Chapter 3

Building a Better (Efficiency-Oriented) Rate Structure

Despite changes in the utility finance paradigm, certain foundational components of financial management are as important as ever, including determining revenue requirements, allocating cost, and designing rates — in this case, rates that support and encourage efficiency.

Traditional ratemaking involves three discrete steps:[13]

Step 1 — Identify costs and the utility's revenue requirements.

Step 2 — Allocate costs to customer classes.

Step 3 — Design rates and charges to recover costs from customers.

Figure 4 shows the step framework of traditional ratemaking.

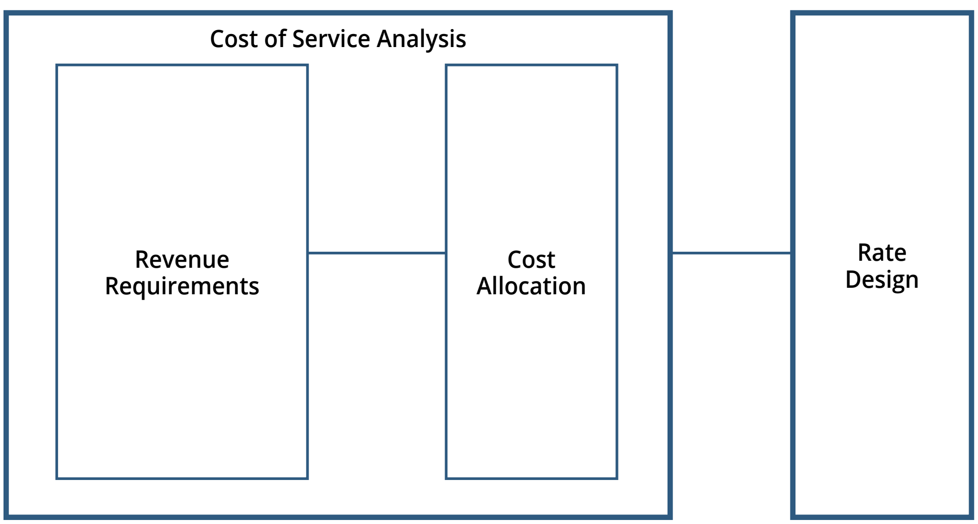
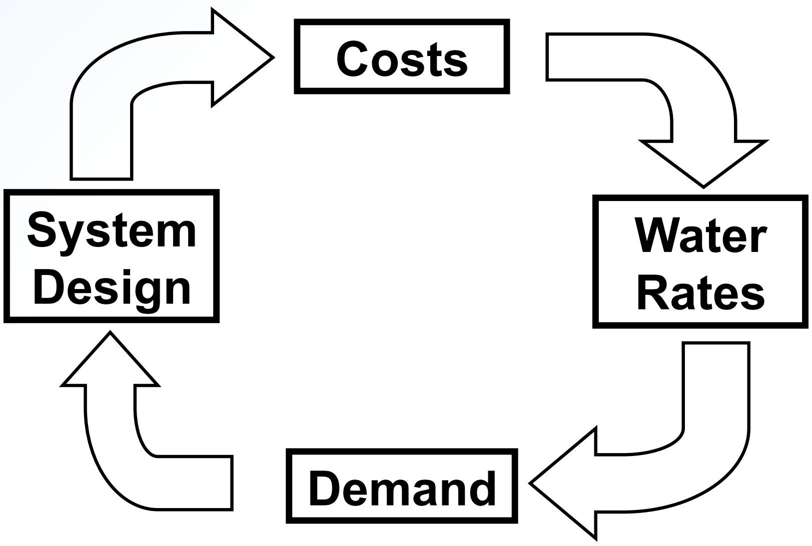


Figure 4 — Cost of Service Analysis

13 American Water Works Association (AWWA) *Manual of Water Supply Practices*, M1, *Principles of Water Rates, Fees and Charges, 6th Edition*, (2012), p. 112.

A more robust ratemaking process is required today to ensure rate structures achieve their objectives. Managers must invest sufficient time in discussing utility objectives at the outset, and conduct appropriate analysis to evaluate the proposed rate structure's performance against those objectives. Finally, the very act of deciding on a rate structure must be a thoughtful process.

These steps support a circular flow of economic logic in which costs to provide water service are recovered through water rates charged to customers. Based on these water prices, customers make consumptive decisions about their demand for water. Utilities can then use the demand information provided by customers to make decisions about how to design and operate their systems, thus changing the costs involved. **Figure 5** illustrates the circular flow of this economic logic.



Source: Beecher IPU/MSU

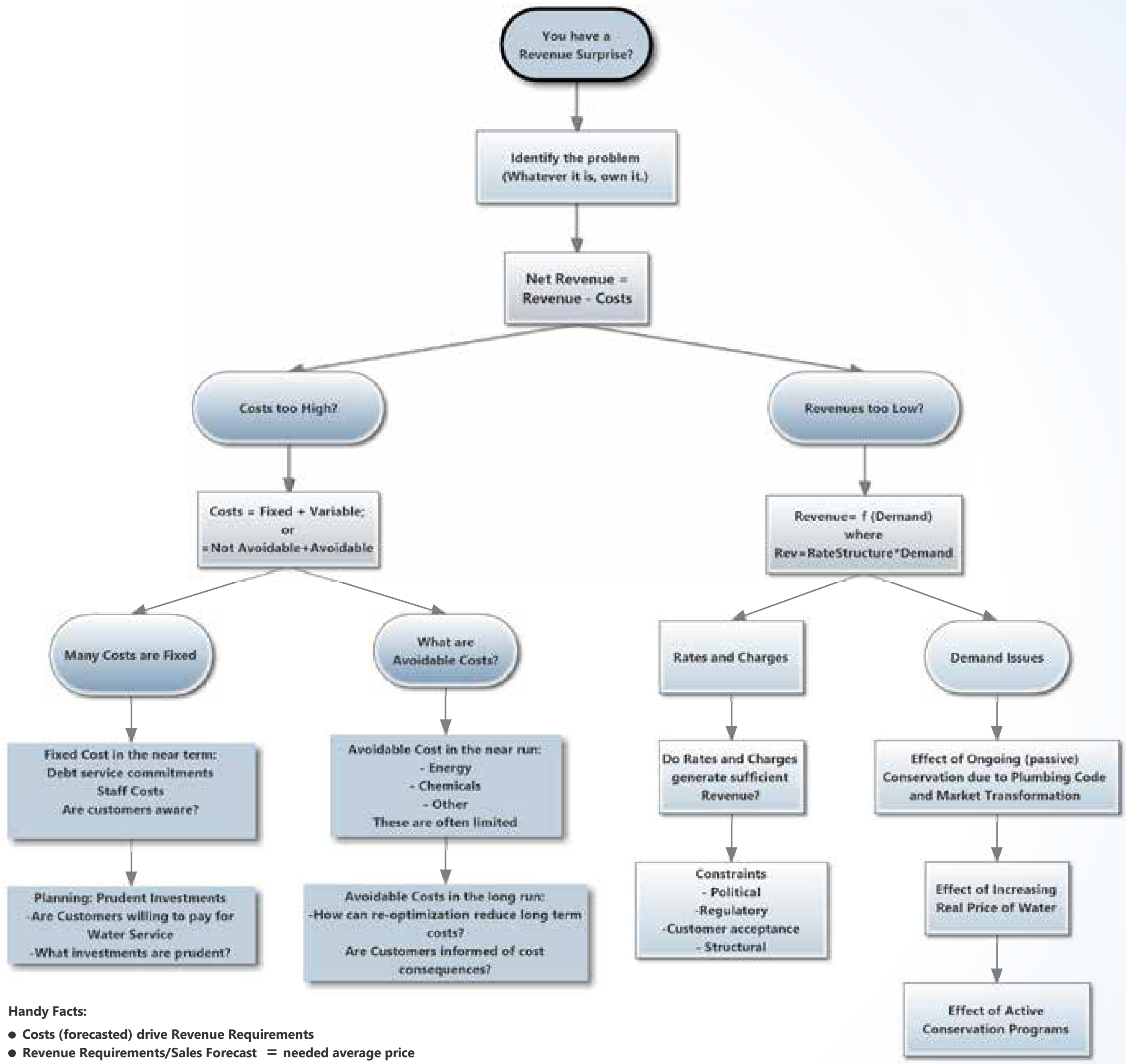
Figure 5 — Flow of Economic Logic

The challenge the industry faces today is that water rates have traditionally been focused solely on historical cost recovery. However, when system costs change quickly and perhaps unpredictably, historical rates do not reflect today's cost consequences, and the rates do not give customers correct information to make consumptive decisions.

Utility managers can also help set themselves up for success by taking stock of their financial position prior to reviewing or developing a rate structure. The AWE Self-Assessment Flowchart can help water utility managers who have financial responsibilities assess their utility and its external environment, which in turn will help them develop an equitable rate structure that will recover the full cost of service. Identifying the nature of the problem (Is a revenue shortfall due to revenues too low or costs too high?) is key to defining the nature of any solution. This Flowchart will help identify the right approach to balancing cost recovery with efficiency and fiscal sustainability. Utilities should examine costs closely, as cost-effective investments in efficiency will reduce long-term required expenditures.

As a matter of note, the AWE Self-Assessment Flowchart adds resource scarcity as a factor, thus complementing, but not replacing, the more complete Self-Assessment processes that have come out of the "Effective Utility Management" movement, as well as additional performance metrics and benchmarking tools that are available in North America and internationally.[14]

How to Avoid Revenue Surprises: Defining the Problem



Source: Chesnutt

Figure 6 — AWE Self-Assessment Flowchart

14 *Performance Benchmarking for Effectively Managed Water Utilities* (Project 4313) User Guide for the Self-Assessment Tool, January 2014, *Performance Assessment of Urban Infrastructure Services*, Cabrera and Pardo, IWA, 2008, and the IWA *Aquarating System* http://www.aquarating.org.

Identify and Prioritize Ratemaking Objectives

The art of ratemaking involves designing rates that balance inherently conflicting objectives in a manner that reflects community values. At a minimum, rates should be sufficient to generate revenue to support operations, maintain and develop capital infrastructure, and preserve (or enhance) the financial integrity of the utility system. In addition, there are other technical and policy objectives for utility services that utilities may want the rate structure to achieve, such as rate stability, equity, simplicity, and public understanding. Utilities may further seek to support or promote economic development through their rate design, or ensure the affordability of minimal levels of service for low-income ratepayers. Water resource efficiency is among the most common policy objectives, particularly with the cloud of water resource scarcity hovering over many regions.

COMMON RATEMAKING OBJECTIVES FOR WATER PROVIDERS

- Revenue Sufficiency
- Revenue Stability
- Rate Continuity
- Resource Efficiency
- Affordability for Customers
- Full Cost Pricing
- Fair and Equitable
- Economic Development
- Public Understanding

As a rule, water utilities are enterprises that must generate enough revenue to fund their operations and maintenance expenses and to finance their capital investments. Revenue adequacy is a threshold condition of effective rate setting, since it alone assures the long-term financial viability of the utility.

Utilities devise rates to achieve revenue adequacy by determining rate revenue requirements. These revenue requirements reflect the annual revenue needs required to meet all of the financial commitments that are not funded through other sources. These other revenue sources may include system development charges, impact fee revenues, miscellaneous charges for administrative or customer account services, or interest earnings. Typically, however, most of a utility's revenues are derived from rates imposed for the water services it delivers.

A more expansive view of revenue requirements would help utilities more easily pursue objectives such as resource efficiency and financial resiliency through their rates. Traditional utility practices have defined revenue requirements in terms of current and known costs involved in delivering water service. With a small number of notable exceptions, water use efficiency investments have not been capitalized, though arguably their primary benefit is to avoid or defer capital expenditures. Revenue requirements are based on a narrow definition of accounting costs that tend to ignore externalities, efficiency of usage, and valid social considerations such as low income affordability. Additionally, similar to revenue forecasting, determining revenue requirements often assumes constancy of future water demand.

A more expansive view of revenue requirements could internalize some costs that have historically been treated as externalities, or it could shift some discretionary costs to true costs. By establishing funds to diversify supply sources and advance preparedness for drought, for example, utilities may better prepare for the implications of climate change. By recognizing asset management and water loss control as primary water use efficiency measures, they may be able to increase investments in infrastructure. Water use efficiency programs that are demonstrated to be cost-effective and that yield high returns may be funded as a component of a water resource service offering rather than a nicety to customers. Rate structures that support conservation, efficiency, and resilience services will have a significant impact on the financial integrity of water utilities in the future. Creating rates that address the future, keep the utility whole, promote resilience, and satisfy the community is assuredly something of an "art."

There is not one single objective of rate making, and water managers must achieve a balancing act in their rate design. AWE's goal is to help water managers conduct better analyses of the tradeoffs from competing objectives resulting from different rate structures to inform decision-making.

