F I E L D R E P O R T

PRINCIPLES OF TARIFF DESIGN FOR WATER AND WASTEWATER SERVICES

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WATER AND SANITATION for HEALTH PROJECT

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by

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ABOUT THE AUTHOR

David Laredo has over 30 years of experience covering a wide variety of projects related to sanitary engineering and utility management. These include studies for agencies at all levels of government (domestic and overseas) concerning engineering for numerous water and wastewater projects, institutional development and strategic planning. His overseas experience covers projects in Egypt, Guatemala, Jamaica, Morocco, Yemen, Lebanon, Sri Lanka, Thailand, Seychelles, Turkey, and Pakistan.

Related WASH Documents

Guidelines for Conducting Willingness-to-Pay Studies for Improved Water Services in Developing Countries, WASH Field Report No. 306, October 1988

Guidelines for Institutional Assessment of Water and Wastewater Institutions, WASH Technical Report No. 37, February 1988

Guidelines for Maintenance Management in Water and Sanitation Utilities in Developing Countries, WASH Technical Report No. 63, June 1989

Water Vending and Development: Lessons from Two Countries, WASH Technical Report No. 45, May 1988

Willingness-to-Pay for Water in Rural Areas: Methodological Approaches and an Application in Haiti, WASH Field Report No. 213, September 1987

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WASH FINANCIAL MANAGEMENT SERIES

The Water and Sanitation for Health (WASH) Project is developing a series of publications dealing with financial management and cost recovery issues. Currently there are four reports in this series. Titles of these publications are as follows:

Report 1	Guidelines for Conducting a Financial Management Assessment of Water Authorities
Report 2	Guidelines for Cost Management in Water and Sanitation Institutions
Report 3	Principles of Tariff Design for Water and Wastewater Services
Report 4	Guidelines for Financial Planning of Water Supply and Sanitation Institutions (Planned)

The four reports provide an integrated package of financial and management assistance. The reports are prepared for audiences at varying skill levels within the financial discipline, both at the operational level and at the administrative level. The approach of the reports is directive. They can be used individually or together. Report 1 is an assessment and diagnostic tool and would logically be the first report used to appraise the current financial management situation of a water supply institution. Weaknesses in cost management, tariff policy, and financial planning that are revealed in this initial assessment can be addressed by using the other reports in the series.

WASH is also able to provide a wide range of technical assistance publications and guidelines in a number of related disciplines. Specific examples include *Guidelines for Institutional Assessment of Water and Wastewater Institutions* and *Estimating Operations and Maintenance Costs for Water Supply Systems.*

EXECUTIVE SUMMARY

This report, the third in the WASH Financial Management Series for water supply and sanitation agencies, discusses the principles of tariff design. It is intended primarily for:

- A.I.D. and host-country personnel involved in program design and evaluation

- A.I.D. and host-country program administrators

- Technical and financial staff of utilities

Tariffs are used primarily to recover costs and achieve financial stability but also for efficient allocation of scarce sector resources, equitable income distribution, and fiscal viability. Even the most carefully designed tariff cannot accomplish all these objectives without trade-offs among them.

The underlying principle is that the beneficiaries of a public service should pay the costs, but controversy surrounds the question of which costs a tariff should cover. A utility must meet the costs of operations and maintenance, capital, short-term loans, and fund reserves. The magnitude of these costs is determined by the levels of service it provides, and the levels of service in turn are influenced by several institutional and technical factors.

Cost centers, an accounting device for disaggregating costs into discrete units or activities, facilitate the design of tariffs. But establishing realistic tariffs must also take into account the efficiency of operations, unaccounted-for water, the utility's institutional capability, and the accurate prediction of ability and willingness to pay.

Once the costs of providing water and wastewater services have been correctly identified, a suitable method of cost recovery must be selected. This report discusses a wide range of options and examines their advantages and disadvantages. The two most commonly used methods are metering and lump-sum payments. But in the final analysis, a utility should choose the method or combination of methods it believes will work best.

Chapter 1

TARIFF CONCEPTS

1.1 Tariff Definition and Objectives

A tariff for water and wastewater services, which is the appropriate price a user of these services is expected to pay, may have several objectives: cost recovery and financial sustainability, efficient allocation of scarce sector resources, income distribution, or fiscal viability (Box 1).

Box 1: Tariff Objectives

1. Financial sustainability and cost recovery
2. Efficient allocation of scarce sector resources
3. Income distribution
4. Fiscal viability

It is unlikely that all these objectives can be met, so even the most carefully designed tariff will require trade-offs.

1.2 The Economic Context

The economist is interested in allocating sector resources efficiently by using the pricing mechanism to reflect supply and demand in the marketplace. In theory, water should be priced at its marginal or incremental cost, that is, the cost of producing the last unit sold. The purpose of relying on a pricing policy that is based on the marginal cost (MC) approach is that it results in an optimum use of existing capacity. Strictly interpreted, the marginal cost approach requires that the price paid for water should be used to ration existing capacity only when that capacity is fully utilized. At this point, when capacity is fully utilized, additional investment is justified. Once the new capital investment has been carried out the price will fall, as the only necessary costs to recover will be running costs. "Efficiency pricing" in this way achieves two goals: (1) efficient use of resources when operating at less than full capacity and (2) providing the signal to invest in additional capacity.

