charges are provided for in the rental agreement. A property owner cannot charge more than the actual cost of utility service to the resident. The "metering system" *may* be inspected and *must* be approved by the state's Division of Weights and Measures. All other aspects of the law fall under the jurisdiction of the Consumer Protection Unit of the state Attorney General's office. The code also stipulates that except for "metering systems already in use prior to July 17, 1996," a property owner may not separately charge residents for utility service unless that service is separately metered, language that clearly bars new RUBS systems from being initiated.

Under Delaware’s system, residents are allowed to request testing of the meter, which is provided by the owner, and the Consumer Protection Unit is authorized to conduct tests on the premises. If the submetering equipment is found to be accurate, the renter is responsible for paying for the testing. If the device is inaccurate, the cost of testing and replacement is covered by the owner. Notably, Delaware's statute explicitly bars a property owner who submeters from being deemed a public utility, and removes submetering practices from the jurisdiction of the Public Service Commission.

Mississippi's recently enacted statute (SB 2797 2002) specifically authorizes submetering of multi-family water and wastewater service in the interest of the conservation of water resources. Property owners seeking to submeter must obtain an acknowledgment of the submetering arrangement in writing from the resident, and charges are capped at the *pro rata* share of all water and wastewater services used by residents. Property owners may not disconnect water and wastewater service for nonpayment of submetered bills, and submeters must meet "standards for accuracy" of the American Water Works Association.

Illinois’ Tenant Utility Payment Disclosure Act (765 ILCS 740) requires that apartment building owners and condominium associations provide residents and condominium owners with the formula for allocating the cost of utility services from a master meter, in writing, before demand for such payments can be made. Copies of the public utility bill must be made available upon request. Charges by apartment owners to residents may not exceed the total public utility bill. Condominium associations are given more flexibility to reprogram any excess charges to other budgeted association accounts, or back to unit owners the following year.

Public Utility Regulation

In **Connecticut**, the Department of Public Utility Control has one brief regulation concerning water submetering. Section 16-11-55(4) (Regulations of Connecticut State Agencies) states: “Submetering shall be permitted only with the approval of the commission.” To secure this approval, however, a property owner must file an “Application for a Connecticut Submeter Supplier Approval to Install and Use.” Sections A and B of the permit application require, for each building to be submetered, submission of a detailed floor plan and plumbing plan, a detailed plan and diagram of submeter installation, and a copy of notices or written materials provided to the resident regarding submetering and reading. The plumber who will install the submeters must also be identified. In section C, the applicant must provide a description of how the applicant will respond to resident inquiries regarding the installation, reading, and billing of the submetered premises, a sample bill that will be sent to residents, the written procedures of the applicant regarding compliance with transparency of the bill adjustment process, and written procedures of the applicant governing resident unit entry. Section D of the permit application describes the responsibilities of the applicant with respect to customer service and complaint handling. This section requires the applicant to provide written copies of customer service documentation given to the resident, including procedures for collecting and returning the water utility security deposit and the collection of late fees. This section also includes the submission of copies of notifications given to the resident, including instructions on complaint filing (with the applicant and the DPUC), requesting a meter reading or test, and contacting the DPUC and local utility. The final section of the application (E) requires the applicant to submit a comment letter for the water utility regarding the submetering proposal, specific provisions in the lease for the facility in question, the letter notifying current residents that this service is going to begin, and the contractual agreement between the applicant and a vendor that will do the billing (if applicable). Note that these submissions, including those that pertain to sample bills, customer service, and complaint handling, are not required for RUBS installations.

In **North Carolina**, the North Carolina Utility Commission (NCUC) regulates submetering through the NCUC Rules Chapter 18 (R18-1-17): Resale of Water and Wastewater

Service and pursuant to North Carolina General Statute 62-110g. These rules require a property owner seeking to allocate utility costs to residents to apply for and obtain a certificate of authority as a Public Utility from the Commission (R18-13) and to file an annual Public Utility Report (R18-15). [Confirmation is being sought that allocators are exempt from most other Public Utility Requirements (section R18-13)].

NCUC's current regulations allow for the property owner, described as a "rent allocator," to charge a resident for the cost of the purchased water as read by an individual meter, as well as a fee of up to $3.75 to compensate the property owner for meter reading and billing costs (R18-16). The regulations also address several customer service issues, including a clear outline of renter notification in the lease about the “base” and “variable” rent charges, and provisions prohibiting the property owner from disconnecting water service as a result of non-payment and from charging the resident for excess usage resulting from a plumbing malfunction unknown to the resident, or that the property owner knows about (R18-17). To date, over 175 property owners are registered as regulated water/wastewater resale companies with the NCUC.

In September 2000, the **Texas** Commission on Environmental Quality (formerly the Texas Natural Resource Conservation Commission) adopted utility regulations (TAC 291.121-127) that apply to water submetering. The regulations were designed to “establish a comprehensive regulatory system to assure that the practices involving submetered and allocated billing of dwelling units and multiple use facilities for water and wastewater utility service are just and reasonable and include appropriate safeguards for tenants.”

Any property owner seeking to bill residents for utility service either through a RUBS system or through submetering must register with the commission. The regulations address: specific requirements for the availability and retention of records; the content of the lease as it pertains to utility billing; limitations on the charges to be allocated; permissible formulas for RUBS allocation; billing practices; discontinuance of service; and, submeter installation and testing. Owners are allowed to have billing completed by a third party for a fee. One of the Texas utilities interviewed offered this service itself (Austin Water Utility).

In 2001, Texas enacted a widely noted set of amendments to the state Water Code addressing submetering in new construction in several important ways (h.b.2404). Previous law had authorized submetering by owners of apartments, manufactured home rental communities, condominiums, and multiple use facilities. The 2001 law required that any such facility placed under construction after January 1, 2003, must have a plumbing system that is compatible with the installation of individual meters or submeters. The law further required that submeters or individual meters be installed, either by the facility owners or by the local utility. Utilities are obligated to install submeters or individual meters if requested by a property owner or manager, unless the utility finds that the installation of meters is not feasible. However, if the utility so finds, then the property owner is not obligated to install meters or submeters either. Three of the Texas utilities surveyed for this study reported that they install individual meters in multi-family properties. However, the practice is not thought to be widespread. Taken together, the effect of these provisions has resulted in few new structures being fully submetered.

Furthermore, the law makes no provision for meters, once installed, to be used for billing purposes. At least one new property is reported to have submeters installed but is actually billing residents through a RUBS allocation system.

Another notable feature of the Texas statute is a set of requirements relating to water efficiency that must be met as a condition of the adoption of any new billing system, either submetering or RUBS. Prior to conversion, owners must perform an audit of each unit and repair any leaks that are found, and must ensure that all faucets, faucet aerators, and showerheads meet current water efficiency standards. Within one year of conversion, any toilets that flush in excess of 3.5 gallons per flush must be replaced with toilets that meet current water efficiency standards (1.6 gpf). The effectiveness of this last provision has been greatly diminished by exempting the large class of toilets designed to flush at 3.5 gpf, commonly installed in Texas from about 1980 to 1992, from the replacement requirement.

The **Virginia** State Corporation Commission (SCC) partially regulates water submetering and RUBS, and allows it. However, at the time of the survey for this report (2002), the SCC reported that the Department of Agriculture as well as the Consumer Service Division of the Consumer Protection Office of Product and Industry Standards have recently informed entities that are making use of RUBS that the use of a RUBS is not allowed under the statutes that those offices enforce.

In both **Wyoming** and **West Virginia**, the Public Service Commissions consider any properties with either submetering or RUBS to be a public utility subject to regulation, which may account for the lack of billing implementation in these two states.

Safe Drinking Water Regulation

In **North Carolina**, the North Carolina Drinking Water Act is administered by the Public Water Supply Section of the Division of Environmental Health, a part of the Department of Environment and Natural Resources. In conformance with guidance from the US EPA, North Carolina's law provides for submetered systems in multi-family properties to be deemed "consecutive water systems." The import of this designation is that under the law, the monitoring, analysis, and record-keeping requirements that would otherwise apply will be satisfied by the monitoring, analysis, and record-keeping performed by the supplying water system, i.e., the public utility. As of the end of 2002, the Water Supply Section reported a total of 236 active submetered apartment systems in its database of 8,000 active public water systems (NC Compliance Report 2002).

Concerns arose in North Carolina that the US EPA's continued insistence that the "sale" of water through billing systems carried obligations for certain on-site monitoring activities presented a potential barrier to expanded use of submetering (EPA 2000). In response, in 2001 the NC General Assembly revised its law (GS62-110g) "for the purpose of encouraging water conservation" by striking reference to "allowing the resale of water" and substituting procedures that "allow a lessor, pursuant to a written rental agreement, to allocate the costs for providing water and wastewater service on a metered use basis" to persons who occupy the same contiguous premises. The practical effect of the attempted work-around by the state is unclear.

The **Alabama** Department of Environmental Management undertook further refinement of the "consecutive water system" designation by creating a new designation, the "segmental water system," and found favor with the US EPA. The designation, which waived on-site monitoring requirements for multi-family properties with billing systems, carried certain additional qualifications. The designation was made available to facilities comprised primarily of indoor plumbing rather than underground distribution lines, and having no on-site water pumping, no on-site storage, and no cross-connection or backflow situations as attested to by licensed plumber. Additionally, segmental systems must employ a certified water operator "to be available as needed" to respond to water quality complaints. Qualifying facilities must apply for recertification every three years, and are maintained in ADEM's database of public water systems. As of the end of 2002, ADEM reported 16 segmental water systems out of a total of 705 active public water systems (ADEM 2002).

Weights and Measures Regulation

In **California**, the Division of Measurement Standards within the Department of Food and Agriculture is responsible for enforcement of state weights and measures laws. The Division works closely with county sealers of weights and measures who carry out most weights and measures enforcement activities at the local level.

Local Regulation Only, Legislation in Progress, or No Policy

The research presented above shows that most states have not implemented comprehensive regulatory strategies toward water submetering and RUBS that are well understood by regulatory agencies and other stakeholders. Despite the lack of comprehensive regulations in many of these states, submetering has occurred and has been dealt with in a variety of different ways. These ad hoc policies have a varied outcome because they are created under specific circumstances. This section outlines notable local policies and legislative proposals.

Massachusetts offers a good example of both the complex issues surrounding submetering, as well as the lack of communication on the issue between state offices, which often share jurisdiction over water-related laws. While nowhere in the state law is the practice of water submetering specifically forbidden, the Department of Telecommunications and Energy (DTE) as well as the Massachusetts Department of Health (MDOH) consider the process to be unlawful based on different precedents. In contrast to these two departments, the Massachusetts Department of Environmental Protection (DEP), which is responsible for the implementation of the federal Safe Drinking Water Act, claims to encourage the practice of submetering in apartment buildings as a general practice.

The DTE regulates utilities, including water, and asserts that the practice is unlawful due to the definition of water companies within chapter 165 of the Massachusetts General Laws (GLM). However, the text of the law is not clearly in agreement. When defining the entities responsible for compliance with the Safe Drinking Water Act, the text of the water section (section 165) of the GLM states:

> "Corporation" or ""company", every person, partnership, association or corporation, other than a municipal corporation, and other than a landlord supplying his tenant, engaged in the distribution and sale of water in the commonwealth through its pipes or mains.

The DOH in Massachusetts is responsible for implementing the tenant/landlord State Sanitary Code. The Code states:

> 410.180: Potable Water
> The owner shall provide for the occupant of every dwelling, dwelling unit, and rooming unit a supply of water sufficient in quantity and pressure to meet the ordinary needs of the occupant, connected with the public water supply system, or with any other source that the board of health has determined does not endanger the health of any potential user. (See 105 CMR 410.350 through 410.352). Examination of the water system shall include an examination of the plumbing system and its actual performance. If possible, such examination shall occur at the times and under such conditions as the occupant has identified the system as being insufficient.

To clarify this part of the code, due to questions regarding submetering as well as general questions regarding billing in apartments, DOH issued an advisory ruling that defines and interprets the word 'provide' to mean both supply and pay for. The advisory further clarifies that this means that the property owner cannot sell water for a separate price other than the average price rolled into the rent. There is no standard outline for how to calculate the average cost of water into the rent. In an interview, DOH noted that the rent can be readjusted with every new lease in the building, and that an increase in rent due to an increase in the cost of water to the property owner over the course of the year is lawful.

In the current Massachusetts legislative session (183rd General Court, 2003 Regular Session), a bill authorizing the assumption of water utility costs by residents has been introduced (2003 MA H.B. 3480). This bill allows for a property owner to submeter water (and other utility services) and charge residents based on usage, adding in charges for administrative costs borne by the owner. The owner is not authorized to charge further fees. The bill also authorizes RUBS using any "method that fairly allocates charges." If passed, this bill would clear a significant amount of regulatory uncertainty described above.

In **Florida**, the state Public Service Commission regulates submetering in counties over which it has jurisdiction. In **Miami-Dade County**, not under the jurisdiction of the PSC, the county adopted a comprehensive ordinance barring RUBS and regulating submetering in 1996, the Miami-Dade Remetering Ordinance.[36] This ordinance authorizes owners and remeterers (third party billing agencies) to submeter individual apartment units and contains requirements for annual registration and fees. In the Miami-Dade system, owners may not collect a profit

[36] Miami Dade Administrative Code. Article 18, Section 8A-380.

from the submetering. Meter testing and performance requirements are also included. The ordinance incorporates property owner/resident issue resolution through a detailed explanation of notification and billing practices. To fit within existing building and plumbing codes, the ordinance requires, in applicable situations, that owners or remeterers present building permits in their initial or annual requests to submeter.   The Miami-Dade Ordinance is included in Appendix E.

The **Washington** State PUC does not regulate submetering or RUBS, under the Washington Administrative Code (WAC) 480-110-255 section 2(g): the commission does not regulate entities or persons that provide water only to their residents as part of the business of renting or leasing. The agency does allow for submetering and RUBS, however, as well as allowing the selling of water, and the collection of variable, fixed, service, late, and installation fees. The agency notes that they do not regulate submetering due to a potential increase in administrative costs to the utilities. The state code is unclear as to how submetering is regulated. It seems, both according to the code as well as the three public utilities interviewed in Washington, that there are no regulations for submetering, but that it is allowed by the state.

In the absence of state regulation in Washington, local governments may step in with regulations on billing allocation, including submetering. In reaction to the potential for fraudulent billing by third party entities, the city of **Seattle** has implemented an ordinance entitled the Third Party Billing Regulation (Seattle Municipal Code, Chapter 7.25). This ordinance was designed primarily to protect residents from deceptive and fraudulent billing for utilities, but has the ancillary effect of defining that submetering and RUBS are allowed, as long as appropriate notice is given to residents and property owners abide by the rules of unit entry described in the other parts of the Residential Landlord Tenant Act of 1973. The ordinance describes the way that property owners must inform the resident of metering changes, and also caps the amount of money that can be charged as an administrative fee ($2 per utility per month; $5 for all utilities per month).

Elsewhere, other localities considering action on billing systems include **Howard County, Maryland**. During its 2003 session, the Maryland General Assembly considered but failed to act on HB 976, a bill that would have barred any further installation of RUBS systems in the state, and require that any separate utility charges to residents be based upon actual use. Howard County has under consideration a more sweeping set of recommendations from a consumer advisory board working on the issue since 2002. The board has recommended that all new multi-family construction be submetered; all existing apartments be converted to submetering within ten years; and that administrative fees be capped at $1 per unit per month.

The city of **Ventura** may become the first city in **California** to require submetering in newly constructed apartment buildings. The city council directed its staff to review the issue in 2003, and is now considering a staff recommendation to require meter installation for each new multi-family unit (Ventura County Star, 4-5-04).

One additional legislative proposal dealing with submetering should be noted. On February 24, 2004, a bill addressing submetering was introduced to the **Minnesota** legislature (2003 MN S.B.2281). This bill authorizes cities in Minnesota to establish water submetering programs and create grant and loan programs using federal, state, private, and city funds to assist owners with the financing of submetering projects.

TENANT ADVOCACY GROUPS

Tenant advocacy groups in the US are dedicated to protecting the rights of people who pay rent for housing. These organizations have an inherent interest in programs such as third party billing for water and wastewater that directly impact renters. To further explore how utility billing affects residents, tenant advocacy groups and organizations were contacted by the research team. The investigation aimed to find out if tenant organizations have taken any stance on submetering and RUBS, and what action (if any) has been taken by these groups. Over 60 tenant organizations across the country were contacted by phone or e-mail in 2003. The effort yielded responses from 20 organizations. Respondents ranged from those who were barely aware of submetering and RUBS to others who were actively involved with these billing systems.

Nine of the respondents reported that they were not involved with any of the issues associated with separate utility billing.[37] Of these respondents, most indicated that they had not been confronted with the issues of submetering or RUBS, and that they focused their efforts on other issues. A representative from the Ecumenical Community Development Organization of New York said, “Most of our advocacy is entered into to address immediate needs of affordable,

[37] The organizations were California Coalition for Rural Housing (CA), Coalition for Economic Survival (CA), Santa Monicans for Renters Rights (CA), People's Regional Opportunity Program (ME), Minnesota Housing Partnership (MN), North Carolina Low Income Housing Coalition (NC), Ecumenical Community Development

clean and decent housing or the lack thereof." Four of the respondents were involved with issues related to separate utility billing for electric and gas, but not for water.[38]

Three of the respondents reported having received an occasional phone call or complaint about RUBS and submetering, but were not taking any action on the issue.[39] The Arlington County Housing Information Center in Virginia reported receiving a variety of e-mail communications from residents related to water billing. The representative explained that the organization can only inform residents of their rights and refer them to their local representative. The representative said, "I can't give you any real numbers but I can safely say that we have heard many many complaints about ratio billing…. Again, the response from tenants has been overwhelmingly negative… Tenants at the more expensive buildings/complexes are usually the ones who complain the loudest and tend to do so by e-mail."

A representative from the Portland Tenants Union in Maine cited separate utility billing as a "major issue for tenants." While this organization is not taking any action at the present time, they do distribute "documentation forms" to all Portland tenants. Through the forms, they maintain a file of utility-billing complaints.

Only two organizations reported taking any action on the issues of separate utility billing for water. A representative from the Cleveland Tenants Organization in Ohio reported a strong aversion to separate utility billing, especially for RUBS. This group helped to successfully organize tenants in Cleveland Heights against a property owner that was allocating water bills with a ratio utility billing system. Now, RUBS is illegal in the City of Cleveland.

A representative from HOME Line in Minnesota reported about their experiences with separate water billing. The representative explained that they regularly represent tenants whose housing providers are violating laws associated with RUBS and said that their organization receives phone calls inquiring about it on the HOME hotline. The representative testified in 2001 to the Minnesota legislature against RUBS. The testimony included results from a study that found RUBS to slightly increase water use in 11 apartments that had been recently converted in Minnesota. Despite the testimony, RUBS remains legal in Minnesota. Since then, the representative reported that RUBS has become very popular with corporate owners of large

Organization (NY), Washington Low Income Housing Network (WA), and Brandywine Tenants Association (Washington D.C.).

[38] The organizations were Florida Housing Coalition (FL), New Jersey Tenants Organization (NJ), Greater Syracuse Tenant Network, and Vermont Tenants Inc (VT).

apartments in the Minneapolis area. However, the representative said that there is not much collective tenant organizing among residents of these properties.

[39] The organizations were Minnesota Senior Federation (MN), Community Alliance of Tenants (WA), and Housing Advocacy Coalition (CO).

CHAPTER 8 ISSUES REGARDING POINT-OF-USE METER STANDARDS

The recent introduction of point-of-use (POU) meters in the multi-family sector for measuring consumption for use in billing has created a need to address plumbing code standards for point-of-use applications. POU meters are used in multi-family dwellings where water use cannot be measured by other means due to the design of the plumbing systems. POU meters are considered submeters since they are installed downstream of the utility master meter. They are designed for installation on the separate water lines going to the various end uses, such as showers, sinks, toilets, etc. It has been estimated that POU meters are applicable for use in nearly 50% of all multi-family properties, with the average dwelling unit requiring around seven POU meters. In these dwelling units, larger meters that capture all consumption at one point cannot be used, because water comes into the dwelling unit from many shared supply lines. It is important to note that there are already accuracy standards for water meters. However, the current standards are applied to meters that are tested in the horizontal position with straight piping and, in the case of the AWWA standard, for cold-water applications. POU meters are being installed under other conditions such as in the vertical position with bent piping and for hot water applications. The question that has been raised in deference to consumer protection is, how accurate are these POU meters under those conditions since the current plumbing codes do not require testing under these application conditions. Thus, installation standards need to be developed where none currently apply and, if necessary, incorporated into the appropriate plumbing and utility codes.

An ad hoc committee was formed to address POU meter application issues by reviewing the current meter standards, discussing the issues, and developing conclusions and recommendations for consensus based application standards. The committee’s comments and conclusions follow the background information presented below on the organizational structure of metering standards in the U. S and their applicability. Recommendations are presented in Chapter 9 and in the Executive Summary.

NATIONAL ORGANIZATIONAL STRUCTURE FOR METERING STANDARDS

The American National Standards Institute (ANSI) accredits developers of standards in the private sector and coordinates their development. ANSI is the private counterpart of the National Institute of Standards and Technology (NIST), a non-regulatory Federal agency. Both the American Water Works Association (AWWA) and the American Society of Mechanical Engineers (ASME) are accredited by ANSI to develop standards. Both the AWWA (C700-95) and ASME (A112.4.7) meter standards are voluntary, industry consensus, product standards that include accuracy requirements. The ASME standard becomes a requirement when it is adopted into a plumbing code, which then requires third party testing and listing. The primary difference between the AWWA and the ASME Standards is that the ASME standards apply to meters downstream of the utility (master) meter. Another way to view it is that the AWWA standards apply to the distribution side of the water system and the ASME standards apply to the plumbing side of the water system. The ASME A112.4.7 currently references the tolerances in AWWA C700-95 for meter accuracy and extends them without change to smaller POU and branch meters, which are sometimes used in submetering applications. The AWWA accuracy standards for 5/8 meters still apply because they were adopted by reference in ASME. According to ANSI, the ASME standard applies to water meters with capacities up to 15 gpm, while AWWA standards apply to water meters above 15 gpm in capacity. Since the AWWA tolerances are incorporated by reference in ASME, there currently is no distinction except that ASME specifies use of the AWWA 5/8-inch positive displacement tolerances on all meter sizes up to and including 5/8 inch.

The AWWA standards, used by most utilities as a basis for meter purchases, covers only cold-water meters with accuracy testing in flow ranges from .25 gpm to the rated capacity. The ASME Standard, adopted by regulators in many parts of the country, and incorporated into many plumbing codes, such as the International Association of Plumbing and Mechanical Officials (IAPMO) and NSF (formally known as the National Sanitation Foundation), covers hot and cold water with accuracy testing from .25 gpm to 15 gpm. So, POU meters fall under the purview of the ASME standards. IAPMO and NSF are non-profit organizations that certify products as having passed various “standards” tests. These organizations primarily list and certify the plumbing products. IAPMO can develop and adopt “Preliminary Standards” (PS) called Interim Guide Criteria (IGC) for incorporation into plumbing codes. Plumbing inspectors look for both the Universal Plumbing Code (UPC) seals on plumbing products certifying compliance with the IAPMO and NSF standards.

Within NIST is the Office of Weights and Measures (OWM), a non-regulatory agency, which promotes uniformity in U.S. weights and measures laws, regulations, and standards to achieve equity. To help accomplish this mission, OWM established the National Conference on Weights and Measures (NCWM). The NCWM is a professional organization of state and local weights and measures officials and representatives of business, industry, consumer groups, and Federal agencies. NIST publishes standards developed by the NCWM. OWM oversees a Device Technology Program, which develops procedures for testing, weighing, and measuring devices. NIST publishes the NCWM Handbook 44, “Specifications, Tolerances, and Other Technical Requirements for Weighting and Measuring Devices”. The Handbook 44 standards, upon adoption by states, become regulation. Handbook 44 has been adopted entirely in 39 states and partly in the remaining 11 states and is updated annually. Weights and measure officials respond to complaints by consumers regarding meter accuracy.

Also hosted by OWM is the NCWM’s National Type Evaluation Program (NTEP). NTEP has 12 participating labs around the country to test compliance with national standards; however, only three labs have testing facilities for water meters and they are in California, Maryland, and New York. Basically, the NTEP provides a central evaluation process for manufacturers. Following successful testing by NTEP, the NCWM can issue an official Certificate of Conformance. The Certificate of Conformance is recognized by most states. In States not recognizing the NCWM certificate, additional testing may be required. NTEP Certificates for Conformance are not issued for water submeters. However, they are tested against Handbook 44 requirements contained in sections 1.10 and 3.36 in California and upon a complaint in the other states.

Handbook 44 requires devices be tested for compliance in the application conditions they are going to be used. The Handbook 44 accuracy requirements are nearly identical to ASME A112.4.7 and AWWA C700. The Handbook is slightly more liberal at the low flow test. All other tolerances are identical. Included in the California device code is a requirement that submeters be tested for accuracy and re-certified once during every 10-year interval. Only California has adopted the requirement that local officials (County Sealers) test and certify all submeters for compliance. However, OWM officials respond to and investigate consumer complaints in all 50 states and approximately 40 state jurisdictions have adopted Handbook 44 Section 3.36 (water meters) as regulation for utility meter applications. NIST Handbook 44 is only used for submetering evaluation in California and New York.

In California, and in many other states, private service agencies can test, seal, and place submeters and other commercial equipment into commerce, pending re-inspection by a sealer. Some are manufactures or distributors for meter products. They must have traceable standards, seal, identify, and report their work. Private testing and calibration agencies are always monitored by weights and measures jurisdictions. When a local sealer finds service work to be incorrect, actions can be filed against the service agent or agency and the incorrect equipment is removed from service until repaired or replaced. "Plumbers", manufacturers, or others who test or calibrate meters may need to register and comply with such requirements in many of the states. Monitoring private certification programs are estimated to cost as much as regulatory certification.

DISCUSSION

The current ANSI (AWWA and ASME) standards are product standards and do not address POU application (installation) conditions that impact meter accuracy, such as meter orientation, piping configurations, water temperature, and a low battery voltage. In addition, meter labeling is not specified for such application conditions, which might define approved orientation positions and temperature ranges. Other issues with POU meters include meter maintenance, meter reading, and installation standards. The current lack of tolerances for application conditions for POU meters is an equity issue for the consumer (owner and resident) and may be an issue for water utilities. For example, utilities may be increasingly drawn into owner-resident issues over meter accuracy and billing practices.

Accuracy Standards

The AWWA meter accuracy standard for positive displacement utility water meters with flows between 1 gpm and 160 gpm at their normal rated flow is +/- 1.5%. For these same meters, the accuracy range for their minimum normal flow is + 1% and –5%. The smallest AWWA meter is a ½" meter where the accuracy test for low flow is at .25 gpm for an accuracy range of +1% and –5%. The AWWA accuracy (C708) for multi-jet meters at .25 gpm is +/-3% because of differences in the flow performance curves with this design.

The ASME submeter accuracy standard for meters with flows between .25 gpm and 15 gpm is +/- 1.5% at their normal flow range. For these same meters, the accuracy range for their minimum normal flow is +1% and –5%. Under the ASME standard, meters can be tested at flows down to 0.1 gpm for an accuracy range of +1% to –5%.

Point of Use Meter Issues

The AWWA meter standards (C700) apply to cold-water meters that are tested at flow rates from .25 gpm to the meters capacity, up to 160 gpm. The NSF/ANSI 61-2001, which is C700 by reference, applies to water meters installed downstream of water utility master meters in flow ranges under 15 gpm for cold and hot water use. However, both these standards address the product and not operation and maintenance standards. Certification tests for these standards are conducted with the meter in generally one orientation, with straight pipes entering and exiting the meter. In practice, however, many submeters and POU meters, in particular, are often subjected to a much wider variety of conditions. Thus, installation standards are needed along with the manufacturer's installation specifications. In addition, the industry needs to agree upon acceptable accuracy standards for POU meters under adverse application conditions not just for the meter under ideal conditions (straight pipe, cold water, and one orientation, etc).

The ad hoc committee discussed what was believed to be the important issues that needed to be addressed in application standards for POU meters. These issues included low battery data transmission and battery life, application accuracy; meter read (consumption) verification, labeling and identification, and maintenance. These issues are discussed below. The committee believes that other issues, such as data transmission, product durability, and testing protocol are already addressed in the various codes.

Battery life

Committee member comments:

- Battery durability within the submeter standard should reference the Underwriters Laboratories standards. Influence factors such as voltage, heat, vibration, etc. are well covered in International Officials for Legal Metrology (OIML) water meter standards.
- The owner, manager, and/or apartment dweller should be notified in advance of the expected battery life.
- When the battery fails, the meter reading should stop, thus notifying (by default) the owner, manager, or other interested party.

- Meters must demonstrate in testing that errors of registration are not introduced by low battery voltage.
- Batteries should issue an accurate measurement or none at all
- A "window of warning" can and should be designed into the circuit board that would provide the required notification; also, the unit can be designed to shut down altogether when voltage drops below a pre-determined threshold
- ASME A112.4.7, paragraph 2.3, provides for a 5-year life and a 3-month warning.
- AWWA specifies a 15-year battery life
- If there is a warning, then there must be some specification as to who receives the warning signal; "display criteria" are needed or the signal should feed into a recording system.
- ASME A112.4.7 states that there shall be an "external indication."
- Complete shut-down of data transmission due to low voltage means no charges would be made to the responsible party and, as such, the failure of the battery would get attention. The immediate response by the owner or manager to such a situation, however, would likely be to create an "estimated bill" for as long as the law allows, which is essentially forever in all but three states that do not allow utility cost allocation (Delaware, Mississippi, and North Carolina) the meter output (reading) should be visible to the property owner, the dwelling unit occupant, and the billing company.
- A shorter battery life means that the device needs to be replaced more frequently with the cost being incurred by the meter manufacturer.
- We are proposing a technical standard and the state and local jurisdictions should deal with billing, etc.

Conclusions based upon committee's comments:

The battery should have a minimum life of 5 years and provide for a 3-month low battery signal as currently specified in the ASME code. However, there needs to be a requirement that the data is not compromised due to low voltage: data needs to be deterministic--either transmitted correctly or not at all.

Visible Meter Reads

Committee member comments:

- Cell phones don't have visible "meters" to show how many minutes have been used; technology is taking us away from visible meter reads; technology permits current reading to always be obtained.
- Having the data displayed on a computer console (instead of the meter itself) is OK, but the data:

(1) Must not be subject to manipulation, either intentionally or not, e.g., RF interference, static electricity, etc;

(2) Must be accessible within a reasonable period of time to the person paying the bill; and

(3) Transmission must be reliable.

(4) Must display the customer's current actual volume

(5) Should include in a non-mandatory appendix to the standard stating individual meter and totalized values be made available.

Conclusions based upon committee's comments:

A visible data read at the meter is not required, provided that the register shall be encoded in nonvolatile memory. Meter customers shall have ready access to current reading values. This is in the current ASME code in Section A112.4.7, paragraph 2.8. The resolution of billing data should be left to the local jurisdiction.

Submeter Accuracy

Committee member comments:

- Testing to application conditions-

  (1) Certificate of Installation should indicate under what physical conditions (including orientation) the meter was installed; the certificate should be provided to the local authority; the testing for that class of meters should, of necessity, be consistent with the manufacturer-recommended installation conditions.

  (2) Manufacturer should provide an error chart showing the accuracy at, for example, 0, 30, 45, 60 and 90 degrees from horizontal, so that the user understands the meter's performance limits.

  (3) Manufacture should provide for an error chart for hot and cold water from 45 degrees Fahrenheit to 150 degrees Fahrenheit.

- If manufacturer's instructions say, "only install in horizontal position" and the meter is not so-installed, then Weights and Measures will require the owner to remove the meter. California Weights and Measures representatives go into the field to check on every installation.

- Plumbing systems are space constrained and meters are being installed in existing systems; conditions of this existing plumbing dictate that these meters will end up in an infinite number of configurations.
- A requirement for measurement at very low flows exists because of leakage in many plumbing systems.
- If the accuracy tolerances required in laboratory tests are different from those required in field applications, there should be a technical justification.
- Once installed, maintenance tolerances are the same as "acceptances tolerances" in California. "Acceptance tolerances" are applied on new equipment or equipment that has been adjusted and is being returned to service. "Maintenance tolerances" are applied everywhere else.
- Conditions of temperature, water pressure, and orientation should be included in the test regime; each test condition, however, would be in isolation from the other conditions.
- If the device is designed for only one orientation, then the manufacturer should mark the device as such.
- Repeatability is critical, both in the laboratory and in the field.
- A meter cannot be accurate to within ±1.5 percent if it is tested or used in both hot and cold applications, because water expands by more than 1.5 percent from 60 to 140 degrees F. However, there are some non-POU meters where accuracy is not affected by orientation and the meter can be calibrated to be accurate at any water temperature. But these meters cannot avoid the accuracy compromise when the temperature changes from one measurement to another, or during a single flow event. However, the expansion of the water has no bearing on the measurement of the volume unless there is a requirement to adjust back to some standard temperature, which there is not.
- No correction is applied to account for expansion of water at the meter. The only corrections made are to account for temperature change, if there is any during testing. They are:
- Temperature change after the water is seen by the meter and when the prover is being read, and

- Expansion of the steel or aluminum prover to the heated water.
- If the design handles both cold and hot water accurately, it is not likely any test would be performed to vary the water temperature during a single volumetric test.
- Distortions in meter readings as a result of pipe bends near the meter must be considered in testing for accuracy as with such installations..
- Pipe bends should be included in the test protocol by incorporating an elbow within an inch or so of the inlet to the meter if this is consistent with the meter application.
- Must also consider the slug of air that precedes the water to a showerhead or tub spout. This is unavoidable in POU applications, and would compromise the performance of any meter design.
- For lower flow ranges, wider tolerances are required; tolerance should be 10 percent; the ASME standard specifies the minimum sensed flow at 0.1-gpm
- NIST is not too concerned with the tolerance at the lower flow ranges; standard should specify some reasonable number.
- Handbook 44 tightens the tolerance of error for one meter in repeated tests to 1/5 the range allowed by the ASME and AWWA standards. This requirement in Handbook 44 is new, and not strictly enforced, in part because testing errors often exceed the tolerance allowed. If this requirement were to be strictly enforced, many meters in common use today would be forced off the market, and most testing labs would have to be upgraded.
- Plumbing systems are limited by code to 80 psi. POU manufacturers design meters for that system and do not want meters tested under conditions that are not legal, and potentially dangerous. Recent code changes are also being added to limit hot water temperature to 130 degrees Fahrenheit.
- No water meter standard specifies accuracy at very low flows. POU meters may not even rotate at 0.1 gpm under certain conditions. So how can they possible be within 10% accuracy? The AWWA standards specify no accuracy requirement between the minimum sensed flow and the minimum measurable flow. ASME requires the minimum measurable flow to be 0.25 gpm, and AWWA sets this level at 0.5 gpm.
- Issues to be considered in testing:

  (1) Drying out and slug of air (tub and shower)

(2) Twisted or kinked flex supply line

- Should be a requirement within the standard as to materials resistance and integrity.
- Performance of the meter after a period of accelerated life testing
- Repeatability of test: tolerance of 0.6 percent as shown in Handbook 44 is too tight. Repeatability test not applicable to ASME standard.
- Laboratory testing applies to more than one meter of a given model or type.
- In California, 3 of each meter model are currently tested based upon a random selection from among 30 submitted.
- All meter orientations should be specified by the manufacturer and indicated on the meter (A= all positions; H =horizontal positions, within 10 degrees; V = vertical positions, within 10 degrees; I = inclined positions, at 30 degrees, 45 degrees, 60 degrees)

Conclusions based upon committee's comments:

Several POU meter manufacturers propose that the current plumbing codes be modified for several testing parameters, including levels of accuracy. These manufacturers are not proposing to change the current accuracy standard of +/- 1.5% under ideal testing conditions. They are proposing, however, that the accuracy level be changed for low flows and for the impact of various adverse conditions such as meter orientation, temperature changes and piping configurations to +3% to –5%. Table 8.1 summarizes their position in regard to the various elements of the current ASME code for accuracy and testing parameters. The committee feels that a plumbing standard is needed for POU meter installations and should consider using AWWA M 6 manual, which covers utility meter installation. The manufacture must also specify installation criteria.

Table 8.1 Comparison of testing issues

Element	Standard	POU Meter Manufacture Stance
Meter orientation	Test for accuracy in application conditions	Same
Accuracy	Normal Flow: +/-1.5% Low flow: + 1%, -5%* Under different test conditions†: +/-1.5%	Normal Flow and ideal conditions: +/- 1.5%, Low Flow: +3%, -5% Under different test conditions: +3%, -5%
Temperature	Up to 150^{o} F	Up to 135^{o} F
Pressure	From 20 psi to 120 psi	From 20 psi to 80 psi‡

* The ASME accuracy test at low flow is conducted at 0.1 gpm for a -5% accuracy range. The AWWA accuracy test is at low flow of .25 gpm for a ½" meter for a –5% accuracy range.
† Such as meter orientation, changes in temperature, bent piping, etc.
‡ At least one manufacturer is ok with the pressure test at up to 120 psi.