Determine Revenue Requirements: Cost of Service

Selecting a Test Year

Determining revenue requirements inevitably entails reference to historical costs and some evaluation of how those costs may change in the future. The first step in this determination involves selecting a representative test year. The selection of the test year and the methods by which it incorporates projected costs can have significant implications. In addition, the test year must meet a "known and measureable" standard. This standard, which is generally required in regulated rate setting contexts, sets a high hurdle in anticipating costs, thus sometimes imposing a "regulatory lag" in cost recovery. Future test year approaches, while based on historical cost data, involve projections of future requirements that not only are uncertain, but that become increasingly uncertain the longer the projection period is extended. These complexities are further compounded by the reality that water utility costs and revenues vary as a consequence of variations in weather and the uncertainties of customer responses to water conservation programs and pricing structures.

Traditionally, the test year has been an actual historical year, typically a recent 12-month period for which cost accounting data are available. It also can be a future year, such as the next immediate year, based on forecast data. Or it can be a hybrid year that combines historical data and cost forecasts. Regardless of the test year, this first step must determine revenue requirements — the total costs that must be recovered through water rates and charges.

For regulated utilities, the choice of a test year is subject to state law and approval by state public utility commissions. Utilities with the option to choose a test year often choose the future year option because it can have some beneficial effects. It reduces the lag between incurring and recovering costs; it produces forecasts of future costs from which estimates of avoided costs can be derived; and it allows utilities to plan for the effects of rate changes on future water use and revenues.

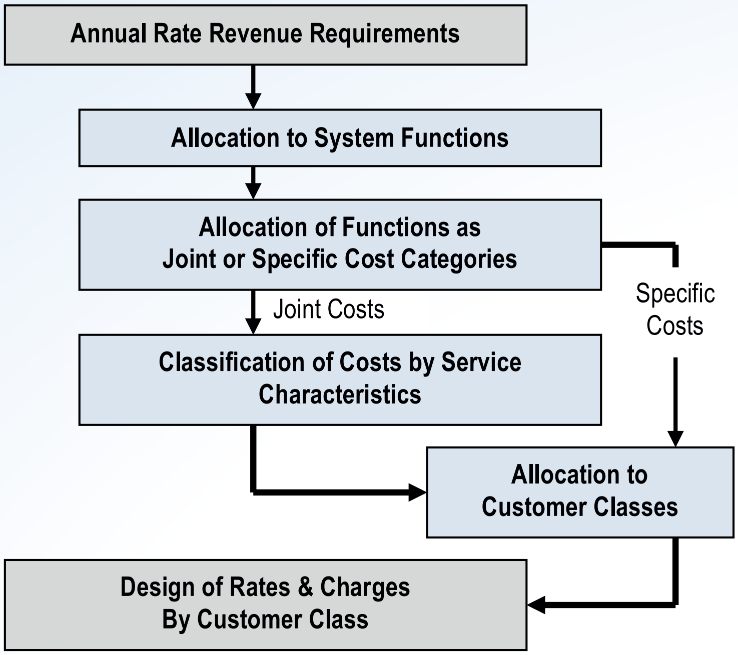


Figure 7 – Revenue Requirements

Publicly-owned utilities typically choose a future test year approach to facilitate alignment with their budgeting processes: the test year is actually the forthcoming budgeted fiscal year. These utilities, which typically operate using a cash-basis approach, may more easily accommodate variances from future projections through management of their fund balance levels. In contrast, investor-owned utilities often are required to adhere to the established policies of the state utility commission that has jurisdiction over their rate-setting practices.[15] For these utilities, actual variances from test year revenue requirements have earned return implications as well as impacting fund balance levels. In terms of promoting water resource efficiency, it has been argued that use of a future test year period is preferable insofar as it enables some consideration of future demand and facility capacity needs, and may advance intergenerational equity by more fully reflecting the long-term costs of resource use and capacity development[16].

The major shortcoming of ratemaking based solely on historical costs (rather than future costs) is the risk of underpricing the water, which can lead to overconsumption and further increase stresses on system capacity. From a practical perspective, using historical data to forecast the future encourages utilities to overinvest in capacity while providing little incentive to deploy existing resources more efficiently through rate design and other load management techniques.

15 See Beecher, Chapter 3 "Institutions, Incentives, and Water Efficiency—Effects of Utility Structure on Conservation" in *A Balanced Approach to Water Conservation in Utility Planning,* 1P-1.25C-4175-02/12-FP, Water Research Foundation (March 2012).

16 J. Michael Harrison, "Forecasting Revenue Requirements," Public Utilities Fortnightly Vol. 103, March 1979, pp. 11-15.

HOW HISTORICAL DATA CAN LEAD TO AN UNEXPECTED OUTCOME

Imagine a utility with a single water source that has a safe yield of 100 million gallons per day (MGD), costs that can be covered by charging customers $1 for each billing unit, and growing demand. Demand forecasts showed that this utility would soon exceed its 100-MGD capacity, so it made a seemingly obvious capital improvement decision: to develop a new water source, this one with a 50-MGD capacity. As a result of this costly endeavor, the utility had to double rates, to $2 per billing unit.

This doubling of water bills caught the attention of the utility's customers who lowered their water use on the basis of the new higher price. The next year, water sales dropped by 20%, to 80 MGD.

Because the utility priced water based upon historical costs, it added new capacity sooner than needed. Customers saw their rates double for the sake of a supply project that could have been delayed several more years...if it ever needed to be built at all.

Determining Revenue Requirements of the Test Year

The second step involves the utility's determination of the revenue requirements for the test year. They may use one of two common accounting alternatives to estimate the financial obligations of the utility to its bondholders, employees, and its customers: the cash-needs approach or the utility approach.

The cash basis approach defines utility revenue requirements as the cash needs of the utility for the year(s) during which calculated rates will be in effect. Under this approach, system revenue requirements are the sum of:

- Operations and Maintenance (O&M) expenses
- Cash-funded capital expenses
- Debt service obligations (principal, interest, reserve funding)
- Payments in Lieu of Taxes and/or franchise fees (if applicable)

The utility basis approach differs from the cash basis approach in its treatment of capital-related costs, such as depreciation and allowed returns. Capital-related revenue requirements are derived based on a rate of return applied to the utility's rate base, and the rate base reflects the book value of system capital investments made by the utility enterprise. It excludes the value of assets contributed to the utility by governmental agencies or developers, (or assets not prudently acquired), including:

- Operations and Maintenance (O&M) expenses
- Depreciation expenses
- Taxes
- Return on rate base

Determining a utility's revenue requirement involves estimating annual costs, including operating expenses and capital costs. Operating expenses include salaries and wages of utility employees, electricity and chemicals for plant operations, and customer metering and billing. Capital expenses include expenditures for plant expansions and upgrades, as well as system renewal and rehabilitation, regardless of whether they are financed through current revenues or debt issuances.

Most publicly-owned utilities use the cash basis approach to determine revenue requirements because it aligns with the municipal budgeting process and is relatively easily understood and administered. On the minus side, however, it does not recognize the decline in the useful life of capital assets — unless annual renewal and rehabilitation costs are included in budgeted capital spending plans — and it is subject to understatement because of all-too-frequent political pressures to limit rate increases.

The utility basis approach is mandated for investor-owned water utilities and publicly-owned utilities under state commission jurisdiction. In addition, public utilities not regulated by a state utility commission may employ the utility basis for determining revenue requirements for service to customers outside their jurisdictional municipal boundaries. The utility basis approach may provide several advantages, such as basing capital costs on invested asset value and explicitly including depreciation expenses. In addition, some argue that the paradigm of rate of return regulation incentivizes efficiency. On the flip side, however, this paradigm may be viewed as complex, difficult to understand and administer, and often arbitrary. Certainly, determining appropriate rates of return has been controversial.

Cost of Service

Designing rates is an inexact science, and the cost allocations that provide the basis for rate design are estimates at best. Cost studies involve the judgments of analysts based on theories and assumptions about the forces that drive system costs. Though average embedded cost studies are used to set overall revenue requirements, marginal/incremental cost analyses define what constitutes an appropriate price signal—a needed benchmark for designing rates.

GLOSSARY OF COST JARGON

Financial versus Management Cost Accounting: Financial accounting for external reporting deals with after-the-fact values, while management accounting for internal purposes takes a proactive view of value. Management accounting—by relating measured costs to cost causation—serves the ends of improving water utility efficiency improvements.[17]

Attributable versus Joint Costs: If all costs could be easily, accurately, and cheaply attributed to individual customers, cost-causation would be relatively straightforward. Such is not the case.[18] Attributable cost is based on causality, while "joint" costs reflect joint functions. Providing capacity for peak periods, for example, also provides capacity for nonpeak periods, and providing flow capacity sufficient for fire protection also provides capacity that may be used for other high-flow needs. Joint costs complicate the task of cost allocation.

Fixed versus Variable Costs: Fixed costs remain unchanged throughout the year regardless of the volume of water produced. Variable costs, or commodity costs, vary directly with the volume of water produced or consumed. Variable costs include purchased water, electricity, and chemicals. In light of the up-front capital costs needed to build new capacity, some traditional costing methods classify system expansion costs as fixed, referring to them as "demand" costs. Marginal or incremental costing methods recognize that the dividing line between fixed and variable depends on the period of time used for the analysis: in the long run, fixed capital expenditures change, thus becoming variable.[19]

Triple Bottom Line: An accounting of costs and benefits that includes finances, societal impacts, and the environment. John Elkington coined the term in 1994.[20]

Full Cost Pricing: Full cost pricing promotes efficient water use by fully recovering the cost of water or wastewater services in an economically efficient, environmentally sound, and socially acceptable manner.[21]

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17 IMA *"Conceptual Framework for Managerial Costing,"* March 2013. Capstone, 1997.

18 Shillinglaw 1963, *"The Concept of Attributable Cost."*

19 IFAC Professional Accountants in Business Committee, *"Evaluating and improving costing in organizations,"* International Good Practice Guide, July 2009

20 Elkington, J., *"Cannibals with Forks: the Triple Bottom Line of 21st Century Business".*

21 USEPA Expert Workshop on Full Cost Pricing of Water and Wastewater Service, IPU-MSU, USEPA Office of Water 2006.

Allocate Costs

Water utilities (and regulators) often use cost-of-service studies to allocate costs, which include capital and operating expenses. The goal is to reflect the cost of service associated with different patterns of water use, such as variations in seasonal and daily peak demands.

Cost of Service Principles/Full Cost Recovery

Rate design emphasizes the principle of cost causation: revenues should be recovered from those who cause costs to be incurred. Further, utilities design rates according to revenue requirements for classes of customers based on account and meter population distributions along with patterns of water use for that class.

To illustrate why costs may be calculated differently for different customers — an allocation of costs based on cost causation — consider a customer group with high peak demands. Additional costs might be associated with that class for the need to have additional storage facilities and pipeline capacities.

Cost-of-service-based rates aim at equal treatment for users with similar costs of service, and rate differentials for users with unequal costs of service. Thus, utilities set rates so revenues from each user class approximate the cost of serving that user class. This practice helps utilities avoid undue price discrimination. When developing rates to encourage efficiency, utilities should retain a focus on the costs — or avoided costs — that are caused by customers using — or not using — water.

Critics argue that some efficiency-oriented rate structures cannot be reconciled with the cost-of-service principle. On the other hand, managers in water utilities that have successfully used efficient rates argue that their rates more accurately reflect the full, long-term cost of providing water service, potentially inclusive of externalities. Indeed, cost-of-service principles have evolved over time and will continue to evolve in ways that help rates more accurately reflect the costs associated with alternative resource choices.

Shifting toward more efficiency-oriented rate structures does not mean that utilities should abandon cost-of-service ratemaking principles. These rate structures must reflect costs, regardless of their specific form. Rates based on correctly measured costs enable utilities and their customers to make efficient supply and demand choices.

Cost of Service Analyses

A cost of service analysis (COSA) helps set the stage for calculating of specific rates and charges.

The COSA process is a multi-step process designed to distribute revenue responsibilities to customer classes in proportion to the demands that those customer classes place on the water system. For example, if residential customers represent 80 percent of the number of accounts and they impose 50 percent of average day demands and 70 percent of peak-day demands, the residential class is allocated 80 percent of customer related costs, 50 percent of average-day demand related costs, and 70 percent of peak-day demand related costs.

Once total costs are determined (budgeted) and offsetting non-rate revenues projected, determining the shares of rate revenue requires three steps:

- *Functionalize costs (supply, treatment, storage, etc.):* This step separates costs into functional categories such as source development, treatment, transmission, and distribution. The accounting system may calculate the costs directly by functional category, or the costs may be estimated indirectly using accounting information.
- *Allocate costs to functions (such as base, maximum day, etc.):* This step assigns functional costs to usage categories using either the base-extra-capacity method or the demand-commodity method. The base-extra-capacity method assigns functional costs to an average day, a maximum day, and maximum hourly usage categories, as well as meter equivalent and customer categories. The demand-commodity method allocates functional costs to demand and commodity usage categories, as well as meter equivalent and customer categories.
- *Distribute the functionalized costs to customer classes:* This step assigns fixed and variable (commodity) costs to customer classes. Fixed costs, such as administrative costs associated with billing and metering, are typically allocated according to the number of service connections. Variable costs are allocated according to water use. Capacity costs are allocated differently under the base-extra-capacity and commodity-demand methods. Interest in advancing economic efficiency has led some utilities to use marginal/incremental cost methods to allocate costs and determine cost of service. Appendix A defines and explicates costing methods and how they apply to water efficiency.

