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WATER/WASTEWATER PRICING AND FINANCIAL PRACTICES IN THE UNITED STATES

Technical Report 1
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By:

John J. Boland

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Near East Bureau
Agency for International Development
Washington, DC 20523

MetaMetrics Inc.
1534 U Street, N.W.
Washington, DC 20009
(202 797-1330

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Foreword

The Near East Bureau of the Agency for International Development requested MetaMetrics Inc. to perform a review of pricing and financial practices in the water/wastewater sector. This volume addresses practices in the United States. A companion volume reviews pricing and financial practices in the Near East, and in countries in the larger region. Specific subject areas of the study include:

- Background on population served, institutional arrangements and growth patterns
- Major current and projected problems of the sector
- Rate-making policies in current use
- Financing arrangements in current use, including the role of subsidies
- Social and economic concepts underlying current practice

The study reported here is based on a review of available data, statistics, survey results and literature. In several cases, it was necessary to perform statistical analyses of raw survey data; otherwise, published analyses were relied on. No primary data were gathered in the course of this study.

The principal author of this report is John J. Boland. Research assistance was provided by Sally M. Kane, Giuseppe E. Scavone, and Arunpal S. Malik. Mr. Leo T. Surla, Jr., provided administrative support, coordinated the study, and conducted the final editing. Many organizations and agencies were contacted in the course of the study, and all proved helpful and informative. Substantial assistance was provided by Robert M. Clark and Nancy Wentworth, both of the U.S. Environmental Protection Agency, and Kyle Schilling and Mark Mugler, both of the Institute for Water Resources, U.S. Army Corps of Engineers.

Guidance, stimulating questions and valuable suggestions were provided at several meetings by Leonard G. Rosenberg, Maureen Lewis, Stephen Lintner, Ken Schofield, Monica Sinding, Holly B. Wise and their associates at the Agency for International Development. Their cooperation and support contributed greatly to the successful completion of the study. Responsibility for the results and conclusions, of course, remains with the author and Metametrics Inc.

EXECUTIVE SUMMARY

The Agency for International Development and the Government of Egypt are developing the principles and conditions for U.S. financial assistance in the water/wastewater sector in Cairo, Alexandria and the Canal Cities. Major pricing policy and financial practice issues affecting efficiency of sector operations now under review include usage of meters, types of rate structures, level of revenues, organization of utilities and the utilization of subsidies. MetaMetrics Inc., under a work order issued by the Near East Bureau of A.I.D., reviewed pricing and financial practices in the Near East and the United States as background for water/wastewater policy development.

This report addresses practices in the United States and is based on a review of available data, statistics, survey results and the literature. Published analyses were relied upon and some statistical analysis of existing data was performed. A total of 262 water utilities and 189 wastewater utilities serving populations of 100,000 or more were included in the study. No primary data were gathered in the course of the study.

THE WATER/WASTEWATER INDUSTRY IN THE UNITED STATES

The water/wastewater utility industry is a major sector in the U.S. economy and accounts for $15 billion in user charges and $8.5 billion in new investment each year. It is the single most capital intensive industry and ranks third with respect to total annual additions to capital. In spite of the magnitude of industry revenues, a typical household pays only about 0.7 percent of its disposable income for water and wastewater services, with the average household expenditure being $14.79 per month. Average per capita usage in urban areas is 668 liters per day. Climate affects usage: per capita water use is higher in the West.

Water/wastewater utilities may be agencies of state or local government, government corporations organized under the laws of state or local government, or private corporations owned by individual investors. Some utilities provide only water service, other provide wastewater service, and still others provide both water and wastewater service.

Water utilities can be divided into two distinct categories: those which are government-owned and those which are investor-owned. Investor-owned utilities, as a group, are financially self-sufficient and receive (with minor exception) no subsidies from state, local or federal government. Only 18 percent of all water utilities are investor-owned. Government-owned water utilities receive several types of transfer from government, both explicit and implicit. Subsidies are not a major source of funds for the water utility industry as a whole.

Wastewater utilities, in contrast to water utilities, rely heavily on subsidies from federal and state government for investment funds. The total explicit subsidy exceeds 50 percent of annual outlays by U.S. wastewater utilities. Relatively little use is made of user charges as a source of

capital; many wastewater utilities do not fully cover operating costs with user charges. No investor-owned wastewater utilities are known to exist in large urban areas.

Water which is produced and pumped into the distribution system but not subsequently recorded on customer meters is unaccounted-for water. This is due to meter misregistration, unmetered connections, unauthorized use, water withdrawn from hydrants, and leakage. Average unaccounted-for water is 12 percent of production.

Water and wastewater costs have risen in nominal terms as a consequence of general price inflation. There is some evidence that water unit costs have fallen in real terms (after adjustment for the effects of general price inflation) at a rate estimated at 2 percent per year. Wastewater unit costs, measured in real terms, may have risen at an estimated annual rate of 4 percent since the early 1970's.

FINANCING PRACTICES

Water utilities obtain investment funds from internal sources (retained earnings) and borrowings. At least half of all water utilities generate some capital internally. Most borrowings are in the form of long-term bonds. Among the government-owned utilities, revenue bonds are more often used than general obligation bonds. Investment funds are used for rehabilitation, reconstruction, expansion, preventive maintenance and new construction of water supply facilities.

Revenue from user charges exceeds operating expense for almost all utilities. Among the government-owned utilities, the average excess of revenue from charges over operating expense is 37 percent; for investor-owned utilities, the excess averages 118 percent. The excess revenue is used for debt service, new investment and, in the case of investor-owned utilities, return to investors.

Wastewater utilities, all of which are government-owned in the size category studied, obtain investment funds from internal sources, borrowing and subsidy. Many wastewater utilities report at least some internal generation of capital. In aggregate, however, the net amount of investment funds realized from user charges is very small. Long-term bonds are used by about half of the utilities surveyed. The principal source of investment funds is the EPA construction grant program, together with related state grant programs. Investment funds are used by wastewater utilities to construct new facilities and to upgrade and/or expand existing facilities. To the extent that borrowing is used as a source of investment funds, recovery is accomplished through the user charge system, as well as any subsidies that may be available other than the construction grant program.

The primary source of operating funds for wastewater utilities is user charges. The excess of user charge revenue over operating expense for all wastewater utilities studied is only 5 percent, compared to 37 percent for government-owned water utilities and 118 percent for investor-owned water utilities. Many utilities, especially the largest and those serving cities in the Northeast and North Central states, routinely experience operating deficits, where operating expenses exceed revenue from charges.

SUBSIDIES

Government-owned water utilities may receive explicit subsidies through exemption from state and local property and other taxes, sharing of local government tax revenue, and subsidized interest rates (tax exempt status) on long-term bonds. Where a utility is operated as an agency of local government without clear organizational and financial separation, there are many possibilities for implicit subsidy, due to cost shifting and other transfers. Some fiscally independent government-owned utilities make payments to local government in lieu of taxes and receive no local government funds, limiting the total subsidy to that associated with long-term bond interest rates. Investor-owned water utilities do not normally receive any subsidy from federal, state or local government.

In addition to the above explicit and implicit subsidies available to government-owned water utilities, wastewater utilities receive a major transfer in the form of payments from federal and state construction grant programs totalling more than $5 billion per year (approximately 75 percent of all wastewater capital outlay). Explicit subsidies to wastewater utilities amount to more than 60 percent of total annual expenditures as contrasted to government-owned water utilities, where the comparable figure is less than 5 percent, or to investor-owned water utilities, which receive no subsidies.

WATER UTILITY RATE-MAKING PRACTICES

Most water utilities meter all customer connections. The overall data are skewed by the existence of two very large partially metered cities: New York City (23 percent metered) and Chicago (31 percent metered). Full metering is nearly universal in the North Central states (except for Chicago) and the South. Meters are read and bills are rendered at intervals of one or more months. Billing periods for government-owned utilities are most likely to be 2 or 3 months, and some utilities use periods as long as 6 or 12 months. Billing periods tend to be shorter in the West. Investor-owned utilities favor 3 month billing periods.

Commodity charges are levied on the basis of metered water consumption. Unmetered customers pay a flat rate, based on number of household units, number of plumbing fixtures, housing value, or some other measure. About two-thirds of all water utilities use a periodic fixed charge in addition to a commodity charge. In the case of government-owned utilities, most periodic fixed charges are service charges, unrelated to water use.

Government-owned utilities utilize commodity charges of the uniform, increasing-block and declining-block forms. About half use the traditional declining-block rate forms which result in a lower charge for increased consumption of water. Evidence points to movement away from this type of design, with uniform and increasing-block forms gaining in popularity. Investor-owned utilities show strong preference for the declining-block form (used by 80 percent of utilities surveyed), and show no sign of change.

As a consequence of the extensive use of declining-block rate forms and the prevalence of other types of discounted rates for large users, there are substantial differences among average costs of water to various classes of users. Residential customers of government-owned utilities pay, on average,

16 percent more than wholesale customers, and 38 percent more than commercial and industrial customers. Investor-owned utilities maintain even larger differentials: residential customers pay 101 percent more than wholesale customers, and 45 percent more than commercial/industrial users.

The absolute level of rates is substantially higher for customers of investor-owned utilities and results in significantly lower per capita use rates. The average monthly water bill for a typical residential customer of a government-owned utility is $6.82; the average bill for a residential customer of an investor-owned utility is $11.35. Monthly residential bills range (among individual utilities) from $2.19 to $17.88.

Government-owned water utilities are characterized by a number of different rate-setting processes, ranging from final approval by a city council to the power for the utilities to set their own rates. Some government-owned utilities are required to submit rate increases to a state regulatory commission for approval. As of 1981, the average government-owned water utility had not changed rates for 2.2 years, and some utilities had used the same rates for as long as 11.5 years. Investor-owned utilities are regulated monopolies, and must submit rate proposals to a state commission for approval. Most of these utilities change rates frequently and the mean time since the last rate increase was 1.2 years. No investor-owned utility had used the same rates for more than 2.5 years.

WASTEWATER UTILITY RATE-MAKING PRACTICES

Where connections are metered and water rates based on meter readings, wastewater utilities are likely to adopt commodity charges on the same basis. About 20 percent of the wastewater utilities surveyed use flat rates for wastewater service. Commodity charges are primarily uniform charges. Periodic fixed charges are widely used and they are about evenly divided between service charges and minimum charges. Some wastewater utilities also levy annual fixed charges, either benefit assessments or ad valorem taxes.

Wastewater utilities are subject to rate-setting processes similar to those applying to government-owned water utilities. The average monthly wastewater bill paid by the typical residential user is $6.95. Individual utilities report typical bills which range from $1.97 to $15.08.

RATE-MAKING POLICY

Existing rate-making practice for both water and wastewater utilities is subject to strong criticism on several counts. Since marginal cost-based techniques are not used to set rate levels, rates are unlikely to promote allocational efficiency. Due to the general use of block-type rate forms, large misallocations are prevalent. Price discrimination is extensive, both among and within classes of customers. Investor-owned utilities, as a group, price discriminate more strongly than government-owned utilities. Conventional rate-making practice also results in significant and sometimes perverse redistributions of income.

Correction of these problems would require complete reform of utility rate-making practices. Rates should be based on relevant marginal costs and

utilize uniform charges within each customer class. Price discrimination among various classes of users should be eliminated. Sound economic and managerial criteria should be used to decide which portion of the total financing requirement is to be met from user charges, and which portion is to be subsidized. When funds are obtained from fixed charges, the rates should be designed to avoid unnecessary redistribution of income. Subsidies should be explicit and stable over time, so that uncertainty and fluctuating levels do not precipitate financial crises. The rate-setting process should assign authority to set rates to those who must bear the responsibility for successful operation of the utility.

The example of the investor-owned water utilities suggests that users are able and willing to pay the full cost of the services they demand. If that cost could be apportioned to promote allocational efficiency and minimize redistribution of income, the total net benefits received from the water/wastewater sector would be increased.

Increasing-block rates represent a divergence from marginal cost pricing principles (not more than one of the block prices can be equal to marginal cost), and produce significant redistributions of income. Among the claimed advantages are increased incentives to conserve water, transfers of income from nonresidential and high-income residential users to low-income households, and recognition of higher cost of service to suburban users having substantial seasonal demands. Critics point out that the conservation incentive provided by these rates applies to the group of large users only, the income transfer is highly non-specific (many low-income households are large users of water), and the level of household water use is not well correlated with unit cost of service.

Many of these criticisms are specific to U.S. conditions, where differences among residential customers with respect to water use and income are comparatively small; the objections may be much weakened for applications in developing countries. Typical third world cities are characterized by very large differences in both personal income and water use habits. The smallest water users in these cities are almost certain to be very low income individuals who use water only for drinking, food preparation and basic sanitation. The purchase of water by such individuals may be severely constrained by available income. Providing lower water prices for these very small users is likely to be desirable on both allocational (increased public good production) and distributional (transfer of income from wealthy to poor) grounds. The socio-economic conditions which lead to this result do not, in general, exist in the U.S.

FUTURE FINANCIAL REQUIREMENTS

Both water and wastewater utilities anticipate major investment in new and/or upgraded treatment facilities in the coming years. Water utilities are in the process of complying with provisions of the Safe Drinking Water Act, which mandates higher levels of treatment in certain cases. Wastewater utilities are continuing to move toward compliance with the requirements of federal water pollution control legislation. Large urban water utilities are likely to be capable of funding and implementing any required capital investments without major difficulty. Wastewater utilities, on the other hand, do not presently fund more than 25 percent of capital outlays. A large increase in

the rate of investment would require major changes in financing practice, or in the level of subsidies, or both.

The 1981 Clean Water Act made significant changes in the federal construction grant program for wastewater utilities, generally narrowing eligibility for grants and reducing federal participation from 75 to 55 percent of eligible cost. Continued reduction in the size of the program would have a major impact on U.S. wastewater utilities. A substantial reduction, or elimination, of this subsidy would require a large increase in the level of user charges. To maintain present investment levels, user charges would have to be doubled. Many utilities would reduce or suspend capital investment until user charges could be increased. There is no evidence that users are collectively unable or unwilling to pay the full cost of wastewater service. Even with doubled user charges, water and wastewater charges would together account for only 1.0 percent of mean disposable household income in the U.S. Certain utilities may require much higher rates and low-income users may experience a more severe impact.

Studies performed during the last several years have described problems associated with an aging and deteriorated urban infrastructure, including water and wastewater facilities. The Congressional Budget Office estimates wastewater capital needs over the next 8 years at $39.3 billion, and municipal water supply needs in the range of $50.4 to $72.8 billion. These estimates total $89.7 to $112.1 billion and cover outlays through the year 1990. Modest increases in user charge levels, coupled with continuation of existing subsidies, would suffice to fund this level of increased construction.

INSTITUTIONAL CHANGE

Proposals and suggestions for modifying the institutional structure of the U.S. water/wastewater industry appear frequently. Among the concepts advanced are integration (combined water/wastewater utilities), regionalization (a single utility serving an entire metropolitan area) and privatization (transfer of utilities or utility facilities from public to private ownership).

Integration has long been advocated as a means of improving operating effectiveness and reducing costs. Recently organized utilities (especially government corporations serving more than one political jurisdiction) tend to be integrated, while older municipal organizations are rarely combined. Custom and inertia are apparently major obstacles to integration.

Wastewater utilities are, in general, larger in size and fewer in number than water utilities, as a result of the more frequent regionalization of wastewater systems. Many organizational and economic advantages are claimed for regionalization. The arguments are particularly compelling in the case of wastewater utilities because of the influence of topography. There are important economies of scale in both water and wastewater utilities: the larger the utility the lower the unit costs.

Privatization of utilities is justified on grounds of improved economic efficiency. The relative performance of government- vs. investor-owned utilities does not support the premise that government ownership leads necessarily to inefficiency. The major consequence of private ownership is the use of

commodity charges to recover many costs that are ultimately funded by assessments or taxes in the case of government-owned systems. Among the results are lower water use and more regressive overall cost incidence. Economic motivation for conversion to private ownership exists primarily from recently enacted provisions of federal tax law, which provide federal subsidies for some types of capital investment.

Despite continuing interest in various forms of institutional change, no trends for change are apparent in the United States at this time. Integration and regionalization promise net social benefits but are blocked by local custom and inertia. The benefits of privatization are controversial, and there is little motivation for change.

SECTION 1

THE WATER/WASTEWATER INDUSTRY IN THE UNITED STATES

1.1 INTRODUCTION

During calendar year 1980, about 129 million cubic meters of water were withdrawn from surface and ground water sources, treated and delivered to users by the public water supply utilities of the United States [Solley, et al., 1983]. Almost 80 percent of the total (102 million cubic meters) was released as wastewater, usually to public wastewater collection and disposal systems. The public water supply systems served about 186 million people in 1980, 82 percent of the resident U.S. population.

The U.S. Environmental Protection Agency (EPA) has sponsored two surveys of community water supply systems, the first in 1976 [Temple, Barker & Sloane, Inc., 1977] and the second in 1982 [Temple, Barker & Sloane, Inc., 1982]. EPA defines a community water supply system as one serving at least 25 persons. The most recent survey found nearly 60,000 community water supply systems: actual data collection was confined to a sample of about 1,000 utilities, however, so true aggregate statistics are not available. No current data were found on the total number of wastewater utilities in the U.S., although earlier accounts suggest that up to 2,600 government-owned wastewater utilities exist in the U.S. [Kish, 1980]. As of 1980, 159 million persons were served by public sewer systems [Bureau of the Census, 1982b, p. 204].

This report addresses financing and rate-making practices of major urban water and wastewater utilities, defined here as those serving at least 100,000 persons. Table 1.1 indicates that, as of 1982, 262 major urban water utilities existed in the U.S. Extrapolating from the sample of 118 utilities in this size category surveyed by Temple, Barker & Sloane [1982], it appears that these 262 utilities (less than 0.5 percent of all community water systems) serve about 91 million persons, nearly half of all those with access to community water supply systems. Table 1.2 shows comparable data for wastewater utilities: 189 wastewater systems serve about 113 million persons.

Further details included in Tables 1.1 and 1.2 show that wastewater utilities are, in general, larger than water utilities: only 11 water utilities, as compared to 22 wastewater utilities, serve more than one million persons. These data reflect the usual pattern of multiple water utilities serving the same metropolitan region, in conjunction with a smaller number of (frequently regionalized) wastewater systems.

Table 1.2 also provides a regional disaggregation of wastewater utility data. Total population served can be compared to 1980 regional populations of approximately 62, 64, 65 and 35 million persons for the Northeast, South, North Central and West, respectively. Major urban systems are, therefore, most important in the Northeast and the West, serving 65 and 67 percent of the population, respectively. Only about 38 percent of the remaining population of the country is served by systems in this size category. No regional aggregate data were found for water utilities.

TABLE 1.1
Water: Total Population Served, by Population Category and Ownership - 1982 (1,000's)*

Ownership	Population Served (1,000) 100-500	500 - 1,000	more than 1,000	all
Government	39,224 (187)	12,638 (18)	24,306 (10)	76,168 (215)
Investor	8,016 (38)	5,747 (8)	1,036 (1)	14,799 (47)
All	47,240 (225)	18,385 (26)	25,342 (11)	90,967 (262)

* Figures in parentheses are estimated total numbers of utilities in category

[Source: Based on data from Temple, Barker & Sloane, Inc., 1982, pp. II-2 and II-3.]

TABLE 1.2
Wastewater: Total Population Served by Utilities in Census Survey, by Region and Population Category - 1980 (1,000's)*

Population Served (1,000's)	Region** Northeast	South	North Central	West	All
100-500	10,159 (40)	5,989 (25)	9,928 (41)	1,470 (7)	27,546 (113)
500-1,000	14,931 (22)	8,243 (12)	8,634 (12)	5,590 (8)	37,397 (54)
more than 1,000	15,198 (7)	6,606 (4)	10,101 (4)	16,449 (7)	48,354 (22)
All	40,287 (69)	20,838 (41)	28,663 (57)	23,510 (22)	113,297 (189)

* Figures in parentheses are numbers of utilities included in totals

** Regions are defined as follows:

Region	Federal Adminstrative Regions
Northeast	I, II, III
South	IV, VI
North Central	V, VII, VIII
West	IX, X

[Source: Based on data from Bureau of the Census, 1982a.]

The remainder of Section 1 describes some general characteristics of the industry, including certain recent trends and issues. Section 2 provides a conceptual basis for addressing financing and rate-making issues in the water/wastewater sector, while Sections 3 and 4 describe actual practices, based on previous empirical studies. Section 5 returns to some of the issues of current concern; Section 6 contains the summary and conclusions resulting from this study.

1.2 ROLE IN THE U.S. ECONOMY

Although available surveys of water and wastewater utility financial data are based on voluntary and partial reporting, it is possible to develop aggregate statistics by extrapolation (by assuming that all utilities in a size class have the same characteristics as those actually surveyed). The results are subject to significant error, but sufficiently accurate for certain gross comparisons. Table 1.3 gives the results of such extrapolations for several measures of aggregate economic impact. The wastewater data, available for 1980, are inflated to 1982 dollars for comparison with the 1982 water data. The gross national product implicit price deflator was used for this purpose [Council of Economic Advisors, 1983, p. 166]. Annual capital outlay by water utilities is estimated from data on internal capital generation.

The data show that the water/wastewater sector collects nearly $15 billion dollars each year from users, and invests some $8.5 billion annually in new plant and equipment. The water utilities of the nation own assets having a net book value of more than $72 billion, about $7.02 for each dollar collected in charges each year. No asset value data are available for wastewater utilities. Table 1.3 also shows that wastewater utilities account for only 30 percent of all user charge revenue, but 82 percent of new capital investment. As explained in Section 3, this disproportionately small share of user charge revenue reflects the relatively greater reliance of wastewater utilities on non-user charges and taxes; the comparatively large share of capital outlays follows from the high cost of new wastewater treatment facilities (largely funded by federal grants).

The importance of the water/wastewater sector to the U.S. economy can be underlined by comparing these data to selected statistics for other sectors of the economy. When converted to equivalent 1980 dollars, 1982 water/wastewater sector investment can be stated as $7.4 billion. Examination of 1980 data for specific industries reveals only two which exceed this level: the petroleum/natural gas extraction industry invested $10.9 billion in 1980, while the electric utility industry invested $25.5 billion in the same year [Bureau of the Census, 1982b]. In fact, the total of <u>all</u> private nonresidential investment for 1980 was only $119.1 billion, falling to $86.5 billion in 1982 [Council of Economic Advisors, 1983, p. 181].

The water/wastewater sector is, by several measures, the single most capital intensive industry in the U.S. economy. With annual capital additions of 58 cents for each dollar of user charge revenue collected, the sector outranks electric utilities (29 cents), petroleum/natural gas extraction (27 cents) and manufacturing industries (generally less than 10 cents) [Bureau of the Census, 1982b]. Other measures of capital intensiveness, such as net assets per dollar of revenue and net assets per employee, confirm the water/wastewater sector as the most capital intensive of all major sectors of the

TABLE 1.3
Water/Wastewater: Aggregate Financial Data

	($ million)
Water (1982 data, in 1982 dollars):	
Total revenue from charges	$ 10,333
Estimated annual capital outlay	1,565
Total net assets	72,590
Wastewater (1980 data, in 1982 dollars):	
Total revenue from charges	$ 4,459
Annual capital outlay	6,977
Total net assets	n/a
Total Water/Wastewater (1982 dollars):	
Total revenue from charges	$ 14,792
Annual capital outlay	8,542

[Sources: Water data from Temple, Barker & Sloane, Inc., 1982, pp. I-5, II-2 and IV-3; wastewater data from Bureau of the Census, 1982a, p. 30.]

economy.

In spite of the sheer size of the industry, expenditures for water/wastewater charges do not comprise a large fraction of typical household budgets. Survey results (described in Section 4) indicate that the typical U.S. household paid $7.63 per month for water service in 1982, and $6.95 per month for wastewater service in 1981. Expressing the 1981 wastewater charge in 1982 dollars (using the Consumer Price Index), this totals $14.79 per month per household. Disposable personal income (after personal taxes and other non-discretionary payments) was $9,362 per year in 1982 [Council of Economic Advisors, 1983, pp. 190-191], or about $2,130 per household per month (average 2.73 persons per household). Water/wastewater charges for the typical household, then, amounted to 0.7 percent of disposable income.

Actual monthly charges vary substantially from place to place and from household to household, and actual disposable income may be much larger or much smaller than the mean. Consequently, some households pay barely perceptible water/wastewater charges, while others may be faced with bills which claim a noticeable fraction of available income. No statistical data on cost incidence are available.

1.3 UTILITY OWNERSHIP AND ORGANIZATION

Water utility data are also available by ownership, as shown on Table 1.1. The two major ownership categories shown distinguish between utilities owned by government and and those owned by private investors. Several subcategories can be defined for each major category, describing the usual organizational forms employed:

Government-owned utilities

- Agencies of local governments, owned and controlled by the local government, staffed and operated in a manner similar to other government agencies, with funds commingled with those of other local activities (the stereotypical "water department").

- Agencies of local governments, owned and controlled by local government, staffed and operated independently and autonomously, either by legislation or by custom, with funds separately maintained and accounted for.

- Government corporations, operating within the jurisdiction of a single local government, organized under local or state law, staffed and operated independently and autonomously, with financial independence (water commissions, districts or authorities).

- Government corporations, operating within the jurisdiction of two or more local governments, usually organized under state law, staffed and operated independently and autonomously, with financial independence (regional water authorities).

Investor-owned utilities

- Independent investor-owned corporations, which may or may not be

affiliated with other investor-owned utilities.

- Private firms which are wholly-owned subsidiaries of investor-owned corporations; parent companies may or may not operate other wholly-owned water utility subsidiaries.

Table 1.1, however, shows only the two major categories: complete data on the number of water/wastewater utilities in any of the subcategories are not available. With respect to water utilities, incomplete data suggests that about one out of four investor-owned systems are wholly-owned subsidiaries of larger firms; no data were found on the incidence of various types of government-owned utilities [Temple, Barker & Sloane, Inc., 1982, p. II-2]. Altogether, investor-owned utilities comprise about 18 percent of all water systems serving populations of at least 100,000 persons; they account for 16 percent of the total population served (15 out of 91 million - see Table 1.1).

No data were found on investor-owned wastewater utilities. It is believed that comparatively few investor-owned wastewater systems exist, and that most of these serve very small populations. No reference has been found in the literature to any investor-owned wastewater system serving a substantial population. Also, nothing is known of the relative numbers of government-owned wastewater utilities choosing the various organizational subcategories.

Many government-owned systems operate as joint water/wastewater utilities, combining both functions within a single organization and fiscal structure. Examples include the Washington Suburban Sanitary Commission (MD) and the East Bay Municipal Utility District (CA), both government corporations operating as regional utilities. Conversely, most major municipally-operated systems (New York City, Chicago, etc.) maintain organizational and fiscal separation between the two functions. Unfortunately, no data on the actual numbers of joint water/wastewater utilities, or their incidence by organization type, were found.