Meter Labeling/Identification

Committee member comments:

- Each POU meter needs to have certain labeling information: model and serial number, name of manufacturer, date of manufacture, meter orientation (vertical, inclined, horizontal) and temperature criteria.

Conclusions based upon committee's comments:

POU meters need to have the name of the manufacturer, model and serial number, and specifications for meter orientation and temperature conditions.

CHAPTER 9 CONCLUSIONS AND RECOMMENDATIONS

The goals of the National Multiple Family Submetering and Allocation Billing Program Study were to determine the merits of separate billing programs including the potential water savings, costs and benefits from various perspectives, and the accompanying administrative and regulatory issues. In the study, a retrospective analysis of water use in multi-family properties in 13 cities was conducted. Properties equipped with submeters or that have undergone a billing system conversion were referred to as "impacted properties". These were identified and compared against the traditional in-rent properties where water and wastewater fees are included as part of the rent. The in-rent group served as the controls. The study compared the two groups using historic billing data provided by participating water utilities combined with information obtained from an extensive series of mail surveys and site visits. The data collected for the study provides a wealth of information about how submetering and allocation affect water use, property owners, and residents. Embedded in these data are insights into this developing industry, including the quantitative aspects of separate billing. The data are also useful for examining the impacts of the 1992 Energy Policy Act (EPACT) plumbing standards and other factors that may influence water use. It is anticipated that the database of submetered and allocated billing program information developed for this study will be a resource for researchers and planners to explore for years to come, particularly if it is maintained and updated.

CONCLUSIONS

Prevalence of Billing for Water and Wastewater at Multi-family Properties

RUBS, submetering, or hybrid metering was reported in 13.4% of the multi-family properties surveyed through the postcard survey. This represents the best estimate from this study of the prevalence of this practice in the multi-family sector. The postcard survey was sent to all of the multi-family properties in the participating study sites' billing databases. Nation-wide the prevalence of separate billing for water and wastewater may be somewhat less because study sites were selected to participate in this study because they where known or thought to have a high concentration of properties receiving water and wastewater bills based on data provided by billing service companies.

Estimated Water Use By Different Billing Methods

One of the central purposes of this study was to determine the water savings associated with submetered and allocation billing programs in multi-family housing. This research question was the over-arching theme for the entire project and a majority of time and effort was spent collecting and analyzing data to provide information on the potential water savings from submetering and RUBS.

Why are water savings so important? Water providers are keenly interested in identifying effective approaches to reducing water demand, as new supplies become increasingly expensive and difficult to obtain. National and state agencies are interested in improving water efficiency and promoting proven methods for achieving savings. The utility billing industry has promoted the practice of charging multi-family customers for water and wastewater services not only as a way to improve property owners' net operating income, but also as a way to effect water conservation. Water savings could provide justification for encouraging, promoting, and expanding billing programs and could unite water providers, regulators, and billing companies in a common goal. As a result there has been intense interest in this question.

Submetering

Submetering achieved statistically significant water savings of 15.3 percent (21.8 gal/day/unit) compared with traditional in-rent properties after correcting for factors such as year of construction (before 1995, 1995 or later), average number of bedrooms per unit, average rent, presence play areas, presence of cooling towers, average price charged for water and wastewater by the local utility, and classification of the property as a retirement community. Not all submetered properties used less water and the statistical model that demonstrated these savings predicted only about 25% of the variability in water use in the observed properties. Statistically significant savings from submetering was found in every single comparison and analysis conducted in this study. Water savings ranged from –5.55 to –17.5 kgal per unit per year, or –15.20 to –47.94 gallons per unit per day (gpd) which is between -10.7% to -25.7%[40].

[40] It should be noted that through the site visits, it was found that 3 out of 20 properties visited (15%) had indicated on the manager survey that they were submetered, but were found to only be metering the hot water. Thus, the submetered sample is likely to contain some hot water hybrids.

RUBS

Ratio Utility Billing Systems (RUBS) did not reduce water use by a statistically significant amount compared with traditional in-rent arrangements. The difference between water use in RUBS and in-rent properties was not statistically different from zero. While some RUBS properties used less water on average than in-rent properties, others used the same or more water on average than in-rent properties. Typically the 95 percent confidence interval for RUBS spanned a range that included an increase in expected water use as well as water savings. Statistically significant water use savings from RUBS were detected in only a single comparison test – the matched pair sample. The matched pair comparison relied on the smallest RUBS sample size in the study and, as explained in detail in the body of the report, and the in-rent control sample did not appear to be representative of the population of in-rent properties in the study. After correcting for a wide variety of factors and evaluating numerous different analytic models, the researchers concluded that no statistically significant impact from RUBS could be reliably expected.

Hot Water Hybrid

Hot water hybrid billing systems may achieve water savings, however in this study the sample of hot water hybrid properties was too small to produce reliable results that can be generalized to the broader population. Analysis of data from the limited sample of hot water hybrid properties does suggest that water savings, somewhat smaller than the magnitude found in submetering, *may* be achieved through this billing methodology. This study was unable to verify this finding of savings in a reliable, statistically rigorous manner because of the small sample size. It should be noted that during the site visits it was discovered that 15% of the hot water hybrid properties had been mislabeled by the managers as submetered. This indicates that HWHs may be more common that originally thought, and is suggestive that they may have comparable savings to submetering. However, further research is needed to verify this.

COSTS AND BENEFITS

Beyond quantifying the water savings that can be measured by implementing a multi-family water and wastewater billing program, there are many issues that arise concerning these systems for utilities, for property owners, and for residents. As is true with any developing field, there are clear benefits to these systems as well as some costs and issues that need to be addressed.

Utility Perspective

Supporting the installation of submeters represents an opportunity for water utilities to capture cost-effective water savings. Savings can be captured in new construction by either requiring the individual metering of multi-family units or by offering incentives in both existing and new multi-family dwellings. Because RUBS has not been found to render reliable savings, it is not cost-effective for utilities to offer incentives promoting RUBS programs. However, since the findings of this report indicate that the savings from fixture upgrades are more substantial than from submetering, utilities should consider offering cost-effective incentives for change-outs for all multi-family properties.

Assuming an annual savings of 7.96 kgal per dwelling unit (du) (21.8 gallons/du/day) from submetering, a utility avoided cost of $500/AF would translate into a present value savings of $152 for each dwelling unit that is submetered, assuming a 20 year useful life. The present value of benefits to the utility could be considered a justifiable subsidy that the utility could offer for submetering or other conservation efforts. Obviously, agency avoided cost and assumptions about product life impact the value of submetering for each utility.

Owner Perspective

In most cases, separate billing for water and wastewater will increase the owner's net operating income and property value. Despite the initial capital investment, submetering remains a cost-effective option for owners. In addition, submetering technology has improved so that the cost for submetering new construction and submetering existing properties is reasonable. In the case of allocation, there is no initial investment and the payback is immediate. Owners could use this increase in income to improve overall water efficiency on the property, including fixture upgrades. Nevertheless, before converting to a separate billing system, owners should be aware of the applicable federal, state, and local regulations.

Resident Perspective

Based on the results obtained in the resident survey, consumers have varied opinions on water billing programs. Often these programs result in a water bill in addition to a monthly rent charge. While consumers receive electric or gas bills, many have come to expect that water charges are included in the rent. As currently practiced, water and wastewater billing programs do not appear to be an appealing option for residents of multi-family dwellings. Also, residents are typically charged a service fee (in conformance with applicable state and local law) in addition to their volumetric or allocated charge. Thus, in the short term, these billing programs cause an increase in monthly costs for residents. While there may be environmental benefits such as increased water conservation, there are many uncertainties involving separate billing that could be perceived as negative. Until separate billing for water and wastewater has some definitive standards and protections for residents, it is unlikely that most residents will embrace it. Direct metering and billing of water for apartment residents encourages water efficiency and promotes a water billing system that is as transparent as other utilities like gas and electricity, phone and cable whereby residents pay for what they use.

If a property owner were to reduce the rent in the approximate amount of the total water and wastewater bill (including the service fee), then the resident might experience no net increase in rental costs if all else is held constant. As noted above, this does not appear to be a common practice. If the property owner were to pay the service fee as recommended (see Recommendation 8, subsection 9), then the overall cost impact to the resident might be reduced. However as practiced today, it appears that water and wastewater billing programs result in increased costs for residents.

ANALYSIS OF PRICE ELASTICITY

Economic goods have a downward sloping demand curve. This means that the higher the price of the good, the less of it that is purchased. Within this broad statement, specific goods respond very differently to price. Some goods respond very little to price change, and others respond a lot. Economists have developed the concept of “price elasticity of demand” to characterize these differences. Price elasticity of demand is defined for each point on the demand curve as: The percentage change in consumption per percentage change in price. Since elasticity is a percent divided by a percent, it is a unitless number.

The elasticity analysis examined the price elasticity of water use based on utility water and wastewater rates. To simplify the analysis, the average non-seasonal (indoor) water use per unit per year in kgal (using 2001 and 2002 billing data) was calculated for each participating study site. These values were then plotted against the combined utility water and wastewater rate in \$/kgal. The cost for water and wastewater ranged substantially from \$2.83/kgal to \$10.11/kgal, providing a useful data set for analysis. To improve the model fit, the data point from Indianapolis was removed from the elasticity model. Indianapolis was the only study site to feature a declining block rate structure (i.e. the more water used, the cheaper the price). All other utilities had either flat rate or increasing block rate structures designed to send an increasing price signal as demand increases.

Two regression equations and curves were fit to these data to determine the price elasticity of demand – a straight line and a power curve. The fit of both models was quite good and the range of elasticities calculated fits well with previous research in this area. The straight line model had the highest coefficient of determination (r^2) value of 0.6437. Elasticities calculated through the straight line model ranged from -0.12 at \$2.83/kgal to –0.65 at \$10.11/kgal with an average of –0.29 and a median of –0.20. The constant elasticity power curve model had a coefficient of determination value of 0.5477. The elasticity calculated through this power model was –0.275. The research team concluded that if a single elasticity value were to be selected, the preponderance of the results from this analysis point to an elasticity of –0.27. However, the linear model result clearly shows that elasticity varies with price and this should be taken into account when applying these values to planning and rate models.

IMPLICATIONS FOR PUBLIC POLICY

The findings of this report carry broad implications for policy-makers at the local, state, and federal level. In this section, data from the report will be placed in the context of key issues facing the nation's urban water and wastewater managers. Following a discussion of key findings, recommendations are made for appropriate public policies toward separate billing systems.

Separate Billing Systems: Rapid Adoption Without Public Incentives

Billing systems for water and wastewater service - most notably submetering and RUBS systems - are expanding rapidly in the multi-family housing market. Although surveys undertaken for this report found no current examples of public sector incentives for either submetering or RUBS, and few effective public mandates to submeter, the number of units covered by separate billing systems are reported to have grown by 25% per year during the last four years. This study's postcard survey of multi-family properties in 13 cities found that 13.4% of the responding properties were billing for water by submetering, RUBS, or hybrid methods (see Table 4.3). Based on the postcard survey, traditional in-rent billing for water and wastewater service prevails in about 84.8% of surveyed multi-family units, and that share is dropping. Confirming the trend, the survey of multi-family property managers in the same 13 cities shows evidence that the pace of conversion of existing mulit-family dwellings from in-rent to separate billing systems accelerated significantly during the years from 1995 through 1999, and that the pace of conversion activity has remained substantial since that time. Such conversions, coupled with newly constructed units that are operated with water and wastewater billing systems from the start, have made billing services a growth industry.

The business case for property owners' growing interest in separate billing systems is indeed compelling. First, water and wastewater costs have begun to rise more rapidly than either core inflation rates or average rent increases, a trend expected to continue for the foreseeable future. Contributing to the national average, of course, are local water and wastewater rate increases that are markedly, and in some cases, acutely, higher than average increases, such as Washington, DC (42% in 1997), Seattle (24% in 2001), and Buffalo (23% in 2004). Thus, shifting payment for water and wastewater charges from owners to residents insulates property owners from a rapidly rising set of costs.

Secondly, a by-product of this shift in payment for water and wastewater service, from the owners' point of view, is the increased net revenue per unit, and its effect on the capitalized value of the units converted to separate billing methods. There is little published evidence that rents have decreased as water and wastewater charges have been shifted to residents. Rents are determined by broad market forces. A $25 monthly water bill amounts to less than 3% of a typical $900 rent payment. What is recognizable, however, is that an increase in net revenue per unit (as a result of redirecting water and wastewater costs to residents) directly influences the capitalized value of the unit, at a ratio of about 10 or 12 to 1 (AWWA WCD 2001). Thus, if separate billing systems increase a property owner's net revenue by $25 per unit per month, the annual net revenue increase of $300 per year will increase the value of the unit by $3,000 to $3,600. Even if the property owner has no immediate plans to sell, the increased value immediately strengthens the owner's balance sheet and increases the amount that might be borrowed against the property for improvements or acquisitions elsewhere.

Even without public incentives to spur submetering and without regard to the effects of separate billing on water consumption, elimination of in-rent payment for water and wastewater charges has a strong appeal to property owners. As a result, the trend in conversion to separate billing is likely to continue.

Water Savings Attributable to Submetering are Nationally Significant

One of the key findings of this report is that water savings attributable to submetering and volumetric billing may reach 15% or more. This finding carries important implications for the nation's drinking water and wastewater utilities. Concern for water efficiency is not confined to utilities facing water shortages or periodic droughts. Nationwide, drinking water and wastewater utilities are expected to face capital requirements of some $274 billion and $388 billion, respectively, through 2019 (US EPA 2002). According to the US EPA, the gap between necessary investments and current levels of revenue may reach $102 billion and $122 billion respectively (US EPA 2002). While not all water and wastewater investments are sensitive to the volume and timing of projected water and wastewater flows, the majority are.[41] The EPA has recognized that reductions in water demand can lead to the deferral or downsizing of water and wastewater capital projects (EPA FY 2005 Budget). Thus, reductions in water consumption by multi-family dwelling residents, if significant, could offer multi-billion dollar cost savings to water and wastewater utilities over time.

The relative significance of water savings in the multi-family housing sector compared with other sectors will vary from utility to utility, depending upon the local housing stock and the types of commercial and industrial activity. At the state and national level, however, these local differences will average out, and the collective savings will be considerable. Nationwide, some 15% of all occupied housing units are configured in multi-family structures of 5 or more units, which are not typically individually metered. The trend in new construction is towards more individual metering. Another 8% of all occupied housing units are contained in structures made

[41]For drinking water utilities, capital improvements pertaining to transmission, treatment, storage, and source waters are positively related to water demand, either average demand, peak demand, or both. For wastewater utilities, expenditures for secondary treatment, advanced treatment, interceptor wastewaters, and combined wastewater overflow are positively related to the volume of wastewater flows. These relationships are not linear, but reduced demands will tend to reduce the capital costs of these types of works.

up of 2 to 4 units. The degree to which the units in these smaller buildings - overwhelmingly (84%) rental units - are individually metered or served by a single master meter per structure will again vary considerably by local practice, but undoubtedly a portion of these residents are billed for water through the traditional in-rent method (US Census Bureau 2003).

In recent years, the nation has been adding multi-family housing at an annual rate of about 270,000 units in structures of 5 or more units and another 35,000 units in structures of 2 to 4 units. Taken together, these units comprised about 20% of all housing starts from 1995 through 2002, a still significant share of all new housing (US Census Bureau 2003).

The relative significance of multi-family water savings for the financing of water and wastewater infrastructure becomes even clearer when considering the locational association of multi-family housing with public utilities. While some 16% of the population is not served by a public water system (USGS 2004), nearly all of this self-served population is housed in single-family homes and mobile homes. Conversely, nearly all multi-family housing is served by public water systems. Thus, the relative share of the total housing stock served by public water systems that consists of multi-family housing is in the range of 28%. Similarly, with some 25% of all households not served by a public wastewater system (US EPA 2002), multi-family housing's share of the housing stock served by public wastewater systems is likely to be about 32%.

To gain further perspective on the significance of savings of 15% in the multi-family sector to public water systems, note that public water systems were estimated to withdraw a total of 40,200 million gallons per day (mgd) in 1995, of which 22,700 mgd were for delivery for all "domestic" uses (USGS 1998). For 2000, total withdrawals were estimated to reach 43,300 mgd, an increase of 7.7% (USGS 2004). For the properties surveyed in this report, the 15% savings attributable to submetering and volumetric billing equates to about 21.9 gallons per unit per day. As an upper bound estimate, if all occupied multi-family units throughout the country were to achieve the water use savings documented in this report (15.3%), the total savings would reach nearly 541 mgd, or 1.2% of the total water withdrawals of public water systems across the United States, and about 2.2% of all deliveries for domestic purposes. As efficiency measures go, these savings are significant, and will have multibillion-dollar implications for infrastructure costs over the next twenty years. *Such savings argue strongly for the inclusion of submetering* *among the nation's key strategies for improving water use efficiency and containing water and wastewater infrastructure costs.*

RUBS Not Found to Yield Water Savings

Another key finding of this report - the lack of demonstrable and statistically significant savings attributable to RUBS allocation systems - argues that this billing practice need not be encouraged or incentivized for supposed water saving benefits. Indeed, in the absence of demonstrable savings, the downside of RUBS allocation systems requires careful consideration. That RUBS billing practices have been adopted in nearly 10% of multi-family housing units to date is evidence that property owners and managers find it advantageous to shift the cost of water and wastewater service to building residents without assistance or incentive from public agencies.

Efficient Plumbing Yields Savings Under All Billing Formats

This study has also found that the date a multi-family structure was built was a significant factor influencing water use in this 13-city sample of multi-family properties. Specifically, those properties built in 1995 or later were found to use 11 kgal per unit per year less water than properties built in 1994 or prior years. These savings are present in properties, regardless of billing type.

It should be noted that 1994 was the effective date for the manufacture of water-efficient plumbing products meeting the standards contained in the Energy Policy Act of 1992 (EPACT). Since previously manufactured products were allowed to be sold from inventory, 1995 is a useful date for assuming fully compliant plumbing fixtures and fittings in new residential construction. At least 10 states had earlier effective dates for state efficiency standards (NWF 1992), and this factor, together with normal replacements for breakage and remodeling, provides the older age class of buildings with some small fraction of water efficient plumbing. Thus the 11 kgal/unit/year reduction experienced by the post-EPACT class of properties is all the more noteworthy. And while other factors may contribute to reduced water consumption in newer units, such as less degradation of performance in newer products, other studies have affirmed the substantial water savings to be realized by water-efficient plumbing (Mayer et. al. 1999, DeOreo et. al. 2000, 2003, 2004).

These findings strongly suggest that the potential water savings resulting from the installation of water efficient plumbing are as large or larger than the water savings attributable to submetering. For all the reasons cited above regarding water and wastewater infrastructure costs, the expeditious conversion of pre-1995 buildings to EPACT-compliant plumbing fixtures and fittings should be an important policy objective.

Separate Billing Shifts Incentives for Water Efficiency

Water conservation professionals recognize that the relative efficiency of water use across similar end-use categories is influenced by two over-arching factors: behavior[42] and hardware (Water Resources Engineering 2002a). In an owner-occupied single-family home the homeowner is responsible for both the behavior of water users and the hardware with which water is used. In response to a rising price signal, this sole decision-maker may choose to modify behavior in the short term, or to upgrade hardware over time, or some combination of the two.

In the multi-family rental setting, residents are responsible for in-unit water use habits and behaviors, while decisions regarding hardware repairs and upgrades are the sole purview of the property owner. Under the traditional in-rent billing format for multi-family water and wastewater charges, the property owner is financially exposed to the water consumption behaviors of residents, but exercises complete choice over the water-using fixtures and appliances that are integral to each rental unit. Price-sensitive building owners may seek to offset rising water and wastewater costs with investments in more efficient hardware and more timely repairs of reported leaks.

When multi-family property owners opt for billing systems for water and wastewater charges, a shift in financial exposure takes place. Residents are now financially responsible for their own water-use behaviors and habits. They are individually responsible in a submetered property, and collectively responsible in a property employing RUBS. Residents may modify those behaviors in response to price signals, and this report has documented the savings of submetered residents, while finding little reliable indication that residents take significant action under a RUBS system. But under either billing system, property owners remain responsible for

[42]Water-use behaviors include not only judgments about how much water to use for routine tasks such as showers, brushing teeth, watering house plants, etc., but also attention to and prompt reporting (to property management) of water leaks in faucets and toilets. Taking action to initiate the maintenance process is clearly an important behavior affecting water consumption.

all repair and replacement decisions regarding fixtures and appliances, even as they are shielded from the price effects of in-unit water consumption. In fact the only cost increases related to in-unit water consumption to which property owners would remain exposed would be the energy cost embedded in hot water in properties where water heating costs are not separately billed to residents. Rising energy prices might encourage a property owner to replace inefficient showerheads with more efficient types, but would offer no incentive for the replacement of in-unit toilets, the largest source of indoor residential water consumption.

The effect of separate billing systems is thus to inject a new degree of price-insensitivity into multi-family residential water use. Water savings resulting from plumbing fixture upgrades - savings that are as large or larger than savings attributable to submetering - may be deferred indefinitely by property owners who will realize no financial benefit from the accelerated replacement of inefficient fixtures. This de-linking of the investment in plumbing upgrades with the financial benefits of reduced consumption is likely to reduce the rate of replacement of plumbing fixtures in pre-1995 multi-family structures, which already lag behind replacement rates for single-family homes (MWDSC and MWDOC 2002).[43] State and local policies regarding separate billing systems should take this phenomenon into account.

Best Management Practices for Billing of Water and Wastewater Service

Results from this study, particularly the resident survey component, revealed that many residents in properties with separate utility billing are unsure of how they are being billed for water service. Bills that lack of clarity create confusion and do not send an effective price signal. A substantial number of residents also expressed dissatisfaction with they way they were billed for water and wastewater service. This dissatisfaction has come to the attention of regulators and officials in some jurisdictions (suburban Baltimore, Maryland, Miami-Dade County, Florida, and Texas for example) and has manifested itself in policies where RUBS and in some cases submetering have been discouraged or even prohibited. The practice of discouraging or prohibiting RUBS and possibly submetering may continue unless more decisive action to protect consumers is taken by the billing industry to ensure consumer protection.

[43]A study in the East Bay MUD service area found total ULFT saturation in 2001 to be slightly higher in multi-family units (37%) vs. single-family units (34%), but the survey universe was not confined to the pre-1995 housing stock (Water Resources Engineering 2002b). Lower levels of free-ridership were dectected for multi-family compared with the single-family sector in utility-supported toilet replacement programs (Whitcomb 2002). This is an indication of a lower rate of "natural," i.e., un-incentivized, toilet replacement in multifamily housing.

The National Submetering and Utility Allocation Association (NSUAA) has taken the positive step of developing a set of self-governing “Best Practices Guidelines for Recovering Water and Wastewater Costs in Apartment Properties.” Best practices, or best management practices (BMPs) as they are commonly called, are often issued by trade and professional organizations to establish a code of conduct and to foster self-governance. Best management practices are a reasonable start for dialogue with policy makers and can be used to protect the interests of multi-family dwelling owners, residents, and the public water utilities that serve them.

Consumer Disputes and Appropriate Recourse

Any system of billing consumers can become a venue for disputes. In the survey of multi-family property managers, nearly half of the properties that had converted to separate billing systems reported that there were complaints from residents when the new system was put in place. Indeed, resistance from residents was the lead difficulty encountered by properties that converted to separate billing. About equal numbers of the complaints about conversion asserted that the bills were "too expensive" and that the billing was "unfair".

Of the surveyed residents who said they were dissatisfied with the way they were billed for water, the leading cause was "accuracy of reported consumption" (46%), followed by the "rates" themselves (40%). For dissatisfied RUBS residents, accuracy was a cause of complaint for 55% while rates were of concern to 35%. For dissatisfied submetered residents, 34% were concerned about accuracy, 44% were concerned about rates, and 54% were concerned about service charges on their bill. Relatively few in-rent residents reported being dissatisfied with their billing at all.

One notable finding of the manager survey was the relatively high rate of non-payment of water and wastewater bills by residents. While 50% of the properties reported non-payment rates of 1% or less, some 26% of properties with submetering or RUBS reported non-payment rates of 10% or more. This compares with non-payment rates in the less than 1% to 2% range typically experienced by water utilities themselves. With this level of dysfunction evident in the billing environment, appropriate forms of recourse will be essential to protect the interests of owners and residents alike.

These findings underscore the observation that separate billing for multi-family water and wastewater charges is fundamentally a property owner-resident issue. A degree of consumer protection is provided by existing landlord-tenant law, and where each state and locality chooses to place itself on the spectrum between property owner rights and resident protections is a function of the give and take of the legislative process in each jurisdiction. Water and wastewater billing systems, frequently involving third-party billing service contractors, present distinctive property owner-resident issues that should be accounted for in state and local landlord-tenant law.

RECOMMENDATIONS

Guiding Principles for Submetering and RUBS Billing Programs

In light of the key findings and issues identified in this report, six principles are offered here to guide the development of policies to address separate billing systems for multi-family water and wastewater charges.

1. Submetering is a practice that offers documented water savings. As such, submetering should be fostered by public policies seeking to encourage water savings, together with appropriate measures to protect the consumer.

2. RUBS is a practice lacking statistically reliable water savings, while offering both similar and distinctive drawbacks compared with submetering. As such, RUBS implementation should be carefully bounded by public policy.

3. Any water and wastewater billing system – whether submetering, RUBS, or various hybrid systems – will reduce a multi-family property owner's incentive to invest in in-unit plumbing efficiency upgrades in pre-1995 structures. The initiation of any separate billing system in pre-1995 dwellings should be coupled with complete plumbing fixture upgrades within a specified time period.

4. The potential drinking water quality issues that may arise within the water systems of multi-family properties – such as backflow, cross-connection, metal uptake, and deterioration of buried distribution lines – should be approached with solutions that address all properties with comparable vulnerabilities, rather than narrowly focusing on properties that implement a water and wastewater billing program.

5. Best Management Practices for the billing of water and wastewater in multi-family housing should be implemented by the appropriate regulatory agency to ensure consumer

protection for property owners and residents and to promote adoption of multi-family submetering.

6. Submetering equipment manufacturers, professional installers, third-party billing services, and owners should be held to reasonable standards of accuracy, reliability, and professional competence and conduct.

Public Policy and Business Practices

A transformation is taking place in the responsibility for water and wastewater service in multi-family properties across the United States. Consistent with the guiding principles outlined above, the researchers offer the following recommendations to increase the likelihood that this transformation advances the public interest while fairly rewarding private investment and initiative.

Policies for Water and Wastewater Utilities

Water and wastewater utilities should implement the following measures to encourage submetering and to secure the benefits of improved efficiency for their systems.

Recommendation 1 – Require notice. Utilities should require multi-family property owners that seek to implement or convert to any billing system, or which have converted in the past, to notify the utility and/or agency. The utilities should keep permanent records of the properties using any water and/or wastewater billing system. As this report demonstrates, the water savings resulting from submetering can be substantial, and the water savings resulting from plumbing upgrades can be even more substantial. But the value for utilities is greatest if these savings can be recognized, plotted into trends, and incorporated into capital facility planning. If a utility does not know what fraction of its multi-family housing has already converted to separate water and/or wastewater billing methods, it will be hard-pressed to estimate the additional savings potential that remains from additional conversion. The status of separate billing and associated plumbing conversion (as recommended above) should be kept as current as possible.

Recommendation 2 – Apply volumetric billing to all multi-family properties. Ensure that volumetric billing is applicable to all multi-family properties for both water and wastewater charges. Although the prevalence of flat or fixed rate structures (where no portion of the charge varies with volume of use) for multi-family structures is unknown, it persists for single-family residences in many communities[44] and may be broadly applicable at least to duplexes, 3-family, and 4-family dwellings in such locations. If multi-family resident billing is to be effective in sending a price signal to consumers in multi-family housing, then a responsive price signal has to be sent by the utility in the first place. Where outdoor use and attendant seasonal variation is large, many communities offer seasonal adjustment factors for wastewater service billed from the water meter and/or exemptions from wastewater charges for submetered outdoor use. Submetering of irrigated landscapes offers an additional opportunity to manage outdoor water use efficiently, and should be encouraged in its own right for large parcels, such as multi-family dwelling complexes.

Recommendation 3 – Promote submetering and fixture retrofit. Encourage submetering through judicious targeting of utility water conservation incentives to multi-family submetering conversions. Utilities with active water conservation programs should consider steps to encourage full and partial capture submetering as well as plumbing fixture replacement in pre-1995 buildings. Since submetering offers substantially more savings than RUBS, utilities should consider directing some or all of their plumbing retrofit incentives in the multi-family sector to properties that choose submetering. Tiered incentives to provide additional benefits for properties electing to submeter is another approach. Fixture retrofit should also be promoted in properties that have already undergone billing conversion. While the design and absolute levels of incentive programs are highly site-specific, utilities should look to their incentive programs as an important tool for tipping the balance toward submetering.

Recommendation 4 – Explore direct billing of multi-family residents in new construction. In the interest of encouraging water efficiency gains, utilities should be open to expanding their role beyond traditional master metering of multi-family properties, particularly in new construction. As automated meter reading technology becomes more widely adopted by utilities themselves, the need for direct access by utility personnel to water meters serving multi-family dwellings becomes far less frequent. New construction allows flexibility for the placement of meters in locations designed to be accessible from, or in close proximity to, public space. Duplexes, 3-family, and 4-family units may be easily plumbed for meters from public

---

[44]In a survey of 420 California cities and districts in 2000, 86% of those surveyed maintained flat (non-volumetric) charges for wastewater service. Surveys in other states by the same firm found non-volumetric charges at 66% of surveyed utilities in Washington, 46% in Oregon, and 32% in Arizona (Black & Veatch 2000).

space. These and other opportunities will present themselves to utilities willing to take the initiative to improve water efficiency and customer service. It should be noted that some utilities may not be interested or willing to venture into multi-family billing that would add a large number of new customers with a high turnover rate.

Policies for State and Local Governments

State law should clearly establish the legal framework for all forms of multi-family billing systems. In lieu of a patchwork of state agency administrative actions, enactment of statutory language that specifically addresses multi-family billing for water and wastewater service is preferable, and would help ensure consistent policy across all agencies and localities. Similarly, state legislation is preferable to a local ordinance, but local action may well be necessary if state legislation is not forthcoming.

Recommendation 5 – Metering for all new multi-family construction[45]

a. **Low-rise multi-family construction:** All new multi-family structures of one to three stories should provide for the measurement of *all* of the water use in each unit. This may be accomplished either through the installation of total-capture submeters for each unit, the installation of utility service meters for each unit, *or* the installation of multiple submeters affixed at every point of use in each unit. Upon occupancy, water and wastewater charges are to be billed to residents based only upon their water usage recorded by these individual measurement devices.

b. **High-rise multi-family construction:** All new multi-family structures of more than three stories constructed after a date which is four years after the effective date of the low-rise requirement above, should provide for the measurement of the water use in each unit. This may be accomplished either through the installation of total-capture submeters for each unit, multiple submeters affixed at points of use throughout each unit, or metered hot (or cold) water use as the basis for allocating all in-unit water use. The allowance of four additional years should be sufficient to resolve any remaining technical issues posed by high-rise plumbing configurations and meter placement. Upon occupancy, water and wastewater charges are to be billed to residents based only upon their water usage recorded by these individual measurement devices, or through an approved hot/cold water hybrid allocation system.

[45] Subsidized and low income housing developments will likely need to be exempted from this regulation because of various national, state, and local regulations governing the maximum allowable charges for rent and utilities.

<u>Recommendation 6 – Efficient plumbing fixtures required when implementing a billing program</u>. Owners may institute a billing system or continue an already existing billing system for water and wastewater charges *provided* that prior to the institution of any separate billing program or for an existing program within 12 months of official notification, owners comply with the applicable provision (a or b) below:

a. **Older Properties:** Owners of multi-family structures constructed *before* January 1, 1995 (or one year after the effective date of a state or local statute setting a 1.6 gpf standard for all new toilets, if earlier), must perform a water audit in each unit to ensure, any leaks identified have been repaired, and each toilet, showerhead, and faucet aerator is either newly manufactured and installed within the previous 12 months, or operating at no more than 125% of the flush volume or flow rate, respectively, contained in the Energy Policy Act of 1992.

b. **Newer Properties:** Owners of multi-family structures constructed *after* January 1, 1995 (or one year after the effective date of a state or local statute setting a 1.6 gpf standard for all new toilets, if earlier) must perform a water audit in each unit to ensure, any leaks identified have been repaired, and each toilet, showerhead, and faucet is operating at no more than 125% of the flush volume or flow rate, respectively, contained in the Energy Policy Act of 1992.

<u>Recommendation 7 – Once submeters are installed a RUBS system cannot be used</u>. Formula allocation systems (RUBS) may not be used in buildings where total-capture meters or partial-capture hybrid systems for individual units have been installed even if the submetering billing program has been abandoned. To preserve the potential for water savings and maintain the relative benefit to consumers to more equitably distribute costs, abandonment of submetered systems should be discouraged. Limited allocation and estimated billing may be permitted in submetered properties on a temporary basis when specific meters cannot be read or are being serviced or replaced.

<u>Recommendation 8 – Consumer protection.</u> State or local landlord-tenant law or similar legal framework should address the special concerns arising from multi-family water and wastewater billing systems. The section below contains recommended practices for property owners, billing service companies, and water utilities to ensure that consumers are treated fairly. Any number of these practices could be fashioned into a statutory requirements. The degree to which some or all of these provisions are written into law will be based upon the experience of each jurisdiction.

Best Management Practices for Billing of Water and Wastewater Service in Multi-Family Housing[46]

The researchers believe a comprehensive set of best practices in the form of regulated industry standards, would benefit all parties involved, including residents, property owners, water providers, regulators, and the billing service providers themselves. The best management practices (BMPs) should be implemented by the appropriate regulatory oversight agencies. BMP standards could greatly improve resident understanding and satisfaction with third party billing, and reduce customer complaints to regulators.

Based on the research results, the following standards for best management practices for water and wastewater billing practices are recommended. BMPs for the billing service industry and for property owners are essentially the same and apply equally. In many cases, property owners and managers handle their own billing for water and are in fact the billing entity. Regardless of who produces the bill, either the owner/manager or a third party billing service company, it is incumbent upon the owner/manager to ensure the proper implementation of these best management practices. The owner maintains the underlying responsibility for the way the billing program is implemented and managed.

Resident rights related to water billing are closely tied to the BMPs for the water billing industry and provide a set of reasonable expectations for residents receiving water and wastewater bills from largely unregulated billing entities.

These best practices are intended to apply generally to *both* submetering and RUBS billing unless specifically noted.

1) Billing entity. Where permitted by law, water and wastewater utility bills may be issued by a property owner or qualified billing agent. Billing agents shall have appropriate insurance coverage.

2) Water cannot be dedicated to public use. Water and wastewater service will only be provided to residents of the property. Non-residents and the general public will not be served. (In many states, this ensures that the property owner is not deemed to be a public utility).

3) Common area and vacant units. The property owner shall pay for water and wastewater service used in common areas, administrative offices, vacant dwelling units, and other portions of the property not designated as dwelling units. Residents are only

[46]These best practices were adopted from and expand upon the guidelines published by the NSUAA

financially responsible for their own water and wastewater service costs. In RUBS properties, common areas should be separately metered. If not possible, a reasonable estimate of common area usage can be made that is based on the property’s specific common area amenities.

4) Water audit and leak repair. Before instituting any separate billing system, the property owner/manager shall conduct a water audit of all units and common areas, testing for leaks, including toilet tank flapper valve leaks, and repair all leaks identified. Upon institution of the separate billing system, the property owner/manager shall commit to a reasonable standard of leak repair in all units, and shall maintain sufficient supplies of materials as may be necessary to ensure that common types of leaks (such as toilet flappers) are promptly repaired. When properly reported, non-emergency leakage at any plumbing fixture or fitting should be repaired within 5 business days. The process for reporting leaks and the owner/manager's commitment to leak repair shall be clearly stated in each resident's bill, and shall also be disclosed as part of the lease agreement.

5) Pass through of water and wastewater costs. Both the commodity and fixed service charges for water and wastewater shall be equivalent to the commodity charges contained in the property owner's bill from the local water and wastewater utility.[47] Neither the billing entity nor the owner/manager shall inflate the costs of these charges. Utility commodity charges and the billing entity charges shall be clearly stated on every bill provided to residents and such rates and charges shall also be disclosed as part of the rental agreement.

6) Submetering and RUBS methods and notification. Water and wastewater bills to residents shall be calculated on the basis of fair and reasonable methods of cost allocation, including submeter readings or allocation formulas. The measurement or allocation method and/or formula is considered a matter of public record and shall be clearly stated on every bill provided to residents. The water and wastewater billing arrangement shall be fully disclosed to the resident in the rental agreement. When a new billing program is started, owners shall provide residents with at least 60 days notice prior to implementation. Billing can only begin after lease signing/renewal.