Some of these costs may be specifically assigned to or excluded from individual customer classes. Wholesale customers, for example, are typically excluded from sharing in distribution-related costs since they maintain their own distribution system.

COSA differs from accounting-based distinctions between fixed and variable costs. Although from an accounting perspective, most water utility costs are fixed, under COSA, most of these costs are typically associated with volume-related functions and recovered through volumetric rates. For example, the cost to repair and replace pipeline assets would typically be allocated to average and peak-day demand related service characteristics though they do not vary with levels of water production.[22]

Within the construct of COSA-based allocations, there are important mechanisms to advance water resource efficiency objectives and provide a foundation for efficiency-oriented water rate design; however, COSA also has inherent limitations that constrain the extent to which it may advance resource efficiency. For example, COSA derives unit cost calculations that reflect average embedded test year costs to apportion revenue responsibilities in proportion to customer class demands. To the extent that test year costs do not include prospective water supply development costs or internalize environmental externalities, the resulting price signals will fail to reflect the full, long-term costs of service.

22 Rates based on accounting definitions, where the preponderance of costs are viewed as fixed and as such are the basis for fixed charges, are relatively uncommon and at variance with industry-standard COSA approaches based on cost causation.

This limitation lies at the heart of the quandary of setting rates that promote economic efficiency and assure no more than full cost recovery. Economic theory posits that the pricing of goods and services at their marginal costs in a competitive market will clear markets and promote resource efficiency. Emulating this outcome in a non-competitive market, where water utilities face atypical long-term cost structures, has, however, proven complicated. If a utility defines marginal costs as the cost of the next unit of service (short-term marginal costs), it would fail to recover the embedded costs of service, which are dominated by fixed capital investment costs. On the other hand, if rates were set equal to long-term marginal costs — those that contemplate future supply development — utilities would accrue net revenues that exceed their average embedded costs.

Here are a few strategies help to address this quandary:

- Redefining revenue requirements to more fully reflect true costs of service.
- Redefining water system functions, such as water supply development and environmental mitigation, to more fully reflect the scope of the utilities' long-term responsibilities.
- Revising rate structures to blend marginal cost and average embedded cost pricing (as discussed in the section on Rate Design).

Even after implementing these strategies, managing the tension between the appeal of leveraging economies of scale so whole customer populations benefit from affordable embedded costs-of-service, and pricing services to reflect long-term, often non-monetized, resource costs remains a challenge. This challenge is further exacerbated by the complexities of estimating the value of future, often non-monetary impacts, of resource utilization.[23]

In this context, it should be further noted that while COSA is an industry standard analytical method, it is not generally required in many jurisdictions, and there are a number of policy reasons why individual communities may choose to deviate from cost-of-service-based rate setting. Some communities, for example, subsidize a specific customer class to advance economic development or low-income affordability policy objectives. These deviations define where the "art" of rate setting complements the mechanics of COSA.

More detail on costing methods can be found in Appendix A.

Customer Classification

In the past, utilities, especially smaller ones, typically adopted a single rate structure for all classes of customers, except possibly for fire protection. Today, utilities are more apt to design class-specific rate structures for different customer groups, such as single family residential, multiple family residential, commercial, industrial, institutional, irrigation-only, and wholesale.

23 Beyond the uncertainties associated with projections of future demand levels, water supply development costs (including environmental mitigation costs) must be projected in an environment of increasing scarcity, climate change, and economic volatility

COSA's focus on cost causation as the basis for equitable distribution of revenue responsibilities depends on effective customer classifications. Effective classifications enable utilities to impose differential rates based on differences in costs to serve different types of customers. Without them, COSA is largely limited to defining appropriate levels of fixed charges and volumetric rates on a system-wide basis.

Effective classification involves grouping customers with different usage characteristics into different classes. The traditional classifications of residential, commercial, industrial, and wholesale reflect these distinctions. In addition, some utilities also classify customers according to types of commercial operations or government sectors.

Classification helps address the principles cited by Bonbright, namely horizontal and vertical equity — horizontal equity meaning that similar customers are treated similarly, and vertical equity being that different customers are treated differently.[24]

Perhaps most importantly for this Handbook, classification is also a powerful mechanism for enabling water use efficiency-oriented rate setting. Utilities may segregate customers with similar consumption patterns and tailor price signals to the attributes of those customers and their consumption patterns. To the extent that residential customers exhibit similar usage patterns and peak-demand characteristics, carefully designed inclining block rate structures can provide price signals that reflect higher per unit costs of serving peak demands. On the other hand, imposing that same type of rate structure on customers that exhibit diverse consumption patterns, as is typical among general commercial classes — which is a heterogeneous class — may penalize larger customers for their relatively higher levels of consumption, irrespective of the relative efficiency of their water usage.

Advances in metering and billing technologies are creating a new platform for creating more discrete and precisely drawn classifications. These technologies even hold the promise of tailoring price signals at the individual customer level. Modern billing software systems, for example, can reference individual users' consumption histories to define the usage thresholds at which inclining block rate tiers should be imposed on that particular customer. This ability provides the basis for water budget-based rate structures mentioned below.

Design a Rate Structure

Building a better water rate structure requires an improved understanding of how different alternatives perform with respect to the desired objectives. Sadly, there are no simple, one-size-fits-all answers to the question "How should water rates be set?" Furthermore, establishing a one-size-fits-all approach would be impractical because rate objectives and rate performance relative to objectives differ so widely among utilities. As a result, this Handbook emphasizes the key principles and analytic tools needed to build better rate structures for individual utilities. When uncertainty is high and the stakes compelling — as is increasingly the case with emerging resource scarcities — the payoff of more active evaluation of rate alternatives can be profound.

24 H. Peyton Young (1994). *Equity: In Theory and Practice*. Princeton University Press.

Rate Structure vs. Rate Level

A foundational step in rate making is drawing the distinction between a rate structure and the rate level:

- **Rate Structure** — The form of the rates: differing combinations of fixed charges and volumetric rates that together form a shape, such as block rates, seasonal rates, or rates that differ by customer class.
- **Rate Level** — The magnitude or height of each specific component of the rate structure.

This distinction can help clarify controversy. The primary concerns address the *rate level*: what should be included in the set of water services offered by a water utility? What is an appropriate expenditure to secure that level of water service? What is the total level of rate revenue required to pay for those expenditures? The second-tier concerns address the *rate structure*: how to generate that level of revenue in a way that satisfies the multiple objectives of the utility and its customers?

Fixed vs. Variable Charges (Service Fees, Drought Surcharges, etc.)

When designing rates, utilities must determine whether to recover costs through commodity charges, which vary with usage, or fixed charges, which do not vary with usage. Revenue collected through commodity charges varies with the amount of water used by customers. Revenues from fixed charges, such as service charges and readiness-to-use charges, are not sensitive to use. Commodity charges send a message that consumers should conserve, while fixed charges provide no incentive to reduce water use. A common practice in rate design provides for recovery of costs that are sensitive to usage (such as pumping costs) from commodity charges, while recovering costs that are not caused by usage (such as connection costs) from the fixed charges.

Fixed charges have often been viewed as working in opposition to water conservation objectives by limiting the extent to which customers may reduce their bills through usage reductions. Nevertheless, when water utilities are facing revenue shortfalls, they sometimes turn to rate designs that recover a large share of their revenues through fixed charges. For an opposing point of view, see LaFrance (2011) "What to Do with Less." LaFrance argues that improved implementation of existing rate setting practices can correct many problems. He cites practices such as "truing up" revenues and costs with current water sales levels, developing more accurate sales revenue forecasts over a 3-5 year period, and empirically checking that reserves are sufficient to absorb risks. LaFrance concludes by stating "...raising fixed fees is not the only way to manage revenue risks—and perhaps is not the best way.[25]"

Three commonly used fixed charges are: service or customer charges, meter charges, and fixed charges with a quantity allowance. In occasional cases, fixed charges may be used to recover all of the utility's rate requirements.

1. **Service or Customer Charges**

   Service or customer charges recover costs associated with such activities as meter reading, billing costs, and other costs that the utility incurs equally per customer or per account. They are generally assessed uniformly to each account per billing period.

25 LaFrance (2011) *"What to do with Less,"* Journal AWWA, Nov. 2011, p. 6.

2. **Meter Charges**

   A meter charge is a fixed fee that generally increases with meter size. It typically recovers the customer-related costs that are a function of meter size, such as meter repairs. Meter charges and service charges may be combined in a utility rate schedule.

3. **Fixed Charge with Quantity Allowance**

   Fixed charges sometimes include a quantity allowance to recover the cost of a minimum amount of billable volume in each billing period in addition to the customer and meter costs. The usage allowance may be set at a level necessary for basic health and sanitary needs, typical indoor water use, or some other basis.

4. **Flat Rates**

   Flat rates recover annual revenue requirements without a volumetric component. They may be assessed uniformly system-wide, or they may vary by customer class.

Utilities can also create special charges for services, such as hook-up fees or system-development charges. These special charges can discourage system expansion in capacity-constrained water systems or encourage expansion in water systems with excess capacity.

The water demand of each individual utility – preferably broken down by well-defined customer classes – goes into determining the appropriate shares of total revenue recovery from fixed and volumetric charges. Utilities with seasonal demand may be able to advance load management objectives while also making revenue recovery more certain through higher fixed charges and strong volumetric price signals related to peak use. Utilities that face supply constraints and experience limited demand peaking may not reduce their revenue uncertainty by shifting shares of cost recovery between fixed and variable charges; rather, they should set price signals that reflect year-round supply scarcities.

Types of Efficiency-Oriented Rate Structures

There are a number of efficiency-oriented rate structures, each designed to incentivize more efficient water use by the customer. Choosing among the various rate structure options depends on the specific objectives to be achieved, and this directly relates to the attributes of water resource use found in the utility system. For example, inefficiencies may be the result of requirements to provide capacity to meet peak demands, which in turn might suggest an increasing block rate structure. To quote from the AWWA M1 *Manual of Water Supply Practices*:

> *"Because a system must be constructed to meet peak-day and peak-month water demands, system capacity is underutilized during non-irrigation seasons. Moreover, if the system were sized to meet the average demand or winter demand only, the resource and infrastructure demands could be much smaller. Consequently, an increasing block rate structure may be designed to recover the cost of constructing and maintaining extra capacity for the peak demands. Because this capacity is underutilized, the per unit cost of water is higher than for base capacity, which is used year round. In short, a block structure can remain consistent with, if not enhance, the relationship of rates to costs of service[26]."*

26 American Water Works Association (AWWA) *Manual of Water Supply Practices*, M1, *Principles of Water Rates, Fees and Charges, 6th Edition*, (2012), p. 112.

However, just implementing an increasing block rate may not be enough to incentivize water use efficiency. Poorly designed increasing block rates — those that do not consider exhibited water use characteristics — can frustrate water use efficiency objectives. By the same token, uniform volume rates for specific customer classes may send price signals that effectively convey the value of water.

Incentivizing water use efficiency through rate design involves three fundamental considerations:

1. The water demand patterns of concern.
2. The water usage characteristics of the ratepayers who are subject to the rate design.
3. The rate structure options available.

Depending on their demand patterns, there are significant differences in the strategies individual utilities may employ to stimulate water use efficiency under different supply and demand circumstances. If a utility with adequate water supplies faces acute peak demands, for example, the increasing block rate structure highlighted in the AWWA quote above may be compelling. It may not be compelling, however, for a utility with adequate peaking capacity but general supply challenges; instead, that utility might adopt uniform volume rates that reflect water supply development costs. Though one can make the case that promoting efficient water use is inherently beneficial since it supports stewardship of an environmental resource, the relative weight of this objective and the importance of ratemaking as a tool to achieve efficiency is likely to vary based on the level of water scarcity or other threats to water quantity.

Similarly, the importance of conveying water use efficiency price signals may increase in circumstances where water use patterns impose significant costs and delivery challenges. In this instance, there are important linkages between COSA and water use efficiency pricing. As a consequence, rate analysts should examine customer class water usage characteristics carefully, especially if certain levels of usage receive differential treatment. Where high volume residential users exhibit higher peaking factors than other residential users, for example, increasing block rates may convey the relatively higher unit costs of delivering water during peak demand patterns. However, if higher volume residential users do not exhibit higher peak period demands, they may be no more expensive to serve than lower volume residential users.

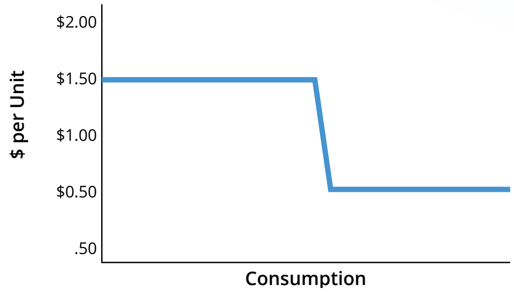
These complexities make it exceptionally important that the range of rate structure options and their relative advantages and disadvantages be known for advancing given policy objectives. Accordingly, provided below is a brief review of both traditional and emerging rate design options along with limited commentary on their merit for advancing the objectives of equity, water use efficiency, and financial resiliency.