1.4 OPERATING CHARACTERISTICS

Prior to examining the financing and rate-making practices of water and wastewater utilities, it is helpful to gain a general understanding of the demands for service placed upon these utilities, and of their general operating characteristics. The principal source of such information for water utilities is the survey carried out from time to time by the American Water Works Association (AWWA), most recently in 1981. This voluntary survey is addressed to all water utilities in the U.S., both government- and investor-owned; it seeks data on operations and rates, but not on finances. Earlier surveys (up to 1970) also collected financial data, but this function has been largely supplanted by the U.S. EPA surveys [Temple, Barker & Sloane, Inc., 1977 and 1982].

The AWWA survey data are reported in raw form, without summary or aggregation. For purposes of this study, therefore, pertinent data for utilities serving populations of at least 100,000 were manually transferred to a computer data bank, and subjected to the necessary statistical analysis. U.S. EPA survey data, on the other hand, are provided as statistical summaries; raw data are not available.

While some isolated data are available on selected operating characteristics of wastewater utilities, there appear to be no comprehensive surveys comparable to the AWWA or EPA surveys of water utilities. Reported data are obtained from samples which are so small or so biased as to preclude generalization; furthermore, different studies employ mutually inconsistent data and assumptions. As a result, no statistical summaries of wastewater utility operating data could be formulated.

1.4.1 The AWWA Survey Data

The AWWA survey contacted 2,924 water utilities in 50 states, receiving 1,397 usable responses [AWWA, 1981]. Of these, 138 substantially complete responses are available for utilities serving populations of at least 100,000 persons. By way of comparison, The 1982 EPA survey estimated the total number of water utilities in this size category at 262, actually contacting 118 of these [Temple, Barker & Sloane, Inc., 1982]. Table 1.4 shows the population served and the ownership for the 138 utilities included in the AWWA data. A comparison of Table 1.4 to Table 1.1 indicates that the AWWA data account for 77 percent of the total population served by all utilities in this size range. It should be noted that the AWWA survey reports data for 15 utilities serving more than 1 million persons, while the EPA survey indicates a total number of 11 utilities in this category. Since no raw data are available, it is not possible to verify the accuracy of the EPA survey count: the AWWA result has been verified.

Table 1.5 shows the AWWA survey data by region, as well as ownership. No comparable data are available from the EPA survey. Tables 1.4 and 1.5 show that investor-owned utilities are most common in smaller communities, serving 18.9 percent of the persons residing in areas with more than 100,000, but less than 500,000 population. Also, these privately owned utilities, which account for more than 15 percent of the overall included population, serve only 4.3 percent in the South, but 21.6 percent in the Northeast.

1.4.2 Water Use

Average municipal water use, when expressed on a per capita basis, is characterized by large differences among utilities in the same statistical class. These differences result from differing climate, rate level, income and relative size of non-residential uses. One source of variation could be removed by considering only residential water use, but accurate data on water use by user sector are available for only a handful of utilities. Data shown here, therefore, are for total water use, divided by population served.

Table 1.6 shows per capita water use as reported in the AWWA survey, disaggregated by population category and ownership. Average per capita use, for all 137 utilities providing data, is 668 liters/capita/day (lcd): individual utilities range from 326 to 1,867 lcd, an almost 6 to 1 variation. Within the population range examined, differences in the size of utilities appear to have no significant effect on per capita use. Investor-owned utilities, however, report much lower average per capita use (521 lcd, as compared to 700 lcd for government-owned utilities), and a smaller range (328 to 935 lcd, a 3 to 1 variation). This reflects the much higher rate levels prevalent in investor-owned utilities, discussed in Section 4.

TABLE 1.4
Water: Total Population Served by Utilities in AWWA Survey, by Population Category and Ownership - 1981 (1,000's)*

Ownership	Population Served (1,000) 100-500	500 - 1,000	more than 1,000	all
Government	17,559 (86)	11,199 (16)	30,082 (11)	58,839 (113)
Investor	4,079 (18)	2,229 (3)	4,517 (4)	10,824 (25)
All	21,638 (104)	13,428 (19)	34,598 (15)	69,664 (138)

* Figures in parentheses are numbers of utilities reporting usable data.

[Source: Based on data from American Water Works Association, 1981.]

TABLE 1.5
Water: Total Population Served by Utilities in AWWA Survey, by Region and Ownership - 1981 (1,000's)*

Ownership	Region				
	Northeast	South	North Central	West	All
Government	17,621 (27)	10,434 (29)	18,571 (33)	12,213 (24)	58,839 (113)
Investor	4,866 (10)	467 (2)	3,059 (9)	2,433 (4)	10,824 (25)
All	22,487 (37)	10,901 (31)	21,629 (42)	14,647 (28)	69,664 (138)

* All utilities serve 100,000 or more persons; figures in parentheses are numbers of utilities reporting usable data.

[Source: Based on data from American Water Works Association, 1981.]

TABLE 1.6
Water: Per Capita Use, by Population Category and Ownership - 1981 (liters/person/day)*

Ownership	Population Served (1,000) 100 - 500	500 - 1,000	more than 1,000	all
Government:				
Mean	708	655	709	700
Maximum	1,867	1,021	1,106	1,867
Minimum	326	376	434	326
	(85)	(16)	(11)	(112)
Investor:				
Mean	523	514	516	521
Maximum	935	632	687	935
Minimum	328	367	395	328
	(18)	(3)	(4)	(25)
All:				
Mean	675	633	658	668
Maximum	1,867	1,021	1,106	1,867
Minimum	326	367	395	326
	(103)	(19)	(15)	(137)

* Figures in parentheses are number of utilities reporting usable data.

[Source: Based on raw data from American Water Works Association, 1981.]

The influence of climate on per capita use is shown in Table 1.7, which separates data by region and ownership. The Northeast can be seen to have generally lower per capita use (575 lcd), while use in the West is generally higher (788 lcd). The spread between highest and lowest observation is not greatly reduced by the regional disaggregation, however, except in the South (2.4 to 1 variation). Investor-owned water utilities continue to show lower per capita use levels and narrower ranges in all regions.

1.4.3 Capacity Requirements

Although average water use determines the quantity of water which must be provided and, to some extent, the magnitude of operating costs, most water supply facilities are designed to accomodate the maximum daily rate of use likely to be experienced. A useful statistic for comparing relative facility requirements among utilities is the maximum/average day ratio. Systems with large maximum/average day ratios require disproportionately large investments in supply, treatment and transmission facilities, other things being equal. Systems with small ratios use proportionately less capital.

Table 1.8 shows that, for 128 utilities providing data, the mean value of the maximum/average day ratio was 1.66 in 1981. Individual systems, however, reported ratios ranging from 1.00 (maximum day equal to average day) to 5.81. The latter value, if correct, would indicate an extraordinary requirement for capital investment by comparison to the quantity of water actually sold. Investor-owned systems report generally lower maximum/average ratios, with much less variation among individual responses. The highest ratio found for an investor-owned system is 2.85; no private system serving more than 500,000 persons reported a ratio greater than 2.00. This characteristic of investor-owned systems, like lower per capita use, is generally consistent with rate levels higher than those set by government-owned systems.

When maximum/average day ratios are disaggregated by region (Table 1.9), average values are highest in the North Central and West regions, where summer droughts can be more severe, and lowest in the relatively humid Northeast. Investor-owned utilities follow the same general regional pattern.

Actual capacity currently in place is measured by subtracting the maximum day water use level from the maximum capability of the water supply system, and expressing the result as a percentage of maximum day use. This measure, known as the reserve margin, indicates the relative availability of capacity for further growth in water use. Table 1.10 shows reserve margins by population category and ownership; Table 1.11 shows the same information by region and ownership. While reported margins vary from nil (0.1 percent) to 246.7 percent, the average system (out of 99 reporting data) has a reserve margin of 37.4 percent on maximum day. Investor-owned utilities report, in general, slightly lower average reserve margins (mostly the result of fewer systems with grossly excess capacity).

Regional data show somewhat larger reserve margins in the South and West, possibly a response to greater variability in weather conditions in those areas. Reserve margins for investor-owned utilities are much lower in every region except the West, where the result may simply be a small sample anomaly (only 2 utilities provided data).

TABLE 1.7
Water: Per Capita Use, by Region and Ownership -- 1981 (liters/person/day)*

Ownership	Northeast	South	North Central	West	All
		Region			
Government:					
Mean	614	702	681	827	700
Maximum	1,867	1,078	1,636	1,611	1,867
Minimum	326	441	388	534	326
	(27)	(29)	(33)	(23)	(112)
Investor:					
Mean	470	639	533	563	521
Maximum	667	738	935	687	935
Minimum	362	540	328	403	328
	(10)	(2)	(9)	(4)	(25)
All:					
Mean	575	698	649	788	668
Maximum	1,867	1,078	1,636	1,611	1,867
Minimum	326	441	328	403	326
	(37)	(31)	(42)	(27)	(137)

* All utilities serve 100,000 or more persons; figures in parentheses are numbers of utilities reporting usable data.

[Source: Based on raw data from American Water Works Association, 1981.]

TABLE 1.8

Water: Maximum Day/Average Day Ratios, by Population Category and Ownership - 1981*

Ownership	Population Served (1,000) 100 - 500	500 - 1,000	more than 1,000	all
Government:				
Mean	1.72	1.54	1.57	1.68
Maximum	5.81	2.47	2.29	5.81
Minimum	1.00	1.05	1.26	1.00
	(80)	(15)	(11)	(106)
Investor:				
Mean	1.59	1.47	1.70	1.59
Maximum	2.85	1.69	2.00	2.85
Minimum	1.14	1.17	1.26	1.14
	(15)	(3)	(4)	(22)
All:				
Mean	1.70	1.53	1.60	1.66
Maximum	5.81	2.47	2.29	5.81
Minimum	1.00	1.05	1.26	1.00
	(95)	(18)	(15)	(128)

* Figures in parentheses are number of utilities reporting usable data.

[Source: Based on raw data from American Water Works Association, 1981.]

TABLE 1.9
Water: Maximum Day/Average Day Ratios, by Region and Ownership - 1981*

Ownership	Region: Northeast	South	North Central	West	All
Government:					
Mean	1.40	1.68	1.88	1.73	1.68
Maximum	2.47	2.69	5.81	2.61	5.81
Minimum	1.00	1.13	1.29	1.19	1.00
	(27)	(25)	(31)	(23)	(106)
Investor:					
Mean	1.50	1.39	1.54	2.14	1.59
Maximum	2.07	1.50	2.00	2.85	2.85
Minimum	1.14	1.28	1.26	1.69	1.14
	(8)	(2)	(9)	(3)	(22)
All:					
Mean	1.42	1.66	1.80	1.77	1.66
Maximum	2.47	2.69	5.81	2.85	5.81
Minimum	1.00	1.13	1.26	1.19	1.00
	(35)	(27)	(40)	(26)	(128)

* All utilities serve 100,000 or more persons: figures in parentheses are numbers of utilities reporting usable data.

[Source: Based on raw data from American Water Works Association, 1981.]

TABLE 1.10

Water: Reserve Margin, by Population Group and Ownership - 1981 (percent of max. day)*

Ownership	Population Served (1,000) 100 - 500	500 - 1,000	more than 1,000	all
Government:				
Mean	38.9	47.3	29.0	39.1
Maximum	246.7	116.7	58.1	246.7
Minimum	0.1	1.8	1.3	0.1
	(60)	(12)	(9)	(81)
Investor:				
Mean	23.5	25.2	52.2	30 2
Maximum	72.6	35.1	176.1	176.1
Minimum	1.9	17.0	4.3	1.9
	(11)	(3)	(4)	(18)
All:				
Mean	36.5	42.9	36.1	37.4
Maximum	246.7	116.7	176.1	246.7
Minimum	0.1	1.8	1.3	0.1
	(71)	(15)	(13)	(99)

* Figures in parentheses are number of utilities reporting usable data.

[Source: Based on raw data from American Water Works Association, 1981.]

TABLE 1.11
Water: Reserve Margin, by Region and Ownership - 1981 (percent of max. day)*

Ownership	Region: Northeast	South	North Central	West	All
Government:					
Mean	42.6	44.7	35.2	34.7	39.1
Maximum	111.3	246.7	137.9	81.9	246.7
Minimum	0.1	1.3	0.5	7.5	0.1
	(19)	(19)	(28)	(15)	(81)
Investor:					
Mean	23.1	19.7	20.5	99.9	30.2
Maximum	72.6	19.7	36.5	176.1	176.1
Minimum	2.5	19.7	1.9	23.6	1.9
	(6)	(1)	(9)	(2)	(18)
All:					
Mean	37.9	43.5	31.6	42.4	37.4
Maximum	111.3	246.7	137.9	176.1	246.7
Minimum	0.1	1.3	0.5	7.5	0.1
	(25)	(20)	(37)	(17)	(99)

* All utilities serve 100,000 or more persons; figures in parentheses are numbers of utilities reporting usable data.

[Source: Based on raw data from American Water Works Association, 1981.]

1.4.4 Water Losses

Much attention has been focused in recent years on the problem of leakage, especially from older, deteriorated water distribution systems. Water lost in this way increases operating and capital costs, and may overtax limited sources, causing shortages. The only available indicator of water losses is unaccounted-for water. It is the difference between water produced and delivered to the distribution system, and the total water sold, as measured by customer meters. Unaccounted-for water, usually expressed as a fraction of total water production, is only an approximate estimator of water loss, however. It is affected by meter inaccuracies which, in the case of customer meters, may be relatively large. Unaccounted-for water also includes unmetered uses, water withdrawn from hydrants for fire suppresion or other purposes, water used by the utility to flush mains, etc. Overlapping reading cycles for customer meters result in fluctuations from year to year.

Table 1.12 shows a summary of unaccounted-for water fractions, as reported by 120 utilities from the AWWA sample. The average value of the fraction is 0.12, indicating that 12 percent of all water pumped and treated was not recorded on customer meters. Individual values range from 0.00 (indicating zero losses, probably due to under-registration of production meters) to 0.55 (more than half total production unaccounted-for). No significant differences are evident among population categories, and investor-owned utilities report, if anything, slightly higher unaccounted-for water.

Table 1.13 gives the same data as Table 1.12, organized by region and ownership. The North Central region appears to be characterized by somewhat lower unaccounted-for water, but otherwise no important regional differences can be seen. Investor-owned utilities continue to report slightly higher values than those provided by government-owned systems.

Tables 1.12 and 1.13 include some utilities which are not completely metered. In these cases, the water use of the unmetered customers is necessarily included, biasing the results to some extent. Tables 1.14 and 1.15 remedy this problem by excluding data for utilities which are less than 99 percent metered. Also excluded from these tables are data which show unaccounted fractions less than 2 percent. This removes the several utilities which reported no or nil unaccounted-for water, on the assumption that such results represent errors in measurement or reporting. The effect of these exclusions is to reduce the sample size from 120 (Tables 1.12 and 1.13) to 91 (Tables 1.14 and 1.15) utilities.

Table 1.14 gives an overall average unaccounted-for fraction of 0.12, unchanged from Table 1.12. The range of values is also similar, 0.02 to 0.55. The difference between investor-owned and government-owned utilities is narrowed somewhat, but results are otherwise nearly identical. Regional results, shown on Table 1.15, are also very similar, except for slightly lower values for the investor-owned utilities. Unmetered customers and excessively low estimates, therefore, do not appear to be significant factors in explaining typical levels of unaccounted-for water use, or in explaining the wide variation in this measure among individual utilities.

TABLE 1.12
Water: Fraction Unaccounted-For, by Population Category and Ownership - 1981*

Ownership	Population Served (1,000) 100 - 500	500 - 1,000	more than 1,000	all
Government:				
Mean	0.11	0.13	0.08	0.11
Maximum	0.55	0.35	0.17	0.55
Minimum	0.00	0.04	0.00	0.00
	(70)	(16)	(9)	(95)
Investor:				
Mean	0.16	0.14	0.18	0.16
Maximum	0.42	0.19	0.30	0.42
Minimum	0.00	0.08	0.12	0.00
	(18)	(3)	(4)	(25)
All:				
Mean	0.12	0.13	0.11	0.12
Maximum	0.55	0.35	0.30	0.55
Minimum	0.00	0.04	0.00	0.00
	(88)	(19)	(13)	(120)

* Figures in parentheses are number of utilities reporting usable data.

[Source: Based on raw data from American Water Works Association, 1981.]

TABLE 1.13
Water: Fraction Water Unaccounted-For, by Region and Ownership - 1981*

Ownership	Region: Northeast	South	North Central	West	All
Government:					
Mean	0.11	0.14	0.09	0.09	0.11
Maximum	0.28	0.35	0.25	0.55	0.55
Minimum	0.00	0.00	0.00	0.00	0.00
	(19)	(23)	(31)	(22)	(95)
Investor:					
Mean	0.18	0.16	0.12	0.20	0.16
Maximum	0.42	0.18	0.16	0.31	0.42
Minimum	0.04	0.14	0.00	0.08	0.00
	(10)	(2)	(9)	(4)	(25)
All:					
Mean	0.13	0.14	0.09	0.11	0.12
Maximum	0.42	0.35	0.25	0.55	0.55
Minimum	0.00	0.00	0.00	0.00	0.00
	(29)	(25)	(40)	(26)	(120)

* All utilities serve 100,000 or more persons; figures in parentheses are numbers of utilities reporting usable data.

[Source: Based on raw data from American Water Works Association, 1981

TABLE 1.14
Water: Fraction Unaccounted-For, Utilities at Least 99% Metered and Reporting at Least 2% Unaccounted-For, by Population Category and Ownership - 1981*

Ownership	Population Served (1,000) 100 - 500	500 - 1,000	more than 1,000	all
Government:				
Mean	0.12	0.13	0.11	0.12
Maximum	0.55	0.35	0.17	0.55
Minimum	0.02	0.06	0.02	0.02
	(55)	(14)	(6)	(75)
Investor:				
Mean	0.15	0.14	0.14	0.15
Maximum	0.31	0.19	0.15	0.31
Minimum	0.04	0.08	0.12	0.04
	(10)	(3)	(3)	(16)
All:				
Mean	0.12	0.13	0.12	0.12
Maximum	0.55	0.35	0.17	0.55
Minimum	0.02	0.06	0.02	0.02
	(65)	(17)	(9)	(91)

* Figures in parentheses are number of utilities at least 99% metered and with at least 2% unaccounted-for water which reported usable data.

[Source: Based on raw data from American Water Works Association, 1981.]

TABLE 1.15

Water: Fraction Water Unaccounted-For, Utilities at Least 99% Metered and Reporting at Least 2% Unaccounted-For, by Region and Ownership - 1981*

Ownership	Region: Northeast	South	North Central	West	All
Government:					
Mean	0.12	0.15	0.10	0.11	0.12
Maximum	0.28	0.35	0.25	0.55	0.55
Minimum	0.04	0.06	0.02	0.02	0.02
	(17)	(17)	(26)	(15)	(75)
Investor:					
Mean	0.15	0.14	0.13	0.17	0.15
Maximum	0.21	0.14	0.16	0.31	0.31
Minimum	0.04	0.14	0.06	0.08	0.04
	(7)	(1)	(5)	(3)	(16)
All:					
Mean	0.13	0.15	0.10	0.12	0.13
Maximum	0.28	0.35	0.25	0.55	0.55
Minimum	0.04	0.06	0.02	0.02	0.02
	(24)	(18)	(31)	(18)	(91)

* All utilities serve 100,000 or more persons; figures in parentheses are numbers of utilities at least 99% metered and with at least 2% unaccounted-for water which reported usable data.

[Source: Based on raw data from American Water Works Association, 1981.]

1.5 TRENDS IN WATER/WASTEWATER SERVICE COSTS

A major concern in the development of financing and rate-making policy for water/wastewater utilities is the behavior of costs over time. Nominal costs (as measured in current dollars) are almost certain to rise, due to general price inflation. This fact is important for rate-making policy, signifying the inevitability of periodic rate increases, but it is not necessarily relevant to financing policy or to the impact of rates on utility users. A more informative data series is comprised of real costs, adjusted to remove the effects of general price inflation. When real costs increase over time, utilities must seek ever-larger sources of funds, and consumers may be required to bear increasing cost burdens.

Even though water/wastewater utilities are characterized by large and well-documented positive economies of scale, no a priori conclusions can be drawn with respect to time trends in costs. On one hand, the use of large amounts of embedded capital and steady growth would both suggest falling real costs over time. Opposing and possibly reversing this trend, however, is the need to bear much higher than average incremental costs for new facilities (especially water sources) and the cost consequences of greatly increased wastewater treatment requirements. The result could be falling, level, or rising real costs, depending on the relative strength of the various factors.

Unfortunately, there has been little careful examination of time trends of utility costs. Recurrent surveys of water utilities, such as earlier AWWA surveys and the recent EPA surveys, include cost data for some of the surveyed utilities. The sample for each survey, however, differs substantially from the samples in previous surveys (includes different utilities); furthermore, unit cost data are characterized by large variances. As a result, although trends in unit costs are found, differences are rarely statistically significant.

One approach to measuring time trends is to choose a fixed sample of utilities, monitoring costs for those utilities over a reasonable period of time. This has been done by Clark and Gillean [1977] for five urban water utilities (Kansas City, Mo.; Cincinnati, Ohio; Dallas, Texas; Elizabethtown, N.J.; and Fairfax County, Va.), for the period 1965-1974. Their results are summarized as Table 1.16. Operating and capital expenditures are shown both in current dollars, and in 1982 dollars. The constant dollar figures are obtained by inflating current dollar data according to changes in the Gross National Product implicit price deflator. This index is chosen so as to approximate the impact of cost changes on the economy as a whole. If the impact on only residential consumers was of interest, another deflator such as the Consumer price Index would have been used. No substantial differences in observed trends would have resulted, however.

Table 1.16 shows that both operating expenses and capital outlays (measured on a per-unit basis) increased in nominal terms over the period 1965-1974, although the average annual rate of change in total expenditure was only 3.21 percent per year. After the data are converted to constant (1982) dollars, a different pattern emerges. Operating expense was nearly constant (decreasing at an average annual rate of 0.61 percent) while capital outlay dropped noticeably (3.47 percent per year): total unit outlays fell at an average annual rate of 1.59 percent. These results apply only to five specific utilities during the 1965-1974 time period, or course. Other water utili-

TABLE 1.16
Water: Average Operating and Capital Costs for Five Water Utilities, by Year, in Current and 1982 Dollars ($/cubic meter produced)

Year	Operating Expense	Capital Outlay	Total
Current Dollars:			
1965	0.0562	0.0317	0.0879
1966	0.0546	0.0306	0.0852
1967	0.0556	0.0312	0.0868
1968	0.0541	0.0324	0.0865
1969	0.0599	0.0300	0.0899
1970	0.0621	0.0315	0.0936
1971	0.0663	0.0316	0.0979
1972	0.0700	0.0325	0.1025
1973	0.0764	0.0361	0.1125
1974	0.0758	0.0343	0.1101
1982 Dollars*:			
1965	0.1602	0.0903	0.2505
1966	0.1512	0.0845	0.2359
1967	0.1495	0.0839	0.2334
1968	0.1397	0.0837	0.2234
1969	0.1472	0.0737	0.2210
1970	0.1452	0.0736	0.2188
1971	0.1479	0.0705	0.2184
1972	0.1502	0.0697	0.2200
1973	0.1547	0.0731	0.2278
1974	0.1404	0.0635	0.2039

* Current dollar values inflated by Gross National Product fixed weight implicit price deflator [Council of Economic Advisors, 1983, p. 168]

[Source: Clark and Gillean, 1977, pp. 101-102.]

ties may have had different experience, and the costs of the five utilities studied may behave differently at other times. There are no other consistent data on water utilities which would permit more general conclusions regarding time trends.

With respect to wastewater utilities, annual estimates of cost data are prepared on a national basis by the Bureau of the Census [1982a, 1981, 1980 and 1979]. These estimates (developed from a random sample of 16,000 local government, 85 percent of which replied to the Bureau's request for data) are for "sewerage" expenditures, a category which includes both wastewater collection and treatment, and storm sewers. The latter activity is believed to make a minor contribution to the sums shown, however.

Table 1.17 gives operating expenses, capital outlays, and total expenditures for four recent fiscal years (years ending September 30), by level of government. The results, expressed in current dollars, show sharply rising cost levels in all categories. No significant differences can be noted in the rates of increase or in the cost shares borne by the various levels of government.

Table 1.18 shows summary data from Table 1.17, expressed in both current and constant (1982) dollars. These data indicate increasing real, as well as nominal cost. Real operating expenses increase at an average annual rate of 5.63 percent, while real capital outlays grow at a 5.14 percent annual rate. Total annual expenditures increased at an average annual rate of 5.30 percent per capita expenditures increased at a 3.89 percent annual rate. As in the case of water utilities, these data cover only a short period of time (the 1980 data are the most recent available in this form). Trends noted, especially for capital outlays, may not be representative of other periods, past or future.

It has long been assumed that water utility unit costs (expressed in constant dollars) fall over time, while real wastewater costs are presently increasing rapidly. There is little reliable data with which to test these assumptions, especially in the case of water utilities. Those data which could be found, however, support both statements: water costs are seen to be falling slightly (for five specific utilities in the 1965-1974 period), and wastewater costs are rising relatively rapidly (over the 1977-1980 period).

1.6 CURRENT ISSUES

The problem of ensuring adequate financing arrangements and appropriate rate-making policies for water/wastewater utilities requires continual attention. Conditions are constantly changing, requiring adjustment and revision of past policies, and directing attention to new issues. In the U.S., public utilities of all kinds experienced unusually heavy economic pressure during the 1970's, as high levels of price inflation, rising real costs, and increased consumer activism combined to reduce net income and operating margins to historic low levels.

Many water and wastewater utilities responded to these pressures by reducing or eliminating discretionary capital outlays, and in some cases by reducing maintenance efforts as well. These actions did not, of course, remove the original source of difficulty, but they did create or exacerbate

TABLE 1.17
Wastewater: Total Expenditures for Wastewater and Storm Sewerage Services, by Fiscal Year ($ million) (current dollars)

Fiscal Year	City	Special District*	Other*	Total
Operating Expenditures:				
1976-77	1,446	519	351	2,316
1977-78	1,663	571	409	2,643
1978-79	1,916	693	470	3,078
1979-80	2,159	827	546	3,532
1980-81	2,723	n/a	n/a	n/a
Capital Outlays:				
1976-77	2,244	919	985	4,149
1977-78	2,200	919	1,073	4,191
1978-79	2,539	1,484	1,397	5,420
1979-80	2,907	1,555	1,552	6,014
1980-81	3,512	n/a	n/a	n/a
Total Expenditure:				
1976-77	3,690	1,438	1,336	6,465
1977-78	3,863	1,490	1,482	6,834
1978-79	4,455	2,177	1,867	8,498
1979-80	5,066	2,382	2,098	9,546
1980-81	6,235	n/a	n/a	n/a

* "Special districts" include all types of government corporations, serving both single and multiple jurisdictions; "other" includes counties, townships and government units other than cities and special districts.

