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Financing Water Infrastructure

By
Strategic Alternatives
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Abstract

Water is often perceived as a free resource, but there are costs associated with obtaining and treating it. This paper examines how Ontario municipalities finance their water and sewage system infrastructure. The authors discuss the objectives for delivering drinking water, as well as the economic and legislative context for water and sewage services in the province. The concepts of demand and supply as they apply to water services are examined in detail, as is the setting of water rates. Capital funding for water and sewage systems in Ontario is described both in theory and in terms of the practice in Ontario's municipalities over the past decade. The authors also examine how various accounting practices affect this issue, and present financial data for a number of municipalities in Ontario and an assessment of their financial well-being. A summary of key concepts at the end of the paper gives readers the opportunity to draw their own conclusions.

About the Authors

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1 Objectives

This paper is intended to provide the Walkerton Inquiry with the detailed information necessary for making recommendations that can assure the long-term safety of the province's drinking water. This section outlines the various objectives of municipal water systems.

1.1 Safety

The Commission's mandate is to consider the objective of safety in water supply operations.

'Safety' can be defined as the absence of threat or hazard. But for such a definition to provide a sound basis for analysis, 'absence' must be defined specifically, using the language of risk and certainty. At one end of the risk spectrum is a guaranteed absence of threat or hazard – the elimination of all uncertainty. This situation might be achieved with, for instance, the use of fail-safe designs, the implementation of intensive monitoring and maintenance programs, the elimination of all upstream sources of contamination, and so on. This elimination of uncertainty is conceivable, but would be prohibitively expensive.

Our capacity to eliminate uncertainty, or even to reduce it significantly, is limited by affordability. This term, as used here, refers both to the ability of individuals to pay for water and the ability of municipalities to deliver treated water.[1]

When we step back from the unattainable goal of a *guaranteed* absence of hazard and threat, we allow for a small but real amount of risk. The goal of safety therefore means minimizing, but not totally eliminating, the risk of hazard or threat in water supply systems. Achieving this goal means incurring expenses over and above those required for simply delivering treated water to customers. The optimal level of safety can thus be defined in terms of balancing the added benefits to users of increased safety with the added costs associated with achieving that level of safety.

This paper has been prepared for discussion purposes only and does not represent the findings or recommendations of the Commissioner.

[1] Throughout this document, the term 'municipality' should be understood to include public utility commissions.

In considering the trade-off between costs and safety in water and sewage systems, we need to recognize a number of key characteristics about water:

- Water is essential to life; consumers in urban areas cannot do without a municipal water supply system.
- Municipal water systems are characterized by a high degree of natural monopoly, meaning that the service is most efficiently provided by a single entity.
- While raw water is considered by many to be free, there are direct and indirect costs associated with obtaining, treating, and distributing water.

These characteristics have a direct bearing on the approaches that are used to manage and finance water supply operations.

1.2 Efficiency

'Efficiency' involves allocating resources to the production of those goods and services that generate the greatest net gain for society (i.e., total societal benefits minus total societal costs). Efficient policies therefore usually maximize net benefits. An efficient operation is managed so that the cost of achieving the desired standards of service is minimized. Efficiency also requires that water supply customers use water in a manner that prevents valued economic and natural resources from being wasted in the production of water that provides little or no value to society.

1.3 Conservation and Sustainability

Environment Canada describes water conservation as "doing the same with less, by using water more efficiently or reducing where appropriate, in order to protect the resource now and for the future."[2] The Ontario Water Works Association cites a clearer definition of the term: "any socially beneficial reduction in water

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[2] Canada, Environment Canada, 2001, *The Management of Water*, [online], [cited February 2001], <www.ec.gc.ca/water>.

use or water loss."[3] The phrase "socially beneficial" implies economic efficiency in the sense of yielding a net benefit to society. The objectives of conservation and efficiency are thus compatible and mutually reinforcing.

Sustainability is closely linked to conservation. Sustainability ensures that the use of resources and the environment today does not damage prospects for their use by future generations.[4] With respect to municipal water supply operations, sustainability has implications for the development and management of infrastructure *and* for the development and protection of the sources of supply.

1.4 Equity

'Equity,' or fairness, can be defined in terms of both benefits received and ability to pay.[5] In order for there to be equity in terms of benefits received, the distribution of taxes or user fees should correspond to the distribution of benefits. In some cases, this correspondence can be achieved through user fees that function like market prices for privately produced goods and services. In other cases, a beneficiary-pay tax that is more loosely related to the use of services, such as the property tax, may secure this linkage.[6]

The principle of equity according to benefits received cannot be applied in all situations, however. For example, it cannot be applied where the beneficiaries cannot be identified and non-users cannot be excluded from enjoying the service; where the beneficiaries extend beyond the immediate users (spillovers); where the service is largely a collective, public, good; or where the good is redistributive in nature. Under these circumstances, the principle of equity according to ability to pay is applied: taxes are fair if their burden is distributed in accord with the ability of taxpayers to pay them.

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[3] D. Baumann, J. Boland, and J. Sims, 1984, "Water conservation: The struggle over definition," *Water Resources Research,* vol. 20, no. 4, pp. 428–34, as cited in Ontario Water Works Association [OWWA], 1999, *Water Efficiency: A Guidebook for Small and Medium Sized Municipalities in Canada* (Toronto: OWWA).
[4] Ontario Round Table on Environment and Economy, 1990, *Challenge Paper* (Toronto: Queen's Printer for Ontario).
[5] J. Bossons, H. Kitchen, and E. Slack, 1993, *Local Government Finance: Principles and Issues,* Report prepared for the Ontario Fair Tax Commission, Toronto.
[6] A. Tassonyi, 1993, The Benefits Rationale and the Services Provided by Local Governments, prepared for the Ontario Fair Tax Commission, Toronto [unpublished].

Intergenerational equity dictates that each generation of users should pay for the facilities that it requires and not for those required by other generations of users.[7] This means that financing mechanisms should be designed to match the cost of a facility with the benefits it provides to its users over time.

1.5 Accountability

The principle of accountability calls for taxes (charges) and expenditures to be designed in ways that are clear, so that policy-makers can be made accountable to taxpayers for the services they deliver and the costs they incur. The more direct the relationship between the beneficiaries of a government service and the payment for that service, the greater the degree of accountability. Matching taxes and user fees with beneficiaries increases the level of accountability – people know what they are getting for the tax paid or fee charged, and are therefore better able to judge whether or not the expenditure level is appropriate.[8]

Accountability is also improved by ensuring that decisions regarding both service delivery and funding are made by the same body. When, for example, one level of government is responsible for delivering a service while another is responsible for paying for it, consumer/taxpayers do not know who is responsible and whom to hold accountable when something goes wrong.

1.6 Administrative Ease

The term 'administrative ease' with regard to a water supply system refers to the time and resources devoted to administering it. Administrative costs may include those associated with metering, billing, and record keeping; calculating rates each year; and securing customer compliance with water billings.

The simpler the system, the easier it is to administer. For example, water charges should be easy to implement and update, and should be transparent to customers. Compliance follows from customer acceptance. "Water and wastewater rates are a source of economic information for the customer, and

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[7] There may be a particular equity issue where a municipality that has been using a pay-as-you-go approach changes to a debt approach. Current customers would benefit, since they would be paying for neither current nor future facilities.
[8] Bossons, Kitchen, and Slack.

should accordingly be designed and promoted in a way that will foster customer understanding."[9]

1.7 Conflict among Objectives

It is often difficult to achieve all of these objectives at the same time. For example, maximizing administrative ease would dictate that municipalities set a flat rate for water consumers across the municipality. Greater economic efficiency, however, can be achieved by charging different rates for different types of users at different times of day. Time-of-day metering for water supply is difficult and expensive; if the cost of such metering (a factor in administrative ease) in a system exceeds the economic benefits it provides, then time-of-day pricing is not ultimately a good policy for that system. Similarly, economic efficiency might suggest charging more to some users than to others, but the principle of equity according to ability to pay might mean that a policy whereby low-income users pay lower fees is more appropriate.

Municipalities thus have to make choices among objectives when pursuing financing for water and sewage services.

2 Economic Framework

In this section, we evaluate the major issues relating to financing water infrastructure within an economic framework, with an emphasis on the objectives outlined in section 1.

2.1 The Nature of Water and Sewage Services

Municipalities in Ontario currently finance water and sewage services from a number of sources, including user fees, property taxes, and intergovernmental grants. The appropriate way to pay for water and sewage works and services depends largely on the characteristics of the service: does it have public good characteristics or private good characteristics?

A public good is defined by two characteristics: (1) non-excludability (it is difficult or very costly to exclude someone from using the good), and (2) non-

[9] M. Fortin, 1990, "The economics of water conservation," in *Towards User Pay for Municipal Water and Wastewater Services* (Ottawa: Rawson Academy of Aquatic Science), p. 32.

rivalness in consumption (one person's enjoyment does not affect another person's enjoyment, up to the point of congestion). Street lighting is a common example of a public good; everyone in the vicinity can use the light provided by street lamps, and one person's use of it does not detract from another's. The characteristics of public goods necessitate government responsibility.

In contrast, a private good has the following characteristics:

- Its beneficiaries can be identified and the quantity that each consumes can be measured.
- Individuals can be excluded from consuming it (in other words, a price system can function).
- Spillovers do not exist; these are benefits or costs that accrue to those other than those for whom the good was intended, either from consuming it (as in the case of education, for example) or from not consuming it (as in the case of garbage collection, for instance).
- Provision of the good is not intended to redistribute income (e.g., from high-income to low-income customers).

Services provided by government fall along a continuum, with pure public goods at one end and pure private goods at the other. There are few purely public goods; most have a mix of public and private good characteristics. Generally, the more the characteristics of a good or service resemble those of a private good, the more desirable it is to charge for the good directly. While water and sewage services possess some elements of public goods, they more closely approximate private goods; thus, it is desirable to charge for them.

2.2 The Rationale for User Charges

Efficiency is the main economic reason for user charges. At the same time, user charges aid in financing water and sewage works and services by providing a source of revenue that can be used to cover costs.

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[10] For a more detailed discussion of this point, see R.M. Bird and T. Tsiopoulos, 1997, "User charges for public services: Potential and problems," *Canadian Tax Journal*, vol. 45, no. 1, pp. 35–37.

User charges that are correctly set promote economic efficiency by "providing information to public sector suppliers about how much clients are actually willing to pay for particular services," and by "ensuring that citizens value what the public sector supplies at least at its (marginal) cost."[10] As outlined in section 1.2, efficiency is one of the goals of water and sewer management. According to economic theory, society should allocate its scarce resources to those services that provide people with as large a bundle as possible of the services that they want at prices that are correctly set; this is what is meant by 'efficient resource use.'[11]

If water supply and sewage collection are financed by taxes or by flat-rate charges that do not vary with the amount of water used, the price for consuming each litre of water is effectively zero, even though there are costs associated with providing that water. The water service appears to be free to customers. When volumetric charges (i.e., user charges that vary with the amount used) are imposed, customers see the water supply as a service that must be paid for, and respond by using less water. The charge should be equal to the cost of supplying the water; a charge that is too high leads to under-consumption and a charge that is too low to over-consumption.

Over-consumption leads to high demand that grows too quickly. Rapid growth of demand results in treatment facilities being unable to provide an adequate supply. Municipalities may, in turn, respond with investments in water supply and treatment capacity that are premature and/or too large. Rapid growth in demand also causes excessive extraction from the raw water source and excessive discharge of sewage effluent.

Thus, over-consumption forces municipalities to build water and sewage systems that are larger than is socially optimal. Setting user charges that correctly reflect the cost of water supply thus helps to prevent this by linking water demand to the cost of investments via water rates.

2.3 Marginal Cost Pricing

Economic theory shows that the most efficient charges are those that equal the marginal cost of supplying the service. 'Marginal cost' is defined as the cost of

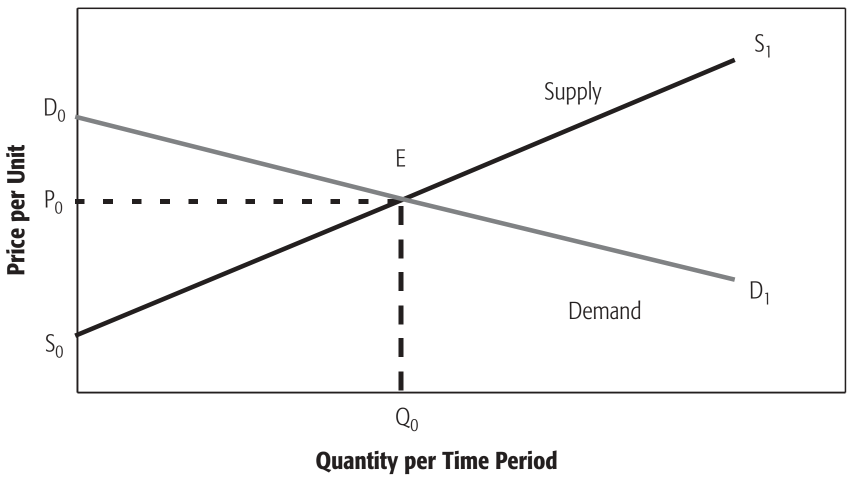
[11] Ibid.

providing an additional unit of the particular service.[12] Thus, under marginal cost pricing, the price of a good can vary according to the number of units bought. Under the alternative method of 'average cost' pricing, each unit of the service has the same price, which is calculated by dividing the total cost for a given quantity of production by the total quantity produced.

The use of marginal cost pricing to promote efficiency can be illustrated using the conceptual framework of supply and demand (shown in figure 2-1).

'Supply' is the quantity of a product that is offered for sale. The upward-sloping line in figure 2-1 is called a 'supply curve.' Any point along this line represents the marginal, or incremental, cost of producing additional units of output. The marginal cost is the change in total cost that occurs as total production increases. Suppliers will not sell a product if the price does not cover the cost of producing it.[13]

Figure 2-1 Demand and Supply Curves



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[12] The term 'marginal cost' as used by economists is different from the term 'cost' as used in financial accounting. In the accounting sense, cost refers to the money spent to provide water, such as labour cost, material cost, and the like. In the economic sense, and specifically the marginal cost pricing approach, costs also include 'opportunity cost,' i.e., the value of the benefits that could have been obtained had the inputs been used for some other purpose.
[13] The actual relationship between supply, price, cost and production is much more complex than this; supply curves are simple graphical tools used to examine and explain the concept of supply.

'Demand' is the quantity of product that customers want to buy. The downward-sloping line in figure 2-1 is the 'demand curve,' and any point along this line represents a quantity that customers will buy for a given price. The downward slope indicates that consumers are willing to buy more of a particular product only if the price is lower. The price shown along this curve represents the price that customers are *willing to pay* for different quantities of the good.

At the point where the demand curve intersects the supply curve, labelled E in figure 2-1, the customer's willingness to pay equals the supplier's cost of producing the last unit of service. The price at E is the 'equilibrium price,' at which demand equals supply. Setting the price at this equilibrium point is economically efficient because the value of consumption (of the last unit) just equals the cost of production (of that unit). Moving away from this point in either direction entails a loss to someone: if the price is less than marginal cost, the consumer places less value on that unit than it costs to produce it and over-consumes, causing a loss to the producer; if the price is greater than marginal cost, the consumer pays a higher price on the last unit than it cost to produce it.

The concept of supply and demand as described above is applicable to private goods and services in an open and competitive market. When goods are provided by the public sector, there may be situations in which behaviour related to supply and demand deviates from the above theory. In the case of water and sewage services, the basic concepts hold true, but the shape of the supply curve reflects the unique circumstances affecting each municipality.

For example, a small municipality may face a very high initial cost for its first communal water supply system because the size of the system is too small to achieve economies of scale.[14] As the municipal population grows and the system expands, economies of scale are realized, especially in administrative activities, and marginal costs decrease; the supply curve for such a municipality would slope downward.

Beyond a certain size of water system, however, many of the potential economies of scale are already fully realized, so expansions in production occur at a relatively constant unit cost. This is the situation in many mid-sized municipalities in Ontario that rely on groundwater wells: capacity is expanded by adding new

[14] 'Economy of scale' refers to the phenomenon of per unit costs declining as the quantity of service increases; this concept, and how it reates specifically to water and sewage services, is presented in detail in section 5.5.

wells that cost the same as existing wells.[15] At this point marginal cost is constant, so the supply curve flattens out. However, once the demand in these municipalities exceeds the sustainable yield of local aquifers, municipalities must switch to surface water, which requires expensive treatment, and/or use high-cost pipelines to import water from more distant sources. Under these conditions, the marginal cost increases and the supply curve slopes upward, as in the private sector. Once the new source of supply is secured, however, marginal costs may once again level out.

As for the demand curve for water and sewage service, the quantities along the curve represent different types and volumes of use. As well, the demand curve reflects an expectation that the product meets regulated standards for quality and availability. Any changes in this kind of expectation cause the demand curve to shift – it may change shape or move its position relative to supply (see section 4).

2.4 Problems with Implementing Marginal Cost Pricing

Economists have long argued the case for marginal cost pricing over average cost pricing.[16] The water supply industry has been slow to embrace the approach, not because it has been ineffectively promoted but because the demand for new rate-setting methods is weak. In particular, marginal cost pricing has been perceived as an unnecessarily complex approach that cannot guarantee the matching of revenues with anticipated costs and that, furthermore, could cause revenue instability.[17] But recent years have seen an increased focus on innovative rate structures as a result of a growing emphasis on economic incentives to manage demand in response to drought and/or the exhaustion of low-cost

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[15] This assumes that costs are measured in constant dollars (meaning they have been adjusted so that year-to-year comparisons are not distorted by inflation) and that external factors, such as new regulations, do not have a significant impact.

[16] The very early work on this topic is reviewed in S.V. Berg and J. Tschirhart, 1988, *Natural Monopoly Regulation* (Cambridge, U.K.: Cambridge University Press). R. Turvey (1976, "Analyzing the marginal cost of water supply," *Land Economics*, vol. 52, no. 2, pp. 159–68) was among the economists who started developing practical methods to calculate marginal cost rates. Economists such as S. Renzetti (1999, "Municipal water supply and sewage treatment: Costs, prices, and distortions," *Canadian Journal of Economics*, vol. 32, no. 3 [May]) continue to do research in the area; others, such as T.W. Chesnutt et al. (1997, *Designing, Evaluating and Implementing Conservation Rate Structures* [Sacramento, Calif.: California Urban Water Conservation Council]) have produced detailed technical manuals on marginal cost pricing.

[17] See American Water Works Association [AWWA], 1992, *Alternative Rates*, AWWA Manual M34 (Denver, Colo.: AWWA).

sources of supply. These economic incentives involve conservation-oriented rate structures that target high-volume uses.

A registry of U.S. water supply agencies using conservation-oriented rate structures shows a gradual adoption of marginal cost rates; 4 out of 22 agencies in the registry use marginal cost calculations to help set their rates using volumetric charges.[18] The marginal cost charge is designed to target a specific component of customer demand, such as lawn irrigation, that is high and sensitive to price. For example, Phoenix has a seasonal rate structure; its peak-season rate is now based on an estimate of the long-run marginal cost. The introduction of this approach has reduced average residential water use by 1.0% to 1.6%, and peak month demand by 3.6%.[19] The Los Angeles Department of Water and Power uses a two-tier rate structure with the second tier aimed at high seasonal water use. Its marginal cost calculation takes into account the cost of acquiring new water supplies to service growth, as well as the potential cost to customers of failure to meet growing demands.[20]

Regulatory agencies are also slowly coming to accept marginal cost rates. A 1994 survey of state regulatory utility commissions, which are the agencies charged with the responsibility of regulating the rates of investor-owned utilities in the United States, revealed that two out of forty-five commissions actively encouraged marginal cost pricing, while nine discouraged it.[21]

The Los Angeles example given above demonstrates an important feature of marginal cost pricing: it is a forward-looking analysis that requires the municipality to have a long-term capital plan, including reasonable estimates of the capital and operating costs associated with servicing growing demand. The actual calculation of the marginal cost can be relatively complicated; it calls for a measure of judgment and training on the part of the analyst, who must select one of the several alternative estimation methods that can be used.

While its advantages as a tool for achieving efficiency are clear, implementing marginal cost pricing for water and sewage services may be difficult in practice,

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[18] Chesnutt et al.

[19] Ibid.; also R.W. Cuthbert and P.R. Lemoine, 1996, "Conservation-oriented water rates," *Journal American Water Works Association*, vol. 88, no. 11.

[20] Chesnutt et al.

[21] J.A. Beecher, P.C. Mann, Y. Hegazy, and J.D. Stanford, 1994, *Revenue Effects of Water Conservation and Conservation Pricing* (Columbus, Ohio: National Regulatory Research Institute). Over half of the same commissions approved marginal cost pricing for non-water utilities.

if not impossible. Some of the impediments, particularly for smaller municipalities, are as follows:

- *Natural Monopoly* A major impediment to marginal cost pricing relates to the monopolistic nature of water and sewage servicing. Since there is usually only one water and sewage system in a municipality, it operates as a public monopolist, most likely a 'natural monopolist,' meaning that economies of scale exist over the entire range of output. In a natural monopoly, both average and marginal costs decline as output increases, and marginal costs must be below average costs. In municipalities where the population is not growing and there are no planned expansions to the system, marginal costs may be below average costs. Under these circumstances, setting price equal to marginal cost will not generate sufficient revenues to pay the operating costs of the water and sewage systems.[22]

- *Insufficient Cost Information* For marginal cost calculations to be reliable, the municipality must have a plan that identifies realistic long-term capital costs for water and sewage infrastructure investments. Smaller municipalities that are not experiencing growth may have a five- or ten-year capital plan, but many only have a clear idea of the capital investments they will need to make over the next two to four years. In the absence of realistic estimates of capital costs, these municipalities are not able to calculate long-run marginal costs accurately. Furthermore, municipalities that do not include asset replacement in annual operating costs cannot calculate marginal costs accurately.

- *Lack of Expertise* Staff in most municipalities may be capable of setting rates based on average costs at levels that achieve full cost recovery. Marginal cost pricing, however, requires more specialized skills, including knowledge of economics and engineering. There may not be sufficient expertise in smaller municipalities to calculate marginal costs.

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[22] Where marginal costs are greater the average costs, marginal cost pricing is both feasible and useful as a demand management tool. Marginal costs may be greater than average costs in cases where large capital investments for capacity expansion are being planned. Care should be taken, however, not to design a rate structure that will cause undue revenue instability. For instance, setting the volumetric rate for all water used in the summer based on a high marginal cost will increase the utility's dependence for revenue generation on summer water sales; summer water sales, however, are the most variable component of total sales, so such a rate structure will increase revenue instability.

- *Poor Budgeting and Accounting Practices* Municipalities with poor budgeting and accounting practices may not have access to the financial data and other necessary information in a form that is conducive to calculating marginal costs.

- *Conservation Objective* Municipalities that encourage conservation as a policy objective may want to charge prices that are above the marginal costs in order to restrict consumption.

- *Lack of Metering* Municipalities that do not have meters cannot set volumetric water prices because they have no way of measuring consumption (demand).

- *Lack of Rate Knowledge Among Customers* To respond to price signals in an appropriate manner, customers have to be aware of what they are paying for water. Large industrial customers, for example, are usually quite conscious of the cost of their water, especially if it is a major input to their production process. Residential and commercial customers, on the other hand, are less likely to be aware of the cost of water. Some renters may never see a water bill for their premises; while some owners may see the water bill only as part of a combined utility bill. However, it is worth noting that rate structures characterized by aggressive volumetric charges (for instance, seasonal or excess-use charges that are two to ten times higher than the basic volumetric charge) are, in and of themselves, likely to make customers more aware of the charges.

Because of these constraints, marginal cost pricing is not the norm in the water supply industry; average cost pricing tends to prevail.[23] But this does not mean that the concept is of no use to the water supply industry. Recent water pricing initiatives increasingly seek to strike a balance between marginal cost pricing and more traditional approaches that emphasize cost recovery.

3 Legislative Framework

The financing of water and sewage systems in Ontario is governed by provincial legislation, which sets the framework for what municipalities are allowed to do with respect to setting water rates and recovering costs. This legislation is fairly

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[23] Marginal cost pricing is more prevalent in other utility services.

general and permissive; municipalities are free to select a user rate format that suits local conditions and to adopt whatever specific fees for services that it prefers. There are no codified guidelines. A general theme of the legislation appears to be that, as long as all decision making is the responsibility of an elected government body that is responsible to its customers, there is no need for the province (either directly or through an arm's-length agency, board, or commission) to regulate rates.

Provincial legislation is much more specific, however, regarding allowable mechanisms for charging new customers for the capital cost of providing services for new development. In this area, the province legislates what methods are permissible and describes them. Charges related to new development cannot be levied unless they are first passed by local municipal councils, then applied in accordance with the municipality's approved bylaws.

3.1 General Provisions for Cost Recovery

All municipalities in Ontario charge water system fees, and provincial legislation gives municipalities the freedom to decide for themselves the level (price) at which these fees are set. (This is also the case for many other municipal fees and charges.) According to the *Public Utilities Act*,

> The corporation may regulate the distribution and use of the water in all places where and for all purposes for which it may be required, and fix the prices for the use thereof, and the times of payment, and may erect such number of public hydrants and in such places as it may see fit, and may direct in what manner and for what purposes the same shall be used, and may fix the rate or rent to be paid for the use of the water by hydrants, fireplugs and public buildings.[24]

Municipalities collect a wide range of relatively minor charges designed to recover the costs of specific services related to water and sewage. For example, they may impose charges to

- turn water on and/or shut water off;
- test water meters (in which case the customer is charged if the meter registers accurately);

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[24] *Public Utilities Act*, RSO 1990, c. P.52, s. 8.

- use water for construction purposes (typically via a hydrant);
- supply statements of account;
- process dishonoured cheques;
- update accounts to record change of occupancy;
- thaw frozen water lines;
- cover administration costs when payments are late; and
- cover the cost of administering a lien in respect of non-payment for water and sewage services.

None of the examples cited above are specifically identified in the legislation; the types and amounts of charges levied are entirely local decisions.

Since the legislation allows municipalities to set their own prices, the portion of water and sewage system costs that are recovered from user fees (direct water and sewage billings, fees and charges, and charges on the tax bill) varies across the province. Table 3-1 shows that, in 1999, about 86% of water and sewage system costs were recovered through a variety of charges and fees (all revenues except property taxes and provincial grants). Ontario grants for water and sewage system operating expenditures have accounted for less than 1% of water and sewage system expenditures over the last ten years. Direct water and sewage billings have shown the largest increase over the ten years; dependence on property taxes has fallen dramatically over the same period.

Table 3-1 Sources of Operating Revenue for Water and Sewage, as a Percentage of Total Revenue, Ontario, 1989 to 1999

Year	Ontario Grants	Revenue from Other Municipalities	Fees and Charges	Direct Water and Sewage Billings	Charges on Tax Bill	General Property Taxes
1989	0.5	1.3	4.4	75.0	1.1	17.7
1990	0.5	1.3	3.6	74.1	1.1	19.5
1991	0.4	2.0	3.1	76.2	1.1	17.2
1992	0.4	1.9	3.1	74.6	1.1	19.0
1993	0.4	2.1	2.9	77.8	1.1	15.8
1994	0.4	2.2	3.2	80.2	1.1	12.9
1995	0.4	2.3	3.0	82.4	1.1	10.7
1996	0.2	2.2	3.2	82.1	1.2	11.0
1997	0.2	1.9	3.6	82.9	1.4	10.0
1998	0.2	2.0	4.2	88.4	1.7	3.5
1999	0.3	1.1	4.2	88.1	1.7	4.6

Note: The property tax allocated to water and sewage systems (shown in the final column above) has been calculated as the difference between total operating expenditures and specific revenues. Revenues from other municipalities (shown in the third column) include grants, fees and service charges related to water and sewage. Charges on the tax bill (shown in the second-last column) include water and sewage service charges, water and sewage system connection charges, and fire service charges. Totals may not add up due to rounding.
Source: Ontario, Ministry of Municipal Affairs and Housing, Financial Information Returns [FIR] database.

Many municipalities rely on property taxes to recover the costs of providing capacity in water systems for fire protection. This approach is commonly referred to as 'hydrant rental,' a term that reflects the wording of the legislation ("may fix the rent") rather than an accurate description of the service being provided.