Declining Block

In any examination of rate design options, it is also important to note the historic use of declining block structures, which still exist today in certain parts of the country.

Graph 1

Declining Block Consumption Charge



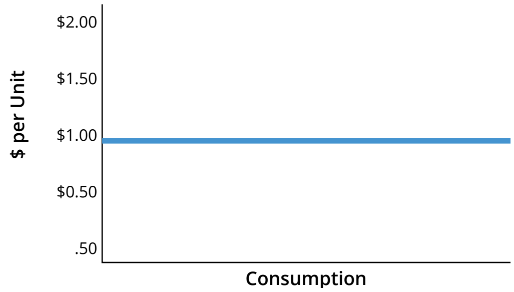
As displayed in **Graph 1**, declining block rates divide a customer's consumption into volume ranges or "blocks" and charge more for the initial units of consumption and less for later units of consumption. There is no standard limit to the number or size of blocks used in a declining block structure. Also, there is no standard for how steeply the blocks decline.

Declining block rates have often been regarded as anathema to water efficiency since they send a positive price signal for higher volumes of use. Interestingly, declining block rate structures had their origin in efficiency, as they presented an efficient rate for a declining cost industry. Economies of scale would reduce the average price if additional consumption could be encouraged. When there are no limiting factors, encouraging growth will encourage a lower average cost/price for all customers. Today, in what is recognized as an increasing cost industry, they provide an incorrect price signal to customers. As with any rate structure, the applicability of declining block rates must be assessed against the local conditions.

Uniform

Graph 2

Uniform Block Consumption Charge

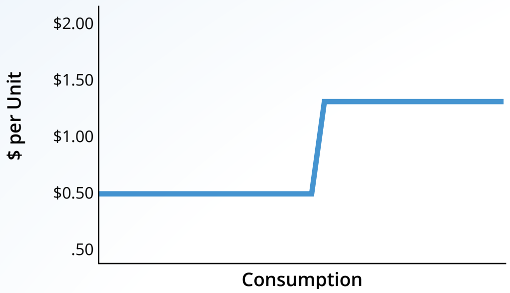


As displayed in **Graph 2,** a uniform rate is a single charge per unit of consumption. The charge remains constant for all metered consumption of water on a year-round basis. A customer's utility bill increases by a uniform amount for each additional unit of water consumed. Uniform volume rates can be an efficient water rate structure if the applicable rate conveys the full costs of water. Uniform rates are particularly appropriate when applied to customer classes composed of customers with relatively similar demand loads. Customer class-specific uniform rate designs that differ across classes based on cost-causative principles can have the effect of rendering more accurate, better tailored price signals that can promote water efficiency as opposed to system-wide inclining/declining block rates that ignore cost-causation.

Inclining Block

As displayed in **Graph 3**, increasing block rates also divide a customer's consumption into blocks but charge less for initial units of consumption and more for later units of consumption. As with the declining block rate structure, there is no standard number or size of the blocks, nor is there a standard for how steeply the blocks increase.

Graph 3
Inclining Block Consumption Charge



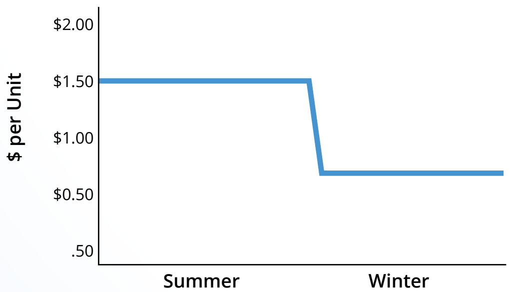
Inclining block rates have traditionally — and somewhat simplistically — been viewed as promoting efficiency because of the price signal that conveys higher costs for higher volumes of use. As noted in the AWWA M1 Manual, for utilities facing peak demand management, inclining block rates may indeed be appropriate, particularly for customer classes exhibiting relatively homogeneous demand patterns, such as residential users.[27]

However, in part because of the extent to which efficiency-oriented or conservation rates have been misinterpreted to equate to inclining block rates, it is important to recognize the limitations and appropriate applicability of this rate form. Poorly designed inclining block rates can be less effective in promoting efficiency than well-conceived declining or uniform volume rates, and they can impose profound inequities.

The crux of the matter lies in careful evaluation of the utility's exhibited demand patterns, most preferably by well-defined customer classes. Inclining block rates that provide meaningful incentives to alter usage levels within relevant ranges of use for the targeted customer group can be powerful for efficiency-oriented water rates. For example, inclining block residential rates that significantly increase the per unit cost of water that is associated with high irrigation demands can strongly incentivize customers to moderate their lawn watering practices. On the other hand, system-wide inclining block rates often have the effect of penalizing often relatively efficient large users simply for being large.

Seasonal

Graph 4
Seasonal Consumption Charge



As displayed in **Graph 4**, seasonal rates impose different charges per unit of service based on the time of year. Generally, a utility will charge more per unit of consumption during the peak water demand season and less during the low demand season. Typically, utilities employ rates for summer and winter, but it is also possible to have more seasonal divisions.[28]

27 *American Water Works Association (AWWA) Manual of Water Supply Practices, M1, Principles of Water Rates, Fees and Charges, 6th Edition,* (2012)

28 Seasonal rates are generally not used for sewer service since billable wastewater flow contributions are generally invariant with changes in weather patterns.

Seasonal rates may be particularly appropriate, and they may promote efficiency in circumstances where the utility's sources of supply have differential availability on a seasonal basis and/or when exhibited demand patterns exhibit profound, cost-inducing, seasonal variations. For utilities seeking to extend efficiency signals to commercial and institutional users, seasonal rates are often more equitable than inclining block rate forms insofar as they reflect higher costs of seasonal use without imposing penalties simply on the basis of customer size.

All of these rate structures can be modeled and analyzed using the AWE *Sales Forecasting and Rate Model*.

Innovative Rate Structures

In addition to the traditional volumetric rate structure options, some communities are implementing rate structures — or components of rate structures — to send precise price signals to individual users and/or to reflect the economics of water services delivery. These rate structures or concepts include surcharges, water budget-based rates, marginal or incremental cost pricing, and value of service pricing.

1. **Surcharges**

   Surcharges may be added to fixed charges or to the base volumetric rates ($/hundred cubic feet) for some or all of a utility's customers for two general purposes. Surcharges may be assessed to collect a targeted amount of revenue for a specific purpose, or they may be designed to send a price signal to customers during a specified period of time, such as during a drought, to support water use efficiency programs, or to fund special water supply development initiatives. The effectiveness of surcharges in sending efficiency-related price signals depends on the clarity of the need.

2. **Water Budget-Based Rates.**[29]

   Water budget-based rates, which are also sometimes called goal billing, allocation-based rates, or customer-specific rates, establish rate blocks based on specific characteristics of each customer, such as persons per household, lot size, or evapotranspiration requirements of landscaping. Rates rise as usage exceeds the pre-established budget goal. The distinguishing characteristic of water budget-based rates is the way in which the rate block is defined rather than the pricing. These examples of water-budget-based rates offer an illustration:

   - **Evapotranspiration-based water budgets for separately metered irrigation-only customers:** The utility defines a goal for each irrigation-only account by combining a customer-specific estimate of landscaped area with an estimate of evapotranspiration requirements. The utility may visit the site or use commercially available real estate data to establish the area. Local weather data can provide the information needed to estimate evapotranspiration.

29 *"Water Budgets and Rate Structures — Innovative Management Tools,"* American Water Works Association Research Foundation, (Project 3094), 2007.

- **Water budget-based rates for single-family residential customers:** Single-family residential account water-use goals require consideration of both indoor and outdoor uses. Outdoor water use allotments may factor in irrigable area, house footprint area, driveways, and pools. Indoor water allotments may either be based on an amount per person or household.
- **Budget-based rates for nonresidential customers:** Commercial, Industrial, and Institutional (CII) users may have customer-specific rates established by analyzing their historical water use and their industrial processes. This analysis may require a relatively intensive information-gathering effort of surveys with follow-up. Historically, water budget-based rates have been difficult to enact for commercial customers.

Budget-based water rates were pioneered in communities facing limited water supplies or shortages. They require public education and communication efforts, ongoing customer service to address questions, complaints, and appeals, and they may put a demand on billing system capabilities.

That said, the concept of water budget-based rates has considerable appeal as a mechanism to encourage efficient water use practices and to distribute revenue responsibilities equitably within customer classes. In communities that have historically encouraged water conservation, budget-based rate structures may become successful aids to conserving water. These water budget rate structures are often more expensive to administer,[30] but for many utilities, the benefits they produce may outweigh their costs over time. They may have particular appeal because they convey precisely focused efficiency price signals, and they have been perceived by customers as being fairer than other rate structures.[31] When collected revenue exceeds goals, water budget-based rates have also been used to help fund dedicated water use efficiency or watershed programs.

30 With advances in water metering and billing technology, both the administrative cost and accuracy of water-budgeting is likely to make this form of rate more viable in future.

31 As noted in the WRF Report (op cit.) budget-based rates have been criticized as less than perfectly efficiency-oriented because they primarily aim to improve water use efficiency of current landscape (short-run efficiency). Budget-based rates may provide insufficient incentive to change to a more efficient landscape mix (long-run efficiency). Other critics have cited this and potentially more fundamental flaws. (Beecher, 2011) These rates represent a tradeoff that communities have made between administrative costs, equity of water shortage allocations, and short- and long-run water efficiencies.

WESTERN MUNICIPAL WATER DISTRICT ADOPTS BUDGET BASED RATES TO REDUCE WATER USE AND ACHIEVE REVENUE STABILITY

Western Municipal Water District, a wholesale and retail water provider, serves about 23,000 retail customers in Southern California. Operating in a semi-arid region, Western relies on expensive and increasingly unreliable imported sources that make up 75 percent of its supplies. In 2008, Western adopted a Water Efficiency Plan encompassing programs, education and outreach, as well as a new rate structure to support its goals. In 2011, Western rolled out budget-based rates to customers in service areas previously facing uniform or increasing block rates. Western's primary objectives for a new rate structure included:

- **Financial Stability:** Western had been raising rates over time while asking customers to conserve. They wanted a rate structure to deliver the message that rates would only increase when absolutely necessary, and ensure efficient use would result in the lowest possible cost.
- **Customer Equity:** Western sought a structure that placed equal responsibility on customers to efficiently manage the region's supplies, and did not require some to pay for the wasteful use of others.
- **Water Use Efficiency:** Western had long invested in efficiency to stretch local supplies and avoid rising supply costs, and new state regulations required further cuts.

Western developed a five-tier budget-based rate structure. Every customer receives a personalized water budget designed to meet their specific indoor and outdoor water needs. Residential budgets are calculated based on each customer's landscaping, real-time localized weather data and the number of residents, among other factors. Most customers' water use regularly remains within their water budget (Tiers 1-2), and they are billed at the lowest available rates. The only customers who are billed in the higher tiers (Tiers 3-5) are those whose use exceeds their water budget. The naming of tiers also clearly communicates whether use is efficient, inefficient or unsustainable.

Residential Budgets in Detail:

Water Budget:

- **Tier 1** – Efficient Indoor Use: based on the efficient indoor water needs of your household
- **Tier 2** – Efficient Outdoor Use: based on the efficient outdoor water needs of your property

Water Waste:

- **Tier 3** – Inefficient Use: Based on exceeding your total water budget by up to 25%
- **Tier 4** – Excessive Use: Based on exceeding your total water budget by between 25% and 50%
- **Tier 5** – Unsustainable Use: Based on exceeding your total water budget by more than 50%

Western's management believes the rate structure has achieved their objectives:

- Western customers are becoming more efficient. Customers collectively lowered their 'over-budget' water use by 34 percent in 2013 when compared to 2012. Western's efficiency programs are funded with revenue from upper tiers, meaning that inefficient customers pay for efficiency programs.

Continued on next page

Western Municipal Water District Adopts Budget Based Rates to Reduce Water Use; Achieve Revenue Stability, Continued

- All revenue to cover O&M costs is collected from the first and second tiers, creating revenue stability for Western. While customers will become more efficient over time and use only their water budget, Western will not need to raise water rates to recover lost revenue resulting from reductions in water usage in the higher tiers.

Western recommends several successful practices for utilities considering budget-based rate structures:

- **Create Open Dialogue:** Finance and Water Resources teams collaborated to understand conflicting objectives and design rates to increase efficiency without compromising financial integrity.
- **Learn from Peers:** Western met with neighboring agencies with budget-based rates to understand their challenges and successes.
- **Cover O&M Costs in Lower Tiers:** Thoughtful tier design has helped guarantee revenue stability.
- **Adopt Financial Policies:** Maintaining an operating reserve helps buffer unanticipated operating costs.
- **Empower and Educate Customers:** Western sent a letter to every customer to explain their personalized budget, and provided a form and prepaid return postage to request adjustments – an immediate opportunity to address discrepancies. In the first eight weeks, 6,000 forms were sent in. Western sent assistance letters to larger users, continues to help customers lower their usage and has invested in thorough training of customer service staff.
- **Ensure Administrative Oversight:** Investing in a rate consultant and legal specialist helped ensure all regulatory requirements and statutes were met, including thorough documentation of the cost of service study.