[Sources: Bureau of the Census, 1982a, 1981, 1980, 1979; 1980-81 data from Bureau of the Census, 1982c.]

TABLE 1.18
Wastewater: Total and Per Capita Expenditures for Wastewater and Storm Sewerage Services, Current and 1982 Dollars ($ million)

Fiscal Year	Operating Expense	Capital Outlay	Total
Current Dollars:			
1976-77	2,316	4,149	6,465
1977-78	2,643	4,191	6,834
1978-79	3,078	5,420	8,498
1979-80	3,532	6,014	9,546
1982 Dollars*:			
1976-77	3,495	6,261	9,757
1977-78	3,700	5,867	9,567
1978-79	3,936	6,932	10,868
1979-80	4,110	6,999	11,109
Per Capita Expenditures (1982 dollars)**:			
1976-77	22.87	40.98	63.85
1977-78	24.03	38.10	62.12
1978-79	25.15	44.29	69.44
1979-80	25.85	44.02	69.87

* Current dollar values inflated by Gross National Product fixed weight implicit price deflator [Council of Economic Advisors, 1983, p. 168]

** Expenditures in 1982 dollars divided by estimated population served, interpolated from Bureau of the Census, [1982b, p. 204]

some additional problems. All problems, both existing and emerging, will affect future financing and rate-making policies, and any discussion of policy must consider them.

Several of the major issues of current concern are discussed further in Section 5. These include (often conflicting) demands by a wide range of interests for substantial changes in the design of water and wastewater rate structures. Such changes, if adopted, could affect the degree to which utilities can rely on user charges as a source of future revenue, as well as the characteristics of customer demand (and therefore costs). Another issue refers to uncertainty regarding future treatment and water quality requirements, with respect to both known and yet-to-be-identified pollutants. This uncertainty translates into uncertainty regarding future cost levels and financing requirements.

Underlying all other issues is the problem of the deteriorating infrastructure of many U.S. water and wastewater utilities. In the most severe cases, it is claimed, needed repairs and replacement have been deferred until utilities face massive and immediate requirements for re-investment, requirements which may go far beyond their financing ability. Other sources state that the problem can be addressed by incremental improvements in present financing and rate-making practices, and that many of the recommended policies (federal intervention, special taxes, etc.) are unnecessary. In either case, the infrastructure problem is clearly important, and a necessary part of the present discussion.

SECTION 2

ELEMENTS OF UTILITY FINANCING PLANS

Subsequent chapters of this report document financial and rate-making practices of water/wastewater utilities in the United States. In order to understand the significance of these practices, and to permit useful comparisons among them, it is helpful to review the underlying principles of economics and finance which govern the design of financing plans. These principles, and their application to the water/wastewater industry, are summarized in this chapter.

2.1 PRIVATE AND PUBLIC GOODS

Private sector organizations engaged in the sale of ordinary market goods must rely, in a market economy, on user charges (prices) as the principal source of funds, augmented on occasion by borrowings, investor contributions and government subsidy. Government agencies engaged in providing general government services use tax proceeds, intergovernmental transfers and, sometimes, debt proceeds. Public utilities, especially government-operated utilities, may use all of these sources of funds and more (capital contributions from customers, for example). Still, the dominant practice in the U.S. water/-wastewater industry is to rely on user charges as a major source of revenue. A study of water/wastewater utility financing, therefore, must give special attention to the nature and consequences of user charges.

Each user charge application is associated with a unique set of impacts on utility customers, on the utility and on society as a whole. The impacts of user charges differ markedly from those of other financing measures; impacts also differ from one type of user charge to another. In order to understand the consequences of user charges, it is necessary to understand the nature of the economic goods to which they are applied--in this case, urban water and wastewater services.

Economic goods produced by public utilities, whether publicly or privately owned, may differ in important ways from goods produced by private sector organizations and sold in normal markets. Public utility products, including water and wastewater services, often possess characteristics of public as well as private goods, a fact which has implications for both the suitability and consequences of user charges.

2.1.1 The Nature of Economic Goods

<u>Private Goods</u>

Private goods can be defined as having two characteristics: (1) they are individually consumed and (2) it is possibly to exclude certain individuals from consumption of the goods. The first characteristic, sometimes called "rivalry", means that a unit of the good consumed by one person is not,

therefore, available to anyone else. A hamburger is individually consumed: once eaten by one person, it cannot be eaten again.

The second characteristic, "exclusion", indicates that means exist to limit consumption of the good to persons who meet certain criteria; e.g., those who have paid for the good they wish to consume. An underground water resource is certainly subject to rivalry, since water withdrawn by one user is no longer available to others. But in a state with no groundwater laws it may be impossible to exclude anyone from sinking a well and tapping the aquifer.

A good which has both "rivalry" and "exclusion" characteristics is one which can be, in a market economy, produced and sold by private individuals through normal markets. Consumption can be limited to those who obtain the good by paying the market price, and those who do not pay will not have access. Musgrave and Musgrave (1973, p. 52) refer to goods with both characteristics as "marketable private goods." The absence of either characteristic results in market failure: without "rivalry" the benefits of consumption cannot be confined to those who pay, and without "exclusion" the benefits of consumption cannot be denied to those who do not pay. In either case, the market is unable to perform its role as allocator of economic resources.

It should be noted that whether a good exhibits the "exclusion" characteristic is often related to feasibility, rather than any intrinsic property of the good. It is feasible and nearly costless to exclude those who do not pay for a hamburger, since payment and delivery are coupled. Some costs are involved in excluding those who do not pay for water or wastewater service, although such exclusion is considered feasible in the U.S. In general, the feasibility of exclusion is a function of available technology, as well as prevailing standards of individual freedom and social justice.

Public Goods

A public good (also called a social good) is one which lacks "rivalry". It is consumed collectively rather than individually, and the benefits of consumption are not confined to specific individuals. The marginal cost of providing a public good to another consumer is zero, since it is, if available at all, available to all. A general improvement in air quality, therefore, is a public good, since all who breathe must inevitably enjoy the benefit of better quality air. Many government services (e.g., national defense) are also public goods, because they benefit all simultaneously.

Merit Goods

While the conceptual distinction between private and public goods is easy to understand, unambiguous assignment of actual economic goods to one or the other category is less obvious, and frequently impossible. Many goods are found to have both private and public good aspects. The public good aspect may result from externalities (benefits or costs visited upon third parties not involved in the production or consumption of the good) or social policy. Sometimes, public good aspects are considered so strong or important that the good is produced in the public sector, even though private sector production would be possible (there is rivalry in most aspects of consumption, and exclusion is feasible). Such a product is called a merit good, a term which

reflects the implied social judgement that public provision is meritorious.

Examples of merit goods include public education (provided free to all in the U.S.), fire fighting services (once a private sector market good, but now usually supplied by the public sector) and ambulance service (private and public sector providers often exist side-by-side). All of these goods are individually consumed, and non-payers can be easily excluded in every case. Yet, society has frequently decided not to rely on conventional markets to provide and allocate these goods; overriding social concerns not captured in the calculus of the market have dictated their assignment to the public sector and, in most cases, the avoidance of user charges.

2.1.2 Water and Wastewater Services

Urban Water Supply

Water used for residential, commercial, industrial and public purposes in urban areas is provided individually to users, who use it individually. Once used, the water is no longer suitable (by reason of chemical and biological quality) for many uses and is, furthermore, not physically available to other users. Water is, therefore, characterized by rivalry in consumption.

Where water is delivered under pressure to house and building connections, and where suitable valves are provided and under control of the water utility, individual water users can be readily excluded from the benefits of service. As shown in Section 1, this is predominantly the case in the U.S. Since both rivalry and exclusion characteristics are present, U.S. urban water service is a marketable private good.

On the other hand, U.S. urban water supply has been associated with important public good aspects. During the twentieth century, these have arisen out of concern for public health. The provision of bacteriologically safe drinking water to virtually 100 percent of the U.S. urban population has been credited with the near eradication of typhoid and cholera in this country. This benefit is collectively consumed by the population, and non-participants can not be excluded from the better health conditions that have resulted. Urban water supply also confers collective and partially non-excludable benefits on property owners, by making modern fire protection services feasible.

In spite of the past importance of certain public good aspects, and the probability of their continuing role, urban water supply has rarely been proposed for merit good status: it is almost universally viewed as a marketable private good. As such, water service can be financed through user charges, and provided by either private or public sector organizations.

Urban Wastewater Service

Where wastewater is removed from individual buildings through a system of closed sewers (and subsequently collected, treated as necessary and discharged), the service provided is individually consumed. The sewers have fixed routes and finite capacity. As a result, the increment of system capacity

utilized by a user or group of users is not simultaneously available to others. Wastewater service, like water supply, is characterized by rivalry in consumption.

Individual users of wastewater services can be effectively excluded by depriving them of water service. Since most wastes are carried into the sewer by water, little use of the sewer can be made in the absence of water. The conditions which lead to excludability in the case of urban water supply (individual building connections and valves at each connection) render wastewater service effectively excludable at the same time. Under these conditions, wastewater service can be viewed as a marketable private good.

As in the case of water supply, the general provision of adequate wastewater service has been associated with important public health benefits. Moreover, proper collection practices have been responsible for past improvements in urban living standards, and proper treatment and disposal have improved and will continue to improve the quality of the aquatic and terrestial environments. All of these benefits are collectively consumed and are effectively non-excludable: they are public goods. When compared to the public good aspects of water supply, wastewater-related collective benefits are probably more important and of greater current interest in the U.S. The case for merit good status is, therefore, somewhat stronger for wastewater services, when compared to water supply.

Nevertheless, the private good aspects remain. One possible solution suggested by economic theory is to treat wastewater service as a market good, financing it through user charges and providing it through public or private sector organizations. The public goods associated with wastewater service could then be made the subject of government regulation, so as to insure that adequate health and environmental conditions are maintained. This approach corresponds generally to U.S. practice, as discussed elsewhere in this report.

2.2 GOALS OF A FINANCING PLAN

The operation of a water/wastewater utility requires a continuous flow of funds sufficient to defray operating, maintenance and administration costs as they arise, as well as any additional amounts necessary to permit capital expenditures, including rehabilitation and replacement. These funds may have many sources, including user charges, borrowing, subsidies, inter-governmental transfers, etc. The set of decisions which determines (1) the total amount to be raised in any given period (the revenue requirement), (2) the specific sources to be used (including the design of user charges, debt instruments, etc.) and (3) how revenue requirements will be divided among those sources is the financing plan of the utility.

Utility financing plans have implications which include, but go well beyond immediate economic impacts on the utility and its customers. Because of the quasi-public sector nature of the water/wastewater industry, the functions of utility financing plans are not unlike those of public finance generally. Musgrave and Musgrave [1973, p.6] discuss public finance in terms of allocation, distribution and stabilization functions, where the latter category refers to stability in the macroeconomic indicators of the overall economy. An analogous framework is adopted here: water/wastewater utility financing plans are analyzed in terms of their (1) allocation function, (2) distribution

function and (3) institutional stabilization function.

2.2.1 Allocation

A financing plan fulfills the allocation function if it contributes to an overall assignment of resources which maximizes social welfare. In a market economy, it is convenient to use that allocation of resources which would result from universal perfect competition (in all factor and product markets) as the prototype welfare maximizing allocation. According to this standard, goods should be sold at prices (user charges) which are equal to their relevant marginal costs. Marginal cost-based pricing practices correspond to the behavior of competitive firms, and insure that the good is allocated to only those consumers whose marginal valuation is at least equal to the incremental cost of production.

Where the producer is a monopoly, and production results in both public and private goods, significant market failures occur. A monopoly, even one which practices marginal cost pricing, faces no market test for capital expenditures: it may over- or under-capitalize, resulting in production at other than minimum average cost. Also, monopoly pricing practices are not likely to correspond to those of competitive firms. Where profit maximization is permitted as an objective, prices are strictly higher than marginal cost; in the case of public ownership or regulation, prices are administered and bear no necessary relationship to marginal cost. When prices exceed marginal cost, some consumers will be prevented from consuming additional units of the good, even though they would be willing to bear the full cost of replacing those units. When prices are below marginal cost, some units will be consumed by users who are not willing to bear the cost of the goods consumed. In both cases, private goods will not be allocated in a way consistent with welfare maximization.

The production of public goods introduces other problems. When production is joint (the amount of public good produced depends, at the margin, upon the production and consumption of related private goods), reliance on marginal cost pricing will result in under-production of the public good. This follows because price-rationing of the private good tends to limit the amount of the public good produced, according to the marginal valuation of the private good by individual consumers and without regard to the collective benefits of increased quantities of the public good. Where the public good is infra-marginal (the amount produced depends upon the existence of the private good, not on changes in the amount consumed), care must be taken that estimated marginal costs do not include amounts attributable to the production of the public good; otherwise the marginal cost-based prices will be biased, and will misallocate the private good.

Since public utilities face no market test for investments, there is no guarantee that funds withdrawn from the economy to finance capital outlays are appropriately productive. Utilities may over- or under-invest for any of a variety of reasons, resulting in social returns which are less than or greater than, respectively, the social opportunity cost of the capital used. Also, efficient allocation requires that any capital funds used be obtained from sources having the lowest social cost. Because utilities do not face the true social cost of capital in every instance (due to subsidized interest rates, grants, customer contributions, etc.), they may obtain additional capital from

relatively high-cost sources, thereby imposing greater than necessary costs on society.

2.2.2 Distribution

The distribution of wealth and income is an important consideration in the formulation of public policy in all countries, regardless of economic system. While few would agree to the definition of an "optimal" distribution, there is general agreement that most existing distributions are undesirable. Evidence for this agreement includes broad public support for the extensive redistribution programs which characterize most market economies (graduated income taxes, public pension and disability benefit programs, public medical care programs, income subsidies to unemployed or low-income persons, etc.). Socialist economies, which attempt to build distributional goals into the structure of society, also find it necessary to explicitly redistribute income and wealth in some cases.

Public utility financing plans perform the distribution function when they produce distributions of the benefits and costs of utility service that are consistent with the distributional goals of society. In a country which relies on other measures for redistributing income and wealth, for example, this may require a distribution-neutral financing plan: the closest possible match between cost borne and benefits received for each affected person. Most, if not all, actual financing plans are not distribution-neutral, however. The question is whether the resulting redistribution is consistent with social goals, or whether it produces unwanted shifts of net benefits or net costs.

2.2.3 Institutional Stabilization

The water/wastewater industry is characerized by decreasing average costs throughout the full range of output. This is the result of the very large amounts of fixed capital required to provide service, and the large economies of scale in related construction. As a result, water/wastewater utilities are natural monopolies, so that each location is served by a single water utility and a single wastewater utility. Any attempt to provide competitive services would result in much higher costs, due to duplication of distribution lines, collecting sewers, etc.

Demand for the services provided is also very inelastic, due to the absence of near substitutes. Consequently, any organization which provides water or wastewater services would, in the absence of government intervention, be able to set very high (profit-maximizing) prices without fear of entry or other competitive pressure. In recognition of this problem, water/wastewater services are usually provided by public sector organizations (publicly-owned utilities); where investor ownership is permitted, conditions of services, rates, and other matters are normally subject to regulation by a public agency.

Social concerns over monopoly status go beyond the prevention of monopoly pricing, however. Since for a given locality each service is provided by a single utility, with no alternative supplier, the population of that area is completely dependent on the single utility to continue to supply the service,

and to do so with reasonable effectiveness and efficiency. Unlike the private sector market, firms or agencies which prove inept or ineffective in the water/wastewater utility sector will not be replaced by better managed or more efficient firms: they will, instead, continue to function, transferring the consequences to consumers in the form of deteriorating service and higher costs. Society has an interest, therefore, in maintaining water/wastewater utilities as stable, well-managed and effective organizations.

Financing plans have the capability, within limits, to promote good management and effective operation of water/wastewater utilities. To the extent that a financing plan does this, it fulfills the institutional stability function. Such plans consist of financing measures which tend to preserve adequate managerial autonomy, provide economic incentives for socially beneficial actions, and document accountability for imprudent actions. Financing plans of this type are consistent with the maintenance of stable, effective water/wastewater utilities.

2.3 TAXATION

Proceeds derived from the tax levies of federal, state and local government constitute the principal source of funds for support of public sector activities. Many government programs are funded entirely from tax proceeds; others, including the provision of water/wastewater services, have access to other revenue sources (e.g., user charges). As shown in Section 3, publicly owned water/wastewater utilities vary widely in their reliance on tax proceeds as a source of funds.

Since taxes are levied without respect to use of utility services, the type and level of taxes chosen is not expected to affect individual decisions regarding use of those services. Within the utility sector, therefore, tax policy does not directly affect the allocation of goods and services. Outside the utility sector, taxes affect allocation in various ways, depending on the tax base and method of levy. These allocational effects are well described in the public finance literature [e.g., Musgrave and Musgrave, 1973]. The following paragraphs outline the distributional effects of taxes used to fund water/wastewater services.

2.3.1 Principles of Taxation

Taxes can be divided into three categories according to underlying taxation principles:

- Head (capitation) taxes--the tax levy is an equal amount for each person;
- Ability-to-pay taxes--the tax levy varies with income, or other measure of ability-to-pay; and
- Benefit taxes--the tax levy varies with benefits received from the program supported.

In addition to providing funding for transfer payments, taxes are themselves an effective means of redistributing income. The redistributional

characteristic of a tax is determined by comparing the incidence of the tax to the incomes of taxpayers. Taxes which do not increase with income, or those which increase less than proportionately with income, are said to be regressive. Such taxes comprise a smaller percentage of the income of higher income persons. Taxes which tend to increase more than proportionately with income are progressive (represent a larger percentage of the income of higher income taxpayers). Other things being equal and distribution-neutral (such as all government program benefits and transfers), progressive taxes redistribute income from higher to lower income persons, while regressive taxes shift income from lower to higher income persons.

Head taxes, therefore, can be seen as highly regressive, since they do not vary with income at all. Taxes based on the ability-to-pay or the benefit principle may be regressive or progressive, depending on their specific design. Sales and excise taxes, which presumably reflect the ability-to-pay principle, are typically regressive over a wide range of family incomes. This reflects the fact that, for most households, consumption of taxable goods increases less than proportionately with income. Federal income taxes, designed on an ability-to-pay principle to be strongly progressive, have acquired so many exemptions and exclusions as to produce frequent exceptions to the progressive intention.

Benefit taxes, designed on the principle of correspondence to the incidence of benefits, cannot be easily categorized with respect to regressivity/-progressivity. Still, actual benefit taxes often display significant differences between the incidence of the benefit and the incidence of the tax. Air travel taxes, for example, support airport subsidies and air traffic control by charging the first class passenger three or four times the tax paid by the discounted coach passenger on the same plane.

For purposes of this report, taxes can be divided into two kinds: (1) dedicated taxes which are levied by or on behalf of the utility, and whose proceeds are dedicated to utility purposes; and (2) general taxes which are levied by local, state or federal government, and whose proceeds are available for any or all government purposes. Dedicated taxes tend to be designed according to the benefit principle, while general taxes reflect a mixture of principles, depending on the level of government at which they are levied. As discussed in Section 3, the use of tax proceeds as a source of funds is by no means universal in the water/wastewater industry, and is particularly rare in the case of investor-owned utilities.

2.3.2 Dedicated Taxes

Dedicated taxes are those levied for the sole purpose of providing funds to support the provision of water/wastewater services. The funds may be intended to defray operating, maintenance and administration costs, or to provide for capital outlays, or both. Some dedicated tax revenues are restricted by statute to the uses for which they were collected. Other taxes are dedicated as a consequence of bond covenants, or simply by general agreement as to the purpose of the tax. Proceeds from dedicated taxes may be segregated from other revenues (accrued to trust funds), or they may be commingled with the proceeds from other taxes and from user charges. In all cases where the utility purpose of the tax levy is clear, whether or not such use is legally binding, the tax will be considered to be dedicated.

Ad Valorem Taxes

As used by water/wastewater utilities, ad valorem taxes are levied on the basis of real property values. They resemble ordinary real property taxes in every way except that their use is confined to those real properties considered to be benefited by the water/wastewater utility service, and the resulting revenues are dedicated to the provision of that service. Within the set of benefited properties, ad valorem taxes follow the ability-to-pay principle. Their incidence is the same as that of real property taxes; like real property taxes they are generally considered neutral to mildly regressive [Musgrave and Musgrave, 1973, pp. 412-421].

Among those communities which utilize ad valorem taxes, the definition of "benefited property" is subject to wide variation. Frequently, all properties accessible to, whether or not presently served by utility facilities are taxed. In other cases, all properties within a statutory service district or a political jurisdiction, whether accessible to existing facilities or not, are subject to the tax. Ad valorem levies which are confined to properties actually taking service are not treated as taxes here (since the burden of the levy results from a decision to use the services); they are classified as user charges. Some jurisdictions use tax rate differentials to distinguish between properties actually served (higher rate) and those not served but subject to the tax (lower rate). The portion of the levy which is common to all (the lower rate) can be considered a tax; the surcharge for connected properties is a user charge.

The practice of taxing non-served properties rests on the notion that properties without public water/wastewater service are benefited because (1) connections are possible from existing facilities and health, fire protection and other public good-related benefits are already present; or (2) connections and related benefits will be available in the future. In both cases, property values are expected to reflect these benefits in a tangible way, thus justifying the application of a benefit-based tax. Since the benefits derive from public goods, user charges are not feasible (there is no incentive to pay, since non-payers cannot be excluded).

Benefit Assessments

Benefit assessments include all types of dedicated benefit taxes levied by or on behalf of water/wastewater utilities other than those based on real property values. These taxes may be levied as a fixed amount per property, a fixed amount per resident, or on other bases. Most frequently, they take the form of "front-foot benefit assessments," where the tax is levied as a fixed amount per foot of property line adjoining the street where the utility services are provided. A variant method bases the tax on the square footage of property area. Benefit assessments may apply to properties accessible to utility services, or to all properties in the affected area (using the same "benefited property" notions described for ad valorem taxes). As before, benefit assessments which apply only to properties actually served are treated as user charges rather than taxes.

Front-foot (or square-foot) benefit assessments may be uniform over a utility service area, or they may be separately calculated for areas as small as a single block. In the latter case, they usually reflect the actual cost

of installing water mains and/or sanitary sewers in the affected area. Front-foot assessments are sometimes levied as a lump sum to be paid on a one-time-only basis, but more frequently they are annual charges for a fixed number of years (such as the amortization period for the facilities provided).

The income incidence of benefit assessments depends on the basis of the levy. There is ordinarily no explicit consideration of ability-to-pay principles in their design. While only properties receiving some level of benefit (according to the definition of "benefited property" in use) are taxed, incidence varies widely within that group. Fixed per-property levies are certain to be highly regressive with respect to income, and insensitive to the actual level of benefit received. Front-foot assessments, on the other hand, vary with income (as lot size varies with income). Since lot sizes do not, in general, increase proportionately with income, benefit assessments are likely to be somewhat more regressive than real property or utility ad valorem taxes.

2.3.3 General Taxes

Publicly owned utilities may use general tax revenues in a number of ways. Explicit subsidies received (wastewater facility construction grants, state grants-in-aid, etc.) represent general tax proceeds from the level of government granting the subsidy. Implicit subsidies, including cost shifting and revenue sharing between the utility and local government, transfer revenues from local general taxes to the water/wastewater operation. These funds are not dedicated, because the taxes which provide them are general-purpose taxes. The amount of revenue diverted to the utility, if any, is a matter of discretion for the agencies involved.

Federal Tax Levies

Funds transferred to water/wastewater utilities from the federal government are obtained from taxes levied predominately on the ability-to-pay principle. Table 2.1 shows the distribution of federal tax revenues by source for 1980. Nearly 70 percent of the total was obtained from the individual income tax which is, at least by design, strongly progressive. Corporate income taxes provide another 18.4 percent, leaving only about 12 percent obtained from other sources (sales, excise, gross recipts taxes, etc.). Overall, federal tax levies are somewhat progressive with respect to income.

The incidence of federal taxes is, of course, unrelated to the incidence of benefits from any particular water or wastewater system. In fact, a very large fraction of the revenue is provided by taxpayers residing elsewhere in the country, far beyond the reach of any specific benefits. While the general availability of such subsidies can be said to ultimately provide benefits to most of those who provide the funds, it remains true that each specific transfer represents a significant regional transfer of income.

State and Local Tax Levies

While fund transfers from state governments often differ fundamentally from purely local transactions, it is difficult to separate the discussion of state and local tax levies. The use of subsidies, inter-government transfers

TABLE 2.1
Tax Revenues by Source, as percent of total taxes; 1980

Type of Tax	Federal* %	State/Local %
Individual income	69.6	18.8
Corporation income	18.4	6.0
Real property	- 0 -	30.7
General sales and gross receipts	- 0 -	23.0
Alcohol and tobacco	2.3	2.9
Motor fuel	1.4	4.4
Other sales, excise and gross receipts	5.4	5.5
Death and gift	1.8	0.9
Other	1.1	7.8
	100.0	100.0

* Does not include taxes dedicated to the Social Security trust fund.

[Source: U.S. Bureau of the Census, Statistical Abstract of the United States: 1982-83, 103th ed., U.S. Govt. Printing Office, Washington, DC, 1982, p. 275.

and revenue sharing is so common between state and local levels of government as to make any attempt to independently characterize either level misleading. Similarly, both state and local governments display considerable variety in the types of taxes they choose to levy, and the degree to which they rely on any particular tax. Examples drawn from a particular locality may indicate little of practice elsewhere. The data presented are aggregated, therefore, giving the characteristics of the sum of all state and local taxes.

Table 2.1 shows that, for 1980, individual income taxes comprised less than one-fifth of all state and local government tax revenues. It should also be noted that many state and local income tax levies are much less progressive that the federal individual income tax. Some are progressive at low income levels only, while others use a single tax rate for all taxpayers, regardless of income. The largest single source of tax revenue shown on Table 2.1 is the real property tax, the traditional mainstay of local governments. This tax, generally considered neutral to mildly regressive, provides more than 30 percent of all tax revenue.

State and local governments also make heavy use of general sales and gross receipts taxes (23 percent of total tax revenue in 1980). Because of the disproportionate relationship between taxable consumption and income, these taxes are regressive for most middle and upper income persons. Certain sales taxes, such as taxes on food, are regressive for nearly all individuals. "Sin" taxes (taxes on alcohol and tobacco) are also likely to be regressive.