In water supply and wastewater facilities, strict marginal cost pricing is problematic because of the large capital indivisibility, or "lumpiness," associated with large block investments such as treatment plants, reservoirs, and trunk mains. The relatively high start-up costs, characteristic of urban areas, are contrasted with relatively low operation and maintenance costs. Significant fluctuations would occur in water prices or tariffs based on purely marginal cost calculations.

Another characteristic of capital indivisibility is that it results in excess capacity at periodic points. New capacity is added in lumps or blocks of investment which typically are designed to meet future demand over a number of years. After high initial costs, the added cost to provide for additional consumers is negligible. However, recovering the full cost of the investment from existing consumers is not equitable because they are being asked to pay for capacity of which they can only use a small proportion and which is added in anticipation of future demand. A classic adaptation of the marginal cost approach to allow for uneven cost characteristics in the water sector is to set price equal to an estimate of incremental operation and capacity cost averaged over time using discounted cash flows. This is referred to as the average incremental cost approach.

In practice, however, there are problems in applying marginal cost concepts to the design of tariffs. These problems include lack of information on current consumption, future investments, and operational costs, and difficulties in forecasting demand. Some argue that only when metering is used can the pricing mechanism send effective market signals. Tariffs based on average historical costs, for example, can send misleading messages to consumers and result in water being priced too cheaply. The main goal remains the most efficient use of water through the pricing mechanism. Some utilities in developing countries are making use of marginal cost analysis. A recent World Bank document provides data on 35 water supply projects that are using an approach based on marginal cost principles. Their tariffs would represent 80 percent of MC once the projects become operational.

1.3 Financial Viability and Equity

A criticism of "efficiency pricing" techniques is that they could conflict with the attainment of a financially viable operation and with a concern for equity issues.[1] MC-based pricing necessitates an assessment of the future, whereas financial analysis based on accounting techniques is oriented more to the near term. Overall however, because MCs are typically above average costs in water supply, financial objectives would normally be met as well.

Both equity and financial objectives are important in the water supply and sewerage sector. When average costs are falling (and therefore marginal cost is less than average cost), marginal cost pricing would mean financial loss for the agency. This situation is common but almost always temporary and is the result of excess capacity in the system. In practice, two-part tariffs are often used, one based on marginal cost and the other on financial costs.

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[1] J.J. Boland, "Marginal Cost Pricing: Is Water Different?" *The Role of Social and Behavioral Sciences in Water Resource Planning and Management*. Baumann and Haimes (eds.). pp. 126-37. New York: American Society of Civil Engineers, 1988.

Tariffs are often designed to achieve cross-subsidies among users. For instance, industrial consumers, who are perceived as able to pay more, are sometimes charged higher prices than residential consumers, whose rates do not reflect the economies of scale of treatment plants and the diseconomies associated with distribution networks. As another example, "lifeline" tariffs without regard to cost may attempt to provide water at a life-sustaining level for the indigent. Although water consumption tends to be correlated with income, very poor consumers may not even be able to afford individual connections that deliver the benefit of below-cost "lifeline" rates. They may share a single connection, which because of the increased volume nullifies the direct subsidy. A more effective approach may be to use unit rates that increase with the total quantity consumed until the marginal cost of production is reached.

A key difference between the financial and economic objectives of public sector pricing is that the former are concerned with the revenues needed to ensure viability while the latter are concerned with relaying the appropriate price signals to consumers. Tariffs, of course, must be high enough to cover total financial costs over time. Given the imperfect markets in many developing countries, costs calculated only in financial terms are often below economic levels. Revenues are returned in local currency, but investments and operating costs may require a mix of foreign and local funds. Using MC as a proxy for tariffs will be a start. However, meeting the financial objectives of water supply and wastewater institutions, which are concerned with equity and the availability of resources, may require tactical trade-offs with the economic goals of optimal resource usage and efficiency pricing.

A well-designed tariff structure is a major part of ensuring an efficient utility. The structure must meet a number of financial criteria, including an adequate rate of return on assets, sound operating ratios, and sufficient internal cash generation. Studies have shown, however, that even properly designed tariffs are not enough to ensure cost recovery and sustainability if metering, billing, and collection systems, which support tariff revenues, are deficient. In addition, the tariff structure may not be able to respond quickly to increases in nonrevenue water in the short term because of legal and administrative processes. Higher tariffs, should they occur, may decrease consumption, discourage new consumers, and result in lower sales volume. Although tariffs alone cannot remedy all financial deficiencies and ensure complete viability of a water or wastewater system, they do go a long way to achieving financial sustainability.

Chapter 2

OPERATIONAL ISSUES

This chapter reviews the operational issues involved in establishing or extending tariffs for cost recovery and discusses their applicability to different types of utilities and programs.

2.1 Costs Included in the Tariff

The principle underlying the imposition of direct charges for publicly provided services is that the cost of these services should be recovered from the beneficiaries. Tariffs have become the established mechanism for this recovery.

The costs to be included in tariffs for water and wastewater services are widely debated. Some combination of these costs, which are discussed in this section, is applicable to most utilities. If the total cost of providing service is recovered, the utility can function as a completely self-sustained unit.

2.1.1 Operations and Maintenance Costs

A minimum expected of most tariff systems is the full recovery of O&M costs, which can be classified into the following categories:

- Payroll
- Power
- Fuels, lubricants, and chemicals
- Materials, supplies, and equipment
- Miscellaneous

Payroll

Payroll costs cover salaries, bonuses, and all allowances paid directly to employees for work performed, and the costs of employee benefits such as paid vacation and sick leave, holidays, pensions, and medical, life, and other social insurance.