3.2 Revenue Security

The *Public Utilities Act* also provides municipalities with the power to enforce collection of water and sewage charges. Specifically, the legislation states:

> Where rates that are based on the water rates or charges charged or chargeable in respect of any land are imposed on the owners or occupants of such land in respect of the construction, operation or maintenance of sewage works or in respect of sewage service, the corporation may, in default of payment of the rates in respect of sewage works or sewage service, shut off the supply of water provided by the corporation to such land, but the rates in default are, nevertheless, recoverable.[25]

In addition, amounts owing on water and sewage accounts can be applied as a lien against properties and collected in the same manner as property taxes. The powers thus vested in municipalities by the *Public Utilities Act* are intended to ensure full recovery of all water user charges.

3.3 Capital Works for New Development

The *Development Charges Act, 1997*, allows municipalities to charge development fees to cover the cost of providing major water and sewage facilities such as treatment, trunk mains, and pumping, as well as some other services, for new servicing:

> The council of a municipality may by by-law impose development charges against land to pay for increased capital costs required because of increased needs for services arising from development of the area to which the by-law applies.[26]

[25] Ibid., s. 28(4).
[26] *Development Charges Act, 1997*, SO 1997, c. 27, s. 2(1).

The recovery of the capital cost of providing water and sewage services for new developments via these charges is general practice in Ontario, although it is not a requirement. Before the current legislation was in place, going back almost 40 years, similar charges, called 'lot levies,' could be applied to new developments in Ontario under authority of the *Planning Act*. A number of studies have suggested that the development charge is usually passed on by the developer to the buyer of the new home (see section 7.5.3), who also becomes a new water and sewage system customer. Customers are also expected to pay for the water and sewage system connections made on their private property.[27]

In 1989, the original *Development Charges Act, 1989*, was passed. This act laid out guidelines for the use of development charges, but did not specify the services for which development charges could be levied. Thus, municipalities could charge for any growth-related capital costs, including both hard services (water, sewers, roads, and the like) and soft services (city halls, recreational facilities, police and fire facilities, parks).

The new *Development Charges Act, 1997*, identifies the services that can be financed using development charges and clarifies how these charges are to be determined. Under the new legislation, the growth-related costs of hard services, such as water supply, may be fully funded by development charges, but a 10% discount is required for some other services. The new act also excludes certain kinds of developments from development charges, including cultural or entertainment facilities (i.e., museums, art galleries, and theatres), tourism facilities (such as convention centres), parkland acquisition, hospitals, waste management services, and municipal headquarters.

The legislation also requires that a municipality undertake a background study before implementing a development charges bylaw. The study must include (1) estimates of the anticipated amount, type, and location of development; (2) calculations for each service for which a development charge would be levied; and (3) an examination of the long-term capital and operating costs for capital infrastructure required for the service. For each service, the background study must include an estimate of the total capital costs, and of the way these costs will be allocated between new development and existing development.[28]

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[27] An exception to this is the supply and installation of water meters. Most municipalities provide and install water meters at no additional charge in a space left for the meter in the plumbing that leads into the premises.

[28] In the 1989 act, municipalities were permitted to levy charges that reflected standards "no higher than the standards to which such services are currently provided or have been provided at any time

3.4 Works Built to Serve a Specific Location

Two provincial statutes relate to the provision of water and sewage services to serve a particular location or area:

- The *Local Improvement Act* allows for the initiation of public works projects, including water and sewage works, based on a petition. This legislation also allows such projects to be initiated by municipal council; this is often in response to environmental concerns. A two-thirds majority at council is needed to proceed with the works, as is approval by the Ontario Municipal Board. The cost of the works is recovered by applying a frontage charge to the properties they serve. The act legislates what costs can be included in this charge, and exactly how it is to be calculated and applied.

- The *Municipal Act* gives municipalities the authority to recover costs associated with capital facilities, and sets out cost-recovery mechanisms that can be used:

  > The council of a local municipality, in authorizing the construction of sewage works or water works, may by by-law impose a sewer rate or water works rate upon owners or occupants of land who derive or will or may derive a benefit therefrom sufficient to pay all or such portion of the capital costs of the works as the by-law may specify.[29]

  In this act, "sewage works or water works" includes mains, treatment, and storage facilities; thus, the works being constructed and area served could range from a watermain serving a local street to a complete water system.

The legislation sets out various ways these charges can be calculated, including frontage charges on lands that receive an immediate – or deferred – benefit from the services; flat-rate charges; and "any other method which the council considers to be fair."[30] This last provision is a good example of the highly permissive nature of the legislation.

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in the ten years preceding the calculation." In the more recent legislation, standards have been limited to "the average level of service provided in the municipality over the ten-year period immediately preceding the preparation of the background study."

[29] *Municipal Act*, RSO 1990, c. M.45, s. 221(2).

[30] Ibid., s. 221(9) as amended.

3.5 Forced Connection

Provincial legislation also allows a municipality to force the connection of customers to water or sewage works and to recover the cost of the service(s) from those customers. The *Municipal Act* states:

> Councils of local municipalities may pass by-laws requiring owners of buildings or any class of classes of buildings in the municipality or in any defined area thereof to connect the said buildings or class or classes of buildings to the sewage works or water works of the municipality.[31]

There are at least two reasons why municipalities might invoke the powers of this section of the act: (1) to alleviate deteriorating environmental conditions, such as depletion of groundwater by private wells or pollution of groundwater by leaking septic tanks; or (2) to generate revenue, particularly in the case where some residents are resisting connecting to a new system. Since municipalities typically build facilities to serve all residents within a particular geographic area, revenues are needed from all these customers to support the system. The legislation thus enables municipalities to ensure full recovery of water system costs.

3.6 Exemption from Connection

The *Municipal Act* also allows municipalities to exempt customers from the requirement to connect. However, exempting customers from connection does not necessarily mean that the exempt customer is not liable for water system costs; the act allows municipalities to charge customers user rates, even if the customer is not connected:

> A by-law passed under subsection (1) may provide for exempting owners of buildings, or any such class or classes thereof as may be specified in the by-law, in the municipality or in any defined area thereof from the application of the provisions of the by-law requiring the connection of such buildings or such class or classes thereof to the sewage works or water works of the municipality upon payment by the owner to the municipality of such amounts or

[31] Ibid., s. 222(1).

> amounts computed by such method as may be provided for in the by-law, and the amounts or method of computation provided for may be different for owners of different classes of buildings, and the by-law may provide for the manner in which and the period for which the payments shall be made.[32]

This section of the act is most often applied to newly built, smaller, water or sewage systems where user rate revenues are needed to support the new system.[33]

3.7 Alternative Financing

Section 210 of the *Municipal Act* allows a municipality to enter into agreements with others for the provision of capital facilities, and gives some flexibility in the sale or leasing of public facilities.[34] This provision opens the door to public-private partnerships in water supply, including, potentially, full divestiture. However, there do not appear to be any provisions for regulating the user rates that could be charged by privately owned and operated facilities. The lack of such provisions does not affect cases where municipalities enter into public-private partnerships, because contract terms and conditions can be used to control changes in user rates. In the case of outright divestiture, however, rate regulation would probably be warranted; this, in turn, would require the creation of a regulatory framework, perhaps similar to the Ontario Energy Board and its associated legislation.[35]

3.8 Debt Limits

Municipalities in Ontario are permitted to borrow for capital expenditures within certain prescribed limits.[36] For most municipalities, debt charges cannot

[32] Ibid., s. 222(2).
[33] Note that the incremental water system operating costs resulting from the connection of a new customer are minor in comparison to other system components; thus, the savings that result when some customers do not connect, or conversely, the added costs if they do connect, are relatively low.
[34] At the same time, provincial policy may dictate that any municipality that proposes to sell all or part of its water or sewage works to the private sector would first have to repay the face value of any provincial capital grants it has received since 1978; see Ontario, Ministry of the Environment, 2001a, “Water and Sewage Services Improvement Act,” Media backgrounder [online], [cited January 2002], <www.ene.gov.on.ca/envision/news/00197.htm>.
[35] The Ontario Energy Board regulates electricity rates in Ontario, among other duties.
[36] Set out in O. Reg. 799/94.

exceed 25% of own-source revenues (total revenues minus transfers from other levels of government, transfers from reserves, and proceeds from the sale of property). Approval by the province is required for any capital borrowing that exceeds the established limit.

With respect to debt limits, 'capital' refers to any undertaking that requires long-term financing.[37] In Ontario, debt is issued in the form of general obligation debentures that are backed by the general revenues of the municipality. Municipalities must pass a bylaw before they can issue debentures.

Prior to 1993, municipalities in Ontario required approval from the Ontario Municipal Board for all borrowing. Toward the end of the 1980s, there was increased recognition that existing infrastructure needed to be renewed and that new infrastructure was required to accommodate growth. At the same time, provincial debt was growing and the province was not keen on providing increased capital grants to municipalities; it was also felt that municipalities had enough unused capacity for borrowing that they could incur more debt than they had at the time.[38]

Changes to provincial legislation in 1992 permitted municipalities to undertake capital borrowing without Municipal Board approval, provided that prescribed debt limits were not exceeded. At the time, the formula for the limit (calculated by the Ministry of Municipal Affairs) was that a municipality's annual payment relating to debt and financial obligations must not exceed 20% of its operating expenditures. This guideline was later changed to the current 25% of own-source revenues on the grounds that not all revenues were under the control of a municipality (for example, many receive conditional provincial grants), and that, under the old formula, an increase in expenditures would automatically increase the debt limit.

[37] Here, 'long-term' is defined as extending beyond the term of the council of the municipality.
[38] The Ontario 1989 Provincial Budget Paper E, "Municipal Government Finance" (Ontario, Ministry of Finance [Toronto: Queen's Printer for Ontario]) provides some support for this idea. Information presented in the paper showed that municipalities tended to have low debt levels relative to guidelines and that municipalities had the fiscal capacity to take on additional debt. One of the reasons given for the low debt levels was the high interest rates of the 1980s, which resulted in a switch to 'pay-as-you-go' financing of capital expenditures.

3.9 Regulations Affecting Expenditure Levels

In addition to the provincial laws that prescribe municipal fiscal management related to water and sewage systems, there are also regulations that affect the level of expenditures that a municipality is required to undertake. For example, a number of regulations have been enacted pursuant to the *Ontario Water Resources Act* related to various aspects of water service, including operator training and certification, operating standards, water quality standards, and waterworks construction. Each regulated requirement has a direct impact on the costs, both capital and operating, that municipalities incur in providing water services.

The *Drinking Water Protection Regulation*, which was passed in August 2000, provides new standards in several areas, including a disinfecting, chemical treatment of surface waters, water quality monitoring, laboratory certification, and the reporting of water quality test results, including the use of the Internet.[39] The requirements imposed by this regulation are likely to increase the cost of providing water services for some municipalities.

4 Demand for Water and Sewage Systems and Services

This section examines the demand for water services, including determinants of demand and price elasticity of demand. It includes a discussion of why knowledge of price elasticity is important, and of the impact of metering.

4.1 Quantity Requirements

Water systems are designed to meet two distinct needs: (1) potable water for individual customers; and (2) firefighting.

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[39] Ontario, Ministry of the Environment, 2001b, *Ontario Drinking Water Standards* [online], [cited January 2002], <www.ene.gov.on.ca/envision/WaterReg/Pibs4065.pdf>.

4.1.1 Customer Demand

In providing water and sewage services, municipalities must be able to accommodate a range of customers, usually categorized as residential and non-residential; this latter category includes industrial, commercial, and institutional customers. Regardless of category, all municipal water customers typically have a number of expectations about their water supply – specifically, that water will be

- available 24 hours per day;
- free of pathogens and toxic substances;
- free of objectionable tastes and odours;
- suitably pressurized at all times; and
- sufficient to meet volumetric demands at all times.

For the residential sector, typical factors affecting demand include price, household income, type of housing (single family versus multi-family), and lot size, among others.

Non-residential demand in a community depends on the level and mix of commercial, industrial, and institutional activities, as well as the price of water and the production practices and technologies of the non-residential customers.

Table 4-1 shows 1996 data on per capita water use in Ontario, divided into categories of smaller and larger municipalities (defined as under and over 10,000 residents), both for all customers and for residential customers only.

The data in table 4-1 indicate that residential per capita water use tends to be higher in smaller municipalities, while total water use (residential and non-residential combined) per capita tends to be lower in these same municipalities.

The likely reasons for the higher levels of residential water use in smaller municipalities include higher proportions of single-family dwellings, larger lot sizes, and a lower incidence of customer metering compared with municipalities serving larger populations. The higher total water use for larger municipalities clearly stems from non-residential users, which include industrial, commercial, and institutional customers. The median non-residential water use is 54% of total use in large municipalities but only 28% in smaller communities.

4.1.2 Fire Flow

Communal (municipal) water supply systems were originally designed and built with fire protection in mind, and the requirement to provide fire protection continues to this day.[40]

Firefighting water supply requirements are expressed in terms of minimum standards of flow and pressure for a specified duration. They vary across a given municipality depending on the class of development. Guidelines for determining fire flow requirements are established by the Insurance Bureau of Canada on the basis of a number of factors, including type of building construction, type of use or occupancy, and exposure or orientation relative to adjacent buildings.

The requirements for fire flow can impose a significant demand for capacity on a water system; it may need to exceed customer demand by a considerable amount in order to ensure readiness to serve firefighters' needs. The proportion of the total capital cost of a water system that is for fire protection can vary from 15% for large municipalities to as much as 75% for small municipalities, since the cost of the basic need is the same for both. Yet, while fire readiness accounts for a large portion of the *capacity* that must be built into a water

Table 4-1 Per Capita Water Use in Ontario, 1996

		Water Use per Capita (Lpcd)* Residential Customers Only		Water Use per Capita (Lpcd) All Customers	
	Number of Municipalities	Median	50% Range**	Median	50% Range**
All Municipalities	271	312	244 to 406	506	398 to 630
Municipalities with Population <10,000	170	352	270 to 459	500	381 to 650
Municipalities with Population ≥10,000	101	261	214 to 324	519	439 to 627

*Litres per capita per day.
**The range between the 25th and 75th percentiles.
Source: Based on analysis of data from Canada, Environment Canada, 1996, Municipal Utility Database [MUD].

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40 Section 4.1.2 is based on M.J. Hammer and M.J. Hammer, Jr., 2001, *Water and Wastewater Technology*, 4th ed. (New York: Prentice Hall); and R.M. Loudon, 1979, *Water Rates in Ontario: Principles and Practices* (Peterborough, Ont.: Ontario Municipal Water Association and American Water Works Association, Ontario Section).

system, the actual *volume* of water used for firefighting and firefighter training is probably less than 1% in most municipalities.

4.1.3 Non-Revenue-Generating Water

The American Water Works Association (AWWA) has promoted the use of the term ‘non-revenue water’ (NRW) to describe water from which no revenue is generated.

In a 1995 survey of 138 Canadian water systems serving 10,000 or more people, the median level of NRW demand and demand that was not authorized was estimated to be 14.2%. For the middle 50% of these systems (from the 25th to the 75th percentile), the range of NRW demand was 8.6% to 23.4%.[41]

The numerical difference between the amount of water produced and discharged from the water source and the total volume of water billed to customers has traditionally been referred to as ‘unaccounted-for water,’ or UFW. The amount of UFW is typically calculated by subtracting the amount sold retail from the amount produced, then dividing by the amount produced to arrive at a percentage. This volume of water typically covers the following uses:

1. flushing of water and sewer mains;
2. firefighting and firefighter training;
3. drawing water from hydrants for various other purposes, such as street flushing;
4. unmetered park watering;
5. inaccuracies in retail customer meters; and
6. leakage in watermains and service connections.

Some water is also used in water treatment plants (e.g., for filter backwashing). This water, however, is usually taken before it reaches the supply facility meter, and therefore is not reflected in UFW figures. In any case, since it is part of the production process, this amount should not really be considered water loss, but treated as a separate issue. This water accounts for 2% to 3% of the total volume of water produced by a facility.[42]

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[41] American Water Works Association [AWWA], 1995b, *Canadian Utility Profiles* (Denver, Colo.: AWWA).
[42] Hammer and Hammer.

Note that items 1 through 4 in the list above represent water usage that could (and should) be accounted for in order to manage volume efficiently and, potentially, charge those responsible for its use. In fact, charges for item 2 are meant to recover the cost of fighting fires. Item 5 also represents a problem that should be addressed to ensure that customers are paying for what they use and that as much as possible of the water produced is generating revenue.

An Ontario survey conducted in 1999 yielded an estimate of 15.0% for the UFW median, and of 11.0% to 20.0% for the middle 50% range. In the all-Canada survey cited above, when the unauthorized and unaccounted for uses (assumed to represent UFW) were estimated separately,[43] the median was 10.0% and the range for the middle 50% was 3.6% to 16.5%. The higher values found in the Ontario survey may simply reflect differences arising from survey methodology rather than real differences between Ontario water systems and those located elsewhere in Canada.

The AWWA recommends that no more than 1% of a municipality's total annual production be used in identified unmetered uses such as fire flow, street cleaning, and water and sewer main flushing, and that NRW be no more than 10%.[44]

4.2 Patterns of Water Use

Water demand exhibits predictable variations on an hourly, daily, and seasonal basis. Seasonal fluctuations in both hourly and maximum day variations are key determinants of the production and transmission capacity a facility requires. Local distribution systems are designed to meet the demand during maximum-use hours, as well as the capacity needed for fire flow.

Hourly variations in residential demand exhibit two peaks, one in the morning and the other in late afternoon, with minimum use occurring between about 11 p.m. and 5 a.m.[45]

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[43] OWWA, 1999. NRW amounts were not reported in this survey.
[44] L.M. Buie, 2000, "Accounting for lost water," *Journal American Water Works Association*, vol. 92, no. 7; and American Water Works Association, Leak Detection and Water Accountability Committee, 1996, "Committee report: Water accountability," *Journal American Water Works Association*, vol. 88, no. 7.
[45] P.T. Bowen, J.F. Harp, J.W. Baxter, and R.D. Shull, 1993, *Residential Water Use Patterns* (Denver, Colo.: American Water Works Association Research Foundation).

Hourly variations in non-residential water use depend on the prevalence of industrial shift work and late-evening commercial activity. In most municipalities, seasonal variations in demand depend on the prevalence of outdoor water uses, especially lawn watering. In humid regions, total seasonal demand for outdoor water use is quite small in terms of actual volumes used.[46] Estimates for Ontario suggest that it is about 5% of total demand.[47]

From a design perspective, the important aspect of seasonal demand is the *maximum day water use* within the peak season. This is the maximum daily amount of water produced over an annual period. Typically, estimated maximum day demand is used to determine capacity requirements for water treatment, pumping, and transmission systems. (In contrast, an *average day factor* [incorporating an allowance for inflow and infiltration] is used to estimate sewage capacity requirements.) Maximum day demands are measured using the ratio of maximum day demand to *average day demand*. Table 4-2 presents the ratios for Ontario.

The values in table 4-2 indicate that the median ratio of maximum day demand to average day demand in smaller municipalities (1.80) is about 13% higher than it is in larger municipalities (1.60). Higher maximum day demand for smaller systems is not unexpected, since the larger number of users in larger populations would tend to reduce the degree of variation of demand.

Table 4-2 Ratios of Maximum Daily Flow to Average Daily Flow, Ontario

	Median	50% Range
All Municipalities	1.73	1.49 to 2.17
Municipalities with Population ≥10,000	1.80	1.50 to 2.23
Municipalities Population >10,000	1.60	1.49 to 1.97

Note: Sample size is 220; 50% range is based on the 25th and 75th percentiles.
Source: Based on analysis data from Canada, Environment Canada, 1996, MUD.

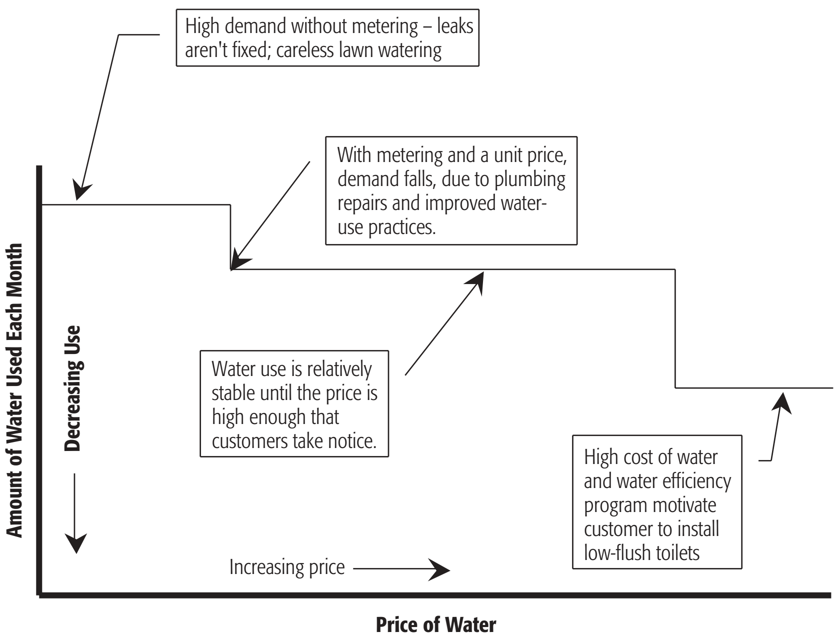
[46] Hammer and Hammer.
[47] M. Fortin and B. Veale, 1983, *Existing and Future Water Demand for the Grand River Basin*, Technical report no. 26, Grand River Basin Water Management Study, Brantford, Ont.; Braun Consulting Engineers, M. Fortin, Maddaus Water Management, and H. Cummings and Associates, 1999, *Water Conservation and Efficiency Study, Final Report*, prepared for the City of Guelph, Ont.

4.3 Demand Curve for Water

A water services demand curve describes the relationship between the quantity of water demanded and the price charged for its consumption, holding other factors such as household income and number of customers constant.[48] The basic premise underlying a demand curve, as discussed in section 2.3, is that consumption falls as the marginal price of the good or service increases, and vice versa. Thus, a higher volumetric price for water provides the customer with an incentive to conserve it. Conversely, a lower price provides a disincentive to conserve water, or, stated differently, an incentive to use water. Demand curves usually apply to different types of customers (such as residential and non-residential).

Figure 4-1 shows the probable response of an individual household to successive increases in the price of water.

Figure 4-1 An Individual Household's Demand for Water



[48] Section 4.3 is based in part on New East Consulting Services, R.M. Loudon, and M. Fortin, 2001, *Conservation Water Rate Study*, Draft final report, Prepared for Capital Regional District, B.C.

The demand curve in Figure 4-1 is the thin line that steps down as price increases. This shape is called a 'step function.'[49]

Most estimated demand curves, however, are smooth curves, showing continuous relationships between price and water demand, not uneven step functions, because they describe the aggregate behaviour of many customers. Different households use different amounts of water and respond to price changes in different ways; the more households that are considered together, however, the smoother the curve. For instance, figure 4-2 might represent the demand curve for 20 households, while figure 4-3 might represent the demand curve for 1,000 households. Various curves have been developed that demonstrate the behaviour of the residential component of municipal water demand, the water demand of specific industrial sectors, and aggregate municipal demand.

What determines demand? With respect to residential customers, the factors include the following:[50]

- household income and related factors (i.e., standard of living, ownership of water-using fixtures and appliances);
- type of housing (single-family or multi-family, lot size, age of housing) and average household size;
- water price and rate structure;
- weather (precipitation, temperature, evapotranspiration,[51] season length); and
- use of water conservation measures and practices.

The list of typical determinants presented above is supported by research that found residential water demand to be, on a per capita basis, (1) greater for newer homes than older homes, and (2) greater for single-family residences than multi-family residences.[52] The same study found that both weather patterns and underground irrigation and sprinkler systems have a strong influence on

[49] A 'function' is a mathematical relationship between two variables such as price and demand. A simple function for water demand might be the following:

household demand per month = 30 cubic metres – 0.2 x (price per cubic metre of water).

A cubic metre is equal to 1,000 litres.

[50] Planning and Management Consultants, 1992, *Evaluating Urban Water Conservation Programs: A Procedures Manual* (Sacramento, Calif.: California Urban Water Agencies).

[51] This term refers to the transfer of moisture that has already fallen as precipitation back into the atmosphere through evaporation.

[52] Bowen et al.

the variability of use, and that household size (number of persons living in the house) has little impact on per capita (per person) use.

Industrial demand curves are based on theories of production that include water and other factors.[53] Aggregate municipal demand curves include similar factors. While the demand for water is determined by a number of factors, as mentioned above, the slope of the demand curve depends only on the relationship between quantity demanded and price. This relationship is discussed in detail in the next section.

Figure 4-2 Sample Demand Curve for Water – 20 Households

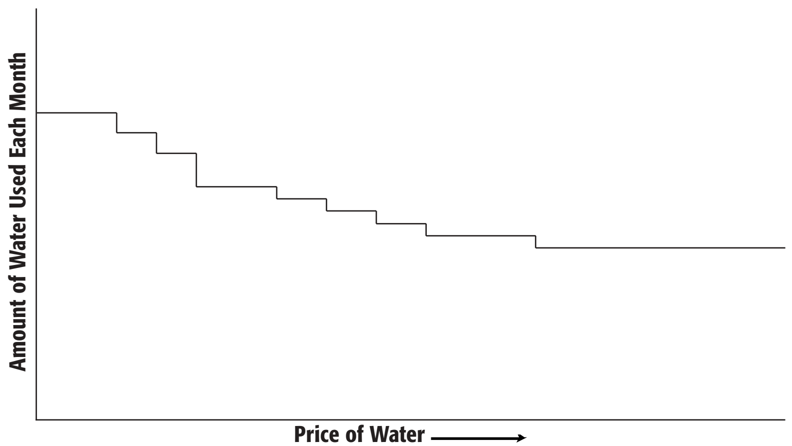
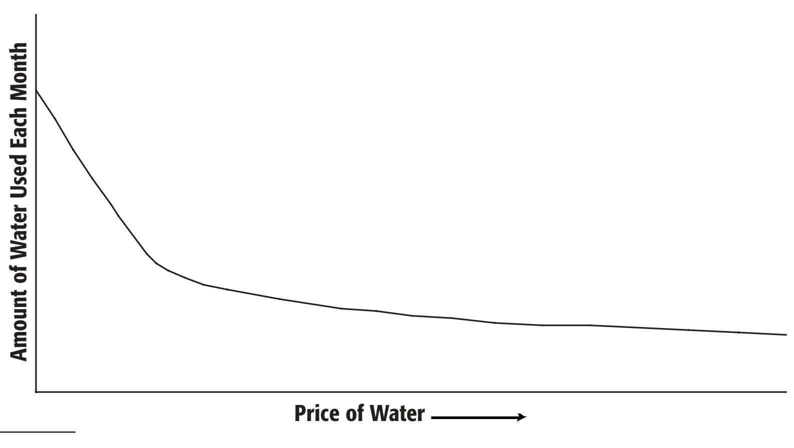


Figure 4-3 Sample Demand Curve for Water – 1,000 Households



[53] See, for example, S. Renzetti, 1988, "An econometric study of industrial water demands in British Columbia, Canada," *Water Resources Research*, vol. 24, no. 10, pp. 1569–75.

4.4 Price Elasticity of Demand

'Price elasticity of demand' measures the extent to which a change in the quantity demanded is sensitive to a change in price.[54] If the quantity demanded is highly sensitive to a price change, then demand is said to be 'elastic.' Demand curves with this characteristic have a relatively flat slope. If, on the other hand, quantity demanded is highly insensitive to a price change – that is, the quantity demanded does not change very much when the price changes – the demand is defined as 'inelastic,' and the demand curve will have a relatively steep slope.

The measure of price elasticity is called a 'price elasticity coefficient'; this number is the ratio of the percentage change in quantity demanded divided by the percentage change in price. It corresponds to the mathematical slope of the demand curve*;* because demand curves slope downward from left to right, these coefficients are always negative numbers.