Overall, funds derived from state and local government general tax levies can be characterized as mildly to strongly regressive with respect to income. The only exception from this generalization might apply to the lowest-income households, who may escape the full burden of some of the taxes. Regional income transfers may occur in the case of state tax revenues, but not when revenues are obtained from local taxes. The incidence of state and local taxes is unrelated to the incidence of benefits from water/wastewater services.

2.4 USER CHARGES

User charges are prices charged for services provided by a water/wastewater utility. Services may include access to the system (a physical connection), available capacity (maximum rate at which water can be withdrawn during a critical period, for example), or quantity of water delivered or wastewater removed. All of these services are characterized by rivalry in consumption and, under typical U.S. conditions, the ability to exclude non-payers. They are, therefore, marketable private goods and can be allocated through a system of prices. Any charge or levy which varies with the presence or absence, or the level of use of any utility service is a user charge (price).

The quantity of a particular service which is demanded can be expected to vary with the type and level of user charge associated with that service. User charges, therefore, affect the allocation of goods and services within the utility sector. Since the incidence of user charges may differ from the incidence of benefits derived from related services, the distribution of income is also affected by user charges. These relationships are discussed in the following paragraphs.

2.4.1 Commodity Charges

Commodity charges are prices charged per measured unit of service received. For water utilities, they take the form of a charge for each 1,000 gallons (or 100 cubic feet, or cubic meter) of water delivered. Wastewater utilities base the commodity charge for general wastewater service on the quantity of water used (water use is the most common surrogate for wastewater contribution). Water meters are read at intervals to determine the quantity of water delivered, and bills rendered after each meter reading (after the end of the billing period). Meters may be read monthly, bimonthly, quarterly, semiannually, or annually. Some wastewater utilities impose additional commodity charges for the discharge of industrial waste; these may be based on volume (as measured by water use or by sewage flow meters) and/or strength (suspended solids concentration, biochemical oxygen demand, etc.)

Commodity charges may be uniform for all units of water delivered, or they may vary according to the total quantity used during the billing period, by time of year, or with the quantity used during some previous billing period. Table 2.2 shows hypothetical examples of some commodity charge designs in use in the U.S., including uniform, decreasing block, increasing block, increasing rate, seasonal, and summer surcharge commodity charges. These basic designs are sometimes combined to yield commodity charges with both decreasing and increasing block features, seasonal decreasing block charges, etc. The "lifeline" rate design, which provides a quantity of water (and wastewater service, where applicable) sufficient for minimal household needs at a lower than average price, is a form of the increasing block structure.

Wastewater commodity charges (based on metered water use) can be included in the stated water charges, or provided on a separate rate schedule. In the latter case, wastewater charges are sometimes a uniform percentage surcharge on water charges (thus following the same rate design). Otherwise, the wastewater charges follow a design independent of the water rate design. Any of the basic forms shown on Table 2.2 may be used. Regardless of the design of wastewater commodity charges, those levied on the basis of metered water use are indistinguishable from water commodity charges from the user's perspective, and from the perspective of economic analysis. The relevant rate level is the sum of the charges, and the relevant rate design is found by combining the two schedules.

Economic theory shows that when prices are set everywhere equal to marginal cost (simulating the result of universal perfect competition) goods and services are allocated optimally. Whether or not water/wastewater commodity charges are set equal to marginal costs is an empirical question, not addressed in this study. It can be observed, however, that some rate designs are inconsistent with marginal cost pricing principles. In particular, block-type structures (including summer surcharge designs) and increasing rate structures preclude the use of marginal cost pricing for at least some customers. This follows because, while marginal costs may vary from one type of customer to another, they are unlikely to vary with a customer's own water use at some previous time, whether in the same (block structures) or an earlier (summer surcharge) billing period. The fact that different prices are assigned to different customers on the basis of differences in previous use means that price cannot be equal to marginal cost except by chance (and only for one group of customers). All block-type rates, as well as increasing rate de-

TABLE 2.2
Commodity Charge Designs; Hypothetical Examples

Basis of Charge	Charge/Period* ($/1,000 gal.)
A. Uniform commodity charge	
For all water delivered	1.50
B. Decreasing block charge	
For the first 10,000 gal./period	2.00
For the next 90,000 gal./period	1.60
For all over 100,000 gal./period	1.35
C. Increasing block charge	
For the first 10,000 gal./period	1.30
For the next 90,000 gal./period	1.50
For all over 100,000 gal./period	1.80
D. Increasing rate charge	
For all water delivered to customers:	
Using up to 10,000 gal./period	1.40
Using between 10,000 and 100,000 gal./period	1.50
Using more than 100,000 gal./period	1.75
E. Seasonal uniform charge	
For all water delivered:	
Periods ending June through Sept.	1.80
Periods ending Oct. through May	1.30
F. Uniform charge with summer surcharge	
Periods ending Oct. through May:	
For all water delivered	1.40
Periods ending June through Sept.:	
For all water delivered up to 130 % water use in last winter period	1.40
For all water in excess	2.10

* Examples shown for 3-month billing periods

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signs, amount to price discrimination among utility users, with the usual consequences for efficiency and income distribution.

Commodity charges, properly designed and set, are capable of promoting the efficient allocation of services within the water/wastewater utility sector. They may also provide the utility with some market signals regarding customers' willingness to pay for new capacity, although they do not insure that cost minimizing investment decisions are made.

Commodity charges also determine, in part, any redistribution of income which occurs as a consequence of providing utility services. When commodity charges are based on marginal cost, costs and benefits are equated at the margin, thus minimizing redistribution. If commodity charges are lower than marginal costs for some customers, but higher for others, income is distributed from the latter group to the former. Block-type rates, in particular, are responsible for redistribution of this type. To the extent that water use is positively correlated with income, decreasing block rates provide subsidies to higher income persons at the expense of those with lower incomes, while increasing block and increasing rate designs accomplish the reverse. Any redistribution resulting from commodity charges can be reinforced, maintained, or reversed by the effect of other user charges, discussed below.

Among the issues related to institutional stability is the goal of stability in earnings (sometimes incorrectly described as "revenue stability"). Utilities generally prefer revenues which track costs as closely as possible, minimizing fluctuations in earnings (the excess of revenues over costs). The use of commodity charges promotes earnings stability, since increases or decreases in the use of water/wastewater services (as a consequence of changes in weather, industrial activity, etc.) result in increases or decreases in the revenue collected, as well as costs incurred. Where commodity charges are set equal to marginal (incremental) costs, small changes in service use should produce revenue changes nearly equal to the associated cost changes, thus maximizing earnings stability.

2.4.2 Periodic Fixed Charges

Periodic fixed charges are prices charged for access to a water/wastewater utility system and/or for the availability of necessary system capacity. Both water and wastewater utilities use periodic fixed charges, which are billed at regular intervals (monthly, bimonthly, quarterly, semiannually, or annually). At least three forms are in general use:

- Service charge -- a charge made <u>in addition to</u> a commodity charge for all units of water or wastewater service used;

- Minimum charge -- a fixed charge <u>for a specified minimum quantity</u> of water or wastewater service, used in conjunction with a commodity charge for all units in excess of the minimum quantity; and

- Flat rate -- a fixed charge for water or wastewater service, used with <u>no commodity charge</u>.

The minimum charge is equivalent (with respect to efficiency and income distributional characteristics) to a service charge coupled with an increasing

block commodity charge, where the price in the first block (the minimum quantity) is zero. If the minimum quantity is sufficiently small that a trivial number of customers terminate their consumption below that quantity, then the presence of the zero price is unimportant. The flat rate, of course, is associated with a zero price for all units of consumption; the consequences of this policy differ substantially from those of policies which include commodity charges.

Periodic fixed charges, although fixed for any particular customer, typically vary among groups of customers. They may vary according to customer class (residential, commercial, etc.), according to average water use range or according to the size of the water meter (5/8 inch, 3/4 inch, 1 inch, etc.). These distinctions reflect the dual role of the periodic fixed charge: it is a price for access and for required capacity. The latter service, while not directly measurable, is presumed to vary among customers classes, or according to meter size. Flat rates are typically subject to even more variation among individual customers. In the case of the residential class, for example, flat rates may be a function of the number and type of plumbing fixtures in the structure, the lot area, floor space, etc. These measures act as surrogates for required capacity as well as probable commodity use (in the absence of a commodity charge).

As prices for system access, periodic fixed charges have possible efficiency implications. Whether efficiency effects actually appear, however, depends on the sensitivity of the demand for system connections to changes in the periodic fixed charge. In suburban areas, and in parts of the country where individual water wells and/or septic systems are real alternatives to public utility service, changes in the level of the periodic fixed charge (all other charges and factors remaining the same) can induce changes in the number of customers who elect to connection to the public system. In this case, efficiency is promoted by setting the charge equal to the marginal cost of providing an additional customer access to the system (apart from any differential capacity costs or commodity costs). In all other cases (where private systems are not feasible or permissible), the periodic fixed charge has little to do with efficiency. Regardless of efficiency effects, this charge combines with other charges to perform a redistributive role.

Although periodic fixed charges may be intended, in part, as prices for capacity, and are sometimes used in place of prices for commodity use (flat rates), they serve no efficiency-related function in these roles. Once determined for a particular customer, they are fixed: changes in required capacity or in commodity use by that customer will not usually result in changes in the level of the charge. A possible exception concerns the use of flat rates differentiated on the basis of number and type of plumbing fixtures. If a customer decides to alter required capacity and commodity use by changing the number of plumbing fixtures, the flat rate will change as well. It seems unlikely that customers change plumbing fixtures in response to flat rates; no theoretical or empirical support for such a linkage can be found in the literature. The efficiency relevance of periodic fixed charges, therefore, is apparently limited to the provision of system access, and then only where close substitutes for public water/wastewater systems are available.

Like other user charges, periodic fixed charges promote institutional stability by increasing the stability of earnings in the face of fluctuating demand for services. They provide a revenue stream which grows with increas-

ing numbers of customers, compensating the utility for the growing costs of providing system access. Since the marginal cost of system access is the incremental cost of adding one more customer, periodic fixed charges which are set on the basis of marginal cost contribute to earnings stability (provided deviations from the expected rate of new connections are small).

2.4.3 Annual Fixed Charges

Annual fixed charges are levied independent of the periodic billing cycle of the water/wastewater utility, and are unrelated to commodity use. They are, however, limited to those actually connected to the utility system. This fact distinguishes annual fixed charges from the various kinds of benefit assessments discussed above as taxes, which apply to all within a specified area, whether connected to the utility or not. Otherwise, annual fixed charges are identical in form to benefit taxes. They may be levied on an ad valorem basis, on a front-foot basis, as a fixed amount for all customers in a specific class, or on other bases. The charges may apply annually for an indefinite period, but more often (especially in the case of front-foot assessments) have a definite term (such as 20 or 30 years).

Where annual fixed charges are used, they may be avoided only by failing to connect to the utility system. Consequently, as in the case of periodic fixed charges, they have possible efficiency effects. These effects only appear where private water and/or wastewater facilities are feasible and permissible. Under these circumstances, customer decisions to connect to the system will be affected by the level of annual fixed charges (as well as periodic fixed charges and expected commodity charges). Efficient decisions can only be assumed when the annual fixed charges, together with periodic fixed charges where applicable, reflect the incremental (marginal) cost of providing access to the system. When private provision of water/wastewater services is not a possible alternative, customers are not expected to respond to changes in the level of annual fixed charges, and no efficiency effects are present.

Annual fixed charges, similar to other user charges, may act to redistribute income among utility customers. Redistributions are most pronounced when a system-wide charge (such as an ad valorem charge on all users) is used to finance improvements which benefit a small number of customers (those residing in a newly added service area, for example). Redistributions are minimized by policies which limit annual fixed charges to customers benefited by them: many utilities levy front-foot benefit assessments which exactly recover the cost of each main extension from those users who actually connect to that extension.

As with other user charges, annual fixed charges promote earnings stability (and therefore institutional stability) if the revenues received track the costs incurred. When annual charges are used to finance capital costs, and they are levied after the fact in amounts just sufficient to recover the costs, this goal is achieved. When charges must be levied before costs are incurred, or when annual charges are used to recover costs other than separable capital outlays, application of conventional marginal cost pricing principles would insure results consistent with earnings stability.

2.4.4 One-Time-Only Fixed Charges

The remaining category of fixed charges includes all those which are levied only once against any particular customer connection. These one-time-only charges usually take the form of connection, or hook-up charges which must be paid at the time of initial connection to the system. One-time-only charges recover, at least, the cost incurred by the utility in constructing the customer connection (usually that portion between the nearest water main or collecting sewer and the customer's property line; most utilities require the customer to arrange privately for construction on private property). Many utilities also require a capital contribution from the customer at this time, perhaps as much as several thousand dollars for each customer connected.

The efficiency implications of one-time-only charges are identical to those of periodic and annual fixed charges: the three levies, taken together, comprise a fixed cost which must be considered along with variable commodity costs when connection to a public system is contemplated. In cases where connection is optional (alternatives are available), fixed charges can be expected to influence decisions. If those decisions are to be efficient, the charges must reflect the incremental (marginal) costs of providing the connection and related access to the system. If no close substitutes for public utility service are available, the number of connections should not be sensitive to the level of the charges.

As with other fixed charges, one-time-only charges may redistribute income when the amount of the charge exceeds the directly related benefits. The practice of requiring large capital contributions may redistribute income from new customers to old ones, where the old customers were never required to make similar contributions (either as a lump sum or gradually through the rate structure). Here the old customers receive the benefit of the facilities which the new customers pay for. Failing to require capital contributions from new customers, where old customers have paid debt service and/or depreciation charges over the years, can be viewed as the reverse redistribution (old to new), since new customers enjoy the benefits without payment.

As before, earnings stability is promoted whenever charges match incremental costs of providing the related service. A one-time-only charge which fully compensates the utility for the cost of constructing the physical connection, as well as the opportunity cost associated with allocating scarce system capacity to the new customer, will keep fluctuations in the number of new customers connected from altering the long run revenue-cost balance. One-time-only charges which are too high or too low will result in unstable earnings in the face of fluctuating connection rates.

2.5 BORROWING

2.5.1 Long-Term Borrowing

The principal means of long-term borrowing by water/wastewater utilities is the issuance and sale of long-term bonds. Each bond has a maturity date, a face amount and a coupon interest rate (many utility bonds issued before July 1, 1983, are coupon or bearer bonds as opposed to registered bonds; the distinction is technical and does not affect this discussion). The utility

agrees to two types of payments to bondholders: (1) it will pay (usually in semiannual installments) interest on the face amount at the coupon rate from date of issue to date of maturity and (2) it will pay the face amount at the maturity date. The investor (bond buyer), in return, purchases the bond for a sum of money which reflects current capital market conditions and the investor's appraisal of the relative risk associated with the bond. The utility's net proceeds are the total amounts paid by bond buyers, less the commissions and expenses incurred in the issuance and sale.

Maturity dates vary widely among individual bonds. A common practice is to offer a group of bonds at one time having maturity dates ranging from the medium-term (five years, for example) to the long-term future (perhaps as much as fifty years). In this way, the utility's repayments of principal are spread over time. Other utilities issue all bonds with a maturity date thirty or more years in the future, relying on a sinking fund to distribute the repayment burden over time.

A sinking fund is an interest-bearing account or portfolio of very low-risk investments which is provided for the sole purpose of accumulating funds sufficient to meet bond repayment obligations. Equal periodic payments are made to a sinking fund from utility revenues. The fund accrues interest until disbursements must be made, either for bond interest or for principal repayment. The periodic payment for a particular bond issue is calculated so that the amount deposited in the sinking fund over the life of the bonds, together with interest earned on the deposits, will be just exhausted with the last required payment.

The difference between the purchase price of a newly-issued bond and its face amount results from the difference between the market interest rate applicable to such bonds and the coupon rate. Where the market rate (which incorporates both current capital market conditions and the perceived riskiness of the investment) exceeds the coupon rate, buyers will bid prices below the face amount (the bonds will be "discounted"). In this fashion, the actual rate of return (to the bondholder) will equal the required market rate. If the market rate is below the coupon rate, the bid price will be higher than the face amount (the bonds sell at a "premium").

Water/wastewater utilities may issue one of three types of bonds, depending on the provisions for securing bondholders' investment. These are:

- General obligation bonds - issued by units of government, pledging the full faith and credit of the government jurisdiction to bondholders. The government promises to take any steps, including selling tangible assets and increasing taxes, necessary to insure repayment. General obligation bonds are typically regarded as among the safest (lowest risk) debt instruments available.

- Revenue bonds - issued by units of government, but pledging only the revenues which may be obtained by the utility itself. These bonds typically include convenants which obligate the utility to set rates and charges sufficient to insure repayment. A variant type is the special assessment bond, repayable from the proceeds of specified benefit assessments. Utility revenue bonds are considered only slightly more risky than general obligation bonds, although relative risk varies among utilities.

- Mortgage bonds - issued by investor-owned utilities, pledging the physical assets (or some specified portion of the physical assets) of the utility. Utility mortgage bonds are considered very safe investments, although the degree of riskiness varies from utility to utility, and may be similar to that associated with government-issued revenue bonds.

Where bonds are issued by state or local government (general obligation and revenue bonds), interest payments received by bondholders are exempt from federal individual income tax. This provision of the federal tax law makes interest payments received from utilities equivalent, in terms of after-tax proceeds, to relatively larger sums of money obtained from other sources. As a consequence, effective interest rates (resultant rates after considering both coupon rate and purchase discount/premium) for bonds issued by government-owned utilities are distinctly lower than market rates for the non-tax-exempt bonds of investor-owned utilities. This tax provision amounts to a subsidy, from the federal treasury, to government-owned utilities. The size of the subsidy may be as much as one-half of the total interest payments actually made by these utilities.

Long-term bonds usually incorporate covenants, which consist of promises made by the issuing utility to bond-buyers. These covenants commit the utility to a number of specific financial practices (including the maintenance of an adequate sinking fund), designed to reduce risk of default as much as possible. The more comprehensive and believable the promises, the lower the perceived risk. Past financial practices and evidence of managerial competence are also given considerable weight by investors in determining bond bid prices. Many bond issues are reviewed by one of the two major rating agencies (Moody or Standard and Poor), who assign a rating to the issue based on their evaluation of its overall soundness (lack of risk). The higher the rating, the lower the effective interest rate which investors require. Since bond interest payments are fixed in nominal terms over the life of the bond, steps taken by utilities to improve bond ratings, if effective, provide benefits in the form of lower financing costs over many years.

The use of long-term financing instruments may create concerns over two different types of redistribution of income: intertemporal transfers and outside subsidy. The first affects all utilities whenever the burden imposed to repay a bond (the periodic payments to a sinking fund) does not match, over time, the benefits received from the bond proceeds (the use of a new facility, for example). If the benefits are realized early, but the bond payments go on for a long time, customers using the facility in the later years are required to subsidize earlier customers. In cases where bond proceeds may be used to defray current operating expenses, thus postponing a rate increase, current customers are again subsidized by future customers.

The second redistribution results from the tax-exempt status of bonds issued by state and local governments. Income is shifted from all federal taxpayers (the donors) to utility customers (the beneficiaries). The amounts that would otherwise be part of utility interest expense (if full market interest rates applied) are contributed by federal taxpayers who are not, for practical purposes, receiving any service from the utility. The incidence of the burden among that group (relatively progressive) differs from the incidence which would have occurred had the utility been required to pay the additional interest (generally regressive incidence).

2.5.2 Short-Term Borrowing

In addition to long-term bonds, water/wastewater utilities also use funds borrowed for short periods of time (up to several years). Proceeds from short-term borrowings may be needed because of unanticipated cash flow problems (revenues fall below expenditures due to weather conditions, economic activity, etc.) or as a substitute for long-term borrowing. The latter situation arises when utilities postpone the issuance of long-term bonds, usually in the hope of better future market conditions, borrowing money in the short-term which will be repaid from the proceeds of the expected bond issue.

Short-term borrowings may be open-ended (such as a standing line of credit with a financial institution which may be borrowed against up to some established limit) or of definite term. In the latter case, the borrowings are usually refered to as "notes" and may have maturity dates ranging from thirty days to as much as two or three years after the date of issue. Notes issued in the expectation of future bond proceeds (or, in the case of wastewater utilities, construction grant proceeds) may be marketed as "bond anticipation notes" (or "grant anticipation notes").

Open-ended lines of credit usually have flexible interest rates (rates which change monthly in accordance with changes in the prime rate, for example), while notes are more often associated with fixed interest rates over their term. Since all of these transactions are normally conducted between the utility and financial institutions, the federal individual income tax exemption for interest payments by state and local governments does not apply. All short-term interest rates, therefore, reflect current capital market conditions, adjusted to reflect the risk associated with the specific investment.

Since short-term borrowings must be made at market rates, no subsidies to or from the utility are associated with their use. Also, because of the short period of time between borrowing and repayment, inter-temporal income transfers are minimal. So long as they reflect sound financial management and do not exceed the ability of the utility to arrange repayment, short-term borrowings are of little import for economic efficiency, income distribution or institutional stability.

2.6 INTER-GOVERNMENTAL TRANSFERS AND SUBSIDIES

2.6.1 Wastewater Facility Construction Grants

The Construction Grant Program of the U.S. EPA provides subsidies (grants) from the federal treasury to municipal, intermunicipal, state and interstate agencies for the planning, design and construction of wastewater treatment facilities. Grants are limited to the construction or upgrading of treatment plants, or of certain other eligible facilities (principally major intercepting sewers required to convey sewage to the treatment plants). Construction grants are not available to investor-owned wastewater utilities, or to private sector firms constructing industrial treatment facilities. No federal construction grants are available for water utilities.

The Construction Grant Program was first authorized by Congress in 1956

(P.L. 84-660, the Water Pollution Control Act Amendments of 1956), and initial grants were for a maximum of 30 percent of construction cost, not to exceed $250,000 for any single applicant. The program has been re-authorized numerous times, with the maximum federal cost share and the total authorized outlays rising rapidly through the 1960s and 1970s. The Water Pollution Control Act Amendments of 1972 (P.L. 92-500) increased the federal share to 75 percent, and authorized annual obligations up to $7 billion (for 1975). More recent legislation has reduced both the maximum federal share (to 55 percent) and the number and type of projects eligible for grants, although the program remains sizable (P.L. 97-117, Clean Water Act Amendments). As of 1983, cumulative outlays by the federal government are estimated in excess of $35 billion (Clark and Gillean [1983]).

Subsidies of the kind embodied in the Construction Grant Program raise a number of issues. Whenever the full cost of utility service is not borne by the entity responsible for setting rates and charges, the likelihood of misallocation of economic resources is increased. Because only a fraction of construction cost must be provided locally, utilities may be motivated to construct excess facilities. The federal program includes complex and often burdensome conditions and regulations designed to avoid this problem. Also, since the subsidy is available for construction only, and operating costs must continue to be fully borne by local users, incentives are created for the design of high capital cost/low maintenance cost facilities, even at the risk of substantially higher life cycle costs. No empirical analyses reported to date have addressed this problem, so nothing is known of its importance.

The Construction Grant Program has doubtless accomplished a considerable redistribution of income. From a national viewpoint, taking the program as a whole, the redistribution has been from all federal taxpayers to users of wastewater systems in those communities which have spent large amounts on new or upgraded treatment systems: generally suburban areas and growing cities, or cities with a history of inadequate or obsolete facilities. Within any given city, a redistribution from higher- to lower-income persons has probably predominated, due to the general progressiveness of federal taxes and regressiveness of utility charges and assessments.

From the viewpoint on any specific incremental project, the program provides a subsidy from the nation's taxpayers as a whole to a specific community's wastewater service users. This transfer is the relevant one at this stage in the program's history, since it is the source of the political pressure to continue the program. Each community has everything to gain and little to lose by obtaining further grants, in spite of bearing a portion of the burden of grants obtained by others. Even if ending such a program was known to be beneficial to all, each individual is motivated to support its continuation.

Although the Construction Grant Program has existed in some form or another for more than 25 years, it is annually threatened with extinction. The demise of a program which has shielded wastewater utilities from such a large portion of their construction costs is sure to be a destabilizing influence on many organizations. When faced with the full cost of needed facilities, many utilities will find it difficult to increase rates and charges sufficiently to recover construction outlays. Others may postpone improvements until the quality of service is degraded. Funds now provided by the federal government will be raised, for the most part, through bond issues,

greatly increasing wastewater utility participation in the bond market. The result may well be higher interest rates for all municipal bonds, thus increasing the cost of all local government services.

2.6.2 Revenue Sharing

Each unit of general government (federal, state and local) has the power to levy taxes, and to allocate the proceeds from those taxes as it sees fit. The practice of routine allocation, by one unit of government, of a portion of its tax receipts to another unit of government without specifying the exact use of the transferred funds is known as revenue sharing. Tax revenues may be shared in this fashion between units of general government at different levels (between federal and local government, for instance), or between a unit of general government and a special-purpose governmental unit, and the same or different levels. For example, a state government may provide general-purpose funds to local water utilities, or a local government may decide to allocate ten percent of all property tax proceeds to the water/wastewater utility operated by the same government.

Revenue sharing, like construction subsidies, shields utility users from the total cost of the services which they demand. Accordingly, the possibility of resource misallocation exists. Since shared revenues are not earmarked for any specific purpose within the utility, some types of misallocation can be avoided. The utility still faces the full cost of all inputs, and is free to set charges which properly reflect those costs at the margin. If that is done, with the benefit of the shared revenue transferred to customers in the form of inframarginal credits, no misallocation need occur. Where the subsidy is used to reduce charges below marginal costs, however, services and facilities are likely to be used inefficiently.

With respect to income redistribution, revenue sharing simply substitutes the income incidence of the tax sources of the donor government for the incidence of the rates and charges of the utility, at least for the fraction of total utility income which is shared revenue. Because the donor government is a ordinarily state or local entity (the federal government has no program for sharing revenue with local utilities at this time), this often amounts to substituting one regressive tax system for another. The direction of the net effect must be determined empirically; it is not subject to generalization.

To the extent that revenue sharing programs are of indefinite duration, especially if they constitute a significant fraction of total utility income, they may be destabilizing influences. The sudden termination of the subsidy would require the utility to either increase revenues or decrease outlays, or both; either step could be difficult in certain cases. Relatively small subsidies, or subsidies provided by stable, long-term revenue sharing programs, do not threaten institutional stability in any important way.

2.6.3 Cost Shifting

Cost shifting occurs when the operation and/or financing of a government-owned water/wastewater utility is combined with the operation and/or financing of some other government activity, and when utility-related costs are not or cannot be properly separated. For example, buildings and equipment may be

shared by a municipal water utility and the highways department. The associated costs are therefore joint costs, applying to both operations, and separation becomes largely arbitrary. Services provided to the utility by other government agencies (for example, legal, personnel and purchasing services) may be apparently costless (no charge is made), or a fixed annual amount may be transferred from the utility's budget irrespective of the level of service used.