Power

This category includes the cost of operating pumps and other electrically driven equipment (e.g., air conditioning and office machines) and of lighting. Power costs are related to the level of service provided and only a very small portion of these costs can be considered fixed.

Fuels, Lubricants, and Chemicals

Costs in this category are related to the O&M of vehicles and mechanical equipment, and to treatment processes.

Materials, Supplies, and Equipment

These costs are for items consumed in a given budget year. Equipment costs may include a component for assets that are used for more than one year but whose useful life is relatively short (see Section 2.1.2—Capital Costs).

Miscellaneous

This category serves as a catchall to ensure that O&M costs not included in one of the categories above are part of the total to be recovered through the tariff. Miscellaneous costs can include the following:

- Property/liability insurance
- Regulatory expenses
- Rent/lease payments on properties not easily classified by function
- Bad-debt allowances
- Contributions to working-capital reserve fund
- Contributions to emergency reserve fund

If the utility's accounting practices provide for such allowances and its budget is large, the amount of the last four costs listed can be very high. In general, a bad-debt allowance is the amount charged per year to system users for noncollected revenues of past years or an amount expected during the current year. Contributions to working capital and short-term interest are charges to system users to cover funds spent in a given year to make up for cash-flow shortages. Contributions to emergency reserves are charges to users to cover funds spent on unexpected repairs or to alleviate short-term cash shortages that are difficult to predict.

Most tariff systems ordinarily are designed to recover total O&M costs. **The most important consideration is to ensure that all these costs are identified.** The categories described above have been found convenient, but any comprehensive and logical classification will suffice The system selected should be one that best suits the individual utility or program.

2.1.2 Capital Costs

The cost of long-term investments in capital assets must be included in financial planning and cost-recovery applications. Capital assets are such items as pumps, pumping stations, and sewage treatment works that have a useful life of several years. Nonphysical assets such as land and water rights, whose useful life has no limit, also represent investments. Accounting conventions use two methods to estimate capital-financing requirements: the cash-flow (cash-based) approach and the assets-valuation (cost-based) approach.

In the cash-flow approach, capital receipts and expenditures are shown as they are received or incurred, followed by outflows in accordance with loan amortization (principal and interest) schedules. Capital costs therefore are sensitive to interest rates, grace periods, and other terms.

In the assets-valuation approach, capital costs are estimated by using depreciation techniques and establishing a required rate of return on assets. Depreciation is the value of fixed assets consumed during the accounting period. It is usually calculated on the basis of historic accounts on a straight-line basis. For example, if an asset is expected to last 40 years, one-fortieth of its cost is attributed to each year for 40 years. Another way of calculating depreciation is by applying a fixed percentage to a reducing balance. The cost of the return on assets is that percentage of the value of depreciated fixed assets (total capitalization representing the cost of capital) equal to the amount required to cover capital costs. The rate of return on assets expected by public authorities can be viewed as a performance regulator. The higher the rate, the higher the cost requirement. Surpluses created by a high rate of return may or may not be sufficient to fund future assets. This will depend on the existing capital structure and cash flow.

Both approaches may involve policy decisions outside the authority of the public utility. The rate of return on capital assets may be based on comparisons with other public utilities in the country or elsewhere. Loans are often negotiated by a national government through bilateral and multilateral agreements, and the details of interest rates and repayment schedules are then passed on to the public utility concerned.

The choice of method used to calculate capital costs will depend on the sophistication of the organization's accounting system. Correct and comprehensive asset valuation will be difficult if its records are not up to date or do not reflect the true depreciated value of capital assets.

Another point to be considered in setting tariffs is that capital assets with a short life (say automobiles) should be covered by a policy that defines them as either a capital or an O&M expenditure.

Box 2: Costs Included in a Tariff

Operations and Maintenance Costs

Payroll
Power
Fuels, lubricants, and chemicals
Materials, supplies, and equipment
Other
- Operating interest (short term)
- Fund reserves

Capital Costs (annualized)

Physical assets—buildings, treatment plants, vehicles, etc.
Nonphysical assets—land, water rights

2.1.3 Operating Interest Expenses

Operating interest is the cost of short-term borrowing to cover deficit cash flows, which result either from a deficiency in the utility's commercial operations (e.g., billing and collections) or from a failure to set the correct limits for operating funds or to administer these funds efficiently. Operating interest is a legitimate cost for recovery through the tariff. However, if it is historically high or increasing, it may be more prudent to establish special funds (see below) than to continue borrowing.

Borrowing to finance all or large portions of O&M costs is a bad practice, however, and should be avoided. Some utilities post all interest expenses as a single line item, with no differentiation between interest for operations and interest on capital expenditures. If interest is to be recovered by the tariff, care should be taken to classify the type of interest correctly.

2.1.4 Fund Reserves

Many tariff structures allow for revenues to be deposited in special funds. Two examples are funds for O&M expenses (working-capital funds to cover lags in cash flow) and for emergency or contingency reserves (to cover emergency repairs or other unpredictable expenditures, e.g., an increase in the cost of electricity).