For the full case study and sample utility resources, visit www.FinancingSustainableWater.org.

3. Marginal/Incremental Cost Pricing

The basic premise of marginal cost pricing is that since rates affect future usage, the future costs of water are those most relevant for setting rates. Rates based on the marginal cost of water provide signals to consumers about the cost consequences of their usage decisions. Conversely, they also reflect the future cost consequences of consumption decisions.

Theoretically, marginal cost pricing may send accurate price signals to customers and help optimize resource allocations. Practically, however, widespread implementation has not occurred because of limitations such as mismatching revenues with actual costs, unavailability of data necessary to develop accurate marginal costs, and significant divergences from the theoretical market conditions required to ensure optimal resource allocation.

Though marginal cost pricing may have limitations, marginal cost theory and average cost approaches have been successfully blended in water rate design through inclining block rate structures where the last block is set according to the unit cost of the next increment of water supply. This "next increment of supply" reflects the opportunity cost of not conserving; it is the avoided cost achieved by having conserved.

ALTERNATIVE THEORETICAL RATE STRUCTURES

A 2014 report entitled *Defining a Resilient Business Model for Water Utilities* was written by the Environmental Finance Center at UNC and Raftelis Financial Consultants and funded by the Water Research Foundation and the U.S. EPA. It explored three alternative pricing models that focus on generating more reliable and predictable revenue streams over a budget period without sacrificing pricing signals to customers to be more efficient. These models hold the potential to better align the goals of revenue stability, sufficiency, and customer conservation. Ultimately, each of these models would allow the utility to recover more revenue from the fixed portion of a customer's bill, while still financially incentivizing conservation and efficiency. The report contains explanations of these structures using real utility data, although none have been fully implemented and studied. Further exploration is needed on implementation feasibility, customer understanding, and demand response, but the report advances these models as innovative strategies for overcoming the inherent challenges of the utility business model.

A. PeakSet Base Rate Model

Inspired by demand ratchet charges used by power utilities, the PeakSet Base Rate model would charge individualized base charges calculated using a customer's historical maximum month of consumption. A customer's base charge would be individually set based on a three-year rolling average of that customer's peak month of demand. The utility would continue to send a smaller variable price signal every month to send immediate feedback on water use. This model would allow a utility to build more of their cost recovery into the base charge while still promoting customer conservation by using a customer's historical demand to establish that base charge. It would encourage consistent customer water use (because one month of high usage would be costly), reduce financial risk for the utility, and increase financial predictability for customers.

B. CustomerSelect Model

The CustomerSelect model gives customers the choice to select an allotment of use that meets their needs and charges a fixed amount for that allotment for all use under it. Water use exceeding the allotment is charged at a punitive rate. This model is similar to a budget-based rate structure, but rather than the utility establishing the budget for customers, it enables customers to choose their own fixed budget. Potential benefits include increased revenue and stability because customers commit to plans. It would promote water use efficiency, especially around the plan's "break points." It is a relatively simple model to understand, and it advances the utility as a provider of a service. Customers would have an incentive to consume within their plan and to move down to a lower plan the next year. However, providing customers with frequent usage updates may increase customer awareness, but could also signal a license to waste water at the end of the month because they may be able to do so at no extra cost. There may be challenges in the planning process, such as questions related to how to predict what plans customers will choose. Smart meters may also be required as customers will want to track their consumption against their plan.

Continued on next page

C. WaterWise Dividend Model

Some cooperative retail organizations return profit to their "owners" once financial obligations are met. Many times these cooperatives return larger "dividends" to the "owners" that bought more of their product over time. Under the WaterWise Dividend model, utilities seeking revenue stability and efficient customers would adopt an adapted model. Rather than rewarding customers that used more, they would return conservation dividends to customers that used less or used water in a way that minimized costs. The definition of "less" could be established against a customer's budget or relative to an individual customer's historic use. The utility could calculate a dividend according to any number of policies it wants to promote, such as "peak shaving." This model has the benefit of communicating that the utility is a not-for-profit entity, as "profits" are returned to customers. It provides a positive way for utilities to interact with customers, and it helps ensure that financial goals are met. Returning money to citizens is not unprecedented. In January 2013, DC Water announced that it would refund a one-time credit to customer bills because it finished Fiscal Year 2012 with a surplus.

4. Value of Service Pricing

A departure from conventional ratemaking methods that focus on cost recovery involves consideration of factors that reflect customer perceptions about the value of utility service, as well as their "willingness to pay" for different levels or types service. Value-of-service pricing considers customer preferences beyond those traditionally represented in cost-based pricing. In recent years, concepts related to value-of-service pricing have received considerable attention in the water and wastewater industry as concerns have been elevated about the general underpricing of water and sewer services relative to its value, and the disparity between existing funding levels and forecasted infrastructure investment needs.

There are several approaches, with attendant limitations, to estimating the value of water service. Customer preferences can be assessed through surveys and related contingent valuation methods that evaluate users' "willingness-to-pay" for services under various circumstances. Customers might be surveyed, for example, about how much they would be willing to pay for a higher degree of reliability or for additional treatment for a taste or odor issue. Additionally, customer demand patterns under prior pricing regimes may be used to impute value of service. For example, the effect of seasonal rates on consumption may indicate the value customers place on seasonal usage.

There are several specific examples of value-of-service-based pricing in use in the industry. For example, some utilities have developed customer-specific rates to establish reliability pricing, or fire-protection pricing where special service levels are extended to these customers. Additional concepts include:

- **Demand-based (Ramsey) pricing:** One value-of-service approach to pricing is to base prices for different customers on their relative responsiveness to price. Users with relatively price-inelastic demand (not sensitive to price changes) would be charged more than users who are more responsive to changes in price. Ramsey pricing will generally suggest lower prices for large-volume wholesale and industrial customers who may have alternative supply or service options while higher prices for residential customers (who are captive of the utility monopoly). To the extent that the significant water conservation potential is reflected in relatively higher price elasticity, price elasticity based pricing will encourage efficient water use. On the other hand, perceptions of rate fairness may be challenged when pricing for services is based on demand elasticity, especially when water and sewer services are essential to human health and sanitary needs.

- **Property-value pricing:** In Great Britain, charges to unmetered customers are based on "rateable" property values. Customers with more expensive properties, and typically more extensive landscaping requirements, pay more for service than customers with lower valued properties.
- **Negotiated rates:** Some water utilities have had occasion to negotiate rates with large-volume users, including wholesale customers. Negotiated revenue requirements may be based on the cost of service, but the negotiation process can introduce other values and preferences including requirements for implementation of conservation programs, employment programs, or other community-valued programs.

Implementing value-of-service pricing can be complex and may raise a variety of concerns about equity, efficiency, and effectiveness — and it has not been generally accepted by regulatory agencies with jurisdiction over water ratemaking. However, the concepts of value may be incorporated into some elements of water pricing, and there is growing interest in doing so to address chronic sector pricing issues. Prices that are fundamentally cost-based prices, while also incorporating customer preferences, may further service and water resource efficiency goals.

There are also a number of communities that have implemented rate designs generally targeted to specific ratepayer sub-populations that are designed rather explicitly to advance community policy objectives. In general, these rate designs involve the extension of subsidies to one sub-population at the expense of the remaining ratepayer population; therefore, they do not reflect costs-of-service. Perhaps the two most common forms of policy-based rate options: (a) extend subsidies to low-income populations and (b) promote economic development.

a. Low-Income Rates

As water and wastewater rates have continued to increase at well above inflation or income growth rates over the last decade or more, many communities have become increasingly concerned about the affordability of services necessary for basic human health and sanitary needs. Accordingly, some communities have established low-income affordability rates and programs whereby qualifying ratepayers receive discounted rates. These subsidies may come in a variety of different formats ranging from a simple percentage discount on the ratepayers' total bills to rates that are discounted for a limited volume of usage. In general, the concept is to ensure the affordability of minimal usage levels required for human health and sanitary needs, which are often accompanied by targeted low-income assistance programs.

b. Economic Development Rates

Similarly, some utilities have provided rate discounts as a component of a community's economic development program. Economic development rates (EDR) have become of increasing interest among utilities that have excess system capacity. In these circumstances, economic development rates may enable utilities to leverage capacity that would otherwise remain stranded, and in so doing benefit all parties. Existing ratepayers are benefited by virtue of the fact that the largely fixed revenue requirements will be distributed over a larger customer base, and new customers that are eligible for the EDR are recipients of subsidized service. Even without excess system capacity, a community may elect to offer an EDR to help stimulate local job growth and economic expansion.

Ensuring Affordability

Utilities have a responsibility to provide necessary water services for basic human health and sanitary needs. As a result, rate design must involve considerations of affordability for low-income households, which may face challenges if rates are raised.

Any evaluation of a rate structure should involve an in-depth and informed understanding of affordability. The U.S. EPA has provided affordability criteria to help guide utilities — specifically that a water bill is affordable if it costs less than 2.5% of small community's median household income.

However, it has been noted that the reliance on median household incomes means that average bills less than some fraction of median income do not guarantee affordability, and this approach may underestimate the impact on low-income households. A 2013 brief from the U.S. Conference of Mayors (USCM), the American Water Works Association (AWWA) and the Water Environment Federation (WEF) suggested several alternative methods, including assessing the impact on customer water bills across entire income distributions, especially at the lower end; as a percentage of income for potentially vulnerable populations; across neighborhoods known to be economically at risk; and through a variety of other indicators such as the unemployment rate or the percentage of households receiving public assistance.[32]

The AWE *Sales Forecasting and Rate Model* provides an Affordability Index to help gauge the impact of a proposed rate structure by customer class. Users should note that additional precision may be required, depending on the community.

Drought Pricing

Drought pricing incorporates rates into drought/shortage planning. Water utilities in California currently develop drought management plans that call for coordinated response to water shortages, including planning for water rates.[33] When a water utility declares a shortage emergency and requests voluntary or mandatory curtailment of water use, a corresponding change in water rates for the duration of the drought emergency accomplishes several goals:

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32 AWWA, USCM, WEF Brief, 2013
(http://www.awwa.org/Portals/0/files/resources/water%20utility%20management/affordability/Affordability-IssueBrief.pdf)

33 USBR Drought Management Planning Guidelines, the CA DWR Urban Drought Guide, the CA Urban Water Management Planning Act, and the AWWA M1 Manual of Rates' section on Drought Pricing

- Customers receive a higher price signal that indicates the scarcity value of water.
- Water utilities avoid the inevitable "unexpected" revenue shortfall that follows a successful citizen response to calls for curtailed water use.
- Water utilities can avoid the political backlash that may occur if water rates rise after customers have heeded the call to perform a civic duty by curtailing use.

LOS ANGELES DEPARTMENT OF WATER AND POWER ACHIEVES DEMAND MANAGEMENT GOALS WITH UNIQUE VOLUMETRIC RATE STRUCTURE AND LONG-TERM PLANNING

The Los Angeles Department of Water and Power (LADWP) is one of the largest municipal utilities in the nation, serving a population of almost 4,000,000. In 1993, largely in response to the to the California drought of the late 1980s and early 1990s, LADWP adopted an increasing block rate structure that was developed by the Mayor's Citizen Blue Ribbon Committee. The rate structure had several notable innovative features such as a seasonal increasing block rate structure based on marginal cost pricing principles, elimination of fixed charges (resulting in a 100 percent commodity-based revenue generation), an intensive home survey program that accompanied the roll out of rates, rate adjustment mechanisms to balance revenue, and an ongoing public involvement and outreach program.[34, 35]

Due to the high level of public participation, LADWP received feedback that led to the advancement of its relatively standard increasing block rate structure (in which each block is defined by a fixed amount of water) to one based on water budgets. In 1995 the City adopted its current water budget-based rate structure that uses information on lot size, weather zone, and household size to define each customer's block size.

The LADWP water budget-based rate structure has been widely seen as a success that, mixed with a portfolio of innovative conservation measures, helped flatten water demand in spite of a growing population and economy.

The most significant barriers to the program's success cited by staff were the complexity of the reprogramming required by the water budget, reconfiguring billing system reports, and data task of matching addresses to obtain accurate lot size information. These barriers were largely overcome in a six to eight month time frame through the concentrated efforts of existing employees. In general, customers responded very well to the revised 1995 water rate structure that incorporated lot size (5 categories), household size, and temperature zone (3 zones). Of these three factors, staff cited the lot size adjustment as the most important. The lot size adjustment is well understood by customers and contributed the most in terms of gaining acceptance. The household size adjustment and temperature zone adjustments, while acknowledged, were less cited by customers.