Commingling of funds results in even more subtle cost shifting, deriving from problems in allocating interest earned on idle cash, assigning responsibility for short-term borrowings, etc. The cost of managing finances and of maintaining books of account are also difficult to allocate. Another form of cost shifting occurs when the utility provides services to the local government without charge: unmetered water to public buildings, unmetered water to the fire department, provision and maintenance of fire hydrants, etc. Conversely, the utility may escape property taxes on real property, costs which would be borne by investor-owned utilities.

It should be noted that cost can be shifted in either direction: the utility can either benefit or be burdened by these arrangements. Most frequently, both kinds of cost shifts occur simultaneously. It should also be clear that cost shifting is virtually inevitable whenever facilities, operations, or finances are shared. Conversely, when absolutely no sharing occurs cost shifting is not possible. Certain kinds of organizationally separate, autonomous government corporations (water/wastewater authorities, districts, or commissions of certain types), as well as investor-owned utilities, are therefore free of this problem.

Because substantial cost shifting can disguise the true nature of costs from even the most determined analyst, it makes proper rate and charge policy impossible. Misallocations of resources are almost certain to accompany cost shifting, therefore, even with the best of intentions. Cost shifting also alters the income redistributional characteristics of the utility rate structure, by either substituting some amount of local tax incidence for utility rate incidence (when the net cost shift is out of the utility), or the revers (when net cost is shifted in). The arrangements which lead to cost shifting may also be of concern from the standpoint of institutional stability, since they may deny utility managers authority over certain operations for which they are accountable, thus eroding management effectiveness.

2.6.4 Other Transfers

Numerous other possibilities exist for the transfer of funds to or from water/wastewater utility. Federal grants have been available in past years (from the U.S. Department of Agriculture) for water system construction in rural or semi-rural areas. The U.S. Department of Housing and Urban Development has subsidized some types of water and wastewater system construction in urban areas. These programs are not currently active.

Some government-owned utilities receive short-term loans of funds from local governments, either without interest or at interest rates below the current short-term market. These transactions amount to subsidies from the local government, in amounts equal to the difference between market interest cost for a similar loan and the interest actually paid, if any. In other

cases, the local government may borrow or expropriate funds accumulated by the utility with or without payment of interest or principal. Except in the case of borrowing at market interest rates, these actions cause subsidies to flow from the utility to the government (from the utility ratepayer to the general taxpayer).

Some communities have used tax-exempt industrial development bonds to provide low-cost capital to investor-owned water utilities, especially where large capital outlays are needed. This creates a subsidy to the investor-owned utility, from the federal taxpayer; it is one of the few cases where subsidies or transfers involving an investor-owned utility can occur.

All subsidies and transfers have possible implications for resource allocation, distribution of income, and institutional stability. The cases noted here are similar in this respect to construction grants, revenue sharing and cost shifting, as discussed above. In general, transfers which are small in comparison to total utility income and which do not distort cost information are of least concern. Those which are relatively large, distort costs, and are of uncertain permanence can have any of the undesirable impacts noted.

2.7 EQUITY CAPITAL

All business enterprises which produce a product or service, including water/wastewater utilities, make use of a stock of fixed assets, materials, supplies and cash. The total value of this stock of assets (fixed and current) is the capital employed in the activity. Some of the capital is obtained on terms which include definite obligations for repayment: this is debt capital, including both short-term and long-term borrowing. Other capital is contributed without such repayment obligations, and is known as equity capital. The owners of an enterprise are those who contribute the equity capital.

Contributors of equity capital to private sector enterprises expect to receive a return on their investment, after all other claims and liabilities are settled. Water/wastewater utilities are divided among government-owned organizations (having no investors, hence no capital contributed in the sole expectation of securing a return) and investor-owned utilities (similar to other private-sector firms).

2.7.1 Government Ownership

Utilities deriving their equity capital from taxpayers or ratepayers in general, rather than from specific investors, are known as government-owned, or more correctly publicly-owned utilities. These utilities are either agencies of local or state government, or they are government corporations created under the powers of local or state government. Their managements are selected by government and are accountable to government and to the public, through the political process. Those who contribute equity capital seldom do so in the expectation of receiving a return on their investment, and explicit returns are seldom provided.

Government-owned utilities obtain their equity capital in one or more of the following ways:

- Capital contributions directly by local, state or federal government;

- Capital contributions made voluntarily by or required of ratepayers, other than charges paid for services rendered; and

- Internally generated capital deriving from retained earnings and depreciation charges.

In the first case, the donors are the taxpayers of the unit of government providing the grant. The donors for the second and third cases are the ratepayers of the utility.

Funds received directly from government differ from the subsidies described earlier in that some share of utility ownership is implied by a contribution of capital. In fact, because the ownership share has tangible value, the capital contribution is not necessarily a subsidy at all. If normal, market-level returns are earned and paid, the contribution is simply an investment, not different from any other investment. If normal returns are earned but not paid (retained as a source of internally generated capital), the asset value of the utility will increase accordingly. Only where the available of "free" government-supplied capital leads to lower rates and charges does a subsidy appear: the donor government subsidizes utility ratepayers.

Capital contributed by ratepayers, either explicitly or in the form of internally generated capital, does not ordinarily earn a return. In fact, to provide a return on such capital would require increasing rates and charges to the same ratepayers who would receive the return. Such ratepayers can be thought of as providing a susbidy to themselves, by forgoing a return on their investment as a condition for lower rates.

The availability of "free" equity capital may lead to misallocation if the utility perceives capital as actually costless, or as costing less than its proper opportunity cost. This perception can arise if the utility is able to obtain additional increments of equity capital from these sources as needed, so that the cost of contributed capital influences capital investment decisions. More likely, contributed capital is not viewed as variable according to the needs of the utility, but is taken as a fixed source. Variations in capital needs are accomodated by borrowing, so that the cost of borrowing becomes the major factor in evaluating investment costs. Where this is true, no significant allocation issues arise concerning equity sources.

Because of the inherent subsidies and cross-subsidies associated with equity contributions, some attention may be given to the potential for redistribution. Subsidies generated by "free" equity capital fall unevenly on utility ratepayers. Usually, those with the largest utility bills receive the greatest subsidies. When the subsidies are provided by government, this must be matched against the incidence of the taxes used to support the subsidies. If contributions are provided by ratepayers, the incidence of those contributions is the relevant comparison. In the absence of empirical analysis, no general statements can be made about resulting redistributions.

With respect to institutional stability, the major concern is that utilities have access to adequate amounts of equity capital. The inability to

obtain equity when needed can lead to excessive use of debt (increased leverage), which may result in higher effective interest rates and, eventually, the inability to secure more debt capital. A shortage of equity capital, therefore, can cause financial crises, through higher costs and deteriorated standards of service.

2.7.2 Investor Ownership

Investor-owned utilities obtain their equity capital from individual investors, who purchase shares of stock in the corporation. Management is selected by the investors (through the board of directors) and is accountable to them. The stock shares are marketable, so that investors may recover the current value of their ownership interest at any time. Management is expected to set rates and charges, and to control costs, so that a normal, market level rate of return is paid on the contributed equity.

In most cases, investor-owned utilities are regulated by state agencies, with the power to set rates, charges and conditions of service, and to approve or disapprove investments and operating procedures. The regulatory commissions attempt to limit the return paid to shareholders to that just necessary to retain the investment in the business--the minimum normal return. To the extent that this regulatory goal is achieved, no subsidies are associated with investor-supplied equity capital. Furthermore, no actual income redistribution occurs, since investors receive only that which their investment earns.

Investor-owned utilities also make use of ratepayer equity contributions, both explicit and by virtue of internally generated capital. It is usually argued that internally generated capital should accrue to the benefit of the shareholders, rather than the ratepayers, since it is their initial contribution which makes such cash retention possible. Direct contributions by ratepayers, however, are almost universally viewed as accruing to the benefit of ratepayers, in the form of lower rates (these contributions are usually not permitted to earn a return). These contributions, therefore, are identical in their impact to similar contributions to government-owned utilities.

The principal concern regarding institutional stability in the case of investor-owned utilities has to do with the regulatory treatment these utilities receive in the various states. If regulators fail to permit adequate rates of return, new or replacement capital to utilities will not be available. Should this treatment persist over a period of time, deteriorated standards of service and financial crises will result.

SECTION 3

UTILITY FINANCIAL PRACTICES

3.1 SOURCES OF INVESTMENT FUNDS

There are no comprehensive data on sources of funds for capital investment in water and wastewater facilities. The only available information comes from surveys which (1) attempt to enumerate the various sources, without determining the amount of funds obtained from each; or (2) estimate the total funds obtained, without respect to source. Data are also available on total gross proceeds from the sale of municipal bonds during any period, but these data are not easily disaggregated according to criteria such as the purpose of the bond or the population of service area.

Two surveys are used here to establish the sources of investment funds typically used by water/wastewater utilities:

- The 1982 EPA survey [Temple, Barker & Sloane, Inc., 1982], which used a sample including 118 water utilities serving populations greater than 100,000, and received usable data on capital fund sources from 60 of these

- A 1981 rate structure survey by the Water Pollution Control Federation (WPCF) [1982], which obtained usable responses from 33 wastewater utilities serving at least 100,000 persons

These surveys cover, therefore, 23 and 17 percent of all water and wastewater utilities, respectively, in this size range (see Table 1.1 and 1.2). Since response was voluntary and participants, in the case of the WPCF survey, self-selected, the results may not be reliable quantitative indicators of the use of various sources. Instead, they provide some information as to the range of capital sources used, and the approximate intensity of use of individual sources.

3.1.1 Water Utilities

The EPA survey of water utilities is summarized as Table 3.1. It can be seen that about half of all government-owned respondents generate at least some capital internally (from user charges). The term "capital reserve" is understood to apply to the routine practice of budgeting definite sums for capital investment, as opposed to simply using any excess of revenue over budgeted expenditures for this purpose ("retained earnings").

Where depreciation accounting is used, a capital reserve can be established by funding depreciation expense, and accumulating the annual amounts in a depreciation reserve. Other utilities may follow a practice of simply allocating fixed amounts of revenue to "pay-as-you-go" capital construction. When compared to retained earnings, the capital reserve method is used more often by smaller utilities, and less often by the largest systems. Investor-owned utilities report internal generation of capital about as frequently as

TABLE 3.1
Water: Method of Financing Capital Expenditures - 1982*

Ownership/ Financing Method	Population Served (1,000) 100-500	500 - 1,000	more than 1,000	all
Government:				
Internal generation -				
Capital reserve	8	5	2	15
Retained earnings	2	2	3	7
Borrowing -				
Gen. obligation bonds	2	2	2	6
Revenue bonds	9	3	3	15
Short term loans	1	0	1	2
Other -	2	1	2	5
	(18)	(11)	(10)	(39)
Investor:				
Internal generation -				
Capital reserve	6	2		8
Retained earnings	2	0		2
Borrowing -				
Mortgage bonds	5	1		6
Tax-exempt bonds**	2	0		2
Short-term loans	5	0		5
Other -	2	0		2
	(18)	(3)	(0)	(21)

* Figures in parentheses are numbers of utilities reporting usable data; each utility may use more than one financing method in a given category.

** Industrial development bonds issued by local government on behalf of the water utility.

[Source: Adapted from Temple, Barker & Sloane, Inc., 1982.]

government-owned systems. They also tend to favor the use of a capital reserve for the smaller systems, employing retained earnings more often for larger utilities.

Where government-owned utilities use borrowing as a source for capital funds, revenue bonds are the most frequently used debt instrument. Short-term loans are used by only 2 of the 39 government-owned utilities polled. Of those investor-owned utilities which report borrowing, short-term notes are used with about the same frequency as long-term mortgage bonds. Only 2 (out of 21) investor-owned utilities reported using tax-exempt industrial development bonds.

3.1.2 Wastewater Utilities

The WPCF survey of wastewater utilities obtained the results summarized as Table 3.2. Virtually all of the 33 utilities responding generate at least some capital funds internally (through periodic or annual charges to customers). No information on the means of accomplishing this (capital reserve or retained earnings) is provided. It can also be noted that about half of the responding utilities report the use of bonds (no data are given on the relative use of revenue or general obligation bonds), and nearly all make use of grants and subsidies.

3.1.3 Municipal Bonds

With respect to the choice between revenue and general obligation bonds by local governments, one study [Helms and Clark, 1978] notes a sharp increase in the use of revenue bonds by municipalities during the period 1971-1975 (from 35 to 50 percent of all municipal bonds issued). This is attributed to financing requirements of new wastewater treatment facilities. Helms and Clark also list the major reasons for choosing revenue bonds over general obligation bonds as a source of government-owned utility investment funds:

- The municipality may be unable to issue general obligations because of legal limitations on the amount of such debt which can be outstanding

- The municipality may choose to avoid issuing debt legally payable from taxation

- Local officials may hold the view that utility facilities should be paid for by users, rather than by the community at large

- Local officials may hold the view that the utility should be self-supporting, without subsidy from general government

- General obligation issues may require voter approval, while revenue bonds usually do not

- In cases where the general obligation debt of a municipality is regarded as risky (requiring a high interest rate), revenue bonds may be considered less risky and, therefore, less expensive

TABLE 3.2
Wastewater: Method of Financing Capital Expenditures - 1981*

Financing Method	No. Utilities**
Internal generation -	
period fixed and commodity charges	31
annual fixed charges	5
Borrowing -	
Long-term bonds	14
Other -	
Grants and subsidies	27

* All utilities serve 100,000 or more persons

** 33 utilities included in sample; each utility may use more than one financing method

[Source: Data from Water Pollution Control Federation, 1982]

The use of general obligation bonds may be subject to statutory and/or institutional constraints regarding the type of projects which can be undertaken

It should also be pointed out that many water/wastewater utilities (such as those organized as autonomous, fiscally independent government corporations) may not have access to general obligation bonds, and must rely on revenue bonds as the sole instrument for long-term borrowing.

Another study of financing practices, conducted by the National League of Cities and the U.S. Conference of Mayors [1983], obtained responses from 809 cities regarding financing practices. Of 592 usable responses, 37.5 percent (222) identified general obligation bonds as the primary source of funding for expansion/new construction of all urban infrastructure; 12.5 percent use revenue bonds as the primary source. Internal generation of capital (through taxes and user charges) is the primary source for 9.1 percent of respondents, while 32 percent rely on subsidies from state and federal government.

A similar study, based on a survey of 112 U.S. and Canadian cities [American Public Works Association, 1981], found that U.S. cities use internal generation, long-term borrowing and subsidies to fund public works-related capital investments (including water and wastewater facilities). Bonds are used least often by the largest cities (60-70 percent of cities over 100,000 population use bonds, as opposed to 80-93 percent of cities under 10,000), and general obligation bonds are indicated slightly more often than revenue bonds. Among the cities of over 100,000 population responding, nearly all report internal generation of some capital (more than half using capital reserves) as well as the use of federal and state grants.

Municipal bonds are considered high-quality, low-risk investments. In spite of the recent well-publicized default of the Washington Public Power Supply System, one finance expert noted that 99.8 percent of all municipal bonds issued since 1940 are either fully paid or current in their payments [N.Y. Times, 1983a]. In addition to this comparative safety, interest income received by bondholders is exempt from federal individual income tax. Borrowers, therefore, especially those in high income brackets, are willing to accept comparatively low returns on their investments.

As of August 9, 1983, one index of municipal bond yields (the Bond Buyer municipal index of 20 bonds) stood at 9.74 percent [Business Week, 1983], at a time when short-term rates on federal government securities were in the 9.5-9.7 percent range, and the prime interest rate was 10.5 percent, about to rise to 11.0 percent [N.Y. Times, 1983b]. General obligation bonds are generally considered more secure, for any given community, than revenue bonds (there are exceptions, as noted above). Interest rates for general obligation bonds are, therefore, expected to be marginally lower.

Interest rates on municipal bonds are typically (under current money market conditions) at least three full percentage points below those charged for non-tax-exempt bonds of similar quality (high-grade utility bonds). Since this differential is attributable to the tax exemption alone, it represents a subsidy granted local governments from the federal treasury.

3.1.4 Corporate Utility Bonds

Investor-owned utilities do not normally have access to tax-exempt bonds, except where the local municipality makes the proceeds of industrial development bonds available (see Table 3.1). Bonds issued by these utilities are conventional corporate utility bonds, secured by a lien on the assets and revenues of the utility. Interest rates are determined by the market's assessment of the quality (risk) of the issue, and do not incorporate subsidies. As of August 9, 1983, high grade utility bond interest rates were in the range of 13-14 percent [Business Week, 1983], as compared to the prime rate of 10.5-11.0 percent.

3.1.5 Conclusions

Based on these several studies, it can be concluded that virtually all water and wastewater utilities generate at least some capital out of user charges (both fixed and commodity charges). No data are available to indicate what fraction of the total capital requirement is met in this way. Between one-half and two-thirds of all utilities obtain capital funds from long-term bonds. Government-owned utilities make extensive use of both general obligation and revenue bonds; there appears to be a trend toward increased use of revenue bonds. Investor-owned utilities are principally dependent on mortgage bonds and short-term borrowing.

Most government-owned utilities depend upon subsidies from state and federal governments as one source of capital funds. Both government-owned water and wastewater utilities have access to the municipal bond market, which incorporates a federal subsidy in the form of a 3.0 percentage point (approximate) differential in interest rate. Direct grants from federal and state governments are used almost universally by wastewater utilities as sources of construction funds.

3.2 APPLICATION AND RECOVERY OF INVESTMENT FUNDS

3.2.1 Application

Investment funds are applied, for the most part, to the construction of physical plant: the facilities needed to provide water and wastewater services. There is considerable variation among utilities with respect to how capital outlays are programmed (capital budgeting), and which categories of expenditures are considered to be capital outlays.

A recent survey of U.S. cities [National League of Cities and U.S. Conference of Mayors, 1983] obtained information on capital budgeting practices as they apply to municipal functions in general. No data were found on water or wastewater utilities specifically, although it can be presumed that practices typical of local government are also typical of those utilities which are agencies of local government. Independent utilities, including government corporations, may employ different capital budgeting practices.

A capital budget is defined by the National League of Cities and U.S. Conference of Mayors [1983, p. 6] as a "process for determining what projects

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[a] city needs to build or repair, where the work should be done and the best approach to financing the construction." Of the 809 cities of all sizes contacted, 605 stated that they used a capital budget, and another 152 indicated that they used some substitute process for the same purpose. Nearly 100 percent of the larger cities reported the use of capital budgets.

Table 3.3 summarizes data obtained for cities having a population of 100,000 or more. More than two-thirds use a capital budget to plan and program projects for five or more years into the future. About 20 percent employ a one year capital budget, implying that capital projects are not viewed differently from operating expenses in these cities. None of the cities in this size range stated that they had no capital budget, although about 2 percent did not respond to this question.

Table 3.4 indicates which categories of expenditures the sample cities consider to be part of capital outlay. Among the full set of cities providing data on capital budgeting practices, 45 percent indicated that preventive maintenance is (at least sometimes) included in capital budgets. Also, 79 percent include major maintenance in capital budgets. Virtually all cities provide for rehabilitation, reconstruction, expansion and new construction in their capital planning. Among cities of 100,000 population or more, 40 percent include preventive maintenance with capital outlays.

No data are available on actual capital outlays of water or wastewater utilities for each of the categories shown on Table 3.4. It is generally understood, however, that most investment by water utilities is for expansion or new construction, and that wastewater utilities spend large amounts for upgrading existing facilities (to meet higher treatment standards) as well as expansion/new construction. Preventive and major maintenance items, even when considered capital expenditures, are usually relatively small in magnitude.

3.2.2 Recovery

To the extent that investment funds are obtained by borrowing, those funds must be recovered in the future from other sources, so that principal and interest can be paid in accordance with the terms of the notes or bonds. There are two major sources for recovery of borrowed investment funds: (1) user charges and (2) anticipated grants.

Virtually all funds borrowed by water utilities, both government- and investor-owned, and most funds borrowed by wastewater utilities are ultimately recovered from user charges. The usual practice is to convert the required principal and interest payments to a uniform annual charge over the life of the debt instrument. This charge become an operating expense of the utility (debt service), and revenues are raised to cover it. The specified amount is paid into a segregated account (sinking fund), from which principal and interest payments are made.

Wastewater utilities receive large federal and state grants dedicated to the construction of upgraded treatment facilities. Since construction payments must usually be made in advance of grant receipt, some utilities borrow funds on a short term basis (grant anticipation notes) to finance construction. These funds are then recovered from the proceeds of the grant. The utility's share of the construction cost (the portion not covered by grants)

TABLE 3.3
Municipalities: Capital Budgets, by Period Covered - 1982

Time Period (years)	No. Cities	Percentage
1	25	19.7
2	2	1.6
3	5	3.9
4	6	4.7
5 or more	89	70.1
Total	127	100.0

[Includes only cities with population of 100,000 or more

Source: National League of Cities and U.S. Conference of Mayors, 1983.]

TABLE 3.4
Muncipalities: Capital Budgets, by Application of Funds - 1982

Program Category	No. Cities Including	Percentage of Total*
All Cities		
Preventive Maintenance	351	44.8
Major Maintenance	621	78.5
Rehabilitation/Reconstruction	744	93.5
Expansion/New Construction	766	95.9
Cities Over 100,000 Population		
Preventive Maintenance	51	39.8

* Percentages are based on number of cities stating that they include or do not include the program category in their capital budget; "not sure" and "no answer" are excluded.

[Source: National League of Cities and U.S. Conference of Mayors, 1983.]

is likely to be funded by internally generated funds or by long-term bonds; the bond portion is then recovered from user charges.

3.3 SOURCES OF OPERATING FUNDS

3.3.1 Water Utilities

Data collected in the course of the 1982 EPA survey of water utilities [Temple, Barker & Sloane, Inc., 1982], summarized on Table 3.5, indicate that U.S. water utilities serving populations of 100,000 or more obtain adequate revenue from user charges to defray all operating expenses. In each of the statistical categories examined, aggregate gross income (the excess of revenues from charges over operating expense) was positive and comparatively large. Government-owned utilities realize gross income which amounts to 37 percent of operating expense (or $10.52 per person served per year); gross income to investor-owned utilities is more than double operating expense ($26.48 per person served per year).

Although data are available for three population categories, no consistent relationship between gross income and population is evident. Investor-owned utilities, however, obtain much larger gross income (on a per capita basis) than government-owned systems, due to higher user charges and lower operating expense. (The lower per capita operating expense is the result of lower per capita water use, as shown on Table 1.6; per unit operating expense is slightly higher for investor-owned systems.)

3.3.2 Wastewater Utilities

Data on revenue and operating expense for wastewater utilities are available from the Bureau of the Census [1982a]. Information similar to that shown for water utilities (Table 3.5) is shown on Table 3.6. Wastewater utilities are shown to collectively recover operating expenses from user charges. Individual categories of utilities, however, may not meet this goal. In particular, utilities serving more than 1,000,000 persons do not, in general recover all operating costs from user charges; they experience a deficit equal to 11 percent of operating expense ($1.91 per person served per year). Data given on Table 3.7 indicates that utilities located Northeast and North Central states also fail to recover total operating costs.

The portion of operating costs not recovered by user charges must normally be defrayed by subsidies from local government (revenue sharing, transfers from the general fund, etc.). State and federal grants are normally restricted to capital outlays and are not available to finance operating deficits. Although the raw data are not available, it can be assumed that many wastewater utilities in each of the statistical categories experience operating deficits, while others maintain surpluses.

3.4 APPLICATION OF OPERATING FUNDS

In the case of government-owned water and wastewater utilities, operating expenses are considered to include payroll; the cost of supplies, materials,

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TABLE 3.5
Water: Per Capita Revenue and Operating Expense, by Ownership and Population Category - 1982 ($/person/yr)*

	Population Served (1,000)			
	100 - 500	500 - 1,000	more than 1,000	all
Government-Owned:				
Revenue From Charges	39.82	43.06	38.79	39.16
Operating Expense	27.56	30.95	28.02	28.64
Gross Income	12.26	12.11	10.77	10.52
	(50)	(20)	(14)	(84)
Investor-Owned:				
Revenue from Charges	48.90	52.41	32.82	48.99
Operating Expense	24.67	21.73	14.89	22.51
Gross Income	24.23	30.68	17.93	26.48
	(26)	(7)	(1)	(34)
All:				
Revenue from Charges	41.31	43.06	38.79	40.52
Operating Expense	26.76	26.37	26.92	26.73
Gross Income	14.55	16.69	11.87	13.79
	(76)	(27)	(15)	(118)

* Amounts are estimated from EPA survey samples; figures in parentheses are numbers of utilities included in averages.

[Source: Temple, Barker & Sloane, Inc, 1982.]

TABLE 3.6
Wastewater: Per Capita Revenue and Expenditures, by Population Category - Fiscal Year 1980 ($/person/yr)*

	Population Served (1,000)			
	100 - 500	500 - 1,000	more than 1,000	all
Revenue From Charges	22.37	22.80	15.66	19.65
Operating Expense	18.98	19.84	17.57	18.66
Gross Income	+3.39	+2.96	-1.91	+0.99
Construction Outlay	30.92	33.12	32.96	32.52
Other Capital Outlay	1.21	1.59	1.99	1.67
Total Capital Outlay	32.14	34.71	34.95	34.19
Net Cash Flow	-28.75	-31.75	-36.86	-33.20
	(113)	(54)	(22)	(189)

* Amounts are estimated from samples by U.S. Bureau of the Census; figures in parentheses are numbers of utilities included in averages.

[Source: Based on data from Bureau of the Census, 1982a.]

TABLE 3.7
Wastewater: Per Capita Revenue and Expenditures, by Region - Fiscal Year 1980 ($/person/yr)*

	Region				
	Northeast	South	North Central	West	All
Revenue from charges	15.15	23.73	24.74	17.54	19.65
Operating Expense	16.03	17.18	26.98	14.35	18.66
Gross Income	-0.88	+6.55	-2.24	+3.19	+0.99
Construction Outlay	36.72	31.05	37.42	20.65	32.52
Other Capital Outlay	0.85	2.92	2.00	1.56	1.67
Total Capital Outlay	37.57	33.97	39.41	22.21	34.19
Net Cash Flow	-38.45	-27.42	-41.65	-19.02	-33.20
	(69)	(41)	(57)	(22)	(189)

* All utilities serve 100,000 or more persons; amounts are estimated from samples by U.S. Bureau of the Census; figures in parentheses are numbers of utilities included in averages.

[Source: Based on data from Bureau of the Census, 1982a.]

and utilities; miscellaneous items of routine expense; depreciation expense, where charged; and payments in lieu of taxes, where charged. For investor-owned water utilities, operating expenses consist of the same items, except that actual taxes (other than corporate income taxes) are included instead of payments in lieu of taxes.

Accounting conventions differ as to whether debt service should be included as an operating expense. Limited observation suggests that at least some government-owned utilities include debt service in this category, while others do not. Investor-owned utilities generally do not treat debt service as a component of operating cost, but as something which must be funded from gross income.

