Georgia Water Series

Issue 5: Rate Design for Small Systems

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ISSUE 5: RATE DESIGN FOR SMALL SYSTEMS

A water department should be run as an enterprise fund. Through various types of user charges--fees, rates, assessments, billing, development charges ---a water utility should be operated on a self-sustaining basis.

To set rates to fund a water utility, an easy three-step process can be employed. The three steps to rate design are to identify all costs, establish the classes of service, and design the rate structure to cover all costs.

Identify Costs

There are two broad categories of costs, operating and maintenance (O&M) and capital costs. O&M costs include salaries, electricity, chemical, and other recurring costs used during the utility's accounting period. In economic terms these are variable costs---they increase as more water is produced. Also included in the category are indirect O&M costs provided by the larger government agency like computer or financial and legal services, purchasing, personnel, accounting and data processing. Nonannual O&M costs also need to be included, such as tank painting. These are expenses incurred only once every few years but can be expensed annually.

The second category of costs is capital costs. These include debt service, the capital spending financed through current revenues, and other revenue-financed capital outlays. These pay-as-you-go capital expenditures are usually equipment that last only a few years such as trucks, tractors, pumps, and furniture. Other capital expenditures include contributions to special replacement funds, and improvement and expansion funds. These are all projects that must be costed out over time. It is essential that revenues allow for adequate facilities and proper replacement and maintenance.

As part of capital spending, funds are usually set aside to cover such costs. These are normally placed under the heading of a reserve fund to cover emergency operating needs, a capital replacement fund, a capital expansion fund, a self-insurance reserve fund, and a debt service reserve fund as required by bond covenants. Some utilities set aside a rate stabilization fund to cover revenues if user fees are uncertain in order to avoid large fluctuations in yearly revenues.

Establish Classes of Service

Once all the cost data have been gathered, the next step is to decide if there are different classes of service that require different rates, such as residential, commercial or industrial users. The rationale is that each type of customer places different demands on the water system. Within these three classes, subcategories may also exist. A utility may break down their customers by those that receive service inside the city limits, or outside the city limits. Residential accounts may be by single family versus multi-family dwellings. Commercial accounts may be set up depending on the types of businesses that exist in a community. Some communities establish an institutional service class for hospitals, schools, colleges, and churches.

Depending on the type of customer, the costs of service may differ. For example, cost factors include hourly, daily, and average customer demand, customer location, or facilities constructed to serve a special customer or class. There is a tradeoff in having many rate classes with only a few customers or few classes with less cost of service correlation.

After identifying the functional categories allocating costs by these classes is necessary. The key question to ask is whether the customer classes established have specific loading characteristics that are different from other classes. Does the cost to serve that class differ from the cost to serve other classes?

Other Cost of Service Considerations

Before designing the total rate structure, utilities should explore their ability to meet some of their costs with special service fees. These fees are designed to match the demands individuals are placing on the system. The most common of these is a tap fee---the fee to connect a new customer. Some utilities charge a service installation or meter turn-on fee. Engineering fees for developers and other service fees that can be charged when customers require individual attention should be established. New account fees are common as are check charges for delinquent accounts. The use of fire hydrants for pool filling should be a separate charge. Finally, before setting rates, the utility must account for any revenue earned through investments. One-time “cost-of-service” charges for connections, extensions, cutoffs, or turn-ons, as long as these are not outrageous, are usually acceptable to consumers.

Among the factors that differentiate costs are demand characteristics. This is found by looking at the ratio of peak usage to average usage by different classes of customers. For example, the rate of maximum hour usage to average day usage could vary between residential and industrial classes. So, customers with high peaking factors are more costly to serve.

The location of customers can also affect costs. It may cost more to bring water service to sparsely populated areas for those outside a city or county limit. Thus, a separate rate could be charged. Also, the types of mains serving classes should be considered. Some, such as large industrial user, require larger lines for service than the typical residential user. What is necessary is to determine whether this affects unit costs. Residential customers make use of both the larger transmission mains and the grid of smaller distribution mains, while industrial users are served chiefly from the large transmission mains.

The third step is to the design the structure of water rates. Usually, a water rate is made up of a fixed minimum charge and a volume consumption charge. The fixed charge covers the cost of some portion of the fixed debt and other fixed costs. Fixed charges sometime have included only billing costs, meter reading, and water maintenance.