The mathematical expression for elasticity is thus

$$\text{(price elasticity of demand)} = \text{(\% change in quantity demanded)} \div \text{(\% change in price)}$$

$$= \frac{\left(\dfrac{\text{change in quantity demanded after the price change}}{\text{quantity demanded before the price change}}\right)}{\left(\dfrac{\text{change in price}}{\text{original price}}\right)}$$

Thus, the calculation using elasticity to estimate a change in the quantity demanded when price changes is as follows:

$$\text{(\% change in quantity demanded)} = \text{(price elasticity of demand)} \times \text{(\% change in price)}$$

If the coefficient is less than –1.0, then demand is inelastic. The smaller the absolute value of this coefficient, the more inelastic is the demand – the more insensitive is a change in quantity demanded to a price change. For example, if price elasticity is –0.8 and the price of water increases by 10%, then the quantity demanded will fall by 8%. If price elasticity is –0.2 (even more inelastic), a 10% increase in the price will lead to a reduction in quantity demanded of only 2%.

[54] Other elasticities measure how demand responds to other changes, such as increases in household income, population growth, and the like.

If, on the other hand, the absolute value of the coefficient is greater than 1.0, the demand is elastic. Once again, the higher the value, the greater the responsiveness in quantity demanded to price changes. A coefficient of –2.0, for example, means that a 10% increase in price will lead to a 20% reduction in quantity demanded, a relatively significant response.

In jurisdictions where customers pay a flat rate, and not a price that is based on volume, the elasticity coefficient is 0.

Economists use a statistical analysis of water use, volumetric water price, and other data to develop demand curves and estimate the price elasticity of demand for water use in various markets. The price used in this type of analysis is total volumetric price, including the water rate plus any sewage rate or surcharge. Estimates of water price elasticity usually lie in the range of –0.05 to –1.0.

Table 4-3 presents price elasticities drawn from a number of studies; in all cases, the reported price elasticity is less than 1, indicating that demand is price inelastic.

The more recent studies referenced in table 4-3 indicate that the demand for water is quite inelastic. Knowledge of price elasticities is important because they are often used in municipal planning to forecast water demand. Planners should exercise care, however, in how they use the published elasticity calculations for any specific municipality, since estimates of elasticity borrowed from the research literature will not necessarily reflect conditions prevailing in the community for which forecasts are being made.

Furthermore, price elasticities in the literature are often presented as point estimates with little or no contextual information; but context is very important in understanding the response of demand to price. Consider the case of the City of Oshawa: In the early 1970s, the price for water in Oshawa was $0.46 per cubic metre.[55] In the late 1970s, the city increased the price to $1.04; the new price reflected the addition of a sewer surcharge and fire protection charges (which had previously been included as part of the property tax). The water price was increased again in 1982 to $1.20 per cubic metre, and remained between $1.10 and $1.20 for the rest of the 1980s. With the initial price increase, the annual water demand dropped by approximately 22%. Over the ensuing years, demand gradually increased, such that the annual water consumption in 1989 was within 6% of what it had been before the price increases. Figure 4-4 shows this rebound of demand.

[55] All prices in this example are given in 1992 dollars.

Price elasticity of demand has three key attributes that should be understood:

1. *Price elasticity varies by type of customer.* Industrial water users may be very sensitive to the price of water, while commercial and residential customers may be less sensitive.

Table 4-3 Water Price Elasticity Information from Various Sources

Source	Findings	
National Regulatory Research Institute, 1991[a]	Residential Industrial	–0.20 to –0.40 –0.50 to –0.80
California Urban Water Agencies, 1992[b]	Single-family residential Winter Summer Multi-family residential Winter Summer Commercial/Industrial	 –0.10 to –0.20 –0.20 to –0.40 –0.05 to –0.20 0.00 to –0.20 –0.10 to –0.30
Canadian Water and Wastewater Association, 1994[c]	In-house residential Outdoor residential Non-residential	–0.2 to –0.4 up to –1.0 –0.5 to –0.8
California Urban Water Conservation Council, 1997[d]	*Long-Run Elasticities* Single-family residential Winter Summer Multi-family residential Winter Summer *Short-Run Elasticities* Single-family residential Winter Summer Multi-family residential Winter Summer	 –0.10 to –0.30 –0.20 to –0.50 0.00 to –0.15 –0.05 to –0.20 0.00 to –0.10 –0.10 to –0.20 0.00 to –0.05 –0.05 to –0.10
National Regulatory Research Institute, 1994[e] and Baumann, Boland, and Hanemann, 1998[f]	In-house residential Outdoor residential Commercial Industrial Total municipal	–0.1 to –0.2 –0.4 to –0.7 –0.1 to –0.4 –0.4 to –1.0 –0.1 to –0.7

Notes:

a Beecher, Mann, and Landers, 1991.

b Planning and Management Consultants, 1992.

c Harris, Tate, Loudon, and Fortin, 1994. These numbers are based on the same source as the National Regulatory Search Institute numbers given in the first row of this table.

d Chesnutt et al.

e Beecher et al., 1994.

f Baumann, Boland, and Hanemann, 1998. The two publications in this row summarize findings from dozens of water demand studies spanning 50 years; only a handful of the studies are either continental in scope or specific to the Pacific northwest region.

2. *Price elasticity of residential demand varies by type of use.* Indoor demand is generally less elastic than outdoor demand, which includes lawn and garden irrigation.

3. *Price elasticity may vary as price increases.* At very low prices, the amount spent on water for most residential customers is negligible, and price elasticity is low. As price increases, the amount customers spend on water becomes a more important consideration for them, and price elasticity increases (i.e., demand becomes more responsive to price).

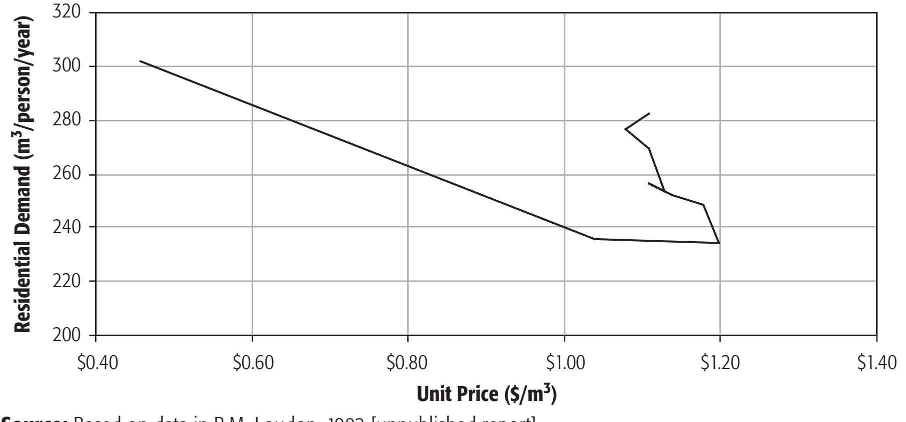
If increases in the price of water do not keep up with inflation, then the total amount that customers spend on water falls in terms of real (non-inflating) dollar values over time. Where this happens, demand may not respond as expected to price increases, since these need to be considered in the context of inflation.

When the water price becomes very high, water demand may 'harden,' or become less responsive to subsequent price increases. This happens when customers have exhausted all of their cost-effective options for reducing water demand (discretionary demand may be minimized, but basic needs still have to be met).

To select a value for elasticity for a community, it is necessary to evaluate the following:

- the mix of customer types receiving water service;

Figure 4-4 Long-term Response of Residential Demand to Changes in Unit Water Price, Oshawa, 1973 to 1989



Source: Based on data in R.M. Loudon, 1992 [unpublished report].

- the relative proportions of indoor and outdoor water use;
- the existing price levels; and
- the community's history of water efficiency programming and water rate adjustments.

The time period is a further complicating factor in the interpretation of price elasticity. Demand studies provide both short-run and long-run estimates of elasticity. Short-run elasticity measures changes in demand that occur within a year, whereas long-run elasticity measures responses that occur over a longer period of time. Long-run elasticities are generally higher than short-run elasticities, since certain water efficiency measures that a customer adopts in response to a price change may take more than a year to implement. In water efficiency planning studies, long-run price elasticities are of greatest interest.

In estimating elasticity, it is often difficult to discern the impact of pricing when other forces, such as weather and population growth, are influencing demand. The same problem exists when forecasting demand with models that include price elasticity. The impact of price changes may be overwhelmed by the impact of other factors. Moreover, if the impact of a water efficiency program is built into the forecast, then it is easy to 'double count,' overestimating the impact of price changes, since the water efficiency measures promoted by the program are the same measures that customers use in responding to price increases.

Over the short term, as demand decreases owing to conservation, the price of water must increase to offset revenue loss.

4.4.1 Impact of Metering

The installation of meters and implementation of volumetric pricing results in a decrease in demand, as is shown in table 4-4. Furthermore, the use of meters is essential if a municipality is to implement volumetric pricing.

The data in table 4-4 show that, in all cases, average and maximum daily flows are higher for unmetered customers than for customers with meters. Customers who do not have meters are typically charged a flat rate for water, regardless of use. Because customers with meters are charged on the basis of water use, they adjust consumption according to their willingness to pay. When meters are first installed, or when volumetric water prices are increased, customer demand usually drops.

4.5 Wastewater Production

The amount of wastewater discharged into sanitary sewers by water customers is generally less than the amount of water consumed (as measured by meters or otherwise), because some of the water is used for irrigation or other purposes, and so is not discharged to the sewage system. Certain industrial customers actually discharge only a small proportion of metered water into the sanitary sewer because they incorporate water into their finished product. Water may be lost through evaporation or be discharged into the storm sewers.

Since customer sewer lines are not metered, municipalities that levy volumetric sewer charges base the charges on metered water use. When recovering sewage service costs using such volumetric sewer charges, therefore, municipalities often give residential customers a discount on metered water volume of 15% to 20% during the summer months to account for outdoor water use.[56]

Although the volume of sewage generated by customers is usually less than that of water consumed for the reasons cited above, the volume of sewage received at a sewage treatment facility can be greater than water demand. For

Table 4-4 Impact of Metering and Volumetric Pricing on Water Demand

	Median	25th Percentile	75th Percentile
Not Metered (87 municipalities)*			
Service Population (#)	4,200	1,568	7,583
Residential Demand (Lpcd)	389	318	491
Total Demand (Lpcd)	600	452	708
Ratio of Maximum Day to Average Day	1.8	1.6	2.25
*Metered** (184 municipalities)*			
Service Population (#)	8,545	2,865	28,000
Average Day per Capita (L/d)	272	217	351
Maximum Day per Capita (L/d)	483	377	566
Ratio of Maximum Day to Average Day	1.64	1.43	2.03

*Defined as no more than 30% metered; average = 2%.
**Defined as at least 50% metered; average = 97%.
Source: Based on an analysis of Ontario data from Canada, Environment Canada, 1996, MUD.

[56] New East Consulting Services, Loudon, and Fortin; also Loudon.

this reason, the demand for sewage collection and treatment capacity exceeds the sewage flow generated by customers. The difference is caused by extraneous flows that enter the sewage system through the sewers: as groundwater that enters through joints and cracks in the pipes – called 'infiltration' – or as surface runoff that enters the system through sewer caps, storm connections, and roof water connections (roof leaders) – called 'inflow.'

Estimated per capita sewage volumes for Ontario municipalities, and how they compare to the water use volumes of the same places, are provided in table 4-5.

If it is assumed that outdoor water use is about 5% (see section 4.2), then the comparison of sewage volumes with metered water volumes shown in table 4-5 suggests that inflow and infiltration (I/I) accounts for about 15% of total sewage volume at the median.

Just as demand for water varies, sewage production varies with the weather and the time of day. Over the course of a day, sewage flows in most municipalities reach a low at around 4 or 5 a.m. and peak around noon.[57] While peak water demand often occurs during the summer months, peak sewage flows occur in the spring; they are due not to changes in customer use but to extraneous flows from wet weather and snow melt.

Municipalities generally try to control I/I in order to improve the efficiency of sewage treatment operations. Control programs involve activities such as sewer inspection and repair, disconnection of roof leaders that discharge to the sanitary sewers, and capital works to replace or mitigate the effects of old sewers that were designed to carry both sanitary sewage and stormwater (called combined sewers).

Table 4-5 Per Capita Wastewater Volumes for Ontario, 1996

		Wastewater Volume (Lpcd)		**Ratio of Wastewater to Metered Water (%)**	
	Count	Median	50% Range	Median	50% Range
All systems	271	570	437 to 750	110	93 to 134
Population <10,000	170	569	406 to 750	108	87 to 141
Population ≥ 10,000	101	572	473 to 736	112	97 to 127

Source: Based on analysis of Ontario data from Canada, Environment Canada, 1996, MUD.

[57] Hammer and Hammer.

5 Supply and Cost of Water and Sewage Services

Municipalities in Ontario supply water and collect and dispose of sewage through communal systems. As noted in section 2, the efficient level of output is a function of both demand and supply; the latter is the subject of this section.

On the supply side, cost is an important factor – municipalities need to know the costs associated with these services in order to (1) ensure they have sufficient funds to cover capital and operating costs of maintaining a safe water system, and (2) set prices that will result in efficient resource use.

This section begins with an overview of the main types of water and sewage systems, including descriptions of major system components. The current supply situation in Ontario is also presented. The section then continues with an explanation of the various costs associated with supplying water and sewage services, ending with a discussion of economies of scale and scope, and of the concept of full cost.

5.1 Water Systems

Typically, the main components of a water system are a treatment system, pumps, transmission and distribution mains, and storage. Low-lift pumps deliver water from the source to the treatment plant. High-lift pumps deliver water under high pressure through transmission mains into the distribution mains. Sometimes booster pumps are also used within the system to maintain pressure to service areas that are more remote or at high elevations. Storage is also provided within the distribution system in the form of elevated tanks or underground tanks with booster pumps. Stored water is designed to provide for fire flows, daily water demand fluctuations, and emergencies. Lateral lines connect the flow to the distribution mains for customers and fire hydrants. Valves are installed throughout the system so that components can be isolated for repair and maintenance and turning customer services on and off.

When developing water supply systems, municipalities must consider both the *quantity* of water needed and the *quality* of the raw and finished waters. Quantity (capacity) requirements for water systems, which are based on customer demand, fire protection requirements, and allowances for system leakage, dictate the size of a system's components. The raw water source and required quality of the finished product typically determine the treatment processes to be used.

5.1.1 System Capacity

The capacity required to meet customer demand is determined by multiplying the population expected to be served by the system at some time in the future (usually 20 years, although some municipalities may use 10 years) and the per capita water use rate.[58] The Ontario Ministry of the Environment stipulates a typical range for average daily water demand of 240 to 450 Lpcd (litres per capita per day).[59] Significant non-residential (industrial, commercial, and institutional) demand can affect this figure. Because it is more efficient to build water treatment plants and storage facilities in large increments (that is, to serve customer demand over a 20-year period), there is usually a considerable amount of excess capacity in a system at the time it is built.[60] This excess diminishes over time as the population (and hence demand) grows. The median ratio of capacity to maximum day demand in Ontario in 1996 was 1.78 – that is, capacity was 1.78 times the highest existing level of demand. At this level, 44% of existing capacity is available to accommodate future growth. Small systems are more likely to have a high level of excess capacity, since they have greater need to find economies of scale, and usually grow more slowly. Although excess capacity is the norm, some municipalities fail to keep up with demand; in 1996, 11% of municipalities had maximum day demands that exceeded the capacities of their systems.[61]

Generally accepted design practice for water system components is as follows:

- Intake facilities and wells, treatment plants, pumps, and transmission mains are normally sized to meet maximum daily demand.

- The distribution system is sized to accommodate maximum daily demand plus required fire flow or maximum hourly consumption. Recommended water pressure in a distribution system is 450 to 520 kPa.

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[58] Often, municipalities will estimate these future populations during master planning studies. As well, the Ontario Ministry of Finance estimates future populations (20-plus years) on a county by county basis.
[59] Ontario, Ministry of the Environment, 1985, *Guidelines for the Design of Water Distribution Systems* (Toronto: Queen's Printer for Ontario).
[60] Underground infrastructure (such as watermains and service laterals), on the other hand, can be expanded incrementally.
[61] Based on an analysis of Ontario Ministry of the Environment 1996 data in Strategic Alternatives et al., 2001, "Water and Sewage Infrastructure Project, Phase 2A, Final Report," prepared for Ontario Ministry of the Environment [unpublished confidential report].

- Storage facilities are built into the system in order to supply water when demand exceeds maximum daily demand.

5.1.2 Treatment Processes

For the purposes of determining treatment requirements, water supply systems can be divided into two broad categories based on the source of the raw water: groundwater (typically accessed via communal wells) or surface water (lakes and rivers). Filtration and disinfection are the two main types of treatment; however, these processes are not used at all facilities.

The basic approach in conventional treatment entails removing particulates and other contaminants from the raw water by coagulation, sedimentation, and filtration, followed by disinfection using chlorine. Alternative disinfectants (e.g., ozone) and methods of disinfection (such as ultraviolet irradiation) may be used, and fluorides are often added to the treated water as a means of aiding in the prevention of dental caries. Typically, groundwater sources require only disinfection, although some groundwater sources may also require treatment to remove contaminants such as high levels of iron and manganese. While some surface waters have, until recently, only been disinfected prior to distribution, the trend now is to provide full conventional treatment for surface waters, or, alternatively, to use newer filtration technologies.

At present, there are 861 water treatment works in Ontario, serving over 95% of the province's residents;[62] the rest of the population is served by private wells. About 80% of the serviced population in Ontario is supplied from surface water sources and the remainder from groundwater sources.[63]

5.2 Sewage Systems

Municipal sewage systems carry sewage discharged by customers to facilities that are designed to clean the sewage to a level that is acceptable for disposal to the environment.

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[62] Ibid.
[63] Ibid.

5.2.1 Components and Capacity

The components of these systems are sewage collection pipes, treatment facilities, and disposal facilities for treated effluent and sludge. Sewage collection pipes include lateral sewers that carry sewage from the customer's premise to a branch sewer or submain, which then conveys the sewage to larger trunk mains. These mains then convey the sewage to the treatment facility. Sewage is normally conveyed by gravity flow, although some systems also rely on force mains, through which sewage is pumped under pressure.

Pipes in sewage collection systems are designed to carry peak flows. Flow levels vary less in trunk sewers than they do in laterals and submains, which carry smaller capacities overall. Design standards for sizing individual units at the treatment facility are based on the quantity and strength of sewage to be treated as well as on the required quality of the effluent.

5.2.2 Treatment Processes

Sewage treatment works are usually classified according to the types of processes used to clean up the sewage prior to its disposal to the environment. The main processes are as follows:

- *Lagoon* This is a rudimentary means of sewage treatment whereby sewage is deposited into a ditch or pond; solids are then allowed to settle and bacterial decomposition occurs naturally over an extended period of time.

- *Mechanical/Primary Treatment* Also referred to as physical/chemical treatment, this type of sewage works relies on mechanical processes, such as sedimentation, and the addition of chemicals.

- *Biological/Secondary* This method is essentially the same as primary treatment with the addition of biological processes whereby microbes decompose the organic material in the sewage.

- *Tertiary Treatment* This method is typically applied after secondary treatment when it is necessary to meet particularly stringent effluent standards; it is sometimes referred to as 'effluent polishing.'

In all cases, sewage treatment results in a liquid product (effluent) and a solid product (sludge). Solids removed from the liquid stream receive further biological treatment and are dewatered before final disposal by incineration, land filling, or application to cropland.

At present, there are 457 sewage treatment works in Ontario, serving over 80% of residents; the rest of the population is served by septic tanks.[64] According to 1996 data, secondary treatment was used for 81% of treatment capacity (by volume) in Ontario; lagoons and primary treatment plants accounted for about 14% of total capacity; and tertiary treatment for the balance.[65]

5.3 Water and Sewage System Costs

The cost of building modern water systems is currently estimated to be approximately $4,000 per capita (not including sewage).[66] This price tag means that water systems are significantly more capital intensive than other utilities such as electricity, telecommunications, and natural gas.

But capital costs are only one type of cost incurred by municipalities that provide drinking water. Annual operations and maintenance (O&M) costs, as well as ongoing administrative costs, also need to be recovered if a water system is to be sustainable over the long term.

For the most part it is not difficult to decide what is a capital cost and what is an operating cost. Differentiating the types of costs is important because each type has different implications regarding financing and cost recovery. For example, capital costs are typically large, infrequent, fixed expenditures that have long-term financing implications. Both O&M and administrative costs are recurring annual costs with different cost control issues. Within these latter two categories, there is typically some portion of the cost that varies with the quantity of drinking water produced, as well as a portion that remains constant.[67]

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[64] Ibid.
[65] Ibid.
[66] G. Powell, 2000, "The State of Ontario's Water Infrastructure," paper presented at Ontario Municipal Water Association Conference, Windsor, Ont., May.
[67] The terms 'fixed' and 'variable' refer to the behaviour of a cost in response to a change in some parameter. A fixed cost is one that does not change as the volume of output, or some other parameter, changes; it is, therefore, fixed. A variable cost is one that does change as the volume of output, or some other parameter, changes. The parameter having the greatest impact on treatment costs is volume. The number of customers (and geographic size of the system) has the greatest impact on distribution (or collection) systems and customer-related costs (such as meter reading).

This section presents information about the types and magnitudes of costs, and describes what is necessary to ensure that municipal decision making is efficient, affordable, and equitable. It also provides background for the discussions about capital planning and financing water and sewage systems in section 7.

5.3.1 Capital Costs

Capital costs are costs that are incurred in the construction or supply of water and sewage systems, including the physical assets such as infrastructure, buildings, and equipment. Related items such as land and design work are also considered to be capital costs.

The cost of repairing and maintaining the physical assets is considered to be an operating cost; replacing them, however, is a capital cost. Issues related to capital costs include the capacity and functionality of the service, system inventory and information, maintenance practices, and municipal accounting practices.

System Size and Functionality As previously stated, water and sewage systems are designed for both the capacity required to meet demand and the needed quality (both incoming and outgoing). These considerations affect the capital cost of the facilities. Here are some examples:

- Local watermains must be sized to provide enough water (1) to meet the annual peak-hour demand or (2) to meet fire protection needs, whichever is greater. The guidelines for fire protection requirements are set nationally, and are higher than customer demand in most areas. Thus, if a 50 mm watermain would suffice to meet customer demand, a 150 mm or 200 mm watermain would be required in order to comply with fire protection requirements. Table 5-1 presents the approximate capital cost of installing various sizes of watermains (and sewers). It should be noted that the values shown in table 5-1 are for illustrative purposes only, and can vary considerably depending on local subsurface conditions and installation procedures.

- The cost to excavate the trenches into which pipes will be laid is affected by subsurface soil conditions. The cost to install watermains in rock is higher than the cost to install watermains in sandy soils. Local climatic conditions also influence watermain construction costs, because pipes must be buried deeply enough that they are not subjected to frost action, which can cause pipes to rupture.

- Different types of treatment systems have very different implications for capital cost. Treatment requirements depend on drinking water standards (the quality of the water when it comes out) as well as on the quality of the water from the source of supply (the quality on the way in) and any specific water treatment regulations (e.g., some jurisdictions require disinfection).

- Employee safety is also a major consideration. For example, where chlorine is used, special purpose–built facilities and provisions for employee safety are required.

Maintenance Practices When evaluating options for water and sewage systems, municipalities may have to make trade-offs between initial capital investment and future maintenance costs. The level of maintenance performed on system components affects their service life and, hence, the timing of their replacement.

Table 5-1 Capital Cost of Installing Water and Sewer Pipes

Pipe Type and Size	Approximate Price per Metre to Supply and Install	
	New Subdivision (per metre)	Replacement (per metre)
Watermain Pipe		
150 mm PVC*	$65.00	$150.00
300 mm PVC	$120.00	$185.00
400 mm CPP**	$190.00	$245.00
Sanitary Sewer Pipe		
200 mm PVC	$75.00	$210.00
250 mm PVC	$85.00	$220.00
300 mm PVC	$95.00	$230.00
Storm Sewer Pipe		
450 mm PVC	$120.00	$215.00
600 mm concrete	$135.00	$275.00
900 mm concrete	$320.00	$420.00
1350 mm concrete	$570.00	$665.00

Note: Prices are in 1999 dollars and may vary significantly due to local subsurface conditions.
* Polyvinyl chloride, a type of plastic.
** Concrete pressure pipe.
Source: Greater Toronto Sewer and Watermain Construction Association.

One example is installing corrosion protection on watermains. Doing this increases the capital cost (both of the initial installation and of periodic anode replacement), but can ultimately result in lower repair costs and greatly extend the service life of the watermain. Another example is the use of stainless steel instead of a painted surface – here too, a higher initial capital cost lowers subsequent maintenance costs.

Often, the need to ensure safety and reliability (both extremely important considerations for water and sewage systems) dictates maintenance practices. In other cases, maintenance activities are undertaken to prolong the service life of system components and defer capital investment.

System Inventory and Condition An asset inventory provides municipalities with details about individual water system components, such as their size and location. Condition assessment provides municipalities with information about the integrity of each component, including its anticipated service life.

Uncertainty regarding the future cost of replacing underground infrastructure is a concern for many municipalities. The uncertainty stems from a lack of information about buried water system components – many municipalities do not have a complete inventory of their buried infrastructure, nor do they know the condition of these assets. In order to estimate replacement costs, municipalities need, at the very least, the following basic information: watermain locations, dimensions, and repair frequencies.

Table 5-2, based on a survey by the Ontario Water Works Association, reveals that many municipalities, especially smaller ones, do not have even basic information about underground assets. According to the survey results, only 40% of municipalities serving less than 1,000 accounts had information about the lengths of their watermains – in contrast to 92% of municipalities with over 35,000 accounts. With respect to information about watermain breaks, the results were even worse for smaller municipalities – only 14% indicated that they had this information. Knowledge about main breaks is quite useful in flagging stretches of mains that may need replacement. These survey results tend to imply that the smaller the municipality, the less likely it is to have an inventory of underground assets.

Other factors, such as age, construction materials, installation techniques, location, and subsurface soil conditions can also affect the life of physical assets; however, the extent to which municipalities collect this information is not known.

At present, many municipalities may not have sufficient information to predict the service life of their buried infrastructure. Without this information, they cannot determine how long their water systems will last, nor the timing or cost of capital investments that will be needed to renew or replace these systems.

There is a general perception that, because infrastructure is aging and the amount of aged infrastructure is increasing annually, many municipalities will soon be forced to invest substantial capital in renewing their water systems. This perception is based primarily on studies of the water supply sector that compare investment rates with estimates of underground asset values. But without better inventory information, this perception cannot be confirmed or refuted. Better system inventories are needed to more accurately assess the capital investments that will be needed in the future to restore Ontario's aging water infrastructure.[68]

Illustrative Example of Capital Costs Table 5-3 presents estimated replacement values for the various components of an actual Ontario municipal water system serving a population of 70,608. The information is presented for illustrative purposes only, to provide an indication of the magnitude of capital costs associated with water systems.

According to the information shown in the table, the per capita cost of replacing the entire system as described would be almost $4,107 per person served.

Table 5-2 Availability of Information on Watermain Assets

Size of Municipality (number of accounts)	Number of Municipalities	Percentage of Municipalities with Information about	
		Watermain Length	Watermain Breaks
Less than 1,000	35	40	14
1,001 to 5,000	36	53	44
5,001 to 35,000	26	88	85
Greater than 35,000	13	92	92

Source: Based on analysis of data in Ontario Water Works Association, 1999.

[68] Implementation of the Ontario *Drinking Water Protection Regulation*, which requires all municipalities to report on the condition of their waterworks, may partially alleviate this lack of information.