Other funds are reserves usually stipulated in the terms covering borrowed funds for long-term debt. One such fund is a debt reserve fund, which is set equal to the amortized annual payment required to retire the debt. It may be established as part of the initial amount borrowed or built up over a few years from revenue. However the debt reserve is set up, its proceeds should be used only for debt retirement. Thus, if the utility is unable to cover its debt payments, the fund may be used and then built up again. If the fund is intact throughout most of the debt period, it can be used to retire the debt ahead of schedule.

Another fund is one used to pay off capital investments routinely made but hard to predict. Extensions to water mains or sewer systems and modifications or improvements to structures are examples of projects covered by such funds.

The level of reserve funds may be determined by historical records and the budget planning process. It is important to limit such funds to projects that can be completed (or the investment expended) within a single budget year.

2.1.5 Metering and Connection Costs

House connections and the purchase and installation of meters can result in considerable capital expenditures for utilities. In general, individual connection costs are considered to be the responsibility of the homeowner. Metering and other connection costs can be borne by either the homeowner or the utility, which can then recover them through the tariff. By bearing these costs, the utility can exert greater control through the installation of standardized facilities that lower the initial cost to consumers and thereby attract more customers. The converse is that these costs may be high and thus unduly burden the utility.

2.1.6 Return on Investment

Cost-recovery systems have been designed to include a higher return on investment (ROI) than is necessary for capital-cost requirements so as to create a surplus (see Section 2.1.2), which utilities often use as a contingency against unexpected costs. If a surplus is produced, it can be used to stabilize tariffs in future years, to finance needed capital expenditures, or for debt retirement.

Ideally, the ROI should recover only the opportunity cost of capital. An effective argument could be made for recovering costs without any surplus; most utilities do provide services on a no-surplus basis. The purpose of considering ROI in setting tariffs is to compare the return with that of like investments in other sectors.

2.2 User Classes

User classes are the categories in which utilities classify their customers. These categories are determined by administrative requirements (e.g., variations in billing, fees, and meter sizes) and the necessity to monitor and regulate the service. Each utility decides on the number and designation of user classes it needs, but almost every utility will have the following categories:

- Residential
- Commercial
- Industrial
- Institutional
- Government
- Wholesale

Box 3 indicates various combinations of user classes within the broad categories identified above.

Box 3: Various User Classes

- Broad Designation of User or Customer Class

  Residential, commercial, industrial, institutional, government, wholesale

- Secondary Designation within Class

  Single or multiple family
  Served via direct connection, inside dwelling or facility
  Directly served via dedicated connection outside of dwelling or facility (e.g., yard tap)
  Indirectly served via standpipe or roadside tank
  Directly or indirectly served via tanker truck or special vendor
  Low-level users (i.e., minimum service)
  Users with private, individual supplies

- Tertiary Designation within Class

  Metered or fixed-charge accounts
  Fire service accounts
  Privately maintained accounts

User-class designations will depend on the complexity of the service provided and on any special administrative or legal requirements. For example, a single customer class would suffice for a system serving customers with the same use pattern. By contrast, several designations of users would be required for systems with a diverse customer base in which there are significant variations in water use or in which services are provided to other utilities and industries.

The variation in designations can be readily seen from Box 3. The secondary and tertiary designations indicate the possible subdivisions in user classes based on level of service (see Section 2.3) and administrative legal requirements. Residential users, the largest number of accounts in almost any system, can be subdivided into one or more secondary or tertiary designations such as metered and fixed-charge accounts. A more complex group of user classes would result from dividing the broad user designations into one or more of the secondary designations and further indicating which of these could be described as metered, fixed-charge, or "free account" customers.

Commercial and industrial enterprises are usually the largest users of service and are separately designated as a user class. Utilities with formal tariff systems often use meter size to define these accounts; if a metering system is not used, a special account code is usually assigned.

Institutional accounts (schools, hospitals, houses of worship, and facilities owned by charitable organizations) and government accounts (government facilities and public buildings) often show the same use patterns as residential, commercial, or industrial accounts. They are given a separate designation because of the manner in which they are charged for service or the need to monitor and regulate service. The same is true of the user class designated as wholesale customers, who are generally large users covered by a special contractual agreement with the utility. Generally they are other utilities that are provided with bulk services, but it is not unusual for utilities to have a few extremely large users classified as wholesale users.

The designation of user classes depends on the size and mix of the customer base, the complexity of service provided, the variations in demand, legal requirements or special arrangements, and the method of cost recovery used.

2.3 Level of Service

For water supply, level of service defines the quantity, quality, and pressure levels provided. For wastewater, it defines the adequacy of disposal and treatment. Thus, levels of service can be uniform or can vary with the customer class or the topographical characteristics of the service area. For instance, a utility providing a minimum level of water supply service could provide water for a few hours per day at a single location or at a few locations (say standpipes) throughout the service area. Full service could be viewed as water supply throughout the service area, for 24 hours a day, at adequate pressure, and through a mix of house connections, yard taps and standpipes, and special vending arrangements.

Level of service is a basic consideration for service providers because it is the most significant parameter in determining capital investments and O&M costs. Defining the level of service to existing and new or extended systems requires the consideration of many technical and institutional issues, discussed below.