Rate Setting Example

Step one is to identify all the costs of service. This example is for a pubic water system that serves 8,000, selling 720,000,000 gallons of water. The costs and non-water revenues for this system are shown in table 1. The reserve fund in fixed costs was made up of 10% used for reserve, plus another 5% of the annual debt payment for a repair and replacement fund. This 15% level is for example purposes only. When designing rates, each system will have to determine at what level such a reserve fund should be established.

Table 1. Rate Setting Example: Costs

Fixed Costs	
Annual debt service (principal & interest)	$300,000
Reserve 15% of debt service	45,000
Depreciation	100,000
Total	**445,000**
Operating Expenses	
Water purchase cost	700,000
Maintenance/repairs	100,000
Labor (including benefits)	125,000
Utilities	30,000
Office expense	30,000
Professional fees	1,000
Capital outlays	150,000
Other	89,000
Total	**1,225,000**
Total costs	**$1,670,000**
Income (other)	
Tap fees	180,000
Interest income	50,000
Total	**$230,000**

Total costs of this system are $1,670,000. Since they take in $230,000 in tap fees and interest income, the system must generate $1,440,000 from user fees. Dividing the 8,000 customers into the needed revenue shows that the average monthly bill for this water system should be near $15.00. This correlates to an average per customer monthly water use of 7,500 gallons or a price per thousand of $2.00.

Step two is to identify the customer classes and perform a frequency analysis on the customer water use. For this example, two customer classes are used, residential and commercial. After going through the bills of the customers for this system, the frequency of use is shown in table 2. At this stage it is also necessary to establish the costs of service for each customer class (see AWWA manual M1 for examples).

Table 2. Frequency Analysis

Gallons	Residential customers		Commercial customers	
0 - 3,000	2,000	26%	100	36%
3,000 - 10,000	4,400	57%	70	25%
10,000 - 20,000	1,000	13%	40	14%
20,000 - 30,000	200	3%	20	7%
30,000 - 40,000	50	1%	25	9%
40,000 - 100,000	50	1%	10	4%
Over 100,000	20	-	15	5%
Total	7,720		280	

Rate Design

A basic rate structure should be made up of two parts. The base rate is a charge per customer to recover fixed expenses, including the cost of debt service, reserve requirements, capital improvements and depreciation. This charge guarantees enough income to meet basic costs during periods of low water sales. In the short run, most costs are fixed costs. Thus, some of the costs allocated under operating expenses (such as meter reading) are fixed in the short run and do not depend on water usage. Consequently, for utilities that have experienced wide variations in water use it may be necessary to include some operating expenses as fixed costs. This increases the utilities minimum charge but also allows for more revenue stability. However, as the minimum charge becomes a larger part of the total water bill the user charge has less influence on water use. The second portion, the unit rate, is a charge per unit of water sold to cover the cost of operation, maintenance, and administration. With this two-part structure, all customers share equally in the basic cost of the water system and each pays only for the water used. In our example the base and user charges are as follows:

Base charge:
Fixed costs/mo. $37,083.33
divided by 8,000 customers $4.64
Unit charge (based on use of 720 mg)
($1,225,000 - $230,000 ÷ 720,000) $1.38/thousand

The expected annual revenue under a base rate of $4.64 and a per unit rate of $1.38/thousand gallons sold would be:

Base rate: ($4.64 x 8,000 x 12) $445,440
Water sales: ($1.38 x 720,000) 993,600
$1,439,040

Other income 230,000
Total income $1,669,040

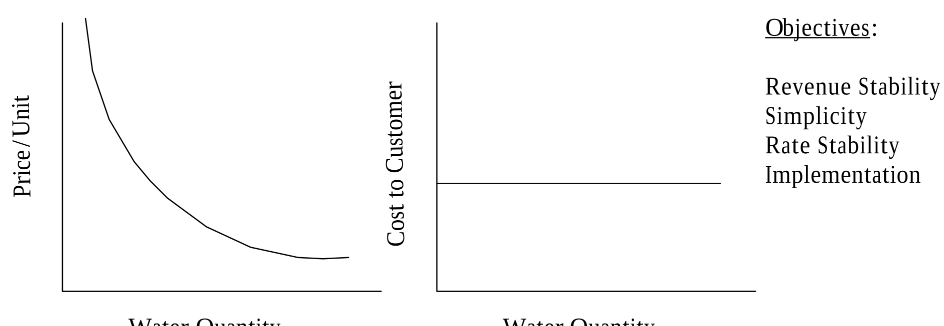
In this example, the monthly revenue requirement is $120,000 divided among 8,000 customers, producing a fixed charge of $5.00 per customer---near the amount found in the example.