Figure 5-1 shows the estimated replacement value of specific components from table 5-3 on a per capita basis. The distribution system would require the largest

Table 5-3 Sample Water System Costs for an Ontario Municipality Serving a Population of 70,608

Facility Description	Capacity	Estimated Cost to Replace
WATER SUPPLY AND TREATMENT		
Water Supply		
Water Street dam		**$5,000,000**
Treatment Facilities		
Water treatment plant (built in 1922, with major expansions in 1952 and 1967)	104 ML/day	$41,500,000
Water treatment plant reservoir and contact tank conversion		$1,000,000
		$42,500,000
WATER DISTRIBUTION		
High-Lift Pumping		
Pump house		$2,000,000
Pumps and water wheels	115 ML/day	$1,200,000
Electric generating facilities		$1,300,000
Zone X pumping	55 ML/day	$2,500,000
		$7,000,000
Reservoirs		
Elevated tank A	4.5 ML	$2,300,000
Reservoir A	18.2 ML	$4,500,000
Reservoir B	9.1 ML	$3,000,000
Elevated tank B	2.3 ML	$1,000,000
Elevated tank C	0.45 ML	$800,000
		$11,600,000
Booster Pumping Stations		
Reservoir	45.5 ML/day	$2,700,000
Water Ave	3.0 ML/day	$110,000
Tap Street	8.9 ML/day	$135,000
Faucet Drive	8.6 ML/day	$135,000
Pipe Road	20.0 ML/day	$260,000
Connection Drive	21.9 ML/day	$450,000
Meter Drive	1.2 ML/day	$110,000
		$3,900,000
Distribution System		
Watermains	375 km	$141,000,000
Hydrants	1,764	$8,000,000
Water Services	23,589	$71,000,000
		$220,000,000
TOTAL REPLACEMENT VALUE		**$290,000,000**

Note: The values in the table are actual numbers developed by an Ontario municipality; the costs are in 1999 dollars. The street names have been changed.
Source: Strategic Alternatives, Enid Slack Consulting, and Public Works Management, 1999.

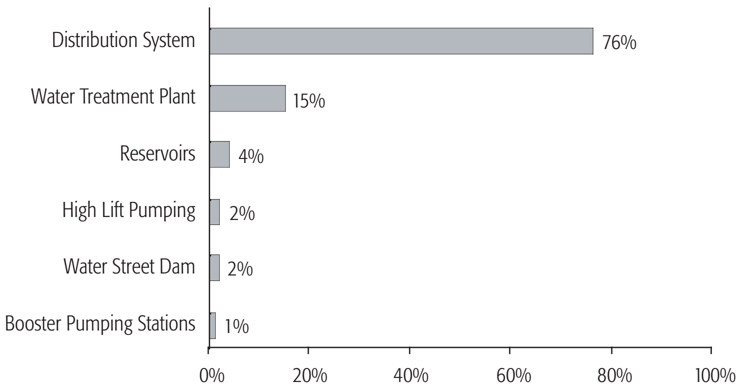
capital investment if the municipality had to replace the water system –- 76% of the total cost. This proportion is typical; the underground pipe network often represents up to 80% of the value of the system.[69] Given that a large proportion of capital costs are attributable to the underground infrastructure, it is reasonable to expect municipalities to have detailed information about this asset.

5.3.2 Operating Costs

Operating costs are costs that relate to maintaining day-to-day functions – operation, maintenance, and administration. They include labour, materials, energy, taxes, and contract services. Most of these costs are recurrent –- that is, they continue year after year. Operating costs are recovered during the year in which they are incurred. From an accounting perspective, operating costs are usually recorded by object code (i.e., labour, materials, power), but are also often reorganized into functional codes (e.g., supply, treatment, distribution, customer services).

In Ontario, legislation does not constrain the methods by which municipalities can recover operating costs. In general, they are primarily recovered from user rates. Specific services may be recovered using special fees, however – for example, a municipality may charge for turning a customer's water service on or off.

Figure 5-1 Estimated Cost of Replacing Water System Components as a Percentage of Total Cost



Source: Based on data in table 5-3.

[69] Stephen R. Godwin and George E. Peterson, 1984, "Guide to assessing capital stock condition," in *Guides to Managing Urban Capital,* vol. 2, study prepared by the Urban Institute in collaboration with Public Technology, Washington, D.C., p. 15.

5.4 Minimizing Costs

In section 1, efficiency was identified as an important objective of water supply financing. Efficiency includes meeting standards of service at the minimum cost possible.

It is important to note that minimizing costs does not mean simply lowering operating costs. Operating costs can be lowered by deferring maintenance, for example; in the short term, such an action does not affect output, since treated water is still being delivered to customers. But over time, inadequate attention to maintenance can cause premature failures of pumps, watermains or other system components. In the end, higher costs may thus be incurred for emergency repairs and premature capital replacements, and the standards of service delivery may decline as the frequency of low pressure, poor water quality, or service interruptions increases.

In this example, deferring maintenance costs is inefficient. To achieve efficiency, the *total costs* need to be minimized, including both capital and operating costs, and without compromising either quality or quantity of production.

5.5 Economies of Scale and Scope

Economies of scale are reductions in per unit cost arising from opportunities to use resources more efficiently as the scale of operations increases. For capital works, economies of scale occur for a variety of reasons including reductions in requirements for construction materials per unit of volume being stored or conveyed.

Table 5-4 illustrates the magnitude of potential cost savings that can be realized in both operations and capital facilities as water system size increases. The first row in the table, for example, shows that the capital cost associated with chlorination for a water treatment plant serving 50,000 people is 48% of the capital cost for chlorination at a plant serving only 5,000. The unit capital cost for chlorination drops even further when the population served is 500,000.

Water system costs are highly dependent on local factors that are not reflected in these data, which are based on aggregate information; hence, the data presented in table 5-4 should be interpreted with caution. Moreover, the growth of a water system may entail shifts in production and operations that cost more or generate less revenue, offsetting any gains from economies of scale. Consider the following two examples:

- A municipality that is currently supplied from groundwater sources must expand water supply capacity using a surface water source in order to accommodate growth in demand. Unit costs will increase because water treatment facilities that use surface water as the raw water source are generally more expensive than those that rely on groundwater. The municipality is facing *diseconomies of scale*.

- The service area of a municipality is expanded into an area with large lot sizes. The cost of growth in the distribution system may exhibit diseconomies of scale in such a case if land use in new areas is less dense than in older areas.

Table 5-4 Impact of Economies of Scale on Unit Costs

	Economy of Scale Factor*	Unit Cost Compared with Unit Cost of Serving 5,000 People	
		Population = 50,000	Population = 500,000
CAPITAL COSTS			
Chlorination – New or Rehabilitation	0.684	48%	23%
Conventional Filter plant – New	0.881	76%	58%
Conventional Filter plant – Rehabilitation	0.606	40%	16%
Reverse Osmosis Plant – New	0.814	65%	42%
Reverse Osmosis Plant – Rehabilitation	0.278	19%	4%
Computer and Automation (SCADA) – New	0.578	38%	14%
Computer and Automation (SCADA) – Rehabilitation	0.481	30%	9%
OPERATING COSTS			
Production and Purification O&M	0.911	81%	66%
Transmission and Distribution	0.944	88%	77%
Customer Accounts	0.949	89%	79%
Administration and General	0.862	73%	53%
Total OM&A	**0.815**	**65%**	**43%**

* The scale factor is the exponential coefficient, b, from a logarithmic cost function of the form: (total cost) = A x (total volume)^{b}. Values for b that are less than 1.0 indicate economies of scale; values for b greater than 1.0 would indicate diseconomies of scale.

Source: Capital cost scale factors from Cadmus Group, 2001; operating cost factors from Kingdom, Knapp, and LaChance, 1996.

Economies of scope occur when an enterprise achieves cost savings by producing a range of different products. An obvious example in the water supply sector is the provision of both fire protection water and drinking water supply using the same distribution system – economies of scope derive from not having to build two separate distribution systems. In Ontario, many municipal public utility commissions supply both water and electrical power to customers. This amalgamation provides another example of an opportunity to achieve economies of scope, since savings can be realized by sharing operational staff between the two services for tasks such as reading customer meters and making emergency repairs.[70] At a broader level, a municipality achieves economies of scope by establishing single departments to provide overhead services, such as accounting, to all of its operating divisions.

5.6 Defining Full Cost and Full-Cost Recovery

'Full cost' can mean different things to different people: the accountant may want to include depreciation; the engineer might argue for incorporating the pending costs of replacing deteriorating infrastructure; the environmentalist might only be satisfied when environmental costs are considered; and the economist would want to include all opportunity costs.

A very basic definition is that full cost includes all operating and capital costs associated with service provision. This statement, however, is too general to guide policies and procedures relating to cost recovery. A more useful definition would make reference to the accounting system used to classify and record costs. For the modified accrual-based accounting system used by Ontario municipalities (see section 8.2), these costs consist of the following:

- current O&M expenditures;
- principal and interest payments on debt;
- capital expenditures paid out of current revenues;
- transfers to reserve funds for future capital expenditures; and
- any other miscellaneous costs.

Implicit in this definition is the assumption that investments in infrastructure are sufficient to maintain the service condition of existing assets and to meet the growing demands for service.

[70] L. York, 2001, Manager, Water Department, Town of Perth, Ont. [personal communication with authors].

Full-cost recovery has been identified by the Canadian Water and Wastewater Association (CWWA) as a primary objective for water and sewage operations.[71] The CWWA has identified the following key elements of a full-cost recovery policy:[72]

1. Funds of the operating authority are to be kept separate from general municipal funds; any surplus remains with the authority, and deficits are recovered from the authority's own revenue sources.

2. A break-even operation prevails; a surplus or deficit in one year is offset in subsequent years.

3. Full costs for water and sewage include an allocated portion of general municipal costs for general services such as administration, finance, and engineering.

4. All capital costs, including the initial investment outlay, the cost of financing that investment, and the costs of ongoing repairs and replacements, are recognized and recovered.

CWWA's full-cost recovery policy requires that virtually all costs be recovered locally rather than from grants from higher levels of government. While municipalities are expected to take full advantage of government grants, they should recognize that any reliance on grants moves them away from full-cost recovery (and away from financial self-sufficiency). The CWWA policy also implies full-cost pricing, namely the recovery of virtually all water and sewage costs through user rates and related charges, rather than through municipal property taxes. Certain costs may, however, be justifiably recovered from property taxes under this policy if the associated service does not benefit water and sewage customers. For example, fire protection costs are often charged back to the municipality and recovered from the property tax, since firefighting services protect and enhance property value.

The notion of full cost proposed above does not address the issue of external costs associated with water and sewage services. External costs result from the

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[71] Harris, Tate, Loudon, and Fortin.

[72] M. Fortin and M. Loudon, 1997, *Primer on Setting Municipal Water and Wastewater Rates* (Ottawa: Canadian Water and Wastewater Association).

indirect impacts of water and sewage operations; examples include costs related to the following:

- the environmental impact of the withdrawal of water from surface and ground sources;
- the impact of discharge of treated sewage; and
- the impact of disposal of treatment plant sludges.

Costs associated with these impacts are considered external because they are not incurred as an actual expenditure by the municipality or its customers. These change from external costs to internalized costs when the regulatory action of senior governments forces the municipality to adopt measures to prevent or offset these impacts, or to compensate injured parties for their losses. Regulations that stipulate the quality or disposition of wastewater treatment plant effluent and sludge are an example of such regulatory action to prevent external environmental costs. Once internalized, external costs become part of the cost of doing business, and are recovered from customers like any other costs.

If external costs are not internalized, it is probably not reasonable to expect the municipality to voluntarily estimate and recover them, because (1) the valuation of external costs is often a technically difficult and contentious task, and (2) revenues corresponding to the recovery of external costs would represent a windfall to the municipality without any guarantee that a corresponding benefit would be realized by the affected parties.

6 The Price of Water

This section presents various pricing mechanisms for water, and reviews those currently in use in Ontario.

There are two main types of charges that municipalities levy to recover the costs of supplying water and sewage services: fixed charges, which are independent of the volume of water consumed, and volumetric charges, which vary with the amount of water consumed. Where both fixed and volumetric charges are used, the price constitutes a two-part tariff. There are also wholesale rate structures (currently, uniform single-block volumetric rates) for the sale of water by an upper-tier municipality (e.g., York Region, Waterloo Region, or Niagara Region) to lower-tier area municipalities.

6.1 Fixed Charges

Where customer water use is not metered, a flat-rate charge is applied. (Non-residential customers are usually metered even in areas where residential customers are not. Overall, the percentage of unmetered customers in Ontario is decreasing.[73]) Fixed charges may be the same for all customers or they may vary according to some attribute of the customer such as household size, assessed property value, or the number of water-using fixtures in the house. Different types of fixed charges are described below.

6.1.1 Single Fixed Charge

A 'single fixed charge' (or 'uniform fixed charge') is levied against every customer on each bill and is independent of the amount of water used. Many water system costs (such as billing, collecting, and metering costs) do not vary with volume, so a fixed charge is appropriate. It is usually used to recover costs directly related to customers.. Uniform fixed charges are generally used in small municipalities where there are few larger meters and few resources for keeping updated billing records.

6.1.2 Meter Charge

A 'meter charge' is a fixed charge per month for each customer that varies by the size of a customer's meter size or water service. The meter size, which is a good indicator of the supply capacity provided to the customer, is normally used. The charge for large industrial meters is typically over a hundred times greater than the charge for a residential meter. The charge varies because some of the cost components that are recovered through the meter charge vary with meter size, such as meter and service pipes within the road allowance, and the cost of reading the meter. Some of the other costs usually recovered through this charge, such as billing costs, do not necessarily relate to meter size. Water system fire-protection capacity costs are also often included in the fixed charge. Generally, meter charges that vary by meter size are the fairest type.

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[73] See Ontario Water Works Association [OWWA], 2000, *Survey of Municipal Water Rates and Operations Benchmarking in Ontario, 1999* (Toronto: OWWA).

6.1.3 Demand Charge

A ‘demand charge’ is a fixed charge per billing period that is based on a customer’s peak demand. Different approaches may be used to measure peak demand, but for a retail rate, a billing period is usually the shortest time period for which it is feasible to measure demand, so the peak is typically considered to be the maximum total demand for a single billing period in the previous year. This measure of peak demand for a customer remains constant for the billing year. The demand charge can replace the meter charge as a fixed rate. This charge is common for electricity sales but not for water service, especially at the retail level.

6.1.4 Minimum Bill

Where the fixed charge includes a minimum consumption allowance, it is referred to as a ‘minimum bill.’ The minimum bill provides the customer with a specified consumption allowance at no additional cost. The customer pays the minimum charge plus a volumetric consumption charge on any water used in excess of the consumption allowance. The minimum bill can be justified as a means of covering some fixed costs that are ongoing whether a customer uses water or not. It provides a municipality with a revenue cushion that is unaffected by annual variations in use. The consumption allowance associated with a minimum bill should be sufficiently low that only a small percentage of customers pay only the minimum bill. Otherwise, it starts to function like a flat-rate charge.

6.2 Volumetric Rates

‘Volumetric rates’ are based on the volume of water used by the customer. ‘Block rates’ refer to volumetric charges that are levied on different classes (blocks) of customer or reflect different levels (blocks) of consumption. Different block rates can be used to achieve different objectives, depending on how the rates are structured and on local patterns of demand.

6.2.1 Single Block Rate

The 'single block rate' structure applies a constant volumetric rate to all water used in the billing period. Figure 6-1 presents the single block rate as a graph. All customers pay the same amount for each unit of water used under this type of rate. This is the simplest format for a volumetric rate structure.

For example, if the volumetric charge under a single block rate structure was $1.50/m^3, and the water used in a one-month period was 24 m^3, then the water bill for that month would be 1.50/m^3 x 24 m^3, or $36.00.

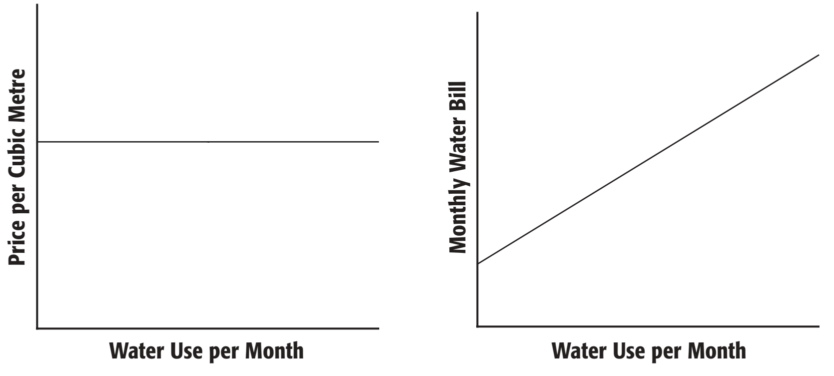
6.2.2 Declining Block Rate

A 'declining block rate' structure applies volumetric charges that decrease in steps as usage increases; figure 6-2 illustrates this concept.

The first block in the declining block rate structure represents the highest volumetric charge; successive blocks represent lower charges. Thus, with a declining block rate structure, the price per cubic metre of water decreases as more water is used. For example, consider a customer using 28 m^3/month in a municipality with declining block rates as follows:

Block 1: 0 to 24 m^3/month at $1.207/m^3
Block 2: 24.1 to 200 m^3/month at $1.000/m^3
Block 3: 200.1+ m^3/month at $0.700/m^3

Figure 6-1 Single Block Rate: Price per Cubic Metre and Monthly Water Bill



The water bill for the month would be

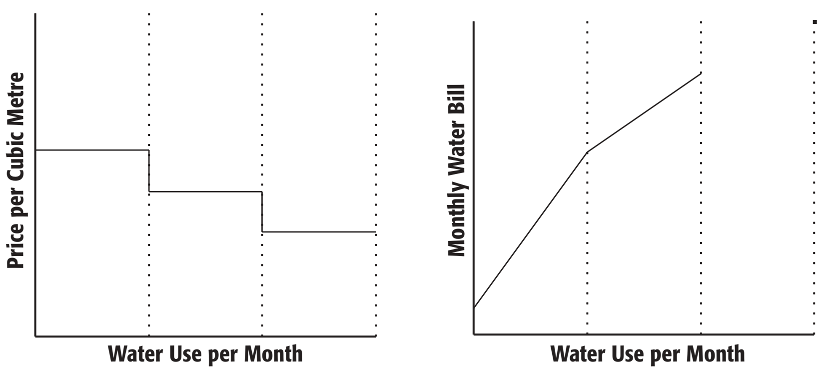
$$(\$1.207/m^3 \text{ x } 24 \text{ m}^3) + (\$1.000/m^3 \text{ x } (28 \text{ m}^3 - 24 \text{ m}^3)) = \$32.97.$$

Traditionally, the consumption limits for the first block are set to encompass the largest amount that a customer in a single-family dwelling is likely to use. The upper consumption limits for the second block would encompass the consumption of most medium to large commercial customers, and the third (and any subsequent) blocks would encompass larger industrial users. A typical declining block volumetric rate structure has at least three blocks, but structures with only two blocks are also frequently used now.

It is often argued that declining block rate structures do not promote water conservation since the price of water declines as more water is used. This argument is more a matter of perception than reality, however. Any volumetric tariff structure, including the declining block volumetric charge, provides the customer with an economic incentive to conserve water, since the water bill always increases with the amount of water used. The key issue with respect to conservation concerns the size of the price incentive. The declining block volumetric charge may be an appropriate tool for water conservation if small customers are responsible for the inefficient water use in a system, since it targets smaller customers with the highest rates, thus giving them a greater incentive to conserve water.

Declining block charges were originally designed to achieve an equitable allocation of costs among customers. Costs for building and operating the excess system capacity that is used to satisfy peak demands are recovered

Figure 6-2 Declining Block Rate: Price per Cubic Metre and Monthly Water Bill



primarily from residential customers, who, as a customer class, are the main cause of peak demand. The rate design is cost-based; and is not meant to favour industry as a means to promote economic development.

6.2.3 Increasing Block Rate

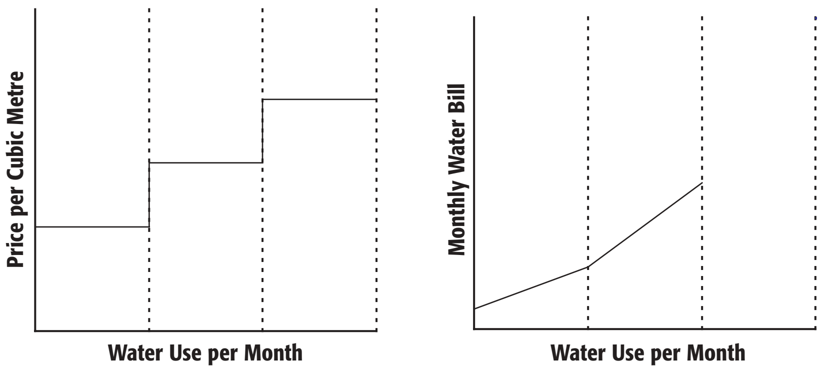
With an 'increasing block rate' structure, the price of water increases with increasing use. This structure is shown in figure 6-3. The first block for a customer class is designed to cover the normal use of an average customer in that class. The rate increases for each subsequent block. This rate structure is designed to encourage water conservation. It is appropriate for both residential customers (the main cause of peak demand) and industrial customers since water availability limitations justify shifting the cost burden to the largest users. The differential in charges should be designed to give a clear and strong economic incentive to customers to conserve water (e.g., greater than 25%).

A sample increasing block rate structure might be as follows:

Block 1: 0 to 10 m^3/month at \$0.350/m^3
Block 2: 10 to 25 m^3/month at \$0.700/m^3
Block 3: >25 m^3/month at \$1.400/m^3

Under this sample structure, imagine a residential customer with the following usage:

Figure 6-3 Increasing Block Rate: Price per Cubic Metre and Monthly Water Bill



Monthly meter charge:	\$6.00
Customer water use in one month:	35 m^3

This customer's monthly water bill would be calculated as follows:

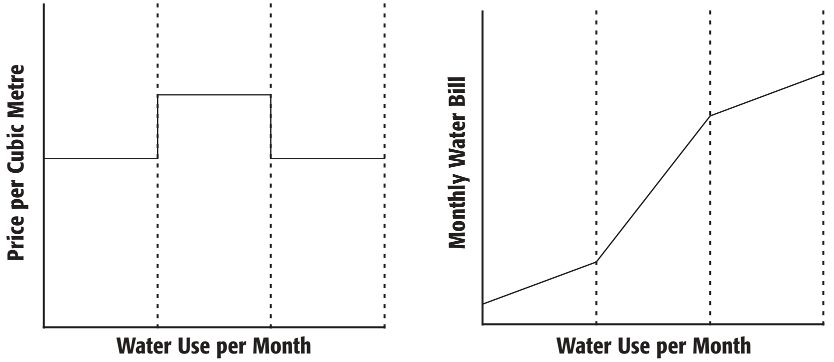
$$\begin{aligned} & \$6.00 \\ + & (\$0.350/m^3 \times 10\ m^3) \\ + & (\$0.700/m^3 \times (25\ m^3 - 10\ m^3)) \\ + & (\$1.400/m^3 \times (35\ m^3 - 25\ m^3)) \\ = & \$34.00. \end{aligned}$$

6.2.4 Humpback Block Rate

A hybrid of the increasing and decreasing block rate structure is called the 'humpback block,' or 'inverted U block.' Figure 6-4 shows the humpback rate structure and its impact on monthly water bills.

Calculating humpback blocks requires an analysis of costs similar to the one used to set declining blocks. Costs are allocated to the same functional cost categories, then assigned to component blocks. The consumption block that captures most of the seasonal demand of residential customers is levied a peak charge. This structure encourages conservation by residential customers, since increasing block limits encompass residential usage, while at the same time offering large industrial users declining charges that reflect the economies of scale inherent in providing such customers with water.

Figure 6-4 Humpback Block Rate: Price per Cubic Metre and Monthly Water Bill



Here is a sample humpback rate structure:

Block 1: 0 to 25 m^3/month at \$0.60/m^3
Block 2: 25.1 to 75 m^3/month at \$1.40/m^3
Block 3: 35.1+ m^3/month at \$0.60/m^3

Imagine a customer with the following usage:

Monthly meter charge:	\$6.00
Customer water use in one month:	35 m^3

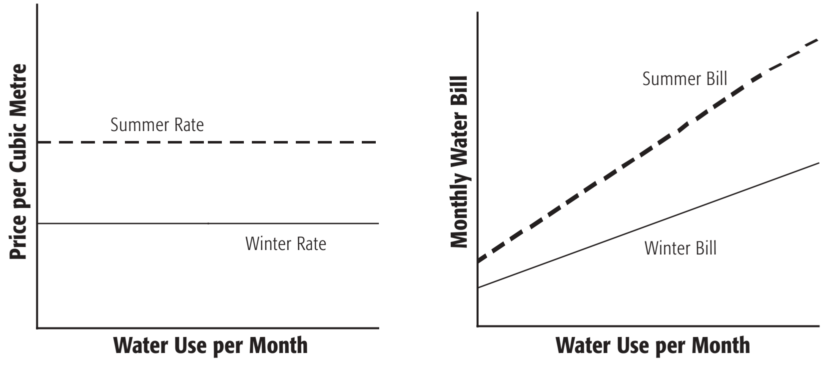
The calculation of this customer's monthly water bill would be as follows:

\$6.00
+ (\$0.60/m^3 x 25 m^3)
+ (\$1.40/m^3 x (35m^3 – 25 m^3))
= \$32.40.

6.2.5 Seasonal Charges

'Seasonal charges,' illustrated in figure 6-5, are high volumetric charges on all water used during the peak water demand season. The off-peak season, or base, charge applies to water consumed during the remainder of the year.

Figure 6-5 Seasonal Rate Structure: Price per Cubic Metre and Monthly Water Bill



This kind of charge promotes water-conservation in areas where seasonal demands are the target of conservation efforts. The rationale for a seasonal charge is that peak demands require oversizing supply facilities relative to the capacity required to meet demand for most of the year. Seasonal charges allow the municipality to recover the extra costs of this excess capacity directly from the customers that cause those costs.

A sample seasonal rate structure might be as follows:

Base charge:	$1.00/m^3
Peak season volumetric charge:	$1.462/m^3

Imagine a sample customer with the following usage:

Monthly meter charge:	$6.00
Customer water use per month in summer:	28 m^3
Customer water use per month in winter:	16 m^3

This customer’s monthly water bill would be calculated as follows:

$6.00 + $1.462/m^3 x 28 m^3 = $46.94 in the summer.
$6.00 + $1.00/m^3 x 16 m^3 = $22.00 in the winter.

6.2.6 Excess-Use Charges

An ‘excess-use charge’ is a high volumetric charge that applies to all demand during the peak water demand season in excess of a certain threshold; see figure 6-6 for a graphic representation of this rate structure. The threshold is set equal to average off-peak season consumption or a modest multiple of this amount, for example, 1.3 times winter demand. A base charge applies to all of a customer’s off-peak season consumption and to the portion of peak season consumption that is below the threshold.

A sample excess-use rate structure might be as follows:

Base charge:	$1.00/m^3
Excess use charge:	$3.145/m^3 (applied to demand above 120% of winter demand)

Imagine a customer with the following usage:

Monthly meter charge:	\$6.00
Customer water use per month in summer:	28 m^3
Customer water use per month in winter:	16 m^3

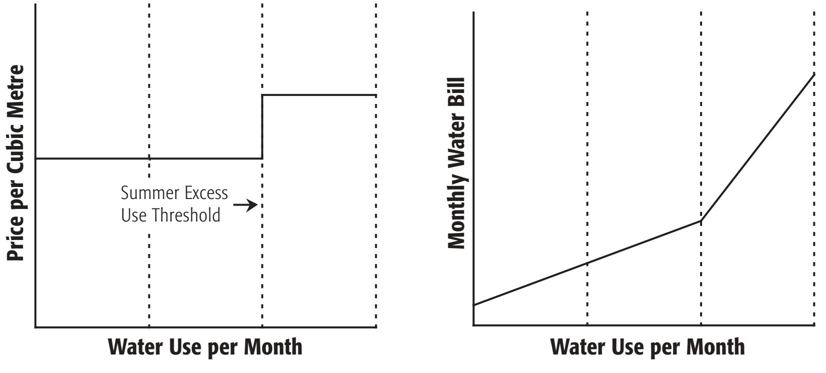
This customer's monthly water bill would be calculated as follows:

$$\begin{aligned} & \$6.00 \\ + & \$1.000/m^3 \text{ x } (1.2 \text{ x } 16 \text{ m}^3) \\ + & \$3.145/m^3 \text{ x } (28 \text{ m}^3 - 1.2 \text{ x } 16 \text{ m}^3) \\ = & \$52.88 \text{ in the summer.} \end{aligned}$$

$$\$6.00 + \$1.000/m^3 \text{ x } 16 \text{ m}^3 = \$22.00 \text{ in the winter.}$$

For both seasonal charges and excess-use charges, the differential between the peak season and off-peak season charge must be large enough for customers to notice the difference and have a strong incentive to save water. One way to achieve this is to recover all capital costs for expansion from the peak season charge. This approach generally produces a large seasonal charge; but it also increases the risk of inadequate cost recovery, since the municipality relies on variable seasonal demands to recover a major portion of its costs. Sound judgement must therefore be exercised in designing seasonal charges.