7) Billing practices. Water and wastewater bills shall be sent promptly after meter readings are made or after the master-meter bill from the utility is received. This is essential to ensure that the price signal is received in reasonably close proximity to the time of consumption. A reasonable amount of time (minimum of 10 business days) shall be allotted between the residents' receipt of a bill and the date payment is due.

8) Records retention and inspection. The property's master water and wastewater utility bills shall be retained for a period of not less than 24 months, and shall be available for inspection by any resident at reasonable hours and without charge. However, a nominal fee can be charged for any requests to copy bills.

[47] In most cases, these charges will be based on the local utilities' rate schedules for multifamily housing, often priced by the size of the service connection to the master meter. In the case of duplex, 3-family, and 4-family units, the smaller service connections to these structures may result in their being charged at the same rate as single-family residences.

9) **Fees.** The billing entity may charge reasonable fees. Fees are divided into two categories: (a) ***recurring service fees***; and (b) ***other fees***. ***Recurring service fees*** (also called monthly fees, administrative fees, or meter fees) shall be charged to the property owner/property manager, not to the residents. Where not subject to regulation, the owner is in the best position to negotiate favorable service fee charges with the billing company and responsibility for recurring service fees gives the owner an interest in negotiating the best fee. Property owners should pay the meter service fee since it is part of the infrastructure of the building and as such would be like repair and maintenance of any building supplied fixture or appliance. ***Other fees*** (new account fees, late fees, returned check fees, and other reasonable fees that relate to a specific resident account) shall be paid by the residents.

10) **Complaints and disputes.** A fair method for promptly resolving complaints and billing disputes shall be established by the billing entity that should have parity to the process that exists for the property owner contesting a bill to the local water utility. The billing entity shall be available during normal business hours via a toll free number, printed on every bill, to handle billing questions and complaints.

11) **No shutoff of service.** As stated by law, water and wastewater service cannot be shutoff to residents by the owner or his agents. The rental agreement can provide for a utility deposit or other legal remedy through which unpaid utility bills can be collected.

12) **Information to be included in regular bills.** The bill is the fundamental communication between the billing entity and the resident. As such, bills must be clear, comprehensible, and comprehensive. Billing entity water and wastewater bills shall include:

(a) Clear statement of the current water and wastewater commodity charges and fees as well as any overdue or pending amounts;

(b) Billing period covered by the bill;

(c) Date payment is due;

(d) Date after which payment is overdue;

(e) Explanation of the billing method (Submetering, RUBS, hybrid);

(f) Explanation of how charges are determined for current billing period. For ***submetering*** this will simply be a beginning and ending meter read, the volume consumed, and the commodity rate per unit volume. For ***hybrid metering*** this will be a beginning and ending meter read, the (hot or cold water) volume consumed, the calculation for allocating the remaining water volume, and the commodity rate per unit volume. For ***RUBS*** this should include the total volume of water used at the property (as measured by the utility at the master meter(s)), the deductions for common area, the percent of remaining amount allocated to the individual unit, the volume allocated to the unit, and the commodity rate per unit volume.

(g) Utility commodity charges and the billing entity commodity charges (to assure equivalence);

(h) Information for reporting leaks;

(i) Toll free or local telephone number for customer complaints and billing disputes, and a brief description of the dispute resolution process.

Policies for the US Environmental Protection Agency

Recommendation 9 – Property owners should not be subject to the full suite of National Primary Drinking Water Regulations. Property owners should not be subject to the full suite of National Primary Drinking Water Regulations, with attendant registration and monitoring requirements, solely by virtue of their action to adopt a billing system for water and wastewater service, whether submetering or RUBS. The implementation of either billing system is unlikely to change the quality of water provided to customers on the property.

During the course of this study, EPA's interpretation of the requirements of the Safe Drinking Water Act have undergone substantial change on this issue, and the Assistant Administrator's memorandum to Regional Administrators dated December 16, 2003, goes a long way toward adopting this recommendation. The new guidance was drawn to focus on submetering, due to the potential of submetering to support full-cost pricing and the lack of documented water savings attributable to RUBS. EPA should, however, recognize that the value added to a property owner's balance sheet by instituting a billing system – either RUBS or submetering – creates an opportunity to fund the conversion of long-lasting but inefficient plumbing fixtures and fittings to EPACT compliant plumbing. Plumbing conversion will achieve immediate and significant water use reductions in properties of either billing type.

Recommendation 10 – EPA should promote water efficiency in multi-family housing. As part of its "Sustainable Infrastructure Program," the EPA Office of Water should devise a road map for the research, demonstration, and deployment of emerging technologies and practices that can make significant breakthroughs in multi-family water use efficiency. Property owners and their trade associations, water and wastewater utilities, state and local governments, tenant associations, landscape contractors, building contractors, and environmental advocates are all potential stakeholders and partners in such an effort. EPA should help accelerate the transformation of water and wastewater billing practices in multi-family housing through targeted research, technical assistance, model ordinances, voluntary bench-marking, and public recognition. But while this report advances our understanding of the benefits of submetering, the report has also found several other variables that significantly effect the water consumption of multi-family housing. The transfer of utility bill payment to residents is an important foundation upon which to build additional gains in water use efficiency.

Policies for Point of Use Meters

Recommendation 11 – Explore Policies for POU Standards. The current plumbing codes do not adequately address POU meters on a number of issues. Industry consensus standards are needed for application condition accuracy, installation protocols, product labeling, and maintenance. The International Association of Plumbing and Mechanical Officials (IAPMO), the National Institute of Standards and Technology (NIST), and to the American Society for Mechanical Engineers (ASME) must evaluate the recommended changes in the plumbing standards.

Based upon the conclusions drawn from the ad hoc committee discussions the following recommendations are offered as standards for POU meters:

Labeling and Identification: Meters shall have the name of the manufacturer, model and serial number, approved orientation positions, and approved temperature ranges.

Manufacturer: Shall specify installation criteria.

Maintenance: Maintenance requirements for POU meters should be consistent with larger utility meters.

Low Battery Voltage: Data transmission needs to be deterministic in that either the data is transmitted accurately or not at all.

Visible Meter Reads: The meter shall have an encoded non-volatile memory. Metered customers shall have ready access to current reading values.

Accuracy: Changes to the current accuracy standards need to be addressed through applications to the appropriate plumbing organizations.

Installation Standards: Use or cite AWWA M6 Manual as reference and follow manufacturer installation specifications. Create a new IAPMO installation standard for water submeters.

RECOMMENDATIONS FOR FURTHER RESEARCH

This research and modeling effort points to some important areas for further study and suggests areas for improvement in data development and study design. Detailed sets of recommendations are also outlined in the AWWA publication (AWWA WCD 2001). As submetering and RUBS billing programs proliferate throughout the United States it will be important to evaluate the implementation and impact of these programs. Some questions for future research include: Are water savings from submetering reliable over a number of years? Are there any statistically verifiable water savings associated with hybrid metering programs?

There are questions that remain concerning RUBS billing practices. Can statistically significant water savings be achieved through a RUBS program if improvements are made to the information provided to the customer? Another question that was raised during this study was whether or not RUBS billing could induce conservation when the number of units commonly metered was lower, thus causing a less dilute price signal. The majority of RUBS properties in this study were larger than 10 units, with the average RUBS property having 184 units. Another study might aim to look at RUBS properties with less than 10 units.

Point-of-use metering is likely to gain wider acceptance in the coming years as additional products and companies enter the market. These systems offer potential to identify leakage and provide useful information on water use to customers, property managers, and water conservation planners. It will be important to evaluate POU metering programs to determine if they are achieving the desired goals and if the potential benefits of the data they can produce are being realized.

Interested parties such as state regulators, local decision makers, water utilities, property owners, and tenants rights organizations need to be kept informed of changes in the regulatory climate nationwide for submetering and RUBS. It may be worthwhile to establish a central repository for collecting and sharing information on regulation, perhaps with AWWA or another similar organization.

Finally this report has put forward 11 central recommendations along with an extensive set of best management practices for the billing industry. How will these recommendations be implemented? Assuming they are implemented, are they achieving the desired impact? These are important questions for future study.

APPENDIX A

SURVEY INSTRUMENTS

POSTCARD SURVEY INSTRUMENT

DENVER WATER

Denver Water is participating in a comprehensive national study regarding the ways multi-family housing properties in the United States handle water billing.

Please help by answering the three questions on the attached postcard. When you are done please detach the postcard with the three questions and drop it in the mail. No postage is necessary.

All information is completely confidential and will only be examined in combination with thousands of other responses.

By returning the postcard you will be entered into a drawing sponsored by the survey research company to win $100.

If you have questions about this survey, please call National Research Center, Inc. (the company administering this survey) at 1-877-467-2462x104.

You or your company may own or manage many residential properties. Please answer these questions for this property:

1. How are residents billed for water usage at this property?

- ☐ Resident water usage is included as part of their rent.
- ☐ Residents pay for water through their tenant/homeowner association dues.
- ☐ Each unit has its own individual water meter.
- ☐ The water bill for each unit is divided between residents based on the square footage, the number of rooms, or the number of occupants, etc. (RUBS).
- ☐ The water bill for each unit is based on the amount of hot water each unit uses.
- ☐ Other

2. Who bills the residents for water usage at this property?

- ☐ The property management company or landlord/owner
- ☐ The local utility
- ☐ A third party billing service Name of service: ____________________
- ☐ Other ____________________

3. How many units are in this property? _______________ *units*

MANAGER SURVEY INSTRUMENT

National Multiple Family Housing Manager Survey

SOUTHERN NEVADA WATER AUTHORITY

Southern Nevada Water Authority
Conservation Division, Mail Stop #110
1900 E. Flamingo Suite 295
Las Vegas, NV 89119

[mailing address will go here, to show through envelope window]

Dear [XXX],

Planning for a safe and secure water supply meeting the needs of both customers and the environment involves knowing how people use and pay for water as well as what might motivate them to conserve. With better information, utilities can make wiser water planning decisions and better stewards of the public's money and the public resources.

The Southern Nevada Water Authority is participating in an important national study of water use and water billing in multi-family housing properties across the United States. This study is sponsored by a consortium of water providers and by the National Apartment Association (NAA) and the National Multi-Housing Council (NMHC). The **property in the box below** was randomly selected to be part of a small group of customers asked to assist with this study.

You can play a vital role in helping shape a sensible water future by completing and returning the attached survey form. We need the property manager or someone in a similar position at the **property in the box below** to complete this questionnaire. It would be most helpful if you could take 10 or 15 minutes today to sit down and complete this form. If you are not in a position to complete this survey yourself, please take a moment to pass it along to someone who can. We have provided an addressed, postage-paid envelope for returning the survey when it is completed.

All information collected for this study will be kept strictly confidential and will only be examined in combination with thousands of other responses.

We sincerely appreciate the time and effort it takes to assist with this research effort. As a token of our thanks for completing and returning this survey, you will be entered into a drawing sponsored by National Research Center, Inc. (the company administering the survey). **The winner will receive a cash prize of $500.**

If you have any questions about this survey, please call the National Research Center at this toll free number: 1-877-467-2462 x104.

On behalf of the Southern Nevada Water Authority and water providers across the country, thank you for responding to this request and helping us plan the most sensible water future that we can.

Sincerely,

Kent A. Sovocool

Kent Sovocool
Senior Conservation Programs Analyst

Please have the "Property Manager" for the address below respond to this survey

[Property Name]
[Property Street Address]
[Property City, State, Zip]

All questions refer to the address above

National Multiple Family Housing Manager Survey

Please complete this survey for the property shown on the cover letter.

Property Characteristics

1. How is the property classified?

- ❑ Government subsidized (public) rental housing -------> ❑ Local ❑ State ❑ Federal
- ❑ Private rental
- ❑ Condominium
- ❑ Private resident owned----------> ____% owner-occupied
- ❑ Other ___________________________

2. Which type(s) of building(s) is on this property? (Please check all that apply.)

- ❑ 1 to 2 stories
- ❑ 3 to 5 stories
- ❑ more than 5 stories

3. How many residential buildings are on this property?

________ *number of buildings*

4. How many units are in this property?

________ *number of units*

5. How many of each of the following types of units are on the property?

Efficiency/Studio-----------> ______ *# of units*
1 Bedroom------------------> ______ *# of units*
2 Bedroom------------------> ______ *# of units*
3 Bedroom------------------> ______ *# of units*
4 or more Bedroom--------> ______ *# of units*

6. If property is a rental, what is the typical rent for the following types of units that are on the property?

❑ **Not a rental**
Efficiency/Studio-----------> $______ *per month*
1 Bedroom------------------> $______ *per month*
2 Bedroom------------------> $______ *per month*
3 Bedroom------------------> $______ *per month*
4 or more Bedroom--------> $______ *per month*

7. Approximately how many people live on the property in total?

________ *number of people*

8. In what year was the construction of the property completed?

Year ________

9. About how many acres is the total property? (1 acre = 43,560 square feet)

________ *acres*

10. About what percent of the total property is irrigated landscape?

________ *%*

11. Is there a separate water meter for irrigation?

❑ Yes ❑ No ❑ Don't know

12. Do you have a separate source of water such as a well or ditch for irrigation?

❑ Yes ❑ No ❑ Don't know

13. What is the current vacancy rate?

________ *% vacant*

14. Over the last two to three years, has the vacancy rate gone up, gone down, or stayed about the same?

- ❑ The vacancy rate has gone up
- ❑ The vacancy rate has gone down
- ❑ The vacancy rate has stayed about the same
- ❑ Don't know

15. Is the property considered a senior citizen/retirement community?

- ❑ Yes
- ❑ No
- ❑ Don't know

Property Amenities

16. Which features and amenities that are common or shared by residents can be found on the property? (Please check all that apply.)

❑ Sauna/Steam room
❑ Water features/fountains
❑ Landscape ponds
❑ Play area
❑ Tennis courts
❑ Basketball courts
❑ Hot tub
❑ Exercise room
❑ Common shower
❑ Common kitchen
❑ Club house
❑ Cooling tower
❑ Common bathrooms
❑ One common laundry room/facility
❑ More than one common laundry room/facility
❑ Food service facility/restaurant
❑ Store or other commercial facility
❑ Other________________________________

17. Does the property have a pool?

❑ Yes ------------------------> **(Check all that apply)** ❑ Indoor ❑ Outdoor
❑ No

18. Does the property have an outdoor sprinkler system?

❑ Yes ------------------------> **What are the typical months for irrigation? (Please check all that apply)**
❑ No
❑ Don't know

❑ All year round
❑ January
❑ February
❑ March
❑ April
❑ May
❑ June
❑ July
❑ August
❑ September
❑ October
❑ November
❑ December

Water Fixtures

19. Do the units come with hook-ups for washing machines?

❑ Yes------------------------>**What percent of the units have washing machines?** _______ %
❑ No
❑ Don't know

20. Do all or some of the units come equipped with dishwashers?

❑ Yes
❑ No
❑ Don't know

21. Have any of the washing machines been replaced since 1995?

❑ Yes------------------------>**What percent of the units have had their washing machines replaced since 1995?**
❑ No
❑ Don't know

❑ Less than 25%
❑ 25% to 49%
❑ 50% to 75%
❑ 76% to 99%
❑ All
❑ Don't know

22. Have any of the toilets been replaced since 1995?

❑ Yes------------------------>**What percent of the units have had their toilets replaced since 1995?**
❑ No
❑ Don't know

❑ Less than 25%
❑ 25% to 49%
❑ 50% to 75%
❑ 76% to 99%
❑ All
❑ Don't know

23. Have any of the faucets been replaced since 1995?

❑ Yes------------------------>**What percent of the units have had their faucets replaced since 1995?**
❑ No
❑ Don't know

❑ Less than 25%
❑ 25% to 49%
❑ 50% to 75%
❑ 76% to 99%
❑ All
❑ Don't know

24. Have any of the showerheads been replaced since 1995?

❑ Yes------------------------>**What percent of the units have had their showerheads replaced since 1995?**
❑ No
❑ Don't know

❑ Less than 25%
❑ 25% to 49%
❑ 50% to 75%
❑ 76% to 99%
❑ All
❑ Don't know

Water Bill Payment

25. How are residents billed for water usage at this property? (Please check all that apply)

- ❑ It is included in the rent or in the resident/homeowner association dues
- ❑ The water bill for each unit is based on the amount of hot water each unit uses
- ❑ Each unit has its own individual water meter and individual units are charged for the water they use
- ❑ The water bill for each unit is calculated based on the square footage, the number of rooms, or the number of occupants---> ❑ Square footage ❑ Number of rooms ❑ Number of occupants ❑ Other
- ❑ Other ______________________________
- ❑ Don't know

26. Why was this particular method of billing for water usage selected? (Please check all that apply)

- ❑ It conserves water usage by residents
- ❑ It is the easiest way to bill for water usage
- ❑ Increased profitability of property
- ❑ We must comply with local laws and regulations
- ❑ It is the least expensive way to bill for water
- ❑ Other ______________________________
- ❑ Don't know

27. Who bills the residents for water usage at this property? (Please check only one)

- ❑ No one, it is included in the rent or resident/homeowner association dues
- ❑ A separate company billing service (not the property manager or billing service) ------> Name of service: ______________________________
- ❑ The property management company, landlord/owner, or resident/homeowner association
- ❑ The local utility
- ❑ Other ______________________________
- ❑ Don't know

28. Which of the following are residents billed individually for? (Please check all that apply)

- ❑ Natural Gas/ Heating Oil
- ❑ Garbage
- ❑ Electric
- ❑ None
- ❑ Other ______________________________
- ❑ Don't know

If residents are billed for water in-rent or through resident/homeowner association dues, answer the following question, otherwise skip to the next section (starting with question #30)

29. Have you considered converting to individual water meters for each unit or billing for water using a calculation based on square footage, the number of rooms, or the number of occupants, etc. for each unit?

- ❑ No
- ❑ Yes--->**What were the things you considered when thinking about converting?**
  - ❑ It conserves water usage by residents
  - ❑ It is the easiest way to bill for water usage
  - ❑ We must comply with local laws and regulations
  - ❑ It is the least expensive way to bill for water
  - ❑ Increased profitability of property
  - ❑ Too expensive
  - ❑ Resident resistance
  - ❑ Prohibited by law
  - ❑ Other ______________________
  - ❑ Don't know

If residents are billed for water using individual water meters for each unit OR billed for water using a calculation, please answer the following questions. (Otherwise skip to the next section.)

30. Was the current billing system in place since the property was developed or put in place at a later time?

- ❑ Since the property developed **(Skip to #32)**
- ❑ At a later time-----------> Year________
- ❑ Don't know

31. Were there resident complaints when the new water billing system was put in place?

- ❑ Yes ------> **What were some of the complaints? (Check all that apply)**
  - ❑ Too expensive
  - ❑ Unfair
  - ❑ Too complicated
  - ❑ Other _____________ ___________________
- ❑ No
- ❑ Don't know

32. What is the typical rate of non-payment of the water bill?

_______ *%*

❑ Don't know

33. How frequently are residents billed for water?

- ❑ Monthly
- ❑ Bi-monthly
- ❑ Quarterly
- ❑ Annually
- ❑ Other ___________________________
- ❑ Don't know

34. What are the water rates that residents are charged?

Choose one method:

$_______ *per K gallons (1000 gallons)*

$_______ *per HCF (100's of cubic feet; 1 HCF=748 gallons)*

❑ Don't know

35. Are sewer service charges included with the water bill?

- ❑ Yes -----------> **What are the charges? $_________**
- ❑ No
- ❑ Don't know

36. Does the property owner/manager pay for sending water bills to residents?

- ❑ Yes ------> **How much? $____________**
- ❑ No
- ❑ Don't know

37. Is there a monthly service charge for the billing service added to residents' water bill?

- ❑ Yes ------> **How much? $____________**
- ❑ No
- ❑ Don't know

38. What are the administrative difficulties you encountered, or are encountering, when converting to individual billing for water? (Please check all that apply)

- ❑ None
- ❑ Didn't have to convert
- ❑ Difficulty obtaining permits
- ❑ Resistance from government or regulatory officials
- ❑ Resistance from local water utility
- ❑ Resistance from residents
- ❑ Don't know
- ❑ Other ______________________________

39. If this property is a rental, does the lease include language about resident's paying for water?

- ❑ Property is not a rental
- ❑ Yes----> **Can a resident's security deposit be docked for failure to pay the water bill?**
  - ❑ Yes
  - ❑ No
- ❑ No
- ❑ Don't know

40. If this property has individual water meters for each unit are there any provisions for testing the meters?

- ❑ Yes
- ❑ No --> **skip to question #41**
- ❑ Don't know --> **skip to question #41**

40a. How often are they tested?

____

40b. By whom are they tested?

____

41. If this property has individual water meters for each unit are you required to test your water periodically for water quality by any regulatory agency?

❑ Yes ❑ No ❑ Don't know

For Everyone

42. As a part of our study, we will be surveying residents of multi-family properties about their water use habits. If possible, could you provide us with the unit addressing for this property? This may be attached as a separate document, or you can list the addresses below. (You may also use a shorthand method, if that would be easier, for example:

1101, 1103, 1105 Elm Street
Each building has units 101-115, 201-215

OR

15345 Hazel Circle
Buildings 1, 2, 3, 4
Each building has units A,B,C,D,E,F,G)

If the list is available electronically, you may e-mail it to us at Jason@n-r-c.com if you prefer.

____
____
____
____
____
____
____
____
____
____
____
____
____
____
____

43. Please write in your name, phone number, and email address in the space below so that we may contact you during business hours if we have additional questions.

Name:_________________________________
Address:_______________________________
City, State, Zip:__________________________
Phone:________________________________
E-mail:________________________________

Thank you for participating in our study. Please return your completed survey in the enclosed postage-paid envelope to:

National Research Center, Inc.
3005 30th Street
Boulder, CO 80301

If you have any questions about this questionnaire, please call (toll-free) 1-877-467-2462 x104.

RESIDENT SURVEY INSTRUMENT

National Multiple Family Housing Resident Survey

The City of Austin Water Conservation Program
P.O. Box 1088
Austin, TX. 78701

[mailing address will go here, to show through envelope window]

October, 2003

Dear Resident,

Planning for a safe and secure water supply meeting the needs of both customers and the environment involves knowing how people use and pay for water as well as what might motivate them to conserve. With better information, utilities can make wiser water planning decisions and be better stewards of the public's money and the public resources.

The City of Austin Water Conservation Program is participating in an important national study of water use and water billing in multi-family housing properties across the United States. This study is sponsored by a consortium of water providers and by the National Apartment Association (NAA) and the National Multi-Housing Council (NMHC). This property was randomly selected to be part of a small group of customers asked to assist with this study.

You can play a vital role in helping shape a sensible water future by completing and returning the attached survey form. It will only take 5 minutes of your time. We have provided an addressed, postage-paid envelope for returning the survey when it is completed.

All information collected for this study will be kept strictly confidential and will only be examined in combination with hundreds of other responses.

We sincerely appreciate the time and effort it takes to assist with this research effort. As a token of our thanks for completing and returning this survey, you will be entered into a drawing sponsored by National Research Center, Inc. (the company administering the survey). **The winner will receive a cash prize of $500.**

If you have any questions about this survey, please call National Research Center at this toll free number: 1-877-467-2462 x108.

On behalf of the City of Austin Water Conservation Program and water providers across the country, thank you for responding to this request and helping us plan the most sensible water future that we can.

Sincerely,

Tony Gregg

Tony Gregg
Manager, Water Conservation Program
City of Austin

1. **Indicate how many of each of the following types of water-using appliances or fixtures you have. Circle the appropriate number.**

	none	1	2	3	4 or more
a. Toilets	0	1	2	3	4+
b. Bathtub with shower	0	1	2	3	4+
c. Bathtub only (no shower)	0	1	2	3	4+
d. Shower only (no bathtub)	0	1	2	3	4+
e. Whirlpool bathtub w/ jets	0	1	2	3	4+
f. Bathroom sink	0	1	2	3	4+
g. Kitchen faucet	0	1	2	3	4+
h. Indoor utility sink	0	1	2	3	4+
i. Outdoor faucet/hose	0	1	2	3	4+

2. **Do you have any of the following types of water-using appliances or fixtures in or as part of your apartment/housing unit?**

	Yes	No
a. Garbage disposal	❑	❑
b. Dishwashing machine	❑	❑
c. Evaporative/swamp cooler	❑	❑

3. **Do you use water from your apartment for any of the following?**

	Yes	No
a. Potted plants	❑	❑
b. Outdoor lawn/garden/flower bed that you maintain (not common or community landscaping)	❑	❑

4. **Do you have a washing machine in your apartment/housing unit?**

❑ No ➔ **Where do you most commonly do your wash?**
- ❑ Common area laundry
- ❑ Off-site laundry
- ❑ Other___________________________

❑ Yes ➔ **Is it a… (please check one)**
- ❑ Top-loading washing machine
- ❑ Front-loading washing machine

What is the brand, model, and year of the machine?

Brand ______________________ *Model*___________________________ *Year*___________

5. **Please specify the year, brand name and gallons per flush of your toilet(s). The year of manufacture is typically stamped into the porcelain on the underside of the tank lid or inside on the wall of the tank. (Enter as much information below as you can.)**

Toilet 1 .... *Year*_________ *Brand*_________________________ *Gallons per Flush*___________

Toilet 2 .... *Year*_________ *Brand*_________________________ *Gallons per Flush*___________

Toilet 3 .... *Year*_________ *Brand*_________________________ *Gallons per Flush*___________

6. Please rate each of the following on a scale from 1 to 5, where 1 is "not at all important" and 5 is "extremely important."

	not at all important				extremely important
a. How important is conserving water in your household?	1	2	3	4	5
b. How important is it for households in your community to conserve water on a regular basis?	1	2	3	4	5

7. In the last several years, has your household taken any action to conserve water?

- ❑ No
- ❑ Yes ➔ **If yes, what type of action have you taken to conserve water? (Please check all that apply.)**
  - ❑ Take shorter showers
  - ❑ Installed low-flow showerheads
  - ❑ Installed water savers (inserts) in toilet
  - ❑ Installed ultra-low-flush toilets
  - ❑ Installed low-flow faucet aerators
  - ❑ Use garbage disposal less often
  - ❑ Other ___________________________
  - ❑ Use dishwasher less/use fuller loads
  - ❑ Use washing machine less/use fuller loads
  - ❑ Repaired leaks in faucet/toilet
  - ❑ Re-use household water
  - ❑ Washing car less often
  - ❑ Had a home water audit done

8. In the last several years, has your landlord taken any action to conserve water?

- ❑ Not applicable (I am the owner)
- ❑ Don't know
- ❑ No
- ❑ Yes ➔ **If yes, what type of action has your landlord taken to conserve water? (Please check all that apply.)**
  - ❑ Installed low-flow showerheads
  - ❑ Installed water savers (inserts) in toilet
  - ❑ Installed ultra-low-flush toilets
  - ❑ Other ___________________________
  - ❑ Installed low-flow faucet aerators
  - ❑ Repaired leaks in faucet/toilet
  - ❑ Re-use household water for landscaping

9. From what sources, if any, have you heard or read about water conservation? (Please check all that apply.)

- ❑ None
- ❑ Water bill inserts
- ❑ Homeowner or apartment newsletters
- ❑ Newspapers
- ❑ Other ______________________________
- ❑ Radio public service announcements
- ❑ Television public service announcements
- ❑ Radio news
- ❑ Television news

10. How are you billed for water usage at this property? (Please check all that apply)

- ❑ It is included in the rent or in the resident/homeowner association dues ➔ ***go to question #14***
- ❑ The water bill is based on the amount of hot water used
- ❑ My household has its own individual water meter
- ❑ The water bill is calculated based on the square footage, the number of rooms, or the number of occupants ➔
  - ❑ Square footage
  - ❑ Number of rooms
  - ❑ Number of bedrooms
  - ❑ Number of occupants
  - ❑ Fixture count
  - ❑ Other
- ❑ Don't know
- ❑ Other ___________________________________

11. Utilities, landlords or billing companies often charge a service fee on their bills. Is a service charge added to your water bill in addition to the amount you owe for the water used?

- ❑ Yes ➔ How much is the service charge per bill? ______________________________
- ❑ No
- ❑ Don't know

12. What is your opinion about the way you are billed for water?

- ❑ I am satisfied with the way I am billed for water
- ❑ I have no opinion about the way I am billed for water
- ❑ I am dissatisfied with the way I am billed for water ➔ **Why are you dissatisfied? (Please check all that apply.)**
  - ❑ Rates
  - ❑ Service charge
  - ❑ Late fees
  - ❑ Accuracy of reported water consumption
  - ❑ Other ______________________________

    ____

13. Have you ever tried to resolve a complaint about your water billing?

- ❑ Not applicable ➔ ***go to question #14***
- ❑ No ➔ ***go to question #14***
- ❑ Yes ➔ **13a. Was there a method set up for you to resolve your complaint?**
  - ❑ No
  - ❑ Yes ➔ Please describe ______________________________

    ____

  13b. Do you feel your complaint was handled fairly?
  - ❑ No ➔ Please explain ______________________________

    ____
  - ❑ Yes ➔ Please explain ______________________________

    ____

14. Do you think the way you are billed for water makes your household more likely to conserve water?

- ❑ Yes
- ❑ No
- ❑ Don't know

15. How many people, including yourself, reside full-time at this address?

_____ Adults, including yourself (age 18+)

_____ Teenagers (age 13-17)

_____Older Children (age 6-12)

_____Younger Children (age 3-5)

_____Infants or Toddlers (under age 3)

16. Do you rent or own your residence?

- ❑ Own
- ❑ Rent ➔ **How much is your monthly rent?**
  - ❑ Less than $300
  - ❑ $300-$499
  - ❑ $500-$799
  - ❑ $800-$1299
  - ❑ $1300-$1699
  - ❑ $1700-$1999
  - ❑ $2000-$2499
  - ❑ $2500 or more

17. About how much do you estimate your <u>household's</u> total income before taxes was in 2002? Please check the appropriate box below.

- ❑ Less than $15,000
- ❑ $15,000 to $24,999
- ❑ $25,000 to $34,999
- ❑ $35,000 to $49,999
- ❑ $50,000 to $74,999
- ❑ $75,000 to $99,999
- ❑ $100,000 or more

18. Please attach a copy of you water bill. For privacy reasons, you may cross out your name and account number.

If you are unwilling or unable to attach your water bill, please return your completed survey. Not enclosing a copy of your water bill will not affect your chances of winning the $500 cash prize for returning a completed survey.

Thank you very much for participating in this survey. Please send this questionnaire in the enclosed postage-paid envelope to:

National Research Center, Inc.
3005 30th Street
Boulder, CO 80301

BILLING COMPANY SURVEY INSTRUMENT

Sample Cover Letter

January 28, 2004

«MM» «FIRST» «LAST»
«TITLE»
«COMPANY»
«ADDRESS»
«CITY», «STATE» «ZIP»

Re: National Submetering and Allocation Billing Program Study

Dear «MM» «LAST»:

For the past two years Aquacraft, Inc. and the National Research Center, Inc. have been conducting an in-depth study of third party billing for water in the United States. This study is funded by the US EPA, the National Apartment Association (NAA), the National Multi-Housing Council (NMHC), and a consortium of 10 water providers across the US. We anticipate completing this study and making results available to the public in the first quarter of 2004 and results will be available at the February NSUAA workshop in Orlando.

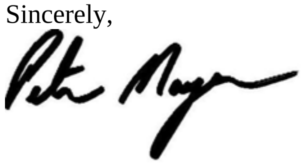
An important component of this study includes a survey of companies directly involved in submetering and allocation billing for water in order to better understand the industry business practices and policies.

Please take a few moments to complete and return the attached questionnaire. If you are not in a position to complete this survey yourself, please pass it along to someone who can. We have provided an addressed, postage-paid envelope for returning the survey when it is completed.

All survey information will be kept strictly confidential and will only be reported in summary form. If you have any questions about this survey, please call Aquacraft, Inc. at 303-786-9691.

On behalf of the project sponsors as well as water providers and other interested parties across the country, thank you in advance for your assistance and timely response.

Sincerely,



Peter W. Mayer
Vice President

National Multi-Family Water Billing Company Survey

Please answer the questions in this survey and return the survey in the stamped and addressed envelope provided. Also, please include a sample copy of your water bill format and any administrative policy and customer service documents you may have. Thank you.

General Information

1. Approximately how many water and/or wastewater bills does your company send per month?________________________________

2. In what year did your company start billing for water in multi-family housing?

Year ____________

❑ We do not send bills for water and/or wastewater in multi-family housing (*please return survey*)

3. Is your company bonded?

❑ Yes ❑ No ❑ Don't know

4. Are you active in water billing across the country (where permitted) or only in specific regions?

❑ Across the country

❑ Specific regions→ Please specify general regions (i.e. Pacific NW, mid-west, etc.)

____

____

____

5. Which billing method(s) does your company use?

❑ Submetering only

❑ Allocation (RUBS) only

❑ Hot water submetering only

❑ Other methodology only

❑ Combo of submetering and RUBS→ please specify relative percentage:

% Submeter	________%
% RUBS	________%
% Hot water meter	________%
% Other	________%
TOTAL	100 %

Bills, Fees, and Customer Service

6. Do you have written customer service standards?

❑ Yes ❑ No ❑ Don't know

7. Do you have a standard bill format or does it vary from property to property? *(If possible, please attach a sample water bill with this survey.)*

❑ Standard Format

❑ Variable Format

❑ Other (please explain)________________

____

8. Do you put a customer contact phone number on each bill?

❑ Yes ❑ No ❑ Don't know

9. Do you include any informative historic consumption information on the water bill?

❑ Yes ❑ No ❑ Don't know

10. As a company policy do you typically include charges for common area usage?

❑ Yes→ If yes how is it determined? ________

____

____

❑ No

❑ Don't know

11. How is your service charge determined? (*Check all that apply.)*

❑ Flat fee per bill

❑ Based on the utility service charge

❑ Based upon a percent of the bill

❑ Other (please explain)________________

____

____

12. What are your typical per bill service charges? ***(please total all non-commodity related charges)***

- ❑$1
- ❑$2
- ❑$3
- ❑$4
- ❑$5
- ❑Other____________________________

13. What is the typical rate of non-payment of water bills?

____________%

- ❑ Don't know

14. Do your resell water at a profit at any of your properties?

- ❑ Yes→ If yes by what %?_______________
- ❑ No
- ❑ Don't know

15. What is the time frame for late payment? ***(Check <u>all</u> that apply.)***

- ❑ Same as local utility
- ❑ Until next bill
- ❑ Until third bill
- ❑ _____ days
- ❑ Other_______________________________
- ❑ Not applicable/we do not charge late fees
- ❑ Don't know

16. If you charge late fees, how are your late fees structured? ***(Check all that apply.)***

- ❑ Not applicable/we do not charge late fees
- ❑ Same as local utility late fee structure
- ❑ Fixed dollar amount $___________
- ❑ A percent of the amount billed _______%
- ❑ Other_______________________________
- ❑ Don't know

17. At the start of service are customers given information on your late fee payment structure and payment time frame?

- ❑ Yes
- ❑ No
- ❑ Don't know
- ❑ Not applicable

17. How is the final bill to a customer determined (prior to move out)?

Explain_______________________________________

____

____

18. Do you have an administrative process to handle customer complaints?

- ❑ Yes
- ❑ No
- ❑ Complaints are handled by on-site manager
- ❑ Don't know
- ❑ Not applicable

19. What are common customer complaints? ***(Check all that apply.)***

- ❑ Bill itself
- ❑ Amount of bill (consumption charge)
- ❑ Service charge
- ❑ Bill format
- ❑ Customer service information
- ❑ Other ___________________________________
- ❑ Don't know
- ❑ Not applicable

20. Have you ever gone through a bill complaint/dispute process with a customer?

- ❑ Yes
- ❑ No
- ❑ Don't know
- ❑ Not applicable

21. Would you support a set of national administrative guidelines for your industry?

- ❑ Yes
- ❑ No
- ❑ Maybe, if our industry had input
- ❑ Don't know

SUBMETERING

The next few questions apply only to companies that are involved in submetering (or hot water submetering) for at least part of their business. If your company does not submeter, please skip ahead to question #26.

22. How do you read the water meters at your submetered properties? ***(Please check all that apply.)***

- ❑ Manual read of water meter by a person
- ❑ Automatic meter reading technology→Please specify system used: ____________________

  ____

  ____
- ❑ Other→Please explain __________________

  ____

  ____
- ❑ Don't know

❑ Not applicable

23. Do you have a meter maintenance standard?

❑ Yes→If yes please describe maintenance program ______________________________
____
____

❑ No
❑ Don't know
❑ Not applicable

24. Do you have a meter testing standard for accuracy?

❑ Yes
❑ No
❑ Don't know
❑ Not applicable

25. Are residents allowed to request meter testing for accuracy?

❑ Yes→ If yes, is there a charge? ❑ Yes ❑ No
❑ No
❑ Don't know
❑ Not applicable

RATIO UTILITY BILLING SERVICE (RUBS)

The next few questions apply only to companies that are involved in Ratio Utility Billing Service (RUBS) for at least part of their business. If your company does not bill using RUBS, please skip these questions and proceed to the end of the survey.