Using the rates developed above, an average customer with a water demand of 7,500 gallons in a month would pay a bill based on the minimum charge of $4.64 plus a use charge of 7.5 times $1.38. This would result in a monthly charge of $14.99 --- almost exactly what was expected at the beginning of this exercise.

Customer Categories: When a system decides to have more than one customer category, it is necessary to divide system costs into service categories and then allocate those costs to the various customer groups. Step one is the same: a system's total costs must be determined. In step two, it is necessary to allocate those costs among service categories such as source of supply, water treatment, transmission/distribution, customer accounts, and administration/general. Items like the cost of chemicals would be divided between supply and treatment categories. Next, is a determination of what percentage of costs in each category should be charged to each customer group. For example, since the expense of meter reading and billing is about equal for all customers, the cost can be allocated dependent on the percentage of customers in each category. Thus, if 90% of customers are residential, 90% of these costs would be allocated to that category. Other considerations would include added costs to supply water to a large user or the cost of larger lines to accommodate an industrial customer if unit costs differ. After costs are estimated for each customer class then the rate design is accomplished for each category using a base and a unit charge.

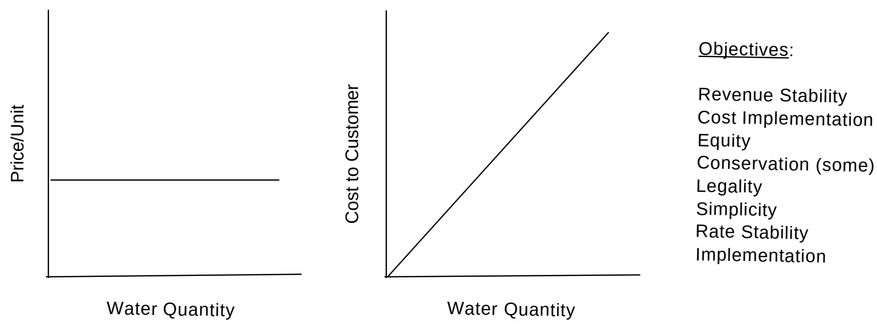
Block Design: There are five basic rate designs using block pricing that a utility can use. The first, and now least used is the flat rate (Figure 1). This is a rate, normally used when a system is not metered, of one price no matter how much water is used. An example is a monthly bill of $5.00 independent of actual water usage. The objective met by this system is revenue stability. Knowing the number of customers served means knowing the monthly revenue. This also meets the objective of simplicity. All customers know their bills, and accounting costs are minimal. Rate stability and implementation are also met here. Of course, this type of system provides no incentive for customers to treat water usage carefully. Less than 5% of public utilities use flat rates. Most flat rates are charged by small, private utilities --- mobile home parks, apartments and other multi-family units. For example, in Georgia, 5% of public utilities use a flat rate while 27% of the private systems in the state use such a structure. In addition, 38% of Georgia's private utilities do not charge for water and 21% include the charge in the rent. So 86% of private utilities do not charge for water consumption on a user basis.

Figure 1. Flat Rate



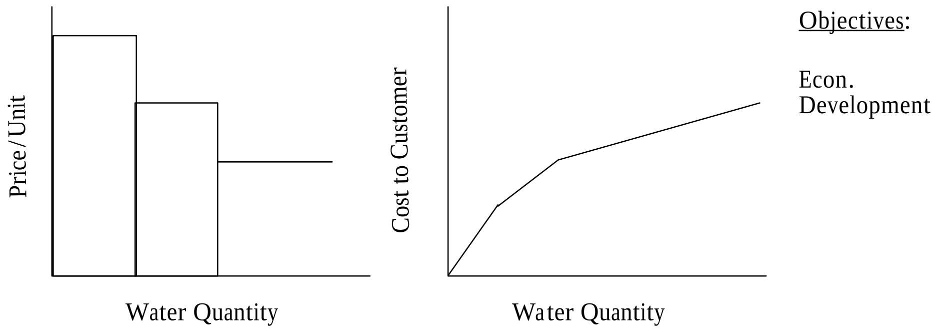
A more common rate structure is the uniform rate (Figure 2). In 1994, 59% of the respondents to a survey in Georgia used a uniform block rate structure. In a 1998 survey of Georgia wastewater rates, uniform rates were used by 69% of the respondents. Here the price per unit remains constant despite consumption. Water costs are directly proportional to the amount used. For example, a rate may be established as $1.70 per thousand gallons used. If a customer used 10,000 gallons in a month, their bill would be $17.00. If they used 15,000, the bill would be $25.50 (15*$1.70). Revenue and rate stability are promoted with this rate structure since knowing the total amount of water sold, revenues can be anticipated. This is easy to implement and is simple enough for most customers to understand. One objective met by this method is that of equity: all within a rate class are treated the same. Some conservation is promoted since as water use increases, though the rate stays the same, the bill does go up.