Figure 6-6 Excess-Use Rate Structure: Price per Cubic Metre and Monthly Water Bill



6.3 Sewage Charges

Sewage collection and treatment expenses are almost always recovered through surcharges on water bills. For residential customers, and for most commercial/industrial customers, these rates are not based on actual sewage flow but rather on water flow. There has been a gradual shift over the years in Ontario from levying sewer charges on the property tax bill to applying them as a surcharge on water bills.

6.3.1 Sewer Surcharge Approach

The reason for the move toward sewage system surcharges on water bills has primarily been to achieve some measure of user pay for sewage services. But it also has the advantage of moving costs off the property tax bill, which is increasingly under pressure from rising costs in other services.

The use of customers' water meter readings to calculate sanitary sewage charges is the most practical way of allocating sewage costs among customers. It is a reasonable allocation method, but does not precisely reflect customers' actual sewage flow. More precision would be achieved if there existed a practical sewage meter that could be installed on customers' sewer connections, but there is nothing of this kind currently available that is practical and economical.

The main objection to linking sewage charges to the volume of water used by a customer is that some of the water consumed is not discharged to the sanitary sewer, for example, water used by residential customers for lawn irrigation and car washing, or water used by non-residential customers for cooling in manufacturing operations (which is discharged to the storm sewer) or for refrigeration/air conditioning (which evaporates in cooling towers). Since almost all customers have some non-sanitary water use, however, much of this type of use could be considered to balance out.

Some municipalities have refined the sewer surcharge to allow for non-sanitary use. For example, some municipalities calculate summer residential sewage charges using only a portion of the water volume in order to account for lawn watering. Some also adjust non-residential charges to allow, for example, for cooling water that is diverted to storm sewers. Most municipalities, however, do not make such adjustments. It has been observed that since sewer rates have to be increased to offset the loss in revenue resulting from reducing charges for some customers, the net result may not be worth the extra cost involved. Furthermore, due to inflow and infiltration, the amount of sewage flow that reaches sewage treatment plants is more than the amount discharged by customers, so having customers pay for non-sanitary water use could be considered an appropriate offset to account for this additional flow.

6.3.2 Sewer Use Charges

Municipalities have sewer use bylaws that set limits on the levels of various quality parameters for the sewage that customers are allowed to discharge to the sewage system. The province has guidelines for these parameters and has developed a model sewer use bylaw.

Some of these sewage quality parameters, such as suspended solids (SS) and biochemical oxygen demand (BOD), are treatable; the limits on them relate to what the sewage treatment plant is designed to treat efficiently. Other parameters, such as heavy metals, have limits because the municipality's sewage treatment plant is not designed to remove them effectively.

If an industry wishes to discharge levels of treatable pollutants above the bylaw limits, most municipalities will accommodate this, if possible, but charge extra for the level of pollutants exceeding the bylaw limits. For example, the maximum limit for BOD is typically set by bylaw at 300 milligrams per litre (mg/L). The municipality may enter into an agreement with a particular customer to allow this limit to be exceeded at a charge, calculated as follows:

% exceeding x quantity x charge rate.

Thus, if, for example, the charge rate per unit of flow in that municipality is $233.16, and the total flow discharged to the sewer is 10,000 cubic metres, then for a customer that discharged an average of 600 mg/L of BOD to the sewer system, the extra-strength sewage charge would be as follows:

$$= [(600 - 300) \div 300] \times [10{,}000 \text{ m}^3] \times [\$223.16 /\text{m}^3]$$
$$= \$2{,}232.$$

The purpose of the extra-strength sewage charge is twofold. First, it allows a municipality to recover the extra costs that it incurs as a result of the higher concentration of sewage. These costs are both direct (such as for chemicals), and indirect (in that part of the plant's capacity is used up and so not available for other customers or for growth). The second reason for the charge is to encourage the customer to reduce the pollutant level to bylaw limits, either by changing the production process to reduce the production of the pollutant or by pre-treating the sewage so that the pollutant is removed before being discharged to the sewer.

6.4 Current Pricing Practices in Ontario

Water pricing in Ontario is generally based on average cost pricing rather than marginal cost pricing. Water prices based on marginal cost should reflect the immediate and future cost of the resources that are used to provide the service. Because many municipalities do not have complete inventories or capital plans that are comprehensively defined over the long term, however, future costs cannot be predicted with accuracy. What municipalities do have are historical costs. These are used to calculate the average cost of providing the service.

6.4.1 Water Service Pricing

Figure 6-7 shows a breakdown of the types of water rates used for residential customers in Ontario. Almost 40% of municipalities use flat rates for residential customers. The next most commonly used rate structure is a constant unit charge.[74] An increasing block rate structure is used for residential customers in slightly more than 6% of Ontario municipalities.

Municipalities that use flat rates tend to be smaller. Consequently, the proportion of the serviced population in the province that is charged via a flat rate structure is less than the proportion of municipalities that use this structure.

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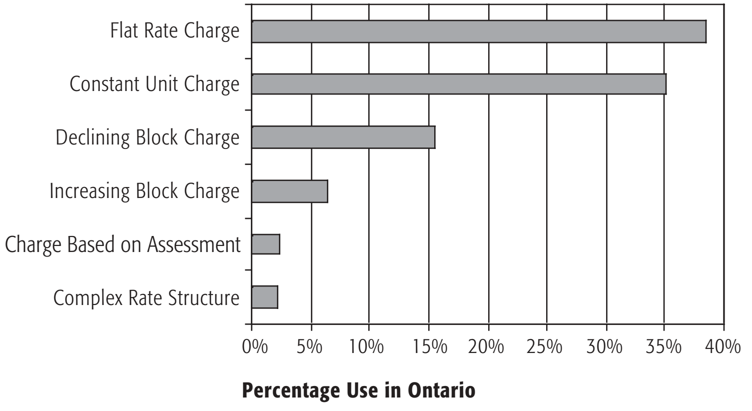
[74] According to the Environment Canada data, flat rate water charges are the most commonly used rates for residential customers in Canada; in 1996, flat rates were used in 54% of all municipalities with water systems. However, the flat rate is much more prevalent in smaller communities. In Ontario, 83% of the serviced population is charged for water on the basis of a volumetric rate, and this figure is likely to increase to over 90% once the City of Toronto implements its decision to meter the downtown core.

The distribution of rate structures for commercial customers is shown in figure 6-8.

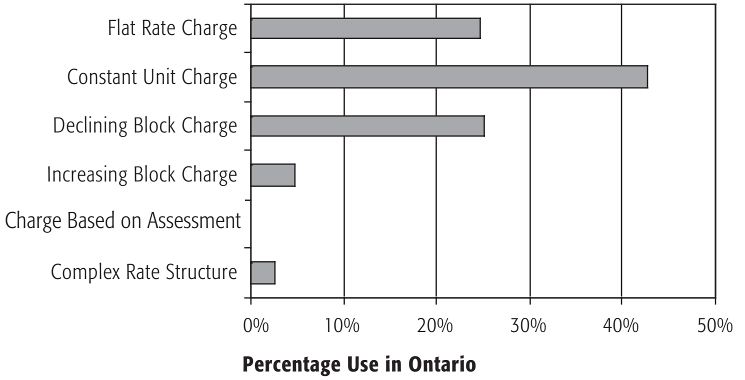
Flat rate charges are used for commercial customers in 25% of municipalities in Ontario. The most commonly applied rate structure for commercial customers is the constant unit (single block rate) charge, which is used by over 40% of municipalities. The fixed component of the charge often varies with the size of the service connection. Minimum charges corresponding to a minimum amount of water consumption in each billing period are common in these systems.

Figure 6-7 Incidence of Various Rate Structures for Residential Customers, Ontario



Source: Environment Canada (2000) data for 379 municipalities.

Figure 6-8 Incidence of Various Rate Structures for Commercial Customers, Ontario



Source: Environment Canada (2000) data for 379 municipalities.

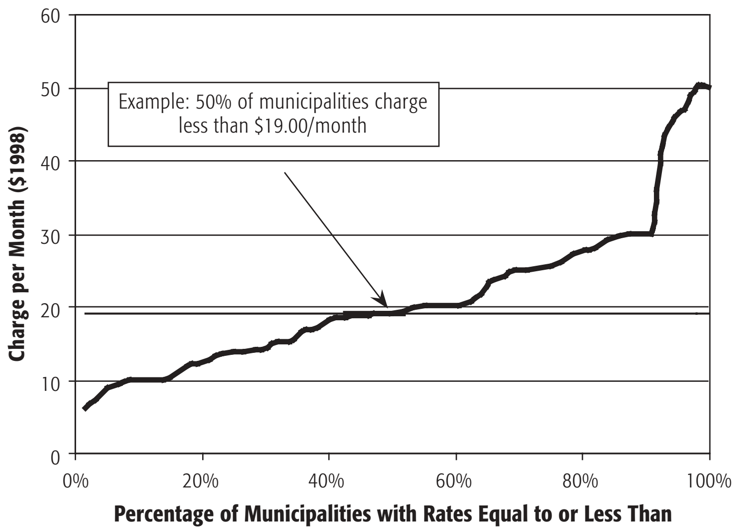
Figure 6-9 shows typical monthly water charges for residential customers in Ontario who pay flat rates. About 50% of municipalities charge $19.00 per month or less.

Figure 6-10 shows the typical monthly water charges for residential customers on metered systems. For this second group of customers, 50% of municipalities charge $16.70 per month or less. The difference between the median monthly charges for the two kinds of rate structures (flat rate for unmetered customers and volumetric for metered customers) is $2.30, or about 12%.

6.4.2 Sewer Service Pricing

Table 6-1 shows the prevalence of various sewer charge structures in Ontario. The most common is a flat rate charge, which is used by 58% of municipalities. The next most common is a percentage of the water bill; in 31% of Ontario municipalities, the charge is set at more than 40% of the water bill; charges ranging from 20% to 40% of the water bill are used by 9% of Ontario communities.

Figure 6-9 Typical Monthly Residential Water Bill: Flat Rate Systems, Ontario, 1998

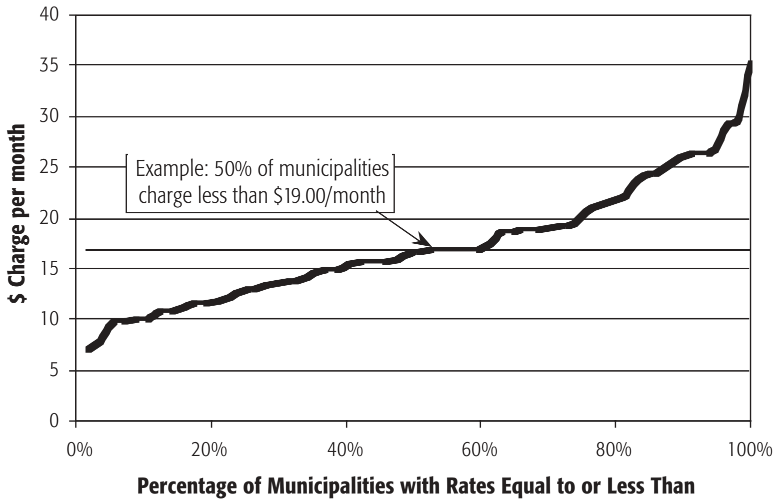


Source: OWWA, 2000 (data courtesy of Robert Goodings and Anthony Haslam, CH2M Hill Engineering Ltd.).

Figure 6-11 shows a distribution of monthly residential sewage bills for Ontario municipalities. As the figure shows, half of the municipalities in the province charge less than about $15.00 per month for sewage collection, disposal, and treatment.

The information presented here about the incidence of water and sewage rates and typical monthly charges should be interpreted with care, particularly when comparing practices in Ontario with other jurisdictions. Context is important.

Figure 6-10 Typical Monthly Residential Water Bill: Metered Systems, Ontario, 1998



Source: OWWA, 2000 (data courtesy of Robert Goodings and Anthony Haslam, CH2M Hill Engineering Ltd.).

Table 6-1 Distribution of Various Sewer Charge Structures (Includes Residential and Commercial Customers), Ontario, 1996

Type of Charge	Frequency
Flat Rate	58%
Percentage of Water Bill	
<20%	1%
20% to 40%	9%
>40%	31%

Note: Numbers may not add up to 100% due to rounding.
Source: Canada, Environment Canada, 2000, Municipality Utility Database [MUD].

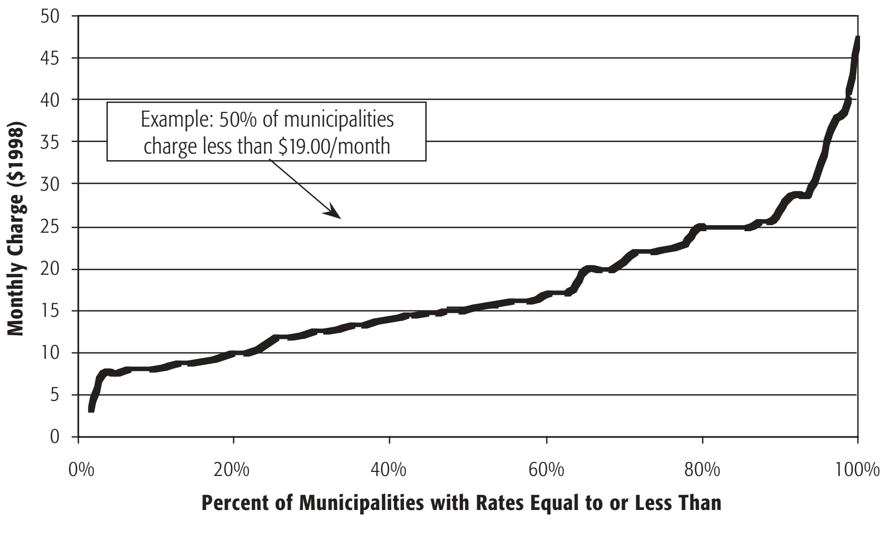
Factors such as the cost of living in an area and the regulatory framework must be fully recognized if such comparisons are to be meaningful.

6.5 Average Cost Pricing and Two-Part Tariffs

Average cost pricing is the most commonly used method of determining water supply price in Canada. It is easier to administer than marginal cost pricing because it is easier to calculate; it is also easier to explain to customers. As discussed in section 2, however, from an economic efficiency standpoint there are drawbacks to applying average cost pricing. For example, it is inefficient if unit costs decline as output increases; in such a case, the price based on average cost is too high and the amount of water produced too low, relative to what customers really want. In other words, resources are misallocated.

In its simplest form, an average cost price is estimated by dividing the total financial cost of providing the water service by the total volume of water produced. This price format is commonly used to set wholesale prices in two-tier regional water supply systems, but it is not common at the retail level. An alternative rate structure, the two-part tariff, is the most common format at the retail level. It combines a fixed monthly charge (designed to cover costs of

Figure 6-11 Typical Monthly Sewage Bill, Ontario, 1998



Source: OWWA, 2000 (data courtesy of Robert Goodings and Anthony Haslam, CH2M Hill Engineering Ltd.).

meter reading, billing, customer accounting, capital and maintenance costs of meters, see section 6.1) with a volumetric charge applied to all consumption (see section 6.2). Charges in such a two-part rate structure are normally based on an average cost calculation. However, the two-part rate structure provides an opportunity to base efficient prices on a volumetric charge that approximates marginal cost. This approach has been applied in the United States as a means of setting conservation-oriented rate structures.

6.6 Affordability

Determining the affordability of water and sewage services usually involves comparing the annual amount spent on these services with household income. Statistics Canada provides income estimates that can be used to identify low-income households, as presented in table 6-2, but the federal government has not developed an official measure of household poverty for Canada.[75] Because there is no consensus on how to measure affordability, it is unlikely that this issue can be properly addressed at present.

The above discussion assumes that affordability is an appropriate objective for municipalities when setting water rates (or any other user charges). The justification for this assumption is not obvious, however. While water and sewage services may not be affordable to low-income families in some municipalities, it is not clear that the municipality should be responsible for resolving this problem. There is no intrinsic merit or logic to an arrangement that finances low-income relief for water bills using cross subsidies from other water customers as opposed to general tax revenues – in fact, this practice would violate the 'benefits received' component of

Table 6-2 Statistics Canada's Low-Income Measures

Income Measure	Description	Current Value
Low-Income Cutoff	Income level at which a household spends 64% of its after-tax income on food, shelter, and clothing (this amount is 20% higher than the average amount)	From $23,260 for rural households to $33,658 for households in large cities (based on 1999 dollars)
Low-Income Measure	50% of the median family income	$27,172 (based on 1998 dollars)

Note: Current values are based on before-tax income for a four-person household.
Source: Paquet, 2001.

[75] B. Paquet, 2001, *Low Income Cutoffs from 1990 to 1999 and Low Income Measures from 1989 to 1998*, cat. no. 75F0002MIE-00017 (Ottawa: Statistics Canada, Income Statistics Division).

equity. Design and delivery of poverty relief programs are better left to poverty relief agencies; table 6-3 presents a list of potential strategies that could be delivered by such agencies with the support of those responsible for water supply.

When considering affordability, we must distinguish between *ability to pay* and *willingness to pay*. The former is a question of whether consumers can pay for the service; the latter reflects consumer preference about purchasing services relative to price. As water prices rise, consumers may demonstrate a reluctance (unwillingness) to pay, and so reduce consumption, even if the price is economically justified.[76]

Table 6-3 Measures for Addressing the Affordability of Water and Sewage Services

Measure	Description
Lifeline Rates	A low initial charge in the rate structure that provides a minimum volume of water at a low cost. A reasonable guideline for the lifeline charge is to set it to recover direct O&M costs net of capital charges. This is an effective means of helping poor households that also gives financial help to all domestic customers, since it usually applies to all customers. For this reason, it is not well targeted to the intended recipients.
Counselling and Referral	Assists households in planning and budgeting expenditures.
Shorter Billing Cycle	Billing every month or two rather than every three or four months. This reduces the size of the bill and helps with household budgeting. But it does not reduce the overall cost, so it does not help households where cost, not budgeting, is the real problem.
Debt Forgiveness	Writing off the arrears of poor customers and allowing them to continue receiving the service with a clean slate. Useful when poverty is a temporary crisis.
Discounts or Income-Based Payments	Poor customers pay a discounted charge or a geared-to-income bill. Implementation of this approach requires a means test and an extensive administrative structure.
Targeted Conservation	Promoting and subsidizing the adoption of conservation measures by poor households to help them reduce their water bill.
Flow Restrictions	A degrading of the service level (as an alternative to disconnection) as an inducement to pay arrears. The restricted flow provides water for drinking and basic sanitation needs.
Community Assistance	Assistance in the form of cash transfers from the municipality or from voluntary contributions.

Source: Based on Beecher, 1994.

[76] United States, Environmental Protection Agency, Office of Water, 2001, *Information for States on Developing Affordability Criteria for Drinking Water*, [online], [cited January 2002], <www.epa.gov/OGWDW/smallsys/affdoc-02.html>.

7 Capital Finance

This section begins with a discussion of the way municipalities identify capital needs. It also contains a summary of municipal capital expenditures, and describes how municipalities finance these expenditures.

7.1 Identifying Capital Needs

The municipal capital planning process begins with the identification of the capital works needed to meet the expected demands for service and ensure that performance standards are met.

Long-term capital plans are developed using master planning studies. These studies generally cover the following:

1. the goals and objectives of the municipality with respect to resource management and infrastructure development for the next 20 years or more;
2. anticipated capital needs, such as growth due to new customers, replacement due to deterioration, or upgrades to meet new or emerging standards;
3. the range of alternative approaches available to accommodate growing demands for service; and
4. a set of preferred supply and demand management options.

To achieve item 4 above, various methods for managing supply and demand must be evaluated according to a number of criteria, for example:

- total cost (net present value of life cycle costs);
- financial impact (e.g., on total debt, debt servicing, cash flow, and reserves);
- impact on user charges and fees;
- risk (including security of supply and safety of finished product);
- environmental impacts; and
- social impacts (e.g., household displacement or disruption, and affordability).

Capital needs (item 2 in the list above) are identified as a result of asset management efforts, official planning, community and council inputs, and initiatives from senior governments and regional agencies, such as public health agencies and conservation authorities.

In addition to a long-term capital plan, municipalities generally prepare shorter-term capital plans; these refine the recommendations regarding capital projects and address the need for specific capital works, such as system expansions, as well as major repairs and replacements – usually within a five- to ten-year planning period. Capital plans provide budgets, schedules, and financing plans for these projects.

Once approved, a capital plan sets the stage for tendering, contracting, and construction activity over the next 12 to 18 months. Consequently, the first few years of a capital plan must be very detailed; the final years, on the other hand, may only identify major projects, such as plant expansions, giving aggregate budgets for smaller types of projects, such as the replacement of mains. Municipalities typically revise capital plans on an annual basis, through budget-setting exercises. These plans may also be revised within the budget year as required. The budget identifies revenues and expenditures for the fiscal year and provides a monetary plan of action for upcoming activities as well as a basis for controlling and evaluating municipal actions.

The capital planning process described above is used by larger municipalities, particularly if they face rapid growth. Smaller municipalities may follow a similar, but less detailed, process; but often the planning process of small municipalities is ad hoc, relying in large part on the knowledge and experience of staff as a basis for determining capital needs each year.

When a capital planning process is used, municipalities will generally know up to 10 years in advance what capital expenditures are needed for water and sewage works. When new construction or major expansion of water or sewage works is included in a municipal capital plan, the new or expanded system is typically designed to accommodate 20 years of growth (although some recent municipal plans are designed to accommodate only 10 years of growth). This approach is illustrated in figure 7-1.

Figure 7-1 Typical Municipal Capital Planning for Major Water and Sewage Works

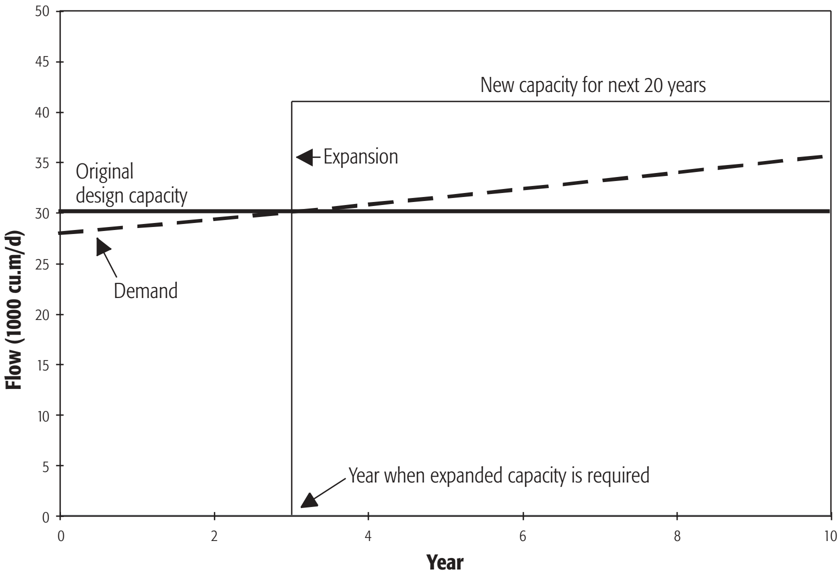


Table 7-1 Capital Expenditures on Water and Sewage, Ontario, 1989 to 1999

Year	Capital Expenditures (millions of dollars)			
	Sanitary Sewers	Water	**Total Water and Sewers***	Percentage of Total Municipal Expenditures
1989	394.2	332.6	**726.9**	23.1
1990	397.0	381.2	**778.2**	21.9
1991	424.9	369.1	**794.0**	23.3
1992	445.4	302.1	**747.4**	23.0
1993	371.6	338.6	**710.2**	23.4
1994	374.5	393.2	**767.8**	24.7
1995	401.4	488.3	**890.0**	23.3
1996	342.3	454.6	**796.9**	23.7
1997	475.0	425.9	**900.9**	25.3
1998	284.0	395.0	**679.0**	19.9
1999	293.7	395.2	**688.9**	17.1

*Totals may not add up due to rounding.

Note: Figures for sanitary sewers (second column) include sewage treatment plants, public washrooms (other than in parks and community centres), service operating agreements with the Ministry of the Environment, other sewage system expenditures, and administration; they also include expenditures on storm sewers where there is a combined storm and sanitary sewer system. Expenditures on water (third column) include the waterworks system, debt charges met from taxation, service operation agreements with the Ministry of the Environment, and administration.

Source: Ontario, Ministry of Municipal Affairs and Housing, 2001, MARS database.

7.2 Water and Sewage Capital Expenditures in Ontario

Table 7-1 shows capital expenditures for water and sewage for all Ontario municipalities from 1989 to 1999. As a proportion of total municipal capital expenditures, capital spending on water and sewage systems appears to have been declining since 1998. A similar pattern can be seen in water and sewage operating expenditures (see section 7.3, below).

In some years, capital expenditures on sanitary sewage exceed the capital expenditures on water; in other years, the reverse is true. Water and sewage facilities have long service lives. Large increments of capital investment are required at certain times to replace aging facilities and take advantage of economies of scale.[77] It is sometimes more cost-effective to add large increments of capacity at once than to expand in small increments over a period of time. The need to make large capital expenditures in one year, however, poses a financing challenge to municipalities.

Table 7-2 shows capital expenditures per household in both current and constant (1999=100)[78] dollars for municipalities in counties and districts only. Municipalities located in counties and districts generally are the smaller municipalities in Ontario. Residents in those municipalities that do not incur expenditures on water and sewage either have septic tanks or buy water directly from neighbouring municipalities.

In constant dollars, capital expenditures per household were less in 1999 than in 1989 but they have been higher in some of the intervening years, again reflecting the lumpy nature of capital investments. Expenditures per household in constant dollars were lower in 1998 and 1999 than in any of the earlier years, however.

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[77] P. Mann, 1999, *Financing Mechanisms for Capital Improvements for Regulated Water Utilities* (Columbus, Ohio: National Regulatory Research Institute), p. 3.

[78] If expenditures increase over time because of a general increase in the price level that is beyond the control of individual municipalities, then it is appropriate to analyze expenditure increases in terms of constant dollars, using inflation figures to convert expenditures for each year to the equivalent number of dollars from one particular year.

7.3 Operating Expenditures

Table 7-3 shows operating expenditures for water and sewage in Ontario from 1989 to 1999. As a percentage of total municipal expenditures, operating expenditures on water and sewage have fallen from 10.6% in 1989 to 9.2% in 1999. This decrease reflects the fact that other municipal expenditures have risen more quickly than water and sewage costs.

Table 7-2 Capital Expenditures on Water and Sewage per Household, Municipalities in Ontario Counties and Districts, 1989 to 1999 (current $ and constant 1999=100 $)

Year	Sanitary Sewers current $	Water current $	Total Water and Sewers* current $	Sanitary Sewers 1999 $	Water 1999 $	Total Water and Sewers* 1999 $
1989	73	116	**189**	90	143	**232**
1990	80	113	**193**	94	133	**227**
1991	100	139	**239**	112	156	**268**
1992	132	114	**246**	147	127	**273**
1993	110	119	**229**	120	130	**250**
1994	117	128	**245**	128	140	**267**
1995	140	145	**285**	149	154	**304**
1996	136	138	**274**	143	145	**287**
1997	106	126	**232**	109	130	**239**
1998	66	144	**210**	67	147	**214**
1999	91	107	**198**	91	107	**198**

Note: Expenditure and household data apply only to those municipalities that incur water and sewage expenditures. See note to table 7-1 regarding what water and sanitary sewer figures comprise.
* Totals may not add up due to rounding.
Source: Ontario, Ministry of Municipal Affairs and Housing, 2001, MARS database.

Table 7-3 Operating Expenditures on Water and Sewage, Ontario, 1989 to 1999

Year	Operating Expenditures (millions of dollars)			
	Sanitary Sewers	Water	**Total Water and Sewers***	Percentage of Total Municipal Expenditures
1989	617.7	652.3	**1,270.0**	10.6
1990	713.3	694.8	**1,408.1**	10.3
1991	771.0	752.4	**1,523.5**	10.0
1992	808.3	783.8	**1,592.1**	9.7
1993	851.3	783.3	**1,634.7**	9.7
1994	839.5	826.6	**1,666.0**	9.8
1995	872.9	830.9	**1,703.8**	10.0
1996	889.9	868.2	**1,757.2**	10.8
1997	898.7	914.2	**1,812.9**	11.1
1998	861.9	928.5	**1,790.4**	9.1
1999	915.7	969.5	**1,885.3**	9.2

Note: See note to table 7-1 regarding what water and sanitary sewer figures comprise.
* Totals may not add up due to rounding.
Source: Ontario, Ministry of Municipal Affairs and Housing, 2001, MARS database.

