Conservation Water Rates for Residential Customers: A Practical Overview

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Water withdrawals for public supply in Florida totaled 2,541 million gallons per day in 2005, or 37 percent of total freshwater withdrawals in the state. Despite improved water use efficiency, Florida's rapid population growth led to about a 30-percent increase in withdrawals for the public water supply between 1990 and 2005 (Marella 2008). With the population of Florida expected to grow at about 37,000 residents each year (UF/BEBR 2009), increased water demand will cause problems because of the state's limited water sources such as ground and surface waters.

To combat this problem, utilities and water management districts are examining demand management options as an alternative to water supply expansion. Conservation water rates, one of the demand management tools, are included in the recommendations made for a drought-resistant Florida by Conserve Florida work groups (FDEP 2007) and suggested by the Florida Section of American Water Works Association as a strategy to achieve the Florida 2030 vision of eliminating the "…wasteful, uneconomical, impractical or unreasonable use of water resources" (Section 373.227, Florida Statutes, cited by FSAWWA 2008). This article provides an overview of conservation rates—what defines them, what determines their effectiveness, what are their advantages and disadvantages, and how they can be implemented.

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Defining Conservation Rates

A general requirement for a conservation water rate structure is to provide incentives for consumers to conserve water. Several criteria are suggested to define a conservation rate structure.

Structural Form

The first criterion identifies the structural form of the rate (i.e. the per-gallon rate changes as water usage changes). Conservation rates are usually associated with uniform, inclining block, or seasonal volumetric (seasonal) rate structures (Figure 1). Each of these general categories can include very different water rate structures and create different incentives for customers to conserve water.

For example, inclining block rate structures can differ by the number of price blocks, the price difference between the blocks, and the water usage volumes covered by each block. The Alliance for Water Efficiency (2008) suggests that three to four blocks are adequate for an effective residential rate design, and nationwide for utilities using inclining block rates for residential customers, the average number is three and a half blocks (AWWA and Raftelis 2009).

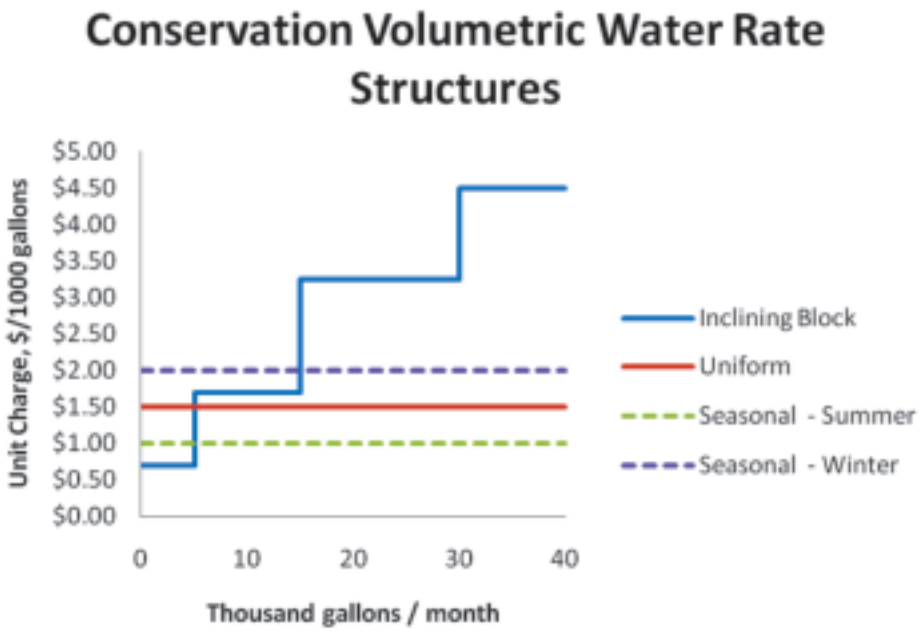

Figure 1. Conservation Volumetric Water Rate Structures

Furthermore, the Alliance for Water Efficiency (2008) recommends selecting the first price block such that minimum water usage is provided to a typical household at a minimum reasonable price, and that the price increase between the blocks is greater than 50 percent. More than half of the residential customers should exceed the water consumption limit for the first price block when the new rate structure is first implemented. At least 30 percent and 10 percent of customers should be paying the rates for the third or fourth price blocks, respectively (at least during seasonal peak demand) (AWE 2008).