Figure 2. Uniform Rate



The decreasing rate structure (Figure 3) is still used by 26% of Georgia systems. One objective met is economic development. Decreasing rate structures are often also used to reflect the economies of scale present in serving larger users, and to reflect their higher load factors and the fact that they use less of the distribution system. Such a rate structure is an indirect way of charging rates to different customer classes whose unit cost of service differ. While decreasing rates make the added use of water less expensive on a per unit basis, clearly water bills do increase as does consumption. Consequently, a decreasing rate structure does not in and of itself encourage or promote water usage. For a large industrial user, water is an input and presents a cost of production. Thus, a profit-maximizing entity seeking to minimize costs would not necessarily use water beyond their needs. In this structure, the rate paid for water declines as use increases. Thus, it is often used in low-income and rural areas to attract large firms that use large amounts of water. An example would be a system where a customer who uses between one and 5,000 gallons would pay $1.50 per thousand. For use between 5,000 and 8,000 gallons the rate would drop to $1.00 per thousand and for all use above 8,000 the rate would go to $0.50 per thousand. For a customer using 10,000 gallons in a month the bill would be 5x$1.50 + 3x$1.00 + 2x.50 or $11.50 per month.

Figure 3. Decreasing Block Rate

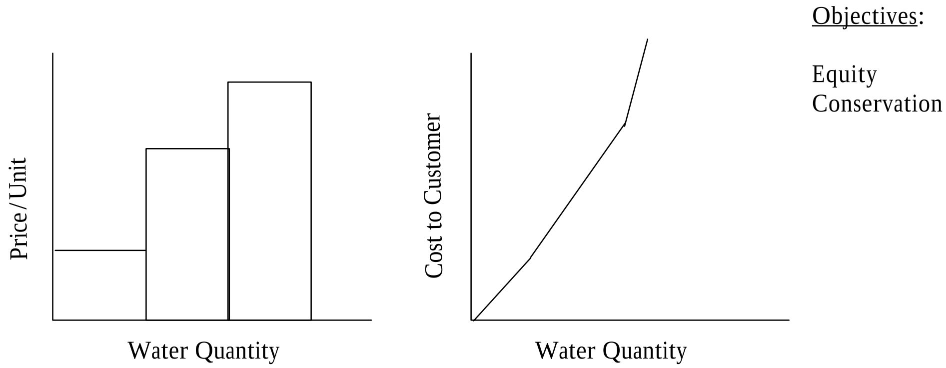


In contrast is an increasing block structure (Figure 4). Here the main objective is to encourage conservation. In Georgia, approximately 10% of water systems are increasing rate blocks. The structure may have negative effects on revenue stability and has a negative effect on large users. Here, the price of water increases as consumption increases. For example, for use between zero and 5,000 the rate may again be $1.50 per thousand. For 5,000 to 8,000 gallons the rate per thousand would go to $2.00 and for use above 8,000 gallons the rate could go to $3.00 per thousand. The total bill for 10,000 gallons here would be $18.50 (5x1.5+3x2.00+2x3.00). Equity is accomplished since consumers who use lower amounts of water pay less, and those who put the most demands on the system pay a higher rate.