Table 7-4 shows water and sewage expenditures per household for those municipalities in counties and districts that incur water and sewage expenditures.

As Table 7-4 shows, operating expenditures per household for water and sewer services rose by slightly more than the rate of inflation over the last ten years. The average annual increase per household in constant dollars was 0.5% (1.0% per year on average for sewage expenditures and 0.2% per year for water expenditures). This finding suggests that municipal operating expenditures for water and sewage have generally kept pace with inflation and the growth in population over the ten-year period. In the last couple of years (1998 and 1999), however, water and sewage expenditures per household in constant dollars have fallen. It is too soon to tell whether these last two years represent a new trend.

Table 7-5 shows a breakdown of operating expenditures for water and sewage for municipalities in counties and districts: wages and salaries (including benefits); debt charges; materials, services, rents (including financial expenses); transfers to own funds (e.g., transfers to the capital fund and to reserves and reserve funds); other transfers (including payments for which no specific good or service is received, such as transfers to local boards); and inter-functional transfers (where one department provides a service to a different functional area, for example, the fire hydrant service provided by the waterworks department for fire protection). Over the ten-year period shown in the table, transfers to own funds have increased. There has been a decrease in the

Table 7-4 Operating Expenditures on Water and Sewage per Household, Municipalities in Ontario Counties and Districts, 1989 to 1999 (current $ and constant 1999=100 $)

Year	Sanitary Sewers current $	Water current $	Total Water and Sewers* current $	Sanitary Sewers $ 1999	Water $ 1999	Total Water and Sewers* $ 1999
1989	129	178	**307**	158	219	**377**
1990	145	184	**329**	170	216	**386**
1991	149	197	**346**	167	221	**388**
1992	155	201	**356**	172	223	**395**
1993	159	204	**363**	174	223	**397**
1994	159	212	**371**	174	231	**405**
1995	175	205	**380**	186	218	**405**
1996	172	225	**397**	180	236	**416**
1997	179	229	**408**	184	236	**420**
1998	172	219	**391**	175	223	**399**
1999	175	222	**397**	175	222	**397**

Note: Expenditure and household data apply only to those municipalities that incur water and sewage expenditures. See note to table 7-1 regarding what water and sanitary sewer figures comprise.
* Totals may not add up due to rounding.
Source: Ontario, Ministry of Municipal Affairs and Housing, 2001, MARS database.

proportion of expenditures accounted for by wages and salaries, debt charges, and materials, services, and rents.

7.4 Financing Capital Expenditures

A capital investment that is made in one year on a water or sewage treatment facility results in a stream of benefits to users over a long time horizon, for example, 25 years. What, then, is the best way to pay for the investment, which usually must be spent within a relatively short time period, given that the benefits are to be enjoyed over a long period? Intergenerational equity dictates that each generation of users should pay for the facilities that they require and not for the facilities required by other generations of users. This means that the financing mechanism should be designed to match the cost of the facility with the benefits to its users over time.

7.5 Sources of Revenue

Capital expenditures may be financed from a variety of sources, including own-source revenues, reserves and reserve funds, borrowing, development charges, and special assessments. (Operating expenditures, on the other hand, are financed out of property taxes and user fees.)

Table 7-5 Breakdown of Operating Expenditures on Water and Sewage, Municipalities in Ontario Counties and Districts, 1989 to 1999

	Percentage of Total					
	Wages, Salaries, and Benefits	Debt Charges	Materials, Services, and Rents	Transfers to Own Funds	Other Transfers	Inter-functional Transfers
1989	20.5	17.3	40.0	22.0	0.5	–0.4
1990	21.3	16.5	40.4	21.6	0.4	–0.3
1991	21.5	15.2	39.8	23.4	0.3	–0.1
1992	21.1	15.4	41.0	22.4	0.5	–0.4
1993	20.7	15.8	40.5	22.6	0.4	–0.1
1994	20.9	15.6	40.9	21.8	0.4	0.4
1995	19.6	15.5	40.1	24.1	0.5	0.2
1996	19.4	14.2	39.5	25.8	0.5	0.5
1997	18.3	14.8	37.5	28.2	0.3	0.9
1998	17.6	14.8	37.2	29.2	0.1	1.2
1999	17.6	14.7	34.9	31.2	0.3	1.3

Note: Totals may not add up due to rounding.
Source: Ontario, Ministry of Municipal Affairs and Housing, 2001, MARS database.

7.5.1 Property Taxes

The property tax is the main source of revenue for municipalities in Ontario, although it is not currently used much for water and sewage works and services. It is levied on residential, commercial, and industrial properties. The basis of the property tax is the assessed value of real property. Provincial legislation requires that the assessment be based on the property's current value, defined as the price that would be struck between a willing buyer and a willing seller in an arm's-length transaction. A property tax rate (a percentage of the value of the property), or series of rates by type of property, is applied to the assessed value of property to determine the taxes payable. The amount levied for property taxes is not related to the use of water and sewage services because property values (the basis of the property tax) are not necessarily related to water and sewer use. One exception might exist, however, for water for fire protection. Furthermore, there is a closer relationship between the use and payment for the service where special area rates are levied for water and sewage in one part of a municipality where the service is provided.

Property taxes are mainly used for municipal operating expenditures, but can also be used for financing debt costs arising from previous capital expenditures and for financing future capital projects (to accomplish this goal, a portion of the taxes is placed in a reserve fund; see section 7.7). Property taxes are more appropriate for funding operating expenditures than capital expenditures because the benefits of long-term capital investments are largely enjoyed by future generations. If property taxes were used to fund these expenditures, current and previous taxpayers would pay for projects that would largely be enjoyed by future generations. Using property taxes would also mean that infrastructure would be competing for limited property tax funds with operating demands for local services such as policing, firefighting, and social services. In the current political climate, residents are highly resistant to any increases to property taxes.

7.5.2 User Fees

User fees for water and sewage are discussed in detail in section 6. They may be used for funding both operating and capital expenditures. These rates can be set to cover the operation, repair, maintenance, and capital costs of the water and sewage systems. Paying for capital expenditures from direct water and sewage billings is preferable to using property taxes for this purpose because there is a closer relationship between use and payment.

7.5.3 Development Charges

A development charge is defined as a levy on developers to finance the costs associated with development or, in some cases, redevelopment. In either case, development charges can only be used to pay for costs associated with growth. These charges are levied for works constructed by the municipality; the funds collected have to be used to pay for the infrastructure made necessary by the development. (Section 3.3 gives an overview of the legislation governing development charges.)

Municipalities in Ontario have, historically, required developers to provide or pay for on-site services such as streets, street lighting, sidewalks, and other public facilities within subdivisions. As a condition of approving the subdivision, the municipality requires the developer to take responsibility for providing (or funding) these services to municipal specifications. More recently, municipalities have extended the responsibility of developers to include paying for the off-site costs associated with new development. These growth-related costs have traditionally included 'hard' costs for roads, water, and sewage systems, and, for a time, also included 'soft' costs for such services as libraries, recreation centres, and schools. The rationale for charging developers for off-site costs related to growth is that growth should 'pay for itself' and not be a burden on existing taxpayers.

Examples of the capital costs against which development charges can be applied include the costs to do the following:

- acquire land or an interest in land;
- improve land;
- acquire, lease, construct, or improve buildings and structures;
- acquire, lease, or improve facilities, including vehicles, with a useful life of seven years or more, furniture and equipment (other than computer equipment), and materials required for circulation, reference, or information purposes by a library board;
- cover interest on borrowed money to pay for the above costs; and
- undertake any necessary studies in connection with any of the above.

Ontario municipalities that levy development charges are required to establish and report on separate development charge reserve funds.

A number of studies investigated the issue of which party ultimately pays the development charge and found that, over the long term, development charges are generally borne by the new home buyer.[79] In some cases, the pre-development landowner, or some combination of the home buyer, the pre-development landowner, and the developer, may bear the cost. Who bears the burden of development charges depends on a number of factors, including whether the charge is uniform within housing markets, what the demand and supply conditions are in the market for new housing, and whether the developer knows the magnitude of the charge before undertaking the development. To the extent that the new home buyer pays it, a development charge is similar to a user fee.

Development charges have the potential to be efficient if they are charged on a development-by-development basis. Since the cost of services varies according to the type and location of the development, an efficient development charge also varies according to these factors. The evidence indicates that it is more costly to provide some hard services (such as water) to low-density neighbourhoods than to high-density neighbourhoods. To be efficient, then, development charges for low-density developments should be higher than for high-density ones. Similarly, developments located close to existing services should pay less than those further away.

If a development charge is based on average costs, however, the result is that these hard services are underpriced in low-density neighbourhoods and overpriced in high-density neighbourhoods. A development charge that is the same amount per unit regardless of the location of the unit does not reflect the true costs of the development to the municipality, and will not lead to efficient development decisions. Nonetheless, most municipalities in Ontario levy development charges based on average costs uniformly across the municipality.

One of the differences between levying development charges and increasing property taxes to pay for capital costs relates to the party borrowing the funds. In the case of the property tax, the municipality borrows funds; in the case of the development charge, developers and new home buyers borrow funds. In most cases, municipalities can probably borrow more cheaply than new home buyers, and probably also more cheaply than developers.

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[79] See, for example, E. Slack, 1994, *Development Charges in Canadian Municipalities: An Analysis* (Toronto: Intergovernmental Committee on Urban and Regional Research) and T.P. Snyder and M.A. Stegman, 1986, *Paying for Growth Using Development Fees to Finance Infrastructure* (Washington, D.C.: Urban Land Institute).

7.5.4 Special Assessments and Local Improvement Charges

Special assessments (and local improvement charges) are charges levied on residential, commercial, and industrial properties to pay for additions or improvements to existing capital facilities that border on those properties. Although the size of the charge is based on a particular capital expenditure that falls in a particular year, the cost may be spread over a number of years. The amount of the charge to each customer is generally based on frontage, size of lot, size and type of assessment base, or zone. Special assessments have been widely used by Canadian municipalities to finance capital expenditures such as paving or repaving streets, installing or replacing watermains and sewers, constructing sidewalks, and providing equipment for street lighting.

The advantage of using special assessments to finance public works is that many public works increase the value of nearby land, providing a potential financial benefit to the owners. A special assessment or local improvement charge allows the municipality, which constructs the works, to recoup its cost from the owners of those properties that directly benefit from the government expenditure.

In theory, the apportionment of capital costs to the benefiting property owners should reflect the value of the additional benefits received by each property, as measured by an increase in property value. For example, a watermain on a residential street presumably makes that street relatively more desirable. When a watermain is installed, therefore, the resulting increase in demand for a given supply of residential properties on that street should increase prices. Thus, all other things being equal, the benefit of the watermain will be reflected in property values. In reality, however, it is difficult to isolate the impact of one capital expenditure from other influences on the value of a particular property. For this reason, measures such as frontage and lot size are used to set the level of the special assessment that is applied to each property.

Using assessed value as a measure of benefit is not appropriate, as it is highly unlikely that assessed values are directly correlated with increases in property values attributed to the specific local improvement. In other words, it is unlikely that the benefits of a local improvement are greater for a higher valued property than for a lower valued property.

The most commonly used basis is frontage. This is an appropriate approach in cases where the cost of the improvement increases as the frontage increases. For example, the cost per connection of water distribution lines increases with the number of feet of pipe between connections. Where the cost of the improvement is related to the size of the lot, the lot size is a more appropriate measure. Finally, where the benefits are spread over an entire neighbourhood, as with a park, the zone method is appropriate.

7.5.5 Subsidies and Grants

Over the years, the province, through the Ontario Ministry of the Environment, has provided grants to municipalities for the purpose of planning, designing, and building water and sewage facilities through a variety of programs, including the following:

- Direct Grants, 1974–1992;
- Lifelines, 1987–92;
- jobsOntario, 1993;
- Municipal Assistance Program, 1993–97;
- Provincial Water Protection Fund, 1997–2000; and
- Ontario Small Town Development Infrastructure Program, 2000 (OSTAR).

Of these programs, the Direct Grants program was probably the largest, providing grants of up to 85% of the total capital cost of a waterworks project, depending on the size of the population served.[80]

Additional provincial government grants have been administered by other ministries, such as Municipal Affairs and Housing, and Northern Development and Mines.[81]

Funding through provincial grants to municipalities can take two forms: unconditional and conditional. *Unconditional* grants can be spent on any municipal function or used to reduce local taxes. These grants are generally used to close the fiscal gap between a municipality's revenues and its expenditures or to meet equalization objectives. For example, unconditional grants are used to ensure that all municipalities can provide at least the average level of service by

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[80] Ontario Sewer and Watermain Construction Association [OSWCA], 2001, *Drinking Water Management in Ontario: A Brief History,* [online], public submission, Walkerton Inquiry, prepared by Strategic Alternatives, February, [cited January 2002], <www.walkertoninquiry.com/part2info/publicsubmissions/index.html>.

[81] For more details, see A. Sancton and T. Janik, 2002, *Provincial-Local Relations and Drinking Water in Ontario* (Toronto: Ontario Ministry of the Attorney General), Walkerton Inquiry Commissioned Paper 3, Walkerton Inquiry CD-ROM, <www.walkertoninquiry.com>.

levying an average tax rate. In other words, unconditional grants are often used to enable poorer municipalities to provide adequate levels of service.

Conditional grants have to be spent on particular functions set out by the donor. Conditional grants can be either matching or non-matching. *Non-matching grants* are lump-sum transfers and require no funds to be put up by the recipient. A *matching grant* is one in which the donor pays a specified percentage of expenditures made on a particular function. For example, the Ontario Ministry of the Environment historically provided a grant to cover 33.3% of the costs of rehabilitating water distribution and sewage collection systems. Under this arrangement, the municipality was, in a sense, paying for the rehabilitation with 66.7-cent dollars.

The economic rationale for conditional, matching grants is that the benefits spill over beyond municipal boundaries. In other words, providing a public service in one municipality may result in benefits (or costs) to residents of other municipalities. This spillover effect can result in a misallocation of resources, since in making decisions about public services each municipality considers only the benefits to its own residents. A properly designed conditional grant can encourage municipalities to invest more in services that have some benefit to other jurisdictions in the province.[82] A correct matching rate reflects the size of the spillover.

The theoretical and empirical literature on the impact of grants suggests that conditional matching grants stimulate municipal spending because of the price and income effect.[83] Matching grants lower the price of the services being aided relative to the other services provided by the municipality (the price effect). They also provide additional funds to the municipality (the income effect). Compared to an unconditional lump-sum grant, which only has an income effect, conditional matching grants are expected to result in greater municipal spending.

Conditional matching grants can both undermine accountability and distort municipal decision making, however. In terms of accountability, when two levels of government each contribute to a service, it is difficult for taxpayers to know who is responsible. In terms of municipal decision making, a conditional matching grant can result in more resources being devoted to the funded service than is socially optimal. Unconditional grants to municipalities that do not

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[82] Another way to address spillovers is to restructure municipal boundaries to better reflect the areas over which local service benefits are enjoyed.

[83] See R.M. Bird and E. Slack, 1993, *Urban Public Finance in Canada*, 2nd ed. (Toronto: John Wiley and Sons), p. 129.

have sufficient revenues to provide adequate services do not distort local decision making in the same way as conditional grants for specific services.

As shown in table 7-6, provincial capital grants for water and sewage have declined significantly in recent years, starting in 1997.

Table 7-7 shows provincial capital grants as a proportion of capital expenditures for water and sewage for different categories of municipality, as well as for all municipalities in the province, from 1989 to 1999. The categories used are Toronto (which comprised six cities with a metropolitan government until 1997, and a single city from 1998 on); urban regions (including all regions

Table 7-6 Provincial Capital Grants for Water and Sewage Services, Ontario, 1989 to 1999

	Total Amount of Capital Grants (millions of dollars)		
Year	**Sanitary Sewers**	**Water**	**Total Water and Sewers***
1989	84.6	70.5	155.0
1990	106.4	60.6	167.0
1991	107.2	82.3	189.5
1992	104.2	54.9	159.1
1993	83.4	75.1	158.5
1994	88.8	102.3	191.1
1995	113.3	129.3	242.7
1996	101.1	96.4	197.5
1997	48.7	36.4	85.1
1998	24.1	16.7	40.8
1999	31.9	37.4	69.3

Note: Dollars are current for the year in which the amount was reported.
* Totals may not add up due to rounding.
Source: Ontario, Ministry of Municipal Affairs and Housing, MARS database.

Table 7-7 Provincial Grants as a Percentage of Capital Expenditures for Water and Sewage Services by Type of Municipality, Ontario, 1989 to 1999

Year	Toronto	Urban Regions	Rural Regions	Counties	Districts	Provincial Total
1989	13.0	11.1	49.6	36.6	51.4	**20.7**
1990	17.4	14.1	33.3	30.5	57.5	**21.1**
1991	7.7	15.8	48.2	33.1	57.6	**23.6**
1992	6.4	11.5	42.5	30.5	59.2	**20.8**
1993	3.6	10.3	55.4	29.1	67.6	**21.8**
1994	6.1	11.1	46.5	34.1	59.8	**24.3**
1995	5.2	15.0	49.4	40.3	65.7	**27.2**
1996	2.5	13.2	38.8	34.6	58.1	**23.6**
1997	1.2	3.0	18.4	18.0	37.1	**9.0**
1998	3.5	3.4	−13.1	8.1	28.3	**6.1**
1999	0.0	1.2	18.9	15.7	49.8	**9.2**

Source: Ontario, Ministry of Municipal Affairs and Housing, MARS database.

except rural regions); rural regions (which include Haldimand-Norfolk, District of Muskoka, and Oxford County); counties; and districts in Northern Ontario.[84]

Provincial grants for water and sewage have declined over the last ten years as a proportion of capital expenditures, particularly in the last three years of the period.[85] In urban regions and larger municipalities, capital grants are not significant and have declined dramatically. They still represent a significant portion of capital expenditures in districts and, to a lesser extent, in rural regions and counties.

Prior to the local services realignment in Ontario in 1998, the province provided significant capital grants to municipalities for water and sewage. Although the responsibility for the delivery of water and the collection and treatment of sewage rested with municipalities, the province became involved in the financing, construction, operation, and ownership of both water supply and sewage treatment systems in 1957, with the creation of the Ontario Water Resources Commission.[86] Before the transfer of funding responsibility to municipalities in 1998, provincial capital grants to municipalities for water and sewage were about $85 million.

The federal government has also provided assistance to municipalities for water and sewage projects. In 2000, the federal government initiated a $100-million Green Municipal Investment Fund and a $25-million Green Municipal Enabling Fund. These one-time grants are designed to help municipal governments improve the 'eco-efficiency' of their operations.[87] The Enabling Fund is a matching grant that covers up to 50% of the cost of feasibility studies. The Investment Fund offers a range of financial services aimed at improving the financial performance of proposed projects. Fund initiatives focus on the following areas:

- energy services, such as community energy systems, waste heat capture, or landfill gas recovery;

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[84] These categories are based on provincial government definitions. For more information about municipal governance structures, see Jim Joe et al., 2002, *Governance and Methods of Service Delivery for Water and Sewage Systems* (Toronto: Ontario Ministry of the Attorney General), Walkerton Inquiry Commissioned Paper 17, Walkerton Inquiry CD-ROM, <www.walkertoninquiry.com>.
[85] The main provincial grant to municipalities today is an unconditional grant known as the Community Reinvestment Fund (CRF).
[86] OSWCA.
[87] Federation of Canadian Municipalities, "Green Municipal Investment Fund Overview," [online], [cited January 2002], <www.fcm.ca/scep/support/GMIF/gmif_index.htm>. Only municipal governments and/or their public or private sector partners are eligible for these funds; provincial/territorial governments are not.

- municipally owned and operated buildings and facilities;
- public transportation technologies and fleets;
- renewable energy technologies;
- solid waste management;
- storm runoff management;
- wastewater treatment services, and
- water distribution and water conservation.

Although this fund is a federal government initiative, the Federation of Canadian Municipalities' National Board of Directors approves project funding. This initiative is one of very few examples of the federal government offering financial assistance directly to municipalities without the participation of the provinces, and can be viewed as an attempt to ensure that municipal projects of a national interest are funded and implemented.

7.6 Debt Financing

Municipalities generally use borrowing (debt financing) to pay for at least part of major public capital works. Repayment of the borrowed funds comes from operating revenues such as property taxes and user fees.

Provincial guidelines in Ontario require that a municipality's debt charges not exceed 25% of its own-source revenues (meaning revenues that the municipality is able to generate on its own, for example, from property taxes). Most municipalities are well within this guideline. Regional governments are responsible for raising capital funds for all area municipalities within their jurisdiction even though it is the lower-tier governments that levy and collect property taxes. Although debentures are issued on the revenue base of the municipality and servicing its own debt is an obligation of the lower tier, it is the upper tier that is allowed to borrow. Single-tier municipalities, no matter how small, also have the power to issue debt in Ontario.

7.6.1 The Decision to Borrow

The arguments for borrowing to fund capital projects are as follows:[88]

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[88] See J.E. Petersen, 2001, *Subnational Debt, Borrowing Process, and Creditworthiness* (New York: World Bank), p. 3.

- Current revenues (property taxes and user fees) are usually not sufficient to fund large expenditures on a pay-as-you-go basis. The pattern of capital expenditures is lumpy; a municipality may find it needs millions of dollars to finance an infrastructure project one year and then have declining capital costs for a few years. Furthermore, for most major projects, all of the spending needs to be done before any benefits are reaped. Borrowing the funds allows a municipality to smooth out taxpayers' payments for the project over time.

- Borrowing allows municipalities to synchronize the costs and benefits of infrastructure over time. A project built today will result in benefits over the next, say, 25 years. If funds are borrowed, the project can be paid for over the same period through repayment of the principal and interest. This means that those who benefit from the facility (the users over the next 25 years) also pay the costs. These charges are generally paid out of revenues from property taxes and direct water and sewage billings. Borrowing is more equitable and efficient when those paying for services are enjoying the benefits.

- Future inflation reduces the cost of borrowing. Debt can be repaid with funds that are worth less than their value at the time of borrowing.

The arguments against borrowing, or in favour of pay-as-you-go financing, are as follows:[89]

- No interest costs are incurred; the money saved can be spent on other projects.
- Debt capacity is saved for other, potentially more important, projects.
- Future users, who have no say in whether or not debt is issued, are not required to pay for projects approved by those in power today.
- The use of credit could lead to over-commitment of future resources to pay back the debt.

7.6.2 Types of Debentures

A significant source of funds for long-term borrowing in most provinces is the public market, where municipalities issue serial debentures and sinking-fund debentures.

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[89] Ibid.

Serial debentures are issued for a given number of years, with a certain number of them reaching maturity and being redeemed by the municipality each year. Serial debentures may take different forms:

- Annuity serials are similar to home mortgages in that the total of interest and principal repayment is roughly the same throughout the life of the security. In the early years, the interest portion of the payment is higher, while in later years the principal portion is higher. Annuity serials may be favoured in instances where capital projects must be built with a capacity large enough to service additional users in the future. Examples of municipal projects that may be financed in this way include water and sewage plants, fire stations, and police stations. Under this financial arrangement, a municipality is able to avoid heavy debt service charges in the early years of the project and to redistribute the costs in a more equitable and manageable manner.

- Straight serials require annual principal payments of approximately equal amounts. Interest payments are higher in the early years and decline as the securities approach maturity. Straight serial debentures carry heavier debt charges in earlier years than in later years. They therefore have the advantage of continually lowering interest charges, which frees the municipality to borrow in the future without increasing its annual debt servicing charges. For most capital projects, however, this method of financing violates the principle of ensuring that those who receive the benefits from the capital project are those who bear the cost. Straight serial debentures are often preferred by municipalities, however, because they have a simpler maturity schedule, are easier to understand, and are quicker to market than annuity serials.

- Irregular serials involve a 'balloon maturity' date – that is, repayment of a significant portion of the principal is postponed until the full term of the issue is reached. Irregular serials can be used in financing capital projects where there is some uncertainty as to the amounts that will be available for servicing the debt after the construction costs have been met. When combined with the creation of reserve funds, these serials can be justified as an adequate basis for funding certain local capital projects. This type of debenture is disallowed in Ontario, however, and is seldom used even where it is permitted.

Sinking-fund debentures are issued to mature at a fixed future date. Each year the municipality pays an agreed sum of money to a trustee who, in turn, invests the portion that is not immediately applied toward paying the debt or discharging the obligation.

Local governments tend to place a greater reliance on serial debentures than on sinking-fund debentures. Sinking funds are more expensive and more difficult to administer because they require expert advice on the investment of funds, as well as frequent actuarial computations to ensure that enough funds will be available to cover the principal payment at maturity. Furthermore, the types of securities that can be held in sinking funds are closely restricted, and they frequently generate less revenue than is obtainable from other safe securities. Sinking-fund debentures can also be more difficult to market than serial debentures because of their inflexible maturity dates.

Sinking funds, on the other hand, provide at least one benefit for the municipality: the opportunity of selling their own securities to the sinking fund. This possibility is especially advantageous when market conditions do not favour the public issuance of new debentures; however, it does not appear to be sufficiently appealing to outweigh the substantial administrative costs associated with the operation of sinking funds.

All securities issued as either serial or sinking-fund debentures fall under the heading of general obligation bonds. Municipal debentures, regardless of their function or purpose (water, sewage, roads, libraries, fire stations, and so on), must all rank equal and concurrent (*pari passu*). This means that the full faith and taxing power of the issuer stands behind all of them. A municipally issued debenture for sewers, for example, may generate incremental revenue, but it legally carries no greater security interest in the property base than a debenture issued for a community centre.

7.6.3 Bond Ratings

The rate of interest on municipal debentures as well as other features that define their marketability are largely dictated by the municipalities' bond ratings. These ratings are established by major rating services[90] either at the request of the municipality or, if the bond issue is extremely large, on the agency's own initiative. This rating involves a detailed assessment of a municipality's capacity

[90] The best-known include Moody's Investors Service, Standard and Poors Corporation, and the Canadian Bond Rating Service (the last two of these have now merged).

both to bear debt and to raise revenue. A municipality's bond issue is rated only in terms of its *credit* risk, not in terms of its investment merits.

The bond rating system assigns specific ratings for each bond issue. These ratings are based on the credit quality and risk associated with the municipality's ability and willingness to repay the debt's principal and interest in a timely manner. They are not buy or sell recommendations, nor are they an indication of the marketability or price of the security in question or an evaluation of performance quality. The highest ratings are assigned to the most solid issues – those for which the risk of late payment or default is deemed to be minimal. Such issues carry ratings of AAA (highest quality), AA (very good quality), or A (good quality).[91] Issues that are of lesser quality – perceived to be less likely to return both principal and interest – carry ratings of BBB (medium quality), BB (lower medium quality), or B (poor quality). If the issue is considered speculative it is assigned a rating of C.

A municipality's rating determines the interest rate of its bond issues. The exact differential in interest rate associated with the different ratings is not consistent either among municipalities or over time. Typically, however, the difference between an AAA and an AA rating may be in the order of one-half of a percentage point. For each consecutive lower rating, the differential may rise by roughly one-quarter of a percentage point.

Table 7-8 provides a partial listing of current bond ratings assigned to Ontario municipal bonds by Canadian Bond Rating Services. The table shows that larger municipalities tend to have higher ratings. (As a point of comparison, the Province of Ontario currently has an AA rating. The Municipal Finance Authority of British Columbia has an AAA rating. All other province-wide municipal finance corporations in Canada have the same rating as the province where they are found because the province guarantees their debt [see section 7.8.1].)

7.6.4 Municipal Reluctance to Borrow

Water and sewage debt accounts for about 30% of the total debt incurred by Ontario municipalities, and this proportion has remained roughly the same over the last ten years. The evidence shows that the use of borrowing in general by Ontario municipalities has, on average, fallen over the last ten years.

[91] Ratings used by Canadian Bond Rating Services, 2000.