It is important to note that operating expenses may be mistated for individual utilities, as a result of implicit subsidies flowing to or from the utility from or to (usually) local government. This is discussed further in the following paragraphs. To the extent that operating expense for a government-owned utility includes debt service, the expense is understated because of the interest rate subsidy. Also, to the extent that payments in lieu of taxes are not made, or are insufficient, operating expenses for government-owned utilities may not be comparable to those reported for investor-owned systems.

3.5 THE ROLE OF SUBSIDIES

3.5.1 Definition

For purposes of this report, a subsidy is defined as a transfer of money between a water/wastewater utility and a unit of federal, state or local government, other than a charge for services rendered. Transfers also occur among various groups of utility customers: these transfers, sometimes called cross-subsidies, are actually redistributional effects of rate structures, and are discussed in Section 4.

The subsidies discussed here are principally transfers from government to the utility, which lower user charges at the expense of the taxpayer. Also possible, but less common, are transfers from the utility to some unit of government: taxes are thereby lowered at the expense of the ratepayer. Subsidies, regardless of their direction, can be explicit or implicit. When explicit, they are known to all parties and documented. Implicit subsidies may be deliberate or may arise unintentionally from the financial practices of the utility and the local government; they are seldom widely known and usually undocumented and difficult to detect and measure.

3.5.2 Types of Subsidy

Section 2.6 described the major categories of subsidy affecting water/wastewater utilities. They are:

- EPA wastewater facility construction grants, including the related state construction grants

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- Revenue sharing, usually with local government
- Cost shifting, usually with local government, but including federally subsidized bond interest rates
- Other transfers, including miscellaneous grants and subsidized loans from units of government

None of these subsidies are ordinarily available to investor-owned utilities. The only exception has been the occasional use of tax-exempt industrial development bonds through a local government/utility partnership. Recent changes in federal policy with respect to these bonds may preclude such subsidies in the future. Otherwise, all four types of subsidy apply to wastewater utilities, and all except the first apply to government-owned water utilities.

3.5.3 Uses of Subsidy

Construction Grant Program

The federal construction grant program, combined with the related state matching grants, is undoubtedly the largest single subsidy in the water/wastewater sector. Table 3.8 shows the total outlays by the federal government in recent years, both in current and in constant (1982) dollars. Since fiscal year 1981, the last year for which complete data are available, the scope of the program has been reduced somewhat, but grant outlays are still close to the levels shown on Table 3.8 (the 1982 estimate is $4,291 million). In the next several years, as program changes take full effect, the size of this subsidy is expected to decline.

No data could be found on the total size of state wastewater construction grants, but they are believed to be in the range of 10-20 percent of the federal grants. Typically the state grants are awarded in conjunction with the federal grants, on a proportionate basis. If true, this would bring the overall magnitude of wastewater construction grants to over $5 billion, when measured in 1982 dollars. This total compares to the aggregate 1982 capital outlay estimated for the wastewater sector (see Table 1.3) of about $7 billion.

Revenue Sharing

A substantial number of government-owned water utilities have routine access to tax revenues, via transfers from the local government general fund. The 1982 EPA survey found that nearly 10 percent of all utilities serving populations of 100,000 or more received such transfers (see Table 3.9). Where the transfers occurred, the subsidies averaged about $12.00 per person served per year, or about 30 percent of the average user charge for customers of government-owned water utilities (see Table 3.5).

Similar transfers undoubtedly occur for wastewater utilities, but no data were found which would indicate their frequency or magnitude. Considering the prevalence of operating deficits in wastewater systems (see Tables 3.6 and 3.7), it seems likely that transfers from local general funds would be more

TABLE 3.8
Wastewater: EPA Construction Grant Program Outlays, by Fiscal Year ($ million)

Fiscal Year	Current Dollars	1982 Dollars*
1977	3,530	5,327
1978	3,187	4,461
1979	3,756	4,804
1980	4,343	5,054
1981	3,881	4,123

* Current dollar values inflated by Gross National Product fixed weight implicit price deflator [Council of Economic Advisors, 1983, p. 168]

[Sources: 1977-1980 data from Bureau of the Census, 1982a and 1981; 1981 data from Department of the Treasury, 1982.]

TABLE 3.9
Water: Subsidies to Government-Owned Utilities from Municipal General Funds, by Population Category - 1982

	Population Served (1,000)			
	100 - 500	500 - 1,000	more than 1,000	all
Percent of Utilities in Population Category Receiving Subsidy (percent)	10.0	5.6	10.0	9.6
Average Subsidy (for those receiving subsidy) ($ million)	1.64	6.73	50.0	4.23
Per Capita Subsidy (for those receiving subsidy) ($/person/year)	7.79	9.58	20.57	11.99
Estimated Total Subsidy (for all utilities in population category)* ($ million)	30.6	6.7	50.0	87.3
Estimated Total Subsidy as a Percentage of All Water Revenue (for all utilities in population category)* (percent)	1.96	1.36	5.28	2.91

* Estimates based on 27 percent sample for 100-500,000 category, and 100 percent samples for other two categories.

[Source: Temple, Barker & Sloane, 1982.]

prevalence of operating deficits in wastewater systems (see Tables 3.6 and 3.7), it seems likely that transfers from local general funds would be more common than reported for water utilities.

Cost Shifting

No data are available on the prevalence or significance of cost shifting between water/wastewater utilities and various units of government. Of the various forms of cost shifting, only the bond interest rate subsidy seems readily accessible to analysis. Such an analysis would require a comprehensive summary of outstanding utility bond indebtedness, by age of issue, together with historical data on the alternative non-tax-exempt interest rates for each year.

For bonds sold at the present time (1983) the subsidy is equal to roughly one-third of the total interest payment: the subsidy may be relatively larger or smaller for bonds sold at other times. The 1982 EPA survey reports that interest payments by government-owned water utilities serving populations of 100,000 or more average $4.32 per person served per year. If the 1983 magnitude of the interest subsidy is representative, the per capita amount of the subsidy would be about $1.50 per year. The survey noted, however, that many water utilities have no long-term debt, and consequently receive no subsidy from this source.

Other Transfers

No data are available on the prevalence or the magnitude of possible transfers in this category.

3.6 RECENT PROPOSALS

3.6.1 Privatization

A number of proposals have appeared in the recent literature pertaining to water/wastewater utility financing. Most of these involve "privatization" in one form or another, and can be placed into one of the following two categories:

- Privatization of operation and ownership, where a formerly government-owned water or wastewater utility is acquired by private investors, and operating like the investor-owned water utilities discussed here

- Privatization of specific facilities, where certain physical assets of a government-owned utility are purchased by private investors, then leased back to the utility for operation

The first proposal has been advocated by Hanke [1983], who states that private organizations are inherently more efficient than government institutions, and can therefore provide utility services at lower cost to the public. He predicts that "within the next 10 to 15 years many municipal systems will

be put up for sale, either in whole or in part." Although direct comparisons are difficult to make because of the prevalence of subsidies, both explicit and implicit, in the government-owned utility sector, there appears to be no present evidence in support of Hanke's position. There are no known cases of a government-owned utility being sold to private investors; in fact, the reverse transaction (government purchasing an investor-owned utility) is a common event.

Changes in the federal corporate income tax system, enacted since 1981, have given rise to many proposals for privatization of specific facilities. Current provisions, including investment tax credits and accelerated depreciation, permit private firms with taxable income from other sources to face negative effective taxes on certain investments. A firm would be able, therefore, to purchase a facility from a municipality, lease it back at a cost equivalent (from the muncipality's point of view) to the purchase price, and still realize lower overall tax liability.

This arrangement amounts to a subsidy from the federal treasury to the lessor and, to the extent that net benefits accrue to the municipality, to the lessee. No efficiency gains would be expected, since no change in actual operation or investment policy occurs. A review of the recent literature has disclosed no reported instance of such a strategy applied to a government-owned water or wastewater utility, although applications have been reported for other municipal public works facilities (an incinerator in Baltimore, MD, for example).

3.6.2 Autonomous Water/Wastewater Utilities

Students of the water utility sector have long advocated the formation of autonomous, fiscally self-sufficient utilities which have the power to set rates to cover all costs. Although specific data are not available, there are large numbers of completely self-sufficient water utilities, some organized as government corporations and others operating as agencies of local government. These utilities must raise revenues from user charges which defray operating expense, payments in lieu of taxes to the local government, debt service, and any capital expenditure not supported by borrowed funds. To the extent that long-term borrowing is practiced, however, small subsidies may still be received via the tax-exempt bond interest rate.

As pointed out by Kish [1980], this level of self-sufficiency is unknown in the wastewater utility field. Virtually all wastewater systems receive relatively large state and federal subsidies for treatment plant construction, and most systems fall short of self-sufficiency even if the construction grants are ignored. There has been some movement toward creating more autonomous wastewater utilities in recent years. Many combined water/wastewater regional authorities already enjoy this status (Washington Suburban Sanitary Commission (MD) and the East Bay Municipal Utility District (CA) are two notable examples).

Some cities (such as Baltimore, MD) have created financially independent wastewater agencies within city government. Increased self-sufficiency will result in higher user charges in the short run, and still higher charges as the EPA construction grant program is eventually phased out. It will, at the same time, reduce the burden of these programs on the general taxpayer.

SECTION 4

UTILITY RATE-MAKING PRACTICES

As described in Section 3, user charges comprise the largest single source of funds for water/wastewater utilities in the U.S. These funds are derived from the application of a relatively complex set of rates and charges, known collectively as the rate structure, or tariff, of the utility. Each utility determines which types of rate and charge will be used, and how the amount of each rate or charge will be calculated. The total amount collected from all rates and charges, or the amount collected from any specified group of rates and charges, is the rate level.

The major objective, from the utility's point of view, of rates and charges--to collect a specified amount of revenue--is met by setting an appropriate rate level. Within limits, any rate structure can produce sufficient revenue, provided the rate level is set high enough. The choice of rate structure is important, however, as it determines the allocative efficiency with which water and wastewater services will be produced and used, the distributional effects of the user charge system, and other impacts such as institutional stability, public acceptance, etc.

Although the list of possible variations in utility rate structure is nearly endless, a relatively small number of general types (rate forms) are in common use. This section reviews the use of these rate forms by water and wastewater utilities, and the general consequences of observed practice. The rate-setting process is also discussed, with emphasis on legal and institutional barriers to innovation and change.

4.1 USE OF ALTERNATIVE RATE FORMS

4.1.1 Metering

In determining rate-making policy, the first choice to be made is whether water customers are to be metered. When customers are metered, a commodity charge can be applied to water and wastewater; customers who are not metered can be billed only under flat rate systems. As noted in Section 2, there are many allocational and distributional advantages to the use of commodity charges. On the other hand, metering individual connections is expensive (especially where meters must be installed in existing buildings), and the use of a commodity charge requires that the meters be read and the resulting data processed at regular intervals (billing periods).

The decision to meter is separate from the decision to apply a commodity charge: metering is a prerequisite to commodity charges, but commodity charges do not necessarily follow metering. Residential users in Australia, for example, are universally metered, but most pay a flat rate based on property valuation for both water and wastewater service. In the U.S., many communities use a commodity charge for water service, but a flat rate for wastewater service.

The most general practice in the U.S. is to meter all connections, and to use commodity charges of some kind for both water and wastewater. There are numerous exceptions to this statement, however. Table 4.1 shows the extent of metering by water utility ownership and population category. All groups examined are at least 94 percent metered in aggregate, except government-owned utilities serving 1 million persons or more: these utilities are only 82 percent metered as a group. This exception is caused by the presence of New York City and Chicago--only 23 and 31 percent metered, respectively-- in the sample. In spite of these large partially metered government-owned utilities, the extent of metering does not differ appreciably between government-owned and investor-owned utilities.

Available data on the extent of metering are likely to be misleading with respect to one important user class: multi-family residences. A multi-family structure, which may contain from several to several hundred individual dwelling units, is counted as metered if a single master meter is provided. The 1980 U.S. Census indicates that 30 percent of all housing units are in structures containing 2 or more units, and 18 percent are in buildings with 5 or more units [Bureau of the Census, 1982b]. Available surveys make no reference to multi-family metering practice, but discussion in the literature implies that individual metering is rare. Metering data shown here, therefore, can be interpreted as applying to connections (buildings, generally), not dwelling units. A utility which is reported to be 100 percent metered may still include a substantial number of household units which are not individually metered.

Table 4.2 shows the same sample data displayed on Table 4.1, arranged by water utility ownership and region. No large differences appear among the regions, except the South, which contains no sampled utilities less than 95 percent metered. Investor-owned utilities are, again, similar to government-owned systems, except in the Northeast, where the private systems average only 92 percent metered (as compared to 96 percent for the public systems).

It should be noted that both Tables 4.1 and 4.2 include a substantial number of utilities which are fully metered (110 out of 132). Table 4.3 shows, by ownership and population category, the metered fractions for only those utilities which are <u>not</u> fully metered (not more than 99 percent metered). There are only 16 public systems and 6 investor-owned systems in the sample which meet this criterion. These 22 partially metered systems are collectively 77 percent metered: the investor-owned systems generally meter a larger number of connections than the government-owned utilities. The same data are shown as Table 4.4, organized by region. Once again, all partially metered utilities in the South are likely to meter a larger fraction of connections than utilities elsewhere; investor-owned utilities meter more completely than government-owned systems in all regions.

4.1.2 Billing Periods

Another fundamental choice in the development of rate-making policy is the definition of the billing period: the interval at which meters will be read (where used) and bills rendered. Short billing periods create higher meter reading, billing and collection costs; they also improve the reponse of customers to changes in the rate structure, reduce adverse customer reactions to high bills and improve cash flow for the utility.

TABLE 4.1
Water: Fraction Connections Metered, by Population Category and Ownership - 1981*

Ownership	Population Served (1,000) 100 - 500	500 - 1,000	more than 1,000	all
Government:				
Mean	0.98	0.99	0.82	0.96
Maximum	1.00	1.00	1.00	1.00
Minimum	0.22	0.95	0.23	0.22
	(82)	(16)	(11)	(109)
Investor:				
Mean	0.94	0.99	0.94	0.95
Maximum	1.00	1.00	1.00	1.00
Minimum	0.38	0.99	0.78	0.38
	(16)	(3)	(4)	(23)
All:				
Mean	0.97	0.99	0.85	0.96
Maximum	1.00	1.00	1.00	1.00
Minimum	0.22	0.95	0.23	0.22
	(98)	(19)	(15)	(132)

* Figures in parentheses are number of utilities reporting usable data.

[Source: Based on data from American Water Works Association, 1981.]

TABLE 4.2
Water: Fraction Connections Metered, by Region and Ownership - 1981*

Ownership	Region: Northeast	South	North Central	West	All
Government:					
Mean	0.96	0.99	0.96	0.93	0.96
Maximum	1.00	1.00	1.00	1.00	1.00
Minimum	0.23	0.95	0.31	0.22	0.22
	(26)	(28)	(33)	(22)	(109)
Investor:					
Mean	0.92	0.99	0.98	0.94	0.95
Maximum	1.00	1.00	1.00	1.00	1.00
Minimum	0.38	0.99	0.91	0.78	0.38
	(9)	(2)	(8)	(4)	(23)
All:					
Mean	0.95	0.99	0.96	0.93	0.96
Maximum	1.00	1.00	1.00	1.00	1.00
Minimum	0.23	0.95	0.31	0.22	0.22
	(35)	(30)	(41)	(26)	(132)

* All utilities serve 100,000 or more persons; figures in parentheses are numbers of utilities reporting usable data.

[Source: Based on data from American Water Works Association, 1981.]

TABLE 4.3
Water: Fraction Connections Metered for Utilities not more than 99% Metered, by Population Category and Ownership - 1981*

Ownership	Population Served (1,000) 100 - 500	500 - 1,000	more than 1,000	all
Government:				
Mean	0.83	0.96	0.34	0.75
Maximum	0.99	0.98	0.48	0.99
Minimum	0.22	0.95	0.23	0.22
	(11)	(2)	(3)	(16)
Investor:				
Mean	0.82		0.78	0.81
Maximum	0.99		0.78	0.99
Minimum	0.38		0.78	0.38
	(5)	(0)	(1)	(6)
All:				
Mean	0.83	0.96	0.45	0.77
Maximum	0.99	0.98	0.78	0.99
Minimum	0.22	0.95	0.23	0.22
	(16)	(2)	(4)	(22)

* Figures in parentheses are number of utilities not more than 99% metered which reported usable data.

[Source: Based on data from American Water Works Association, 1981.]

TABLE 4.4

Water: Fraction Connections Metered for Utilities not more than 99% Metered, by Region and Ownership - 1981*

Ownership	Region: Northeast	South	North Central	West	All
Government:					
Mean	0.54	0.97	0.75	0.67	0.75
Maximum	0.84	0.99	0.99	0.98	0.99
Minimum	0.23	0.95	0.31	0.22	0.22
	(2)	(4)	(5)	(5)	(16)
Investor:					
Mean	0.64	0.99	0.91	0.78	0.81
Maximum	0.90	0.99	0.92	0.78	0.99
Minimum	0.38	0.99	0.91	0.78	0.38
	(2)	(1)	(2)	(1)	(6)
All:					
Mean	0.59	0.97	0.80	0.69	0.77
Maximum	0.90	0.99	0.99	0.98	0.99
Minimum	0.23	0.95	0.31	0.22	0.22
	(4)	(5)	(7)	(6)	(22)

* All utilities serve 100,000 or more persons; figures in parentheses are numbers of utilities not more than 99% metered which reported usable data.

[Source: Based on data from American Water Works Association, 1981.

Data are available on water utility billing periods from the AWWA survey; no data were found on wastewater billing periods, but these are assumed similar to water utility practice (because of the high incidence of joint billing). Table 4.5 is a summary of billing periods, by utility ownership and population category. The same information is provided by region on Table 4.6.

Because of a flaw in the AWWA survey instrument, responses indicating 1 month billing periods are confounded with lack of response (respondents were directed to provide the billing period if it is not 1 month). Nothing is known, therefore, of the degree to which 1 month billing periods are used. The table shows that 68 percent of all utilities, regardless of ownership, choose billing periods of 2 or more months. One government-owned utility reported a 12 month billing period, and 3 reported 6 months. Government-owned utilities seem more likely than investor-owned systems to use a 2 month period. Table 4.6 shows that shorter billing periods are strongly preferred in the South and the West. In general, 2 and 3 month periods are the most common choices.

Although the AWWA survey sought a single answer to the billing period query, many utilities have more than one billing period. A common arrangement is a 1 month period for a relatively few "large" customers (those with monthly consumption above a certain level, or those provided with connections larger than a certain size), and a 2 or 3 month period for all other customers. Since the few large customers may comprise as much as one-third of total revenue, this policy improves cash flow at the cost of a small number of additional bills.

4.1.3 Rate Forms

Commonly used rate forms include flat rates, uniform rates, and both declining and increasing block-type rates. Examples of all of these (except flat rates) are shown as Table 2.2. As described in Section 2, flat rates may take many forms, but are similar in that they are not based on water use (are not commodity charges). Commodity charges may be accompanied by periodic fixed charges which, in turn, may be minimum charges (including a specified quantity of water use) or service charges (including no water use). Block-type rates vary widely as to the number and size of the blocks, and the differentials in water rates between blocks. No survey data are available on specific block designs, or on the degree of uniformity or diversity among them.

Survey data on rate design are available from the 1982 EPA survey (water utilities) and from the 1981 WPCF survey (wastewater rates). The WPCF survey, in particular, is comparatively small, and utilizes a possibly biased sample. Still, the surveys provide some overview of the range of practice, although quantitative results must be used with caution.

The EPA results for all water utilities are shown as Table 4.7, organized by population category. It can be seen that, of the 83 utilities reporting a single type of commodity charge, 50 use the declining-block form. No data are available for those utilities who reported more than one rate form in use, but it is likely that declining block forms are chosen frequently. Only 4 of 115 utilities providing data reported no commodity charges: these utilities use a flat rate independent of water use. Of the 57 utilities with periodic fixed

TABLE 4.5
Water: Billing Period, by Population Category and Ownership - 1981 (no. of utilities)

Ownership	Population Served (1,000) 100 - 500	500 - 1,000	more than 1,000	all
Government:				
12 mos.	1	0	0	1
6 "	3	0	0	3
3 "	23	7	4	34
2 "	30	4	4	38
1 mo. or no data	28	5	3	36
Total	85	16	11	112
Investor:				
12 mos.	0	0	0	0
6 "	0	0	0	0
3 "	9	1	3	13
2 "	4			4
1 mo. or no data	5	2	1	8
Total	18	3	4	25
All:				
12 mos.	1	0	0	1
6 "	3	0	0	3
3 "	32	8	7	47
2 "	34	4	4	42
1 mo. or no data	33	7	4	44
Total	103	19	15	137

[Source: Based on data from American Water Works Association, 1981.]

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TABLE 4.6
Water: Billing Periods, by Region and Ownership - 1981 (months)*

Ownership	Region: Northeast	South	North Central	West	All
Government:					
12 mos.	1	0	0	0	1
6 "	3	0	0	0	3
3 "	19	2	11	2	34
2 "	3	8	10	18	39
1 mo. or no data	1	19	11	4	35
Total	27	29	32	24	112
Investor:					
12 mos.	0	0	0	0	0
6 "	0	0	0	0	0
3 "	8	1	5	0	14
2 "	0	0	1	2	3
1 mo. or no data	2	1	3	2	8
Total	10	2	9	4	25
All:					
12 mos.	1	0	0	0	1
6 "	3	0	0	0	3
3 "	27	3	16	2	48
2 "	3	8	11	20	42
1 mo. or no data	3	20	14	6	43
Total	37	31	41	28	137

* All utilities serve populations of 100,000 or more

[Source: Based on data from American Water Works Association, 1981.]

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TABLE 4.7
Water: Characteristics of Rate Structures, by Population Category - 1982*

No. of Utilities With Rate Element	Population Served (1,000) 100 - 500	500 - 1,000	more than 1,000	all
All:				
Commodity Charges:				
Uniform Charge	13	5	6	24
Declining Block	36	10	4	50
Increasing Block	7	1	1	9
Multiple Charge Types	17	10	1	28
None	2	1	1	4
Total	75	27	13	115
Periodic Fixed Charges:				
Service Charge	22	5	5	32
Minimum Charge	13	5	3	21
Flat Rate	2	1	1	4
None	21	6	4	31
Total	58	17	13	88

* Each utility may use more than one rate element in a given category

[Source: Adapted from Temple, Barker & Sloane, Inc., 1982.]

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charges, more than half use a service charge, rather than a minimum. No significant differences among population categories are evident.

Table 4.8 provides the same information as Table 4.7, except that government-owned utilities are separated from investor-owned systems. The most striking result is the marked preference of investor-owned utilities for the declining-block rate form: 20 out of 25 utilities reporting commodity charge forms use this design. By contrast, uniform commodity charges assume greater importance for government-owned systems; declining-block forms are used by only one-half of those public systems reporting rate form. It is also evident that government-owned systems prefer service charges, while investor-owned utilities favor minimum charges.

Table 4.8 also shows the result of a trend away from declining-block rate forms which has accelerated in the last ten years. Many government-owned utilities, in response to consumer pressure or as a means of reducing water use, have replaced declining-block forms with uniform rates or, in some cases, increasing-block rates. There are no data on the number of utilities who may have retained declining-block designs, but have reduced the number of steps or the rate differential between them.

Wastewater rate design data are shown on Table 4.9. With respect to commodity charges, 25 of the 32 utilities surveyed have some form of commodity charge, and 21 of those use a uniform charge on water use. Declining-block forms are much less prevalent, used by either 3 or 4 (depending on the circumstances of the water bill surcharge response) of the 25 utilities. Periodic fixed charges are almost evenly divided between service charges and minimum charges. Relatively few wastewater utilities report the use of annual fixed charges.

Table 4.9 also shows that 26 out of 32 respondents utilize some form of industrial waste charge. Typically, these charges supplement the normal commodity charge (based on quantity) and are based on wastewater strength, usually measured by biochemical oxygen demand (BOD) or suspended solids concentrations. By setting unit charges for these strength indicators, the charges create incentives for industrial dischargers to utilize pretreatment, where that option is more efficient than centralized treatment.

4.1.4 Rate Levels

The overall rate level for water and wastewater utilities is discussed in Section 3. Water utilities, in general, use commodity charges to generate revenue sufficient to recover operating expense, debt service and some portion of capital outlay requirements. Wastewater utilities, on the other hand, set user charges which barely cover operating expense. Within the framework of these overall rate levels, it is helpful to examine differential rate levels among the various sizes and types of utility, and among various classes of customer.

Table 4.10 shows average costs of water service for various types of utility, disaggregated by customer class. In all cases, residential customers face substantially higher average costs than customers in other classes. This differential is particular noticeable for investor-owned utilities, where average costs to residential users are 45 percent greater than those applying

TABLE 4.8
Water: Characteristics of Rate Structures, by Population Category and Ownership - 1982*

Ownership/ No. of Utilities With Rate Element	Population Served (1,000) 100 - 500	500 - 1,000	more than 1,000	all
Government:				
Commodity Charges:				
Uniform Charge	12	5	6	23
Declining Block	20	7	3	30
Increasing Block	4	0	1	5
Multiple Charge Types	11	7	1	19
None	2	1	1	4
Total	49	20	12	81
Periodic Fixed Charges:				
Service Charge	15	5	5	25
Minimum Charge	6	2	2	10
Flat Rate	2	1	1	4
None	15	5	4	24
Total	38	13	12	63
Investor:				
Commodity Charges:				
Uniform Charge	1	0	0	1
Declining Block	16	3	1	20
Increasing Block	3	1	0	4
Multiple Charge Types	6	3	0	9
None	0	0	0	0
Total	26	7	1	34
Periodic Fixed Charges:				
Service Charge	7	0	0	7
Minimum Charge	7	3	1	11
Flat Rate	0	0	0	0
None	6	1	0	7
Total	20	4	1	25

* Each utility may use more than one rate element in a given category.

[Source: Adapted from Temple, Barker & Sloane, Inc., 1981.]

TABLE 4.9
Wastewater: Characteristics of Rate Structures - 1981*

Rate Element	No. Utilities** Yes	No	Total
Commodity Charges:	25	7	32
Water Bill Surcharge	1		
Uniform Charge	21		
Declining Block	3		
Industrial Waste Charge	26	6	32
Period Fixed Charges:	27	5	32
Service Charge	9		
Minimum Charge	11		
Flat Rate	7***		
Annual Fixed Charges:			
Ad Valorem Tax	3		
Benefit Assessments	3		
One-Time-Only Charges:			
Connection Charge	23	2	25

* All utilities serve 100,000 or more persons.

** 33 utilities included in sample; each utility may use more than one rate element in a given category.

*** Not including 2 utilities with commodity charges which also report flat rates for unmetered customers.

[Source: Data from Water Pollution Control Federation, 1982.]