26. What method(s) do you use to determine commodity charges for RUBS customers? *(Check all that apply.)*

❑ Flat fee
❑ Based on area (square footage) of apartment
❑ Based on number of bedrooms
❑ Based on number of residents
❑ Based on number of bathrooms
❑ Based on number of fixtures
❑ Other ______________________________
____
____

❑ Not applicable

27. Do you subtract common area water use and/or irrigation from RUBS customers' bills?

❑ Yes, for <u>all</u> RUBS properties
❑ Only for <u>some</u> RUBS properties
❑ No
❑ Don't Know
❑ Not Applicable

28. What method(s) do you use to determine the amount to subtract for common area and/or irrigation usage? *(Check all that apply.)*

❑ Never subtract for common area usage
❑ Fixed dollar amount subtracted
❑ Fixed volume of water subtracted
❑ Based on a percentage of total water use→ please specify percent __________
❑ Amount based the specific common area amenities present at each property (i.e. swimming pool, hot tub, kitchen, cafeteria, landscaping, water feature, etc.)
❑ Based on property owner's specifications
❑ Other ______________________________
____
____

❑ Not applicable
❑ Don't Know

29. Do you track or have you ever tracked water consumption at a property before and after implementation of RUBS?

❑ Yes→If yes, please summarize findings_____
____
____
____
____
____

❑ No
❑ Don't Know
❑ Not Applicable

Thank you for taking the time to complete this important survey. Please return the survey in the stamped and addressed envelope provided. Also, please include a sample copy of your water bill format and any administrative policy and customer service documents you may have. Thank you.

Results from this study will be available in mid-2004. Results will be posted on our web site – www.aquacraft.com as well as on the web sites of some participating water utilities.

SITE VISIT PROTOCOL

Matched Pairs Site Visit Protocol

General Information

Page 1

Utility

PropID 9999

Billing Method

Property Name

Service Address

Svc City, St

Svc Zip

Contact Name(s

Contact Phone

Contact Phone 2

DateOfVisit

Arrive

Depart

Auditor Name(s)

Organization

MatchPairID:

SitePlan Available (y/n)

Aerial Photo Available (y/n)

Scaled Map Available (y/n)

Final comments

Water Account Information

Water Accounts

Acct #

Monthly Water Use (kgal)

January	February	March	April	May	June	July	August	September	October	November	December	Total

Matched Pairs Site Visit Protocol

Property Characteristics

Page 2

Utility

PropID 9999

Prop Name

Residential Buildings on site

Non- Residential Buildings on site

Apartment Units

Type of property

Year building was completed

Current Vacancy Rate %

	Efficiency/studio	1 bedroom	2 bedroom	3 bedroom	4+ bedroom
Number of each type of apartment					
Monthly Rent for each type of apartment					

	# Adults	# Children	Total
Number of Residents (Estimate)			

How are Residents Charged for Water?

Explanation of water billing method (if necessary

Was the current billing system in place since the property developed? (y/n)

If it was put into place at a later time, what year did conversion take place?

Who bills for water usage at the property

If billed by a third party, what is the service company's name?

Unit Plumbing Fixtures

Does the apartment have clothes washer hook-ups? (y/n)

If so, what % of apartments have clothes washers installed %

Do some or all of the units come equipped with dishwashers?

If so, what % of apartments have dishwashers installed? %

What % of the following fixtures and appliances have been replaced since 1995? (Which are water saving/low flow?)

Toilets (1.6 gpf)

Showerheads

Clothes washers (front loaders)

Faucets

Site Facilities

Utility	
PropID	9999
Prop Name	

Laundry

Is there one common laudry room/facility?

Is there more than one common laundry room/facility?

Is there a separate water meter for the laundry? (y/n)

Number of central laundry facilities

Total # clothes washers (all central laundry facilities)

Central Laundry CW Brand

Central Laundry CW Model

Recreation

Does the property have a pool? (y/n) Type of pool (indoor/outdoor)

Number of indoor pools Indoor pool sq ft or indoor pool gallons

Number of outdoor pools Outdoor pool sq ft or outdoor pool gallons

Hot Tub/Jacuzzi (y/n) Hot Tub Gallons

Sauna/steam room? (y/n) # steam rooms # saunas

Outdoor tennis courts? (y/n) Outdoor basketball courts?

Do you hose courts down How often?

Water Features

Landscape ponds? (y/n) Pond sq ft

Is the pond filled? (y/n) How often

Fountains? (y/n) Is the fountain recirculating? (y/n)

Landscape and Irrigation

Utility	
PropID	9999
Prop Name	

Is there a separate irrigation meter? (y/n)

What is the total irrigated area? (sq ft)

How was the area obtained?

☐ Arial ☐ Measuring Wheel ☐ SiteMap ☐ Other

How is the property irrigated?

☐ Don't Irrigate ☐ Automatic ☐ Manual ☐ Other

Estimate the percentage of each type of vegetation:

Turf	Shrub/Tree	Flowers	Other

Utilities: Cooling and Heating

Cooling towers (y/n) How many? Is there a constant blowdown/bleed? (y/n)

Swamp coolers (y/n) How many?

Boilers for space heating? (y/n) How many? Is there a constant blowdown/bleed? (y/n)

Random Unit Visits

To be completed after the site visit by the auditor

How many units were visited?

Using information from the manager survey, property owner interview, and random unit visits, what is your best educated guess on the percent of low flow/water saving fixtures listed below?

Toilets (1.6 gpf) SH (<2.5 gpm) Faucet (<2.2 gpm) CW (front loader)

Random Unit Visits

Utility

Prop ID:

Building | Unit No.

How many bedrooms in the unit?
How many bathrooms in the unit?

Is there a clotheswasher hook-up? (y/n)
Clothes washer installed?(y/n)
Make | Model

Is there a dishwasher? (y/n)
Make | Model

Room	Fixture Type	Brand	Model	Flow Rate /Vol	Leak?	
					y/n	Describe
Kitchen	Faucet					
Bath 1	Toilet					
Bath 1	Faucet					
Bath 1	Shower					
Bath 2	Toilet					
Bath 2	Faucet					
Bath 2	Shower					

REGULATORY SURVEYS

Sample Cover Letter

Potomac Resources, Inc.
1001 Connecticut Avenue, N.W. Suite 801
Washington, DC 20036
Edward R. Osann, President
telephone (202)429-8873 facsimile (202)429-2248 e-mail eosann@starpower.net

Energy and Natural Resources • Advocacy and Analysis

October 2002

Re: **National Multiple Family Submetering and Allocation Program Study**

Potomac Resources is one of a team of consultants carrying out the "National Multiple Family Submetering and Allocation Program Study." This study is being sponsored by nine major drinking water utilities* and two national apartment associations.** The study is being managed by the East Bay Municipal Utility District in Oakland, California.

The purpose of this study is to identify the effects of billing allocation systems for the assignment of the cost of water service, sewer service, and/or the energy cost of domestic hot water directly to the residents of multiple family apartment buildings. Submetering and other allocation practices may have important implications for water and energy consumption, water and wastewater infrastructure planning, and consumer protection. For additional information about the general aims and goals of this survey, see <www.aquacraft.com>.

A portion of this study is a survey of current public policies related to billing allocation. Because these practices may present issues that extend beyond the jurisdiction of any one agency, this survey is being distributed to three sets of state officials --

- state weights and measures officials;
- state public utility regulators; and
- state drinking water officials.

It would be deeply appreciated if you would take a few moments to answer this survey from the perspective of your own agency. Feel free to answer any questions for which you have current information.

We will be contacting you about this survey, and you may feel free to contact us at 202-429-8873 or by e-mail at <submeteringsurvey@starpower.net>. Completed surveys may be e-mailed back to this same address, or the completed survey may be returned by fax to Potomac Resources, Inc. at 202-429-2248 if you prefer.

Thank you for your participation in this important project. The results of the survey will be made publicly available in the final report of the National Multiple Family Submetering and Allocation Program Study.

Sincerely,

Edward R. Osann

Edward R. Osann
President

* City of Austin TX, Denver Water CO, City of Phoenix AZ, San Antonio Water System TX, San Diego County Water Authority CA, City of Tucson AZ, Portland Water Bureau OR, East Bay Municipal Utility District CA, and the Southern Nevada Water Authority.
** The National Apartment Association and the National Multi-family Housing Council.

October 2002

Survey of State Drinking Water Officials for the National Multiple Family Submetering and Allocation Program Study

Please fax the completed survey to Potomac Resources, Inc. at 202-429-2248.

Definitions

For purposes of this survey, billing allocation systems consist of –

Submetering and *submetered systems* refer to the installation of water measurement devices in each dwelling unit of a multiple family apartment building and the use of such devices for billing each occupied unit for water service, sewer service, and/or the energy cost of domestic hot water, based upon the unit's measured consumption; or

Ratio Utility Billing System, or *RUBS*, is the practice of allocating the total cost of water service, sewer service, and/or the energy cost of domestic hot water in a multiple family apartment building for payment by each occupied unit based upon a formula allocation of the building's primary utility bill. Such allocations may be based upon a unit's floor area, number of bedrooms, number of occupants, or measured hot water usage.

A. Billing Allocation Overview

1. Is the practice of submetering multiple family apartments allowed by your state or agency? Yes ____ No ____ For purposes of this survey, if submetering is not explicitly prohibited, we assume it is allowed.

2. Is the use of a ratio billing system, or RUBS, in multiple family apartments allowed by your state or agency? Yes ____ No ____ For purposes of this survey, if RUBS is not explicitly prohibited, we assume it is allowed.

3. Does the state require submetering in some situations, such as new apartment construction? Yes ____ No ____ If yes, please specify. ____
____

4. Does the state offer incentives for submetering, in either new apartment construction or installation in existing structures? Yes ____ No ____ If yes, please specify. _______________
____

5. Are apartment owners or managers required to inform any public agencies when a submetering system or RUBS system is placed in service? Yes ____ No ____ If yes, must they inform —
   a. the public water system providing service to the master meter? Yes ____ No ____
   b. the wastewater service provider? Yes ____ No ____
   c. any state agency? Yes _____ No _____ If yes, please specify. ____________________

B. Drinking Water Regulatory Issues

1. What is the status of submetered water systems in multiple family apartments under the state's Safe Drinking Water Program? (check one)
   a. public water system ____

b. sequential water system ____
c. not regulated at all under SDWA ____
d. other (please specify) ____

2. What is the status of RUBS systems under the state's Safe Drinking Water Program? (check one)
   a. public water system ____
   b. sequential water system ____
   c. not regulated at all under SDWA ____
   d. other (please specify) ____

3. If some submetered systems or some RUBS systems *are* subject to SDWA regulation and others *are not*, what characteristic(s) of system operation trigger SDWA application to such systems in this state? ____

4. Does your agency have any other regulations or guidelines that pertain to submetering or RUBS? Yes _____ No _____ If yes, please specify. ____
   ____

5. Is your agency currently considering any *new* regulations or guidelines that pertain to submetering or RUBS? Yes _____ No _____ If yes, please specify. ______________________
   ____

6. Does the state building code and/or plumbing code require the issuance of a permit for the installation of submeters in existing multiple family apartment structures? Yes ____ No _____

7. Are you aware of any statutes, regulations, or guidelines of any other state agency or local jurisdiction in your state that pertain to submetering or RUBS? Yes _____ No _____ If yes, please specify. ____
   ____
   ____
   ____

Requests for clarification or further information at this agency may be directed to –

Name ____
Agency ____
Phone ____
e-mail ____

Thank you for your participation in this important project. The results of the survey will be made publicly available in the final report of the National Multiple Family Submetering and Allocation Program Study.

Please fax the completed survey to Potomac Resources, Inc. at 202-429-2248.

October 2002

Survey of State Public Utility Regulatory Officials for the National Multiple Family Submetering and Allocation Program Study

Please fax the completed survey to Potomac Resources, Inc. at 202-429-2248.

Definitions

For purposes of this survey, billing allocation systems consist of –

Submetering and *submetered systems* refer to the installation of water measurement devices in each dwelling unit of a multiple family apartment building and the use of such devices for billing each occupied unit for water service, sewer service, and/or the energy cost of domestic hot water, based upon the unit's measured consumption; or

Ratio Utility Billing System, or *RUBS*, is the practice of allocating the total cost of water service, sewer service, and/or the energy cost of domestic hot water in a multiple family apartment building for payment by each occupied unit based upon a formula allocation of the building's primary utility bill. Such allocations may be based upon a unit's floor area, number of bedrooms, number of occupants, or measured hot water usage.

A. Billing Allocation Overview

1. Is the practice of submetering multiple family apartments allowed by your state or agency? Yes ____ No ____ For purposes of this survey, if submetering is not explicitly prohibited, we assume it is allowed.

2. Is the use of a ratio billing system, or RUBS, in multiple family apartments allowed by your state or agency? Yes ____ No ____ For purposes of this survey, if RUBS is not explicitly prohibited, we assume it is allowed.

3. Does the state require submetering in some situations, such as new apartment construction? Yes ____ No ____ If yes, please specify. ____
____

4. Does the state offer incentives for submetering, in either new apartment construction or installation in existing structures? Yes ____ No ____ If yes, please specify. ______________
____

5. Are apartment owners or managers required to inform any public agencies when a submetering system or RUBS system is placed in service? Yes ____ No ____ If yes, must they inform —
   a. the public water system providing service to the master meter? Yes ____ No ____
   b. the wastewater service provider? Yes ____ No ____
   c. any state agency? Yes _____ No _____ If yes, please specify. ___________________

B. Public Utility Regulatory Issues

1. Are the rates or other terms of service of submetered or RUBS systems in multiple family apartment buildings subject to regulation by the public service commission/public utility commission?
   a. Submetered systems: Yes ____ No ____ If only under certain conditions, please describe.
   ____
   b. RUBS systems: Yes ____ No ____ If only under certain conditions, please describe. ______
   ____

2. Does state law or regulation allow the operators of submetered or RUBS systems to collect from apartment residents —
   a. variable (or "commodity") charges at the primary utility's retail rate? Yes ____ No ____
   b. fixed (or "standby") charges at the primary utility's retail rate? Yes ____ No ____
   c. service fees for the reading and billing of submetered accounts, in addition to the variable and fixed charges of the primary utility? Yes ____ No ____
   If yes, is there a monetary cap on such service fees? ______________________
   d. fees for meter installation, meter testing, or meter replacement? Yes ____ No ____
   e. late fees, collection fees, or change of account ("move-in" or "move-out") fees? Yes ____ No ____

   For purposes of this survey, if collection of such charges or fees is not explicitly prohibited we assume they are allowed.

3. Does state law or regulation require any of the following in the operation of submetered or RUBS systems in multiple family apartment buildings —
   a. local or toll-free point of contact for billing questions? Yes ____ No ____
   b. testing of meter accuracy upon complaint, without charge? Yes ____ No ____
   c. written dispute resolution process? Yes ____ No ____
   d. prohibition of cut-off of water service for lack of payment of an apartment resident's account?

   Yes ____ No ____

4. Does your agency have any other regulations or guidelines that pertain to submetering or RUBS? Yes _____ No _____ If yes, please specify. ______________________________________
   ____

5. Is your agency currently considering any *new* regulations or guidelines that pertain to submetering or RUBS? Yes _____ No _____ If yes, please specify. ____________________
   ____

6. Does the state building code and/or plumbing code require the issuance of a permit for the installation of submeters in existing multiple family apartment structures? Yes ____ No _____

7. Are you aware of any statutes, regulations, or guidelines of any other state agency or local jurisdiction in your state that pertain to submetering or RUBS? Yes _____ No _____ If yes, please specify. ____
   ____
   ____
   ____

Requests for clarification or further information at this agency may be directed to –

Name ____
Agency ____
Phone ____
e-mail ____

Thank you for your participation in this important project. The results of the survey will be made publicly available in the final report of the National Multiple Family Submetering and Allocation Program Study.

Please fax the completed survey to Potomac Resources, Inc. at 202-429-2248.

October 2002

Survey of State Weights and Measures Officials for the National Multiple Family Submetering and Allocation Program Study

Please fax the completed survey to Potomac Resources, Inc. at 202-429-2248.

Definitions

For purposes of this survey, billing allocation systems consist of –

Submetering and *submetered systems* refer to the installation of water measurement devices in each dwelling unit of a multiple family apartment building and the use of such devices for billing each occupied unit for water service, sewer service, and/or the energy cost of domestic hot water, based upon the unit's measured consumption; or

Ratio Utility Billing System, or *RUBS*, is the practice of allocating the total cost of water service, sewer service, and/or the energy cost of domestic hot water in a multiple family apartment building for payment by each occupied unit based upon a formula allocation of the building's primary utility bill. Such allocations may be based upon a unit's floor area, number of bedrooms, number of occupants, or measured hot water usage.

A. Billing Allocation Overview

1. Is the practice of submetering multiple family apartments allowed by your state or agency? Yes ____ No ____ For purposes of this survey, if submetering is not explicitly prohibited, we assume it is allowed.

2. Is the use of a ratio billing system, or RUBS, in multiple family apartments allowed by your state or agency? Yes ____ No ____ For purposes of this survey, if RUBS is not explicitly prohibited, we assume it is allowed.

3. Does the state require submetering in some situations, such as new apartment construction? Yes ____ No ____ If yes, please specify. ____
____

4. Does the state offer incentives for submetering, in either new apartment construction or installation in existing structures? Yes ____ No ____ If yes, please specify. ______________
____

5. Are apartment owners or managers required to inform any public agencies when a submetering system or RUBS system is placed in service? Yes ____ No ____ If yes, must they inform —
    a. the public water system providing service to the master meter? Yes ____ No ____
    b. the wastewater service provider? Yes ____ No ____
    c. any state agency? Yes _____ No _____ If yes, please specify. ___________________

B. Weights and Measures Issues

1. Has the state adopted any standard for the accuracy of meters used in submetering multiple family apartments?

Yes ____ No ____ If yes, what is the standard? ______________________________________

____

If yes, is this standard mandatory for all submeters installed in this state? Yes _____ No _____

2. Does the state require testing for the accuracy of apartment submeters –
   a. Prior to installation ____ OR upon field installation (i.e., in the "as installed" position)____;
   b. By a public official ____ OR by the manufacturer or installer ____ ;
   c. By testing each individual meter ____ OR by testing a representative sample ____? If a sample, what size? _____
   d. Periodically *after* installation? _____ If so –
      i. How often? _____
      ii. What percent tested each year? _____

3. Does the state require periodic replacement of installed submeters? Yes _____ No _____
   If yes, how long may a submeter remain in operation before replacement is required? _________

4. Does your agency have any other regulations or guidelines that pertain to submetering or RUBS?
   Yes ____ No ____ If yes, please specify. ____
   ____

5. Is your agency currently considering any *new* regulations or guidelines that pertain to submetering or RUBS? Yes ____ No ____ If yes, please specify.________________________
   ____

6. Does the state building code and/or plumbing code require the issuance of a permit for the installation of submeters in existing multiple family apartment structures? Yes ____ No _____

7. Are you aware of any statutes, regulations, or guidelines of any other state agency or local jurisdiction in your state that pertain to submetering or RUBS? Yes ____ No ____ If yes, please specify. ____
   ____
   ____
   ____

Requests for clarification or further information at this agency may be directed to –

Name ____
Agency ____
Phone ____
e-mail ____

Thank you for your participation in this important project. The results of the survey will be made publicly available in the final report of the National Multiple Family Submetering and Allocation Program Study.

Please fax the completed survey to Potomac Resources, Inc. at 202-429-2248.

National Multiple Family Submetering and Allocation Billing Program Study
Survey of Drinking Water Utility Managers

September 2003

Please **fax** this survey when complete to Potomac Resources, Inc. at 202-429-2248, or return by
e-mail to <submeteringsurvey@starpower.net>.

Definitions

For purposes of this survey, billing allocation systems consist of –

Submetering and ***submetered systems***, which refer to the installation of water measurement devices in each dwelling unit of a multiple family apartment building and the use of such devices for billing each occupied unit for water service, wastewater service, and/or the energy cost of domestic hot water, based upon the unit's measured consumption; or

Ratio Utility Billing System, or ***RUBS***, which is the practice of allocating the total cost of water service, wastewater service, and/or the energy cost of domestic hot water in a multiple family apartment building for payment by each occupied unit based upon a formula allocation of the building's primary utility bill. Such allocations may be based upon a unit's floor area, number of bedrooms, number of occupants, or measured hot water usage.

Characteristics of this Utility

1. Utility name____
2. Mailing Address____
   ____
3. Is this utility a public agency or a private company or corporation? ❑ Public ❑ Private
4. Do you serve retail customers or wholesale customers? ❑ Retail ❑ Wholesale ❑ Both
5. What is the population served by this utility? ______________________________
   5a. Approximately what percent of your customers are multi-family housing accounts? _______%

Billing Allocation Policies

6. Does this utility allow the resale of your water by third parties? ❑Yes ❑No
   6a. If yes, does this utility allow the resale of water at a profit by third parties? ❑Yes ❑No
7. Does this utility have regulations regarding multi-family sub-metering programs? ❑Yes ❑No
   7a. If yes, is sub-metering allowed? ❑Yes ❑No
   7b. If no, what is the primary reason for prohibiting it? ________________________________
8. Does this utility have regulations regarding multi-family billing allocation (RUBS) programs? ❑Yes ❑No
   8a. If yes, are billing allocation programs allowed? ❑Yes ❑No
   8b. If no, what is the primary reason for prohibiting it? _______________________________
9. Are apartment owners or managers required to inform this utility when a submetering system or RUBS system is placed in service? ❑Yes ❑No
10. Does this utility currently install sub-meters (or individual meters) in individual units in any apartment buildings? ❑Yes ❑No
    10a. If no, do you plan to individually meter units in new multi-family construction? ❑Yes ❑No
    10b. If yes, within the next: ❑ 1-3 years ❑ 4-6 years ❑ 7-10 years
    10c. If no, what is the primary reason that your utility does not seek to sub-meter individual apartment units?
    ____
11. Does this utility provide any financial incentives or rebates for apartment owners that invest in sub-metering equipment? ❑Yes ❑No
    11a. If yes, how much of an incentive do you offer? $_________
    11b. If no, do you plan on offering an incentive in the future? ❑Yes ❑No

12. If your utility has any existing regulations or written guidance regarding sub-metering or billing allocation programs, it would be greatly appreciated if you could forward them by fax or by e-mail along with this completed survey to Potomac Resources.

Contact Information

Requests for clarification or further information at this utility may be directed to –

Name ____
Phone ____
e-mail ____

Thank You

Thank you for your participation in this important project. The results of the survey will be made publicly available in the final report of the National Multiple Family Submetering and Allocation Billing Program Study.

Please **fax** the completed survey to Potomac Resources, Inc. at 202-429-2248, or return by **e-mail** to <submeteringsurvey@starpower.net>.

APPENDIX B

ENUMERATED SURVEY RESPONSES

POSTCARD SURVEY RESPONSES

Question #1: Billing Method

How are residents billed for water usage at this property?	In-rent or HOA	Submetered	RUBS	Hot water hybrid	Other	All Properties
It is included in the rent or in the resident/homeowner association dues	100.0%	.0%	.0%	.0%	.0%	85.3%
The water bill for each unit is based on the amount of hot water each unit uses	.0%	.0%	.0%	100.0%	.0%	.5%
Each unit has its own individual water meter and individual units are charged for the water they use	.0%	100.0%	.0%	.0%	.0%	3.9%
The water bill for each unit is calculated based on the square footage, the number of rooms, or the number of occupants, etc.	.0%	.0%	100.0%	.0%	.0%	9.1%
Other	.0%	.0%	.0%	.0%	100.0%	1.2%
Total	100.0% N=6760	100.0% N=311	100.0% N=717	100.0% N=42	100.0% N=92	100.0% N=7922

Question #2: Billing Party

Who bills residents for water usage at this property?	**In-rent or HOA**	**Submetered**	**RUBS**	**Hot water hybrid**	**Other**	**All Properties**
No one, it is included in the rent or homeowner association dues	93.6%	.8%	2.5%	10.0%	20.3%	83.9%
A separate company billing service (not the property manager or landlord)	.1%	38.1%	64.4%	45.0%	1.3%	5.4%
The property management company, landlord/owner, or resident/homeowner association	1.6%	32.5%	27.6%	15.0%	7.6%	4.3%
The local utility	1.6%	28.2%	3.0%	30.0%	8.9%	2.9%
Other	3.1%	.4%	2.5%	.0%	62.0%	3.6%
Total	100.0% N=6631	100.0% N=252	100.0% N=435	100.0% N=40	100.0% N=79	100.0% N=7437

Question #3: Number of Units

How many units are on this property?	**In-rent or HOA**	**Submetered**	**RUBS**	**Hot water hybrid**	**Other**	**All Properties**
10 or fewer	28.2%	9.5%	6.6%	35.7%	26.1%	25.8%
11 - 20	30.4%	18.3%	5.6%	11.9%	15.9%	27.7%
21 - 50	22.2%	16.5%	11.3%	11.9%	21.6%	21.0%
51 - 100	8.7%	10.6%	9.7%	14.3%	10.2%	8.9%
101 - 200	6.3%	14.4%	27.1%	11.9%	14.8%	8.4%
201 - 300	2.3%	9.9%	22.2%	7.1%	5.7%	4.2%
301 - 500	1.6%	16.9%	14.0%	4.8%	4.5%	3.2%
more than 500	.3%	3.9%	3.6%	2.4%	1.1%	.8%
Total	100.0% N=6635	100.0% N=284	100.0% N=609	100.0% N=42	100.0% N=88	100.0% N=7658
Average Number of Units per Property	43	167	184	93	82	60

MANAGER SURVEY RESPONSES

Question #1: Property Classification

How is the property classified?	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
Government subsidized	10.1%	.0%	2.9%	3.7%	16.7%	7.5%
Private rental	58.5%	74.4%	84.5%	88.9%	33.3%	65.9%
Condominium	18.9%	11.2%	4.5%	.0%	.0%	14.8%
Private resident owned	9.1%	12.8%	2.9%	3.7%	16.7%	8.1%
Other	3.4%	1.6%	5.3%	3.7%	33.3%	3.7%
Total	100.0% N=824	100.0% N=125	100.0% N=245	100.0% N=27	100.0% N=6	100.0% N=1227

Question #2: Types of Buildings

What types of buildings are on this property?*	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
1 to 2 stories	66.4%	73.4%	68.8%	57.1%	66.7%	67.4%
3 to 5 stories	24.3%	23.4%	28.1%	35.7%	16.7%	25.2%
more than 5 stories	9.6%	3.1%	3.5%	7.1%	16.7%	7.7%
Number	N=857	N=128	N=256	N=28	N=6	N=1275

* Percents may add to more than 100% as respondents could give more than one answer.

Question #3: Number of Residential Buildings

How many residential buildings are on this property?	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
1	36.6%	18.0%	18.6%	21.4%	16.7%	30.6%
2	8.5%	1.6%	4.3%	10.7%	33.3%	7.1%
3 - 5	16.3%	10.9%	8.5%	14.3%	.0%	14.0%
6 - 10	12.4%	19.5%	14.3%	17.9%	.0%	13.6%
11 - 20	14.4%	21.9%	29.1%	14.3%	16.7%	18.2%
21 - 30	4.7%	14.1%	12.0%	14.3%	.0%	7.3%
31 or more	7.1%	14.1%	13.2%	7.1%	33.3%	9.2%
Total	100.0% N=847	100.0% N=128	100.0% N=258	100.0% N=28	100.0% N=6	100.0% N=1 267

Question #4: Number of Dwelling Units

How many units are in this property?	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
10 or fewer	8.9%	10.1%	4.2%	3.6%	16.7%	8.0%
11 - 20	19.2%	21.7%	5.0%	10.7%	.0%	16.3%
21 - 50	20.5%	14.7%	11.6%	7.1%	16.7%	17.8%
51 - 100	19.4%	10.1%	8.5%	17.9%	.0%	16.2%
101 - 200	19.5%	9.3%	27.8%	28.6%	16.7%	20.4%
201 - 300	6.6%	11.6%	21.6%	7.1%	.0%	10.1%
301 - 500	4.5%	19.4%	17.8%	21.4%	33.3%	9.2%
more than 500	1.4%	3.1%	3.5%	3.6%	16.7%	2.1%
Total	100.0% N=865	100.0% N=129	100.0% N=259	100.0% N=28	100.0% N=6	100.0% N=1287
Average number of units in the property	98	152	195	200	249	126

Question #5: Types of Units

Proportion of Units of Each Type	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
Percent of units that are efficiency/studio units	11%	3%	8%	3%	33%	10%
Percent of units that are 1 bedroom units	40%	25%	44%	45%	23%	40%
Percent of units that are 2 bedroom units	40%	56%	41%	49%	44%	42%
Percent of units that are 3 bedroom units	8%	14%	6%	3%	0%	8%
Percent of units that are 4 or more bedroom units	1%	2%	1%	0%	0%	1%
Number of Properties	N=803	N=120	N=239	N=27	N=6	N=1195

Question #6: Typical Rent by Type of Unit

Typical rent for the following types of units*	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
Monthly rent for efficiency/studio	$507	$598	$544	$691	$734	$526
Monthly rent for 1 bedroom	$607	$773	$641	$735	$827	$635
Monthly rent for 2 bedrooms	$766	$903	$823	$962	$1,081	$804
Monthly rent for 3 bedrooms	$967	$1,191	$1,042	$1,215	N/A†	$1,030
Monthly rent for 4 or more bedrooms	$1,131	$942	$1,252	N/A†	N/A†	$1,128
Monthly rent for all units	$665	$837	$727	$843	$843	$702
Monthly rent per bedroom	$466	$494	$491	$542	$594	$477
Number of Properties	N=583	N=94	N=217	N=25	N=4	N=923

* If the property is a rental, what is the typical rent for the following types of units that are on the property?

† Data not available, units of this type not surveyed.

Question #7: Number of People per Property

Approximately how many people live on the property in total?	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
10 or fewer	4.6%	9.3%	4.7%	9.5%	.0%	5.1%
11 - 20	21.0%	14.4%	3.8%	9.5%	20.0%	16.9%
21 - 50	17.6%	15.5%	9.5%	4.8%	20.0%	15.6%
51 - 100	17.0%	7.2%	8.1%	.0%	.0%	14.0%
101 - 200	17.0%	14.4%	10.9%	28.6%	20.0%	15.8%
201 - 300	8.3%	4.1%	9.5%	9.5%	.0%	8.1%
301 - 500	6.8%	13.4%	28.0%	9.5%	.0%	11.5%
more than 500	7.8%	21.6%	25.6%	28.6%	40.0%	13.0%
Total	100.0% N=761	100.0% N=97	100.0% N=211	100.0% N=21	100.0% N=5	100.0% N=1095
Average number of people on the property	177	293	386	392	431	233
Average number of people per unit	1.97	1.88	2.00	1.72	1.72	1.96

Question #8: Year of Construction

In what year was the construction of the property completed?	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
1930 or earlier	7.3%	.8%	1.6%	.0%	.0%	5.3%
1931 to 1950	3.2%	1.7%	3.3%	3.7%	.0%	3.1%
1951 to 1960	5.8%	.8%	1.2%	7.4%	.0%	4.4%
1961 to 1970	23.4%	7.5%	14.6%	.0%	.0%	19.4%
1971 to 1980	29.3%	9.2%	24.0%	7.4%	33.3%	25.7%
1981 to 1990	22.2%	32.5%	35.4%	55.6%	16.7%	26.7%
1991 to 1994	2.1%	6.7%	2.4%	7.4%	50.0%	3.0%
1995 to 2000	6.1%	33.3%	15.4%	14.8%	.0%	10.9%
2001 to 2003	.5%	7.5%	2.0%	3.7%	.0%	1.6%
Total	100.0% N=805	100.0% N=120	100.0% N=246	100.0% N=27	100.0% N=6	100.0% N=1204

Question #10 and #11: Acreage and Irrigated Landscape

Acreage and percent irrigated landscape		In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
About how many acres is the total property?	Mean	377	8,254	38	4,391	22	1,276
	Standard Deviation	5,280	79,602	387	20,074	33	26,993
	Number of Properties	N=583	N=97	N=172	N=21	N=4	N=877
About what percent of the total property is irrigated landscape?	Mean	23%	26%	32%	43%	27%	25%
	Standard Deviation	28%	30%	33%	37%	17%	30%
	Number of Properties	N=727	N=88	N=206	N=24	N=4	N=1049

Question #11: Separate Water Meter for Irrigation

Is there a separate water meter for irrigation?	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
Yes	20.6%	37.1%	29.9%	25.0%	33.3%	24.3%
No	68.2%	51.6%	54.2%	64.3%	50.0%	63.5%
Don't know	11.2%	11.3%	15.9%	10.7%	16.7%	12.2%
Total	100.0% N=829	100.0% N=124	100.0% N=251	100.0% N=28	100.0% N=6	100.0% N=1238

Question #12: Separate Source of Water for Irrigation

Separate source of water for irrigation*	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
Yes	1.9%	6.3%	2.0%	3.7%	.0%	2.4%
No	94.3%	88.2%	91.7%	92.6%	66.7%	93.0%
Don't know	3.8%	5.5%	6.3%	3.7%	33.3%	4.6%
Total	100.0% N=844	100.0% N=127	100.0% N=254	100.0% N=27	100.0% N=6	100.0% N=1258

* Do you have a separate source of water such as a well or ditch for irrigation?

Question #13: Current Vacancy Rate

	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
0%	36.6%	25.0%	12.4%	14.8%	25.0%	29.9%
1% - 3%	15.4%	9.2%	16.5%	14.8%	25.0%	15.0%
4% - 5%	14.5%	17.5%	14.9%	22.2%		15.0%
6% - 7%	4.5%	13.3%	10.8%	18.5%	25.0%	7.1%
8% - 9%	5.1%	10.0%	16.5%	11.1%	25.0%	8.2%
10%	8.8%	9.2%	8.0%	7.4%		8.6%
11% - 15%	6.5%	5.8%	13.3%	3.7%		7.8%
16% or more	8.5%	10.0%	7.6%	7.4%		8.4%
Total	100.0% N=798	100.0% N=120	100.0% N=249	100.0% N=27	100.0% N=4	100.0% N=1198
Mean	5.6	7.0	7.2	5.9	3.8	6.0
Std Deviation	7.6	7.9	5.8	4.8	3.9	7.3
Number	N=798	N=120	N=249	N=27	N=4	N=1198

Question #14: Vacancy Rate Trend

Vacancy rate gone up, gone down, or stayed about the same*	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
Gone up	26.7%	34.4%	29.3%	46.4%	16.7%	28.4%
Gone down	12.3%	5.6%	23.8%	21.4%	33.3%	14.3%
Stayed about the same	54.7%	52.8%	39.8%	32.1%	50.0%	51.0%
Don't know	6.3%	7.2%	7.0%	.0%	.0%	6.3%
Total	100.0% N=845	100.0% N=125	100.0% N=256	100.0% N=28	100.0% N=6	100.0% N=1260

* Over the last two or three years, has the vacancy rate gone up, gone down, or stayed about the same?

Question #15: Senior Citizen Community

Is the property considered a retirement community?*	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
Yes	12.1%	5.5%	.0%	3.6%	16.7%	8.9%
No	87.6%	94.5%	98.8%	96.4%	83.3%	90.8%
Don't know	.2%	.0%	1.2%	.0%	.0%	.4%
Total	100.0% N=858	100.0% N=127	100.0% N=257	100.0% N=28	100.0% N=6	100.0% N=1276

* Is the property considered a senior citizen/retirement community?

Question #16: Water-Using Features and Amenities

Which features and amenities can be found on the property?*	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
Sauna/steam room	10.8%	6.9%	14.8%	16.0%	16.7%	11.5%
Water features/fountains	12.6%	29.9%	25.3%	28.0%	33.3%	17.2%
Landscape ponds	5.7%	13.8%	5.9%	20.0%	.0%	6.7%
Play area	18.5%	28.7%	17.3%	24.0%	.0%	19.1%
Tennis courts	7.9%	10.3%	18.1%	32.0%	33.3%	11.0%
Basketball courts	7.3%	12.6%	13.5%	8.0%	16.7%	9.2%
Hot tub	20.3%	46.0%	46.0%	68.0%	50.0%	29.3%
Exercise room	22.4%	50.6%	56.5%	76.0%	50.0%	33.5%
Common shower	15.9%	21.8%	22.4%	40.0%	66.7%	18.6%
Common kitchen	16.7%	25.3%	15.6%	40.0%	50.0%	17.9%
Club house	26.7%	50.6%	53.2%	72.0%	33.3%	35.5%
Cooling tower	7.7%	.0%	2.5%	.0%	16.7%	5.8%
Common bathrooms	28.5%	56.3%	43.9%	64.0%	66.7%	35.1%
One common laundry room/facility	56.2%	34.5%	46.8%	24.0%	50.0%	51.6%
More than one common laundry room/facility	28.2%	20.7%	44.7%	32.0%	33.3%	31.3%
Food service facility/restaurant	5.0%	1.1%	1.3%	4.0%	16.7%	3.9%
Store or other commercial facility	2.6%	3.4%	2.1%	.0%	16.7%	2.6%
Other	3.3%	5.7%	.8%	.0%	.0%	2.9%
Number	N=724	N=87	N=237	N=25	N=6	N=1079

* Percent of properties with each feature or amenity.