Continued on next page

34 Darwin C Hall and W. Michael Hanemann, 1996, *"Urban Water Rate Design based on Marginal Cost,"* in , Advances in the Economics of Environmental Resources: Marginal Cost Rate Design and Wholesale Water Markets, Volume 1, JAI Press, Inc., Greenwich, Connecticut, pp. 95-122.

35 Chesnutt, T.W., C.N. McSpadden, and D.M. Pekelney, *An Impact Evaluation of Home Water Surveys in Los Angeles, A report for the Metropolitan Water District of Southern California,* October 1996.

LA DWP staff provided recommendations to utilities considering implementing a water budget-based rate structure. These include:

- Public acceptance is critical. Public workshops permitted LADWP to elicit customer feedback on the 1993 increasing block rate structure, construct adjustments to the rate structure and, with augmented customer outreach, win over more of its customer base.
- It is imperative that a water budget have a rational basis that can be clearly communicated to customers. By providing a rational basis for defining the width of tiers, water budget-based rate structures can be perceived by customers as being intrinsically fairer.

The LADWP water budget-based rate structure has now been in place for more than two decades and continues to be an effective billing methodology. It has maintained required utility revenues, reinforced incentives to use water efficiently, and has achieved broad customer acceptance within a major metropolitan area having a diverse customer base.

For the full case study and sample utility resources, visit www.FinancingSustainableWater.org.

The AWE *Sales Forecasting and Rate Model* facilitates planning for drought rates and probabilistic revenue management where water shortages might occur, even if they are unlikely.

A Framework for Building a Rate Structure

As summarized in **Table 1**, a sequential decision structure may help utilities as they build rates designed to encourage efficient use.[36] For many rate managers, some of the decisions may not constitute feasible choices, but the decision structure attempts to include the range of all potentially relevant decisions.

1. Should all costs be recovered through rates and charges? Some water utilities have other sources of revenue or financial support, which can affect the willingness of rate managers to implement innovative rates.
2. Should the rate structure be applied to all customers and if not, how should rates vary across customer classes?
3. How will the rate structure address fixed charges?
4. Should the rate structure incorporate seasonal variations, and if so, how should the peak period be defined and what should be the specific rate periods and seasonal rate levels?
5. If the structure will include block rates, how many blocks, what will the break points be between blocks, and what rates will be attached to each block?
6. How will the rates be integrated into the utility's drought management plans?

36 Chesnutt, T. W., J. A. Beecher, P. C. Mann, D. M. Clark, W. M. Hanemann, G. A. Raftelis, C. N. McSpadden, D. M. Pekelney, J. Christianson, and R. Krop. (1997) *Designing, Evaluating, and Implementing Conservation Rate Structures*, A handbook for the California Urban Water Conservation Council, Sacramento California, http://www.cuwcc.org.

Table 1 — A Decision Framework for Efficiency-Oriented Rate Design

PRIMARY CHOICE:	OPTIONS	IMPLICATIONS
1. Recover all costs through rates and charges	External tax support	Some revenue sources from outside the water rate structure.
	No external tax support	Recovers all costs through rates and charges attached to water service.
2. Differentiate rates and charges by customer class	Same rates for all customers	Recovers revenues under a single rate structure for all customers
	Class-based rates	Recovers revenues through different rate structures for different groups of customers (such as residential, commercial, and industrial).
3. Design the fixed component of the customer bill	No fixed charges	Recover all revenues through variable charges.
	Same fixed charge for customers	Recovers metering, billing, and other charges. Reflects no cost variations based on customer-class distinctions.
	Different fixed charge for customers	Reflects cost variations in metering, demand, billing, and other factors based on meter size or other customer-class distinctions.
4. Vary rates by season (Peak Pricing)	Year-round rates	No variation in rates by season of use.
	Seasonal rates	Rates that vary for two or more time periods within a year, reflecting seasonal variation in costs.
5. Vary rates by block of water usage (Block Rates)	Uniform rate	The rate does not vary with usage for all customers or all customers within a class (uniform rates by class).
	Block rates	Requires a determination of: (1) the number of blocks, (2) unit rates for each block. (3) block switchpoints by usage
	Water Budget-based Block Rates	Define block width by a technical definition of efficient water use: a water budget conditional on customer characteristics.
6. Vary rates during drought emergencies (Drought Pricing)	No Drought Pricing	Rates are not integrated into drought management plan.
	Drought Pricing	Rates increase during shortage events to reflect scarcity value.

Adapted from Designing, Evaluating, and Implementing Conservation Rate Structures[37]

37 *Designing, Evaluating, and Implementing Conservation Rate Structures*, A handbook for the California Urban Water Conservation Council, Sacramento California, 1997, (http://www.cuwcc.org)

PERFORMANCE METRICS

Performance Metrics (PMs) can help rate setters determine the effectiveness of certain rate structures in promoting efficiency. One approach is to use a customer-weighted performance approach: what is the proportion of customers whose last unit of consumption is priced at the long-term marginal cost of water? A second approach builds on the first by determining a quantity-weighted average: what proportion of a utility's total sales face a marginal price that is set to the long-term marginal cost of water?

Regardless of the approach, efforts to assess the efficiency-orientation of a rate structure should include the following considerations:

- The estimated short-run and long-run marginal/incremental cost of water over time
- Estimates of performance metrics in peak and peak periods
- The average system water price (total sales quantity divided by total system revenue from rates)
- The proportion of system revenues generated from non-volumetric sources (fees and charges)
- The estimated system loss (total production quantity minus total sales quantity).

Evaluate the Rate Structure against Objectives

A good rate decision process begins by formalizing the criteria that will be used to judge alternatives. Public involvement efforts should begin with an attempt to develop a consensus on appropriate criteria for judging alternatives.

With appropriate criteria in place, analysts can evaluate rate alternatives and make tradeoffs explicit. Some criteria for evaluating rate structures emphasize measurable outcomes, such as the effects of a rate structure on utility revenues, customer bills, and resource efficiency. Others emphasize less easily measured issues, such as understandability to customers, acceptability to decision makers, or effect on the conservation ethic of the community.

Evaluating a rate structure can help reveal the consequences of rate structure choices. The depth of analysis depends on the costs and benefits. Water utilities with stable system costs and demands may need to invest less in evaluation. Water utilities facing rapidly changing system costs, demands, or other uncertainties may need to invest more.

Benefits of Rate Evaluation

- **Improved Decision Making** — An improved understanding of rate consequences can lead to a more informed basis for choosing among rate alternatives.
- **Avoided Surprises** — Designing rates is not error-free and some of the efficiency-oriented rate structures (block rates) require more work to design correctly. A better rate evaluation can avoid the surprise of unanticipated outcomes.
- **Reduced Uncertainty** — A standard strategy for coping with uncertainty is to invest in better and more certain information.

- **Improved Likelihood of Public Acceptance** — Changing rates in accordance with changed conditions can affect some customers more than others. Identifying the impact of rates on different groups of customers permits utility officials to address political considerations early in the ratemaking process.

Costs of Rate Evaluation

- **Direct Utility Costs** — The cost of labor and materials.
- **Indirect Utility Costs** — Overhead or administrative costs.
- **Direct Contract Costs** — The cost of any analyses contracted out.
- **Cost of Communication** — Complicated analyses can be more difficult to explain to decision makers and the public.

Two broad criteria govern the complex choices related to rate setting alternatives: effectiveness in meeting the utility's goals and the feasibility of implementation. "Feasibility" addresses political possibilities while "effectiveness" addresses economic or water use efficiency effects. Not infrequently, these two criteria are at odds with each other: options that are highly effective may not be feasible, while more feasible options may not be effective. This tension between efficiency and equity is an ongoing concern of policymaking and ratemaking for utility services.

Rate evaluation can take on many different forms, spanning a continuum from quantitative to qualitative.

Types of empirical analyses often used in rate evaluation:

- **Modeling Water Demand Variability** — Evaluating the effect of rate alternatives on water demand.
- **Modeling Water Revenue Variability** — Evaluating the effect of rate alternatives on utility revenue and finances.
- **Customer Bill Analysis** — Evaluating the effect of rate alternatives on customers.

Rate evaluation provides better information about the consequences of rate alternatives to water utility managers, regulators, and the community-at-large.

Figure 8 shows some of the inputs and outputs needed for rate evaluation. Once evaluated, the results should help lead to a rate structure decision.

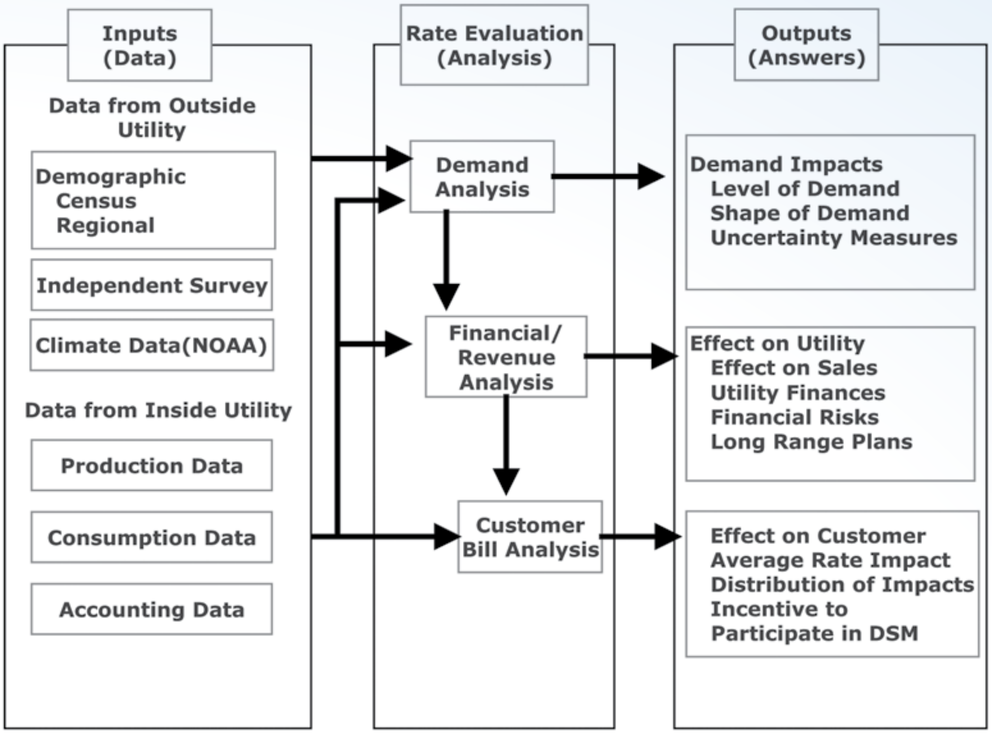


Figure 8 — Rate Evaluation

Adapted from Designing, Evaluating, and Implementing Conservation Rate Structures[38]

At best, technical rate evaluations provide informational inputs. Decision-makers, however, must not just evaluate how each rate alternative stacks up against the established design criteria, they must also engage the political debate of "values" versus "facts."

Good evaluations help focus the debate on how different parties value outcomes. They also help estimate the measureable consequences of a rate structure and clarify the magnitude of tradeoffs among alternatives. Since some of the criteria can be quantified and others cannot, no rate evaluation provides all of the answers to all of the questions, and no spreadsheet can make a decision, much less take responsibility for the consequences of that decision.

38 *Designing, Evaluating, and Implementing Conservation Rate Structures*, A handbook for the California Urban Water Conservation Council, Sacramento California, 1997, (http://www.cuwcc.org)

Effectiveness in Achieving Objectives

The quantifiable effects of an efficient rate structure include:

- Revenue
- Consumption
- Costs and Resource Efficiency

Of course, the effectiveness of an efficiency-oriented rate structure depends on the perspective of the viewer. Each of the stakeholders — utilities, customers, and society — might have a different perspective. From the utility's perspective, an effective efficiency-oriented rate structure generates sufficient revenues to pay for the cost of service and maintain financial viability. From the customer's perspective, a rate structure is effective if it sends signals to customers about the true worth of water and enables better consumption decisions, which in turn enhances the utility's ability to manage its load. In addition, customers' decisions about when and how much to consume send the utility signals about the worth of additional or improved water service. In this way, an effective efficient rate structure can improve the balance between water consumption and production and thus encourage resource efficiency.

Rate setters should always bear in mind, however, that many of the problems surrounding the implementation success of new rate structures result from unintended and unexpected consequences.

Revenue Effects: Rates that limit the difference between revenue received and cash expended are desirable as long as the rates balance the twin objectives of achieving revenue sufficiency and avoiding undue earnings. Cash flow instability can increase the need for costly short-term financing. In extreme cases, revenue shortfalls may require emergency rate increases, which are unpopular, difficult to implement, and politically costly. If not addressed quickly, revenue shortfalls can result in bond rating downgrades for a water utility, a very expensive penalty. Lastly, an uncertain future can make system planning more difficult and expensive.

Consumption Effects: Rate structures can be a tool of demand management in two ways:

- **"Load management":** the short run problems caused by the "shape" of demand.
- **"Capacity planning":** the long run problems of meeting demand.