A fifth rate design is the use of seasonal charges or excess use surcharges to deal with peak demands, especially in the summer months. Seasonal charges are normally used in conjunction with a uniform rate system that is in effect from October to April. For May through September, if the use is 25% to 30% above the winter use, a surcharge of between 25% and 100% is added to the bill. If the surcharge is set at 130% of use, with a 50% addition to the bill and a normal per thousand gallon rate of $2.00, a person using 15,000 gallons of water in July where normal monthly use is 10,000 gallons would pay a bill of $32.00. This is made up of $2.00 per thousand for the first 13,000 gallons of use (130% of normal use) and $3.00 per thousand for use over 13,000 gallons, or $2.00x13 + $3.00x2. Excess use charge would work the same way but may be kept year-around and not confined to just summer months. It is the summer, however, when such charges are likely to occur.

This pricing structure approximates marginal cost pricing. The economic theory behind surcharges is that prices during peak demand periods should exceed prices during off-peak periods. It is peak use that strains the capacity of the system and triggers the need for expansion. Therefore, peak users should pay the extra costs associated with system expansion.

Figure 4. Increasing Block Rate



The National Rural Water Association (1986) has examined different rate structures using three basic criteria for evaluation. First, does the rate structure match different demands on the system? These include high treatment or power costs, seasonal usage variations, weather and climate problems and types of customers and water use habits. Second, does the rate structure promote water conservation or at least restrict water usage? Finally, is the price charged each category of customer fair? Within each system, those customers who peak the system should pay their fair share.

As shown in Table 3, the flat, non metered structure fares poorly on all counts. Revenues remain constant, no matter how much water is used or seasonal variations in demand. When a flat fee is charged, consumers have no incentive to conserve since despite their water usage, the bill remains constant. While all customers are treated the same under this system, fairness should include having those putting the most burden on the system pay for that extra use.

Table 3. Comparison of Block Structure

Rate Type	Revenues vs. Demands	Conservation	Fairness
Flat	Poor	Poor	Poor
Uniform	Excellent	Good	Good
Decreasing	Fair	Poor	Fair
Increasing	Excellent	Excellent	Fair

Source: National Rural Water Assoc. (1986).

The decreasing block structure is a bit better in terms of revenue vs. demands. While the structure can be designed to pay for system demand, as water use goes up, revenues go up at a slower rate. Often, revenues do not keep up with demand.

A uniform rate does provide revenues in direct proportion to demand. There are some conservation elements in the structure since the more water a consumer uses the higher the water bill. Since all are treated equally, and heavy volume users do pay a higher bill, if not a higher rate, the structure affords some fairness.

The increasing rate structure keeps revenues up with demand and is designed to encourage conservation. The fairness issue is a concern with this rate structure. While heavy volume users not only face a higher bill than low volume users, the rate is also higher. Thus, those putting the most burden on the system pay more. However, this structure puts a burden on large families and other large volume users that has nothing to do with how efficiently they may be using water (National Rural Water Association).

Designing Water Rates: A Further Example

The following is an example of designing rates for the fictitious "Flint County." What kind of place is Flint County? About 80,000 people live in Flint with nearly half living in its major city of Lansing. The population of Flint is increasing, but not quickly. The largest firms in the County are textiles, food, paper, and metals and machinery. Unemployment is at the State average, as are income levels. The County is currently seeking bonds to finance an increase in its reservoir size. There are 10,674 customers on the water system, using about 2.4 million gallons of water per day, or 859,970,000 gallons per year.

Step 1. Identify Costs and Other Revenue

Operating expenses	$1,430,105
Capital costs (principle and interest)	1,017,264
Depreciation and reserves	332,780
Costs needed to be covered by revenues	$2,780,149

Operating expenses include administration, wages, benefits, electricity, chemicals, purchased water, fuel and utilities, parts, an equipment replacement fund, equity funding, contract services, leases, and rentals.

Revenues Other Than from Rates:

Penalties and cutoffs	$53,143
Tap fees and fire charges	216,663
Interest income	153,629
	$423,435
Transfers In (out)	0
	$423,435

Revenue Needed From Rates: $2,780,149
- 423,435
$2,356,714

Number of Customers: 10,674

The average monthly bill required to raise the sufficient revenues is:

$$10{,}674 * 12 = 128{,}088$$

$$\frac{\$2{,}356{,}714}{128{,}088} = \$18.40$$

Average monthly customers use:

$$\frac{859{,}970{,}000}{10{,}674} = \frac{80566.8}{12} = 6713.9 \text{ gallons}$$

Average price per thousand required: $2.63

Step 2. Identify Customer Classes and Perform Frequency Analysis

The type of industry Flint has indicates that there may be customers with a high peak rate of use as compared with an average rate of use. Thus, those customers that can be identified that require larger capacity pumps, pipes, and other system facilities should form a separate class of customers. For this example, there should be at least two classes of service, residential and commercial/industrial.