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TABLE 4.10
Water: Average Cost, by Customer Class, Population Category and Ownership - 1982 (cents/cubic meter)*

Ownership	Population Served (1,000) 100 - 500	500 - 1,000	more than 1,000	all
Government:				
Residential	23.93 (26)	17.51 (12)	16.48 (6)	21.17 (44)
Commercial/ Industrial	16.19 (26)	14.53 (12)	13.42 (6)	15.36 (44)
Wholesale	17.83 (19)	18.52 (11)	19.21 (6)	18.27 (36)
Investor:				
Residential	43.01 (21)	33.00 (5)	22.35 (1)	40.39 (27)
Commercial/ Industrial	28.32 (20)	28.16 (5)	14.71 (1)	27.77 (26)
Wholesale	20.73 (14)	20.13 (3)	10.43 (1)	20.06 (18)
All:				
Residential	27.05 (47)	22.03 (17)	16.85 (7)	24.84 (71)
Commercial/ Industrial	18.18 (46)	18.49 (17)	13.50 (7)	17.78 (70)
Wholesale	18.31 (33)	18.99 (14)	18.65 (7)	18.53 (54)

* Figures in parentheses are number of utilities providing usable data.

[Source: Temple, Barker & Sloane, Inc., 1982.]

to commercial and industrial customers, and more than twice those stated for wholesale customers. Because some utilities do not sell water at wholesale, however, the latter comparison may suffer from small sample bias.

All classes of utility show significant economies of scale with respect to retail rates: the larger the utility, the lower the average price. This relationship is not apparent for wholesale customers, perhaps a result of the small number of utilities with wholesale customers.

Large absolute differences between government-owned and investor-owned utilities continue to be evident: residential users on public systems pay nearly twice as much as those on investor-owned systems for a cubic meter of water. The consequences of this price differential are shown on Table 4.11. Residential per capita use rates are substantially lower for investor-owned systems. The only exception is the single investor-owned utility serving more than 1 million persons, which happens to have a relatively low rate level when compared to other investor-owned utilities (see Table 4.10).

A crude comparison, using data from Tables 4.10 and 4.11, reveals that a price increase of 90.8 percent (investor-owned average price to residential users, compared to government-owned average price) is associated with a per capita use decrease of 12.3 percent. These data are consistent with price elasticity of demand on the order of -0.2, similar to results of past studies of residential water demand. The differences in water use, therefore, may be fully explained by differences in rate level between government-owned and investor-owned systems.

No data on average cost by customer class were found for wastewater systems.

Another means of comparing various types of utilities is by calculation of typical residential bills. The typical bill is the monthly cost to a residential user with water usage that is considered "typical." The AWWA survey obtained information on the cost of 28.4 cubic meters per month, an amount close to the average monthly usage of single family residences. The results are tabulated on Table 4.12. The same differential between government-owned and investor-owned systems is seen, as well as falling monthly cost with increasing utility size. On average, a residential customer pays $7.63 per month for 28.4 cubic meters of water, although some customers pay as much as $17.88 and others as little as $2.19 (an 8 to 1 variation).

The same data are shown on Table 4.13, arranged by region. Residential bills are generally lowest in the South and the West, and highest in the Northeast. Investor-owned utilities, in particular, have lower rates in the West.

Similar analyses can be performed for wastewater customers, using the results of the WPCF survey. That survey, however, simply asked utilities to state the monthly bill for a typical residential customer, without specifying the level of water use to be considered "typical." The data received is no doubt inconsistent to some degree, as utilities apply different definitions of "typical" (some used 39.4 cubic meters per month water use, most did not specify their assumptions).

Tables 4.14 and 4.15 show the results, by population category and by

TABLE 4.11
Water: Per Capita Residential Use, by Population Category and Ownership - 1982 (liters/person/day)*

Ownership	Population Served (1,000) 100 - 500	500 - 1,000	more than 1,000	all
Government	330 (34)	351 (13)	219 (8)	318 (55)
Investor	280 (22)	274 (5)	274 (1)	279 (28)
All	322 (56)	329 (18)	222 (9)	312 (83)

* Figures in parentheses are number of utilities providing usable data

[Source: Temple, Barker & Sloane, Inc., 1982.]

TABLE 4.12
Water: Typical Residential Bill, by Population Category and Ownership - 1981 ($/month)*

Ownership	Population Served (1,000) 100 - 500	500 - 1,000	more than 1,000	all
Government:				
Mean	7.04	6.66	5.34	6.82
Maximum	14.45	9.73	8.27	14.45
Minimum	2.84	3.85	2.19	2.19
	(82)	(16)	(11)	(109)
Investor:				
Mean	11.76	10.10	10.09	11.35
Maximum	17.88	13.04	12.06	17.88
Minimum	3.73	7.17	7.51	3.73
	(18)	(3)	(3)	(24)
All:				
Mean	7.89	7.20	6.36	7.63
Maximum	17.88	13.04	12.06	17.88
Minimum	2.84	3.85	2.19	2.19
	(100)	(19)	(14)	(133)

* Amounts are for average monthly water use of 28.4 cu. meters; figures in parentheses are number of utilities reporting usable data.

[Source: Based on data from American Water Works Association, 1981.]

TABLE 4.13
Water: Typical Residential Bill, by Region and Ownership - 1981 ($/month)*

Ownership	Northeast	South	North Central	West	All
		Region			
Government:					
Mean	7.49	6.54	6.58	6.72	6.82
Maximum	13.48	11.27	14.00	14.45	14.45
Minimum	4.37	2.90	2.19	2.84	2.19
	(26)	(28)	(32)	(23)	(109)
Investor:					
Mean	13.11	10.79	11.42	5.60	11.35
Maximum	17.69	11.78	17.88	7.17	17.88
Minimum	7.33	9.79	3.96	3.73	3.73
	(10)	(2)	(9)	(3)	(24)
All:					
Mean	9.05	6.83	7.64	6.59	7.63
Maximum	17.69	11.78	17.88	14.45	17.88
Minimum	4.37	2.90	2.19	2.84	2.19
	(36)	(30)	(41)	(26)	(133)

* All utilities serve 100,000 or more persons; amounts are for average monthly water use of 28.4 cu. meters; figures in parentheses are numbers of utilities reporting usable data.

[Source: Based on data from American Water Works Association, 1981.]

TABLE 4.14
Wastewater: Typical Residential Bill, by Population Category - 1981 ($/month)*

	Population Served (1,000)			
	100 - 500	500 - 1,000	more than 1,000	all
Mean	7.25	8.52	5.44	6.95
Maximum	15.08	14.18	8.32	15.08
Minimum	3.10	4.50	1.97	1.97
	(20)	(4)	(8)	(32)

* All utilities serve 100,000 or more persons; amounts are as stated by utilities for "typical" residential water use (in some cases defined as 39.4 cu. meters/month); figures in parentheses are numbers of utilities reporting usable data.

[Source: Data from Water Pollution Control Federation, 1982.]

TABLE 4.15
Wastewater: Typical Residential Bill, by Region - 1981 ($/month)*

	Region				
	Northeast	South	North Central	West	All
Mean	9.06	7.46	4.61	6.37	6.95
Maximum	15.08	9.18	7.58	14.18	15.08
Minimum	6.00	5.55	1.97	3.10	1.97
	(8)	(7)	(6)	(11)	(32)

* All utilities serve 100,000 or more persons; amounts are as stated by utilities for "typical" residential water use (in some cases defined as 39.4 cu. meters/month); figures in parentheses are numbers of utilities reporting usable data.

[Source: Data from Water Pollution Control Federation, 1982.]

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region, respectively. Wastewater bills are substantially lower than water bills, and no clear economies of scale are evident. The average bill is $6.95 per month (as of 1981), and some utilities charge as much as $15.08 and others as little as $1.97 (a nearly 8 to 1 variation). Also, wastewater bills are somewhat lower in the West, and markedly lower in the North Central states.

4.1.5 Connection Charges

Survey data show that most utilities levy a one-time charge for new connections (Table 4.9 indicates that 23 of 25 wastewater utilities report such a charge). No statistical analyses of these charges were found; available information is limited to the practices of a small number of individual utilities.

Connection charges range from relatively small "tap permit fees" to substantial charges which include an explicit capital contribution to the system. In the first category, San Jose, California, charges $23.00 for new residential wastewater connections. Cincinatti, Ohio, levies a $40.00 charge for the same service. Some utilities, of course, make no charge at all (New Orleans, for example), while others simply bill the property owner for the actual cost of connection construction (Cambridge, Mass.) [WPCF, 1982].

Among utilities collecting amounts in excess of connection construction cost, East Bay Municipal Utility District (California) makes three distinct charges for new water connections: (1) a new customer account charge of $12.50; (2) an installation charge, currently $750 for a typical residential connection to an existing main; and (3) a system capacity charge. The District is presently considering a revision to the system capacity charge which would provide spatially differentiated levies ranging from $200 (at the lowest elevations) to $3,500 (at the highest, most remote locations) for residential customers [East Bay MUD, personal communication, 1983]. The WPCF survey [1982] noted wastewater connection charges as high as $1,000 per residential connection (Reno-Sparks, Nevada), although other utilities are believed to set higher charges.

Larger connections (for commercial, institutional and industrial users) are usually associated with higher charges (East Bay MUD has proposed system capacity charges as high as $840,000 for 12-inch connections with turbine meters). Wastewater utilities sometimes base industrial connection charges on the anticipated characteristics of the wastewater (San Jose, California, charges an additional $13,000 for each 1,000 lbs./day of BOD, and $7,000 for each 1,000 lbs/day of suspended solids). Other charges are based on estimated peak flow (Los Angeles), on average flow (Miami, Florida), or on number of plumbing fixtures (Reno-Sparks, Nevada).

4.2 THE RATE-SETTING PROCESS

4.2.1 Rate-Setting Practice

Relatively little is known of overall experience with rate changes by water/wastewater utilities. Survey data do not indicate how many rate proposals are rejected (especially for government-owned utilities) or modified be-

fore the final decision is made. Data on requests and approvals exist only in the case of rate proposals reviewed by state regulatory agencies, and these data are difficult to collect and summarize meaningfully.

The 1981 AWWA survey provides information on rate increase frequency for water utilities. Table 4.16 shows these data, organized by ownership and population category. Government-owned utilities are seen to average 2.2 years since the last rate increase, while investor-owned utilities average 1.2 years. At least some of the difference is attributable to several government-owned utilities which have not increased rates in many years (11.5 years in one case). No clear trend in rate increase frequency with respect to utility size can be detected.

Table 4.17 shows the same data displayed on Table 4.16, now organized by region. The relatively recent rate increases shown on Table 4.16 for investor-owned utilities appear here for every region. No other relationships are evident, except the slightly higher frequency of rate increases in the North Central states.

Table 4.18 shows data from the 1982 EPA survey of water utilities regarding the prevalence of rate review by state regulatory commissions. It can be seen that about 23 percent of all government-owned utilities responding are required to undergo review by a state agency. As expected, virtually all of the investor-owned utilities are subject to such review.

4.2.2 Government-Owned Utilities

Proposals for rate changes affecting government-owned utilities begin with utility management. Typically, the proposal arises out of a recognition that anticipated revenue is inadequate to meet current or anticipated costs. Utility management proposes increased rate levels, sometimes suggesting changes in the structure or relationship of charges.

There are two distinct ways in which such a proposal may be dealt with. The first way, typical of government agencies (utilities operated as an agency of local government), requires that the proposal be approved by the elected administrative and legislative officials of the community. In the case of a mayor-council government, the mayor may reject the proposal immediately, modify it, or accept it as drafted by the utility management. The proposal then moves to the city council, where it is the subject of debate, possibly including public hearings. The council may reject the increase, modify it, or approve it as offered.

This process provides considerable opportunity for rejection or modification of the rate proposal by individuals who are not responsible, and may not be held responsible by the public, for the operation of the utility. There are strong incentives for irresponsible behavior: councilmen can seek the credit for stopping or reducing utility rate hikes, while avoiding the blame for later deterioration of service. The process is slow and unpredictable as to outcome; local official do not welcome rate change proposals and may exert considerable pressure on utility management to avoid submitting them.

The second type of rate-setting process is typical of the independent government corporation, such as a regional water or wastewater authority. In

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TABLE 4.16
Water: Years Since Last Rate Increase, by Population Group and Ownership - 1981 (years)*

Ownership	Population Served (1,000) 100 - 500	500 - 1,000	more than 1,000	all
Government:				
Mean	2.2	1.7	2.6	2.2
Maximum	11.5	5.5	4.5	11.5
Minimum	0.5	0.5	1.5	0.5
	(80)	(16)	(9)	(105)
Investor:				
Mean	1.3	1.0	1.0	1.2
Maximum	2.5	1.5	1.5	2.5
Minimum	0.5	0.5	0.5	0.5
	(15)	(2)	(2)	(19)
All:				
Mean	2.1	1.6	2.3	2.0
Maximum	11.5	5.5	4.5	11.5
Minimum	0.5	0.5	0.5	0.5
	(95)	(18)	(11)	(124)

* Figures in parentheses are number of utilities reporting usable data.

[Source: Based on data from American Water Works Association, 1981.]

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TABLE 4.17
Water: Years Since Last Rate Increase, by Region and Ownership - 1981 (years)*

Ownership	Region: Northeast	South	North Central	West	All
Government:					
Mean	2.5	2.6	1.6	2.0	2.2
Maximum	6.5	11.5	6.5	5.5	11.5
Minimum	0.5	0.5	0.5	0.5	0.5
	(26)	(29)	(29)	(21)	(105)
Investor:					
Mean	1.3	1.5	1.3	0.5	1.2
Maximum	1.5	1.5	2.5	0.5	2.5
Minimum	0.5	1.5	0.5	0.5	0.5
	(8)	(1)	(9)	(1)	(19)
All:					
Mean	2.2	2.6	1.5	2.0	2.0
Maximum	6.5	11.5	6.5	5.5	11.5
Minimum	0.5	0.5	0.5	0.5	0.5
	(34)	(30)	(38)	(22)	(124)

* All utilities serve 100,000 or more persons; figures in parentheses are numbers of utilities reporting usable data.

[Source: Based on data from American Water Works Association, 1981.]

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TABLE 4.18
Water: Utilities Requiring Approval of State Regulatory Agency for Rate Changes, Population Category and Ownership - 1982

Ownership	Population Served (1,000) 100 - 500	500 - 1,000	more than 1,000	all
Government:				
Required	13	4	2	19
Not Required	36	16	11	63
No Answer	1	0	1	2
Total	50	20	14	84
Investor:				
Required	26	6	1	33
Not Required	0	1	0	1
No Answer	0	0	0	0
Total	26	7	1	34
All:				
Required	39	10	3	52
Not Required	36	17	11	64
No Answer	1	0	1	2
Total	76	27	15	118

[Source: Temple, Barker & Sloane, Inc., 1982.]

this case, the proposal also begins with management. The approving authority, however, is the board of control (board of directors, authority members, etc.). These individuals, who may be appointed or elected, are responsible both in fact and in the view of the public for the successful operation of the utility. They are, therefore, motivated to consider requests for rate increases on their merits. Political considerations are not absent, of course, but board members must take ultimate responsibility for any short-sighted actions taken in the interest of public favor.

The management/board process is likely to be more technical in nature, and predictable as to outcome, than the management/council process. Since independent utility boards usually lack the power to grant subsidies from the public treasury, they are obliged to set rates which cover anticipated costs, net of any subsidies that may already be available. Financial disruption and instability are less likely to occur.

A variation on the two processes described occurs when the final rate decision is subject to review by a state regulatory agency. In the case of government-owned utilities, this review is often confined to rates applying outside the political jurisidiction which owns the utility. Also, the state agency's examination is likely to be less comprehensive than similar reviews of investor-owned utility proposals. In either case, the criteria are well known to all parties; the outcome of the review is generally predictable within reasonable limits. State regulatory commissions rarely engage in arbitrary or irresponsible behavior.

4.2.3 Investor-Owned Utilities

The rate-setting process in investor-owned utilities is more-or-less uniform for all such utilities, due to the key role of state regulatory agency. The proposal for a rate increase begins, as usual, with utility management. It is drafted in the form of an application for change to the state regulatory agency, following the format and including the documentation prescribed by that agency.

The agency usually has the power to approve an application immediately but, in almost all cases, the matter is scheduled for a series of evidentiary and (usually) public hearings. At these hearings, the utility management, possibly assisted by expert witnesses, presents its argument for higher rates; other interested parties may participate to support or oppose the increase. The regulatory agency decides whether to award any, part, of all of the requested increase based on well-established criteria and the evidence developed in the hearings.

These rate cases are time consuming (usually requiring 6 to 12 months) and relatively costly (the utility may have to hire lawyers and experts who specialize in this process). However, they are comparatively objective and predictable, and not likely to result in arbitrary or irresponsible decisions.

4.3 CRITIQUE OF RATE-MAKING PRACTICE

4.3.1 Allocation

Water and wastewater rates contribute to the efficient allocation of goods when they are based on the marginal cost of supplying water and wastewater services (see Section 2). In the case of commodity charges, this means that the commodity rate should equal the relevant marginal cost of supplying water to the customer, or of removing and treating wastewater from the customer's premises. Marginal cost is the incremental cost foregone by providing one less unit of service (or the incremental cost added by providing one more unit). It is sometimes called the "avoidable" cost, since it measures that part of the utility's total cost which would actually be avoided if a unit of service is not required.

Marginal costs are forward-looking: they estimate the avoidable cost of service in the immediate future, rather than reflecting historical or embedded costs from the past. Techniques for estimating marginal costs of providing public utility services have been extensively developed during the past 10 or 20 years, primarily for electric, gas and telephone utilities. The major difficulty in applying these techniques to water and wastewater utilities stems from the relative size and indivisibility ("lumpiness") of water/wastewater capital outlays: alternative approaches to determining marginal capacity costs tend to yield different results. A recent World Bank review of this issue, which includes a detailed comparison of approaches, provides useful criteria for selecting appropriate methods [Saunders, et al., 1977].

Since marginal costs are related to the variable and capacity costs associated with pumping, storing and treating water, and the variable costs of pumping, treating and discharging wastewater, they do not vary appreciably from one customer to another. The only exception may apply to pumping costs, where customers in one part of a service area are served by more levels of pumping than those in other parts. Otherwise, essentially the same costs are created no matter where water is withdrawn from a distribution system, or no matter where wastewater is added to a collection system.

Block-type rate structures, on the other hand, confront different users, even those in the same customer class, with different prices for water and wastewater service. The price depends not on the marginal cost of supply at the time of use, but on the quantity of water used at other times in the billing period. Block-type rate structures, both increasing and declining, are inconsistent with marginal cost pricing, and likely to promote misallocation of resources.

Uniform charges avoid the difficulty of confronting different customers with different prices: all pay the same price for all units of water used. If that price is approximately equal to the relevant marginal cost, uniform charges are capable of promoting efficient allocation. However, water/wastewater ratemaking practice does not ordinarily include calculation of marginal costs. Charges are set on the basis of precedent and incremental change, or they result from some calculation of allocated average cost.

Current water prices do not, in general, approximate marginal cost. One recent study [Baumann, et al., 1980] found that combined water/wastewater

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rates in Tucson (Arizona) were lower than marginal costs, while those in Atlanta (Georgia) were noticeably higher. A study of ten water utilities in the Washington (DC) area concluded that prices in the region were generally higher than properly estimated marginal costs, sometimes exceeding marginal costs by as much as 100 percent [Jack Faucett Assoc., Inc., 1982].

Current rate-making practice, therefore, does not promote efficient allocation in the water/wastewater sector. More important, to the extent that block-type rates are used, efficient allocation is impossible. Although government-owned utilities show evidence of a trend away from declining-block rates, they sometimes replace that rate form with increasing-block rates, which also preclude efficient allocation. The use of uniform charges may be increasing, but there is no evidence on this point. Investor-owned utilities, perhaps in response to regulation-induced incentives, continue to favor declining-block rates as they have in the past.

4.3.2 Distribution

Commodity Charges

Because they impose widely different cost burdens on customers who receive essentially the same service, conventional water/wastewater user charges are responsible for significant redistribution of income among utility customers. Table 4.10 illustrates this point for water utilities. Customers in different user classes pay quite different average prices (cost to customer per cubic meter) for water. This is mainly the result of block-type rate structures which, given the extensive use of declining-block designs, cause large users of water to face much lower prices. While there are some differences in the average avoidable costs of service to various customers, these differences are typically on the order of several percent (much smaller than the differences in average price).

Depending on the design of the declining-block rate, differences similar to those noted on Table 4.10 may also occur within a user class. The largest residential customers, with large amounts of seasonal use (lawn and garden irrigation, swimming pool, etc.), may pay a much lower average price than the smallest user. Since many large residential users require relatively more water during the summer season, when the cost of supply is the highest, this contrast may be further augmented by noting that the largest customer may actually impose larger unit costs on the utility, while paying the lowest average price. The large customer is also likely (but by no means certain) to be a higher income customer, benefiting from transfers funded by smaller, possibly lower income customers.

Increasing-block rates (sometimes called "progressive" rates) are frequently proposed as an alternative to decreasing-block designs. Where increasing-block rates provide a low-cost block to smaller residential customers, they transfer some income from larger to smaller users. On average, this may amount to a transfer from higher- to lower-income users. Close examination of usage vs. income data, however, will reveal that many large users have relatively low income (large families, or several families per meter), while some high-income customers use relatively little water (one or two persons per household, condominimum or townhouse housing units, etc.) Increasing-block

rate forms also tend to transfer income from non-residential (commercial and industrial) to residential users.

All of these factors point to significant distributional effects from all forms of block-type rates. Declining-block rates are responsible for generally perverse (from higher- to lower-income users) redistribution, while increasing-block rates provide the opposite result. Both types of redistribution include numerous exceptions, due to relatively weak correlation between water use and income. Only uniform charges, based on relevant marginal costs, would minimize the distributional effects of commodity charges.

Other Funding Sources

Since existing customers of a water/wastewater system are able to vary only water use, then only commodity charges based on water use have allocational effects. When those charges are uniform and based on relevant marginal costs of water/wastewater services, distributional effects from these charges are largely eliminated. The remaining sources of funds (fixed charges, taxes, assessments, subsidies, etc.), although without allocational significance in the water/wastewater sector, are capable of significant income redistribution.

Periodic and annual fixed charges levied on a simple per-connection basis, for example, are likely to be very regressive. Those annual charges, assessments or dedicated taxes which are based on property values (or, arguably, front footage) are less regressive, perhaps progressive in some circumstances. While it is possible to fully fund both water and wastewater services from a combination of commodity and other charges, it may be undesirable to do so, because of the regressivity of many of these charges.

A major role of subsidy, therefore, is to replace some of these fixed user charges and dedicated taxes with tax revenue obtained from other sources. Where that source is the federal treasury, the overall incidence is likely to be more progressive than for the user charge alternative. Subsidies derived from state or local government taxes, however, may result in little or no net improvement. All subsidies involve geographic redistribution, however: least in the case of local subsidies, and greatest in the case of federal subsidies.

4.3.3 Institutional Stability

Water/wastewater utilities function best when management is provided with both the authority and the responsibility necessary to operate the utility. With respect to rate-making policy, this implies that management should be held responsible for the level of rates, and should be given the necessary authority to set rates. This creates incentives to minimize cost and to set adequate and fair rates.

Relatively few utilities enjoy this degree of autonomy. The closest approximation is probably the investor-owned utility, which must have its rates approved by a regulatory commission. In that case, while approval authority is vested in the state agency, the criteria for approval are relatively well known and, within limits, utility management is influential in the decision. This contrasts to the situation of the utility which is an agency of local government, where the city council accepts, rejects or modifies rate

proposals in unpredictable and seemingly arbitrary ways. Some government-owned utilities, it should be noted, enjoy rate-making autonomy to a degree comparable to or exceeding the regulated investor-owned utility.

It is also important that a utility have access to adequate sources of funds, so that financial crises do not preclude good management and sound planning. The sources should be reliable, as well as adequate, and not subject to unexpected fluctuation. Commodity charges which are higher or lower than marginal costs, for example, cause revenues to drop more or less rapidly, respectively, than costs in the event of unusually wet weather or poor economic conditions. This can lead to wide swings in gross income, placing financial stress on the utility.

The heavy dependence of wastewater utilities on the EPA construction grant program may well be another source of instability. Should the administration pursue its sometime stated intention of phasing out the program in the next year or two, a major flow of funds to virtually all wastewater utilities would end rather abruptly. This would probably require a halt to all major construction projects, regardless of need, until substitute revenue sources could be identified and developed.

4.3.4 Simplicity and Public Acceptance

Simplicity and public acceptance are closely related: it is easiest for the public to accept rate-making policies which they understand and which appear reasonable. The simpler are the resulting rates, the easier it is for the public to understand them and to regard them as reasonable. Most existing rate structures, on the other hand, are rather complex (incorporating many different charges and, often, declining-block rate forms). These rates appear to have been accepted because they have existed for many years.

Where public participation in the rate-making process has revealed the existence of choices, however, public pressure has usually resulted in abandonment of declining-block structures in favor of simpler designs. One exception may be the increasing-rate design used by the Washington Suburban Sanitary Commission. This highly complex rate was actually devised by a citizen's committee, principally to price discriminate against large water users, most of them non-residential.

4.4 RECENT PROPOSALS

Proposals for improvement in the area of water/wastewater utility rate-making have focused on two areas: (1) improving rate-making policy and (2) improving the efficiency of rate review by state regulatory agencies.

The first area includes a variety of proposals for change, mostly confined to changes in the rate form applied to commodity charges. Some advocate marginal cost-based pricing practices, which promise to improve allocational efficiency in the sector while reducing unwanted redistribution of income. Others propose introduction of increasing-block rates, usually on water conservation grounds, although economic arguments are sometimes advanced. Most proposals for rate design improvement have been directed at water tariffs: wastewater commodity charges receive relatively little attention.

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The second area of concern addresses the cost and delay inherent in proceedings before state regulatory bodies. Most discussion pertains to the problem of small investor-owned water utilities, serving communities of 5,000 persons or fewer. For these organizations, the cost of submitting a rate increase proposal to a state commission may exceed the size of the revenue increase requested by many times. A recent study revealed that 18 out of 45 state commissions have adopted simplified or shortened filing requirements, while 22 use simplified proceedings for these utilities [Lawton and Davis, 1983].

SECTION 5

CONCLUSIONS

5.1 FINDINGS

5.1.1 The Water/Wastewater Industry in the U.S.

The water/wastewater utility industry is a major sector in the U.S. economy, accounting for $15 billion in user charges and $8.5 billion in new investment each year. It is the most capital intensive industry in the U.S., and ranks third with respect to annual additions to capital. Because of its capital intensity, the industry is particularly sensitive to limitations on the use of capital, or to fluctuations in the cost of capital. In spite of the magnitude of industry revenues, a typical household pays only about 0.7 percent of its disposable income for water and wastewater service.