Question #17: Pool Status

Does the property have a pool?	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
Yes, indoor	2.6%	2.4%	2.7%	.0%	.0%	2.5%
Yes, outdoor	40.5%	48.8%	71.6%	53.6%	50.0%	47.9%
Yes, indoor and outdoor	.3%	.8%	1.2%	3.6%	.0%	.6%
Yes, type unspecified	2.0%	1.6%	2.7%	7.1%	.0%	2.2%
No	54.6%	46.5%	21.8%	35.7%	50.0%	46.8%
Total	100.0% N=862	100.0% N=127	100.0% N=257	100.0% N=28	100.0% N=6	100.0% N=1280

Question #18: Outdoor Sprinkler System Status

Does the property have an outdoor sprinkler system?	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
Yes	61.4%	77.3%	77.6%	75.0%	83.3%	66.7%
No	37.9%	22.7%	21.2%	21.4%	16.7%	32.5%
Don't know	.7%	.0%	1.2%	3.6%	.0%	.8%
Total	100.0% N=848	100.0% N=128	100.0% N=255	100.0% N=28	100.0% N=6	100.0% N=1265

Question #18, follow-up: Months of Irrigation

What is the typical number of months for irrigation?	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
Zero	43.0%	30.2%	30.1%	28.6%	16.7%	38.7%
One	.1%	.0%	.8%	.0%	.0%	.2%
Two	1.4%	.0%	1.2%	.0%	.0%	1.2%
Three	1.7%	2.3%	2.7%	7.1%	16.7%	2.2%
Four	4.7%	4.7%	3.1%	10.7%	16.7%	4.6%
Five	5.1%	3.1%	4.2%	10.7%	.0%	4.8%
Six	4.6%	3.9%	7.3%	7.1%	.0%	5.1%
Seven	3.0%	1.6%	5.0%	.0%	.0%	3.2%
Eight	2.1%	.8%	1.2%	3.6%	.0%	1.8%
Nine	.8%	.0%	.4%	.0%	.0%	.6%
Ten	.5%	.0%	.0%	.0%	.0%	.3%
Twelve -- All Year Round	32.9%	53.5%	44.0%	32.1%	50.0%	37.3%
Total	100.0% N=865	100.0% N=129	100.0% N=259	100.0% N=28	100.0% N=6	100.0% N=1287

Question #19: Washing Machine Hook-ups

Do the units come with hook-ups for washing machines?	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
Yes	32.0%	81.1%	56.1%	78.6%	50.0%	42.8%
No	65.8%	18.9%	43.5%	21.4%	50.0%	55.6%
Don't know	2.2%	.0%	.4%	.0%	.0%	1.6%
Total	100.0% N=856	100.0% N=127	100.0% N=253	100.0% N=28	100.0% N=6	100.0% N=1270

Question #19, follow-up: Percent of Units with Washing Machines

What percent of the units have washing machines?*		In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
What percent of units have washing machines?	Mean	81%	94%	73%	89%	89%	81%
	Standard Deviation	32%	14%	34%	24%	11%	31%
	Number of Properties	N=219	N=74	N=124	N=19	N=3	N=439

* Only of properties where the units come with washing machine hook-ups

Question #20: Dishwasher Status

Do all or some of the units come equipped with dishwashers?	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
Yes	59.8%	88.3%	89.8%	92.9%	50.0%	69.4%
No	37.0%	9.4%	10.2%	7.1%	50.0%	28.3%
Don't know	3.2%	2.3%	.0%	.0%	.0%	2.4%
Total	100.0% N=856	100.0% N=128	100.0% N=256	100.0% N=28	100.0% N=6	100.0% N=1274

Question #21: Washing Machine Replacement

Have any of the washing machines been replaced since 1995?	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
Yes, less than 25%	6.5%	3.5%	9.7%	11.5%	16.7%	7.0%
Yes, 25% to 49%	4.8%	.9%	5.6%	19.2%	.0%	4.9%
Yes, 50% to 75%	3.7%	2.6%	3.6%	3.8%	16.7%	3.6%
Yes, 76% to 99%	2.9%	.9%	2.1%	3.8%	.0%	2.5%
Yes, All	12.1%	5.3%	14.4%	7.7%	50.0%	11.9%
Yes, don't know what percent	16.1%	5.3%	7.7%	7.7%	.0%	12.8%
No	20.6%	7.0%	13.8%	23.1%	16.7%	17.7%
Don't know	24.7%	31.6%	21.0%	3.8%	.0%	24.0%
Property built 1995 or later	8.5%	43.0%	22.1%	19.2%	.0%	15.6%
Total	100.0% N=620	100.0% N=114	100.0% N=195	100.0% N=26	100.0% N=6	100.0% N=961

Question #22: Toilet Replacement

Have any of the toilets been replaced since 1995?	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
Yes, less than 25%	24.8%	9.8%	26.4%	35.7%	16.7%	23.8%
Yes, 25% to 49%	11.7%	7.3%	8.8%	10.7%	33.3%	10.7%
Yes, 50% to 75%	7.1%	4.1%	4.8%	10.7%	.0%	6.4%
Yes, 76% to 99%	3.6%	2.4%	2.4%	.0%	.0%	3.1%
Yes, All	11.2%	6.5%	11.6%	3.6%	16.7%	10.7%
Yes, don't know what percent	11.1%	15.4%	12.4%	7.1%	16.7%	11.7%
No	7.6%	5.7%	6.8%	14.3%	16.7%	7.4%
Don't know	16.7%	8.9%	9.6%	.0%	.0%	14.0%
Property built 1995 or later	6.4%	39.8%	17.2%	17.9%	.0%	12.1%
Total	100.0% N=832	100.0% N=123	100.0% N=250	100.0% N=28	100.0% N=6	100.0% N=1239

Question #23: Faucet Replacement

Have any of the faucets been replaced since 1995?	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
Yes, less than 25%	20.0%	10.7%	15.4%	25.9%	16.7%	18.3%
Yes, 25% to 49%	17.6%	8.2%	17.5%	7.4%	16.7%	16.4%
Yes, 50% to 75%	14.0%	4.1%	16.3%	33.3%	16.7%	13.9%
Yes, 76% to 99%	4.6%	.8%	4.1%	3.7%	.0%	4.1%
Yes, All	4.2%	6.6%	5.7%	.0%	16.7%	4.7%
Yes, don't know what percent	15.7%	18.9%	14.6%	7.4%	33.3%	15.7%
No	3.8%	.8%	2.4%	3.7%	.0%	3.2%
Don't know	13.7%	9.8%	6.5%	.0%	.0%	11.5%
Property built 1995 or later	6.4%	40.2%	17.5%	18.5%	.0%	12.2%
Total	100.0% N=826	100.0% N=122	100.0% N=246	100.0% N=27	100.0% N=6	100.0% N=1227

Question #24: Showerhead Replacement

Have any of the showerheads been replaced since 1995?	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
Yes, less than 25%	13.0%	8.2%	10.1%	18.5%	.0%	12.0%
Yes, 25% to 49%	12.9%	4.9%	11.3%	7.4%	16.7%	11.7%
Yes, 50% to 75%	11.1%	5.7%	12.5%	7.4%	.0%	10.7%
Yes, 76% to 99%	6.4%	4.9%	7.3%	7.4%	.0%	6.4%
Yes, All	15.7%	4.9%	18.1%	25.9%	50.0%	15.5%
Yes, don't know what percent	14.3%	18.0%	13.3%	7.4%	33.3%	14.4%
No	4.7%	1.6%	2.8%	7.4%	.0%	4.1%
Don't know	15.4%	11.5%	7.3%	.0%	.0%	13.0%
Property built 1995 or later	6.4%	40.2%	17.3%	18.5%	.0%	12.2%
Total	100.0% N=823	100.0% N=122	100.0% N=248	100.0% N=27	100.0% N=6	100.0% N=1226

Question #25: Water Billing Method

How are residents billed for water usage at this property?	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
included in rent or in the resident/hoa dues	100.0%	.0%	.0%	.0%	.0%	67.3%
based on the amount of hot water used	.0%	.0%	.0%	100.0%	.0%	2.2%
individual water meters; charged for individual water usage	.0%	100.0%	.0%	.0%	.0%	10.0%
calculated on square footage	.0%	.0%	18.5%	.0%	.0%	3.7%
calculated on number of rooms	.0%	.0%	4.6%	.0%	.0%	.9%
calculated on number of occupants	.0%	.0%	62.5%	.0%	.0%	12.6%
other calculation	.0%	.0%	14.3%	.0%	.0%	2.9%
other	.0%	.0%	.0%	.0%	60.0%	.2%
multiple methods	.0%	.0%	.0%	.0%	40.0%	.2%
Total	100.0% N=865	100.0% N=129	100.0% N=259	100.0% N=28	100.0% N=5	100.0% N=1286

Question #26: Why billing method was chosen

Why was this billing method selected?*	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
It conserves water usage by residents	1.9%	49.6%	32.0%	48.1%	33.3%	14.5%
It is the easiest way to bill for water usage	25.7%	45.7%	39.5%	33.3%	33.3%	31.0%
Increased profitability of property	3.2%	19.7%	21.9%	33.3%	33.3%	9.7%
We must comply with local laws and regulations	5.2%	8.7%	16.4%	18.5%	16.7%	8.3%
It is the least expensive way to bill for water	11.8%	9.4%	16.4%	18.5%	33.3%	12.8%
Other	32.1%	9.4%	11.3%	14.8%	16.7%	24.8%
Don't know	34.3%	21.3%	21.5%	14.8%	33.3%	29.8%
Number	N=789	N=127	N=256	N=27	N=6	N=1205

* Percents may add to more than 100% as respondents could give more than one answer.

Question #27: Who bills the residents for water usage

Who bills the residents for water usage at this property?	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
No one, it is included in the rent or resident/homeowner association dues	91.4%	3.1%	7.0%	3.7%	33.3%	62.6%
A separate company billing service (not the property manager	.5%	44.9%	60.2%	77.8%	16.7%	19.3%
The property management company, landlord/owner, or resident	1.8%	29.9%	27.0%	7.4%	33.3%	10.2%
The local utility	1.7%	18.9%	2.7%	7.4%	.0%	3.8%
Other	3.3%	2.4%	2.7%	3.7%	16.7%	3.2%
Don't know	1.2%	.8%	.4%	.0%	.0%	1.0%
Total	100.0% N=815	100.0% N=127	100.0% N=256	100.0% N=27	100.0% N=6	100.0% N=1231

Question #28: Other services/utilities for which residents are billed

Which of the following are residents billed individually for?*	In-rent (or HOA)	Submetered	RUBS	Hot water hybrid	Other	Total
Natural gas/heating oil	26.9%	51.5%	21.9%	33.3%	50.0%	28.7%
Garbage	3.7%	31.5%	19.1%	37.5%	25.0%	10.7%
Electric	84.1%	93.8%	93.4%	100.0%	75.0%	87.4%
None	17.2%	16.9%	13.7%	20.8%	25.0%	16.6%
Other	7.3%	10.8%	12.5%	8.3%	.0%	8.8%
Don't know	1.0%	.0%	.0%	.0%	.0%	.7%
Number	N=806	N=130	N=256	N=24	N=4	N=1220

* Percents may add to more than 100% as respondents could give more than one answer.

Question #29: Considered Converting to RUBS or Submetering

Considered Converting to RUBS or Submetering* †	In-rent (or HOA)	Total
No	74.0%	74.0%
Yes	24.6%	24.6%
Don't know	1.4%	1.4%
Total	100.0% N=731	100.0% N=731

* Only asked of properties where residents are billed for water in-rent or through HOA dues

† Have you considered converting to individual water meters for each unit or billing for water using a calculation?

Question #29, follow-up: Issues Considered When Thinking About Converting to RUBS or Submetering

What did you consider when thinking about converting?* †	In-rent (or HOA)	Total
It conserved water usage by residents	52.5%	52.5%
It is the easiest way to bill for water usage	9.5%	9.5%
We must comply with local laws and regulations	3.4%	3.4%
It is the least expensive way to bill for water	10.1%	10.1%
Increased profitability of property	28.5%	28.5%
Too expensive	54.7%	54.7%
Resident resistance	37.4%	37.4%
Prohibited by law	1.7%	1.7%
Other	16.8%	16.8%
Don't know	3.9%	3.9%
Number	N=179	N=179

* Percents may add to more than 100% as respondents could give more than one answer.

† Only asked of those in-rent or HOA properties who considered converting

Question #30: How Long Current Billing System in Place

Current system in place since the property was developed* †	Submetered	RUBS	Hot water hybrid	Total
Since the property developed	47.1%	11.6%	21.4%	24.2%
At a later time	42.1%	75.3%	67.9%	63.7%
Don't know	10.7%	13.0%	10.7%	12.1%
Total	100.0% N=121	100.0% N=215	100.0% N=28	100.0% N=364

* Was the current billing system in place since the property was developed or put in at a later time?

† Only asked of properties using RUBS, submetering, or hot water hybrids

Question #30, follow-up: Year Converted

When was the current billing system put in place?*	Submetered	RUBS	Hot water hybrid	Total
1986	8.0%	.0%	.0%	1.1%
1990	8.0%	.7%	.0%	1.6%
1992	4.0%	.0%	.0%	.5%
1993	4.0%	.0%	.0%	.5%
1995	4.0%	.0%	.0%	.5%
1996	8.0%	.0%	.0%	1.1%
1997	.0%	4.1%	.0%	3.3%
1998	.0%	7.5%	30.8%	8.2%
1999	12.0%	18.5%	30.8%	18.5%
2000	16.0%	17.1%	.0%	15.8%
2001	12.0%	19.2%	15.4%	17.9%
2002	20.0%	22.6%	15.4%	21.7%
2003	4.0%	10.3%	7.7%	9.2%
Total	100.0% N=25	100.0% N=146	100.0% N=13	100.0% N=184

* Only asked of those who put new system in place after the property was developed

Question #31: Were There Resident Complaints When the New Billing System Was Put in Place

Were there resident complaints* †	Submetered	RUBS	Hot water hybrid	Total
Yes	21.8%	60.8%	47.4%	51.2%
No	67.3%	23.9%	26.3%	33.6%
Don't know	10.9%	15.3%	26.3%	15.2%
Total	100.0% N=55	100.0% N=176	100.0% N=19	100.0% N=250

* Were there resident complaints when the new water billing system was put in place?
† Only asked of properties using RUBS, submetering, or hot water hybrids

Question #31, follow-up: What Were Some of the Complaints among Those Properties Reporting Complaints

What were some of the complaints?* †	Submetered	RUBS	Hot water hybrid	Total
Too expensive	50.0%	61.4%	62.5%	60.3%
Unfair	16.7%	66.3%	87.5%	62.8%
Too complicated	.0%	8.9%	37.5%	9.9%
Other	50.0%	18.8%	37.5%	23.1%
Number	N=12	N=101	N=8	N=121

* Percents may add to more than 100% as respondents could give more than one answer.
† Only asked of properties using RUBS, submetering, or hot water hybrid; only asked of those where there were complaints

Question #32: Typical Rate of Non-Payment

What is the typical rate of non-payment of the water bill?*	Submetered	RUBS	Hot water hybrid	Total
0%	40.8%	37.3%	13.0%	36.2%
1% - 2%	14.5%	18.7%	26.1%	18.1%
3% - 5%	15.8%	15.1%	21.7%	15.8%
6% - 10%	13.2%	10.8%	21.7%	12.5%
11% - 15%	2.6%	6.0%	4.3%	4.9%
16% - 20%	6.6%	4.8%	4.3%	5.3%
21% or more	6.6%	7.2%	8.7%	7.2%
Total	100.0% N=76	100.0% N=166	100.0% N=23	100.0% N=265
Mean	6.1	6.4	7.4	6.4
Std Deviation	9.7	10.3	8.2	10.0
Number	N=76	N=166	N=23	N=265

* Only asked of properties using RUBS, submetering, or hot water hybrids

Question #33: Billing Frequency

How frequently are residents billed for water?*	Submetered	RUBS	Hot water hybrid	Total
Monthly	89.3%	97.2%	85.7%	93.7%
Bi-monthly	6.6%	1.4%	3.6%	3.3%
Quarterly	1.6%	.5%	3.6%	1.1%
Annually	.8%	.0%	.0%	.3%
Other	.0%	.9%	3.6%	.8%
Don't know	1.6%	.0%	3.6%	.8%
Total	100.0% N=122	100.0% N=217	100.0% N=28	100.0% N=367

* Only asked of properties using RUBS, submetering, or hot water hybrids

Question #35: Are Service Charges Included

Are wastewater service charges included in the water bill?*	Submetered	RUBS	Hot water hybrid	Total
Yes	84.3%	80.3%	96.3%	82.8%
No	8.3%	12.7%	3.7%	10.5%
Don't know	7.4%	7.0%	.0%	6.6%
Total	100.0% N=121	100.0% N=213	100.0% N=27	100.0% N=361

* Only asked of properties using RUBS, submetering, or hot water hybrids

Question #36: Property Owner/Manager Pay for Sending Water Bill to Residents

Owner/manager pay for sending water bills to residents?* †	Submetered	RUBS	Hot water hybrid	Total
Yes	46.3%	48.8%	35.7%	47.0%
No	46.3%	39.9%	50.0%	42.8%
Don't know	7.4%	11.3%	14.3%	10.2%
Total	100.0% N=121	100.0% N=213	100.0% N=28	100.0% N=362

* Does the property owner/manager pay for sending the water bills to residents?
† Only asked of properties using RUBS, submetering, or hot water hybrids

Question #37: Monthly Service Charge for Billing Service

Is there a monthly service charge?* †	Submetered	RUBS	Hot water hybrid	Total
Yes	45.9%	25.5%	60.7%	35.1%
No	41.8%	63.2%	35.7%	53.9%
Don't know	12.3%	11.3%	3.6%	11.0%
Total	100.0% N=122	100.0% N=212	100.0% N=28	100.0% N=362

* Is there a monthly service charge for the billing service added to residents' water bills?
† Only asked of properties using RUBS, submetering, or hot water hybrids

Question #38: What Were Some of the Administrative Difficulties Encountered

What were some of the admin. difficulties encountered?* †	Submetered	RUBS	Hot water hybrid	Total
None	60.3%	44.1%	35.7%	48.8%
Didn't have to convert	16.5%	5.9%	3.6%	9.2%
Difficulty obtaining permits	.0%	.0%	3.6%	.3%
Resistance from government or regulatory officials	.8%	.9%	3.6%	1.1%
Resistance from local water utility	.0%	.0%	3.6%	.3%
Resistance from residents	6.6%	28.2%	39.3%	22.0%
Don't know	10.7%	14.5%	21.4%	13.8%
Other	5.8%	10.5%	14.3%	9.2%
Number	N=121	N=220	N=28	N=369

* Percents may add to more than 100% as respondents could give more than one answer.
† Only asked of properties using RUBS, submetering, or hot water hybrids

Question #39: Does the Lease Include Language about Resident's Paying for Water

Lease include language about resident's paying for water?*	Submetered	RUBS	Hot water hybrid	Total
Property is not a rental	5.5%	2.3%	3.6%	3.4%
Yes	86.4%	94.9%	89.3%	91.8%
No	4.5%	2.3%	7.1%	3.4%
Don't know	3.6%	.5%	.0%	1.4%
Total	100.0% N=110	100.0% N=214	100.0% N=28	100.0% N=352

* Only asked of properties using RUBS, submetering, or hot water hybrids

Question #39, follow-up: Docking Resident Security Deposit

Can a resident's security deposit be docked?* †		Submetered	RUBS	Hot water hybrid	Total
Can a resident's security deposit be docked for failure to pay the water bill?	Yes	81.3%	82.1%	87.5%	82.3%
	No	17.6%	14.1%	4.2%	14.4%
	Don't know	1.1%	3.8%	8.3%	3.3%
Total		100.0% N=91	100.0% N=184	100.0% N=24	100.0% N=299

* Can a resident's security deposit be docked for failure to pay the water bill?
† Only asked of properties using RUBS, submetering, or hot water hybrids

Question #40: Meter Testing

Are there any provisions for testing the meters?* †	Submetered	Hot water hybrid	Total
Yes	26.0%	17.6%	25.0%
No	36.6%	47.1%	37.9%
Don't know	37.4%	35.3%	37.1%
Total	100.0% N=123	100.0% N=17	100.0% N=140

* If this property has individual water meters for each unit, are there provisions for testing the meters?
† Only asked of properties using submetering or hot water hybrids

Question #41: Required to test your water periodically

Required to test for quality by any regulatory agency?* †		Submetered	Hot water hybrid	Total
If this property had individual water meters for each unit, are you required to rest your water periodically for water quality by any regulatory agency?	Yes	7.8%	.0%	6.7%
	No	56.7%	73.3%	59.0%
	Don't know	35.6%	26.7%	34.3%
Total		100.0% N=90	100.0% N=15	100.0% N=105

* If this property had individual water meters for each unit, are you required to rest your water periodically for water quality by any regulatory agency?
† Only asked of properties using submetering or hot water hybrids

RESIDENT SURVEY RESPONSES

Question #1: Number of Water-Using Appliances or Fixtures

Indicate how many of each you have.*		**In-rent or HOA**	**Submetered**	**RUBS**	**Hot water hybrid**	**Utility-submetered**	**Total**
Toilets	None	.3%	.0%	.1%	.0%	.0%	.1%
	1	63.8%	47.1%	62.0%	65.6%	27.5%	58.7%
	2	30.9%	44.2%	34.5%	26.9%	58.8%	35.8%
	3	4.4%	8.4%	3.1%	7.5%	12.7%	5.0%
	4+	.7%	.3%	.3%	.0%	1.0%	.4%
Total		100.0% N=732	100.0% N=391	100.0% N=999	100.0% N=93	100.0% N=102	100.0% N=2317
Bathtub with shower	None	3.8%	1.3%	1.5%	.0%	1.0%	2.1%
	1	79.5%	55.4%	71.0%	79.3%	30.1%	69.5%
	2	16.0%	43.3%	27.4%	20.7%	68.0%	28.1%
	3	.3%	.0%	.1%	.0%	1.0%	.2%
	4+	.4%	.0%	.0%	.0%	.0%	.1%
Total		100.0% N=708	100.0% N=383	100.0% N=988	100.0% N=92	100.0% N=103	100.0% N=2274
Bathtub only (no shower)	None	94.8%	95.9%	95.8%	98.6%	96.3%	95.7%
	1	4.3%	3.0%	3.6%	1.4%	.0%	3.4%
	2	.4%	1.0%	.5%	.0%	3.8%	.7%
	3	.2%	.0%	.0%	.0%	.0%	.1%
	4+	.2%	.0%	.0%	.0%	.0%	.1%
Total		100.0% N=466	100.0% N=296	100.0% N=745	100.0% N=72	100.0% N=80	100.0% N=1659
Shower only (no tub)	None	74.6%	85.4%	86.3%	81.7%	90.2%	82.7%
	1	24.1%	14.0%	12.8%	16.9%	6.1%	16.2%
	2	1.2%	.6%	.6%	1.4%	3.7%	1.0%
	3	.2%	.0%	.1%	.0%	.0%	.1%
	4+	.0%	.0%	.1%	.0%	.0%	.1%
Total		100.0% N=519	100.0% N=308	100.0% N=783	100.0% N=71	100.0% N=82	100.0% N=1763
Whirlpool bathtub with jets	None	95.5%	94.4%	94.3%	100.0%	98.7%	95.1%
	1	3.7%	2.9%	4.3%	.0%	1.3%	3.6%
	2	.6%	2.0%	1.3%	.0%	.0%	1.1%
	3	.0%	.7%	.1%	.0%	.0%	.2%
	4+	.2%	.0%	.0%	.0%	.0%	.1%
Total		100.0% N=487	100.0% N=306	100.0% N=771	100.0% N=71	100.0% N=77	100.0% N=1712
Bathroom sink	None	.8%	.0%	.4%	.0%	1.0%	.5%
	1	63.2%	47.8%	58.2%	61.1%	22.0%	56.6%
	2	24.8%	38.3%	36.1%	27.8%	59.0%	33.6%
	3	9.8%	11.8%	4.2%	11.1%	17.0%	8.1%
	4+	1.4%	2.1%	1.0%	.0%	1.0%	1.3%
Total		100.0% N=726	100.0% N=389	100.0% N=996	100.0% N=90	100.0% N=100	100.0% N=2301

* Indicate how many of each of the following types of water-using appliances or fixtures you have.

Question #1: Number of Water-Using Appliances or Fixtures (continued)

Indicate how many of each you have.*		In-rent or HOA	Submetered	RUBS	Hot water hybrid	Utility-submetered	Total
Kitchen faucet	None	1.0%	1.0%	1.0%	.0%	.0%	.9%
	1	96.4%	97.1%	97.5%	98.9%	97.0%	97.1%
	2	1.8%	1.8%	1.2%	1.1%	2.0%	1.5%
	3	.1%	.0%	.2%	.0%	.0%	.1%
	4+	.7%	.0%	.1%	.0%	1.0%	.3%
Total		100.0% N=720	100.0% N=381	100.0% N=987	100.0% N=91	100.0% N=101	100.0% N=2280
Indoor utility sink	None	91.9%	92.2%	94.7%	94.7%	95.2%	93.5%
	1	7.8%	7.2%	4.9%	5.3%	4.8%	6.1%
	2	.2%	.3%	.4%	.0%	.0%	.3%
	3	.2%	.3%	.0%	.0%	.0%	.1%
Total		100.0% N=529	100.0% N=321	100.0% N=799	100.0% N=75	100.0% N=84	100.0% N=1808
Outdoor faucet/hose	None	62.4%	57.9%	86.5%	92.0%	48.9%	72.4%
	1	21.1%	18.0%	11.4%	8.0%	47.8%	17.1%
	2	13.7%	22.8%	1.7%	.0%	3.3%	9.2%
	3	1.2%	1.1%	.0%	.0%	.0%	.6%
	4+	1.5%	.3%	.4%	.0%	.0%	.7%
Total		100.0% N=582	100.0% N=356	100.0% N=825	100.0% N=75	100.0% N=90	100.0% N=1928

* Indicate how many of each of the following types of water-using appliances or fixtures you have.

Question #2: Presence of Other Water-Using Appliances or Fixtures

Do have any of the following?*		In-rent or HOA	Submetered	RUBS	Hot water hybrid	Utility-submetered	Total
Garbage disposal	Yes	77.3%	82.2%	88.5%	95.7%	84.5%	84.0%
	No	22.7%	17.8%	11.5%	4.3%	15.5%	16.0%
Total		100.0% N=728	100.0% N=388	100.0% N=1002	100.0% N=92	100.0% N=103	100.0% N=2313
Dishwashing machine	Yes	57.4%	88.0%	86.9%	96.7%	94.2%	78.8%
	No	42.6%	12.0%	13.1%	3.3%	5.8%	21.2%
Total		100.0% N=700	100.0% N=392	100.0% N=1000	100.0% N=92	100.0% N=103	100.0% N=2287
Evaporative/swamp cooler	Yes	4.1%	13.1%	3.4%	2.6%	1.1%	5.2%
	No	95.9%	86.9%	96.6%	97.4%	98.9%	94.8%
Total		100.0% N=653	100.0% N=359	100.0% N=890	100.0% N=77	100.0% N=93	100.0% N=2072

* Do you have any of the following types of water-using appliances or fixtures in or as part of your apartment/housing unit?

Question #3: Use of Water for Outdoor Plants

Do you use water from your apartment for any of the following?		In-rent or HOA	Submetered	RUBS	Hot water hybrid	Utility-submetered	Total
Potted plants	Yes	61.3%	62.4%	55.0%	51.6%	60.2%	58.3%
	No	38.7%	37.6%	45.0%	48.4%	39.8%	41.7%
Total		100.0% N=727	100.0% N=388	100.0% N=1003	100.0% N=91	100.0% N=103	100.0% N=2312
Outdoor lawn/garden/flower bed that you maintain (not common or community landscaping)	Yes	21.2%	21.2%	6.5%	3.5%	6.9%	13.5%
	No	78.8%	78.8%	93.5%	96.5%	93.1%	86.5%
Total		100.0% N=678	100.0% N=372	100.0% N=943	100.0% N=85	100.0% N=101	100.0% N=2179

Question #4: Presence of Washing Machine

Do you have a washing machine in your apartment/housing unit?	In-rent or HOA	Submetered	RUBS	Hot water hybrid	Utility-submetered	Total
No	64.6%	18.1%	45.2%	38.7%	78.6%	48.0%
Yes	35.4%	81.9%	54.8%	61.3%	21.4%	52.0%
Total	100.0% N=740	100.0% N=393	100.0% N=1009	100.0% N=93	100.0% N=103	100.0% N=2338

Question #4, follow-up part 1: Where Do Laundry

Where do you most commonly do your wash?*	In-rent or HOA	Submetered	RUBS	Hot water hybrid	Utility-submetered	Total
Common area laundry	85.1%	69.7%	80.3%	91.7%	78.9%	81.9%
Off-site laundry	11.8%	24.2%	14.3%	5.6%	14.5%	13.6%
Other	3.2%	6.1%	5.4%	2.8%	6.6%	4.5%
Total	100.0% N=442	100.0% N=66	100.0% N=442	100.0% N=36	100.0% N=76	100.0% N=1062

* Only asked of those who do not have a washing machine in their apartment

Question #4, follow-up part2: Type of Washing Machine

Is it a front- or top-loading machine?*	In-rent or HOA	Submetered	RUBS	Hot water hybrid	Utility-submetered	Total
Top-loading washing machine	88.0%	94.9%	91.0%	90.7%	86.4%	91.3%
Front-loading washing machine	12.0%	5.1%	9.0%	9.3%	13.6%	8.7%
Total	100.0% N=258	100.0% N=315	100.0% N=543	100.0% N=54	100.0% N=22	100.0% N=1192

* Only asked of those who have a washing machine in their apartment

Question #5, follow-up part 3: Average Number of gallons per flush

Please specify the gallons per flush of your toilet		In-rent or HOA	Submetered	RUBS	Hot water hybrid	Utility-submetered	Total
Toilet1 gallons per flush	Mean	3.26	2.24	3.03	2.24	2.68	2.86
	Std Deviation	5.73	1.90	5.13	1.33	1.44	4.59
	Number	N=199	N=165	N=252	N=31	N=15	N=662
Toilet2 gallons per flush	Mean	2.85	2.40	2.23	3.09	2.32	2.49
	Std Deviation	2.73	2.21	1.67	1.55	.83	2.19
	Number	N=77	N=96	N=84	N=7	N=9	N=273
Toilet3 gallons per flush	Mean	2.64	4.40	3.80	N/A*	2.05	3.64
	Std Deviation	1.52	3.75	2.67	N/A*	.64	3.02
	Number	N=12	N=19	N=4	N=0	N=2	N=37

* Data not available.

Question #6: Perceived Importance of Water Conservation

Please rate each of the following*		In-rent or HOA	Submetered	RUBS	Hot water hybrid	Utility-submetered	Total
How important is conserving water in your household?	Not important at all	2.4%	1.0%	2.0%	3.3%	4.0%	2.1%
	2	4.4%	3.6%	5.1%	1.1%	5.9%	4.5%
	3	21.9%	25.2%	24.2%	26.1%	24.8%	23.7%
	4	31.5%	32.6%	33.7%	31.5%	35.6%	32.9%
	Extremely important	39.8%	37.5%	34.9%	38.0%	29.7%	36.8%
Total		100.0% N=723	100.0% N=389	100.0% N=996	100.0% N=92	100.0% N=101	100.0% N=2301
How important is it for households in your community to conserve water on a regular basis?	Not important at all	3.0%	1.9%	3.1%	1.1%	7.7%	3.0%
	2	7.4%	7.2%	9.3%	5.7%	6.6%	8.1%
	3	24.1%	27.8%	26.2%	21.8%	28.6%	25.7%
	4	28.0%	25.3%	28.4%	34.5%	30.8%	28.1%
	Extremely important	37.4%	37.8%	33.1%	36.8%	26.4%	35.1%
Total		100.0% N=692	100.0% N=360	100.0% N=947	100.0% N=87	100.0% N=91	100.0% N=2177

* Please rate each of the following on a scale from 1 to 5, where 1 is "not at all important" and 5 is "extremely important."

Question #7: Water Conservation Action Taken by Household

In the last several years, has your household taken any action to conserve water?	In-rent or HOA	Submetered	RUBS	Hot water hybrid	Utility-submetered	Total
No	14.9%	16.1%	16.9%	18.5%	20.0%	16.3%
Yes	85.1%	83.9%	83.1%	81.5%	80.0%	83.7%
Total	100.0% N=727	100.0% N=391	100.0% N=996	100.0% N=92	100.0% N=100	100.0% N=2306

Question #7, follow-up: Type of Resident Water Conservation Action

What action resident has taken to conserve water*	In-rent or HOA	Submetered	RUBS	Hot water hybrid	Utility-submetered	Total
Take shorter showers	54.9%	58.5%	63.6%	58.1%	57.5%	59.5%
Installed low-flow showerheads	37.9%	30.2%	22.5%	32.4%	21.3%	29.1%
Installed water saver (inserts) in toilet	14.9%	8.9%	8.0%	4.1%	7.5%	10.2%
Installed ultra-low-flush toilets	23.8%	10.5%	8.8%	8.1%	3.8%	13.7%
Installed low-flow faucet aerators	14.4%	9.8%	6.4%	8.1%	.0%	9.4%
Use garbage disposal less often	48.5%	46.5%	55.1%	58.1%	52.5%	51.5%
Other	10.2%	6.8%	8.3%	4.1%	8.8%	8.5%
Use dishwasher les/use fuller loads	52.0%	76.9%	78.5%	83.8%	87.5%	70.3%
Use washing machine less/use fuller loads	48.6%	70.2%	56.8%	71.6%	38.8%	56.3%
Repaired leaks in faucet/toilet	50.4%	38.5%	41.7%	40.5%	56.3%	44.5%
Re-use household water	10.5%	8.3%	9.4%	8.1%	5.0%	9.4%
Washing car less often	28.0%	36.6%	28.4%	31.1%	36.3%	30.1%
Had a home water audit done	1.3%	.9%	.7%	.0%	.0%	.9%
Number	N=617	N=325	N=827	N=74	N=80	N=1923

* Percents may add to more than 100% as respondents could give more than one answer.

Question #8: Water Conservation Action Taken by Landlord

Landlord taken any action to conserve water?*	In-rent or HOA	Submetered	RUBS	Hot water hybrid	Utility-submetered	Total
Not applicable (I am the owner)	17.8%	15.6%	2.9%	1.1%	2.0%	9.6%
Don't know	49.2%	66.8%	71.1%	78.3%	73.5%	63.9%
No	6.2%	9.9%	9.7%	6.5%	11.8%	8.6%
Yes	26.9%	7.7%	16.3%	14.1%	12.7%	17.9%
Total	100.0% N=726	100.0% N=392	100.0% N=999	100.0% N=92	100.0% N=102	100.0% N=2311

* In the last several years, has your landlord taken any action to conserve water?

Question #8, follow-up: Type of Landlord Water Conservation Action

What action landlord has taken to conserve water*	In-rent or HOA	Submetered	RUBS	Hot water hybrid	Utility-submetered	Total
Installed low-flow showerheads	47.2%	41.4%	43.6%	53.8%	30.8%	45.0%
Installed water saver (inserts) in toilet	25.9%	20.7%	16.0%	23.1%	15.4%	21.2%
Installed ultra-low-flush toilets	44.0%	27.6%	27.0%	30.8%	7.7%	34.5%
Other	14.5%	34.5%	14.7%	23.1%	.0%	15.8%
Installed low-flow faucet aerators	22.3%	17.2%	14.7%	15.4%	15.4%	18.5%
Repaired leaks in faucet/toilet	63.2%	48.3%	58.9%	30.8%	76.9%	59.9%
Re-use household water for landscaping	2.6%	.0%	1.8%	.0%	.0%	1.9%
Number	N=193	N=29	N=163	N=13	N=13	N=411

* Percents may add to more than 100% as respondents could give more than one answer.