Institutional Considerations:

- National/regional development objectives
- Financing
- Capability of entity providing service
- Water supply and sanitation demands and expectations of the service population (demand forecasts)
- Willingness to pay for the service by the served population

Technical Considerations:

- Appropriate levels of technology
- Topography of service area
- Capacity of the source of supply
- Quality standards of the service provider (either legislated or adopted as common practice)
- Quantity and quality of water to be supplied and wastewater to be disposed of
- Pressure levels to be maintained (water supply only)
- Method of collection and final disposition of effluent (wastewater only)
- Hours of continuous service

2.4 Cost Centers

2.4.1 General

Cost centers provide tariff analysts with a convenient mechanism to determine the components of a utility's total cost of service. For purposes of tariff determination, the cost-of-service analyses for most water and wastewater utilities can be accomplished by disaggregating costs to the level of discrete units or activities and then combining each unit's costs to produce a logical set of cost centers. Use of cost centers facilitates the design of tariffs to cover all or part of the cost of providing service. The key to relating cost-center analysis to tariff design is to select groups of activities and facilities for which costs can be readily determined and which illustrate the cost of providing discrete components of service. These groups can be combined into cost centers and then allocated to user classes.

A detailed explanation of how to establish cost centers and allocate costs is presented in the WASH report, *Guidelines for Cost Management in Water and Sanitation Institutions*, Report Number 2 in the Financial Management Series. Box 4, which shows a sample intersection of organizational structure and cost center structure, is adapted from that report.

In analyzing water supply and sanitation systems, many alternative cost centers can be envisaged. Perhaps the easiest is one made up of discrete subsystems, the costs of which can be determined individually. A more complex system would be a large urban or regional system in which the activities required to provide service often overlap. In this type of system, determining the cost of various activities is obviously more difficult.

Ordinarily, the database for determining the cost of each cost center is documentation that supports the financial accounting and budgeting systems, combined with the engineering and operating data logged as part of the utility's operations. If the analysis recognizes that within a given system or subsystem some user classes benefit more than others, costs can be allocated accordingly.

The choice of cost-center structure and the methods used to determine costs depend on the nature of the service provided. A small system with few user classes may be a cost center in itself. Larger systems may require more than one cost center, depending on the nature of the service. Consider, for instance, a water system that has several discrete distribution systems served from a common source, conveyance pipeline, and treatment plant. Costs related to the distribution systems could probably be directly determined and thus directly allocated to each discrete system. The costs related to source development, transmission, and treatment, however, require an indirect method of allocation. In this case, the average or maximum daily water supply delivered to each distribution system could be used. The overall administrative and engineering costs required to sustain the system would also require indirect allocation to each system.

Box 4: Sample Intersection of Organizational Structure and Cost Center Structure

	Departments						
	General Manager	Chief Engineer		Maintenance	Finance	Personnel	Customer Relations
Functions		Plant Mgmt	Construction				
General Admin.	√				√	√	√
Supply			√	√			
Water Treatment Raw Water		√	√	√			
Wastewater		√		√			
Water Distribution Installations			√	√			
Repairs			√	√			
Waste Collection Installations			√	√			
Repairs			√	√			
Billings	√						√

The analysis described above applies in situations in which costs are recovered totally or partially from the users benefiting from the service. However, the application need not be limited to cost-recovery situations; it has definite advantages in any program providing service. These advantages include:

- Identifying costs for use in program design, including system upgrading or extensions
- Monitoring comparative costs among systems to identify possible inefficiencies
- Identifying the cost of components of sectoral programs or overall sector costs, as well as the level of subsidy required (if such a policy is established) for each component or the sector as a whole

2.4.2 Cost Center Allocations for Centrally Provided Service to Large Urban or Multi-service-area Jurisdictions

The concepts presented above are easily applied to a utility responsible for a single service area with a uniform group of customers. Detailed cost allocations are unnecessary and a single cost center can be established. However, if the service area has several customer classes receiving varying levels of service, costs may have to be allocated to components of the service. The question is: Do service levels vary enough to justify varying charges for customer classes? If they do not, cost recovery can be based on the total cost allocated to the service area.

Many utilities serving large urban areas impose a single tariff even though service levels vary, perhaps because of the difficulty of accurately allocating costs among customer classes. There are also many cases in which service is provided at equal levels but tariffs for large residential users and commercial and industrial users differ from those for smaller domestic users. Higher rates are justified on the basis of income distribution, equity, and high demand elasticity, especially if the water is a very small component of the total cost of production. Lower rates, on the other hand, are justified because they result in economies of scale, reducing distribution and billing costs for a single large consumer.

Difficulties tend to arise when one jurisdiction is responsible for several service areas, providing different levels of service at varying costs. If the jurisdiction is governed by a policy that requires tariffs to be based on actual costs of service, some cost allocations may become complicated. These are costs for:

- Office of the director
- Financial and accounting activities

- Billing and collection
- Human resources (including recruitment and training)

They are classified as administrative costs and can be further classified as O&M and capital costs, as explained earlier. For the most part they are O&M costs, except for those related to engineering work and the work involved in acquiring the financing for capital projects, and must be separated by cost center or service area. However, the detailed records to do this are often not readily available. Indirect administrative expenses—for example, administrative support provided by other agencies—are even more difficult to allocate.

In these circumstances, information is usually gathered from interviews with employees; estimates of employee time and other costs by supervisors; work-order analyses; and analyses of the number of employees serviced, records handled, and bills prepared. Subsequently, data can be collected to make these allocations more quickly and accurately, but this would probably require investments in new practices and procedures (see Section 2.7).

2.5 Efficiency of the Operation

An important consideration often overlooked in establishing tariff systems is the efficiency of the operation. Customers will react favorably to good service and will be willing to pay for it. Conversely, poor service will evoke universal opposition to new or revised tariffs.