That rate changes have predictable effects on both the level and shape of demand should be recognized and incorporated into long-term utility planning. With sensitivity to the effect of rates on demand, rate structures can be designed to target either total or peak water demands (Hasson, 1993). For example, water utilities confronting system peaking problems might benefit from considering seasonal pricing, while utilities confronting a general shortage of water will benefit from conserving water year-round. Since design criteria for capacity expansion often are driven by peaking requirements, even these simple examples are not as straightforward as they appear. Rate structures should be compatible with, and preferably advance, both short-term load management and long-term capacity planning.

Modeling Water Demand Variability

Demand forecasting serves many purposes, and is a critical step in the planning, design and evaluation of a rate structure. In order to ensure that revenue collected will cover costs, water utilities need to anticipate how much water they expect to sell. As water rates are typically reviewed and revised every few years, it is also important that water utilities forecast future demand several years in advance to ensure that sufficient funds are collected.

In the past, demand forecasts have tended to overestimate demand as they have relied on historical consumption patterns and simple assumptions. Methods have improved over time to capture the trend of declining water demand and incorporate variables that impact demand, such as weather and climate change, new legislation, penetration of more efficient technology, efficiency programs, and demographic changes.

UNDERSTANDING WATER DEMAND

Lessons Learned from Setting Urban Rates that Encourage Efficiency and Conservation

- **Lesson 1:** Rates influence demand.
- **Lesson 2:** "Price elasticity" is the percentage change in demand induced by a one percent change in price, all other factors being constant.
- **Lesson 3:** Demand can be thought of as the sum of demands for different end uses of water.
- **Lesson 4:** Demand for outdoor uses is more price-elastic than demand for indoor uses.
- **Lesson 5:** Demand for water during peak (summer) periods is greater than demand during off-peak (winter) periods.
- **Lesson 6:** Residential water demand is inelastic, meaning that the response of residential demand to rate changes, though not zero, is small.
- **Lesson 7:** Demand is more elastic in the long run than in the short run.
- **Lesson 8:** Demand is influenced by forces other than price, such as population growth, the economic cycle, weather fluctuations, income growth, and technological change.
- **Lesson 9:** Demand responses are more difficult to predict when there are large changes in price.

Source: Mitchell, D.M. and W.M. Hanemann[39]

The simplest approach to analyzing demand would be to use a single important determinant to create a forecast. Population, for example, might be the single-most important force driving urban water demand. As population grows, water demand also tends to grow. As a result, water managers often think in terms of per capita water use (total water use divided by total population). As simple as this sounds, however, there are exceptions, especially in the short term. If the weather is particularly wet and cool, for example, water use might decrease due to reduced lawn watering.

39 Mitchell, D.M. and W.M. Hanemann (1994), *Setting Urban Water Rates for Efficiency and Conservation*," A report for the California Urban Water Conservation Council Sacramento California, http://www.cuwcc.org.

In the long run, however, more people usually does mean more total water use. The utility may also add total water requirements to the forecast by multiplying a population forecast by a per capita water requirement.

The simplicity of this approach no doubt helps to explain its popularity. The main weakness of the approach is that it omits other forces that influence demand, so it does not go far enough.

WATER DEMAND AS A WATER REQUIREMENT

Future Water Demand = Population X Per Capita Water Requirement

Strengths:	Inexpensive, easy to do, and easy to explain
	Accounts for population growth
Weaknesses:	Implicitly assumes that rates do not affect water demand
	Does not account for how other forces affect water demand
	Provides no measure of the pattern of demand (load shape)
	Provides no measure of the uncertainty surrounding demand

To develop a more complete and explicit understanding of water demand, analysts must incorporate more than population growth into a model of water demand, such as climate, economic forces, and price. In-depth demand modeling can yield cost-effective returns to the water utility.

Other than population, what are the important forces that drive future water demand and uncertainty about future water demand? In a given year, weather conditions can cause demand to increase or decrease. Strong regional economic activity can increase water demand through additional commercial or industrial water use. In addition, a rising economic tide can broadly increase personal income levels and encourage additional population in-migration. Changes in water rates, as emphasized throughout this report, will change the relative attractiveness of water conservation and induce changes in water consumption. For this Handbook, the driver variable of a water requirements model—per capita water use—serves as the dependent variable. After accounting for population, why might per capita water use change over time?

Weather: Per capita water use can go up or down in any given year due to weather fluctuations. Per capita water use in hot and dry years generally is higher than water use in cool and wet years. Other things being equal, increases in rainfall or decreases in temperature tend to decrease per capita water use due to decreased demand for outdoor water uses. The reverse, of course, also holds true. Decreases in rainfall and increases in temperature tend to increase per capita water use due to increased outdoor water use.

Composition of Users: Changes in the composition of water users can also change per capita water use. The total water use of a city derives from several different types of water users—residential, commercial, industrial, and institutional. If, for example, a city loses a water-intensive industrial customer, per capita use will initially decline. (Population is constant and total water use is reduced.) Likewise, increased economic activity can result in an immediate increase in commercial and industrial water use.

Income: Over the long-term, per capita income can increase as a result of economic prosperity. Real income growth—that is, income growth above the rate of inflation—is consistent with increased per capita water use. Higher income households tend to have larger yards, lusher landscapes, dishwashers, clothes washers, spas, and pools. Not all high income households use more water than low income households but, in general, increases in real personal income over time tend to increase household water use.

Price: Changes in the price of water can also affect decisions over the use of water. It has been documented that water rates have been increasing nationwide for a number of reasons.[40] Competing water users, increased water quality standards, infrastructure replacements, and the expense of developing new sources of water have all translated into higher water costs. When customers are charged more for water, they can choose to use less water. In the short-term, water users may be limited in how much they can reduce water use through changes in their water-using habits. Over the long-term, water users can choose to change both their water-using habits and their water-using equipment. Thus, the long-term response to increases in water rates is greater than the short-term response.

How can these determinants be formally incorporated into an understanding of water demand?

There are several methods in use for estimating future demand with varying levels of complexity depending on the number of variables. Models can also be classified as aggregate (total water demand for an entire service area or customer class) or disaggregate (demand by individual customer or individual end uses). In principle, disaggregate models can answer a wider range of questions; they also require more detailed data, more data manipulation, and more data validation.

The AWE *Sales Forecasting and Rate Model* helps water managers incorporate several variables through a simulation technique called "indexed sequential simulation":

Weather Variability: Given historical data on precipitation and average maximum daily air temperature, the model randomly draws five-year sequences of these data for use in each simulation trial. For each weather sequence, the model adjusts average water use for each rate class based on how much the sequence deviates from long-term normal weather.

Account Growth: The model requests the expected growth rate over the next five years for each rate class, as well as the lower and upper bounds for this growth. You then select from one of three probability distributions constructed from these values to represent the uncertainty of future account growth.

Water Use Curtailment: This component allows simulation of the effect of water use curtailments as specified via drought/shortage curtailment levels by the water manager. It presents multiple options for simulating water use curtailment.

Further guidance on choosing among these probability distributions is given in the User Guide in Appendix C. More technical guidance for building more sophisticated multivariate water demand forecasting models can also be found in Appendix B.

40 Alliance for Water Efficiency. (2012), Declining Water Sales and Utility Revenues: A Framework for Understanding and Adapting.

IRWD'S LAND USE-BASED APPROACH TO DEMAND FORECASTING

Irvine Ranch Water District's (IRWD) water supply and resource planning is driven by land use plans proposed by the major land developers in its service area. IRWD uses an advanced geographic information system (GIS)-based utility demand forecasting tool to estimate water/wastewater demands in response to changes in the land use. Water supply planners are able to track growth and estimate the supply and demand requirements in their service area, and they can identify system capacity requirements by conducting a "what-if" analysis while dynamically forecasting the demand on the distribution system.The model is periodically re-calibrated by comparing projections to actual demands. This analysis allows IRWD to overcome supply and demand planning challenges using the wealth of GIS data in its service area.

Modeling Water Revenue Variability

Robust evaluation of efficiency-oriented rate structures requires an additional layer of forecasting impacts. Since variations in demand tend to create revenue volatility, forecasting models must consider the impact of block rate structures on sales and revenue. Accurately forecasting long-term sales volume lies at the heart of establishing a correct rate level. Analysts must consider water supply availability, future water demand, and the effect of different types of rates on revenue.

Many financial analyses rely on an overly simple model of future sales. Some of these simple approaches include: sales next year will be like sales last year; or, the growth in sales this year will equal the growth in sales last year; or, the trend in sales will equal the trend in the preceding ten years. These methods do not account for the effects of climate on demand in a given year, the potential effect of swings in the business cycle, and the effect of rates on demand. Weather normalization helps balance some of this oversimplification.

Revenue prediction for rate design requires a short-term price elasticity estimate that reflects the demand response that might occur in a one- or two-year period. If an estimate of elasticity in a rate design is too low, it can be adjusted in the next rate redesign. Utilities concerned about uncertainty surrounding price elasticity should conduct sensitivity analyses to see how much predicted revenue will change with different price elasticity assumptions.

The estimates in **Table 2** provide a good starting point for incorporating residential demand response, but the demand response of commercial and industrial customers would be more variable. In general, nonresidential demand response is thought to be greater than residential demand response.

Table 2 — Recommended Short Run Elasticity Estimates for Short Run Rate Design

SINGLE FAMILY RESIDENTIAL CUSTOMERS	RANGE OF ESTIMATES	POTENTIAL SHORT RUN REDUCTION IN DEMAND FOR A 10% REAL PRICE INCREASE
Winter season	-.00 to -.10	0.0% to 1.0%
Summer season	-.10 to -.20	1.0% to 2.0%
Multiple Family Residential Customers		
Winter season	-.00 to -.05	0.0% to .5%
Summer season	-.05 to -.10	0.5% to 1.0%
Irrigation Only Customers	-.20 to -.30	2.0% to 3.0%
Commercial/Industrial	-.15 to -.25	1.5% to 2.5%

Source: Chesnutt and Mitchell

Most empirical studies have found the long-term residential price elasticity to range between 0.2 and 0.6. Griffin (2006) concluded that price elasticity for annual residential water use is likely to lie in the range of 0.35 to 0.45, meaning that a 10% rate increase may produce a 3.5% to 4.5% reduction in demand over time.[41]

Indoor residential water demand is more inelastic than outdoor residential demand. On a percentage basis, residential water users have displayed a willingness to reduce outdoor consumption more readily than indoor consumption. The corollary of this finding is that summer demand tends to be more elastic than winter demand, because most outdoor use occurs during the summer. One study that estimated residential price elasticities separately found that outdoor water use has a higher magnitude of price response. Households having no outdoor irrigated area had a price elasticity of about 4.6%.[42] **Figure 9** shows how single-family residential price response varied as a function of irrigated area.

41 Griffin, Ronald C. (2006). *Water Resource Economics: The Analysis of Scarcity, Policies, and Projects.* The MIT Press, Cambridge, MA.

42 Chesnutt, T.W., C.N. McSpadden, and A. Bamezai, *Ultra Low Flush Toilet Programs: Evaluation of Program Outcomes and Water Savings,* A report for the Metropolitan Water District of Southern California, July 1995. The time-series cross-sectional panel data of 2944 single family households in Los Angeles and Santa Monica controlled for household meter-specific variability, season of the year, a seasonally-varying response to weather variations, and participation in ongoing ULF toilet, LF showerhead, and meter replacement programs.

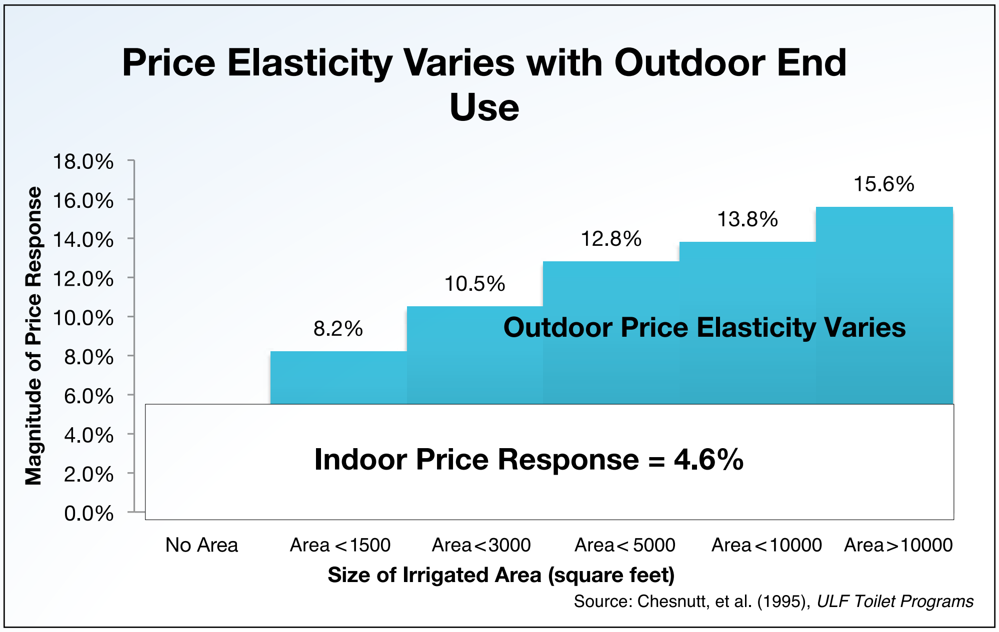


Figure 9 — Residential Price Elasticity Varies with Outdoor Water Use[43]

Additionally, residential customer demand for water is more responsive to price over the long-term than over the short-term. Another way of stating this is that it takes time for price changes to fully influence the demand for water. Right after a price increase, consumers are mostly locked into their water using appliances and landscaping. While they can modify their water using behavior in response to the price increase or change in rate structure, they may not be able to adjust their stock of water-using equipment (appliances, plumbing fixtures, etc.), at least not right away. Over time, as this stock of capital wears out and is replaced, improvements in the efficiency of the capital can be realized. Thus, long-run demand tends to be less inelastic than short-run demand. These are broad generalizations, however. Demand responses are often specific to the time and circumstances in which the price adjustment occurs, and therefore can significantly vary by region and time period.