These recommendations are not always implemented, however. Nida and Eskaf (2009) show that the rate structures used by North Carolina utilities are effectively uniform for water usage below 15,000 gallons per month, and that the majority of customers are unaffected by the higher price blocks. Similarly, the Environmental Finance Center (2007: 3) reports that in Georgia, water conservation incentives created by uniform and inclining block rate structures are similar in the sense that customers who reduce their consumption by 40 percent, from 10,000 to 6,000 gallons/month, are "likely to receive the same reward, both in terms of total bill reduction and percent bill reduction, whether they are being charged increasing block or uniform rates."

Inclining block rate structures are becoming popular in Florida. Table 1 illustrates this trend. For example, in 1998, 10 of the 16 Florida utilities included in this sample used inclining block rates, and by 2009, 14 of the 16 utilities were using inclining block rates at the rate of three to six price blocks.

Fixed Fees & Volumetric Charges for Water

Volumetric water rates are usually combined with fixed water fees and volumetric and fixed fees for wastewater. The strength of con-

servation price signals is influenced by the ratio of fixed to volumetric fees in customers' bills.

Generally, the lower this ratio (i.e., the higher the share of volumetric fees in the total customer bill is), the more conservation oriented a rate structure is (McLarty and Heany 2008). A rate structure with very steep volumetric price blocks would not necessarily send strong conservation price signals if the fixed fees were much higher than the volumetric charges.

The Alliance for Water Efficiency suggests that conservation rates should be designed so that a large portion (two-thirds or more) of the water charges is based on the quantity of water the customer consumes (AWE 2008). Nationwide, the monthly fixed fee for the median customer ($7.03) comprises 30.2 percent of the total water bill (1,000 cubic feet, or 7,500 gallons of water usage) (AWWA and Raftelis 2009).

In 2007, the California Urban Water Conservation Council established specific guidelines for what constitutes a conservation rate (McLarty and Heaney 2008). To meet California's conservation rate criteria, at least 70 percent of the monthly utility revenue must come from volumetric rates (McLarty and Heaney 2008).

Water Rates & Sewage Charges

Many utilities include wastewater charges in the total customer bill. Wastewater charges typically are based on a percentage of a customer's monthly water use. As a result, wastewater charges cause customers to pay more for non-discretionary water uses in comparison with discretionary uses. This interrelation effectively converts an inclining block into a declining block rate structure, and distorts the economic incentives to conserve water created by conservation water rates.

Communication with the Customers

For conservation price signals to be effective, consumers must understand utility billing procedures. Better billing procedures may improve consumer response to conservation rates. Based on survey results, Whitcomb (2005) estimates that 39 percent of Florida household consumers do not understand water rates. In the same study, only five of 16 utilities reported water prices on bills, and none reported a full schedule of prices on water bills.

In addition to clear billing procedures, a transparent rate-making process also is important. Without transparency and accountability in the rate design planning process, consumers may view rate increases as punitive and reactionary, rather than as necessary conservation policy tools.

Despite increased interest and research in conservation rates, a widespread consensus definition has yet to be developed. Currently, there is no quantitative definition in the state of Florida, but that may soon change. The South Florida Water Management District (SFWMD) is taking steps to establish minimum standards. The SFWMD's Water Conservation Program Plan, Strategy 1-A includes the following action step: "work with utilities and the Florida Chapter of the American Water Works Association (AWWA) to define minimum standards in water use permit criteria for conservation rates" (SFWMD 2008).