Utilities must be completely honest in evaluating their standing with their service populations, either through sample household surveys or management audits by the staff or outside consultants. If deficiencies are uncovered they should be rectified, if necessary with additional funding as part of any new financial plan or tariff structure.

2.6 Unaccounted-for Water

A measure of efficiency often used is unaccounted-for or nonrevenue water, which is the difference between the volume of water produced or delivered into the network and the volume of water consumed, whether metered or not. This difference can be determined from the volume billed or, for nonmetered systems, from the estimated volume reaching customers.

Unaccounted-for water is primarily the result of leakage or wastage prior to delivery and inaccurate meter readings. It can also be attributed to the inefficient identification of delivery points and to poor billing systems. High levels of unaccounted-for water represent wasted resources and are symptomatic of poor operational performance. A level of 15 percent or less is acceptable and indicates that a utility has this component of its operation well under control. But levels between 30 and 50 percent are not uncommon.

Utilities can track down unaccounted-for water by leak detection surveys, large-meter calibration programs, and field surveys of large users. Identifying the level and causes of loss is important for tariff design and financial planning. Lowering the level will decrease per-unit production costs and postpone the need for investment in capital works to increase capacity. The utility can often enlist the aid of its customers in identifying wastage and leaks by showing that reduction in unaccounted-for water will ultimately benefit them.

2.7 Institutional Capability

Institutional capability may not be equal to the complexity of a new tariff design for several reasons:

- The accounting and financial systems do not produce data that will allow proper cost tracking and allocations or proper revenue recognition.
- The billing and collection systems are not adaptable to the new tariff.
- Staff members do not have the expertise to implement the new system.
- Customers are confused by previous policy and practices and are likely to oppose a revised tariff.

If utilities have been charging for service and recovering costs from the beneficiaries, there might be few problems. The opposition of customers who are used to paying for water and wastewater service can probably be taken in stride. However, utilities without a commercial orientation must carefully consider the imposition of new tariffs that require new systems and procedures and a transformation of customer attitudes, recognizing that a radical change may cause intra-organizational disruption and may require a transition period and possibly extra investments.

A typical situation would be one in which a governing board or legislative body announces a change in tariffs and expects the utility's operations to continue exactly as before. Implementing the new tariff may require investments for revised systems and practices. While this is going on, revenues may actually decrease (accounts receivable will increase) as customers adjust to the new tariff. The utility's cash flow may slow and operations begin to suffer. If these conditions continue, the deterioration of the utility's physical and administrative systems may advance to the point where it is in worse financial condition than before the new tariff was imposed.

As part of any tariff revision, the socioeconomic impact should be considered as important as the financial justification. For example, willingness-to-pay studies should be conducted to define price elasticities (see Section 2.9). Changes in staff levels or to systems and procedures should be carefully considered, and any extra costs should be included in the new tariffs. The impact of a possible short-term drop in cash flow should also be estimated. If possible, the new tariffs should be phased in only after all customers have been informed.

2.8 Stipulations of External Agreements

When planning changes in tariffs, the utility must also consider the requirements mandated by external agreements, which are often similar to those for special fund reserves (Section 2.1.1). Financial needs may lead utilities to accept external loans without fully considering their effect on tariffs and institutional capability. This can lead to ineffective implementation of tariffs, delays in programs, and lower levels of output.

2.9 Willingness/Ability to Pay

A basic theme underlying the design of most tariff programs is that people are willing to pay their fair share for good service. The key to this is consumer expectations and accepted practice. Expectations differ. What is acceptable to customers in one area may not be at all acceptable to customers in another. Past practice often influences customer expectation. For example, if water and sanitation services historically have been provided for little or nothing, planners cannot expect customers readily to accept the idea of paying what these services cost.

Willingness to pay must be carefully evaluated when designing tariffs based on cost recovery. Past practices, the level of service to be provided, household income, and the amount and types of costs to be recovered should all be considered in this evaluation. (See WASH Field Report No. 306, *Guidelines for Conducting Willingness-to-Pay Studies for Improved Water Services in Developing Countries.*)

Chapter 3

STRATEGIES FOR COST RECOVERY

A cost-recovery strategy covers both the systems and practices used to measure the service and those used to assess and collect charges. At one end of the spectrum are the free services provided by many rural systems at a cost borne by the government. At the other are systems that recover all or very large portions of their costs through tariffs.

There are some axiomatic notions about cost recovery and tariff design that are worth reviewing:

- If water and wastewater services traditionally have been provided at little or no charge, the imposition of tariffs will rarely be immediately accepted by the users. Often, educational efforts and improvements in the quality of service are necessary to gain acceptance and ensure timely payment.

- No service is actually free. If it is provided without charge, the service provider must rely on some outside source to supply the funds. For government entities, this involves trade-offs among competing infrastructure sectors, which are necessary to foster national, regional, or local development objectives.

Box 5: Key Cost-Recovery Implementation Strategies

- The bases for imposing charges are easy to explain and the structure and level of tariffs are equitable and easy to understand.

- The collection methods are based on long-standing or accepted practices.

- Prior to implementation the entity imposing and/or collecting the tariffs fully explained the intent and reasons for imposing or changing the tariffs.

- The entity recognized that after implementation, justifiable complaints would arise and established mechanisms to settle such complaints efficiently.