Water/wastewater utilities may be agencies of state or local government, government corporations organized under the laws of state or local government, or they may be private corporations owned by individual investors. Some utilities provide water service, others provide wastewater service, and still others provide both water and wastewater service. No data are available on the number of utilities in each category of government ownership, or on the number of joint water/wastewater utilities.

As of 1981-82, 262 water utilities and 189 wastewater utilities served populations of 100,000 or more. Of the water utilities, 47 (18 percent) are investor-owned. No investor-owned wastewater utilities are known to exist in large urban areas. Roughly one-half of the population of the U.S. is served by utilities in the size range studied (at least 100,000 service area population).

Several surveys have been conducted of water/wastewater utility data. The U.S. Environmental Protection Agency (EPA) conducted surveys of water utilities in 1976 and 1982 [Temple, Barker & Sloane, Inc., 1977, 1982], covering operating, rate-making and financial data. The American Water Works Association (AWWA) conducted surveys of operating and financial data for water utilities at five year intervals up to 1970 [AWWA, undated]. The most recent AWWA survey includes only operating and rate-making data [AWWA, 1981]. The Bureau of the Census collects financial data for wastewater utilities each year [for example, Bureau of the Census, 1982a]. Also, the Water Pollution Control Federation (WPCF) completed a survey of wastewater utility rate-making practice in 1982 [Water Pollution Control Federation, 1982].

Per capita municipal water use in water utility service areas of 100,000 population or more averages 668 liters/person/day. Individual utilities report data ranging from 326 to 1,867 liters/person/day. Investor-owned utilities are associated with substantially lower per capita use: average use for investor-owned utilities is 521 liters/person/day compared to 700 liters/person/day for government-owned utilities. Per capita water use is generally highest in the West, and lowest in the Northeast.

Most water utility facilities must be designed to accommodate maximum day water use, which averages 1.66 times average day use. Individual utilities reported maximum/average day ratios as low as 1.00 and as high as 5.81. Ratios for investor-owned utilities are generally lower than for government-owned utilities. The ratios are highest in the North Central and West states.

Water utilities maintain average reserve margins (excess capacity as a percent of maximum day) of about 37 percent, although some have as little as 0.1 percent or as much as 246 percent excess capacity. Investor-owned utilities tend to have less excess capacity than government-owned utilities. Reserve margins are highest in the South and West.

Water which is produced and pumped into the distribution system but not subsequently recorded on customer meters is unaccounted-for water. This is due to meter misregistration, unmetered connections, unauthorized use, water withdrawn from hydrants, and leakage. Average unaccounted-for water is 12 percent of production; individual utilities report as little as zero and as much as 55 percent unaccounted-for water. The unaccounted-for fraction is highest in the Northeast and South, and slightly higher for investor-owned utilities.

Although water and wastewater costs have risen in nominal terms as a consequence of general price inflation, there is little information on possible changes in real (inflation-adjusted) cost levels. Conventional wisdom holds that water costs have fallen in real terms over time, while wastewater costs have risen since the early 1970's.

Those data that could be found tend to support this view. A 10-year cost series (1965-1974) for five water utilities shows real unit costs falling at an average annual rate of 1.6 percent. Total national outlays for wastewater services over a 5-year period (1976-1981) exhibit an average annual increase in real per capita expenditures of 3.9 percent. Other cost comparisons available in the literature are judged unreliable, since they compare data for dissimilar samples of utilities, or do not account for changing service levels.

5.1.2 Financing Practices

Water Utilities

Water utilities obtain investment funds from internal sources (appropriation from user charge revenue or retained earnings) or from borrowings. At least 50 percent of all water utilities generate some capital internally, and more than 50 percent borrow investment funds. Most borrowings are in the form of long-term bonds. Among the government-owned utilities, revenue bonds are more often used than general obligation bonds. Short-term borrowing is little used by government-owned utilities; investor-owned utilities are somewhat more likely to borrow for short periods.

Investment funds are used for rehabilitation, reconstruction, expansion and new construction of water supply facilities. In some cases, preventive and major maintenance activities may also be considered capital outlays. About 40 percent of all cities of 100,000 population or more include preven-

tive maintenance as a capital budget item. Borrowed investment funds are normally recovered from user charges. Annual payments are made over the life of the bond, so that ratepayers bear the cost of the facility as it is used.

Water utilities obtain operating funds primarily from user charges. Revenue from charges exceeds operating expense for almost all utilities. For all government-owned utilities, the average excess of revenue from charges over operating expense is 37 percent; for investor-owned utilities, the excess averages 118 percent (revenue from charges is more than double operating expense). The excess revenue is used for debt service, and as a source of internally generated capital.

Wastewater Utilities

Wastewater utilities, all of which are government-owned (in this size category), obtain investment funds from three sources: internal generation, borrowing and subsidy. Virtually all wastewater utilities report at least some internal generation of capital. In aggregate, however, the net amount of investment funds realized from user charges is very small. Long-term bonds are used by about half of the utilities surveyed; none reported short-term borrowing as a source of investment funds. The principal source of investment funds is the EPA construction grant program, together with related state grant programs.

Investment funds are used by wastewater utilities to construct new facilities and to upgrade and/or expand existing facilities. No data are available on other possible uses of capital funds (preventive maintenenance, etc.). To the extent that borrowing is used as a source of investment funds, recovery is accomplished through the user charge system, as well as any subsidies that may be available other than the construction grant program.

The primary source of operating funds is the system of user charges. The excess of revenue from user charges over operating expense for all utilities studied is only 5 percent, however (compared to 37 to 118 percent for water utilities). Many utilities, especially the largest and those serving communities in the Northeast and North Central states, experience operating deficits (operating expenses exceed revenue from charges).

5.1.3 Use of Subsidies

Water Utilities

Government-owned water utilities receive explicit subsidies from three sources:

- Exemption from state and local property and other taxes, applicable to many government-owned utilities (some utilities make payments in lieu of taxes to local governments)

- Sharing of local government tax revenue, applicable to 9.6 percent of the utilities surveyed and amounting, in aggregate, to less than 3.0 percent of water utility revenue

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- Subsidized interest rates on long-term bonds (due to their tax-exempt status), applicable to at least two-thirds of all utilities (those having long-term debt)

In addition, where a utility is operated as an agency of local government without clear organizational and financial separation, there are many possibilities for implicit subsidy, due to cost shifting and other transfers. These subsidies may accrue to the benefit of the utility, or they may flow in the other direction, benefiting local taxpayers at the expense of the utility.

Investor-owned utilities do not normally receive any subsidy from federal, state or local government. The only exception (observed in 2 out of 21 cases) occurs when local governments sell tax-exempt industrial development bonds, then make some of the proceeds available to an investor-owned water utility at a lower-than-market interest rate. This practice is unlikely to be a significant factor in the future.

Wastewater Utilities

Wastewater utilities receive as many as four kinds of subsidy:

- Payments from the EPA and state construction grant program, applicable to all utilities, and totalling more than $5 billion per year (approximately 75 percent of all wastewater capital outlay)

- Exemption from state and local property and other taxes, applicable to many utilities (some utilities make payments in lieu of taxes to local governments)

- Sharing of local government tax revenue (no data are available on the number of wastewater utilities which receive general fund revenue)

- Subsidized interest rates on long-term bonds (due to their tax-exempt status), applicable to those utilities having long-term debt

Wastewater utilities, similar to water utilities, may be operated as agencies of local government without clear organizational or financial separation. This arrangement creates opportunities for implicit subsidy, due to cost shifting and other transfers. Implicit subsidies may accrue to the benefit of the utility, or they may flow in the other direction, benefiting local taxpayers at the expense of the utility.

Considering only grants and explicit transfers of revenues from general funds, subsidies to the wastewater utilities amount to more than 60 percent of total annual expenditures. Other, unrecognized subsidies would further increase this percentage. This can be contrasted to government-owned water utilities, where the comparable figure is on the order of several percent, or to investor-owned utilities, which receive no subsidy.

5.1.4 Rate-Making Practices

Water Utilities

Most water utilities meter all customer connections. In the size range studied, 83 percent of surveyed utilities meter at least 99 percent of all connections. Among the partially metered utilities (less than 99 percent metered), the average use of meters is 77 percent, and individual utilities range from a low of 22 percent to nearly 99 percent. The data are skewed by the existence of two very large partially metered cities: New York City (23 percent metered) and Chicago (31 percent metered). Except for Chicago, full metering in nearly universal in the North Central states and in the South.

Meters are read (where used) and bills rendered at intervals of one or more months. Billing periods for government-owned utilities are most likely to be 2 or 3 months, although some utilities use periods as long as 6 or 12 months. Billing periods tends to be shorter in the West. Investor-owned utilities favor 3 month billing periods. Many utilities use a shorter billing period (usually 1 month) for selected large customers.

Where connections are metered, commodity charges are levied on the basis of metered water consumption. Unmetered customers pay a flat rate, based on number of household units, number of plumbing fixtures, housing value, or some other measure. Government-owned utilities utilize commodity charges of the uniform, increasing-block and declining-block forms. About half use declining-block rate forms, and evidence indicates movement away from this type of design. Conversely, uniform and increasing-block forms are gaining in popularity. Investor-owned utilities indicate strong preference for the declining-block rate form (used by 80 percent of utilities surveyed), and show no sign of change.

About two-thirds of all water utilities use a periodic fixed charge in addition to a commodity charge. In the case of government-owned utilities, most periodic fixed charges are service charges, unrelated to water use. The remainder are minimum charges, which provide a minimum quantity of water at no further charge. Investor-owned utilities are more likely to use minimum charges.

As a consequence of the extensive use of declining-block rate forms and the prevalence of other types of discounted rates for large users, there are large differences among average costs of water to various classes of users. Residential customers of government-owned utilities pay, on average, 16 percent more than wholesale customers, and 38 percent more than commercial and industrial customers. Investor-owned utilities maintain even larger differentials: residential customers pay 101 percent more than wholesale customers and 45 percent more than commercial/industrial users.

Furthermore, the absolute level of rates is substantially higher for customers of investor-owned utilities (91 percent higher for a residential customer). This results in significantly lower per capita use rates for investor-owned utilities. These lower use rates cause, in turn, lower per capita operating cost and capital investment, but slightly higher operating costs per cubic meter (due to economies of scale).

The average monthly water bill for a typical residential customer of a government-owned utility is $6.82 (1981 dollars); the average bill for investor-owned utilities is $11.35. Residential bills are highest in the Northeast, an lowest in the South and West. Data for individual utilities range from $2.19 to $17.88 (an 8 to 1 variation).

Government-owned water utilities are characterized by a number of different rate-setting processes, ranging from ultimate approval by a city council to those cases where self-governing utilities have the power to set their own rates (after approval by a board). Some government-owned utilities (23 percent) are required to submit rate increase proposals to a state regulatory commission for approval. As of 1981, the average government-owned water utility had not changed rates for 2.2 years, although some utilities had used the same rates for as long as 11.5 years.

Investor-owned utilities are regulated monopolies, and must submit rate proposals to a state commission for approval. Most of these utilities change rates frequently: the mean time since the last rate increase (as of 1981) was 1.2 years. No utility had used the same rates for more than 2.5 years.

Wastewater Utilities

Where connections are metered and water rates based on meter readings, wastewater utilities are likely to adopt commodity charges on the same basis. About 20 percent of the wastewater utilities surveyed, however, continue to use flat rates for wastewater service. Among the commodity charges, most are uniform charges; only 3 utilities out of 25 with commodity charges reported declining-block designs. Periodic fixed charges are widely used, and they are about evenly divided between service charges and minimum charges. Some wastewater utilities also levy annual fixed charges, either benefit assessments or ad valorem taxes. Each type of charge was reported by 3 of the 33 utilities surveyed.

The average monthly wastewater bill paid by the typical residential user is $6.95 for the U.S. (1982 dollars). Charges are highest in the Northeast and lowest in the North Central states. Individual utilities report typical bills which range from $1.97 to $15.08 per month (an 8 to 1 variation).

Wastewater utilities are subject to rate-setting processes similar to those applying to government-owned water utilities. Some utilities are subject to final rate decisions by elected local officials, others are autonomous and self-governing, with the power to set their own rates. No data are available on the number of wastewater utilities subject to state rate regulation, or on the frequency of rate increases.

5.2 EMERGING ISSUES AND TRENDS

Many factors and events, some already present and others anticipated in the near future, may influence the future financing and rate-making practices of U.S. water/wastewater utilities. Several of these topics, those which seem likely to make the largest impacts, are summarized in the following paragraphs.

5.2.1 Rate-Making Policy

Rate Reform

Existing rate-making practice for both water and wastewater utilities is subject to strong criticism on several counts. Since marginal cost-based techniques are not used to set rate levels, rates are unlikely to promote allocational efficiency. In fact, due to the general use of block-type rate forms, large misallocations are prevalent. Price discrimination is extensive, both among and within classes of customers. Investor-owned utilities, as a group, price discriminate more strongly than government-owned utilities.

Conventional rate-making practice also results in significant and sometimes perverse redistributions of income. These follow from the price discrimination implicit in block-type rate structures, and from deviations between rate levels and properly assigned cost responsibility. Many customers pay more than the avoidable (marginal) cost of the service they use; the remaining customers pay less. Prices equal marginal cost only by chance.

Another problem, more severe in recent years, is institutional stability. Rates which deviate markedly from marginal cost cause wide and unpredictable fluctuation in gross income as weather or economic conditions change. Also, the practice of heavy reliance on relatively unpredictable subsidies (most prevalent for wastewater systems) exposes the utility to future managerial and financial crises. All of these factors can inhibit the ability of management to plan and implement sound practices.

Correction of all of the problems listed would require nothing less than complete reform of utility rate-making practices. Rates should be based on relevant marginal costs, and should utilize uniform charges, seasonally differentiated where indicated. Price discrimination among various classes of users should be eliminated. Sound economic and managerial criteria should be used to decide what portion of the total financing requirement should be met from user charges, and what portion should be subsidized by other units of government.

When funds must be obtained from fixed charges, the charges should be designed to avoid unnecessary redistribution of income. Where subsidies are to be used, they should be explicit and stable, so that uncertainty or fluctuating levels do not precipitate financial crises. The rate-setting process should minimize the incentive for irresponsible or short-sighted decisions, placing authority to set rates in the hands of those who must bear the responsibility for successful operation of the utility.

The example of the investor-owned water utilities indicates that users are able and willing to pay the full cost of the services they demand. If that cost could be apportioned so as to promote allocational efficiency and minimize redistribution of income, the total net benefits received from the water/wastewater sector would be increased.

Increasing-Block Rate Designs

Survey data indicate that about 8 percent of all water utilities utilize some form of increasing-block rate (see Table 4.7). These applications may range from a "lifeline block" affecting only the smallest users (East Bay Municipal Utility District provides a lower commodity charge for the first 14,000 liters/month use) to a strongly progressive increasing rate system (such as that of Washington Suburban Sanitary Commission, which contains 100 separate water/wastewater commodity charges). Although no regional analysis of survey data was available, other information suggests that increasing-block rates are most commonly used in the arid southwestern states.

Increasing-block rates represent a divergence from marginal cost pricing principles (not more than one of the block prices can be equal to marginal cost), and produce significant redistributions of income. Among the claimed advantages are increased incentives to conserve water, transfers of income from nonresidential and high-income residential users to low-income households, and recognition of higher cost of service to suburban users having substantial seasonal demands. Critics point out that the conservation incentive provided by these rates applies to one group of users only (large users), the income transfer is highly non-specific (many low-income households are large users of water, etc.), and the level of household water use is not well correlated with unit cost of service.

Many of these criticisms are specific to U.S. conditions, where differences among users are relatively small; the objections may be reduced for applications in developing countries. Typical third world cities, for example, are characterized by very large differences in both personal income and water use habits. The smallest water users in these cities are more likely (than in the U.S.) to be very low income individuals who do not use water for any purpose except drinking, food preparation and basic sanitation. Furthermore, the purchase of water by these individuals may be severely constrained by available income. Providing lower prices for smaller users (under these conditions) is likely to be desirable on both allocational (increased public good production) and distributional (relatively unambiguous transfer of income from wealthy to poor) grounds. The socio-economic conditions which lead to this result do not, in general, exist in the U.S.

Low-Income Users

In spite of the relative affluence of the U.S., there are individuals in every city who are unable to provide for even basic needs of food and shelter. Social programs are available to provide at least partial support to very low-income households, but every public utility has a number of customers who are unable to pay for utility services in a timely manner. At the present time, this is an acute problem for electric and gas utilities. The number of households where electric and/or gas service has been disconnected for non-payment is growing rapidly. In Baltimore (Maryland), as many as 2,000 occupied households were without electric service throughout most of the 1982-1983 winter, a condition unprecedented in the city's history. Other major cities report similar experiences.

Public agencies have responded to this problem by establishing a variety of energy assistance programs. Some of these provide cash grants to needy

families with delinquent utility bills; others offer fuel oil at subsidized prices or provide assistance with home weatherization (for energy conservation). The utilities have generally offered low-cost or no-cost assistance with energy conservation, liberal arrangements for payment of past due balances while continuing to receive service, and have assisted customers in obtaining help from public agencies. Some electric utilities are experimenting with more innovative methods, such as providing limited service (the meter is equipped with a load limiter which excludes all but basic uses) to customers unable to pay past due amounts.

No comparable problem has been reported for water/wastewater utilities to date. There may be several reasons for this:

- Water/wastewater services are much less expensive than electric/gas supply (they account for about 0.7 percent of mean disposable household income)

- In many communities, unpaid water/wastewater bills become a lien on real property, and are ultimately paid by the landlord, who may be better able to pay than low-income tenants

- Because most water/wastewater utilities are government-owned, they may be (1) more flexible in making payment arrangements with delinquent customers, or (2) less attentive to unpaid bills

In the absence of specific investigation of this issue, it is not clear that a problem actually exists or, if it exists, how it is being dealt with.

5.2.2 Future Treatment Requirements

In the coming years, both water and wastewater utilities anticipate upgrading treatment facilities and/or constructing new facilities. Water utilities are in the process of complying with the provisions of the Safe Drinking Water Act, which mandates higher levels of treatment in certain cases. More importantly, steadily increasing concern regarding trace organic contaminants in drinking water has already caused changes in disinfection practices, and may eventually bring about much wider use of activated carbon. These changes seem certain to increase both capital and operating costs, although the magnitude of the increase is still in doubt.

Wastewater utilities are continuing to move toward compliance with the requirements of federal water pollution control legislation. The 1982 EPA Need Survey [1982] estimates present treatment plant and interceptor construction needs at $57.3 billion, including $35.4 billion backlog (funds required to comply with current regulations affecting existing populations). Total present need (including all facilities) is stated at $92.6 billion. These totals can be compared to the $7 billion annual rate of investment by wastewater utilities, and the approximate $5 billion annual level of state and federal grants.

Large urban water utilities are likely to be capable of funding and implementing any required capital investments without major difficulty. Wastewater utilities, on the other hand, do not presently fund more than 25 percent of capital outlays. A large increase in the level of capital outlay

would require major changes in financing practice, or in the level of subsidies, or both.

5.2.3 Change in EPA Construction Grant Program

The federal 1981 Clean Water Act made significant changes in the construction grant program, generally narrowing eligibility for grants and reducing federal participation from 75 to 55 percent of eligible cost. The stated intent of the current administration is to continue reducing the size of the program, possibly phasing it out altogether in future years. If accomplished, this would have a major impact on wastewater utilities.

At the present time, wastewater utilities depend on the construction grant program for approximately 75 percent of all investment funds (including both federal and related state grants). A substantial reduction, or elimination, of this subsidy would almost certainly require a large increase in the level of user charges. At present investment levels, user charges would have to be roughly doubled if no other sources of funds were available. Because of certain resistance to such a change, it seems clear that many utilities would be obliged to reduce or suspend capital investment for a time, until user charges could be increased sufficiently.

There is no evidence, however, that users are collectively unable or unwilling to pay the full cost of wastewater service. Even with doubled user charges, water and wastewater charges combined would account for only 1.0 percent of mean disposable income in the U.S.. Certain utilities may require much higher rates, however, and low-income users may experience more severe impacts.

5.2.4 Infrastructure Requirements

Many studies performed during the last several years have described problems associated with an aging and deteriorated urban infrastructure, including water and wastewater facilities [National League of Cities and U.S. Conference of Mayors, 1983; Congressional Budget Office, 1983; American Public Works Assoc., 1981; Subcommittee on Urban Water Supply, 1980]. It is stated that past failures to fund adequate preventive maintenance, or to replace obsolete facilities, have created a backlog of facility needs which must be met in the very near future.

The capital requirement associated with this backlog has been estimated by various authors. The Subcommittee on Urban Water Supply of the President's Intergovernmental Water Policy Task Force [1980] estimates the backlog at $75 to $110 billion for water facilities alone. The Congressional Budget Office [1983] in one of the most comprehensive and balanced studies of the problem, estimates wastewater capital needs over the next 8 years at $39.3 billion, and municipal water supply needs for the same period in the range of $50.4 to $72.8 billion. These estimates total $89.7 to $112.1 billion, and cover outlays through the year 1990. The Congressional Budget Office also calls attention to the higher operating costs which will accompany at least some of the planned capital construction.

Other estimates, appearing in the popular press, have ranged up to $900

billion dollars for water and wastewater facilities. It seems more likely, however, that the best estimates are those in the vicinity of $100 billion. This amount, if spread over ten years, would represent some increase over current levels of capital outlay, but not a major change. Modest increases in user charge levels, coupled with continuation of existing subsidies, would suffice to fund this level of increased construction.

5.2.5 Institutional Change

Proposals and suggestions for modifying the institutional structure of the U.S. water/wastewater industry appear frequently. Among the concepts advanced are integration (combined water/wastewater utilities), regionalization (a single utility serving an entire metropolitan area) and privatization (transfer of utilities or utility facilities from public to private ownership).

Integration has long been advocated as a means of improving operating effectiveness and reducing costs. None of the available surveys address this issue, and no data on the degree to which utilities are integrated were found. Based on limited observation of individual cases, it appears that more recently organized utilities (especially government corporations serving more than one political jurisdiction) tend to be integrated, while older municipal organizations are rarely combined. This evidence points to custom and inertia as the major obstacles to integration.

The AWWA survey included a question pertaining to joint water/wastewater billing [AWWA, 1981]. For 1981, 36 out of 131 reporting utilities (27 percent) stated that wastewater charges were <u>not</u> included on the water bill. The totals include 24 investor-owned utilities, 18 of which did not practice joint billing. This provides no information on the number of integrated utilities, since organizationally separate utilities may have joint billing agreements. On the other hand, utilities without joint billing are almost certainly not integrated.

As in the case of integration, the extent of regionalization is also unknown. The survey data indicate that wastewater utilities are, in general, larger in size and fewer in number than water utilities. This suggests more frequent regionalization of wastewater systems, but provides no information as to the number of such systems which are truly regional. Many organizational and economic advantages are claimed for regionalization, and the arguments are particularly compelling in the case of wastewater utilities, because of the influence of topography. Also, available data clearly establish the existence of important economies of scale in both water and wastewater utilities. Still, the amalgamation of formerly independent utilities into a regional system is seldom reported in the U.S.

Privatization of utilities, or of utility facilities, is typically advocated on grounds of improved economic efficiency. Available data on the performance of investor-owned private utilities, however, does not support the premise that government ownership leads to inefficiency. The major consequence of private ownership appears to be the use of commodity charges to recover many costs that are funded by assessments or taxes in the case of government ownership. The result is lower water use and more regressive overall cost incidence. To the extent that economic motivation for conversion

to private ownership exists, it stems from recently enacted provisions of federal tax law, which provide federal subsidies for some types of capital investment.

Despite continuing interest in various forms of institutional change, no strong trends or motivations for change are apparent at this time. Integration and regionalization promise net social benefits, but are blocked by local self-interest, custom and inertia. The benefits of privatization are more controversial, and the motivation for change is weak and possibly temporary.

5.3 CONCLUSIONS

Water and wastewater utilities comprise a major sector of the U.S. economy, but they levy user charges which comprise a minor fraction of disposable income (about 0.7 percent).

Water utilities can be divided into two distinct categories: those which are government-owned and those which are investor-owned. Investor-owned utilities, as a group, are financially self-sufficient, receiving no subsidies from local, state or federal government. Government-owned water utilities receive several types of transfers from government, both explicit and implicit, but subsidies are not a major source of funds for the industry as a whole. Some government-owned water utilities are operated on a near-self-sufficient basis.

Investor-owned water utilities set substantially higher rates than those adopted by similar government-owned utilities. The higher rates lead to lower per capita water use, lower per capita operating and capital outlays, and slightly higher operating costs per unit of water delivered.

Water utilities are largely metered, and employ commodity charges based on metered water use. Government-owned utilities use uniform charges, increasing-block charges and declining-block charges. There is evidence of movement away from declining-block charges, but at least 50 percent of all utilities still use them. Investor-owned utilities rely principally on declining-block rates, and there is no evidence of movement away from them.

Water user charges are unrelated to marginal cost, and incorporate substantial price discrimination among and within customer classes. Current rate-making practice is responsible for important economic misallocation and redistribution of income.

Wastewater utilities serving large urban areas appear to be entirely government-owned. Most use commodity charges based on water use; uniform charges are most frequent. Wastewater charges are also unrelated to marginal cost, but price discrimination and income redistribution are less severe than in the case of water charges.

Wastewater utilities rely heavily on subsidies from federal and state government for investment funds. The total explicit subsidy exceeds 50 percent of annual outlays by U.S. wastewater utilities. Relatively little use is made of user charges as a source of capital; many wastewater utilities do not fully cover operating costs with user charges.

Water/wastewater utility rate-making practice is in need of general reform if it is to accomplish the allocational, distributional and stabilization goals described. No motivation or incentive for such reform can be discerned at this time.

Changes in water and wastewater treatment requirements, if they occur, will require increased capital spending, and future increases in operating cost. Water utilities are better able to finance such increases, in spite of the relatively higher level of water user charges. Wastewater utilities, already heavily dependent on subsidies, would require large increases in use charges if additional subsidies are not available.

Similarly, any reduction in the existing level of subsidy to wastewater utilities would have a disproportionate effect on user charges. A phasing out of the EPA construction grant program, for example, would roughly double the current level of user charges, unless additional subsidies were provided from other sources.

Urban water and wastewater utilities face a backlog of capital needs, resulting from past failure to maintain or replace facilities, which has been variously estimated at $75 to $900 billion dollars. Estimates in the vicinity of $100 billion seem most reasonable for the next decade. Water utilities will be able to finance their share of this amount without major change in rate level and without requiring massive subsidy. Wastewater utilities, on the other hand, are likely to experience difficulty unless user charges can be substantially increased.

SECTION 6

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