In turn, in Southwest Water Management District, the proposed amendment to the Water Use Permitting Rule for Conservation (Chapter 40d-1 – Procedural, Draft 8-6-09) (SWFWMD 2009) states: "General and Individual Water Use Permittees not subject to rules in effect prior to July 1, 2008 shall adopt a water-conserving rate structure by January 1, 2012. New public water supply permittees permits shall adopt a water-conserving conservation oriented rate structure no later than two years from the date of permit issuance…" (SWFWMD 2009: 31). The proposed amendment also requires providing customers information about their water rates, as well as information that customers can use to compare their water use relative to other single-family customers or to estimate an efficient use at least once a year.

Water Conservation, Utility Revenue & Water Affordability

Water rates should meet at least three key

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Table 1. Trends in Florida Rate Design based on a sample of 16 utilities

Utility	1998 Rate Structure*	2003 Rate Structure*	2009 Rate Structure**
Escambia County Utilities Authority	Uniform	Uniform	Uniform
City of Tallahassee Water Utility	Uniform	Uniform	Increasing with 3 blocks
City of Melbourne Public Works and Utility Department	Uniform	Uniform	Uniform
City of Ocoee Utilities Department	Uniform	Increasing with 6 blocks	Increasing with 6 blocks
City of Palm Coast Utility Department	Uniform	Uniform	Increasing with 4 blocks
Hernando County Utility Department	Uniform	Uniform	Increasing with 5 blocks
Palm Beach County Water Utilities Department	Increasing with 3 blocks	Increasing with 3 blocks	Increasing with 4 blocks
Lakeland Water Utilities	Increasing with 3 blocks	Increasing with 3 blocks	Increasing with 4 blocks
Miami Dade County Water and Sewer	Increasing with 5 blocks	Increasing with 5 blocks	Increasing with 4 blocks
Indian River County Department of Utility Services	Increasing with 4 blocks	Increasing with 4 blocks	Increasing with 4 blocks
Hillsborough County Water Resource Services	Increasing with 5 blocks	Increasing with 5 blocks	Increasing with 4 blocks
St. Petersburg Water Resources Department	Increasing with 4 blocks	Increasing with 4 blocks	Increasing with 4 blocks
Toho Water Authority	Increasing with 5 blocks	Increasing with 5 blocks	Increasing with 5 blocks
Sarasota Utilities	Increasing with 5 blocks	Increasing with 5 blocks	Increasing with 5 blocks
City of Tampa Water Department	Increasing with 3 blocks	Increasing with 3 blocks	Increasing with 4 blocks
Seminole County Department	Increasing with 5 blocks	Increasing with 5 blocks	Increasing with 6 blocks

* Source: Whitcomb (2005)

** Based on rate information provided on companies' web-sites (accessed in August 2009)

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objectives of utilities: 1) Stimulate water conservation, 2) promote financial sustainability of the utility, and 3) ensure water affordability for low-income customers. Conservation rate structures may fail if they: reduce utility revenue, increase revenue stream volatility, or significantly impact water affordability.

Water Rates & Conservation Effectiveness

Responsiveness of the customers' water usage to water rate changes is measured through the price elasticity of demand. Price elasticity is defined as the percent change in water usage in response to the certain percent change in price (rate). Estimates of the price elasticity vary depending on length of time over which rates and water demands are evaluated, initial water rates against which the elasticity is measured, customer classes and income groups, type of water use (indoor vs. outdoor), season and time of day (peak vs. off-peak periods), geographical region, customers' knowledge of their water rates, the presence of other conservation programs, and other factors (see survey studies by Worthington and Hoffman 2008; Espey et al. 1997; Dalhuisen et al. 2003; and AWWA 2000).