3.1 Selection of Strategies

There are only two types of cost recovery—direct and indirect. Direct cost recovery relies on a quantification of the units of service provided and charges for these accordingly. Indirect cost recovery is based on the concept that all consumers are entitled to the benefits of water and wastewater services regardless of the cost.

Direct cost recovery for water systems can be based on quantity, pressure, elevation, availability, location, and purity. Generally, if levels of service can be defined easily by user class, quantity provides the most convenient measure. For wastewater systems, the considerations are quantity and biological, chemical, or toxic loading levels. Indirect cost recovery for both water and wastewater may rely on government revenues, various forms of taxation, general assessments, privatized service, or even barter. Some common methods of direct and indirect cost recovery are listed in Box 6.

Box 6: Types of Cost-Recovery Methods

		Usually Applied To	
Charge Basis	Method of Measuring Service	Capital Costs	O&M Costs
Actual use	Metering	√	√
Flat rates	Estimates	√	√
Water-using fixtures	Inventory	√	√
Taxes/government funds	Estimates	√	√
Surtax on other utility charges	Proportion	√	√
Privatized service	Estimates	√	√
Assessments	Estimates	√	-
Connection charges	Estimates	√	-

Successful cost-recovery methods have the following characteristics:

- They are appropriate to the size and complexity of the utility and the socioeconomic context in which the service is provided.
- They are capable of being understood by those who bear the costs.
- They are acceptable to governing bodies and are within their institutional capabilities.

- They are smoothly implemented and easily administered (see Box 5).
- They show an equitable relationship between the allocation of costs of service and the various user classes.
- They have a built-in mechanism that will compensate for variations in service provided.

3.2 Methods of Cost Recovery

3.2.1 Metering Based on Actual Use

Meters have many advantages, chief among which are that a device to measure a quantity of service implies impartiality, and that the capital and O&M costs of meters are not large in comparison with other utility costs. Water meters are available in a wide range of prices, are relatively simple to install, and require minimal periodic maintenance. The consumption they record appears on a bill, and customers readily understand the cash register analogy. Other advantages are the ability of the utility to exert control by encouraging water sales through use of declining block rates (charging less per unit of consumption as total consumption increases); fostering conservation by increasing block rates; and regulating peak demands (often on a seasonal basis) through pricing policies. The utility can also impose higher charges on large users.

The principal disadvantage with water meters is that minimal maintenance often gets translated into no maintenance. A utility must have a maintenance unit to install, test, repair, and replace meters; storage facilities for new meters; a records system to track installation, repairs, and testing; and specially equipped vehicles for work in the field. Some utilities avoid maintenance by using disposable meters. These are generally inexpensive, cannot be adjusted or repaired, and are used with the understanding that they will be thrown away when they stop functioning.

In addition to a maintenance staff, a utility must have meter readers and a system for transferring meter readings to the billing center and for notifying the maintenance unit of meters in need of repair or replacement. To be responsive to customer complaints, it must be ready to reread meters and to adjust bills if complaints prove valid. Doubts about the accuracy of meters can quickly lead to customer resistance to the cost-recovery mechanism, and, if they are not speedily resolved, can result in attempts to influence meter readers, intentional damage to meters, and illegal connections.

The metering of sewage for the residential, commercial, or small industrial customer usually has been found unsatisfactory. The solids, grease, and other components of the sewage flow have a tendency to clog meters, causing them to misregister or simply stop. Instead, cost recovery is based on the premise that a percentage of the metered water delivered to customers is returned as wastewater. Engineering studies are often used to determine this percentage for the major customer classifications. For wastewater flows generated by large or specialized industrial users, metering may be appropriate and, in some cases, necessary to measure not only the quantity discharged but also the rate of flow.

Metering is favored by international lending agencies, especially for water supply service to medium-sized and large cities. The use of meters has been stipulated in many international development projects because they are seen as a means to control consumption through the pricing mechanism. Meters make the user participate in the marketplace for water, where costs of supply are made explicit through tariffs.

3.2.2 Flat Rates

Flat rate cost recovery is easily implemented, administered, altered, and explained to consumers and provides predictable cash flows. It is appropriate for utilities with a single customer class (or relatively few customers) and no metering capability. All water is sold at a fixed rate, often adjusted to the size of the connection.

The main disadvantage of flat rates is the lack of concern or accountability for waste. This is less of a problem when the majority of the consumers have fairly uniform and limited needs. Special fees can be incorporated into flat rate systems to accommodate extra use, e.g., watering gardens.

Flat rates are more appropriate for wastewater than for water if water supplies are not metered. In metered systems a flat rate as a percentage of the water bill is often charged for wastewater service.

3.2.3 Water-using Fixtures

Cost recovery based on the number of water-using fixtures (e.g., sinks, showers, hot water heaters) is an accepted practice, especially if there is no metering. It has the advantage of appearing equitable, because it is assumed that the fixtures in one facility will use approximately the same amount of water as the same number of fixtures in another.

The major disadvantage is the time and cost required to make the initial inventory of fixtures and to establish customer charges by relating the fixture count to unit flows. Moreover, once such a system is established, it is difficult to update the database at regular intervals. This causes many utilities to neglect this requirement.

3.2.4 Taxes/Government Funds

The government entity under which the utility operates may have a policy requiring all costs for water supply and wastewater service to be met from general taxes or other sources of revenue.