Technical guidance to construct models of system demand and revenue for specific block rate structures can be found in Appendix B.

The propensity of a rate structure to generate revenues that exactly match the revenue requirements of a water utility is subject to a variety of risks involving both supply and demand. These risks can produce revenue instability in the form of both revenue surpluses and revenue shortfalls, and they are associated with changes in the number of customers, changes in customer mix, changes in usage patterns, changes in weather, changes in conservation ethic, changes in the price elasticity of water demands, and changes in rate structure.[44] An important additional source of risk comes from supply or drought-driven curtailments. Finally, another important driver of short-term revenue uncertainty is climatic uncertainty.

43 Chesnutt, T.W., C.N. McSpadden, and A. Bamezai, *Ultra Low Flush Toilet Programs: Evaluation of Program Outcomes and Water Savings,* A report for the Metropolitan Water District of Southern California, July 1995. P.A-18

44 Beecher, J.A. and P.C. Mann (1991), *Cost Allocation and Rate Design for Water Utilities*, Denver, Colorado: The American Water Works Association Research Foundation, March.

These sources of risk need to be assessed in the process of determining revenue requirements and mechanisms such as contingency funds and automatic rate adjustments put in place for coping with the unanticipated revenue changes.[45]

In an ideal world, rate analysts would calculate revenue risks for each rate alternative. The AWE *Sales Forecasting and Rate Model* provides modules to help water managers predict future block sales (volume and revenue) by using empirical price elasticities and conducting a risk theoretic simulation of revenue risks and fiscal sustainability over a five-year time horizon. This kind of information can help water managers make more informed decisions about the tradeoffs involved in developing an efficiency-oriented rate structure.

Customer Bill Impacts

Some attempts at rate innovation have been undermined by an insufficient understanding of who bears the brunt of rate changes. Large changes in rate structure can greatly change exactly who pays what, so an analysis should (1) calculate the change in customer bills that would result from a change in rates, (2) identify subgroups that have relatively larger bill impacts, (3) inform the ratemaking process about those impacts, and (4) investigate measures to mitigate adverse impacts on specific customer groups. Good rate evaluation will help utilities avoid unintentional rate shock.[46]

Figure 10 shows a comparison of the relative bill impacts related to moving from a uniform rate structure to an increasing block rate structure for single-family customers, referring to rate scenarios found in the AWE *Sales Forecasting and Rate Model*. A Board of Directors may want to see additional analyses of bill impacts. Examples of relevant bill impact categories include:

- the annual change in bill impact per customer;
- the average change in summer bills;
- the average change in bills among customers with different seasonal water use patterns;
- the change in bills among small, medium, and large customers in each customer class;
- the average impact by voting district; and
- the change in bills among customer groups that have been vocal in previous rate setting processes.

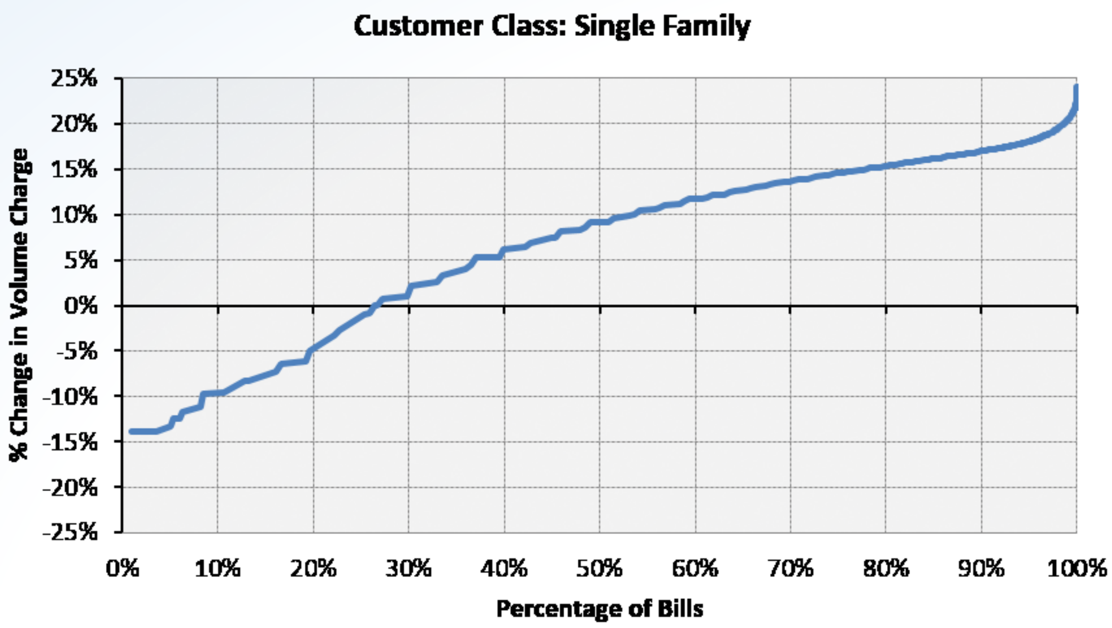
Conducting a careful and thorough analysis of the impact of the rate structure on the customers' bills will help prevent surprises and secure successful acceptance.

45 Chesnutt, Thomas W., Casey McSpadden, and John Christianson. (1996) *"Revenue instability induced by conservation rates."* Journal of the American Water Works Association 88, No. 1 (1996): 52-63.

46 AWWA Water Utility Council, 2004. *Avoiding Rate Shock: Making the Case for Water Rates.* American Water Works Association

Bill Impacts of Proposed Rates Relative to Current Rates

The chart below shows the cumulative distribution of bill impacts by Customer Class under the Proposed service charges and volumetric rates. The x-axis shows the percentage of bills while the y-axis shows the percentage change in the volume charge.



Source: AWE Sales Forecasting and Rate Model

Figure 10 — Customer Bill Impact Relative to a Uniform Rate

PLANNING FOR UNCERTAINTY (PROBABILITY MANAGEMENT/SCENARIO MODELING)

Probability Management—A SIP and SLURP of Water

The fundamental equation used to determine the average required water rate in traditional methods is as follows:

$$Required\ Rate = \frac{Total\ Revenue\ Requirement - Fixed\ Revenue}{Sales\ Volume}$$

$$= \frac{Rate\ Revenue\ Requirement}{Sales\ Volume}$$

Note that all numbers that appear above are treated as certain. Yet it is easy to see how future values of none of these are not known with certainty. Thus the traditional approach is subject to the "Flaw of Averages."

Flaw of Averages

Fact 1 — Planning for the future is rife with uncertainties.

Fact 2 — Most people are not happy with Fact 1 and prefer to think of the future in terms of average outcomes.

Fact 3 — The "flaw of averages" states that plans based on average assumptions are, on average, wrong. The book by Sam Savage, *The Flaw of Averages*, documents numerous ways that this can occur.

The methods of Probability Management were originated to address the "Flaw of Averages" and are embedded in the *AWE Sales Forecasting and Rate Model*.

Traditional water industry rate models assume that future sales are certain, known with certainty, and do not respond to price, weather, the economy, or supply shortages—that is to say, not the world we live in.

The AWE Sales Forecasting and Rate Model addresses this shortcoming through several features:

- Customer Consumption Variability - weather SLURP and drought/shortage conditions
- Demand Response - Predicting future block sales (volume and revenue) with empirical price elasticities
- Drought Pricing - Contingency planning for net revenue neutrality
- Probability Management - probabilistic simulation of revenue risks
- Fiscal Sustainability - Sales forecasting over a 5 Year Time Horizon

PROBABILITY MANAGEMENT AND UNCERTAINTY

ProbabilityManagement.org is a non-profit that promotes the communication and calculation of uncertainties through education, best practices, and the open SIPmath™ standard, which represents probability distributions as auditable data.

Uncertainties can be calculated by storing potential outcomes in data arrays called SIPs (Stochastic Information Packets). For example, the SIP of a die would consist of a column of integers randomly chosen between 1 and 6. Calculations using SIPs are referred to as SIPmath™. SIPmath™ can be performed in almost any computer environment, including a commonly used spreadsheet format with the native data table function. A collection of SIPS is encapsulated in a Stochastic Library. A Stochastic Library that preserves coherence is referred to as a Stochastic Library Unit with Relationships Preserved (SLURP). Examples of these concepts applied to water can be found on the ProbabilityManagement.org website.

Feasibility of Implementation

In addition to evaluating the effectiveness of a rate structure in achieving diverse objectives, a water manager should also evaluate feasibility. The feasibility of a rate structure depends on several factors:

- Consistency with cost-of-service principles
- Administrative cost
- Institutional legitimacy and legality
- Public acceptance

Consistency with Cost-of-Service Principles: A prime consideration for utility managers, this factor raises the issue of institutional legitimacy: will the rate structure receive external approval from oversight bodies?

Administrative Cost: Is the cost of implementing a new rate structure administratively prohibitive? Will it entail major changes in billing or metering practices? Seasonal rates, for example, generally require monthly or bimonthly billing so customers receive a price signal in time to change their consumption behavior within a given seasonal period. The initial cost of converting to a more frequent billing cycle can be high. In some states, in fact, regulators have disallowed expenses related to metering and billing changes because the regulators believed that the benefits would not exceed the costs of the conversion. Additionally, changing the rate structure may require utilities to step up efforts to educate customers and resolve complaints.

Institutional Legitimacy and Legality: Is the new rate structure acceptable to federal, state, and local governments? Might it violate legislative, regulatory, or judicial standards? To complicate this matter, laws and regulations may be different for publicly-owned utilities than for investor-owned utilities, particularly when the former are not under the jurisdiction of a state utility commission. Existing legislation can also influence rate structures. In Massachusetts, for example, publicly-owned utilities cannot use a decreasing-block rate. In Florida, water rates outside a city cannot exceed a 50% differential over rates inside the city. Public utility laws in general call for minimizing price discrimination and avoiding undue discrimination.[47]

It may be wise to work with governing bodies to show that rate setting might serve a larger public purpose and help them enact laws and policies that encourage new approaches to ratemaking.

Public Acceptance: Is the rate structure simple and understandable enough for customers to accept and use to make efficient consumptive choices? Is the rate structure "fair"? Of course, reaching consensus about the concept of "fairness" can be a challenge. For example, higher rates for large-volume users can be controversial if some perceive them as discouraging local and regional economic development.

Public acceptance depends in part on affordability, and regardless of efficient pricing, the cost of water is rising. Affordability and efficiency goals may appear to be at odds: higher prices may encourage efficiency, but some customers may then find water service too expensive. Lifeline rates — charging a lower price for the first block of water consumption — ensure that every customer has affordable access to the minimal usage required for public health and sanitary needs. In addition, water utilities can tailor efficiency programs, such as plumbing retrofits and customer outreach, to the needs of the low-income population.

Another fundamental fairness concern is equity. Might there be concerns about one group subsidizing another and paying more or less of one's "fair share" of costs? In short, today's customers should not be served at the expense of future customers, either in terms of utility costs or resource availability. Economists tend to view efficient solutions as "equitable" when subsidies are minimized. Others, of course, might define equity in quite different terms, such as affordability.

Decide on a Rate Structure

Multiple legitimate perspectives turn water ratemaking into an ongoing balancing act. Rates perceived to be affordable by the customer might not generate enough revenue for the utility. Rates perceived to be equitable might not be efficient. Rates that serve societal needs might require unrealistic changes in a utility's administrative practices. Rate modifications aimed at minimizing revenue volatility might distort the price signals communicated by the rate structure. A lifeline rate motivated by affordability concerns might send a poor signal about the worth of water to users within the lifeline block. Rate structures that try to address multiple equity concerns can become overly complex and difficult to understand. Responsible ratemaking involves inevitable tradeoffs among potentially conflicting objectives.

47 Bonbright, J.C., A.L. Danielson, D.R. Kamershen (1988) *Principles of Public Utility Rates.* Public Utilities Report Arlington VA.