Question #9: Sources of Water Conservation Information

From what sources have you heard about water conservation*	In-rent or HOA	Submetered	RUBS	Hot water hybrid	Utility-submetered	Total
None	7.2%	12.4%	11.2%	12.0%	11.8%	10.2%
Water bill inserts	34.6%	46.1%	41.0%	46.7%	66.7%	41.2%
Homeowner or apartment newsletters	23.1%	16.5%	22.5%	27.2%	18.6%	21.7%
Newspaper	49.9%	41.5%	44.6%	40.2%	31.4%	45.0%
Other	12.9%	10.6%	11.2%	7.6%	6.9%	11.3%
Radio public service announcements	31.5%	31.7%	30.9%	26.1%	18.6%	30.5%
Television public service announcements	49.9%	48.5%	44.2%	44.6%	30.4%	46.1%
Radio news	23.1%	19.1%	24.1%	19.6%	14.7%	22.3%
Television news	49.4%	43.0%	47.9%	45.7%	30.4%	46.7%
Number	N=726	N=388	N=992	N=92	N=102	N=2300

* Percents may add to more than 100% as respondents could give more than one answer.

Question #10: Water Billing Method According To Resident

How are you billed for water usage at this property?	In-rent or HOA	Submetered	RUBS	Hot water hybrid	Utility-submetered	Total
included in rent or in the resident/hoa dues	85.2%	11.3%	25.1%	8.7%	.0%	39.9%
based on the amount of hot water used	.4%	4.4%	3.3%	25.0%	.0%	3.3%
individual water meters; charged for individual water usage	1.0%	55.6%	7.8%	29.3%	.0%	14.2%
calculated on square footage	.1%	1.3%	8.0%	2.2%	.0%	3.8%
calculated on number of rooms	.0%	.0%	1.0%	.0%	.0%	.4%
calculated on number of bedrooms	.1%	.0%	2.0%	.0%	.0%	.9%
calculated on number of occupants	.0%	.5%	10.8%	.0%	.0%	4.8%
calculated on number of fixtures	.0%	.0%	.1%	.0%	.0%	.0%
other calculation	.6%	2.1%	14.6%	5.4%	.0%	7.1%
other	2.1%	3.1%	4.9%	.0%	.0%	3.3%
don't know	7.9%	17.9%	18.1%	23.9%	.0%	14.3%
multiple methods	2.6%	3.8%	4.2%	5.4%	.0%	3.5%
utility submetered	.0%	.0%	.0%	.0%	100.0%	4.5%
Total	100.0% N=725	100.0% N=390	100.0% N=999	100.0% N=92	100.0% N=103	100.0% N=2309

Question #11: Presence of Service Charge on Water Bill

Is a service charge added to your water bill?* †	In-rent or HOA	Submetered	RUBS	Hot water hybrid	Total
Yes	6.7%	43.8%	22.2%	32.5%	27.4%
No	25.0%	19.4%	27.2%	27.7%	25.0%
Don't know	68.3%	36.8%	50.5%	39.8%	47.6%
Total	100.0% N=104	100.0% N=340	100.0% N=742	100.0% N=83	100.0% N=1269

* Is a service charge added to your water bill in addition to the amount you owe for the water used?
† Only asked of those who receive a water bill

Question #11, follow-up: Amount of Service Charge per Bill

How much is the service charge?*	In-rent or HOA	Submetered	RUBS	Hot water hybrid	Total
Mean	6.23	3.91	4.61	4.17	4.27
Std Deviation	4.96	2.49	5.86	2.08	4.35
Number	N=3	N=129	N=128	N=24	N=284

* Only asked of those charged a service charge

Question #12: Opinion About Water Billing Method

What is your opinion about the way you are billed for water?	In-rent or HOA	Submetered	RUBS	Hot water hybrid	Utility-submetered	Total
I am satisfied with the way I am billed for water	45.6%	39.4%	37.1%	27.4%	53.4%	38.9%
I have no opinion about the way I am billed for water	40.0%	29.7%	23.6%	22.6%	30.1%	26.6%
I am dissatisfied with the way I am billed for water	14.4%	30.9%	39.4%	50.0%	16.5%	34.5%
Total	100.0% N=90	100.0% N=340	100.0% N=734	100.0% N=84	100.0% N=103	100.0% N=1351

Question #12, follow-up: Reason for Dissatisfaction

Why are you dissatisfied?*	In-rent or HOA	Submetered	RUBS	Hot water hybrid	Total
Rates	20.0%	27.8%	28.0%	30.0%	27.8%
Service charge	20.0%	33.3%	15.9%	20.0%	19.1%
Late fees	.0%	11.1%	9.8%	10.0%	9.6%
Accuracy of reported water consumption	.0%	22.2%	41.5%	60.0%	38.3%
Paying for other's/complex	20.0%	11.1%	35.4%	.0%	27.8%
No incentive to conserve	.0%	.0%	4.9%	.0%	3.5%
Billing method/calculation unclear	40.0%	16.7%	9.8%	10.0%	12.2%
Not based on my actual usage	.0%	11.1%	18.3%	.0%	14.8%
Based on square footage, not occupants	.0%	.0%	6.1%	.0%	4.3%
Other	60.0%	50.0%	47.6%	80.0%	51.3%
Number	N=5	N=18	N=82	N=10	N=115

* Percents may add to more than 100% as respondents could give more than one answer.

Question #13: Tried to Resolve a Complaint

Tried to resolve a complaint about your water billing?*	In-rent or HOA	Submetered	RUBS	Hot water hybrid	Utility-submetered	Total
Not applicable	51.0%	27.3%	25.6%	17.1%	35.3%	28.1%
No	42.0%	60.9%	62.8%	65.9%	53.9%	60.3%
Yes	7.0%	11.8%	11.6%	17.1%	10.8%	11.6%
Total	100.0% N=100	100.0% N=330	100.0% N=731	100.0% N=82	100.0% N=102	100.0% N=1345

* Have you ever tried to resolve a complaint about your water billing?

Question #13, follow-up part 1: Method Available for Resolving Complaint?

Was there a method set up for you to resolve your complaint?*	In-rent or HOA	Submetered	RUBS	Hot water hybrid	Utility-submetered	Total
No	66.7%	64.9%	67.4%	50.0%	45.5%	63.6%
Yes	33.3%	35.1%	32.6%	50.0%	54.5%	36.4%
Total	100.0% N=6	100.0% N=37	100.0% N=86	100.0% N=14	100.0% N=11	100.0% N=154

* Only asked of those who tried to resolve a complaint

Question #13, follow-up part 2: Was Complaint Handled Fairly

Do you feel your complaint was handled fairly?*	In-rent or HOA	Submetered	RUBS	Hot water hybrid	Utility-submetered	Total
No	50.0%	55.9%	81.3%	64.3%	36.4%	68.8%
Yes	50.0%	44.1%	18.7%	35.7%	63.6%	31.2%
Total	100.0% N=4	100.0% N=34	100.0% N=75	100.0% N=14	100.0% N=11	100.0% N=138

* Only asked of those who tried to resolve a complaint

Question #14: Perceived Impact of Method of Water Billing on Water Conservation Efforts

Billing method make you more likely to conserve water?*	In-rent or HOA	Submetered	RUBS	Hot water hybrid	Utility-submetered	Total
Yes	22.5%	48.4%	28.0%	46.7%	35.6%	30.9%
No	38.8%	31.3%	49.5%	35.9%	28.7%	41.7%
Don't know	38.7%	20.3%	22.5%	17.4%	35.6%	27.4%
Total	100.0% N=685	100.0% N=384	100.0% N=991	100.0% N=92	100.0% N=101	100.0% N=2253

* Do you think the way you are billed for water makes your household more likely to conserve water?

Question #15: Tenure Status

Do you rent or own your residence?	In-rent or HOA	Submetered	RUBS	Hot water hybrid	Utility-submetered	Total
Own	27.6%	20.8%	3.3%	1.1%	.0%	13.7%
Rent	72.4%	79.2%	96.7%	98.9%	100.0%	86.3%
Total	100.0% N=735	100.0% N=390	100.0% N=1001	100.0% N=92	100.0% N=103	100.0% N=2321

Question #16, follow-up: Monthly Rent

How much is your monthly rent?*	In-rent or HOA	Submetered	RUBS	Hot water hybrid	Utility-submetered	Total
Less than $300	26.3%	.3%	1.5%	1.1%	2.0%	7.9%
$300-$499	19.7%	4.6%	10.5%	8.0%	.0%	11.4%
$500-$799	36.0%	46.5%	50.3%	54.5%	3.0%	43.7%
$800-$1,299	14.7%	30.0%	33.0%	23.9%	38.0%	27.5%
$1,300-$1,699	2.7%	15.2%	4.0%	12.5%	44.0%	7.8%
$1,700-$1,999	.4%	2.3%	.4%	.0%	12.0%	1.3%
$2,000-$2,499	.0%	.3%	.1%	.0%	1.0%	.2%
$2,500 or more	.2%	.7%	.1%	.0%	.0%	.2%
Total	100.0% N=517	100.0% N=303	100.0% N=942	100.0% N=88	100.0% N=100	100.0% N=1950

* Only asked of those who rent their residence

Question #17: Annual Household Income

How much was your household's total income was in 2002?*	In-rent or HOA	Submetered	RUBS	Hot water hybrid	Utility-submetered	Total
Less than $15,000	36.4%	12.3%	19.4%	18.8%	12.1%	23.2%
$15,000 to $24,999	14.8%	19.0%	19.3%	9.4%	6.6%	16.9%
$25,000 to $34,999	17.2%	20.2%	19.6%	22.4%	16.5%	18.9%
$35,000 to $49,999	13.1%	15.7%	17.8%	20.0%	15.4%	16.0%
$50,000 to $74,999	9.6%	17.4%	15.8%	15.3%	24.2%	14.5%
$75,000 to $99,999	4.0%	6.2%	5.3%	7.1%	16.5%	5.6%
$100,000 or more	4.9%	9.2%	2.7%	7.1%	8.8%	4.9%
Total	100.0% N=674	100.0% N=357	100.0% N=942	100.0% N=85	100.0% N=91	100.0% N=2149

* About how much do you estimate your household's total income was in 2002?

READ AND BILL COMPANY SURVEY RESPONSES

1) No. Water Bills Sent Per Month	
Avg.	79344
Std. Dev.	117522
Median	36000
Min	2500
Max	450000
Total	1428200

2) Year Company Started Billing	
Avg.	1995.4
Std. Dev.	5.3
Median	1997
Min	1984
Max	2002

3) Bonded?	
Yes	61.1%
No	38.9%
Don’t know	0.00%

4) Regions Active	
National	61.1%
Regional	38.9%

5) Billing Method	
RUBS	5.3%
Combination	94.7%

5) Combination Billing Method Averages	
Submetering	44.7%
RUBS	48.6%
HWH	6.6%
Other	0.0%

6) Written Customer Service Standards?	
Yes	72.2%
No	27.8%

7) Type of Bill Format	
Standard	66.7%
Variable	22.2%
Custom	11.1%

8) Contact Phone Number on Bill?	
Yes	100.0%
No	0.0%

9) Include Historic Consumption?

Yes	33.3%
No	66.7%

10) Include Charges for Common Area Usage?

Yes	22.2%
No	72.2%

11) Determination of Service Charge*

Flat fee service charge	94%
Based on utility service charge	11%
Percent of bill	6%
Other	6%

* Percents add to more than 100 since respondents could give more than one answer

12) Typical Service Charge per Bill

Avg.	$3.29
Std. Dev.	$0.97
Median	$3.00
Min	$1.50
Max	$6.14

13) Non Payment Rate*

Avg.	12.7%
Std. Dev.	9.4%
Median	10.0%
Min	3.0%
Max	35.0%

* 27.8% of respondents reported “Don’t Know”

14) Resell Water at Profit?

Yes	0.0%
No	100.0%

15) Time Frame for Late Payment*

Same as local utility	16.7%
Until next bill	11.1%
Until third day	0.0%
Certain number of days†	66.7%
Other	5.6%
Do not charge late fees	5.6%
Don't know	0.0%

* Percents can add to more than 100 since respondents could give multiple answers
† Average number of days entered was 17.8

16) Late Fee Structure	
No fee	5.6%
Same as local utility	11.1%
Fixed dollar amount*	44.4%
Percent of bill†	22.2%
Other	16.7%

* Entered $ amounts ranged from $5 - $25.
† Entered % amounts ranged from 5 – 10%.

17) Provide Customers Information on Late Fee Structure?	
Yes	72.2%
No	11.1%
Don't know	5.6%
Not applicable	11.1%

17) How is the final bill to a customer determined (prior to move out)? - Verbatims

- On line real time calculation based on that unit's/resident's usage or RUBS calculations
- Move-out read provided by mgmt, we calc final bill.
- Prorated upon customer's history
- Prorated on actual read
- Reading taken and bill issued
- Prorated based on their average daily cost from prior month
- Beginning/ending reading
- We calculate the final bill, but it is collected on-site
- Previous per day average for last 90 days then multiplied by number of days in apt for last bill
- Onsite mgmt handles collection of move out bills. We supply cost/day of last 3 mo. avg.
- Pro rated from last read out to move out date
- prior to move out, yes.
- Pro rated - via fax or email to/from property
- Actual meter read upon move-out
- based on # of days in the bill period
- m/o sheet faxed to waterwatch
- Based on last meter reads on actual move out - estimated if prior to move out

18) Process to Handle Complaints?	
Yes	100%
No	0%

19) Common Customer Complaints*	
Bill itself	22.2%
Amount of bill (consumption charge)	88.9%
Service charge	27.8%
Bill format	11.1%
Customer service information	16.7%
Other	11.1%

* Percents can add to more than 100 since respondents could give multiple answers

20) Gone Through Complaint Dispute Process?	
Yes	94.4%
No	5.6%
Don’t know	0.0%
Not applicable	0.0%

21) Support National Administrative Guidelines?	
Yes	27.8%
No	11.1%
Maybe, if our industry had input	55.6%
Don’t know	5.6%

22) Submeter Water Read Method*	
Manual read	61.1%
Automatic read	94.4%

* Percents can add to more than 100 since respondents could give multiple answers

22) Automatic Read Technology - Verbatims
▪ any non-proprietary systems
▪ Touch Read, Radio Read, Wireless
▪ 3G, Inovonics, RAMAR
▪ Speed read, Raymar, Master meter
▪ Inovonics, RAMAR, Touch reads
▪ Tap Watch
▪ Hexagram
▪ Inovonics
▪ Inovonics wireless
▪ TapWatch, SpeedRead
▪ Speed Read, Inovonics, Quad Logic, Ramar, Master Meter and Link
▪ Radio Frequency systems
▪ Tapwatch
▪ Daily point of use readings with RF technology and modems
▪ Inovonics, Itron, Cybernational
▪ Tapwatch and touch read
▪ point of use and pulse meter transmitter base station with modem

23) Meter Maintenance Standard?	
Yes	72.2%
No	22.2%
Don’t know	0.0%
Not applicable	5.6%

23) Description of Meter Maintenance Standard - Verbatims

- very involved, would not be able to present within the parameters of this section
- Customer specific
- adhering to manufact.
- Whats required by state regulations
- Hourly
- Automated system tracks system performance
- Monthly diagnostic reports - weekly checks on meter and phone data communication. Battery replacement after 5 years

24) Meter Accuracy Testing Standard?

Yes	76.5%
No	17.6%
Don’t know	0.0%
Not applicable	5.9%

25) Can Residents Request Meter Testing for Accuracy?

Yes	77.8%
No	16.7%
Don’t know	0.0%
Not applicable	5.6%

25) Is there a charge for meter testing?*

Yes	60.0%
No	30.0%
Don’t know	10.0%
Not applicable	0.0%

* Only asked of respondent who allow residents to request meter testing for accuracy

26) Methods used to determine commodity charges for RUBS customers*

Flat fee	44.4%
Based on square footage	83.3%
Based on no. bedrooms	33.3%
Based on no. residents	94.4%
Based on no. bathrooms	22.2%
Based on no. fixtures	27.8%
Other	22.2%

* Percents can add to more than 100 since respondents could give multiple answers

27) Subtract common area water use and/or irrigation for RUBS?

Yes, for all RUBS properties	55.6%
Only for some RUBS properties	38.9%
No	5.6%
Don't know	0.0%
Not applicable	0.0%

28) Method to determine amount to subtract from RUBS bill

Never subtract for common area usage	0.0%
Fixed dollar amount subtracted	5.6%
Fixed volume of water subtracted	5.6%
Percent of total use	50.0%
Based on amenities at each property	61.1%
Based on property owner's specifications	61.1%
Other	16.7%
Not applicable	5.6%
Don't Know	0.0%

29) Ever tracked water at a RUBS property before and after conversion?

Yes	55.6%
No	38.9%
Don't know	5.6%
Not applicable	0.0%

29) Summary of RUBS conversion property findings - Verbatims

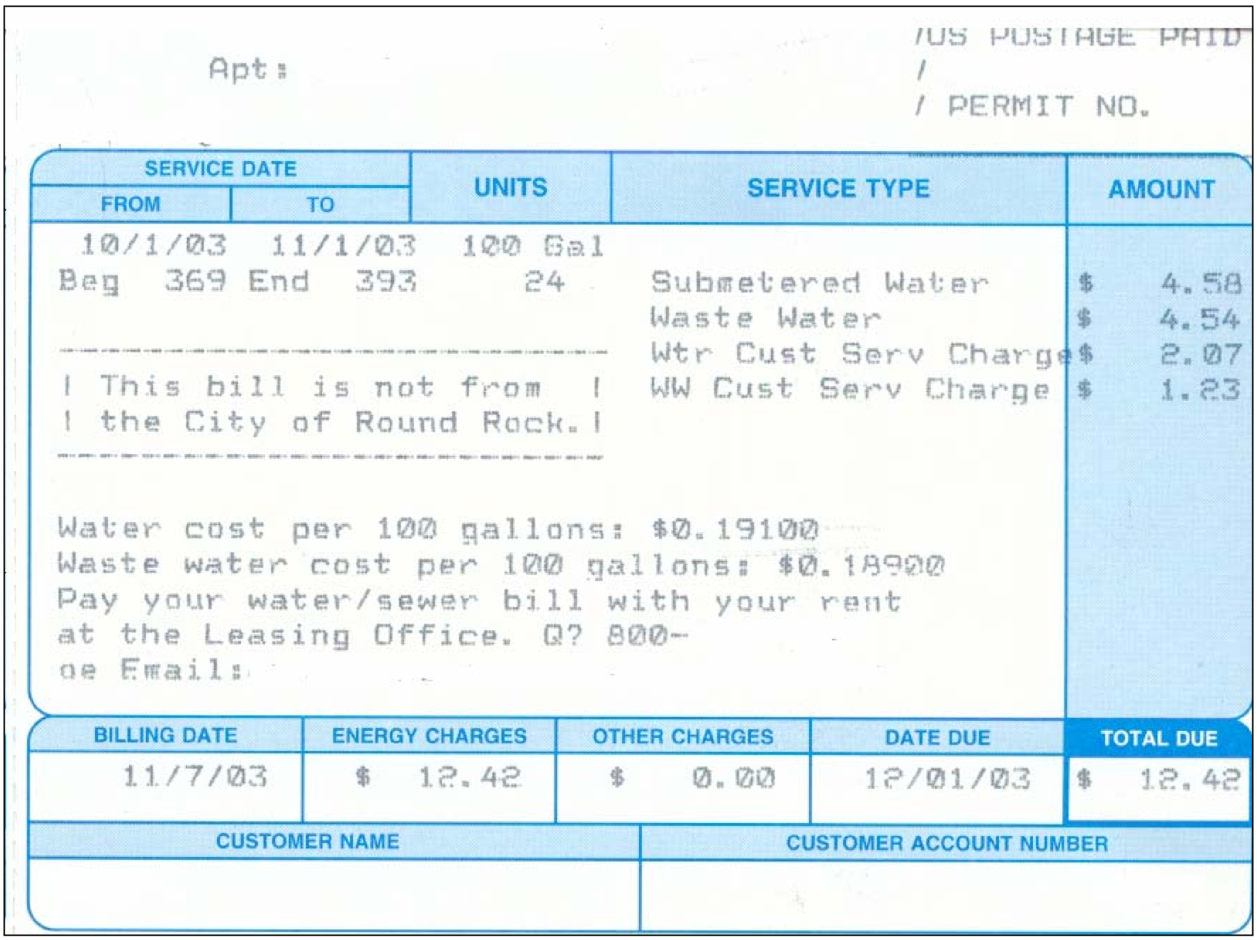
- Findings are a subject to many variables and range from little or no change in consumption to 10-15% reduction
- Consumption reduction of between 10-20%
- 30% to 50% reduction in consumption
- Very little conservation
- 10-15% change
- Year to year comparisons on RUBS only properties yield 6.1% avg. savings. Metered only yield 27.5% avg. savings year to year

APPENDIX C

ADDITIONAL SAMPLE BILLS FROM BILLING SERVICE COMPANIES

SAMPLE SUBMETERED BILLS

These bills were provided by residents as part of the resident survey. All identifying information has been removed to protect the identity of the customer and the third party billing company.



Apt:

/US POSTAGE PAID
/
/ PERMIT NO.

SERVICE DATE FROM	SERVICE DATE TO	UNITS	SERVICE TYPE	AMOUNT
10/1/03	11/1/03	100 Gal		
Beg 369	End 393	24	Submetered Water	$ 4.58
			Waste Water	$ 4.54
			Wtr Cust Serv Charge	$ 2.07
			WW Cust Serv Charge	$ 1.23

| This bill is not from the City of Round Rock. |

Water cost per 100 gallons: $0.19100
Waste water cost per 100 gallons: $0.18900
Pay your water/sewer bill with your rent
at the Leasing Office. Q? 800-
oe Email:

BILLING DATE	ENERGY CHARGES	OTHER CHARGES	DATE DUE	TOTAL DUE
11/7/03	$ 12.42	$ 0.00	12/01/03	$ 12.42

CUSTOMER NAME	CUSTOMER ACCOUNT NUMBER

SAN DIEGO CA
(   )

OCT 03 | SPC

Rent Due The 1st - Rec'd After The
6th Rents Increased $35.00
NSF Checks $35 Plus A $35 Late Rent.
** NO PARTIAL PAYMENTS, NO CASH **
MONEY ORDER OR CHECK ONLY!

Spc #

PLEASE PAY 488.54

YOU MAY RETURN TOP PORTION WITH CHECK TO INSURE PROPER CREDIT

WARNING: Leaking or burning gas may cause cancer.
GAS RATE CHANGE - PRORATION REQUIRED
Space #
Ele CARE Savings $4.16 BILLING DAYS 31 Gas CARE Savings $2.71

Ele BL 316	09/19	919	WATER			GAS BASELINE 15				
Sched DR-LI	08/19	754		09/19	408	Zone Z-2		09/19	8770	
Z-1 LastYr	kwh	165		08/19	406	Therm 1.012		08/19	8756	
MinChg 31	X.144				------	Schedule GRL			------	
165 kwh	X.05516	9.10	100 CuFt->		2			CuFt->	14	
kwh	X.07553							Therms->	14	
Baselne % To KWH X PxChg			Prev Yr->					Prev Yr->		
ALL 165	X.05200	8.58								
200%	X.06885		WATER CUST CHG->		10.68					
300%	X.07777		2 X 1.33		2.66	14	th	X.72078	10.09	
Over	X.09491						th	X.86185		
State Reg	X.00020	.03				CPUC		X.00199	.03	
CPUC Fee	X.00012	.02				CPUC-IF			.21	
Franchise Fee		.22				PPP-Gas		X.04545	.64	
Bond	X									
ELECTRIC TOTAL->		17.95	WATER TOTAL->		13.34	GAS TOTAL->			10.97	

| SPC | OCT 03

PAID
10/1/03

RECEIPT

DATE: 10/1/03 AMOUNT: $488.54 RECEIVED BY: N.W.

MONEY ORDER #: ________ CK#: ________

PATROL	19.00
RV STRG	
MISC	
OTHER	
TRASH	6.58
SEWER	5.95
WATER	13.34
ELECTRIC	17.95
GAS	10.97
RENT	414.75

SUB TOT	488.54
TOTAL →	488.54

UTILITY INVOICE

Portland, OR

Billing Date: November 12, 2003

Reading Date	Meter Reading	CCFs Used	Number of Days in Billing Period
10/6/2003	132.6		
11/3/2003	134.88	**2.28**	**28**

Water @ 1.64/CCF $3.74	
Sewer @ 4.74/CCF of total used CCFs $10.81	
Stormwater Management @ .47/day **$13.16**	
Water/Sewer Amount Due	**$27.71**
Garbage	**$0.00**
Subtotal	**$27.71**
Senior Discount	**$2.77**
Balance Forward Late Fee	
	Total Due **$24.94**

Due Date – 10th of the month

Note: Payment is due on the tenth of each month; payments made after the tenth of the month are subject to a 5% late fee.

BILLING INFORMATION FOR YOUR RESIDENTIAL UNIT
Late Charges may be assesed at $8.00

Please **Make Payments** To:

For Customer Service
(   )
(800)

Account Number:
In Service: / /
Meter 1:4181399
Payments Rec In The Last Perd$ 70.35

	Meter 1	Meter 2
Curr.Rd:	41,770	
PrevRd:	40,480	
Usage:	1,290	

WATER - 0-4000 GALLONS $.26 PER 100 GALLONS
4000 & UP $.38 PER 100 GALLONS
FIXED WATER COST (NO USAGE) $3.95 PER MONTH
SEWER - $.41 PER 100 GALLONS
FIXED SEWER COST (NO USAGE) $8.92 PER MONTH
SERVICE CHARGE - $3.00 PER MONTH

SERVICES	CURRENT CHARGES
Service chg	3.00
Prev Util Chgs$	0.00
Water Charges $	7.69
Sewer Charge $	14.21
Total Charges	24.90
Paymts Recvd $	0.00
Payment Due	$ 24.90

Service From: 09/12/2003

Service To: 10/12/2003

Payment Due: 11/25/2003

Please Cut On Line & Return Portion Below With Payment

SAMPLE RATIO UTILITY BILLING SYSTEM (RUBS) BILLS

Water & Sewer Statement

Your New Statement

Last Month

Previous Balance	-$16.75
Payments	$0.00
Previous Balance Forward	-$16.75

This Month - *Closing Date 11/11/2003*

Current Charges	$22.79
Adjustments, Taxes & Fees	$0.00
New Charges This Month	$22.79
New Balance	$6.04
IF PAID BY 12/2/2003	$6.04
IF PAID AFTER 12/2/2003	$11.04

BILLING SUMMARY -

ACCOUNT NUMBER:

Current Charges

SERVICE ADDRESS:

Seattle, WA

MESSAGES

09/30/03

This bill is not from the City of Seattle. The bill reflects allocated usage.

Charge Description	Qty	Days	Rate	Unit	Amount
ADMIN FEE	1.00	35	2.500000	Cycle	$2.50
WATER - PER OCCUPANT	35.00	35	0.579790	Per Day	$20.29
					Total Water & Sewer Charges $22.79

Total Current Charges: $22.79

For Customer Service Call
1-888-
(Mon-Fri 7 am - 7 pm CST)
or Email us at
@

Please detach at perforation below and return bottom portion with payment

Account #
Invoice date **11-18-2003**
Invoice #

For more information, please read the other side. *Para más información, leyó por favor el otro lado.*

❶

Water: S.A.W.S. Dates: 10-08-2003 to 11-03-2003	Unit of Measure: Gallons Meter reading: -----	$ per Unit: 0.0025 Usage: 3689.1978	Calc Type*: A Amount:	$9.17
Wastew: S.A.W.S. Dates: 10-08-2003 to 11-03-2003	Unit of Measure: Gallons Meter reading: -----	$ per Unit: 0.0015 Usage: 2944.2577	Calc Type*: A Amount:	$4.38

❷ *REMIT TO MANAGEMENT OFFICE:*

San Antonio, TX

* Calculation type: A = Allocated, S = Sub-metered, P = Partial-capture sub-metered

RETURN SERVICE REQUESTED

Late fee *Cargos tardes*
5.00%

DUE BY: ❸
12-04-2003

Startup Fee:	**$0.00** ❹
Deposit:	**$0.00** ❺
Service Fee:	**$0.00** ❻
tax:	**$0.00** ❼
Utility Charges:	**$13.55** ❽

TOTAL DUE: ***CUENTA TOTAL:*** $13.55 ❿

Amount AFTER Due Date: $14.23

Description Code	Service Period From	To	Readings Start	End	Meter Mult.	Rate Period From	To	Rate	Usage	Units	Amount
01	8/20/03	9/19/03				00:00	00:00				$56.16
Prev Bal\Cred										None	$0.00

If Paid Later Than 11/1/03 Please Pay: $58.97

Messages:

Please Make Check Payable To:
Apartments
PLEASE PAY WITH
YOUR RENT PAYMENT.

This bill is not from:

The City of Austin

Pay This Amount: $56.16

Water bill based on 875 SqFt , 4 Occupant(s) For 30 Day(s)

Code Description
01 Water/Sewer
02 Electric
03 Gas
04 Base Customer Charge
05 Past Due
06 Trash Collection
07 Allocated Electric Charge

For Questions Call;

Div. of:

Phone: / 1-800-

Date Due: 11/1/03

Account No.

If you have any questions egarding your billing, please contact ( ) or (800)
Si tiene alguna pregunta acerca de su cuenta, favor de llamar a al ( ) - o (800)

STATEMENT DATE / Fecha de proceso

11/14/2003

ACCOUNT NUMBER / Numero de cuenta

FOR SERVICE AT / Por servicio en

AUSTIN TX

NOT FROM CITY OF AUSTIN

Previous Balance Balance Previo	Payments Pagos	Adjustments Ajustos	Balance Forward Balance Total	Current Charges Cargos Nuevos	New Balance Nuevo Balance
$48.02	$33.27	$0.00	$14.75	$13.90	$28.65

PAYMENTS RECEIVED		
PAYMENT *(10/27/2003)*	**$33.27**	
ADJUSTMENTS		
WATER LATE FEE	**$0.70**	
CURRENT CHARGES		
ALLOCATED WATER & WASTEWATER (09/18/2003 TO 10/17/2003)		
WATER SERVICE	**$5.78**	
WASTEWATER SERVICE	**$7.88**	
CUSTOMER SERVICE CHARGE	**$0.24**	
TOTAL CURRENT CHARGES	**$13.90**	
LATE PENALTIES IF MAILED AFTER 12/01/2003		
5% WATER/WASTEWATER	**$0.70**	
TOTAL PENALTY AFTER DUE DATE	**$0.70**	

MAKE CHECK OR MONEY ORDER PAYABLE TO . RETURN WITH STUB IN ENVELOPE PROVIDED.

11/14/2003 *Escriba el cheque o orden de pago a nombre de . Regresa con talon en sobre adjunto.*

PLEASE PAY $28.65
Favor de pagar

AUSTIN TX

DATE DUE 12/1/2003
Fecha de vencimiento

AFTER DUE DATE PAY $29.35
Despues de la fecha de vencimiento paque

Detach Here	Billing Name		Billing Type	REGULAR
	Account Number		Invoice Date	

Description	Meter Number	Current Meter Read	Prior Meter Read	
SQFT- WATER	206	1,107.0000 Sq Ft	117,574.0000 Tot Sq F	0.0094
SQFT - WASTEWATER	206	1,107.0000 Sq Ft	117,574.0000 Tot Sq F	0.0094

Billing Period

9/26/03	10/27/03		Total
Previous Balance			$30.26
Previous Payments / Adjustments		From 9/23/03 To 10/22/03	($30.26)

Description	Units	Rate	TOTAL
Water	0.0094	1212.05	$11.39
Wastewater	0.0094	1789.27	$16.82
Late Charge			$0.00
Total Current Charges			$28.21

THIS BILLING IS NOT FROM THE CITY OF AUSTIN. THIS BILLING IS FOR SUBMETERED WATER AND SEWER.

FOR A CONVENIENCE FEE YOU MAY PAY BY PHONE USING A VISA / MASTER CARD, OR ATM CARDS WITH VISA / MASTER CARD LOGOS.

DUE DATE FOR CURRENT CHARGE ONLY:	11/21/03	TOTAL AMOUNT DUE:	$28.21

Please Make Checks Payable To:

FOR BILLING INQUIRIES VISIT US AT www. or
CALL 1-800- Mon. - Fri. 9 - 5 Pacific Time

APPENDIX D

STATISTICAL RESULTS

COMPARISON OF SITE VISIT SURVEYS WITH MANAGER SURVEY RESPONSES

Table D.1 Comparison of site visit surveys with manager survey responses, categorical variables

Property Characteristic	Site Visit Compared to Manager Survey	In-Rent	Sub-metered*	RUBS
How is the property classified?	site visit verified manager survey	97.2%	100.0%	100.0%
	site visit found a discrepancy	.0%	.0%	.0%
	site visit filled in a dk/refusal	2.8%	.0%	.0%
The property is not a rental	site visit verified manager survey	100.0%	100.0%	100.0%
	site visit found a discrepancy	.0%	.0%	.0%
	site visit filled in a dk/refusal	.0%	.0%	.0%
Is there a separate water meter for irrigation?	site visit verified manager survey	86.1%	65.2%	72.2%
	site visit found a discrepancy	5.6%	13.0%	.0%
	site visit filled in a dk/refusal	8.3%	21.7%	27.8%
Sauna/steam room	site visit verified manager survey	97.2%	100.0%	100.0%
	site visit found a discrepancy	2.8%	.0%	.0%
	site visit filled in a dk/refusal	.0%	.0%	.0%
Water features/fountains	site visit verified manager survey	91.7%	100.0%	83.3%
	site visit found a discrepancy	8.3%	.0%	16.7%
	site visit filled in a dk/refusal	.0%	.0%	.0%
Landscape ponds	site visit verified manager survey	94.4%	82.6%	88.9%
	site visit found a discrepancy	5.6%	17.4%	11.1%
	site visit filled in a dk/refusal	.0%	.0%	.0%
Tennis courts	site visit verified manager survey	100.0%	100.0%	100.0%
	site visit found a discrepancy	.0%	.0%	.0%
	site visit filled in a dk/refusal	.0%	.0%	.0%
Basketball courts	site visit verified manager survey	97.2%	100.0%	100.0%
	site visit found a discrepancy	2.8%	.0%	.0%
	site visit filled in a dk/refusal	.0%	.0%	.0%
Hot tub	site visit verified manager survey	94.4%	95.7%	100.0%
	site visit found a discrepancy	5.6%	4.3%	.0%
	site visit filled in a dk/refusal	.0%	.0%	.0%
Cooling tower	site visit verified manager survey	100.0%	100.0%	100.0%
	site visit found a discrepancy	.0%	.0%	.0%
	site visit filled in a dk/refusal	.0%	.0%	.0%
One common laundry room/facility	site visit verified manager survey	97.2%	95.7%	88.9%
	site visit found a discrepancy	2.8%	4.3%	11.1%
	site visit filled in a dk/refusal	.0%	.0%	.0%
More than one common laundry room/facility	site visit verified manager survey	100.0%	87.0%	94.4%
	site visit found a discrepancy	.0%	13.0%	5.6%
	site visit filled in a hole	.0%	.0%	.0%
Does the property have a pool?	site visit verified manager survey	100.0%	100.0%	100.0%
	site visit found a discrepancy	.0%	.0%	.0%
	site visit filled in a dk/refusal	.0%	.0%	.0%
Type of pool	site visit verified manager survey	100.0%	100.0%	94.4%
	site visit found a discrepancy	.0%	.0%	.0%

Property Characteristic	Site Visit Compared to Manager Survey	In-Rent	Sub-metered*	RUBS
	site visit filled in a dk/refusal	.0%	.0%	5.6%
Do the units come with hook-ups for washing machines?	site visit verified manager survey	97.2%	91.3%	88.9%
	site visit found a discrepancy	2.8%	8.7%	11.1%
	site visit filled in a dk/refusal	.0%	.0%	.0%
Do all or some of the units come equipped with dishwashers?	site visit verified manager survey	84.8%	100.0%	100.0%
	site visit found a discrepancy	15.2%	.0%	.0%
	site visit filled in a dk/refusal	.0%	.0%	.0%
How are residents billed for water usage at this property?	site visit verified manager survey	100.0%	82.6%	100.0%
	site visit found a discrepancy	.0%	17.4%	.0%
	site visit filled in a dk/refusal	.0%	.0%	.0%
Who bills the residents for water usage at this property?	site visit verified manager survey	94.4%	91.3%	94.4%
	site visit found a discrepancy	2.8%	8.7%	5.6%
	site visit filled in a dk/refusal	2.8%	.0%	.0%
What is the name of the service?	site visit verified manager survey	100.0%	60.9%	61.1%
	site visit found a discrepancy	.0%	8.7%	5.6%
	site visit filled in a dk/refusal	.0%	30.4%	33.3%
Was the current billing system in place since the property was developed or put in at a later time?	site visit verified manager survey	30.6%	78.3%	61.1%
	site visit found a discrepancy	.0%	4.3%	.0%
	site visit filled in a dk/refusal	69.4%	17.4%	38.9%
Number of Properties		N=36	N=23	N=18

* Submetered properties included hot water hybrids in this analysis.