One measure of the extent of a municipality's borrowing is its debt charges relative to its operating expenditures. Table 7-9 shows debt charges for water and sewage relative to the operating expenditures related to these services for several types of Ontario municipality over a ten-year period. By this measure, as the final column shows, the use of borrowing for water and sewage has fallen over the last decade from almost 18% in 1989 to just over 13% in 1999. There has been a decline in debt charges for all types of municipalities; this percentage measure is highest for rural regions and districts.

Local governments, even those with good credit ratings, do not borrow as much as they can. No one has really been able to explain the recent decline in the use of borrowing by municipalities. It has been suggested that they "may perceive themselves as 'crowded out' with respect to their tax base, for example, and under great pressure to finance 'soft' services at the expense of maintaining and improving infrastructure."[92] When times are hard, as they were in the 1930s, the combination of compulsory debt service and local responsibility for

Table 7-8 Bond Ratings for Selected Ontario Municipalities

Municipality	Long-Term Debt Rating
Barrie (city)	AA
Belleville (city)	A
Brantford (city)	A
Brockville (city)	A
Durham (regional municipality)	AAA
Essex (county)	A
Guelph (city)	AA
Haldimand-Norfolk (regional municipality)	A+
Halton (regional municipality)	AAA
Hamilton-Wentworth (regional municipality)	AA
Innisfil (town)	A–
Kingston (city)	A
Lambton (county)	A+
Lindsay (town)	BBB–
Niagara (regional municipality)	AA
Oxford (county)	A
Peel (regional municipality)	AAA
Peterborough (city)	A
Sault Ste. Marie (city)	BBB+
Thunder Bay (city)	A+
Toronto (city)	AA
Windsor (city)	AA
York (regional municipality)	AAA

Note: + or – indicates an issuer's relative strength within a rating category.
Source: Canadian Bond Rating Services and Standard and Poors, 2000.

[92] See R.M. Bird and A. Tassonyi, 2000, Constraints on Provincial and Municipal Borrowing in Canada: Markets, Rules, and Norms, [draft manuscript], p. 15.

social assistance can put a lot of pressure on municipalities and curtail their ability to meet other expenditure requirements.[93]

In this context, efforts to reduce the cost of borrowing by pooling the debt (as is discussed below) may help somewhat, but do not address the fundamental reluctance to borrow. A more permanent solution to the borrowing problem may be to make municipalities more financially sustainable by shifting the responsibility for social services to the province or by increasing municipal revenue sources.[94]

7.7 Use of Municipal Reserves and Reserve Funds

Financing capital projects using reserves and reserve funds[95] is the reverse of financing through borrowing. Instead of borrowing to finance capital expenditures and repaying the debt in the future, reserves and reserve funds reverse this timetable. A portion of current revenue is set aside annually in a special account and allowed to accumulate until it is eventually used to finance or partially finance a specific capital project or projects. While they are accumulating, these funds are deposited in interest-earning accounts.

Table 7-9 Water and Sewage Debt Charges Relative to Water and Sewage Operating Expenditures by Type of Municipality, Ontario, 1989 to 1999

Year	Debt Charges as a Percentage of Operating Costs					
	Toronto	Urban Regions	Rural Regions	Counties	Districts	Provincial Total
1989	17.3	17.0	23.2	18.7	22.0	17.9
1990	15.6	15.8	23.7	17.5	20.5	16.6
1991	16.1	14.4	24.0	16.2	19.8	15.7
1992	15.8	16.5	19.5	16.2	20.2	16.5
1993	14.4	16.0	16.9	16.8	18.0	15.9
1994	14.9	14.6	18.7	16.9	15.7	15.3
1995	14.0	12.8	18.7	16.8	15.1	14.3
1996	12.3	13.2	20.8	15.4	14.1	13.7
1997	11.3	13.3	20.1	16.1	12.8	13.7
1998	11.1	14.0	23.1	16.3	12.9	14.1
1999	9.3	13.2	21.6	16.9	8.3	13.1

Source: Ontario, Ministry of Municipal Affairs and Housing, 2001, MARS database.

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93 Ibid.

94 Ibid, p. 17.

95 A reserve is an appropriation from net revenue after the provision of all known expenditures. It has no reference to any specific asset and does not require the segregation of money or assets. A reserve fund contains assets that are segregated and restricted to meet a particular purpose of the

The use of reserve funds violates intergenerational equity because current users and taxpayers are paying for capital expenditures that will be enjoyed by future generations.

7.8 Alternative Mechanisms for Capital Financing

This section considers some alternative tools for raising funds for capital expenditures – tools that are not currently used in Ontario, such as pooling debt, revenue bonds, and tax-exempt bonds. It also looks at private sector financing.

7.8.1 Pooling Debt

Municipal finance authorities have been established in a number of provinces (British Columbia, Alberta, Saskatchewan, New Brunswick, Nova Scotia, and Newfoundland) to allow municipalities to gain greater access to national and international capital markets and benefit from better credit ratings. The credit risk of all municipalities combined is almost always less than that of the individual municipalities.

Municipal finance authorities generally issue bonds on a regular basis. Some issue them only on behalf of municipal units but others include schools, hospitals, utilities, and other municipal bodies. The administration costs may be funded by the provincial government, by the participants, or by earnings on reserve funds – or by a combination of these sources.[96] In most provinces, loans are directly guaranteed by the provincial governments.

These authorities lower borrowing costs by pooling local government debt issues, adding credit enhancement at the provincial level, and issuing debt in national markets. They also allow lower the administration costs of issuing debt, since they can substitute one contract with an underwriter for numerous separate contracts between participating borrowers and debt issuers. A municipal finance authority

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reserve fund. Reserve funds can be obligatory or discretionary. Obligatory reserve funds must becreated whenever a statute requires revenue received for special purposes to be segregated from the general revenues of the municipality. (Development charges are an example.) Discretionary reserve funds are established whenever a municipal council wishes to earmark revenues to finance a future capital expenditure.

[96] See M. Gilbert and R. Pike, 1999, "Financing local government debt in Canada: Pooled versus stand-alone issues – an empirical study," *Canadian Public Administration,* vol. 42, p. 531.

can also often economize on transactions costs because it issues debentures more frequently than most individual municipal borrowers, and operates in a volatile capital market that is subject to a large amount of uncertainty. It can exercise a greater degree of flexibility over issue terms and costs to municipal clients.

One recent study compared the cost of municipal funds for pooled versus stand-alone issues using data from Ontario.[97] The findings show that pooled financing through a hypothetical municipal financing corporation or authority in Ontario would lower costs to municipal borrowers significantly compared with the actual cost of capital for municipal issues in that province. The authors concluded that the benefits for a municipality in Ontario of participating in such a hypothetical finance authority that issued ten-year debentures through investment dealers varied inversely with its population and credit rating. Issue size was not a factor. In other words, the greatest savings would be enjoyed by municipal units that are small and unrated and borrow for longer periods.

7.8.2 Revenue Bonds

Revenue bonds apply to types of infrastructure that (1) generate a revenue stream and (2) have beneficiaries that can be clearly identified, such as the users of a water or sewage treatment plant. The bonds are backed by future revenues (for example, user fees) that are generated by the specific project. To be marketable, revenue bonds have to be secured by revenue streams that are adequate and predictable, and can be spread over the life of the project. Revenue bonds are efficient because the people paying for the facility benefit from it. Municipalities in Ontario are not currently permitted to issue revenue bonds.

7.8.3 Tax-Exempt bonds

Tax-exempt bonds are not permitted in any Canadian jurisdictions. They are used by some municipalities in the United States, however. Tax-exempt bonds are bonds for which the interest income is not subject to either personal or corporate income tax. They clearly provide a direct advantage to the bond holder. Any issue of tax-exempt bonds would require the approval of both the federal and provincial governments because it is they who would forgo the tax revenues. For a municipality, issuing a tax-exempt bond means being able to borrow funds

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[97] Ibid.

at a lower interest rate than that allowed by regular bonds, since investors are willing to receive lower interest income from a bond if it is not taxable.

Tax-exempt bonds tend to work best in larger municipalities that have access to capital markets; their application to smaller municipalities is limited.[98] This form of financing infrastructure is also not equitable because people with higher incomes benefit more from this tax incentive than those with lower incomes.

7.8.4 Private Sector Financing and Investment

One of the most frequently cited reasons for increasing the role of the private sector in water and sewage services delivery is the opportunity for access to new sources of capital.[99] The use of private capital may be seen as a way of freeing up municipal resources and debt capacity for other activities.

Before providing debt financing, lenders appraise a project's ability to generate cash flow, rather than analyzing the balance sheet. The keys to attracting private sector capital are the underlying contracts and agreements that ensure a secure revenue stream. The greater the risk to the lender (e.g., with short-term contracts), the higher the cost of capital.

Private sector capital is heavily promoted by some observers. One leading private sector proponent suggests that "private sector capital provides an alternative method of financing water supply and sewage facilities, especially for financially strapped municipalities – by allowing municipalities to 'cash in' on their infrastructure."[100]

Private sector capital, however, may not be a universal remedy for funding water and sewage infrastructure. Consider the following comments:

> The public-private partnership gold rush simply has not materialized. The difficulties in establishing the public-private partnership model lies in the enormous conceptual space that separates the public and private sectors.

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[98] See Informetrica, 1992, *Financing Municipal Infrastructure: Alternative Methods* (Ottawa: Canada Mortgage and Housing Corporation and Canadian Home Builders' Association).

[99] For a more detailed discussion of this topic, please refer to the companion document to this report by Jim Joe et al., 2002.

[100] D. Haarmeyer, 1992, *Privatizing Infrastructure: Options for Municipal Water Supply Systems*, Policy Insight no. 151 (Los Angeles, Calif.: Reason Foundation).

> Let's take a hypothetical water treatment plant as an example. In this case, the private sector would build, own, and operate the plant, selling the output to a municipality. The pricing of risk, for example, means one thing to a commercial lender, another to a bureaucrat. To the bureaucrat, the fact the government entity has an obligation to purchase means the risk has effectively been taken out of the transaction. The same transaction looked at with private-sector eyes contains many risks that must be managed. The plant's entire revenue source comes from one source – the municipality.
>
> Over twenty years, a municipality's situation can change drastically. Its industries may contract and its population base may decline. Possibly it will be amalgamated with its neighbours and there may, at that time, be pressure to change the terms of a contract which is no longer required. Unanticipated costs also may adversely affect project economics. Some of these are more or less under the developer's control – such as construction and operating costs – although significant elements of even these costs are really at the mercy of time and circumstance …
>
> Another argument adduced by financiers for public-private partnerships is sheer availability of capital. Beyond some governments in straitened circumstances – which in effect reduces the amount of private sector financing they can sustain – the bulk of municipalities and provincial governments now have the ability to fund infrastructure through traditional borrowing.
>
> After several years in the business, I am convinced that we got it wrong. By focusing the argument on finance, we [led] the discussion away from the real benefits of public-private partnerships, innovation and efficiency.[101]

Some of the assumptions commonly put forward by those in favour of private financing can be challenged, as follows:

- The equity value of an aging infrastructure can be overstated, particularly when there is increasing regulatory risk.

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[101] S. Probyn, 1997, "Public-private partnerships on the road to nowhere," *Financial Post*, April.

- Proponents of private sector capital assume the market for water systems may be larger than probably exists.
- Taxpayers who have funded their municipal water system may not necessarily benefit from the sale of an asset.
- If the system is badly deteriorated (a reason for shifting risk), these same taxpayers will face a rate increase to pay for needed improvements.[102]

In practice, the sale of assets could be used as an alternative source of revenue to taxation. The funds accruing from the asset sale could be applied to finance tax reductions or to reduce borrowing for other services.

> Receipts from sale of assets do reduce public sector debt. In the case of concessions or long-term contracts, there may not be immediate receipts, but in a number of cases a sum is paid up-front by the private sector firm; this will reduce debt, but not the annual deficit. In either case, the amount received by the public body in exchange for the assets will not be invested in the infrastructure itself. It becomes part of the balance sheet of the public entity, not the undertaking. Furthermore, the financing of investment by that undertaking no longer counts as increasing government debt. However, the benefit of this would be offset by any increase in the annual costs of servicing such investments if, for example, the annual cost of financing a new sewage plant by the private sector is greater than financing it by the public sector.[103]

It should be noted that municipalities in Ontario are not prevented from selling their assets, but that the *Water and Sewage Services Improvement Act, 1997,* stipulates that municipalities must repay any grants received in the construction of facilities should it decide to divest them.

The structure of private sector financing and the terms of lending depend primarily on the risk and cash profiles of the project. A summary of typical profiles is presented in table 7-10.

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[102] J.A. Beecher, G.R. Dreese, and J.D. Stanford, 1995, *Regulatory Implications of Water and Wastewater Utility Privatization* (Columbus, Ohio: National Regulatory Research Institute), p. 27.
[103] L. de Luca, 1997, *Labour and Social Dimensions of Privatization and Restructuring – Public Utilities, Water, Gas, Electricity: Part II – Europe* (Geneva, Switzerland: International Labour Organization, Interdepartmental Action Programme on Privatization, Restructuring and Economic Democracy), November.

In general, the financial capability of a municipality and its ability to incur debt at generally favourable rates means that the cost of capital often tips in favour of public sector–based financing for water and sewage projects.

8 Accounting Practices

The focus of reporting and accounting is to document, classify, and summarize transactions so users of the resulting financial reports are able to understand and evaluate municipal operations. The transactions include expenditures such as those described in section 7. This section describes municipal accounting practices and methods, and examines the impact of these methods on the way municipalities track costs.

8.1 Importance of Municipal Financial Statements

The Public Sector Accounting and Auditing Board of the Canadian Institute of Chartered Accountants recommends the following objectives for municipal financial statements:

- Provide reliable, understandable, timely, and consistent information that meets the needs of persons for whom the statements are prepared.
- Provide an accounting of the full nature and extent of the financial affairs and resources for which local government is responsible.
- Demonstrate the accountability of local government for the financial affairs and resources entrusted to it.

Table 7-10 Private Sector Participation in Water and Sewage Projects

	Operations & Maintenance Contract	Lease	Build-Operate-Transfer	Full Concession	Asset Sale
Time Horizon	10 years	25 years	20–30 years	10–20 years	perpetuity
Customer	government	retail customer	government	retail customer	retail customer
Business Risk	fixed fee	subject to market risk	contracted payments	subject to market risk	subject to market risk
Construction Risk	none	none	high	low	very low
Regulatory Risk	none	medium	low	high	very high

Source: Haarmeyer, 1992; also D. Haarmeyer and A. Mody 1998.

- Account for the sources, allocation, and uses of financial resources in the period.
- Provide information that shows the state of local government's finances.[104]

A number of financial management functions have to be fulfilled to meet these objectives. Municipalities need to have systems in place for accounting, for auditing, and for analyzing financial information.[105]

Accounting systems are needed to record revenues and expenditures in a consistent way that allows for comparisons between planned (budgeted) amounts and actual ones.

Financial audits are needed to determine whether the municipality's financial statements provide an accurate and reasonable picture of the municipality's financial position and activities for the reporting period. The financial audit is designed to detect deficiencies in the system of internal financial control, failure to comply with accounting principles and standards or with reporting requirements of the Ontario Ministry of Municipal Affairs and Housing, and instances of errors or of the misappropriation of funds in the financial statements. The focus of the financial audit is therefore on the financial statements; it does not address the issues of efficient resource utilization and the achievement of performance standards such as water quality objectives for drinking water.[106]

Together, capital planning and budgeting, accounting, auditing, and reporting constitute a financial management cycle designed to ensure that the resources required for water and sewage capital works and ongoing operations are available and put to the intended use.

8.2 Accounting Methods

Municipal accounting systems in Ontario are organized on a 'fund accounting' basis. Under this system, a fund is used to report financial transactions relating

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[104] Public Sector Accounting and Auditing Board, 1997, *An Illustrative Guide to Municipal Accounting and Financial Reporting* (Toronto: Canadian Institute of Chartered Accountants).
[105] Section 8.1 is based in part on American Water Works Association [AWWA], 1995a, *Water Utility Accounting*, 3rd ed. (Denver, Colo.: AWWA), and Ontario, Ministry of Municipal Affairs and Housing, 2000, *Municipal Capital Budgeting Handbook* (Toronto: Queen's Printer for Ontario).
[106] Issues of efficiency and performance may be addressed in management audits and performance audits, or other special audits, such as environmental audits.

to a particular aspect or activity of government. Funds commonly used by Ontario municipalities include capital funds, reserve funds, trust funds, and revenue funds. A separate budget is prepared for each fund. Fund accounting features self-balancing double-entry accounts from which a balance sheet and statement of operations can be prepared.

The financial transactions associated with particular funds are subject to legal or administrative restrictions. A reserve fund is used to record the proceeds from development charges and their application to designated capital works, while a utility fund is used to report the transactions of a municipal service that has been set up as a self-financing department.

The accounting method used for most government funds is the modified accrual basis. This system, and the way it differs from the full accrual system, is described in detail below. Comprehensive accounting principles and disclosure requirements are provided in the publication *Municipal Financial Reporting Handbook*.[107] Financial Procedures Bulletins from the Ontario Ministry of Municipal Affairs and Housing provide additional guidelines on special topics. As of January 1, 2000, local governments in Ontario are required to follow recommendations in the *PSA Handbook* published by the Public Sector Accounting and Auditing Board (PSAAB) of the Canadian Institute of Chartered Accountants (CICA). The handbook recommends the modified accrual basis of accounting.

8.2.1 Accrual System

Under a full accrual system (sometimes referred to as 'simple accrual,' or as the 'utility method'), capital costs are recovered through user fees and charges in the following manner:

- Interest costs on debt are recovered directly in the year in which they are incurred through user fees and charges.

- User fees and charges are set to recover (1) expected OM&A (operations, maintenance, and administration) costs, (2) a depreciation charge corresponding to fixed assets, and (3) a return on equity. The cash flow generated by the depreciation charge and the retained portion of the return

[107] Ontario, Ministry of Municipal Affairs, 1990, *Municipal Financial Reporting Handbook* (Toronto: Queen's Printer for Ontario).

on equity is used to pay back principal on debt and to finance investments internally.

Using the full accrual basis of accounting, revenues from taxes and other sources are reported when they are billed by the municipality, and expenses are reported in the period in which the associated benefits are received. Thus, even if the cash expenditure to finance the investment in a particular fixed asset takes place within a single year, the associated expenses reported in the financial statement of operations take the form of annual depreciation charges incurred over the life of the asset. The depreciation charges enable the cost to be spread over the life of the asset, matching the flow of benefits arising from use of the asset with the asset's cost. This method ensures an equitable outcome, since the beneficiaries of an asset pay for its use.

Depreciation charges are used to recover the original cost of an asset. Depreciation is sometimes misunderstood to be a charge intended to cover replacement costs; this is incorrect, however. Such an interpretation would entail double counting of replacement costs. The cost of a major replacement is capitalized as a new fixed asset, to be recovered through new depreciation charges. The cost of asset maintenance and repair is recovered directly, as an expense.

Such a fixed asset accounting system provides information to decision makers and others regarding the value of infrastructure assets and the financial condition of the municipality as it relates to those assets. For instance, a chronic decline in the reported value of fixed assets may signal a failure to invest in asset replacements and a backlog of deferred investment costs. But an accounting system, in and of itself, does not ensure adequate investments to maintain infrastructure assets. Assets must be carefully monitored and managed, and funds committed as needed for infrastructure renewals.

The full accrual system can lead to cash flow difficulties when debt is used to finance large investments. This occurs because annual depreciation charges do not necessarily match the cash requirements for principal repayments. Furthermore, depreciation charges, which are not adjusted to account for inflation, may prove to be insufficient to finance asset replacements, since the value of new assets is subject to inflation. As well, accounting standards and tax laws stipulate allowable depreciation charges, while the return on equity, or profit, is generally subject to external review and approval. Hence, municipalities are not at liberty to set rates based on internally determined requirements for reserve funds. This fact has a detrimental impact on administrative ease.

The accrual-based system of accounting is normally associated with investor-owned enterprises that earn a return on equity. The analogue to this return on equity for municipal water and sewage funds is an operating surplus, which can be transferred into a reserve fund.

8.2.2 Modified Accrual System

The current system used for municipal accounting in Ontario is a modified accrual system, also referred to as cash basis accounting. This system affords municipalities considerable latitude in developing financial strategies.

As with the accrual system, under the modified accrual system capital costs are recovered through user fees and charges. But depreciation and a return on equity are not included as costs in the modified system. Instead, interest costs and principal repayments on debt are recovered directly in the year in which they are due through user fees and charges. User fees and charges are therefore set to recover these and other costs, and to generate further revenue, with the resulting operating surpluses being transferred to (1) the capital fund to finance ongoing investments or (2) reserves or reserve funds to finance planned future investments. Because principal repayments are recovered directly each year as chargeable expenses, municipalities are less likely to face cash flow problems under this system. The financing of capital does not depend on the flow of funds from a depreciation charge and a return on equity.

Since fixed assets are reported on a cash basis, they do not appear on the balance sheet. Instead, fixed assets appear in the municipality's financial statements in the form of direct cash expenditures on capital goods from current revenues or reserves, and of repayments of principal in the case of debt financing. Related transactions include transfers from current revenues into capital reserves to finance future investments.

8.2.3 Comparison of Full Accrual and Modified Accrual Systems

The treatment of OM&A is identical under both the full accrual and the modified accrual accounting systems. As well, both systems can accommodate capital contributions from outside sources. Under the modified accrual system, these would take the form of grants from senior governments or transfers from the municipality's general revenue, or general reserve, funds (such transfers are not customary since municipalities run water utilities on a self-financing basis). Under the full accrual-based system, capital contributions would normally be equity injections from private or public sector investors.

The main difference between the two methods lies in their treatment of capital. The method chosen can also affect the timing and magnitude of costs that are written off as expenses in a given year, and hence the timing and magnitude of capital costs that are passed on to customers.

Another difference between the two systems is that the accrual method allows for the possibility of a payout of dividends to shareholders. This possibility increases the cost of capital, as does the fact that investor-owned utilities pay income tax on profit. The higher cost of capital may be offset, however, by economies of scale and other efficiencies achieved by virtue of the private sector involvement in service delivery (although evidence concerning the relative efficiency of private sector water operations is somewhat mixed).[108]

Both accounting methods can be made to work effectively, given the appropriate level of financial management. The sum of principal repayments and the operating surplus in the modified accrual system can be equated to the sum of depreciation charges and retained earnings in the accrual system. These two sources of funds are similar.

Table 8-1 presents a comparison of the two accounting methods.

Currently, Ontario municipalities are required to follow the modified accrual basis for accounting. However, given the ability to match benefits with costs over the service life of assets and the requirement to fully recover costs each fiscal year, the full accrual method presents a greater opportunity to achieve the objective of service delivery related to equity.[109] Many interested parties therefore support a shift to this method for local governments. This support is not universal, however:[110]

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108 Beecher, Dreese, and Stanford.

109 See, for example, Institute of Chartered Accountants of Ontario et al., 1987, *Fixed Asset Accounting for Municipalities in Ontario*, joint committee report [Toronto]; M. Fortin and B. Mitchell, 1990, *Water and Wastewater Charges for Ontario: The User Pay Principle* (Toronto: Ontario Sewer and Watermain Construction Association); "Balancing the government's books," 1992, *The Economist*, January 25; and Public Sector Accounting and Auditing Board, 1998, *Capital Assets: Implementing PSAAB's New Accounting Standards* (Toronto: Canadian Institute of Chartered Accountants).

110 T. Beauchamp, 2000, "The infrastructure web," *CA Magazine*, June/July.

Table 8-1 Accrual and Modified Accrual Accounting Compared

Item	Accrual Basis	Modified Accrual Basis
Treatment of Investment Costs in Statement of Operations	• An annual depreciation expense is included in costs over the expected life of the asset. The sum of depreciation expenses should equal the original cost of the asset less its scrap value. • The annual depreciation charge does not correspond to any expenditure in the year for the asset in question.	• The statement of operations shows actual capital expenditures for the asset drawn from the capital fund. • Money in the capital fund is transferred from the revenue fund or a capital reserve fund, or comes from newly issued debt or a capital contribution such as a grant.
Treatment of Fixed Assets in Balance Sheet	• The original cost of the fixed asset is recorded when the asset is commissioned; this value is then reduced each year by the amount of the corresponding depreciation charge. • At the end of its service life, the asset's value goes to zero	• The value of the fixed asset does not appear on the balance sheet. • Only current assets are reported (e.g., inventories, cash, accounts payable).
Treatment of Long-Term Debt in Statement of Operations	• Only the interest portion of debt service cost is reported as a cost, not the principal repayment. • The principal is repaid using cash originating from depreciation charges and profit.	• Both the interest and principal portion of debt service cost are reported as costs.
Treatment of Long-Term Debt in Balance Sheet	• Long-term debt is reported as a liability and diminished as the principal is repaid.	• Long-term debt is reported as a liability and diminished as the principal is repaid.
Cost Recovery through User Fees and Charges (Assuming No Grants)	• Cost is recovered in the form of depreciation charges. • The period of recovery extends over the service life of the asset, which may be considerably longer than the repayment period of the debt that financed the investment.	• Cost is recovered in the form of principal repayments and transfers from the revenue fund to capital and reserve funds to finance the investment. • The period of recovery matches the period of debt repayment and revenue fund transfers; it may actually commence prior to the investment when reserves are built in advance.
Financing Costs	• Financing costs consist of interest charges on debt and a return on the equity portion of the investment, including retained earnings (if any).	• Financing costs consist only of interest charges on debt.

Source: Authors.

- The PSAAB in Canada recommends accrual-based accounting based on historical costs for senior governments in Canada, but not for local governments.

- The United States Federal Accounting Standards Advisory Board requires accrual-based accounting based on historical costs, but the U.S. Government Accounting Standards Board allows a non-depreciation renewal approach for the infrastructure of local governments.

- In New Zealand and Australia, accrual-based accounting is required, but an allowance is made for asset revaluation to offset inflation.

- The American Water Works Association's position is that both the full and the modified accrual systems are meant to produce the same result.

Introducing the full accrual method in Ontario would likely entail a significant cost for those municipalities that have incomplete infrastructure inventories, since complete inventories and asset age are needed in order to value the assets and determine depreciation charges.

Furthermore, if a municipal water department adopted the full accrual system, it would be possible to interpret operating surpluses as return on equity. The sudden appearance of this 'profit' might confuse councillors or the public, who might argue that public bodies should be non-profit operations. If water departments were forced to operate on a 'non-profit' basis, that is, with a zero operating surplus, they could experience difficulties in financing investments, since operating surpluses are important funding sources.

8.3 Cost Classifications

All transactions reported in a set of financial accounts are assigned codes, which are used for classification purposes. These codes are summarized in a chart of accounts.

Bodies such as the Government Accounting Standards Board[111] and the National Association of Regulatory Utility Commissioners[112] provide recommendations on

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111 P.R. Delaney, 1999, *CPA Examination Review 1999/2000*, 26th ed. (New York: Wiley).

112 National Association of Regulatory Utility Commissioners, 1984, *Uniform System of Accounts* (Washington, D.C.: the association).

the way governments should classify costs and other transactions. The recommended codes usually represent a multi-level classification system. The first level is classification by object, which is a basic requirement for reporting costs. This classification identifies each cost by type of good or service, such as labour, utilities, chemicals, other supplies, rent. In most organizations a further classification by function or operating unit is also used. In a municipality, an operating unit generally consists of an individual department and the work units within it. A functional classification will closely resemble a classification by operating unit when the municipality is large enough to dedicate staff within work units to specific functions. A functional classification of costs is not recommended for small utilities. For medium and large water systems, the functional classification system generally includes the following major categories:[113]

- source of supply;
- water treatment;
- transmission and distribution;
- customer accounts; and
- administration and general expenses.

Each of the first three categories is further divided into operations and maintenance, and all categories are subdivided into object code categories.

The classification of accounts in municipal financial records serves several purposes. At the corporate level, a detailed multi-level classification of expenditures and other accounts enhances management's ability to monitor and control costs. Detailed cost information facilitates comparisons for benchmarking with other utilities and analyzing efficiency in resource use. Additional benefits specific to water and sewage operations relate to the data requirements for calculating tariffs and other charges.[114]

Figure 8-1 shows a breakdown of one year's water costs for a typical Ontario regional municipality.