Special taxes for water supply and wastewater services are not uncommon in many U.S. cities. For decades the United Kingdom has used a property-tax surcharge known as a water rate. The taxing authority is granted to tax districts by the governing bodies involved. There is little documentation of this practice in developing countries, but neither is there evidence that social taxes to provide basic services are prohibited.

Government funding of basic services relieves a utility of the administrative cost of revenue collections, but it deprives it of the leverage on users through pricing mechanisms and of the motivation to run its operations efficiently. A particular disadvantage in developing countries is that government agencies are not noted for paying their bills to one another readily; seldom do they transfer tax revenues. Further, in times of stringent economic conditions, government cutbacks could lead to underfunding for O&M and, in turn, to the deterioration of systems. At such times, utilities in control of their own finances would be better positioned to react to system needs and to plan for possible underfunding.

3.2.5 Surtax on Other Utility Fees

One of the less common cost-recovery methods is to combine billing for water and wastewater services with that of another utility, most often the one providing electrical service. This can be either a direct fee or a surtax on the primary utility bill.

The problem here is that many households receiving water supply and wastewater service may consume little electricity or none at all. In effect, therefore, large consumers of electricity pay their own share plus part of the low-users' share for water supply and wastewater service. This practice represents a tax on higher income households.

It may produce adequate revenue but is difficult to justify on the basis of equity, because many low-income households will receive virtually free water supply and wastewater services. This approach is valid only with the ability-to-pay argument and requires careful consideration.

3.2.6 Privatized Service

Several methods are used for supplying water to customers who do not have direct connections to water distribution systems. They range from rainwater catchments, deep and shallow wells, handpumps, surface diversions, and standpipes, to delivery by tank trucks, and community storage facilities. Supplies are provided at little or no cost to the users. Many utilities soon realize that, as the demand grows with population growth in urban concentrations, it exceeds the limits of their ability to provide a free service. They often find a solution by encouraging distribution through private vendors or franchises. Costs are recovered from licenses for vendors and franchise fees. The franchise fee covers all or part of the cost of providing water; the franchisee is responsible for O&M of the facility, usually a public standpipe. Although vending fees also provide a degree of cost recovery, it is difficult to control the amount of water drawn by vendors.

The utility must ensure that water of acceptable quality is distributed and that there is no profiteering at the expense of the users. It must also recognize that vendor charges for services formerly provided free may evoke adverse reactions.

3.2.7 Connection Charges and Assessments

Two methods to defray capital costs are connection charges and assessments. Connection charges are levied per capacity unit, usually a standard dwelling unit. The charge by a water supply system constructed at a cost of $500,000 and serving 2,000 similar dwelling units would be $250 per dwelling unit. It could be paid in a lump sum or in installments. If consumers are allowed to finance their connections, there will be no saving of up-front capital requirements; these costs are best recovered in the general tariff. A variation would be to charge each dwelling unit a flat fee and finance the balance through a loan. Another variation would be to have each homeowner donate an agreed percentage of the capital cost per unit in labor or materials rather than cash.

Assessments are charges that reflect the value added to property by water supply or wastewater facilities. They are based on the area of the property or on the length of frontage along a roadway. The charges are collected in a lump sum, in installments, or in contributions of labor and materials.

3.3 Conclusion

Experience indicates that the most favored methods of cost recovery are metering and lump-sum charges or a combination of the two. But the best method for any utility is the one most suited to its particular needs. Its financial planners should use the broad guidelines discussed in making a choice, always recognizing that any choice will necessitate new administrative systems and procedures—and the expenditures they entail.

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THE WASH PROJEC

With the launching of the United Nations International Drinking Water Supply and Sanitation Decade in 1979, the United States Agency for International Development (A.I.D.) decided to augment and streamline its technical assistance capability in water and sanitation an in 1980, funded the Water and Sanitation for Health Project (WASH). The funding mechanism was a multi-year, multi-million doll contract, secured through competitive bidding. The first WASH contract was awarded to a consortium of organizations headed by Camp Dresser & McKee International Inc. (CDM), an international consulting firm specializing in environmental engineering services. Through two other bid proceedings since then, CDM has continued as the prime contracto

Working under the close direction of A.I.D.'s Bureau for Science and Technology, Office of Health, the WASH Project provides technical assistance to A.I.D. missions or bureaus, other U.S. agencies (such as the Peace Corps), host governments, and non-government organizations to provide a wide range of technical assistance that includes the design, implementation, and evaluation of water and san tation projects, to troubleshoot on-going projects, and to assist in disaster relief operations. WASH technical assistance is multi-discip nary, drawing on experts in public health, training, financing, epidemiology, anthropology, management, engineering, community organization, environmental protection, and other subspecialtie

The WASH Information Center serves as a clearinghouse in water and sanitation, providing networking on guinea worm disease, rainwater harvesting, and peri-urban issues as well as technical information backstopping for most WASH assignments.

The WASH Project issues about thirty or forty reports a year. WASH *Field Reports* relate to specific assignments in specific countrie they articulate the findings of the consultancy. The more widely applicable *Technical Reports* consist of guidelines or "how-to" manuals on topics such as pump selection, detailed training workshop designs, and state-of-the-art information on finance, community organiz tion, and many other topics of vital interest to the water and sanitation sector. In addition, WASH occasionally publishes special repor to synthesize the lessons it has learned from its wide field experience.

For more information about the WASH Project or to request a WASH report, contact the WASH Operations Center at the above addres