Table D.2 Comparison of site visit surveys with manager survey responses, continuous variables

Property Characteristic	Site Visit Compared to Manager Survey	In-Rent	Sub-metered*	RUBS
How many residential buildings are on this property?	site visit verified manager survey	80.6%	82.6%	83.3%
	site visit found a discrepancy	19.4%	17.4%	16.7%
	discrepancy of 1-2 buildings	*8.3%*	*4.3%*	*11.1%*
	discrepancy of 3-5 buildings	*5.6%*	*8.7%*	*5.6%*
	discrepancy more than 5 buildings	*5.6%*	*4.3%*	*.0%*
	site visit filled in a dk/refusal	.0%	.0%	.0%
How many units are in this property?	site visit verified manager survey	86.1%	87.0%	100.0%
	site visit found a discrepancy	13.9%	13.0%	.0%
	discrepancy of less than 5 units	*2.8%*	*4.3%*	*.0%*
	discrepancy of 5 - 20 units	*5.6%*	*.0%*	*.0%*
	discrepancy greater than 20 units	*5.6%*	*8.7%*	*.0%*
	site visit filled in a dk/refusal	.0%	.0%	.0%
Number of Efficiency/studio units	site visit verified manager survey	97.2%	95.7%	100.0%
	site visit found a discrepancy	2.8%	4.3%	.0%
	discrepancy of less than 5 units	*.0%*	*4.3%*	*.0%*
	discrepancy of 5 - 20 units	*2.8%*	*.0%*	*.0%*
	discrepancy greater than 20 units	*.0%*	*.0%*	*.0%*
	site visit filled in a dk/refusal	.0%	.0%	.0%
Number of 1 bedroom units	site visit verified manager survey	83.3%	91.3%	94.4%
	site visit found a discrepancy	16.7%	8.7%	5.6%
	discrepancy of less than 5 units	*5.6%*	*.0%*	*.0%*
	discrepancy of 5 - 20 units	*2.8%*	*4.3%*	*5.6%*
	discrepancy greater than 20 units	*8.3%*	*4.3%*	*.0%*
	site visit filled in a dk/refusal	.0%	.0%	.0%
Number of 2 bedroom units	site visit verified manager survey	86.1%	78.3%	94.4%

Property Characteristic	Site Visit Compared to Manager Survey	In-Rent	Sub-metered*	RUBS
	site visit found a discrepancy	13.9%	21.7%	5.6%
	discrepancy of less than 5 units	*.0%*	*4.3%*	*.0%*
	discrepancy of 5 - 20 units	*5.6%*	*8.7%*	*5.6%*
	discrepancy greater than 20 units	*8.3%*	*8.7%*	*.0%*
	site visit filled in a dk/refusal	.0%	.0%	.0%
Number of 3 bedroom units	site visit verified manager survey	94.4%	100.0%	100.0%
	site visit found a discrepancy	5.6%	.0%	.0%
	discrepancy of less than 5 units	*.0%*	*.0%*	*.0%*
	discrepancy of 5 - 20 units	*.0%*	*.0%*	*.0%*
	discrepancy greater than 20 units	*5.6%*	*.0%*	*.0%*
	site visit filled in a dk/refusal	.0%	.0%	.0%
Number of 4 or more bedroom units	site visit verified manager survey	100.0%	100.0%	100.0%
	site visit found a discrepancy	.0%	.0%	.0%
	discrepancy of less than 5 units	*.0%*	*.0%*	*.0%*
	discrepancy of 5 - 20 units	*.0%*	*.0%*	*.0%*
	discrepancy greater than 20 units	*.0%*	*.0%*	*.0%*
	site visit filled in a dk/refusal	.0%	.0%	.0%
Monthly rent for efficiency/studio	site visit verified manager survey	86.1%	87.0%	88.9%
	site visit found a discrepancy	11.1%	13.0%	11.1%
	discrepancy of less than $25	*2.8%*	*4.3%*	*5.6%*
	discrepancy of $25 - $50	*2.8%*	*4.3%*	*5.6%*
	discrepancy of more than $50	*5.6%*	*4.3%*	*.0%*
	site visit filled in a dk/refusal	2.8%	.0%	.0%
Monthly rent for 1 bedroom	site visit verified manager survey	63.9%	52.2%	61.1%
	site visit found a discrepancy	33.3%	47.8%	38.9%
	discrepancy of less than $25	*13.9%*	*21.7%*	*11.1%*
	discrepancy of $25 - $50	*8.3%*	*13.0%*	*5.6%*
	discrepancy of more than $50	*11.1%*	*13.0%*	*22.2%*
	site visit filled in a dk/refusal	2.8%	.0%	.0%
Monthly rent for 2 bedrooms	site visit verified manager survey	55.6%	52.2%	55.6%
	site visit found a discrepancy	41.7%	47.8%	44.4%
	discrepancy of less than $25	*13.9%*	*21.7%*	*5.6%*
	discrepancy of $25 - $50	*16.7%*	*13.0%*	*16.7%*
	discrepancy of more than $50	*11.1%*	*13.0%*	*22.2%*
	site visit filled in a dk/refusal	2.8%	.0%	.0%
Monthly rent for 3 bedrooms	site visit verified manager survey	91.7%	69.6%	88.9%
	site visit found a discrepancy	8.3%	30.4%	11.1%
	discrepancy of less than $25	*2.8%*	*8.7%*	*.0%*
	discrepancy of $25 - $50	*.0%*	*8.7%*	*.0%*
	discrepancy of more than $50	*5.6%*	*13.0%*	*11.1%*
	site visit filled in a dk/refusal	.0%	.0%	.0%
Monthly rent for 4 or more bedrooms	site visit verified manager survey	100.0%	100.0%	94.4%
	site visit found a discrepancy	.0%	.0%	5.6%
	discrepancy of less than $25	*.0%*	*.0%*	*.0%*
	discrepancy of $25 - $50	*.0%*	*.0%*	*5.6%*
	discrepancy of more than $50	*.0%*	*.0%*	*.0%*
	site visit filled in a dk/refusal	.0%	.0%	.0%
Approximately how many people live on the property in total?	site visit verified manager survey	58.3%	69.6%	66.7%
	site visit found a discrepancy	36.1%	13.0%	27.8%
	discrepancy of less than 7 people	*16.7%*	*4.3%*	*5.6%*
	discrepancy of 7 - 40 people	*13.9%*	*4.3%*	*16.7%*
	discrepancy of more than 40 people	*5.6%*	*4.3%*	*5.6%*
	site visit filled in a dk/refusal	5.6%	17.4%	5.6%
In what year was the construction	site visit verified manager survey	86.1%	78.3%	94.4%

Property Characteristic	Site Visit Compared to Manager Survey	In-Rent	Sub-metered*	RUBS
of the property completed?	site visit found a discrepancy	13.9%	21.7%	5.6%
	discrepancy of less than 4 years	*8.3%*	*8.7%*	*5.6%*
	discrepancy of 4-10 years	*.0%*	*8.7%*	*.0%*
	discrepancy of more than 10 years	*5.6%*	*4.3%*	*.0%*
	site visit filled in a dk/refusal	.0%	.0%	.0%
What is the current vacancy rate?	site visit verified manager survey	55.6%	47.8%	50.0%
	site visit found a discrepancy	44.4%	47.8%	50.0%
	discrepancy of 2% or less	*16.7%*	*30.4%*	*27.8%*
	discrepancy of 2.01% - 5%	*13.9%*	*8.7%*	*11.1%*
	discrepancy of more than 5%	*13.9%*	*8.7%*	*11.1%*
	site visit filled in a dk/refusal	.0%	4.3%	.0%
What percent of units have washing machines?	site visit verified manager survey	88.9%	60.9%	72.2%
	site visit found a discrepancy	8.3%	17.4%	11.1%
	discrepancy of 6% or less	*5.6%*	*.0%*	*5.6%*
	discrepancy of 6.01% - 10%	*.0%*	*8.7%*	*5.6%*
	discrepancy of more than 10%	*2.8%*	*8.7%*	*.0%*
	site visit filled in a hole	2.8%	21.7%	16.7%
Year of conversion	site visit verified manager survey	100.0%	56.5%	61.1%
	site visit found a discrepancy	.0%	13.0%	.0%
	discrepancy of less than 4 years	*.0%*	*8.7%*	*.0%*
	discrepancy of 4-10 years	*.0%*	*4.3%*	*.0%*
	discrepancy of more than 10 years	*.0%*	*.0%*	*.0%*
	site visit filled in a dk/refusal	.0%	30.4%	38.9%
Number of Properties		N=36	N=23	N=18

* Submetered properties included hot water hybrids in this analysis.

Table D.2 Comparison of site visit surveys with manager survey responses for fixture changeouts in properties built before 1995.

Property Characteristic	Site Visit Compared to Manager Survey	In-Rent	Submetered*	RUBS	All Properties
What percent of the toilets are water efficient†	site visit verified manager survey	67.7%	43.8%	42.9%	55.7%
	site visit found a discrepancy‡	25.8%	31.3%	42.9%	31.1%
	discrepancy of 1 category	*22.6%*	*31.3%*	*42.9%*	*29.5%*
	discrepancy of 2 categories	*3.2%*	*.0%*	*.0%*	*1.6%*
	discrepancy of more than 2 categories	*.0%*	*.0%*	*.0%*	*.0%*
	site visit filled in a dk/refusal	6.5%	25.0%	14.3%	13.1%
What percent of the faucets are water efficient†	site visit verified manager survey	32.3%	18.8%	35.7%	29.5%
	site visit found a discrepancy‡	61.3%	31.3%	50.0%	50.8%
	discrepancy of 1 category	*32.3%*	*18.8%*	*50.0%*	*32.8%*
	discrepancy of 2 categories	*29.0%*	*12.5%*	*.0%*	*18.0%*
	discrepancy of more than 2 categories	*.0%*	*.0%*	*.0%*	*.0%*
	site visit filled in a dk/refusal	6.5%	50.0%	14.3%	19.7%
What percent of the showerheads are water efficient†	site visit verified manager survey	45.2%	43.8%	35.7%	42.6%
	site visit found a discrepancy‡	38.7%	12.5%	42.9%	32.8%
	discrepancy of 1 category	*32.3%*	*6.3%*	*42.9%*	*27.9%*
	discrepancy of 2 categories	*6.5%*	*6.3%*	*.0%*	*4.9%*
	discrepancy of more than 2 categories	*.0%*	*.0%*	*.0%*	*.0%*
	site visit filled in a dk/refusal	16.1%	43.8%	21.4%	24.6%
Number of Properties		N=31	N=16	N=14	N=61

* Submetered properties included hot water hybrids in this analysis.

† The manager survey asked what percent of units had replaced fixtures since 1995, while the site visits confirmed the percent of fixtures that were water efficient, which may account for some of the discrepancies found between the two data collection efforts.
‡ Discrepancies were counted if property changed from one of these three grouped responses: no or less than 25%; 25% to 75%; or 76% to 100%.

Table D.3 Property Characteristics by Type of Billing Method, In-Rent/Submetered Pairs

		In-Rent	Submetered *	P-Value
Is there a separate water meter for irrigation?	Yes	23.8%	47.6%	0.264
	No	66.7%	47.6%	
	Don't know	9.5%	4.8%	
Sauna/steam room	Yes	10.5%	.0%	0.127
	No	89.5%	100.0%	
Water features/fountains	Yes	35.0%	23.8%	0.431
	No	65.0%	76.2%	
Landscape ponds	Yes	28.6%	9.5%	0.116
	No	71.4%	90.5%	
Tennis courts	Yes	19.0%	9.5%	0.378
	No	81.0%	90.5%	
Basketball courts	Yes	21.1%	6.7%	0.240
	No	78.9%	93.3%	
Hot tub	Yes	40.0%	33.3%	0.658
	No	60.0%	66.7%	
Cooling tower	Yes	9.5%	.0%	0.157
	No	90.5%	100.0%	
One common laundry room/facility	Yes	63.2%	40.0%	0.179
	No	36.8%	60.0%	
More than one common laundry room/facility	Yes	55.6%	50.0%	0.785
	No	44.4%	50.0%	
Type of pool	outdoor	47.6%	57.1%	0.437
	both	.0%	4.8%	
	no pool	52.4%	38.1%	
Do the units come with hook-ups for washing machines?	Yes	47.6%	71.4%	0.116
	No	52.4%	28.6%	
Do all or some of the units come equipped with dishwashers?	Yes	89.5%	90.5%	0.916
	No	10.5%	9.5%	
Percent of units with dishwashers	0	14.3%	11.8%	0.712
	25	.0%	5.9%	
	58	7.1%	.0%	
	90	7.1%	5.9%	
	96	.0%	5.9%	
	100	71.4%	70.6%	
Number of non-residential buildings	0	15.4%	16.7%	0.216
	1	38.5%	50.0%	
	2	.0%	25.0%	
	3	23.1%	8.3%	
	5	15.4%	.0%	
	6	7.7%	.0%	

		In-Rent	Submetered *	P-Value
Number of steam rooms	0	94.4%	100.0%	0.274
	1	5.6%	.0%	
How many saunas?	0	94.7%	100.0%	0.287
	1	5.3%	.0%	
Does the property hose down outdoor courts	Yes	4.8%	4.8%	0.557
	No	19.0%	4.8%	
	Don't know	4.8%	4.8%	
	No courts	71.4%	85.7%	
Does the property fill the pond?	Yes	19.0%	4.8%	0.153
	No	9.5%	.0%	
	Don't know	.0%	4.8%	
	No pond(s)	71.4%	90.5%	
Is the fountain recirculating?	Yes	30.0%	9.5%	0.193
	Don't know	5.0%	14.3%	
	No fountain(s)	65.0%	76.2%	
Type of irrigation	No irrigation	10.0%	11.1%	0.659
	Automatic irrigation	65.0%	77.8%	
	Manual irrigation	20.0%	11.1%	
	Multiple methods of irrigation	5.0%	.0%	
Number of cooling towers	0	95.0%	100.0%	0.300
	1	5.0%	.0%	
Do they blow down the towers	Yes	5.0%	.0%	0.311
	No tower(s)	95.0%	100.0%	
Are there swamp coolers	Yes	4.8%	10.0%	0.520
	No	95.2%	90.0%	
How many swamp coolers	0	95.2%	90.0%	0.379
	2	4.8%	.0%	
	37	.0%	5.0%	
	48	.0%	5.0%	
Are there boilers	Yes	20.0%	5.0%	0.151
	No	80.0%	95.0%	
How many boilers	0	84.2%	100.0%	0.196
	2	10.5%	.0%	
	13	5.3%	.0%	
Year of Property was Built	Before 1994	81.0%	66.7%	0.292
	1995 or Later	19.0%	33.3%	
Rental property or individually-owned property	Rental property	95.2%	90.5%	0.549
	Individually-owned property	4.8%	9.5%	

* Submetered properties included hot water hybrids in this analysis.

Table D.4 Property Characteristics by Type of Billing Method, In-Rent/RUBS Pairs

		In-Rent	RUBS	P-Value
Is there a separate water meter for irrigation?	Yes	28.6%	28.6%	0.591
	No	64.3%	71.4%	
	Don't know	7.1%	.0%	
Sauna/steam room	Yes	16.7%	30.8%	0.409
	No	83.3%	69.2%	
Water features/fountains	Yes	35.7%	41.7%	0.756
	No	64.3%	58.3%	
Landscape ponds	Yes	42.9%	30.8%	0.516
	No	57.1%	69.2%	
Tennis courts	Yes	35.7%	15.4%	0.228
	No	64.3%	84.6%	
Basketball courts	Yes	38.5%	7.7%	0.063
	No	61.5%	92.3%	
Hot tub	Yes	46.2%	57.1%	0.568
	No	53.8%	42.9%	
Cooling tower	Yes	21.4%	.0%	0.088
	No	78.6%	100.0%	
One common laundry room/facility	Yes	81.8%	36.4%	0.030
	No	18.2%	63.6%	
More than one common laundry room/facility	Yes	55.6%	61.5%	0.779
	No	44.4%	38.5%	
Type of pool	indoor	.0%	7.1%	0.538
	outdoor	57.1%	64.3%	
	both	7.1%	.0%	
	no pool	35.7%	28.6%	
Do the units come with hook-ups for washing machines?	Yes	42.9%	50.0%	0.705
	No	57.1%	50.0%	
Do all or some of the units come equipped with dishwashers?	Yes	84.6%	100.0%	0.127
	No	15.4%	.0%	
Percent of units with dishwashers	0	25.0%	.0%	0.164
	90	.0%	9.1%	
	100	75.0%	90.9%	
Number of non-residential buildings	0	14.3%	18.2%	0.701
	1	57.1%	54.5%	
	2	14.3%	9.1%	
	3	.0%	9.1%	
	4	.0%	9.1%	
	5	14.3%	.0%	
Number of steam rooms	0	90.9%	100.0%	0.286
	2	9.1%	.0%	
How many saunas?	0	83.3%	81.8%	0.510
	1	8.3%	18.2%	
	2	8.3%	.0%	
Does the property hose down outdoor courts	No	42.9%	14.3%	0.094
	No courts	57.1%	85.7%	
Does the property fill the pond?	Yes	28.6%	15.4%	0.708
	No	14.3%	15.4%	
	No pond(s)	57.1%	69.2%	

		In-Rent	RUBS	P-Value
Is the fountain recirculating?	Yes	21.4%	41.7%	0.271
	Don't know	14.3%	.0%	
	No fountain(s)	64.3%	58.3%	
Type of irrigation	No irrigation	7.1%	.0%	0.260
	Automatic irrigation	78.6%	92.3%	
	Manual irrigation	.0%	7.7%	
	Multiple methods of irrigation	14.3%	.0%	
Number of cooling towers	0	84.6%	100.0%	0.367
	1	7.7%	.0%	
	3	7.7%	.0%	
Do they blow down the towers	Yes	15.4%	.0%	0.157
	No tower(s)	84.6%	100.0%	
Are there swamp coolers	Yes	15.4%	25.0%	0.548
	No	84.6%	75.0%	
How many swamp coolers	0	85.7%	76.9%	0.479
	2	7.1%	15.4%	
	7	7.1%	.0%	
	12	.0%	7.7%	
Are there boilers	Yes	33.3%	25.0%	0.653
	No	66.7%	75.0%	
How many boilers	0	66.7%	75.0%	0.536
	1	8.3%	.0%	
	2	8.3%	8.3%	
	5	.0%	8.3%	
	6	8.3%	.0%	
	12	.0%	8.3%	
	13	8.3%	.0%	
Year of Property was Built	Before 1994	92.9%	92.9%	1.000
	1995 or Later	7.1%	7.1%	
Rental property or individually-owned property	Rental property	100.0%	92.9%	0.309
	Individually-owned property	.0%	7.1%	

Table D.5 Property Characteristics by Type of Billing Method, In-Rent/Submetered Pairs

		In-Rent	Submetered*
Average number of bedrooms per unit	Mean	1.70	1.73
	Std Deviation	.48	.37
	Number	N=21	N=20
	P-value	0.889	
In what year was the construction of the property completed?	Mean	1980.67	1984.24
	Std Deviation	13.31	13.72
	Number	N=21	N=21
	P-value	0.265	
Average rent	Mean	785.49	792.17
	Std Deviation	245.62	225.77
	Number	N=20	N=18
	P-value	0.902	
Percent ultralow flow toilets	Mean	55.57	63.10
	Std Deviation	40.43	39.83
	Number	N=21	N=21
	P-value	0.427	
Percent low flow showerheads	Mean	71.19	71.19
	Std Deviation	25.19	27.70
	Number	N=21	N=21
	P-value	1.000	
Percent low flow faucets	Mean	86.67	76.43
	Std Deviation	19.13	29.71
	Number	N=21	N=21
	P-value	0.168	
Percent front-loader (efficient) clothes washers	Mean	5.48	5.00
	Std Deviation	21.79	21.79
	Number	N=21	N=21
	P-value	0.946	
How many boilers	Mean	.89	.00
	Std Deviation	3.00	.00
	Number	N=19	N=19
	P-value	0.163	
How many swamp coolers	Mean	.10	4.25
	Std Deviation	.44	13.20
	Number	N=21	N=20
	P-value	0.166	
Number of cooling towers	Mean	.05	.00
	Std Deviation	.22	.00
	Number	N=20	N=21
	P-value	0.330	
Square feet of irrigated property	Mean	69517.55	68790.75
	Std Deviation	157374.66	83318.42
	Number	N=20	N=20
	P-value	0.805	
Percent turf	Mean	46.45	43.72
	Std Deviation	23.75	32.07
	Number	N=20	N=18
	P-value	0.437	
Percent trees	Mean	48.52	52.15
	Std Deviation	26.49	32.08

		In-Rent	Submetered*
	Number	N=21	N=20
	P-value	0.781	
Percent flowers	Mean	7.00	7.22
	Std Deviation	15.67	16.41
	Number	N=10	N=9
	P-value	0.363	
Percent other	Mean	9.00	11.67
	Std Deviation	20.22	19.36
	Number	N=9	N=9
	P-value	1.000	
How many saunas?	Mean	.05	.00
	Std Deviation	.23	.00
	Number	N=19	N=21
	P-value	0.331	
Number of steam rooms	Mean	.06	.00
	Std Deviation	.24	.00
	Number	N=18	N=21
	P-value	0.331	
Number of non-residential buildings	Mean	2.31	1.25
	Std Deviation	2.02	.87
	Number	N=13	N=12
	P-value	0.426	

* Submetered properties included hot water hybrids in this analysis.

Table D.6 Property Characteristics by Type of Billing Method, In-Rent/RUBS Pairs

		In-Rent	RUBS
Average number of bedrooms per unit	Mean	1.78	1.66
	Std Deviation	.52	.44
	Number	N=14	N=14
	P-value	0.551	
In what year was the construction of the property completed?	Mean	1977.79	1980.14
	Std Deviation	10.63	9.49
	Number	N=14	N=14
	P-value	0.200	
Average rent	Mean	752.12	749.29
	Std Deviation	211.37	141.75
	Number	N=14	N=13
	P-value	0.987	
Percent ultralow flow toilets	Mean	33.57	27.86
	Std Deviation	31.16	33.09
	Number	N=14	N=14
	P-value	0.458	
Percent low flow showerheads	Mean	73.93	70.36
	Std Deviation	18.93	24.30
	Number	N=14	N=14
	P-value	0.625	
Percent low flow faucets	Mean	88.57	78.57
	Std Deviation	14.06	18.02
	Number	N=14	N=14
	P-value	0.112	
Percent front-loader (efficient) clothes washers	Mean	7.14	.36
	Std Deviation	26.73	1.34
	Number	N=14	N=14
	P-value	0.362	
How many boilers	Mean	1.83	1.58
	Std Deviation	3.93	3.60
	Number	N=12	N=12
	P-value	0.082	
How many swamp coolers	Mean	.64	1.23
	Std Deviation	1.91	3.32
	Number	N=14	N=13
	P-value	0.637	
Number of cooling towers	Mean	.31	.00
	Std Deviation	.85	.00
	Number	N=13	N=12
	P-value	0.339	
Square feet of irrigated property	Mean	102004.86	39902.93
	Std Deviation	199425.51	59895.18
	Number	N=14	N=14
	P-value	0.243	
Percent turf	Mean	45.21	40.36
	Std Deviation	31.13	28.11
	Number	N=14	N=14
	P-value	0.552	
Percent trees	Mean	44.43	47.07
	Std Deviation	29.75	25.59

		In-Rent	RUBS
	Number	N=14	N=14
	P-value	0.824	
Percent flowers	Mean	4.17	1.78
	Std Deviation	6.65	2.44
	Number	N=6	N=9
	P-value	0.684	
Percent other	Mean	3.33	7.50
	Std Deviation	8.16	17.53
	Number	N=6	N=8
	P-value	0.374	
How many saunas?	Mean	.25	.18
	Std Deviation	.62	.40
	Number	N=12	N=11
	P-value	1.000	
Number of steam rooms	Mean	.18	.00
	Std Deviation	.60	.00
	Number	N=11	N=12
	P-value	0.343	
Number of non-residential buildings	Mean	1.57	1.36
	Std Deviation	1.62	1.21
	Number	N=7	N=11
	P-value	0.876	

APPENDIX E

ARTICLE XVIII. MIAMI-DADE COUNTY REMETERING ORDINANCE*

Sec. 8A-380. Definitions.

The following words and phrases when used in this section shall have the following meanings:

AWWA shall mean the American Water Works Association.

CSD shall mean the Miami-Dade County Consumer Services Department.

Code shall mean Code of Miami-Dade County.

Commission shall mean the Miami-Dade County Board of County Commissioners.

Director shall mean the Director of the CSD or his/her designee.

Individual unit shall mean the occupied space by a specific resident in a multiple unit property, including but not limited to individual units, common areas and swimming pools.

Master meter shall mean a meter used to measure all water service usage of a multiple unit property, including but not limited to individual units, common areas and swimming pools.

Multiple unit property shall mean a property where two (2) or more units are served by a single master meter, including but not limited to, condominiums, cooperatives, apartment and office buildings, town houses, mobile home parks and shopping centers.

Municipality shall mean any self-governing jurisdiction in Miami-Dade County.

Owner shall mean a person, firm, corporation or other business entity who owns a multiple unit property and who purchases water service from WASD at retail rates, and provides remetering.

Partial submetering shall mean the use of a submeter which does not measure the total water

*Editor's note—Ordinance No. 96-137, §§ 1, 2, adopted September 17, 1996, repealed §§ 8A-380—8A-391 and enacted new §§ 8A-380—8A-398. Formerly, such sections pertained to similar provisions and derived from Ord. No. 95-101, § 1, 6-20-95.

service consumption of an individual unit in a multiple unit property resulting in a prorated or estimated water service bill.

Registration shall mean the authorization by the Director required by this article in order to engage in remetering.

Remeterer shall mean a person, firm, corporation or other business entity that provides two (2) or more services to the Owner pertaining to remetering, including but not limited to, submeter installation, submeter reading, billing and record keeping.

Remetering shall mean the resale of water service by use of a submeter by an Owner at a rate or charge which does not exceed the Owner's actual purchase price.

Resident shall mean a person who purchases water service from an Owner.

Submeter shall mean the meter serving an individual unit of a multiple unit property and that is installed after the outlet side of the master meter that allows the reading of individual water service consumption.

Submetering shall mean the measuring of water service to an individual unit by placing a submeter after the outlet side of the master meter to obtain actual readings for the individual unit.

WASD shall mean the Miami-Dade Water and Sewer Department.

Water service shall mean water and/or sewer service as provided by WASD.
(Ord. No. 96-137, §§ 1, 2, 9-17-96)

Sec. 8A-381. Intent and application.

(a) It is the intent of this article to permit remetering and encourage the conservation of water resources.

(b) The provisions of this article shall be construed liberally to promote the following: To establish a comprehensive regulatory system to assure that the practice of remetering of water services and billing are just and reasonable; to assure that billing for water service at multiple unit properties is based on individual unit usage; to assure that Residents are charged fairly for the services provided by those engaged in remetering; to assure that Owners and Residents are protected from unscrupulous business practices; and to establish the rights and responsibilities of the Owner, Resident and the Remeterer.

(c) The provisions of this article shall apply to multiple unit properties utilizing water services.

(d) Any Owner or Remeterer who has installed submeters and who has been individually billing Residents for water service prior to the adoption of this article shall have ninety (90) days from the date of enactment to comply with the provisions of this article.

(e) Any municipality that operates its own water utility in Miami-Dade County may petition, in writing, that the CSD enforce remetering for their retail customers provided that the municipality adopts an ordinance or resolution authorizing Miami-Dade County to regulate water remetering in its municipality. In such cases, all references to WASD shall apply to that municipality's water service.
(Ord. No. 96-137, §§ 1, 2, 9-17-96)

Sec. 8A-382. Registration required.

(a) Initial and annual registrations are required of owners and Remeterers. Each application for initial registration, renewal registration and duplicate or amended registration shall be on a form prescribed by the Director and shall be accompanied by a fee in such amount as shall be established by Administrative Order of the County Manager. Such fees shall be effective upon approval by the Commission. All fees collected shall be deposited in a separate County fund to be utilized solely for the administration and enforcement of this ordinance. No part of such fund shall be used for purposes other than the aforesaid.

(1) Each application for registration by an Owner shall contain the following information:

a. Name, address and type of property to be remetered; Owner's name, telephone number and tax identification number and/or social security number, legal business and trade name, if applicable; names and addresses of any partners, officers, other corporations, entities or trade names through which business is conducted; number of units being remetered; name, address, contact person and telephone number of Remeterer; and name, address, contact person and telephone number of management company, if applicable.

b. Copy of sample lease or condominium agreement that states individual unit is or may be submetered.

c. Date billing is to begin and copy of bill format that meets the requirements of Section 8A-385(a)(3)f.

d. Copies of plumbing and electrical permits, where applicable.

e. Specifications, as approved by AWWA Standards, of submeters and testing equipment to be used.

f. Schedule of submeter installations pursuant to Section 8A-387(d), if applicable.

g. Comparison report of Owner's regular water service charges from WASD and charges billed to the Residents by the Owner for the same period of time. This requirement is not necessary during initial registration.

h. A list of all properties served in Miami-Dade County to include the property name, service address, contact person and telephone number.

i. Other additional information and items as the Director shall require to enforce the provisions of this article.

(2) Each application for registration by a Remeterer shall contain the following information:

a. Company's legal business and trade name, principal or main address and telephone number, tax identification number and/or social security number, names and addresses of any other corporations, entities or trade names through which business is conducted; and names and addresses of Business Owners or Corporate Officers.

b. Copy of occupational license permitting company to do business in Miami-Dade County.

c. Copy of Certificate of Competency as a registered or certified plumbing contractor from Miami-Dade County or the State of Florida, if applicable.

d. Proof of workers' compensation insurance coverage, as required by Chapter 440 of the Florida Statutes, or a state certificate of exemption.

e. Proof of comprehensive general liability which shall have a minimum limit of three hundred thousand dollars ($300,000.00) per occurrence combined single limit for bodily injury and property damage liability.

f. Specifications, as approved by AWWA Standards, of submeters and testing equipment to be used.

g. Other additional information and items as the Director shall require to enforce the provisions of this article.

(3) Each initial application for registration by an Owner or Remeterer who has installed submeters and has been individually billing Residents for water service usage prior to the adoption of this article shall contain, in addition to the requirements in paragraphs (1) and (2) above, the following information:

a. Comparison report of Owner's regular water service charges from WASD and charges billed to the Residents by the Owner for the same period of time.

b. Copy of the signed plumbing and/or electrical permit card or other form of approval issued by the appropriate governmental agency of jurisdiction for the installed submeters.

(b) Any change in ownership, address, telephone number, contact person or other information recorded on a registration application shall be reported to the Director, in writing, within ten (10) days of the change.

(c) Registrations shall become effective upon the date the application is approved by the Director. Completed renewal applications must be submitted to the Miami-Dade County Consumer Services Department, by mail or in person, at least thirty (30) days prior to the expiration of the registration. An incomplete application shall be considered abandoned if an applicant fails to complete their application within sixty days from the date that the application is filed with the CSD. An application submitted subsequent to the abandonment of a former application shall be treated as a new application.
(Ord. No. 96-137, §§ 1, 2, 9-17-96; Ord. No. 03-44, § 1, 3-11-03)

Sec. 8A-383. Regulations.

(a) Employees of the Owner and Remeterer performing work related to remetering, including but not limited to, submeter readers and submeter testers, shall display identification reflecting the Owner's or Remeterer's name and logo.

(b) Only individual units may be submetered and each submeter shall only serve one (1) unit.
(Ord. No. 96-137, §§ 1, 2, 9-17-96)

Sec. 8A-384. Records and reports.

(a) The Owner shall maintain the following records and reports:

(1) Name, address and telephone number of Owner; name, address and telephone number of the Remeterer; and name, address and telephone number of management company, if applicable.

(2) Person to be contacted concerning questions or complaints about service and billing.

(3) Resident's name and location of each unit being submetered.

(4) Copies of the plumbing and electrical permits, where applicable.

(5) Specifications, as approved by AWWA Standards, of submeters and testing equipment to be used on the subject property.

(6) Other information as may be required by CSD to enforce the provisions of this article.

(b) Resident access to submetering records. Upon reasonable request of a Resident, the Owner shall make available for the Resident's inspection, at an agreed upon time and place, the following records during normal business hours (normally, Monday through Friday between the hours of 8:00 a.m. to 5:00 p.m.):

(1) The billing from WASD to the Owner for the current month and the twelve (12) preceding months.

(2) The calculation for billing, i.e., gallons or hundred (100) cubic feet (ccf), for the current month and the twelve (12) preceding months.

(3) All submeter readings and Resident billings for the individual unit for the current month and the twelve (12) preceding months.

(4) All submeter test results for the individual unit for the current month and the twelve (12) preceding months.

(5) Documentation of separate account records for rent and/or maintenance fees and submetered water bills, including date of transaction, as required in Section 8A-385(a)(3)d.

(c) Submeter records and reports. The Owner and/or Remeterer shall maintain the following submeter records and reports.

(1) Submeter equipment record. A record of all submeters, showing the Resident's name and address, date of installation, submeter serial number and date of the last certified test.

(2) Record of submeter tests. All submeter tests shall be referenced in the submeter record required by this section. The record of each test made shall show the serial number of the submeter, the type and manufacturer of the submeter and any testing equipment used, the date of calibration and certification of the testing equipment, unit number where submeter is installed, the date and type of test made, who performed the test, the error and/or accuracy percentage of testing and mathematical data to permit verification of all calculations.

(d) Records and reports pertaining to paragraphs (a) and (b) above must be maintained for a period of four (4) years. Records and reports pertaining to paragraph (c) above must be maintained for a period of ten (10) years. All records and reports shall be provided and/or made available to the CSD upon request in Dade County.
(Ord. No. 96-137, §§ 1, 2, 9-17-96)

Sec. 8A-385. Billing.

(a) The billing process for remetering activities shall be as follows:

(1) Sale/rental agreement for submetering. All sale/rental agreements between the Owner and the Resident shall clearly state that the unit is or may be submetered, that bills for water service will or may be issued on a submetered basis, and that bills shall not include charges for water service for common areas and facilities. The Resident shall initial this provision on the sale/lease agreement. Each Owner shall provide the Resident, at the time the sale/lease is signed, a copy of a narrative summary prepared by CSD (one (1) copy will be provided by the CSD to the Owner) to inform the Resident about remetering. Current Residents must be notified of the information required in this section ninety (90) days prior to the implementation of the service, unless notice was otherwise provided in the Resident's sale/rental agreement.

(2) Condominiums, cooperatives and other such properties in which the units are owned by the Residents shall be billed in the same manner as paragraph (1) above. All common area's water service usage shall be paid by all owners of the association as designated in their by-laws.

(3) Rendering and form of submetered bill.

a. Bills shall be rendered for the same billing period as that of WASD, generally monthly or quarterly, unless service is rendered for less than that period. The submeters shall be read either during or no later than five (5) business days (excluding weekends and legal holidays) after WASD's scheduled window for reading the master meter. Bills shall be rendered as promptly as possible following the reading of the submeters.

b. The billing rate shall be that used by WASD in its billing to the Owner for water service.

c. The Owner shall ensure that water service consumption billed to each individual unit is only for each unit's submetered usage.

d. A separate bill must be issued with the submetered billing information, separate and distinct from any other charges, and shall not be combined with the sale, rental and/or maintenance payment or with any other service provided to the Resident.

e. The bill shall reflect only submetered usage and the applicable taxes.

f. The Resident's water service submeter bill shall show all of the following information:

1. The date and submeter reading of the period for which the bill is rendered.
2. The prior and current submeter readings.
3. The total gallons of ccf of water service being billed.
4. The computed rate for gallons or ccf being billed.
5. The total amount due for water service used and applicable taxes.
6. The name and address of the Resident to whom the bill is issued.
7. The name of the company rendering the submetering bill and the address and telephone number of the person or section from that firm that is to be contacted in case of a billing dispute.
8. The date by which the Resident must pay the bill.
9. The name, address and telephone number of the party to whom payment is to be made, if different from paragraph 7. above.
10. If it is an estimated bill, the bill shall be distinctly marked as such.
11. The telephone number of the CSD with a statement that indicates the CSD may be contacted if disputes are not resolved amicably with Owners and Remeterers.

(4) Due date. The due date of the bill shall not be less than fifteen (15) days after issuance. A bill for service may be considered delinquent if not received by the due date. The postmark date, if any, on the envelope of the bill or on the bill itself shall constitute proof of the date of issuance. An issuance date on the bill shall constitute proof of the date of issuance if there is no postmark on the envelope or bill. If the due date falls on a holiday or weekend, the due date for payment purposes shall be the next business day after the due date.

(5) Disputed bills. In the event a Resident disputes a bill, the Resident shall provide written notice to the Owner which specifically states the reason for the dispute. The Owner shall forthwith conduct an investigation and report the results, in writing, to the Resident within thirty (30) days. The investigation and report shall include, but not be limited to, the nature of the complaint; how the complaint was investigated; an explanation of the results, which shall include identification of any leaks, damaged pipes and running toilets; and, the corrective measures taken or the justification for the bill. A corrected bill must be issued if the disputed bill was found to be in error.