Step 3. Designing Rates

After frequency analysis, it was found that 33% of customers use less than 2,000 gallons per month. The base rate must cover $1,017,264 in debt service and $332,780 in depreciation reserves for a total fixed cost of $1,350,044 per year. For 10,674 customers this equals $10.54 per month. So the minimum can be set at $10.50

To cover the remaining $1,006,670 from rates, that amount is divided by the yearly water use, in thousands, of 859,970 to produce a per unit charge of $1.17. After rounding, the per unit charge would be $1.20 per thousand.

Results:

Base rate: ($10.50 x 10,674 x 12) $1,344,924
Water sales: ($1.20 x 859,970) 1,031,964
$2,376,888

Other income 423,435
Total income $2,800,323
Total income required $2,780,149

Since Flint County is adding capacity, it is clear it should encourage wise water use. A uniform rate structure at $1.20 per 1,000 gallons would produce the following rate chart:

Water used	Water bill
0 gal	$10.50
0 - 1,000 gal	11.70*
1,001 - 2,000	12.90
2,001 - 3,000	14.10
3,001 - 4,000	15.30
4,001 - 5,000	16.50
5,001 - 6,000	17.70
6,001 - 7,000	18.90
7,001 - 8,000	20.10
8,001 - 9,000	21.30
9,001 - 10,000	22.50

* Add $1.20 for each step

The bill for an average customer using about 6,700 gallons would be $18.90. The next step would be to design a commercial/industrial structure to take into account the higher costs of service. If the difference in cost of service is only in larger connections, then the fixed charge would be higher but the per unit charges the same.

Finally, the Flint County water board may want to look at designing an increasing rate structure, or using seasonal surcharges. However, if the community has no major supply problem, they may want to stay with a uniform rate. A summer surcharge could be added if peak demand problems are experienced in July and August.

Marginal Cost-Type Pricing

From an economic perspective, pricing water to equal the marginal cost produces the most efficient use of water resources. However, determining the marginal cost of water production is difficult. If producing below capacity, the marginal cost to a utility is near zero. If producing at capacity, the marginal cost will depend on estimates of future expansion. However, there are two ways pricing can be used to approximate marginal cost pricing. First, the use of seasonal or excess use charges gives the system prices that address the use of water during peak demands. Second, using a block structure with appropriate "switch points" also approximates marginal cost pricing.

A utility can accomplish a marginal cost-type pricing structure by:

1. Having a price differential for large users with a two-block structure.
2. Making the differential substantial.
3. Locating the switch point at a level of use that would be feasible for most users to attain.

Hanemann (1993a) devised such a system for Los Angeles. He suggested that such a system can conform to economic theory since the price differential conveys information to consumers that indicates that some norm is attached to the usage level when the switch point occurs. The message that they are conveying says water use should be no higher than some point. If more water is used, the consumer will pay a higher price. This conforms to the marginal cost concept of information. Such a pricing structure also conforms to the economic theory of demand elasticity. Those customers with higher discretionary uses are more elastic in their demand response and can reduce water use in the face of higher rates.

In the Los Angeles case, they devised a two-tier block with the switch point at a level where demand might be responsive to price. In a block pricing system, the switch point is the usage level at which the switch in rates occurs --- where the block moves up from one price per unit to another. Hanemann suggests a two-tier system is better than one with many blocks that have only small differentials. The Los Angeles case also established different rates set in advance for normal and drought years. For drought years, the switch point was lower and the second block rate higher. They designed the structure to produce a 15% drop in demand during droughts. They established only three classes of service, residential-single family, multi-family, and nonresidential users. The rates proposed to the Los Angeles City Council were $1.71 per ccf for single-family residential users. The switch point was 525 gallons/day at which time the second tier price was $2.27/ccf in the winter and $2.92 in summer. Multi-family customers were charged the same $1.71/ccf until the switch point at 125% of winter use. The second block was only for summer and was the same as the single-family rate. For nonresidential users, the low block price was $1.78/ccf and the switch point and second block was the same as the multi-family users. Drought year rates followed the same idea but were adjusted to different levels of demand reduction (Hanemann, 1993b).

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