"The most likely price elasticity range for long-term overall (indoor and outdoor) residential demand is −0.10 to −0.30" (AWWA 2000: 158). This means that for residential customers, a 10-percent increase in rate (given current rate level) will most likely result in reductions in water usage within the range of 1 percent to 3 percent. In Florida, estimated long-term price elasticities for single-family homes vary between −0.39 and −0.84 depending on the home value and size (Whitcomb 2005).

Conservation Rates & Utility Revenue

Any program or pricing strategy that reduces water consumption has the potential to decrease utility revenue. Among the 23 utilities nationwide that responded to the survey by Wang et al. (2005), 9 percent of the utilities reported that conservation rates increased their revenues and 26 percent reported that revenues decreased (30 percent considered conservation rates to be revenue-neutral and 35 percent did not know or gave no response).

The National Regulatory Research Institute (Beecher et al. 1994), however, concludes that conservation rates can be designed to avoid revenue shortfalls. "The fact that water demand is relatively price inelastic means price increases do not necessarily decrease utility revenues. In fact, under certain circumstances, price increases for conservation or other purposes can substantially increase utility revenues" (Beecher et al. 1994: 3).

Conservation rates potentially can increase revenue variability. With inclining block rates, a significant share of utility revenues is expected to be recovered from high-volume residential customers. "These higher levels of consumption tend to be more subject to variations in seasonal weather and, when coupled with a higher unit pricing, customers tend to curtail consumption in these higher consumption blocks" (AWWA 2000: 100).

A revenue stabilization fund can be used to balance the need for conservation and the need for revenue stability (AWWA 2000). A certain percentage of surplus revenue is allocated to the fund each month, which can be withdrawn from the fund when revenues fall below projections. Several utilities in Florida, including Gainesville Regional Utilities, have adopted this strategy of revenue stabilization.

Excess revenues also can be used to retire bonds to keep future rates low, improve the infrastructure, or educate the public about water rates and water conservation. Deficits in revenues can be addressed through issuing bonds, including a risk margin in calculating revenue requirements, and by developing a mechanism for more frequent rate adjustments (Wang et al. 2005).

Water Affordability

With respect to affordability for low-income customers, Agthe and Billings (1987) demonstrate that by making price blocks steeper, a utility can increase incentives to conserve without adding any price burden to low-income users. Utilities also can forgive service charges to low-income customers, fix water leaks for free, distribute free water-efficient home appliances, offer discounts on customers' bills, or exempt charges for water consumption within the first price block (Saunders et al. 1998).

Benefits of Conservation Rates

Rate structures that provide strong incentives to conserve water provide a number of benefits, including:

- Communicate the need for water conservation (Wang et al. 2005).
- Provide water conservation incentives through rewards for customers with low water usage and penalties for customers with high use (Wang et al. 2005).
- Reduce operating costs and delay the need for system expansion and acquiring additional water supplies and storage capabilities (Wang et al. 2005).
- Reduce the opportunity cost of water withdrawals and wastewater discharges, including the reduction of environmental damages (Wang et al. 2005).
- Provide customers' flexibility in choosing their own approaches to water use efficiency and conservation (in comparison with programs that mandate certain technologies or practices) (Cavanagh et al. 2002; Olmstead and Stavins 2008).

Pitfalls of Conservation Rates

There are a number of barriers to the successful implementation of conservation water rates. Many of these challenges are the same for all water use efficiency / conservation programs, others are specific to the conservation rate strategy.

- ***Negative effects***: Conservation rates can negatively impact utility revenue, such as increasing revenue variability.
- ***Political considerations***: Water rates can be used to subsidize commercial development or to redistribute taxes. When social or political considerations such as these become a major part of rate design, conservation rates are likely to be ineffective and inefficient (Griffin 2001), generating possible reluctance by consumers to accept increased rates.
- ***Source substitution by utility customers***: In Florida for example, homeowners in many cities are allowed privately owned irrigation wells. Substituting well water for tap water can reduce the effectiveness of conservation rates.
- ***Demand hardening***: Reducing water consumption through conservation rates can make it difficult to reduce water usage even further (e.g., during critical drought periods).