(6) Overbilling and underbilling. If billings are found to be in error, the Owner and/or the Remeterer shall calculate a billing adjustment. If the Resident is due a refund, an adjustment shall be made for the entire period of the overcharges. If the Resident was undercharged, the Owner and/or Remeterer may backbill the Resident for the amount which was underbilled for a period not to exceed six (6) months. If the underbilling is twenty-five dollars ($25.00) or more, the Resident shall be offered a deferred payment plan option, for the same length of time as that of the underbilling. Adjustments for usage by a previous Resident may not be backbilled to the current Resident, except that condominium associations may transfer liabilities from owner to owner according to their condominium by-laws.

(7) Delinquent accounts. A one-time per month penalty on current billing not to exceed ten (10) percent of current billing, or a flat rate fee not to exceed ten (10) percent of current billing, may be applied to delinquent accounts. If such penalty is applied, the bill shall indicate the amount due if paid by the due date and the amount due if the late penalty is incurred. No late penalty may be applied if the Resident has not been informed, in writing, of this condition and of the exact dollar amount or percentage

amount of such late penalty. No late penalty may be applied if the bill is in dispute until ten (10) days after the dispute has been resolved.

(8) Owners and remeterers shall not impose any extra charges on the Resident over and above the water service charges and including the applicable taxes that are billed by WASD to the Owner. The bill may not include a deposit, reconnect charge, or additional late penalty, other than as provided in item (7) above.

(b) Estimated submetering bills. Estimated bills shall not be rendered unless:

(1) The submeter has been tampered with or bypassed. The estimated billing shall not exceed two (2) billing periods.

(2) The submeter is found not to be in conformance with AWWA accuracy standards or has stopped and found not to register for any period. The Owner may impose an estimated charge for a period not to exceed one (1) billing period, based on amounts used under similar conditions by the same resident during periods preceding or subsequent thereto, or during the corresponding period in previous years.

(Ord. No. 96-137, §§ 1, 2, 9-17-96)

Sec. 8A-386. Submeters.

(a) Submeter requirements are as follows:

(1) *Use of submeter.* All water resold by an Owner shall be charged for by submeter measurements. The submeter shall conform to AWWA Standards C700, C708 or C710. All submeters shall be rated for a working pressure of at least 150 psi.

(2) *Installation by Owner and/or Remeterer.* Each Owner and/or Remeterer shall be responsible for providing, installing and maintaining in good working condition all submeters necessary for the measurement of water service to the Residents. A shut-off valve shall be installed on the water line on the inlet side of the submeter.

Tamper-proof seal. Each submeter must have a tamper-proof seal or device. This seal or device shall be clearly noticeable to detect if the submeter has been tampered with.

Submeter readings. Each submeter shall indicate clearly the gallons and/or ccf of water for which charge is made to the Resident.

(5) *Location of submeters.* Submeters and shut-off valves used in conjunction with the submeters shall be installed in accordance with AWWA Standards, and shall be accessible for reading, testing and inspection where such activities will cause minimum interference and inconvenience to the Resident.

(b) Submeter testing.

[Tested and inspected for applicable size and type submeter.] All submeters must be tested and inspected, within the time intervals recommended by the AWWA for the applicable size and type submeter, by a facility that is accredited and in compliance with AWWA Standards.

Accuracy requirements for submeters. Submeters shall be tested for accuracy of registration at flow rates and test flow quantities in accordance with the applicable AWWA Standard.

(3) *Submeter tests requested by the Resident.* Each Owner shall, upon a reasonable written request from the Resident and, if the Resident so desires, in the presence of the Resident or their authorized representative, perform a test of the accuracy of the submeter. Prior to scheduling the test, the Resident shall be advised of their liability, if any, for the testing and plumbing charge pursuant to paragraph (4) below. The test shall be made during normal business hours (normally, Monday through Friday between the hours of 8:00 a.m. to 5:00 p.m.), at a time convenient to the Resident desiring to observe the test. Submeter tests must be performed by an accredited and certified water meter testing facility.

(4) *[Test results.]* Following completion of any test pursuant to paragraph (3) above, the owner shall advise the Resident in a timely manner but not to exceed sixty (60) days, in writing, of the test results. if the test results are within the AWWA Standard for the applicable water meter, the Owner may charge a reasonable testing and plumbing charge to the Resident. If the submeter's accuracy is not within the appropriate accuracy standards, no charge shall be made to the Resident for the test.

(5) *Submeter tests prior to installation.* No submeter shall be placed into service unless it has been factory tested or tested by a certified testing facility to comply with AWWA Standards for accuracy. A certification of accuracy shall be required and made available to the CSD upon request. If any submeter is removed from service and replaced by another submeter for any purpose whatsoever, the CSD must be notified, in writing, of the serial number of the new submeter placed in the unit.

(c) Submeter testing facilities and equipment.

(1) Each Owner shall provide or have access to suitable measuring instruments for insuring the accuracy of shop and portable instruments used for testing submeters used in billing.

(2) All testing equipment shall be submitted once each year to a standardizing laboratory of recognized standing, for the purpose of testing and adjustment, and shall be accurate to within twenty-five hundredths (0.25) percent of the actual quantity of water, in accordance with AWWA Standards. Owners and Remeterers who do not own testing equipment must use an AWWA accredited facility to do testing when needed and obtain from them proof that instruments used have been tested and adjusted yearly.

(3) All shop and portable instruments used for testing submeters used in billing shall be calibrated by comparing them with a reference standard at least once each year. Test equipment shall at all times be accompanied by a certified calibration card signed by an AWWA approved facility, giving the date when it was last certified and adjusted. Records of certifications and calibrations shall be kept on file in the office of the Remeterer, Owner or the Owner's designee for no less than four (4) years.

(Ord. No. 96-137, §§ 1, 2, 9-17-96; Ord. No. 03-44, § 1, 3-11-03)

Sec. 8A-387. Prohibited practices.

(a) It shall be unlawful for any person, firm, corporation or other business entity to engage in remetering in violation of the provisions of this article or to individually bill for water service other than by remetering.

(b) It shall be unlawful for any person, firm, corporation or other business entity to engage in the resale of water service without registering with the CSD.

(c) It shall be unlawful for any person, firm, corporation or other business entity to resell water service by use of a submeter at a rate or charge which exceeds the actual purchase price from WASD.

(d) No unit may be submetered unless all units are submetered in each building served by a master meter; provided, however, a building may be submetered in phases over a twelve-month period in accordance with a schedule filed with the CSD.

(e) The submeters cannot be used to avoid water main extensions or payment of appropriate connection charges and other fees due to WASD.

(f) Partial submetering and its billing based on a proration of water service is prohibited.

(g) It shall be unlawful for Owners to make a profit from remetering.

(h) It shall be unlawful for any person, firm, corporation or other business entity to place a submeter in use that is not registering in accordance with the AWWA specifications set forth in this article.

(i) Disconnection of water service by an Owner or a Remeterer for delinquent bills is prohibited. Water service may only be disconnected for emer-

gency purposes, such as water service line problems, leakage, flooding or in the event that a dangerous condition exists which is related to the service being provided.
(Ord. No. 96-137, §§ 1, 2, 9-17-96)

Sec. 8A-388. Administration.

The CSD shall be responsible for the administration and enforcement of the provisions of this article.
(Ord. No. 96-137, §§ 1, 2, 9-17-96)

Sec. 8A-389. Director's duties, functions and powers.

(a) The duties, functions, powers and responsibilities of the Director shall include the following:

(1) Enforce all of the provisions of this article and any regulations promulgated thereunder.

(2) Upon receipt of complaints or upon the Director's initiative, investigate, inspect, sample and test any matters regulated hereunder.

(3) Issue, deny, revoke and suspend registrations and impose conditions, limitations and restrictions upon same in accordance with Section 8A-382 and Section 8A-391 of this Code.

(4) Issue cease and desist orders, notices to correct violations and any other lawful orders of the Director which shall briefly set forth the general nature of the violation of this article and specify the time within which the violation shall be rectified or stopped. If an order to cease and desist or notice to correct violations or any other lawful order of the Director is not obeyed, the Director shall have the power and authority to revoke or suspend the registration of the person, firm, corporation or other business entity engaged in remetering, or deny the issuance of registration and take such other action authorized by this article. Notwithstanding the foregoing, no revocation or suspension of a registration by the Director shall be effective until the rendition by the hearing officer of the appeal, if any, of such revocation or suspension pursuant to Section 8A-397 of the Code of Metropolitan Date County, Florida, or until the time period for filing such appeal has expired, whichever is later. Orders to cease and desist, notices to correct violations and any other lawful orders of the Director hereunder may be enforced by the institution by the Director of civil actions for mandatory and prohibitory injunctions, civil penalties and other remedies and attorney's fees as set forth in Section 8A-396 of the Code of Metropolitan Dade County in a court of competent jurisdiction.

(5) Institute civil actions or proceedings to enforce all the provisions of this article and subpoena issued by the Director or the hearing officer, including seeking mandatory and prohibitory injunctions, the imposition and recovery of civil penalties, restitution and such other remedies and attorney's fees as set forth in Section 8A-396 of the Code. Such civil actions or proceedings may be instituted by the Director regardless of whether a cease and desist order or notice to correct the violation or other lawful order of the Director has been issued or other administrative proceeding is pending.

(6) Prosecute through the State Attorney in the criminal courts for violations of this article.

(7) Issue subpoena to compel the presence of any person or document or thing at any hearing, conference or proceeding authorized herein upon information or belief by the Director that a violation of any provision of this article has occurred or may occur.

(8) Inquire into the practices, functions and policies of Owners and/or Remeterers and make such recommendations to the Commission as the Director may deem necessary.

(9) Administer oaths and certify official acts of the Director.

(10) Investigate, upon the Director's initiative, the practices of any Owner and/or Remeterer.

(11) Apply to any judge of the circuit or county court, criminal or civil division, for the issuance of an administrative search warrant.

(12) Conduct a program for monitoring consumer satisfaction levels in the field of remetering and make such monitoring information available to the Commission and the public.

(13) Institute informal conferences for discussing and resolving any matter covered by this article.

(14) Publish and disseminate information to the public concerning remetering.

(15) Submit to the Commission additional rules, regulations and standards to effectuate the purposes of this article. No such proposed rules, regulations or standards shall become effective until approved by the Commission by ordinance.

(16) Enter into written assurances of compliance pursuant to Sections 8A-82.1 and 8A-390 of the Code of Metropolitan Dade County, Florida, with respect to the matters regulated under this article.

(17) The powers of the Director enumerated herein shall be in addition to and not a limitation of any other powers of the Director pursuant to any other provisions of this article or any other provisions of law or ordinance.

(Ord. No. 96-137, §§ 1, 2, 9-17-96)

Sec. 8A-390. Assurances of compliance.

Each violation of any of the terms and conditions of a verified, written assurance entered into pursuant to Section 8A-82.1 of the Code with respect to the matters regulated under this article shall constitute a separate offense under this article by the persons who executed the assurance, their respective officers, directors, agents, servants and employees and by those persons in active concert or participation with any of the foregoing persons and who receive actual notice of the assurance of compliance. Decisions, actions and determinations of the Director, pursuant to Sections 8A-82.1 and 8A-389(16) or assurances of compliance executed thereunder, shall not be subject to review pursuant to Section 8A-397 of this Code.

(Ord. No. 96-137, §§ 1, 2, 9-17-96)

Sec. 8A-391. Denial, suspension and revocation.

(a) The Director may deny, suspend, or revoke a registration issued pursuant to the provisions of this article if the Director determines that the applicant or registrant has:

(1) Submitted an application that is not filed in accordance with Section 8A-382, is incomplete or untrue in whole or in part.

(2) Violated any provision of this article.

(3) Misrepresented or concealed a material fact on the application, renewal application or replacement application.

(4) Aided or abetted a person who has not obtained a registration to evade or avoid the provisions of this article.

(5) Engages in fraudulent conduct in connection with remetering.

(6) Violated any condition, limitation or restriction of a registration imposed by the Director.

(7) Was enjoined by a court of competent jurisdiction from engaging in the trade or business of remetering or was enjoined by a court of competent jurisdiction with respect to any of the requirements of this article.

(8) Failed to comply with the terms of a cease and desist order, notice to correct a violation, written assurance of compliance or any other lawful order of the Director.

(b) Notwithstanding the foregoing, no denial, suspension or revocation of a registration by the Director shall be effective until the rendition by the hearing officer of the appeal, if any, of such denial, suspension or revocation pursuant to Section 8A-397 of the Code of Metropolitan Dade County, Florida or until the time period for filing such appeal has expired, whichever is later.

(Ord. No. 96-137, §§ 1, 2, 9-17-96)

Sec. 8A-392. Civil penalties.

(a) The Director may institute a civil action in a court of competent jurisdiction to impose or recover a civil penalty in an amount of not more than ten thousand dollars ($10,000.00) for each violation of any of the provisions of this article. Each day during any portion of which such violation occurs or continues to occur constitutes a separate violation. The right of trial by jury shall be available in any court to determine both liability for and the amount of the civil penalties to be imposed and recovered hereunder.

(b) The Director may institute a civil action in a court of competent jurisdiction to seek restitution and other equitable relief as follows:

(1) To recover any sums and costs expended by the Director for investigating, preventing, controlling, abating or remedying any violation of any of the provisions of this article or of the regulations.

(2) To provide restitution to any Owner and/or Resident injured by any violation of any of the provisions of this article or of the regulations.

(3) Upon the rendition of judgment or decree by any of the courts of this state against any person or in favor of the Director under any of the provisions of this article, the trial court or in the event of an appeal, the appellate court, shall adjudge against any such person and in favor of the Director a reasonable sum as fees or compensation for the Director and attorney prosecuting the suit in which recovery is had.

(4) To seek temporary or permanent, prohibitory or mandatory injunctive relief to enforce compliance with or prohibit the violation of any of the provisions of this article or of the regulations.

(Ord. No. 96-137, §§ 1, 2, 9-17-96)

Sec. 8A-393. Criminal penalties.

In addition to any other judicial or administrative remedies or penalties provided by law, rule, regulation or ordinance, if any person intention- violates or fails or refuses to obey or comply any of the provisions of this article or any lawful order of the Director or any cease and desist order of the Director or any notice to correct a violation or any assurance of compliance entered into pursuant to Section 8A-82.1 of the Code and this article, or any condition, limitation or restriction of a registration issued by the Director, such person, upon conviction of any such offense, shall be punished by a fine not to exceed two thousand five hundred dollars ($2,500.00), or by imprisonment not to exceed sixty (60) days in the County jail, or both, at the discretion of the court. Each day or portion thereof of continuing violation shall be deemed a separate offense.
(Ord. No. 96-137, §§ 1, 2, 9-17-96)

Sec. 8A-394. Presumption of continuous operation.

Except as expressly provided otherwise in this article, any person operating in the resale of water service without first registering pursuant to this article shall be presumed to be operating on a continuous basis without registering from the date the registration was first required by this article. Such presumption may be overcome by evidence presented by the reseller of water service. This section creates a rebuttable presumption of continuous operation.
(Ord. No. 96-137, §§ 1, 2, 9-17-96)

Sec. 8A-395. Private cause of action.

Any person who suffers a loss as a result of a violation of any of the provisions of this article, any lawful order of the Director, any cease and desist order or notice to correct a violation issued by the Director or any assurance of compliance entered into pursuant to Section 8A-82.1 of the code and this article, may recover compensatory damages, punitive damages, attorney's fees and court costs as allowed by law from the person committing such violation. Nothing herein shall be construed to require the Director to bring any such action on behalf of a private person.
(Ord. No. 96-137, §§ 1, 2, 9-17-96)

Sec. 8A-396. Attorney's fees and costs.

(a) Upon the rendition of a judgment or decree by any of the courts of this state against any person and in favor of the Director under any of the provisions of this article, the trial court, or, in the event of an appeal in which the Director prevails, the appellate court, shall adjudge or decree against such person and in favor of the Director a reasonable sum as fees or compensation for the Director's attorney prosecuting the suit in which the recovery is had. Where so awarded, compensation or fees of the attorney shall be included in the judgement or decree rendered in the case. This provision shall apply to all civil actions, legal or equitable, filed after the effective date of this article by the Director. Cessation of any violation of any of the provisions of this article whatsoever, prior to rendition of a judgment or entry of a temporary or final decree, or prior to execution of a negotiated settlement, but after an action is filed by the Director under any of the provisions of this article, shall be deemed the functional equivalent of a confession of judgment or verdict in favor of the Director, for which attorney's fees shall be awarded by the trial court as set forth herein above.

(b) All judicial and administrative remedies in this article are independent and cumulative.
(Ord. No. 96-137, §§ 1, 2, 9-17-96)

Sec. 8A-397. Appeals and judicial review.

(a) Any person, firm, corporation or other business entity regulated by this article who is aggrieved by any action, decision or determination of the Director, pursuant to this article may appeal, in writing, by filing a notice of appeal to a hearing officer appointed pursuant to Section 8CC-2 of the Code of Metropolitan Dade County within fifteen (15) days after the date of the action, decision or determination complained of. The notice of appeal shall be sent to the address indicated ont he action, decision or determination. The notice shall set forth the nature of the action, decision or determination to be reviewed and the basis for the appeal. The hearing officer shall specially set such appeal for hearing no later than at the earliest practicable regularly scheduled hearing date or as soon thereafter as possible, but no sooner than ten (10) days after the notice of appeal has been filed, and shall cause notice thereof to be served upon the person filing the appeal by first class mail. The hearing officer shall hear and consider all facts material to the appeal, in accordance with the procedures set forth in Sections 8CC-6(e), (f), (g), (i), (j), (k), (l), (m)(2), (n) of the Code of Metropolitan Dade County (any reference in these sections to Inspector shall mean "Director" and to violator shall mean "the person filing the appeal"), and may affirm, modify or reverse the action, decision or determination appealed from. The decision of the hearing officer shall constitute final administrative review and no rehearing shall be permitted. Nothing herein shall be construed to prevent or prohibit the Director from instituting any civil or criminal action or proceeding authorized by this article at any time. Customers shall not be deemed to be persons regulated by this article for the purposes of this section.

(b) The Director, the Dade County Consumer Advocate or any person, firm, corporation or other business entity regulated by this article who is aggrieved by any decision of the hearing officer pursuant to this section may seek judicial review in accordance with the Florida Rules of Appellate Procedure. The words "action," "decision" and "determination" as used herein shall not include the filing or institution of any action, conference or proceeding by the Director in any court or otherwise. Customers shall not be deemed to be persons regulated by this article for the purpose of this section.
(Ord. No. 96-137, §§ 1, 2, 9-17-96)

Sec. 8A-398. Compliance with the South Florida Building Code.

Any person, firm, corporation or other business entity engaged in remetering shall comply with the provisions of the South Florida Building Code. Such compliance shall include, but not be limited to, applying for and obtaining a plumbing permit and, where applicable, an electrical permit. Nothing in this section is intended to create an obligation on or the authority for the CSD to enforce the requirements of the South Florida Building Code.
(Ord. No. 96-137, §§ 1, 2, 9-17-96)

Sec. 8A-399. Reserved.

GLOSSARY OF TERMS

Allocation – Often used interchangeably with RUBS (see RUBS). Also, see Utility Allocation.

ANOVA – ANOVA is an acronym for Analysis Of Variance, an inferential statistical test. With this test, the means of two or more groups can be compared.

AMR – Automated Meter Reading.

ARM – Automated Remote Metering

Allocation types – The basis by which utility expenses are apportioned to users. Common types include unit count, occupant count, occupant ratio, square footage, and a combination of occupant count and square footage. Less common types include bathroom count and fixture count.

BMP – best management practice(s)

Categorical variables – Variables that are not scaled, but are "nominal," that is, there is no direction or number associated with the levels. Billing method (in-rent, submetered, RUBS, hot water hybrid, other) and type of pool (indoor, outdoor, both) are examples of categorical variables.

Continuous variables – Variables that are numerical and can be scaled. Vacancy rate and average number of bedrooms per unit are examples of continuous variables.

Common area deduction – The practice, in utility allocation, of accounting for common areas utility usage and subtracting that usage from the master metered utility prior to allocation. See also "Pass Through Percentage."

DCU – Data Collection Unit. In an AMR system, the central device that collects usage data from meters. Also known as a Data Collection Device, Central Station and other, similar variations.

du – An acronym that stands for "dwelling unit".

Cubic feet – A frequently used unit of water measurement, one cubit foot is equal to 7.48 U.S. gallons

EPA – Environmental Protection Agency of the United States

EPACT 1992 – Energy Policy Act, signed into law by President Bush in 1992. Mandated exclusive manufacture of 1.6 gpf toilets as well as low-flow faucet aerators and showerheads.

Fixed rates – Part of a master metered or resident utility bill that is not affected by consumption.

HCF – Hundred cubic feet. Typical unit of measure for water used by utilities.

HOA – Homeowners association

Hot water hybrid - The practice of estimating a resident's total water usage based on metered hot water usage.

Hot water ratio billing – The practice of estimating a resident's total water usage based on metered hot water usage.

Impact properties – Multi-family properties that are using a billing method when residents receive a regular bill determined by a system such as submetering, RUBS, or hot water hybrid, etc.

In-rent properties – Multi-family properties that do not separately bill residents for water and/or wastewater, rather these costs are recovered as part of the monthly rent.

Individual metering –The installation of meters for each individual dwelling unit as well as separate common area metering with the local water utility providing customer read, bill and collect services.

kgal – Kilo-gallons or thousands of gallons. Typical unit of measure for water used by utilities. Equal to 748 cubic feet or 0.748 CCF.

Low flow detector – A part of a meter register that indicates any flow through the meter. Also, called a Leak Indicator.

Master metered - When a single meter measures utility usage for an entire property, or an entire building, which usually includes common areas.

Meter – A device that measures utility usage.

Meter register – Mechanical device (sometimes used synonymously with the term "Face") that uses a system of gear reductions to integrate the rotation of the moving element of a meter's measuring chamber into numerical units.

MIU – Meter Interface Unit. A device that translates meter data prior to transmission to a receiver. Also known as a Telemetry Interface Unit.

Multiple linear regression – Multiple regression is a method of determining the relationship between several independent or predictor variables and a dependent variable. The dependent variable must be a continuous variable.

N – Number. The number of cases from which a summary statistic or analysis is derived. In this Study, it usually refers to a number of properties or a number of resident respondents.

NIST – National Institute of Standards and Technology

P-value – The probability value of a statistical hypothesis test; the probability of getting a value of the test statistic as extreme or more extreme than that observed by chance alone, if the null hypothesis is true.

PAC – Project advisory committee

Partial-capture submetering – a type of submetering where only a portion of the total water consumption in each unit is measured.

Pass through percentage – The amount of the master metered utility bill allocated to residents. Also see "Common Area Deduction."

POC – Project oversight committee

Point-of-use (POU) meter – A meter that measures water flow at the actual usage point, such as a faucet or toilet.

Pressure testing – Subjecting a full water system to maximum normal pressure (or normal pressure plus a safety factor) against a closed downstream shut-off.

PUC – Public Utilities Commission

Receiver – In a Radio Frequency (RF) based AMR system, the device that receives the meter data transmissions for the central data collection device.

Repeater – In a Radio Frequency (RF) based AMR system, the device that receives and amplifies the meter RF signals in order to transmit them to the Receiver.

RBC – An acronym that stands for Read, Bill and Collect.

RF - An acronym that stands for Radio Frequency.

RUBS - An acronym that stands for both Ratio Utility Billing System, which is a calculation method that uses a compensation factor to allocate utility costs among users, as well as for Residential Utility Billing System.

Service provider – Generally used to describe either a submetering/billing service provider or a provider of utilities.

Submetering – The practice of using meters to measure master-metered utility consumption by individual users. Also, see partial-capture submetering and total-capture submetering.

Telemetry interface unit – A device that translates meter data prior to transmission to a receiver. Also known as a Meter Interface Unit (see MIU.)

Total-capture submetering – a type of submetering where all of the actual water consumption in each unit is measured.

Transmitter – A Radio Frequency (RF) system component that sends usage data from a meter to a Receiver.

T-test – An inferential statistical test for comparing two means. A dependent or paired t-test is used to compare the mean difference score between paired measurements, as in a repeated measures (like the pre- and post-conversion analysis) or matched pair design.

Utility – Used alternately to describe a provided a natural resource, such as water, gas, electric as well as for the provider of the resource (also see Service Provider.)

Utility allocation – Determining resident charges for utilities by means of a formula rather than measured usage.

WW – wastewater

Water meter size – Normally corresponds to the pipe bore, for example 1". For some models a second designation refers to the matching pipe end connections. For example, a 5/8" x 3/4" meter has a nominal 5/8" and ¾' straight pipe threads.

Waterworks bronze – Refers to one of two generally accepted alloys, one with a nominal composition of 81% copper, 3% tin, 7% lead and 9% zinc or another with a nominal composition of 85% copper, 5% each tin, lead and zinc.

UNITS OF MEASURE – WATER, GAS, AND ELECTRICITY

Water –

- U.S. Gallons (nominally 231 cubic inches of water)
- Cubic Feet, one of which is equivalent to 7.48 gallons.

Thousands of gallons (kgal) and hundreds of cubic feet (CCF or HCF)are the most common water-billing units in the Unites States.

Gas –

Therms, 1 of which equals 100 Cubic Feet.

Electricity –

Kilowatt Hours, which represent the amount of energy delivered at a rate of 1000 watts over a period of one hour. The kilowatt hour is equivalent to 3.9 megajoules of energy.

REFERENCES

Alternatives to master metering in multi-family housing. 1981. Chicago, Illinois: Institute of Real Estate Management of the National Association of Realtors.

ADEM. 2002. Annual Report – Public Water System Violations.

AWWA. 2000. *Principles of Water Rates, Fees, and Charges. 5th ed*. AWWA Manual M1. Denver, Colorado: AWWA.

AWWA WCD (Water Conservation Division). 2001. Water Submetering and Billing Allocation – A Discussion of Issues and Recommended Industry Guidelines. AWWA Draft White Paper, Water Conservation Division. AWWA.

Bauman, D.D., J.J. Boland, and W. M. Hanemann, eds. 1998. *Urban Water Demand Management and Planning*. New York: McGraw Hill, Inc.

Beecher, J., and P.C. Mann. 1996. The Role of Price in Water Conservation: Evidence and Issues. In *Proc. of Conserv96*. Orlando, FL: AWWA.

Billings, R.B. and D.E. Agthe. 1980. Price Elasticities for Water: A Case of Increasing Block Rates. *Land Economics,* 56(1): 73-84.

Billings, R. B., and W. M. Day. 1989. Demand Management Factors in Residential Water Use: The Southern Arizona Experience. *Journal AWWA,* 81(3): 58-64.

Black and Veatch Corporation. 2000. California Wastewater Rate Survey 2000. Irvine, CA.

Blackburn, A.J. 1994. The Impact of Metered Billing for Water and Wastewater on Multi-family Housing in New York. New York, New York: New York City Department of Environmental Protection.

Brown and Caldwell Consulting Engineers. 1984. *Residential Water Conservation Projects – Summary Report*. Washington, D.C.: US Department of Housing and Urban Development (HUD).

Camp, R.C. 1978. The Inelastic Demand for Residential Water: New Findings. *Journal AWWA,* 70(8): 452-458.

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

Cavanagh S.M., W.M. Hanemann, and R.N. Stavins. 2001. Muffled Price Signals: Household Water Demand Under Increasing-Block Prices. (Working Paper of December 2001.)

Corral, L.R. 1997. Price and Non-Price Influence in Urban Water Conservation. Ph.D. diss., University of California at Berkeley, Berkeley, CA.

Cuthbert, W. R. 1989. Effectiveness of conservation-oriented water rates in Tucson. *Journal AWWA*, 81(3): 65-73.

DOE (Department of Energy). 2000. *Final Rule Technical Support Document (TSD): Energy Efficiency Standards for Consumer Products: Clothes Washers*. Washington, D.C.: U.S. Department of Energy. Prepared for the Department of Energy by Lawrence Berkeley National Laboratory and Arthur D. Little, Inc.

Danielson, L.E. 1979. An Analysis of Residential Demand For Water Using Micro Time-Series Data. *Water Resources Research*, 15(4): 763-767.

De Anza Santa Cruz Mobile Estate Homeowners Association Versus De Anza Santa Cruz Mobile Estates. 2001. Santa Cruz County, California: Santa Cruz County Superior Court.

DeOreo, W.B., P.W. Mayer, and D.M. Lewis. 2000. Seattle Home Water Conservation Study. Boulder, CO: Aquacraft, Inc.

DeOreo, W.B., P.W. Mayer, E.L.Towler, and D.M.Lewis. 2003. Residential Indoor Water Conservation Study: Evaluation of High Efficiency Indoor Plumbing Fixture Retrofits in Single-Family Homes in the East Bay Municipal Utility District Service Area. Boulder, CO: Aquacraft, Inc.

DeOreo, W.B., P.W. Mayer, E.L Towler, and L.A. Martien. 2004. Tampa Water Department Residential Water Conservation Study. Boulder, CO: Aquacraft, Inc.

Dietemann, A. 1999. Sub-Metering: The Next Big Conservation Frontier? In *AWWA Annual Conference Proceedings.* Chicago, IL: AWWA.

<u>Dollars & Cents of Multifamily Housing: 2003</u>. 2003. Urban Land Institute, Washington D.C.

Espey, M., J. Espey, W.D. Shaw. 1997. Price Elasticity of Residential Demand for Water: a Meta-Analysis. *Water Resources Research*, 33(6): 1369-1374.

Flechas, F. W. 1980. The Effect of Metering and Price in Attaining Urban Water Conservation in the Denver Metropolitan Area. Masters thesis. University of Colorado at Boulder, Boulder, CO.

Gibbs, K.C. 1978. Price Variable in Residential Water Demand Models. *Water Resources Research*, 14(1): 15-18.

Gibbons, R. 1992. *Game Theory for Applied Economists.* Princeton, NJ: Princeton University Press.

Goodman, J. 1999. Water Conservation from User Charges in Multi-family Rental Housing. Washington, D.C.: American Real Estate and Urban Economics Association.

Gordon, L.P. 1999. The Influence of Individual Metering on Water Consumption in Multi-family Dwellings. Master's thesis. Massachusetts Institute of Technology, Cambridge, MA.

Hanke, S.H. 1970. Demand for Water under Dynamic Conditions. *Water Resources Research*, 6(5): 1253-1261.

Hanke, S. H., and E. Flack. 1968. Effects of Metering Urban Water. *Journal AWWA,* 60(Dec): 1359-1366.

Hanemann, W.M. 1998. Determinants of Urban Water Use. In *Urban Water Demand Management and Planning*. Edited by D.D. Bauman, J.J. Boland, and W.M. Hanemann. New York: McGraw Hill, Inc.

Hewitt, Julie A. and W. Michael Hanemann. 1995. A Discrete/Continuous Choice Approach to Residential Water Demand under Block Rate Pricing. *Land Economics,* 72(2): 173-192.

Howe, C.W. 1982. The Impact of Price on Residential Water Demand: Some New Insights. *Water Resources Research,* 18(4): 713-716.

Howe, C.W. and F.P. Linaweaver. 1967. The Impact of Price on Residential Water Demand and Its Relation to System Design and Price Structure. *Water Resources Research,* 3(1): 13-32.

Jones, C.V., J. J. Boland, J. E. Crews, C.F. DeKay, and J.R. Morris. 1984. *Municipal Water Demand: Statistical and Management Issues*. Boulder, CO: Westview Press.

Koch, R.N., and R.F. Oulton. 1990. Submetering: Conservation's Unexplored Potential. In *Proc. of Conserv90*. Phoenix, AZ: AWWA.

Koplow, D. and A. Lownie. 1999. Submetering, RUBS, and Water Conservation. Cambridge, MA: Industrial Economics, Inc.

Making Sense of Submetering. 2002. The Wellspring Monitor Monthly Newsletter.

Martin, W. E., and S. Kulakowski. 1991. Water Price as a Policy Variable in Managing Urban Water Uses: Tucson, Arizona. *Water Resources Research*, 27(2): 157-166.

Mayer, P.W., W.B. DeOreo, E.M. Opitz, J.C. Kiefer, W.Y. Davis, B. Dziegielewski and J.O. Nelson. 1999. *Residential End Uses of Water.* Denver, Colorado: American Water Works Association Research Foundation.

McClave, J.T., F.H Dietrich II, T. Sinich. 1997. *Statistics, 7th Edition.* Prentice Hall, Upper Saddle River, NJ.

McClelland, L. 1980. Encouraging Energy Conservation in Multi-family Housing: RUBS and Other Methods of Allocating Energy Costs to Residents, Vol. I and II. Boulder, CO: University of Colorado at Boulder.

MWDSC and MWDOC (Metropolitan Water District of Southern California and Municipal Water District of Orange County), 2002. "Orange County Saturation Study."

Moncur, J.E.T. 1989. Drought Episodes Management: The Role of Price. *Water Resources Bulletin*, 25(3): 499-505.

NIST. 2004. *General Information.* Internet. http://www.nist.gov/public_affairs/general2.htm.

NIST. 2004. *Handbook 44: Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices.* Internet. http://ts.nist.gov/ts/htdocs/230/235/h44-04/Word/3.37-H44-04-Z.doc

NRC. 2001. “A National Study of Laundry-Water Use in Multi-Housing.” Research Report. National Research Center, Boulder, Colorado.

NWF (National Wildlife Federation). 1992. “Water Conservation News.”

National Multi Housing Council. 1998a. Apartment Residents in 1998. *NMHC Research Notes*.

National Multi Housing Council. 1998b. Who Pays Apartment Residents’ Utility Bills? *NMHC Research Notes*.

Nieswiadomy, M.L. 1992. Estimating Urban Residential Water Demand: Effects of Price Structure, Conservation, Education. Water Resources Research, 28(3): 609-15.

Palmer, D.H. 1999. The Economics of Submetering. Master-Meter, Inc.

Pint, E.M. 1999. Household Responses to Increased Water Rates During the California Drought. *Land Economics,* 75(2): 246-266.

Planning and Management Consultants. 1984. Influence of Price and Rate Structures on Municipal and Industrial Water Use. Fort Belvoir, VA: Institute for Water Resources, United States Army Corps of Engineers.

Porges, R. 1957. Factors Influencing Per Capita Water Consumption. Water and Sewage Works, 104(May): 199-204.

Rosales, J., C. Weiss, and W. DeOreo. 2002. The Impacts of Submetering on Water Usage at Two Mobile Home Communities in Las Vegas, Nevada. . In Water Sources Conference Proceedings. Las Vegas, NV: AWWA.

Schlette, T. C., and D. C. Kemp. 1991. Setting rates to encourage water conservation. Water Engineering and Management, 138(5):25-29.

Schneider, M.L. and E.E. Whitlatch. 1991. User-Specific Water Demand Elasticities. Journal of Water Resources Planning and Management, 117(1): 52-73.

Seligman, C. and J. M. Darley. 1977. Feedback as a Means of Decreasing Residential Energy Consumption. Journal of Applied Psychology, 62(4): 363-368.

Stevens, T.H., J. Miller, C. Willis. 1993. Effect of Price Structure on Residential Water Demand. Water Resources Bulletin, 28(4):113-125.

Strub, D. 2000. Measure for Measure: Water Submetering and Allocation in Multi-family Housing in Austin, Texas. Master of Public Affairs thesis. University of Texas. Austin, TX.

Strub, D. 2002. New Law Affects Multi-family Billing. *Texas* H_20, Oct./Nov.: 5-6.

US Census Bureau 2000. “American FactFinder: General Characteristics: Population and Housing.” Internet. http://factfinder.census.gov/servlet/BasicFactsServlet (Mar. 13 2003).

US Census Bureau, 2003. "Statistical Abstract of the United States: 2003," Table 959, "Housing Units--Characteristics by Tenure and Region: 2001." Also, Table 942, "New Privately-Owned Housing Units Started--Selected Characteristics: 1970 to 2002."

US EPA (United States Environmental Protection Agency), 2002. "The Clean Water and Drinking Water Infrastructure Gap Analysis," EPA-816-R-02-020.

USGS (United States Geological Survey), 2004. "Estimated Use of Water in the United States in 2000," USGS Circular 1268.

Water Resources Engineering, Inc., 2002. "Overview of Retrofit Strategies: A Guide for Apartment Owners and Managers," prepared for the US Department of Housing and Urban Development, Office of Policy Development and Research.

Water Resources Engineering, Inc., 2002. "Water Conservation Market Penetration Study," East Bay Municipal Utility District.

Whitcomb, John B. (Stratus Consulting Inc.). 2002. "Freeriders in ULFT Programs." California Urban Water Conservation Council.

Wilcut, E. 2002. A Comparison of Water Consumption Patterns Between Bill Allocated and Non-Allocated Multi-family Residential Establishments in San Antonio, Texas. In Water Sources Conference Proceedings. Las Vegas, NV: AWWA.

Young, C.E., K.R. Kinsley and W.E. Sharpe. 1983. Impact on Residential Water Consumption of an Increasing Rate Structure. *Water Resources Bulletin*, 19(1): 81-86.

Young, R.A. 1973. Price Elasticity of Demand for Municipal Water: Case Study of Tucson, Arizona. *Water Resources Research*, 9(4): 1068-72.