Note that water supply costs account for about 31% of costs (25% from supply – operations and 6% from capital from current), which are virtually all fixed costs. Only energy and chemical costs are related to volume, and these represent

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[113] Ibid. Operations with annual operating revenues of over $350,000 are considered to be medium sized, and those over $2,000,000 are considered large.

[114] American Water Works Association, 1995a.

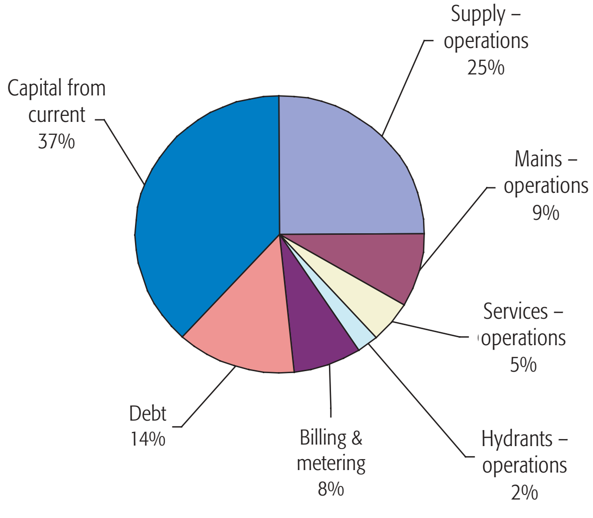
less than 10% of water supply costs. The remaining 69% of costs are related more to the number of customers than to the volume of water and include the cost of mains, services, hydrants, and billing.

The first two categories presented, capital from current and debt, are capital costs, and the remaining cost categories relate to operations.

- *Capital from Current* This cost category covers the capital investments made and paid for in a given year. Such a pay-as-you-go approach is often used for smaller projects that are part of routine programs, such as watermain replacement or upgrading. The availability of funds determines whether or not particular investments of this kind are made; most municipalities have a long list of potential programs for which funding is needed. When funds are available, the key variable driving capital from current investment is the age of the facilities: the closer to the end of the useful life, the higher the probability that investment is needed. In the example, 6% of the cost for this category is for supply, and 31% for distribution.

- *Debt* Debt, which includes both principal and interest charges, is often issued for larger projects such as treatment facilities (in the particular case presented above, in fact, all of the debt is for treatment). Debt is repaid in accordance with a fixed schedule.

Figure 8-1 Water System Cost Breakdown, Sample Ontario Regional Municipality, 2000



- *Billing and Metering* This category includes costs related to meter installation, repair, reading, billing, and customer service. Meter costs are sometimes capitalized, but often not. Labour accounts for most meter reading and billing costs (which include bill collection). These costs are generally variable, depending mainly on the number of customers.

- *Hydrants* These costs are related to the number of hydrants, which is, in turn, based on guidelines related to the length of watermains and the class of customer. The costs included in this category cover hydrant maintenance tasks, such as painting and pumping out. These costs vary in relation to the number of customers.

- *Services* This category refers to maintenance or replacement of the public portion of the customer service lateral (that is, the connection pipe from the watermain up to the street line or right of way). Service costs vary in direct relation to the number of customers.

- *Mains* This cost category covers the maintenance of watermains. It includes labour, materials, and equipment. Costs in this category vary according to the number of customers served, and can also be affected by age of the system, type of pipe, subsurface soils condition, material of construction, and, where frost penetration is a problem, very cold winter temperatures.

- *Supply* This category relates to water treatment, wells, and pumping stations. It involves many costs, such as labour, energy, chemicals, equipment, supplies, contracted services, and insurance. Over the short term, energy and chemicals are considered the only costs that vary with the volume of water consumed by customers; these two items represent about 30% of plant costs, depending on water quality and pumping requirements. Most of the other costs in this category are related to the design capacity of the plant and would only become variable if the plant expanded (at which time the costs would increase in response to the increase in extra capacity). Under certain circumstances, however, all supply costs can vary in relation to the volume of water consumed: this is the case if one municipality (e.g., the Town of Markham) purchases water from a wholesaler (in this case, the Regional Municipality of York), and a reduction in use results in a direct reduction in the water supply bill.

8.4 Accounting and Information Management

The accounting treatment of fixed assets can affect the management of information about water and sewage infrastructure.

Under accrual-based accounting, the value of fixed assets and their depreciation are recorded. This information can be used as a general guide in assessing the status of those assets. For example, a chronic decline in the net value of fixed assets may indicate a failure on the part of management to protect the value of the investments in those assets by timely further investments in major repairs and replacements. It may also signal a growing backlog of deferred investments for repairs and replacements, which may represent a financial risk to the organization.

The modified accrual basis of accounting used in Ontario municipalities reports capital expenditures on a cash basis. Statements show expenditures for debt service and capital investments in the year, but do not report the value of fixed assets or the accumulated depreciation charged against these assets. This information is, therefore, not available to management, council, or outside agencies as a guide in assessing how well the municipality has managed its physical assets.

8.5 Experiences in Other Jurisdictions

The increased support for moving to full accrual-based accounting for municipalities is motivated by concerns over the state of aging infrastructure; there is a lack of reliable information that could be used to evaluate how serious this concern should be. In two jurisdictions, New Zealand and the United States, these considerations have led to reforms in accounting standards for local government.

In 1993, the New Zealand Audit Office reported to parliament that it could not vouch for the long-term financial viability of local governments because no information on the condition of their assets was available and such strategic planning as had been done for future investment requirements was inadequate. In response, the *Local Government Amendment Act* (no. 3) was passed in 1996. Among other provisions, this act requires local governments to adopt fixed asset accounting and to prepare and approve a financial strategy every three years providing long-term financial and asset management plans.[115]

Under the act, depreciation charges are to be estimated and funded through local taxes and user charges. The depreciation charge provides an estimate of the decline in the service potential of assets; funding it in this way ensures that "users of the service pay the real cost."[116] Currently, local authorities are allowed to use the long-run average cost of asset renewals as an alternative to depreciation charges, provided they develop a 20-year capital plan. In the case of long-lived assets, however, the 20-year plan has not provided a realistic estimate of the average annual renewals cost. Conversely, where a realistic depreciation charge is set and funded, local authorities have complained that very large reserve funds will accumulate long before they are needed.[117]

Reforms to local government accounting practices in the United States are very similar to those that have occurred in New Zealand. The requirement for full accrual accounting by local government was established by the U.S. Government Accounting Standards Board (GASB) in a statement that concluded, "Reporting infrastructure assets is essential to provide information for assessing financial position and changes in financial position, and for reporting the costs of programs or functions."[118] Asset reporting requirements are retroactive to 1980 for large municipalities, but not for those with less than $10 million in annual revenues. As in New Zealand, an alternative approach has been approved for infrastructure assets.

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[115] J. Pallot, 2001, *Local Government Reform in New Zealand: Options for Public Management as Governance*, [online], [cited summer 2001], <www.willamette.org/ipmn/test/papers/ salempallot.htm>.
[116] New Zealand, Office of the Controller and Auditor General, 1999, second report to parliament for 1999.
[117] Ibid.
[118] GASB statement no. 34, cited in L.E. Johnson and D.R. Bean, 1999, "GASB statement no. 34: The dawn of a new governmental financial reporting model," *The CPA Journal*, [online], December, [cited January 2002], <www.nysscpa.org/cpajournal/1999/1299/soonDec.htm>.

In the United States, governments may choose to report expenses for repairing and maintaining infrastructure instead of depreciation expense for that infrastructure provided that they (1) manage the infrastructure using a suitable asset management system, including an assessment of the physical condition of assets every three years, and (2) establish a minimum condition level for those assets and demonstrate that they are maintaining them at or above that condition through appropriate investments.[119]

Asset management planning figures prominently in both the New Zealand and the U.S. approaches. In New Zealand it is mandatory, and in the United States it is mandatory so long as depreciation is not charged for infrastructure.

As a source of information on the condition of infrastructure, asset management planning goes well beyond fixed asset accounting in that it requires an assessment of the physical condition of the infrastructure. Fixed asset accounting uses accounting standards and conventions as a basis for estimating depreciation charges, and therefore provides only a proxy measure of the condition of physical assets. Asset management planning goes one step further by developing a strategy and a financing plan for asset maintenance and replacement. In contrast, fixed asset accounting generates cash funds that are available for capital finance, but this does not mean that they will be used for that purpose or that they are needed when received.[120] Asset management planning is therefore a more effective tool than fixed asset accounting as a means of providing information on the condition of infrastructure and the funding required for its maintenance. Financial accounting for fixed assets based on an accrual system of accounting can be useful but is not necessary for this purpose.

The U.S. and New Zealand experiences suggest that one way of ensuring that asset management systems are mandated is to reform the accounting standards for local government.

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[119] T.K. Patton and P.S. Wardlow, 1999, "Why infrastructure reporting?" *GASB Action Report*, [online], vol. 16, no. 5 [cited summer 2001], <www.rutgers.edu/Accounting/raw/gasb/repmodel/viewpoints.html>; Government Accounting Standards Board, 2001, *New Rules for Reporting Infrastructure Information Enacted for State and Local Governments*, [online], [cited summer 2001], <www.rutgers.edu/Accounting/raw/gasb/repmodel/infrastructure.html>.

[120] J.L. Jordan, 1995, "Do you use your depreciation funds wisely?" *Opflow*, vol. 21, no. 12.

9 Municipal Financial Performance

The question is often asked: Are Ontario's municipalities financially sustainable? A municipality's underlying fiscal condition can be measured by the ability of residents to obtain a reasonable level of service at a reasonable cost. To assess its current and potential fiscal health, then, it is necessary to determine its revenue-raising capacity and its expenditure needs. If municipalities are empowered to use only the property tax (not income or sales taxes, for example), then their revenue-raising capacity depends on their property tax base. Expenditure need is much more difficult to determine, especially regarding long-term infrastructure needs, as discussed throughout this paper.

The difference between the expenditure need and the revenue-raising capacity indicates the municipality's fiscal health. A fiscal health index can be created to determine the net effect of a municipality's economic, social, and demographic characteristics on its ability to deliver public services. A positive rating on this health index means that a municipality's revenue-raising capacity exceeds its expenditure needs – that it has revenues left over for increases in service quality or tax cuts after it provides a baseline level of service at the standard tax rate. A negative rating on this index shows that an increase in revenue from outside sources (such as other levels of government) is necessary if the municipality is to provide a baseline level of service at a standard tax rate; the value of the rating would indicate the size of the extra funds needed. There is currently, however, no studies of fiscal health for Ontario municipalities.

Municipalities in Ontario are generally not financially self-sufficient; there is a gap between their own-source revenues and their expenditures. For the province as a whole, municipal expenditures in 1999 were about $20.5 billion and municipal revenues from own sources were about $16.4 billion, leaving a local fiscal imbalance of approximately $4.1 billion, or about $937 per household. This difference is currently made up by provincial grants. It is anticipated that, as responsibilities at the local level increase even as property taxes are being frozen across the province, this amount will increase.[121] The extent to which the province will continue to fund the difference is unclear.

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[121] For a discussion of financial self-sufficiency in Greater Toronto Area municipalities, see E. Slack, 2000, "The road to financial self-sufficiency for Toronto: What are the impediments and how can they be overcome?" in Mary Rowe, ed., *Toronto: Considering Self Government* (Owen Sound, Ont.: Ginger Press).

Local fiscal imbalance occurs essentially because there is a mismatch of expenditures and revenues at the local level. This imbalance tends to increase over time because local revenue sources generally grow more slowly than income, while local expenditures generally grow more quickly. This imbalance can, in principle, be rectified either by increasing the sources of local revenue or by reducing local expenditure responsibilities.

9.1 Financial Indicators

The ability of a municipality to provide services depends on a number of different factors. The financial indicators used by bond-rating agencies and provincial governments to measure the financial viability of municipalities include, for example, the amount of taxable assessment per household, the degree of dependence on provincial grants, and the extent of borrowing (measured by debt charges relative to own-source revenues, debt per household, and the debt-to-reserve ratio). These indicators are discussed in more detail below. Their values are shown in table 9-1 for different types of municipalities in Ontario.

9.1.1 Taxable Assessment

The fiscal capacity of a municipality reflects its ability to raise taxes to meet its expenditure requirements. It is dependent on the size of the municipal tax base. In the case of the property tax, fiscal capacity is generally measured by the size of the assessment base per household. The amount of taxable assessment per household shows the dollar value for residential, commercial, and industrial

Table 9-1 Municipal Financial Indicators, Ontario, 1999

	Taxable Assessment per Household ($)	Dependence on Provincial Grants (%)	Debt Charges Relative to Own-source Revenues (%)	Debt per Household ($)	Reserves per Household ($)	Debt/ Reserve Ratio (%)
Province	153,340	20.1	4.8	856	1,887	45.3
Toronto	174,082	16.1	4.9	1,153	1,289	89.4
Urban Regions	174,185	17.4	4.8	872	2,967	29.4
Rural Regions	150,636	25.2	5.0	703	1,370	51.3
Counties	123,255	25.0	5.1	720	1,159	62.1
Districts	105,021	36.3	3.9	476	1,204	39.5

Source: Ontario, Ministry of Municipal Affairs and Housing, 2001, MARS database.

properties. It is calculated on a per household basis to allow for comparisons across municipalities with different populations, but it should not be regarded as the average residential assessment of a household.

Table 9-1 shows that taxable assessment per household is highest in the urban regions and Toronto, and lower in the counties and districts, especially those with populations of over 25,000. The higher taxable assessments in the urban areas reflect, to a large extent, the greater variety of services that these municipalities have to provide.

9.1.2 Dependence on Provincial Grants

The greater the dependence on provincial grants, the less a municipality relies on its own revenue sources to provide services. Table 9-1 shows the proportion of total municipal revenues in Ontario that consisted of provincial grants in 1999. There is quite a wide range in the extent to which municipalities use provincial grants, ranging from a low of 16.1% in Toronto to a high of 36.3% in municipalities located in districts.

Table 9-2 shows how dependence on provincial grants has changed in the province over the last ten years. Overall, provincial grants have fallen from over 24% of total municipal revenues to about 20% over this period. The decrease occurred mainly in 1998 when the province undertook a local services realignment that shifted responsibilities between the province and municipal governments. This move resulted in a significant decline in provincial input to some types of

Table 9-2 Dependence on Provincial Grants, Ontario, 1989 to 1999

Provincial Grants as a Percentage of Total Revenues

Year	Toronto	Urban Regions	Rural Regions	Counties	Districts	Provincial Total
1989	21.1	21.9	27.5	28.9	40.4	24.4
1990	22.5	23.4	27.8	29.6	40.6	25.5
1991	28.2	26.6	31.0	32.9	43.3	29.6
1992	29.7	29.1	33.6	35.7	44.3	31.7
1993	30.9	28.3	32.3	35.1	43.1	31.6
1994	31.5	27.8	32.1	34.1	42.2	31.3
1995	30.3	26.6	30.0	32.8	40.5	30.1
1996	25.4	22.3	26.4	29.4	36.4	25.8
1997	23.8	20.3	24.1	27.7	35.0	24.1
1998	15.1	17.5	28.4	27.8	40.2	21.0
1999	16.1	17.4	25.2	25.0	36.3	20.1

Source: Ontario, Ministry of Municipal Affairs and Housing, 2001, MARS database.

municipalities (e.g., Toronto and the urban regions), but less of a change for municipalities in the counties and districts. Provincial grants still account for a significant proportion of revenues in the rural regions, counties, and districts.

9.1.3 Borrowing

The amount of debt incurred by a municipality also reflects on its financial stability. As mentioned earlier in this paper, provincial guidelines require that debt charges of Ontario municipalities not exceed 25% of their own-source revenues. This is to ensure that these charges do not crowd out other operating expenditures. Table 9-1 shows the ratio of debt charges to own-source revenues, as well as debt per household, for different types of Ontario municipalities. All types of municipalities are well below the provincial guidelines for borrowing. Indeed, debt charges do not exceed 5.1% of operating expenditures in any category of municipality.

As table 9-3 shows, debt per household for Ontario municipalities has remained roughly the same over the period and has declined in urban regions and districts. Water and sewage debt, on average, accounts for about 30% of the total debt. This proportion has remained roughly the same over the last ten years.

9.1.4 Use of Reserves and Reserve Funds

The size of reserves and reserve funds is an indicator of a municipality's ability to finance capital expenditures. Table 9-4 shows that 1999 reserves per household

Table 9-3 Municipal Debt per Household, Ontario, 1989 to 1999

Year	Toronto	Urban Regions	Rural Regions	Counties	Districts	Provincial Total
1989	$865	$974	$571	$608	$757	$809
1990	$811	$891	$533	$594	$719	$759
1991	$1,154	$1,124	$495	$621	$722	$931
1992	$1,164	$1,204	$487	$643	$701	$968
1993	$1,381	$1,176	$503	$691	$608	$1,015
1994	$1,355	$1,046	$536	$686	$629	$961
1995	$1,371	$1,000	$637	$669	$620	$944
1996	$1,194	$984	$652	$683	$582	$902
1997	$954	$1,025	$679	$696	$520	$866
1998	$1,142	$908	$636	$724	$500	$868
1999	$1,153	$872	$703	$720	$476	$856

Source: Ontario, Ministry of Municipal Affairs and Housing, 2001, MARS database.

range from a low of $1,159 in the counties to a high of $2,967 in urban regions. The debt/reserve ratio is always below 100%, reflecting the fact that municipalities have more reserves than debt.

The amount of money in reserves and reserve funds in Ontario municipalities has increased over the last ten years, as table 9-4 shows.[122] On a per household basis, reserves and reserve funds have almost doubled province-wide. The largest reserves per household are in the urban regions, but there are also significant reserves in the rural regions, districts, and counties. The rate of increase has been somewhat larger in rural regions and districts than in other parts of the province. There appears to be a significant jump from 1997 to 1998 (the year of the local services realignment).

9.2 Observations About Financial Performance

In 1998, Ontario municipalities went through a number of changes, which can be summarized as follows:

- *Local Services Realignment* The province transferred full funding responsibility for water, sewage, roads, transit, social housing, public health, and ambulances to municipalities. It also downloaded more responsibility for social services to municipal governments. (In 1999,

Table 9-4 Reserves and Reserve Funds per Household, Ontario, 1989 to 1999

Year	Toronto	Urban Regions	Rural Regions	Counties	Districts	Province
1989	$940	$1,520	$555	$520	$581	$986
1990	$1,115	$1,637	$605	$560	$633	$1,088
1991	$1,078	$1,693	$659	$602	$644	$1,116
1992	$1,073	$1,768	$731	$637	$668	$1,158
1993	$971	$1,865	$761	$693	$742	$1,196
1994	$968	$1,999	$789	$752	$782	$1,269
1995	$970	$1,986	$798	$782	$887	$1,283
1996	$982	$2,065	$897	$808	$1,012	$1,336
1997	$989	$2,232	$946	$872	$1,084	$1,428
1998	$1,520	$2,613	$1,208	$1,120	$1,200	$1,784
1999	$1,289	$2,967	$1,370	$1,159	$1,204	$1,887

Source: Ontario, Ministry of Municipal Affairs and Housing, 2001, MARS database.

[122] Note that these are total reserves and reserve funds of the municipality and not just for water and sewers.

however, the province took back some responsibility for funding ambulances and public health.) In return, the province took over complete funding of elementary and secondary school education (prior to the downloading, the province funded about 40% of the cost of education, while 60% was funded by property taxes levied by school boards).

- *Municipal Restructuring* A number of municipalities were amalgamated in the late 1990s. The number of municipalities in Ontario was reduced from 815 in 1996 to 471 in 2001. The impact of these amalgamations on municipal costs and property taxes is still being debated.

- *Property Tax Reform and Property Tax Freezes* Effective January 1, 1998, the province reformed property taxes across Ontario, resulting in a uniform assessment system based on current property value. Although the reform did not have an impact on overall property tax revenues, it resulted in a redistribution of property taxes within municipalities. At the same time, many municipalities across the province chose to freeze property taxes. This meant that property tax rates did not increase on an annual basis in many municipalities, even though there was some inflation over the period.

It is impossible to isolate the impact of any one of these changes on a municipality's financial viability, since they all took place at the same time. Furthermore, since municipalities collect information only on expenditures and revenues, not on the state of their infrastructure, it is difficult to know the extent to which they might have let their infrastructure deteriorate to avoid incurring borrowing costs or raising property taxes. What can be known from the data is that operating and capital expenditures per household in constant dollars for water and sewage services were lower in 1998 and 1999 than they had been in earlier years. Provincial grants for water and sewage services were also lower in these two years.

The available information on municipal financial performance indicates that municipalities in Ontario do not incur much debt and have a large amount in reserves. Even after the changes in 1998, reserves per household continued to rise in aggregate. As noted earlier, municipalities have shown increasing reluctance to borrow over the last ten years, so debt per household remains fairly low.

Municipal dependence on provincial grants has fallen, but is still significant in the counties and rural regions. Provincial grants have decreased in the last couple of years, especially for water and sewage capital expenditures, as have both operating and capital expenditures (in constant dollar terms) on water and sewage services.

Provincial grants for water and sewage operating expenditures have always been very small in Ontario (accounting for only 5% of revenues). Provincial capital grants have been more significant, however. If these grants were eliminated, municipalities would likely increase their borrowing. The information provided suggests that they do have room to borrow within provincial guidelines. The issue for municipalities is the extent to which annual debt charges will crowd out other municipal operating expenditures.

10 Summary

This final section presents a summary of some of the more important points in the paper.

The available information on the demand for water suggests the following:

- Water systems are designed to meet both individual demand for potable water and public demand for firefighting. Firefighting can represent a significant component of the demand for capacity, especially in smaller municipalities.

- Residential demand for water depends on a number of factors, including the price of water, the size of the household, the size of the lot, the household's income, and the local climatic conditions.

- Industrial demand for water depends on both the type of business activity carried out and the production techniques employed.

- Municipalities contemplating changes in the price of water and future capital investment are concerned with price elasticity (the extent to which the demand changes in response to prices changes). Residential water demand is relatively inelastic, that is, insensitive to price changes. Industrial demand is more price-sensitive.

- Municipalities that use meters consume less water per capita than those that do not. Meters are, of course, necessary for volumetric pricing arrangements.

The available information on the supply of water suggests the following:

- Water supply is capital-intensive. The cost of building modern water systems is currently estimated to be approximately $4,000 per capita (not including sewage systems), making water systems significantly more capital intensive than other utilities.

- Annual operating and maintenance costs, as well as ongoing administrative costs, need to be recovered if the water system is to be sustainable over the long term.

- Minimizing costs does not simply mean lowering operating costs. Efficiency requires that total costs, including both capital and operating costs, need to be minimized – without compromising the quality or quantity of production.

- Municipalities need to know the full cost of providing water service. Many municipalities, however, do not have a complete inventory of the components of their buried infrastructure; nor do they know the condition of these assets. Without this information, municipalities cannot determine the life expectancy of their water systems – nor can they anticipate the timing or cost of capital investments needed for renewal or replacement.

User fees, or water rates, are the most important source of operating revenue that municipalities use to fund water and sewage services. Legislative provisions for setting municipal water and sewer rates in Ontario are quite general, and therefore permissive with respect to the rate structure and the means of recovering costs. There are no codified guidelines for setting rates; nor is there any senior government involvement, regulatory or otherwise, in municipal rate setting. Municipalities are free to select user-rate formats that suit local conditions and to set specific fees for services as they see fit. Provincial statutes are more restrictive, however, regarding the use of development charges and borrowing.

In general, Ontario municipalities calculate water rates on the basis of average costs.

Average cost pricing is the most commonly used method for determining price in Ontario. From an efficiency perspective, there are drawbacks to this method;

where unit costs decline as output increases, for example, the price will be too high and the amount of water produced too low. On the other hand, while economic theory suggests that marginal cost pricing is the most efficient approach, implementing it can be difficult, if not impossible, in the case of water and sewage services. For example, modifications may be required because of a lack of information about the cost of supply or about customer demand (e.g., because there are no water meters).

The average cost and marginal cost pricing methods are simply tools for setting rates. A more important concern is what costs are covered by these rates; for example, has the municipality included charges for debt repayment? for capital repairs? While most Ontario municipalities currently appear to be able to recover their budgeted costs, these costs may not reflect the full costs of ensuring sustainable water service over the long term. A municipality may have proper pricing for current service but poor infrastructure because it is not spending the money needed to keep the system performing well over the long term. Simply adjusting water rates, however, does not guarantee increased reliability of service or improved safety.

A review of water and sewage operating expenditures shows that they have generally kept pace with inflation and the growth in population over the past decade. In 1998 and 1999, however, water and sewage expenditures per household, measured in constant dollars, fell. It is too soon to tell whether these two years represent a trend.

The sources used to finance water and sewage capital expenditures differ in terms of the population responsible for bearing the burden of the expenditure: past, present, or future generations. Capital expenditures may be financed from a municipality's own sources, including property taxes, user fees, borrowing, development charges, and special assessments. Capital expenditures can also be financed from grants from senior levels of government. When these grants are conditional, they may distort local decision making because they provide financial assistance not available for other services. However, provincial grants as a percentage of municipal water and sewage capital expenditures have declined dramatically over the last ten years. This decline has put pressure on municipalities to use development charges for growth-related expenditures and to finance rehabilitation or renewal through borrowing, property taxes, and user fees. In Ontario, water and sewage capital expenditures as a percentage of total municipal capital expenditures were lower in 1998 and 1999 than they were in any of the previous eight years.

One of the major factors that contributes to a high quality water supply service is realistic budgeting based on complete information about assets and operations. Knowing how long various assets will last, and their condition, is key to determining the costs of infrastructure repair and replacement. Asset information drives water pricing, which in turn drives budgeting, cost recovery, and financing. Because much of water and sewage infrastructure is under ground, its condition is not easily discerned; when the condition of the buried infrastructure is not fully known, there is uncertainty about what costs might be incurred to replace it, and when. In the absence of information about municipal infrastructure condition, municipalities are unable to monitor their financial performance over the long term. Without better information there is also no way to support or refute claims in the literature about an impending infrastructure deficit. This is not to say that the deficit does not exist, but that no data are available to prove that it exists.

The current municipal accounting system is the modified accrual method. An alternative is the full accrual method. Both methods recover capital costs through user fees and charges; they differ in the treatment of debt service costs and the use of depreciation. The full accrual method matches benefits with costs over the service life of an asset and requires that costs be fully recovered each fiscal year. Introducing the full accrual method, however, would likely entail a significant cost for those municipalities that have incomplete infrastructure inventories, since complete inventories and information about asset ages are needed in order to value the assets and determine depreciation charges.

Available information on the financial performance of Ontario municipalities suggests that they do not incur much debt and have a large amount in reserves. Provincial guidelines require that municipal debt charges not exceed 25% of own-source revenues, and most municipalities are well within this guideline. The size of reserves and reserve funds is an indicator of a municipality's ability to finance capital expenditures; on a per household basis, total municipal reserves and reserve funds across the province have almost doubled in the last ten years.

Moreover, municipal dependence on provincial grants has declined over the last ten years. Provincial grants for water and sewage operating expenditures have always been very small (accounting for 5% of revenues), while provincial capital grants have been more significant. If these were eliminated, municipalities would likely have to increase their borrowing.

In 1998, Ontario municipalities went through a number of changes: local services realignment, municipal restructuring, and property tax reform. It is impossible to isolate the impact of any one of these changes on the financial viability of the province's municipalities, since all of the changes took place at the same time. Furthermore, municipalities collect information only on expenditures and revenues, not on the state of their infrastructure. For this reason, it is difficult to know the extent to which municipalities might have let their infrastructure deteriorate to avoid borrowing costs or property tax increases.

Affordability of municipal drinking water is an issue that is often raised. Determining affordability usually involves comparing the annual amount spent on water and sewage services with the incomes of local households. Affordability, however, may not be an appropriate objective for municipalities when *setting* water rates, since there is no logic to subsidizing low-income families' water bills using payments from other water customers rather than general tax revenues; in fact, this practice violates the 'benefits received' component of equity. A distinction should be made between ability to pay, that is, whether or not customers can pay for the service, and willingness to pay, which reflects customer purchasing behaviour relative to price. Consumers may demonstrate a reluctance to pay a given price for water even if the price is economically justified.

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