Research Needs

The authors reviewed about 90 academic publications, government reports, industry articles, and relevant privately or publicly funded studies conducted in the United States and other countries. Most of these studies are available in the Conserve Florida Water Clearinghouse Library, a collection of materials intended to assist water utilities in promoting water use efficiency and conservation (Conserve Florida Water Clearinghouse 2008). Despite the significant number of studies on the subject, there are still gaps in our understanding of water rates and their effects on water usage and utility objectives.

We have identified eight key areas that require further analysis. For several of them, rigorous analysis will depend on the availability of data on individual household water consumption over a long period of time and household socio-economic and demographic characteristics.

- ***Definition of conservation rates***: How conservation rates can be defined to satisfy the water use efficiency and conservation objectives identified by the Florida Section of

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the American Water Works Association and Conserve Florida Water. Institutional factors affecting rate design: More research is needed to examine the decision-making process related to water rate design, and the role of politics, public relations, local history, and other factors in this process. For example, utility managers may be under political pressure to keep rates low or uniform. Interest groups, such as specific commercial sectors, historically may have preferential treatment and may oppose development of conservation rates. Utility ownership may also influence rate design.

- ***Price elasticity of residential water demand***: Most studies examined relatively small changes in water rates, given that both initial and final rates are low. Can the price elasticity estimates from these studies be applicable when water rates are high and rate changes are significant? What changes in water use should utility companies in Florida expect when introducing conservation rates? How applicable are national and state estimates of price elasticity to specific utilities' residential water demands?
- ***Seasonal and drought rates and residential water demand***: The number of studies on the effectiveness of seasonal and drought rates is very limited. Usually, customers need time to learn about rate changes and to adjust their water usage behavior accordingly. The effectiveness of short-term changes in water rate (such as seasonal and conservation pricing) is not well understood and requires further study.
- ***Household decisions related to water consumption***: Although many educational and incentive programs have been developed targeting household water consumption and promoting water conservation (e.g., irrigation and landscape recommendations, conservation water rates, water use restrictions, etc.), little is known about households' decisions related to water use and the effect of different programs on these decisions. What are the different types of water use at the household level? What programs are the most effective in addressing specific water use types, and why? What is the interrelation between different conservation programs targeting residential households?
- ***Reclaimed water use and conservation rates***: As of 2007, Florida was the nation's leader in reclaimed water use, with about 240 billion gallons used annually (Miller 2007). Approximately one-half of the reclaimed water was used for agricultural and urban irrigation and for industrial purposes (Marella 2008). How do conservation water rates affect the consumption of reclaimed water? Can reclaimed water rates affect drinking water use? What is the relationship between drinking water conservation and the volume of reclaimed water produced?
- ***Empirical evidence of the relationship between conservation rates and utility revenue***: Do conservation rates increase or decrease revenue? Can conservation rates provide a solution to the problem that achieving water conservation objectives undermine the financial sustainability of utilities? To what extent does revenue volatility depend on seasonal and weather factors, compared to water rate design?
- ***Water rate and water conservation incentives for large households***: Currently, water use is measured for each residence without any information about the number of household members. Large households can be affected negatively by conservation rates, even when every household member uses water efficiently. To solve this problem, utilities nationwide are experimenting with water rates based on water budgets (e.g., using the inverted block rate structure in which the blocks are defined uniquely for each customer based on an efficient level of water use for that customer) (AWE 2008b)

Conclusions

As Florida's population and its water consumption increase, alternative supply and demand management strategies will become more important. Conservation water rates represent an important demand management tool that should be considered by Florida utilities. Despite the fact that many water rate design studies have been conducted, there are still many questions about controlling residential water usage and designing water conservation rates. Florida's utilities and water management districts need to invest more in studies that address the issues identified here.

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